State of Utah

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Department of
Environmental Quality

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DIVISION OF RADIATION CONTROL
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Director

MEMORANDUM

TO: File

THROUGH: Phil Goble, Compliance Section Manager PRG 2/10/14

FROM: Tom Rushing, P.G. TR 2/10/14

DATE: February 10, 2014

SUBJECT: ES December 26, 2013 Ground Water Protection Level Modification Request and Return to Baseline Monitoring Frequency Request: DRC Findings

Summary:

EnergySolutions ("ES") submitted a December 26, 2013 request ("Request") to the Director of the Utah Division of Radiation Control ("Director") to modify Ground Water Protection Levels ("GWPL's") for nine parameters in the current Utah Ground Water Quality Discharge Permit, Permit No. UGW450005 ("Permit"), and to return ten parameters to baseline monitoring frequency based on the proposed modified GWPL's (pending approval by the Director and inclusion in the Permit) or based on monitoring data results below the GWPL since the original non-compliance (Copy of the ES Request is included as attachment D of this memorandum). The proposed modifications were submitted for Utah Division of Radiation Control ("DRC") review and Director Approval. DRC notes that any modifications of GWPLs are required to be included in the Permit and are subject to public notice and participation protocols as required by Utah Rules and Regulations prior to such inclusion.

A summary of the proposed GWPL modifications and current accelerated monitoring status, Probable-Out-of-Compliance ("POOC") Status or Out-of-Compliance ("OOC") Status, are summarized on Table 1 below:

Table 1 – ES Proposed Permit Modifications

Well Number	Parameter	Current GWPL	Proposed GWPL	Current Accelerated Monitoring Frequency	Baseline Monitoring Frequency
GW-24	Selenium	0.05 mg/L	0.0534 mg/L	Quarterly-POOC	Annual
GW-26	Thallium	0.002 mg/L	0.00255 mg/L	Monthly-OOC	Annual

Well Number	Parameter	Current GWPL	Proposed GWPL	Current Accelerated Monitoring Frequency	Baseline Monitoring Frequency
GW-100	Thallium	0.002 mg/L	0.00422 mg/L	Monthly-OOC	Annual
GW-103	Selenium	0.05 mg/L	0.0580 mg/L	Monthly-OOC	Annual
GW-137	Sum of Radiums	5 pCi/L	5.54 pCi/L	Monthly-OOC	Annual
GW-137	Total Uranium	0.03 mg/L	0.0371 mg/L	Monthly-OOC	Annual
GW-138	Sum of Radiums	5 pCi/L	5.51 pCi/L	Quarterly-POOC	Annual
GW-138	Selenium	0.05 mg/L	0.0695 mg/L	Monthly-OOC	Annual
GW-141	Selenium	0.05 mg/L	0.0705 mg/L	Monthly-OOC	Annual
P3-95 NECR	Thallium	0.002 mg/L	NA	Quarterly-POOC	Annual

Source and Contamination Assessment

The Permit Part I.G.3.b Source and Contamination Assessment Study Plan states "– *within 30 days of the verbal notice to the Director required in Part I.G.3.a of this Permit, the Permittee shall submit for Director approval an assessment study plan and compliance schedule for:*

1. *Assessment of the source or cause of the contamination and determination of steps necessary to correct the source.*
2. *Assessment of the extent of the ground water contamination and any potential dispersion.*
3. *Evaluation of potential remedial actions to restore and maintain ground water quality and ensure that the ground water standards will not be exceeded at the compliance monitoring wells, and best available technology will be reestablished.*"

The following Source and Contamination Assessment Study Plans ("SAP's") were received by DRC (Copies of the ES SAPs are included as Attachment C of this memorandum). DRC notes that SAP's have been submitted for all of the requested wells/parameters in OOC status as required. Selenium in monitoring well GW-24 is currently in POOC status, however this parameter/well has been in OOC status in the past and a summary of past ES studies and response to DRC request for more information related to source of the GWPL exceedances is included on Table 2 below. The table below also includes a summary of the findings of the SAP's:

Table 2 – Summary of ES Source and Assessment Study Plans

Monitoring Well No.	Parameter	Date of Report	Summary of ES Findings
GW-26	Thallium	10/26/2012	Flow in the area appears to have been impacted by local groundwater mounding. ES states that the thallium concentrations are likely due to background influences or analytical

Monitoring Well No.	Parameter	Date of Report	Summary of ES Findings
			uncertainty.
GW-100	Thallium	10/26/2012	ES SAP uses groundwater travel times for thallium to arrive at point of exposure (calculated 106 years) from the Class A Cell to determine that the discharge from the facility is not the source. Waste had only been disposed at the Class A Cell for 12 years at the time of the SAP. SAP states that thallium is likely due to background groundwater concentrations considering low values of analytical results and Ground Water Protection Levels,
GW-103	Selenium	10/26/2012	ES SAP notes that a correlation appears to exist between changing groundwater elevations and selenium concentrations at monitoring well GW-103. The SAP also notes that wastes have not been placed hydraulically up gradient from monitoring well GW-103. The SAP states that selenium concentrations are likely due to dissolution/desorption in the aquifer matrix.
GW-141	Selenium	10/26/2012	ES SAP states that selenium in monitoring well GW-141 is not due to discharges from the site as confirmed by calculated groundwater travel times for selenium to the point of exposure (over 2,000 years), and is likely due to fluctuation of background concentrations.
GW-24	Selenium	8/28/2007	ES SAP states that selenium in monitoring well GW-24 is not due to facility impacts based on calculated groundwater travel times (100+ years). The SAP states that the likely cause of Se OOC is a change in laboratory method. DRC issued a request for information letter (dated February 28, 2008) based on the ES SAP claims.

Monitoring Well No.	Parameter	Date of Report	Summary of ES Findings
GW-24	Selenium	3/28/2008 – Additional Info Response to DRC Request for Information	ES submitted additional information regarding the new method employed showing that a lower detection limit was established. Argues that selenium is present in the aquifer matrix and is readily soluble. Notes that low concentrations of selenium are disposed of in waste impoundments at Clive.
GW-137	Sum of Radiums	2/29/2012	ES SAP states that radium in monitoring well GW-137 is not due to EnergySolutions operations based on calculated groundwater travel times (235 years + for unretarded constituent). SAP states that OOC is likely caused by background fluctuation based on range of concentrations.
GW-137	Uranium	11/27/2012	ES SAP uses ground water flow directions and groundwater velocities and transport to argue that waste disposal is not the source of the OOC. Based on the evaluation ES states that the U concentrations at GW-137 are likely due to background groundwater fluctuations.
GW-138	Selenium	1/26/2012	ES SAP details groundwater gradients and calculated groundwater velocities based on available information. SAP study concludes that selenium concentrations in monitoring well GW-138 are likely due to background groundwater fluctuations.

DRC staff noted that EnergySolutions Request additionally provides the following statements and references indicating that the parameter exceedances are due to fluctuating background concentrations:

- *"They are associated with relatively new monitoring wells located north and east of the Class A West embankment. These wells were completed in the summer of 2009 and background-based GWPL exceptions have not yet been established for them. These new wells replaced similar GWPL exceptions (e.g. GW-113 total uranium and Ra-226 + Ra-228)."*

- *"They are background levels of thallium. In December 2009, the Division of Radiation Control (DRC) added thallium as a monitoring parameter to the GWQDP because the Utah Water Quality Board had recently established a protection level for it. The drinking-water-based universal GWPL for thallium, 0.0002 milligrams per liter (mg/L), is equal to the analytical minimum detection limit (MDL). The combination of background levels of thallium and a universal GWPL established at the limit of detection contribute to the observed thallium exceedances."*
- *"As documented in the Comprehensive Groundwater Quality Evaluation Report, (CD12-0308; EnergySolutions, 2012a), EnergySolutions has thoroughly characterized background groundwater quality at the Clive facility. Continued accelerated monitoring of background conditions is not necessary for protection of human health and the environment."*

DRC notes that the *ES Comprehensive Groundwater Quality Evaluation Report* was dated December 10, 2013 and was submitted as required by Part I.H.22 of the Permit and was due to be submitted 180 days prior to Permit expiration. As of the date of submittal of the ES Request, DRC has not conducted review of the *ES Comprehensive Groundwater Quality Evaluation Report* nor had the opportunity to issue comments and concerns regarding the document.

Based on DRC review of the ES SAPs for the OOC parameters/wells, DRC concurs that the sources of the exceedances are most likely due to fluctuations in background groundwater geochemistry or are due to analytical uncertainty in the data results. DRC performed an independent review of potential concentration trends for the POOC and OOC parameters below.

Trend Analysis

DRC noted that none of the above summarized ES SAP's included an evaluation of concentration trends. DRC performed trend analysis using historical groundwater data plots for each of the OOC/POOC wells as follows:

Selenium Monitoring Well GW-24

Per past correspondence with ES regarding OOC status for selenium at monitoring well GW-24, it was noted that an increasing trend is evident for the well/parameter (Figure 1) when data was plotted using all historical values (since 1992) and the most recent data through the fourth quarter of 2012.

Figure 1 – Data Plot and trend-line for Selenium Data in Monitoring Well GW-24 (1992 through 2012 Analytical Data Results)

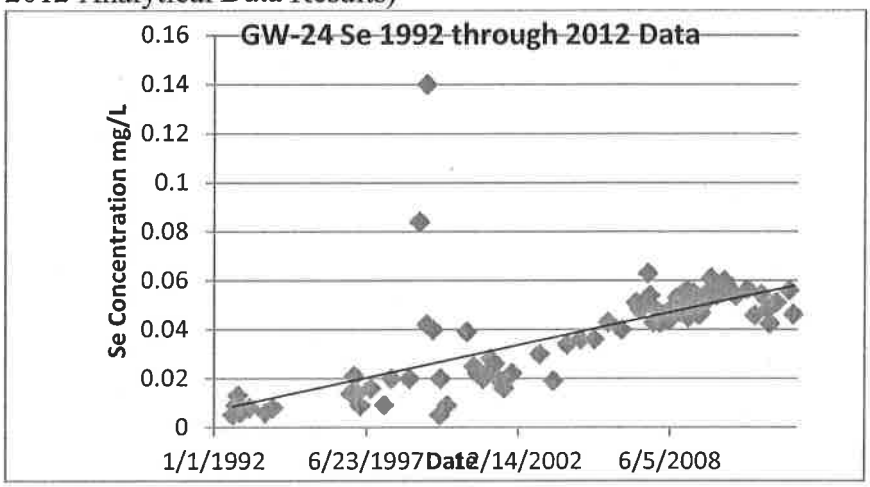
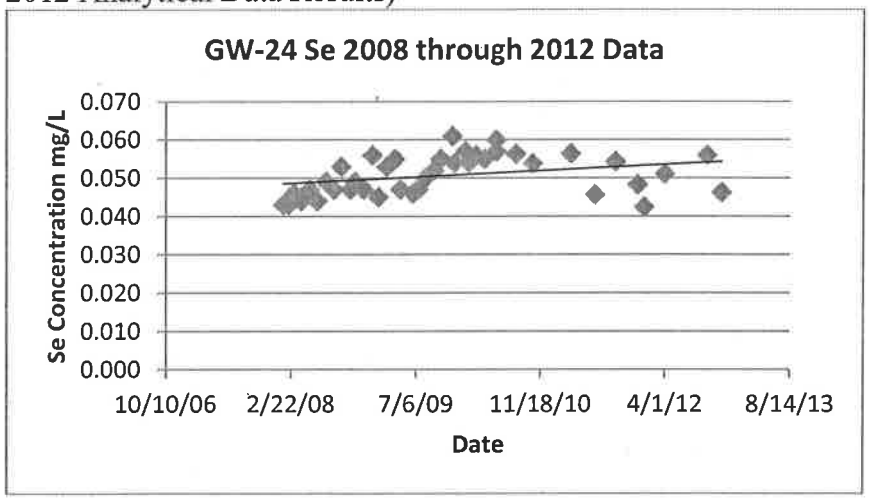


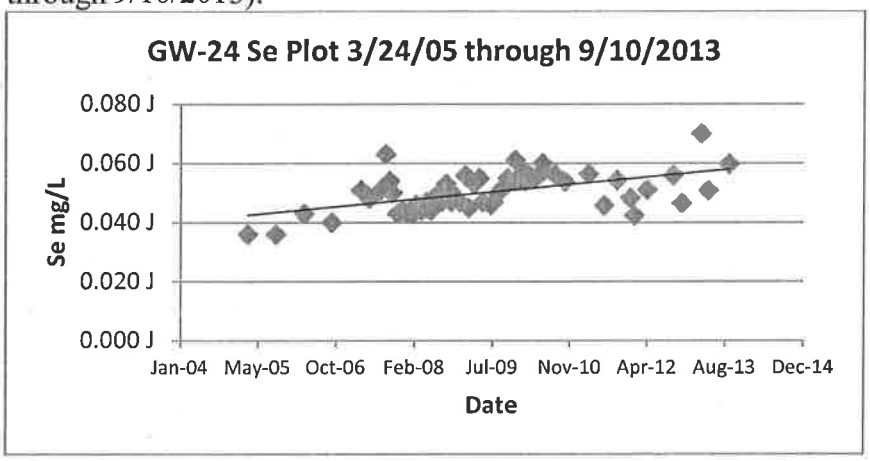
Figure 2 uses only more recent analytical results 2008 through the last quarter of 2012. DRC notes that the plot of only more recent data (five consecutive years of data), Figure 2, shows a relatively flat trend-line, indicating that the concentrations of selenium in the well have stabilized (since a site wide change in laboratory method for selenium).

Figure 2 – Data Plot and Trend-line for Selenium Data in Monitoring Well GW-24 (2008 through 2012 Analytical Data Results)



DRC notes that for the calculation of the revised Se GWPL in the report, ES used data spanning from 3/24/2005 until 9/10/2013. A plot of these data is additionally provided as Figure 3 below:

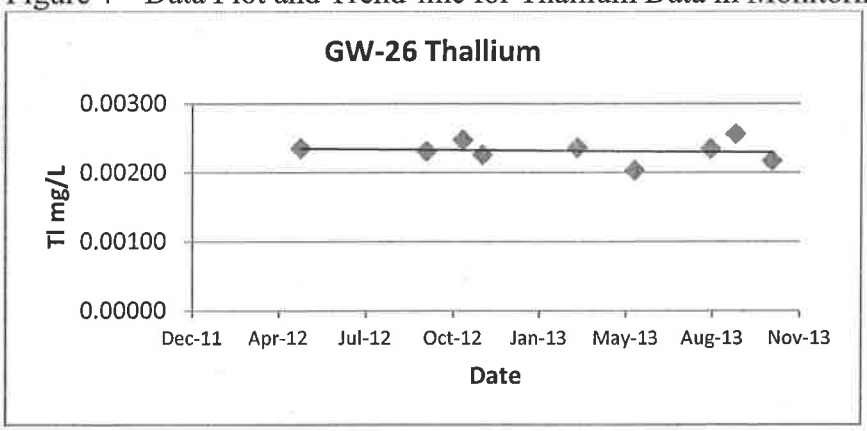
Figure 3 – Data Plot and Trend-line for Selenium Data in Monitoring Well GW-24 (3/24/2005 through 9/10/2013).



Thallium Monitoring Well GW-26

DRC notes that for thallium in monitoring well GW-26, 16 data results were collected between 5/26/2011 and 10/21/2013, and that 7 of the data results were non-detected concentrations (<0.002 mg/L). Per review of a plot of the remaining 9 detected concentrations, no trend is evident (Figure 4). Based on this, and the SAP findings, it is appropriate to adjust the GWPL for Tl in monitoring well GW-26. DRC notes that ES used the Kaplan-Meier method to develop the proposed modified GWCL since there was a large number of non-detects in the data set. These calculations are discussed in the section below.

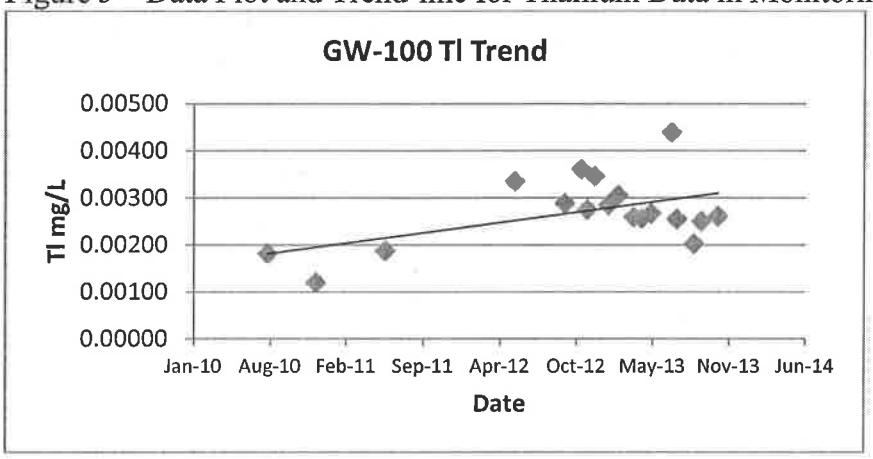
Figure 4 – Data Plot and Trend-line for Thallium Data in Monitoring Well GW-26



Thallium Monitoring Well GW-100

Per DRC review of the thallium data plot (Figure 5) which included data collected from 12/1/2009 through 10/24/2013, a slight increasing trend is noted, however the trend line is basically flat. The data set included 21 results with 3 non detected concentrations (<0.002 mg/L). Based on review of the SAP and data plot it appears appropriate to adjust the GWPL for Tl at monitoring well GW-100.

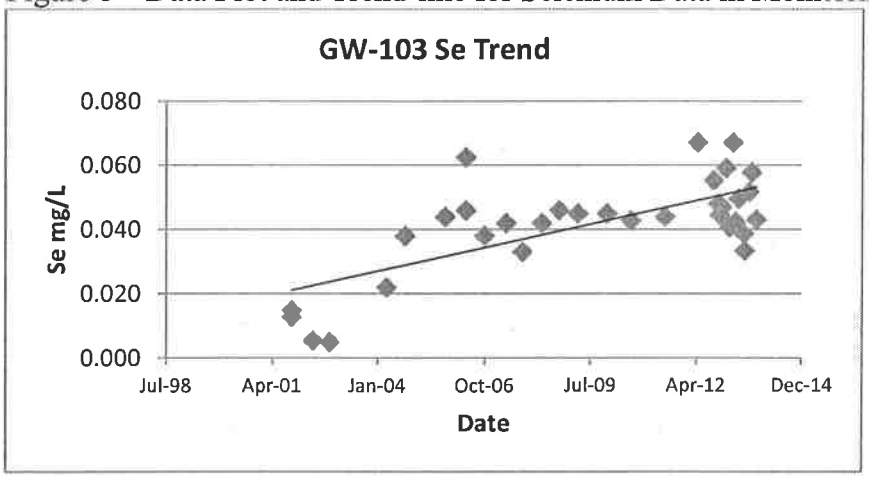
Figure 5 – Data Plot and Trend-line for Thallium Data in Monitoring Well GW-100



Selenium Monitoring Well GW-103

Per review of a selenium data plot (Figure 6) in monitoring well GW-103 (3/30/2005 through 10/24/2013) it appears that the data trend is slightly increasing. Based on review of the SAP and data plot it appears appropriate to adjust the GWPL for Se at monitoring well GW-103.

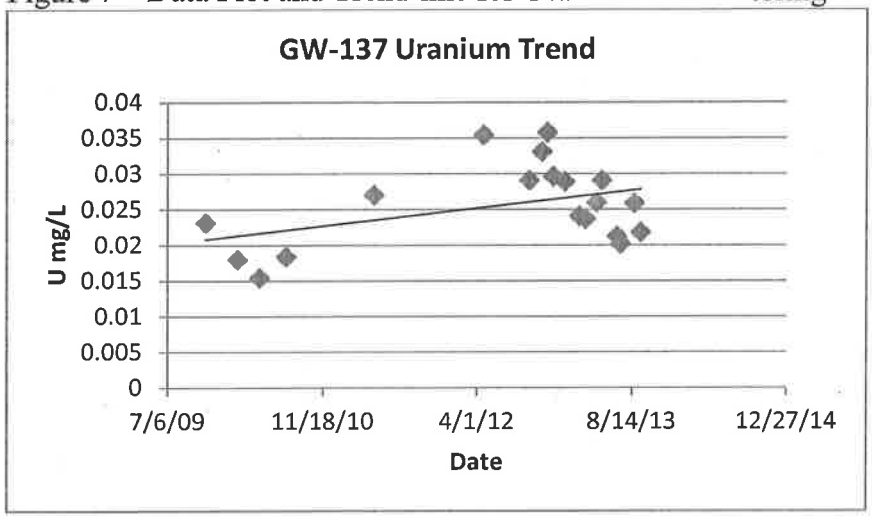
Figure 6 – Data Plot and Trend-line for Selenium Data in Monitoring Well GW-103



Uranium Monitoring Well GW-137

Per review of the uranium data plot (Figure 7) for monitoring well GW-137 (data from 11/5/2009 through 9/10/2013) a slight increasing trend was noted. Based on review of the SAP and plot it appears appropriate to adjust the GWPL for uranium at monitoring well GW-137.

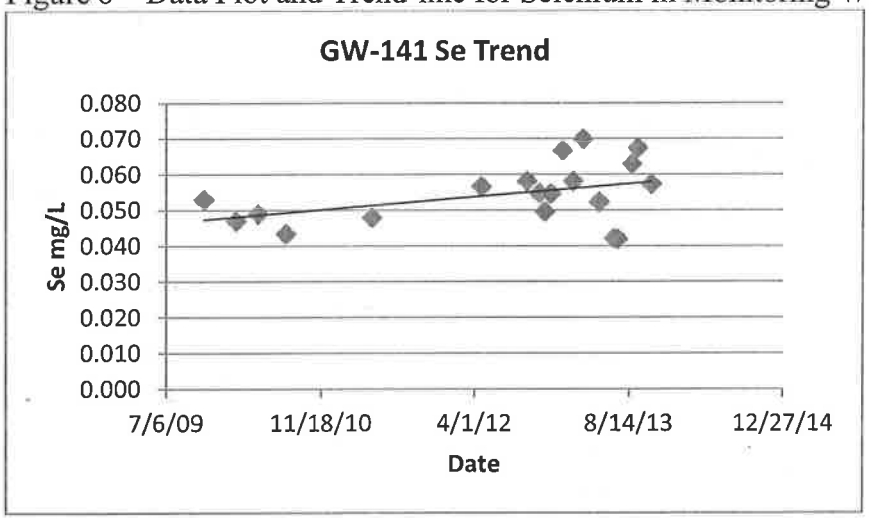
Figure 7 – Data Plot and Trend-line for Uranium in Monitoring Well GW-137



Selenium Monitoring Well GW-141

Per review of the data plot (Figure 8) for selenium in monitoring well GW-141 (data from 11/5/2009 through 10/24/2013) the trend-line is essentially flat. Based on review of the SAP and data plot it appears appropriate to modify the selenium GWCL at monitoring well GW-141.

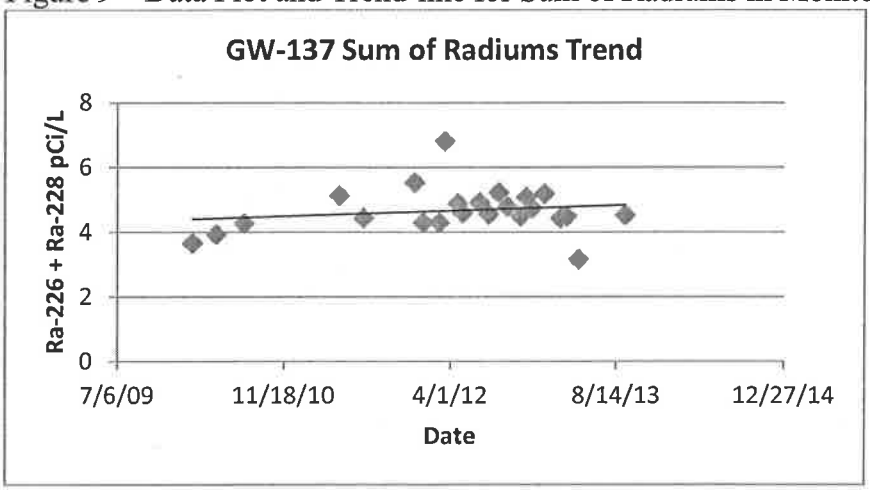
Figure 8 – Data Plot and Trend-line for Selenium in Monitoring Well GW-141



Ra-226 + Ra-228 Monitoring Well GW-137

Based on review of the data plot (Figure 9) for sum of radiums in monitoring well GW-137 (data results from 11/5/2009 through9/10/2013) the trend-line is essentially flat. Per review of the SAP and trend-line it appears appropriate to modify the GWCL for sum of radiums in monitoring well GW-137.

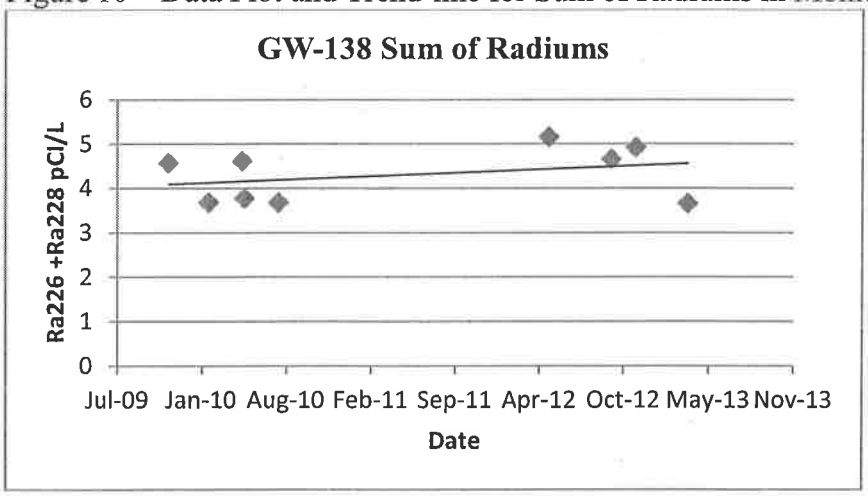
Figure 9 – Data Plot and Trend-line for Sum of Radiums in Monitoring Well GW-137



Ra-226 +Ra-228 Monitoring Well GW-138

Based on review of the data plot (Figure 10) for sum of radiums in monitoring well GW-138 (data results from 11/5/2009 through 3/18/2013) the trend-line is essentially flat. Per review of the SAP and trend-line it appears appropriate to modify the GWCL for sum of radiums in monitoring well GW-138.

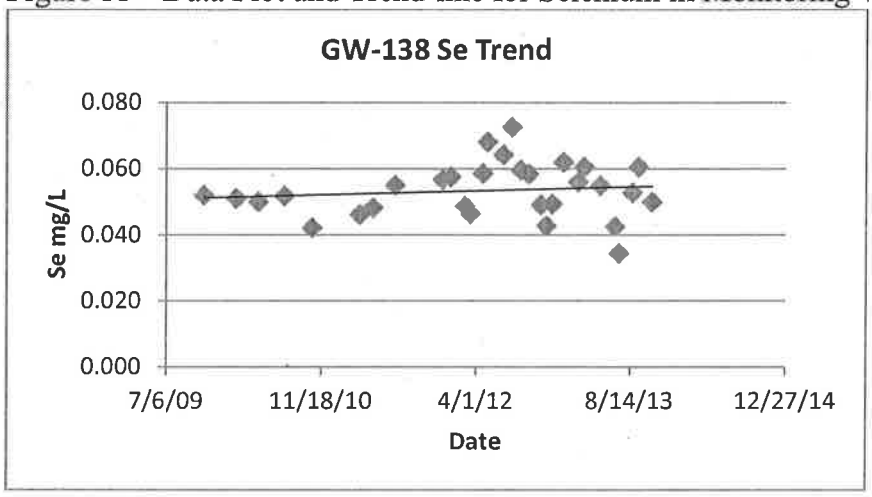
Figure 10 – Data Plot and Trend-line for Sum of Radiums in Monitoring Well GW-138



Selenium Monitoring Well GW-138

Based on review of the data plot (Figure 11) for selenium in monitoring well GW-138 (data from 11/5/2009 until 10/24/2013) the trend-line is essentially flat. Based on review of the SAP and data it appears appropriate to modify the GWCL for selenium in monitoring well GW-138.

Figure 11 – Data Plot and Trend-line for Selenium in Monitoring Well GW-138



DRC Review of ES Statistical Calculations, Tables, and Software

DRC staff noted that for all but one of the reviewed statistical evaluations conducted by ES the following tests were used for evaluation: Skewness and Kurtosis, Shapiro-Wilk, Anderson-Darling. In the case of thallium data for monitoring well GW-26 it was noted that of the sixteen data results, seven were non-detect, requiring the use of a statistical method which could account for a high proportion of non-detects. Therefore, for evaluation of thallium in monitoring well GW-26 ES used Kaplan-Meier variance and mean calculation.

1. *Review of Shapiro-Wilk Statistical Calculations and Data Sets:*

The Report included copies of a summary of statistical evaluation for each well where a modified GWCL was proposed. The summary sheets include a list of the data used for evaluation and a summary of critical values and calculation results. The Report also includes copies of data plots for each well where a modified GWCL was proposed. The plotted summaries include a bar histogram plot (and outlier box plot) and a normality plot, including linear evaluation. The plots were created using a computer program (Analyse-it) and also include summaries of mean, variance, skewness and kurtosis, Shapiro Wilk Statistic (W and p values), Median Range and quartile calculations. DRC noted that the information from the Analyse-it software was transcribed onto the ES summary sheets. A second sheet includes calculation of the Anderson-Darling critical values.

DRC staff conducted a cross check of the Shapiro-Wilk Statistical calculation for two wells/parameters (Selenium in Monitoring Well GW-24 and Uranium in Well GW-137). Copies of the summary spreadsheets for the DRC cross checks are included as Appendix A of this memo. Per the results of the cross checks the ES calculations and DRC calculations are in concurrence regarding calculations for mean + two standard deviations (95%).

No discrepancies regarding data sets used or method applicability were noted. It appeared that all data sets showed normal distribution after removal of outliers and or suspect data. DRC notes that outliers were identified at monitoring wells GW-103 Se (3 results) and GW-137 Ra226+ Ra228 (2 results). In both cases, all outliers removed were outside of 1.5 times the interquartile range and were removed prior to statistical analysis. These criteria for outlier removal are in conformance with the EPA Unified Statistical Guidance (2009).

Selenium data prior to January 5, 2009 was removed from the data set for monitoring well GW-24. ES notes that after removal of the suspect data (as discussed in the data trend section above), "*The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson Darling statistic is less than its critical value. Based on these results, selenium concentrations in groundwater at GW-24 are normally distributed, No outliers were identified or removed from the dataset.* The removal of the data appears to be appropriate based on the change of laboratory method (lowered detection limit) for selenium analysis at that time and an apparent subsequent shift (raising) of concentrations. DRC notes that even with removal of the pre January 5, 2009 data, there is over five years of data results used for statistical evaluation showing an essentially flat concentration trend.

Based on DRC review of the Request, it appears that the proposed modified GWCL's as listed on Table 4 below are appropriate.

2. *Kaplan-Meier Method for Thallium in Monitoring Well GW-26:*

GW-26 Thallium data set includes 16 total samples. Nine of the sixteen samples are detected concentrations, seven are non-detects. EFR states that in the case of GW-26 Thallium, the "*Kaplan-Meier method is used to calculate estimates of the mean and standard deviation that account for the left-censored (non-detected) measurements. Beal 2010 states that because the Kaplan-Meier method is nonparametric; it is more robust with fewer assumptions than Cohen's Adjustment, simple substitution, or maximum likelihood estimators when at least half the samples are detections.*"

DRC notes that the use of the Kaplan-Meier method for the left censored data set for thallium in monitoring well GW-26 is consistent with the US Environmental Protection Agency Unified Statistical Guidance (March 2009). The Kaplan-Meier method is considered a "censored estimation technique" wherein the data population size is weighted to include non-detects proportionately. Per the EPA 2009 Unified Statistical Guidance certain steps must be followed to ensure that the weighted data is normalized (censored probability plot). Per the EPA 2009 Unified Statistical Guidance, the Kaplan-Meier method is applicable where the data is left censored with probability that non-detected concentrations are due to constraints in analytical technology. Per DRC review of the data set used for monitoring well GW-26 thallium evaluation, it was noted that the detected data is in a similar range of non-detects and that the left censored data was therefore probably due to constraints related to the analytical technology/method.

Table 3 – Data Set Used for Kaplan-Meier Evaluation, GW-26 Thallium

Sample Date	Well No.	Parameter	Sample Result (mg/L)
5/26/2011	GW-26	Thallium	<0.00100
4/26/2012	GW-26	Thallium	0.00235
9/17/2012	GW-26	Thallium	0.00231
10/29/2012	GW-26	Thallium	0.00247
11/21/2012	GW-26	Thallium	0.00226
12/6/2012	GW-26	Thallium	<0.00200
1/28/2013	GW-26	Thallium	<0.00200
2/15/2013	GW-26	Thallium	<0.00200
3/11/2013	GW-26	Thallium	0.00236
4/2/2013	GW-26	Thallium	<0.00200 J
5/16/2013	GW-26	Thallium	0.00203
6/4/2013	GW-26	Thallium	<0.00200
7/9/2013	GW-26	Thallium	<0.00200
8/12/2013	GW-26	Thallium	0.00234 J
9/9/2013	GW-26	Thallium	0.00256
10/21/2013	GW-26	Thallium	0.00217

DRC noted that a summary of statistics, Analyse-it software, and data sheet was not included with the Request for the thallium statistical evaluation using the Kaplan-Meier method. DRC requested a copy of the summary or alternate calculation spreadsheet, in order to confirm the calculation and data set used. ES subsequently submitted a copy of the excel spreadsheet and guidance used to perform the calculation (electronically via e-mail on 2/4/2014).

DRC performed a cross check of the calculation for mean and standard deviation (Appendix B DRC Spreadsheet). Per findings of the cross check it appears that the calculations made by ES were appropriate. The proposed modified GWCL raises the current GWPL of 0.002 mg/L to 0.00255 mg/L (see also Table 4 below).

ES Request to Return Monitoring Well P3-95 NECR to Annual Baseline Monitoring Frequency

ES included a request for Director Approval to return monitoring well P3-95 NECR to baseline annual monitoring frequency with the Request. It was noted that thallium in monitoring well P3-95 NECR is currently in POOC status based on a single exceedance of the GWCL per sample results (0.00283 mg/L thallium) for a sample collected on May 24, 2012. ES notes that a total of twelve samples for thallium have been collected at monitoring well P3-95 NECR since its inclusion in the Permit with only the single exceedance for all twelve samples. ES argues that P3-95 NECR should be returned to baseline monitoring frequency based on:

- *The most recent five quarterly thallium results are less than the GWPL. DRC has previously approved requests to return wells to baseline monitoring status based on four and five consecutive quarterly results less than the GWPL (DRC, 2007).*

- *The POOC status is based on a single detection, and detections near the MDL are often spurious.*
- *Even if the single detection is a representative concentration, it is within the range of background concentrations observed in other wells where thallium is detected with some consistency.*
- *It is thallium. The only thallium isotope reported in the facility manifest inventory having a half-life greater than 12 days is Tl-204, with a half-life of 3.78 years. The inventory of Tl-204 in all embankments combined was reported as 907.7 milliCuries or 2.1 milligrams of thallium (CD12-0318; EnergySolutions, 2012b).*

DRC notes that although monitoring wells may have been returned to baseline monitoring in the past based on as few as four parameter laboratory results below the GWPL, it is DRCs policy to require at least eight monitoring results below the respective GWPLs prior to return to compliance monitoring. The justification for this requirement is to show a dependable representation that the parameter will not exceed the GWPL again and re-enter accelerated monitoring status and to demonstrate that the parameter is not displaying an increasing concentration trend.

Therefore, in order to be consistent with DRC policy and uniform with requirements imposed upon other Permittees in the State, DRC is requiring that at least eight consecutive thallium sample results be obtained below the GWPL prior to ES requesting Director Approval to return to baseline annual monitoring. The ES request for Director Approval may be re-submitted after this requirement is met.

Conclusions

Proposed Modified Permit GWPLs

Based on the Request and DRC findings listed above the proposed GWPL exceptions listed in Table 3 below are recommended for inclusion in an upcoming permit modification or renewal. Since the incorporation of the modified GWPLs constitutes raising the current compliance concentrations, the modification will be required to undergo a major modification process including public notice and hearing requirements. The current GWPLs remain in force until authorization (signed Permit) by the Director.

Table 4 – Proposed Modified GWPLs Recommended for Inclusion in the Permit

Well ID	Parameter	Units	Current GWPL	Proposed GWPL Exception	Embankment Location
GW-24	Selenium	mg/L	0.058	0.0634	LARW, 11e.(2)
GW-26	Thallium	mg/L	0.002	0.00255	11e.2
GW-100	Thallium	mg/L	0.002	0.00422	Class A
GW-103	Selenium	mg/L	0.05	0.0580	LARW
GW-137	Ra-226+Ra-228	pCi//L	5	5.54	Class A
	Total Uranium	mg/L	0.03	0.0371	Class A

GW-138	Ra-226 +Ra-228	pCi/L	5	5.51	Class A
	Selenium	mg/L	0.05	0.0695	Class A
GW-141	Selenium	mg/L	0.05	0.0705	Class A

ES Request to Return Thallium in Monitoring Well P3-95 NECR to Baseline Annual Monitoring Frequency

Per the Request and DRC findings as discussed above EnergySolutions requested that thallium at monitoring well P3-95 NECR be returned to baseline annual monitoring frequency based on five consecutive accelerated quarterly samples with results below the GWPL. In order to be consistent with DRC policy and to provide consistency regarding requirements for other DRC Permittees, it is required that at least eight accelerated samples with results below the GWPL be obtained prior to requesting Director approval to return to baseline (compliance) monitoring frequency. A letter will be drafted informing ES of the requirement. The request for Director Approval to return monitoring well P3-95 NECR to baseline annual monitoring may be resubmitted after the obtainment of eight samples with results below the GWCL.

References

Beal, D., 2010, *A Macro for Calculating Summary Statistics on Left-Censored Environmental Data using the Kaplan-Meier Method.* Paper SDA-09, Proceedings of the Southeast SAS Users Group (SESUG) 2010 Conference.

Singh, Anita, Armbya, Narain, Singh, Ashok, 2010, *Pro UCL Version 4.00.05 Draft Technical Guide*, Prepared for US EPA

Utah Division of Radiation Control, March 26, 2007, *Second Semi-Annual Groundwater Monitoring Report for 2005: Close out Letter and Approval to Return to Baseline Monitoring Frequency*, Letter from Dane L. Finerfrock, DRC, to Daniel B. Shrum, ES LLC.

U.S. Environmental Protection Agency (EPA), 2009, *Statistical Analysis for Groundwater Monitoring Data at RCRA Facilities (Unified Guidance)*, EPA 530/R-09-007, March 2009.

Appendix A – DRC Shapiro-Wilk Method Cross Check Spreadsheets

Shapiro Wilk (n<50) Method DRC Cross Check Data Entered 1/23/2014 TR

EnergySolutions Monitoring Well GW-24 Selenium Shapiro Wilk

i	x(i)	x(n-1+1)	x(n-i+1)^x(i)	a(n-i+1)	bi	Data mg/L
1	0.04	0.0698	0.0298	0.3751	0.0112	0.0698
2	0.0424	0.063	0.0206	0.2574	0.0053	0.063
3	0.043	0.061	0.018	0.2260	0.0041	0.061
4	0.043	0.06	0.017	0.2032	0.0035	0.06
5	0.043	0.0598	0.0168	0.1847	0.0031	0.0598
6	0.043	0.057	0.0168	0.1691	0.0028	0.057
7	0.044	0.0564	0.014	0.1554	0.0022	0.0564
8	0.044	0.0563	0.0124	0.1430	0.0018	0.0563
9	0.044	0.056	0.0123	0.1317	0.0016	0.056
10	0.045	0.056	0.012	0.1212	0.0015	0.056
11	0.0458	0.056	0.011	0.1113	0.0012	0.056
12	0.046	0.055	0.0102	0.1020	0.0010	0.055
13	0.046	0.055	0.009	0.0932	0.0008	0.055
14	0.0463	0.055	0.009	0.0846	0.0008	0.055
15	0.047	0.0543	0.0087	0.0764	0.0007	0.0543
16	0.047	0.054	0.0073	0.0685	0.0005	0.054
17	0.047	0.054	0.007	0.0608	0.0004	0.054
18	0.047	0.054	0.007	0.0532	0.0004	0.054
19	0.047	0.0538	0.007	0.0459	0.0003	0.0538
20	0.047	0.053	0.0068	0.0386	0.0003	0.053
21	0.048	0.053	0.006	0.0314	0.0002	0.053
22	0.0483	0.052	0.005	0.0244	0.0001	0.052
23	0.049	0.0511	0.0037	0.0174	0.0001	0.0511
24	0.049	0.051	0.0021	0.0104	0.0000	0.051
27	0.0507	0.051	0.002	0.0350	0.0001	0.051
28	0.051	0.0507	0.0003			0.0507
29	0.051	0.049	-0.0003			0.049
30	0.0511	0.049	-0.002			0.049
31	0.052	0.0483	-0.0021			0.0483
32	0.053	0.048	-0.0037			0.048
33	0.053	0.047	-0.005			0.047
34	0.0538	0.047	-0.006			0.047
35	0.054	0.047	-0.0068			0.047
36	0.054	0.047	-0.007			0.047
37	0.054	0.047	-0.007			0.047
38	0.0543	0.047	-0.007			0.047
39	0.055	0.0463	-0.0073			0.0463
40	0.055	0.046	-0.0087			0.046
41	0.055	0.046	-0.009			0.046
42	0.056	0.0458	-0.009			0.0458
43	0.056	0.045	-0.0102			0.045
44	0.056	0.044	-0.011			0.044
45	0.0563	0.044	-0.012			0.044
46	0.0564	0.044	-0.0123			0.044
47	0.057	0.043	-0.0124			0.043
48	0.0598	0.043	-0.014			0.043
49	0.06	0.043	-0.0168			0.043
50	0.061	0.043	-0.017			0.043
51	0.063	0.0424	-0.018			0.0424
52	0.0698	0.04	-0.0206			0.04
					total =	
					0.0436	

Standard Deviation Calculation:

Mean = 0.0508 Variables = 0.00187834

Standard Deviation = 0.006129176

W Statistic = 0.990814533 .01 Critical n(50) = 0.930

DRC Calculated Limit 0.0631

EnergySolutions Calculated Lim 0.0634

Shapiro Wilk (n<50) Method DRC Cross Check Data Entered 1/23/2014 TR

EnergySolutions Monitoring Well GW-137 Total Uranium Shapiro Wilk

i	x(i)	x(n-1+1)	x(n-i+1)^x(i)	a(n-i+1)	bi
1	0.0154	0.0358	0.0204	0.4808	0.0098
2	0.0179	0.0354	0.0175	0.3232	0.0057
3	0.0184	0.0331	0.0147	0.2561	0.0038
4	0.0202	0.0296	0.0094	0.2059	0.0019
5	0.0212	0.0291	0.0079	0.1641	0.0013
6	0.0218	0.0291	0.0073	0.1271	0.0009
7	0.023	0.0289	0.0059	0.0932	0.0005
8	0.0237	0.027	0.0033	0.0612	0.0002
9	0.0241	0.026	0.0019	0.0303	0.0001
10	0.0259	0.0259	0	0.0000	0.0000
11	0.026	0.0241	-0.0019		
12	0.027	0.0237	-0.0033		
13	0.0289	0.023	-0.0059		
14	0.0291	0.0218	-0.0073		
15	0.0291	0.0212	-0.0079		
16	0.0296	0.0202	-0.0094		
17	0.0331	0.0184	-0.0147		
18	0.0354	0.0179	-0.0175		
19	0.0358	0.0154	-0.0204		
					total =
					0.0242

Data mg/L
0.0358
0.0354
0.0331
0.0296
0.0291
0.0291
0.0289
0.027
0.026
0.0259
0.0241
0.0237
0.023
0.0218
0.0212
0.0202
0.0184
0.0179
0.0154

Standard Deviation Calculation:

Mean = 0.025557895 Variables = 0.000600646

Standard Deviation = 0.005622541

W Statistic = 0.926118595 .01 Critical n(19) = 0.863

DRC Calculated Limit 0.0368

EnergySolutions Calculated Lim 0.0371

Appendix B – DRC Kaplan-Meier Method Crosscheck Spreadsheet

Kaplan Meier Statistical Cross check

Data Entered: 2/4/2014

EnergySolutions Monitoring Well GW-26 Thallium

j	Y_j	$Y_{j-1}<X_i\leq Y_j$	m_j	n_j	$(n_j-m_j)/n_j$	$F(Y_j)$	a_j	mean	Std. Dev.
1	0.00203	<0.00100, <0.00200, <0.00200, <0.00200, <0.00200, <0.00200, <0.00200, 0.00203	1	8	0.8750	0.5000	7.000E-05	1.015E-03	1.306E-08
2	0.00217	0.00217	1	9	0.8889	0.5625	1.206E-04	1.356E-04	2.92275E-11
3	0.00226	0.00226	1	10	0.9000	0.6250	1.519E-04	1.413E-04	2.92196E-10
4	0.00231	0.00231	1	11	0.9091	0.6875	1.725E-04	1.444E-04	8.7579E-10
5	0.00234	0.00234	1	12	0.9167	0.7500	1.800E-04	1.463E-04	1.37595E-09
6	0.00235	0.00235	1	13	0.9231	0.8125	1.881E-04	1.469E-04	1.56767E-09
7	0.00236	0.00236	1	14	0.9286	0.8750	2.844E-04	1.475E-04	1.77188E-09
8	0.00247	0.00247	1	15	0.9333	0.9333	3.684E-04	1.441E-04	4.5204E-09
9	0.00256	0.00256	1	16	0.9375	1.0000		1.707E-04	9.04668E-09

Mean	0.00219
Std. Dev.	0.00018
Mean + 2α	0.00255

Data
ES GW-26
Thallium mg/L
<0.00100
<0.00200
<0.00200
<0.00200
<0.00200
<0.00200
<0.00200
0.00203
0.00217
0.00226
0.00231
0.00234
0.00235
0.00236
0.00247
0.00256

Attachment C – Copies of ES Source and Contamination Assessment Study Plans

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August 28, 2007 CD07-0275

Mr. Dane Finerfrock,Co-Executive Secretary
Utah Division of Water Quality
168 North 1950 West
P.O. Box 144850
Salt Lake City, Utah 84114-4850

Re: Selenium Out-Of-Compliance Monitoring at Monitoring Well GW-24, Groundwater Quality Discharge Permit UGW450005, Part I.G.

Dear Mr. Finerfrock:

A verbal notification was made to the Division of Radiation Control on August 22, 2007, regarding the out-of-compliance status for selenium in monitoring well GW-24. This letter provides additional information concerning elevated selenium concentrations including: all selenium data for GW-24, trending of selenium data with groundwater elevations, and an assessment as to the source, extent, and potential remedial actions in accordance with Condition I.G.3 of Energy*Solutions*' Groundwater Quality Discharge Permit UGW450005 (GWQDP).

Table 1 (attached) provides a summary of all selenium data collected at monitoring well GW-24. The sample collected on March 19, 2007, as part of the semi-annual monitoring program exceeded the Groundwater Protection Level (GWPL) of 0.050 mg/L by 0.001 mg/L. EnergySolutions provided verbal notification to Brian Hamos in April 2007 of a Probable Out-Of-Compliance (POOC) condition in accordance with Condition I.G.2.a. A quarterly sampling schedule was implemented in accordance with Condition I.G.2.b, with the first quarterly sample collected on May 9, 2007. The environmental sample collected with this event did not exceed the GWPL (result of 0.048 mg/L); however, the duplicate sample did exceed the GWPL (result of 0.056 mg/L). These results were received in June 2007, and Energy*Solutions* implemented an accelerated schedule of monthly sampling in accordance with Condition I.G.3.a.2. However, Energy*Solutions* did not provide verbal notification until August 22, 2007.

Energy*Solutions* has collected monthly samples on July 25 and August 23, 2007. Selenium results from the July 25, 2007, sampling event indicated continued exceedance at 0.051 mg/L. Analytical results for the August 23, 2007, sampling event have not been received.

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801.649.2000 • Fax: 801.321.0453 • www.energysolutions.com

Condition I.G.3.b. requires a Source and Contamination Study plan be submitted for Executive Secretary approval 30 days after verbal notification. This plan requires an assessment of the: 1) source or cause of the contamination, 2) Assessment of the extent of groundwater contamination, and 3) evaluation of potential remedial actions to restore and maintain groundwater quality. The remainder of this letter fulfills this requirement.

Source or Cause of the contamination

A plot of selenium data and groundwater elevations is provided as Figure 1. In previous exceedance issues, increasing groundwater elevations have been linked to increasing metals concentrations. The trends in Figure 1, however, do not support a correlation between selenium concentrations and groundwater elevations.

A contour map of groundwater elevation data for March 2007 is provided as Figure 2. Monitoring well GW-24 is located immediately downgradient from waste disposal activities in the 11e.(2) embankment. However, monitoring well GW-24 is over 100 feet from the edge of waste and given the slow groundwater flow velocities (1 to 2 feet per year), it is unlikely that cell leakage is the cause of the selenium exceedances.

A more plausible explanation for the observed exceedances is a change in analytical methods for selenium. Energy*Solutions'* laboratory, American West Analytical Laboratories (AWAL) located in Salt Lake City, phased out its Graphite Furnace/Atomic Absorption (GFAA) unit during the past few years. Energy*Solutions* was made aware of these proposed change and conducted correlation studies to demonstrate that the new methods would provide compatible data. Results suggested that the Inductively Coupled Plasma/Mass Spectrometry (ICP/MS, EPA Method 6020) provided results that were slightly elevated above the GFAA method, however, results were still below GWPLs. EnergySolutions switched analytical methods (with DRC approval) prior to the March 2005 sampling event. After the switch, analytical results for selenium at GW-24 have been at or close to the GWPLs (results of 0.04J, 0.04J, 0.04, 0.04, 0.051, 0.048, 0.056, and 0.051 mg/L). It appears that this new method may be the cause of the increases in selenium concentrations.

Assessment of the extent of groundwater contamination

Selenium data from the two closest monitoring wells GW-92 and GW-126 have selenium concentrations below the GWPLs of 0.05 mg/L. Recent results for selenium at GW-92 are 0.01 mg/L and at GW-126 are 0.04 mg/L. Therefore, there does not appear to be any

real extent of contamination.

Evaluation of potential remedial actions to restore and maintain groundwater quality

At this point in time, Energy*Solutions* suggests that monthly monitoring be continued to evaluate any trends. Results of the monthly monitoring will be included in semi-annual reports provided to the DRC.

Please contact me at 532-1330 with any questions regarding this submittal.

Sincerely,

Daniel B. Shrum
Vice President of Environmental Compliance and Permitting

Enclosures

cc: Brian Hamos, DRC (w/ encl.)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Table 1
Energy*Solutions*
Monitoring Well GW-24
Selenium Results

Date	Laboratory	Selenium Conc. (mg/L) GWPL = 0.05
1/9/92	AWAL	< 0.005
3/20/92	AWAL	0.006
4/2/92	AWAL	< 0.005
6/11/92	AWAL	< 0.005
7/9/92	AWAL	< 0.005
8/7/92	AWAL	< 0.005
9/3/92	AWAL	0.005
10/8/92	AWAL	0.009
11/6/92	AWAL	0.013
12/9/92	AWAL	0.006
1/15/93	AWAL	0.007
2/12/93	AWAL	< 0.005
3/10/93	AWAL	< 0.005
4/8/93	AWAL	0.008
5/13/93	AWAL	< 0.005
8/6/93	AWAL	< 0.005
11/4/93	AWAL	0.006
2/11/94	AWAL	0.008
4/30/94	AWAL	< 0.005
7/13/94	AWAL	< 0.005
10/5/94	AWAL	< 0.005
1/25/95	AWAL	< 0.005
4/6/95	AWAL	< 0.005
7/20/95	AWAL	< 0.005
10/10/95	AWAL	< 0.005
2/8/96	AWAL	< 0.005
10/24/96	AWAL	< 0.005
12/4/96	AWAL	0.014
1/15/97	AWAL	0.021
2/18/97	AWAL	0.014

Table 1
Energy*Solutions*
Monitoring Well GW-24
Selenium Results

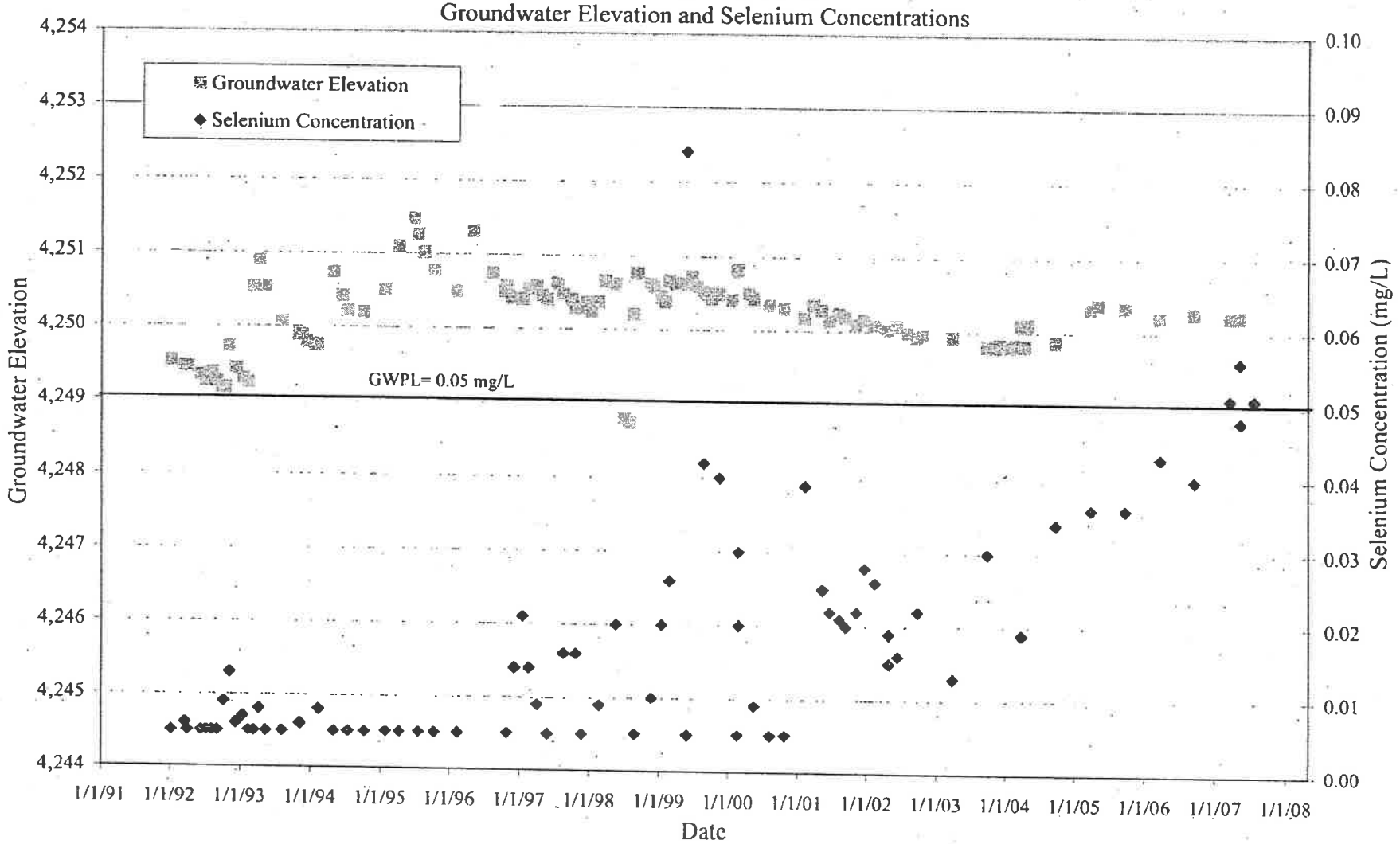
Date	Laboratory	Selenium Conc. (mg/L) GWPL = 0.05
3/31/97	AWAL	0.009
5/23/97	AWAL	< 0.005
8/19/97	AWAL	0.016
10/21/97	AWAL	0.016
11/20/97	MSA	< 1.0
11/20/97	AWAL	< 0.005
2/18/98	AWAL	0.009
5/18/98	AWAL	0.02
8/21/98	AWAL	< 0.005
11/18/98	AWAL	< 0.01
1/13/99	AWAL	0.02
2/24/99	MSA	< 2.6 J
2/24/99	AWAL	0.026
5/25/99	MSA	0.084
5/25/99	AWAL	< 0.005
8/24/99	MSA	0.140 J
8/24/99	AWAL	0.042
11/16/99	AWAL	0.040
2/17/00	AWAL	< 0.0050
2/25/00	AWAL	0.0200 J
2/25/00	AWAL	0.030 J
5/18/00	AWAL	0.0090
8/8/00	AWAL	< 0.0050
8/8/00	AWAL	< 0.0050
10/23/00	AWAL	< 0.0050
2/8/01	AWAL	0.04
5/10/01	AWAL	0.03
6/18/01	AWAL	0.02
6/18/01	AWAL	0.02
8/8/01	AWAL	0.02

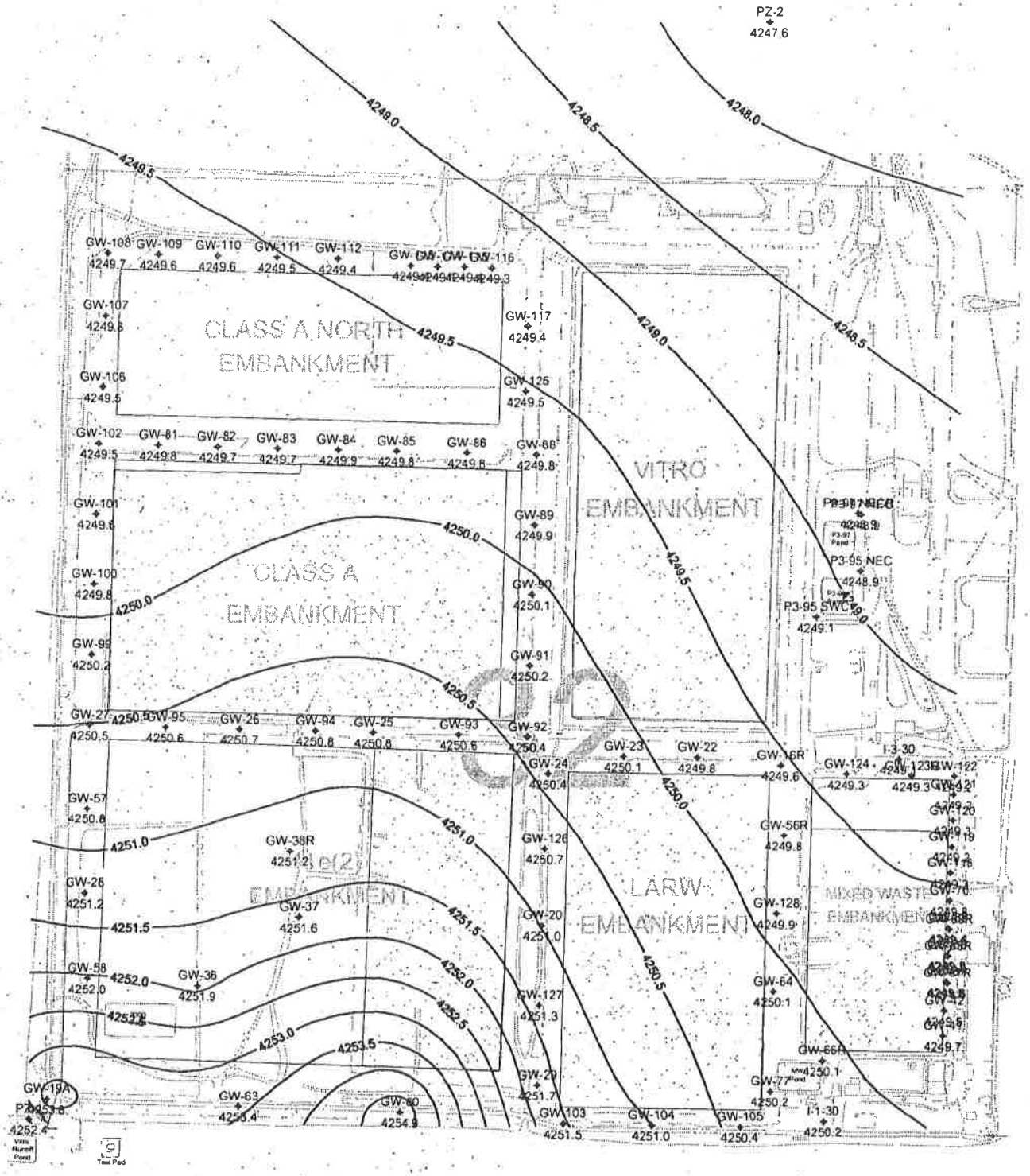
Table 1
Energy*Solutions*
Monitoring Well GW-24
Selenium Results

Date	Laboratory	Selenium Conc. (mg/L) GWPL = 0.05
9/10/01	AWAL	0.02
9/10/01	AWAL	0.02
11/6/01	AWAL	0.02
12/20/01	AWAL	0.03
2/12/02	AWAL	0.026
4/24/02	AWAL	0.019
4/24/02	AWAL	0.015
6/10/02	AWAL	0.016
6/10/02	AWAL	0.016
9/23/02	AWAL	0.022
3/27/2003	AWAL	< 0.013
9/25/03	AWAL	0.03
3/24/2004	AWAL	0.02
9/22/04	AWAL	0.03
3/24/05	AWAL	0.04 J
9/22/05	AWAL	0.04 J
3/22/06	AWAL	0.04
9/14/06	AWAL	0.04
3/19/07	AWAL	0.051
5/9/07	AWAL	0.048
5/9/07	AWAL	0.056
7/25/07	AWAL	0.051

Average	0.063
High	2.600
Low	0.005
# of Samples	82
Stan. Dev.	0.304
$\bar{X}$ + 2 Std Dev	0.671

Figure 1
EnergySolutions, LLC
Monitoring Well GW-24
Groundwater Elevation and Selenium Concentrations





ENERGYSOLUTIONS	DRAWN BY J. LOW	FIGURE 2	SCALE 1 in. = 833 ft.
	CHECKED BY --	SECTION 32	DATE 7/24/07
	APPROVED BY D. SHRUM	FRESH WATER GROUNDWATER CONTOUR MAP CLIVE, UTAH	MARCH 2007 WATER LEVELS

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ENERGYSOLUTIONS

January 26, 2012 CD12-0025

Rusty Lundberg, Co-Executive Secretary
Utah Water Quality Board
195 North 1950 West
P.O. Box 144850
Salt Lake City, UT 84114-4850

Re: Groundwater Quality Discharge Permit (GWQDP) UGW450005: Source and Contamination Assessment Study Plan for Selenium at Monitoring Well GW-138 – Request for Permit Modification

Dear Mr. Lundberg:

This letter provides the Source and Contamination Assessment Study Plan for the presence of background levels of selenium in groundwater at compliance well GW-138. Well GW-138 is located near the northeast corner of the Class A North (CAN) embankment. Selenium exceeded the universal groundwater protection level (GWPL) of 0.05 milligrams per liter (mg/L) in a sample collected on July 14, 2011 and the next quarterly sample collected on December 15, 2011. Notification of the out-of-compliance (OOC) status was provided to the Division of Radiation Control (DRC) by Energy*Solutions* via e-mail on December 30, 2011, and written notification was provided to DRC on January 4, 2012 (CD12-0003). Table 1 provides the timeline for sampling, detection, and notification of the groundwater exceedences.

Table 1
Timeline for Recent Selenium Exceedences at GW-138

Date	Event
7/14/2011	3rd Quarter 2011 POOC groundwater sample collected
10/06/2011	Results received, exceedence observed
12/15/2011	4th Quarter 2011 POOC groundwater sample collected
12/30/2011	Results received, second consecutive exceedence observed
12/30/2011	E-mail notification of OOC
1/04/2012	Written notification of OOC

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Well GW-138 was installed in July 2009, and has been sampled for selenium for ten consecutive quarters. Concentrations have ranged from 0.042 to 0.058 mg/L (Table 1-1, Attachment 1) and appear to be representative of background levels in shallow groundwater.

Energy*Solutions* hereby requests a modification of the GWQDP to provide an exception to the universal GWPL for selenium in well GW-138. Energy*Solutions* proposes an adjusted GWPL of 0.061 mg/L. The Technical Memorandum provided as Attachment 1 presents pertinent information on the statistical basis for this exception request, including: GW-138 selenium data, descriptive statistics, normality testing, and calculation of the GWPL exception. The balance of this submittal addresses the requirements of the Source and Contamination Assessment Study Plan listed in Part 1.G.3.b of the GWQDP.

Source Assessment: Attachment 2 consists of shallow groundwater elevation contour maps for December 2009, May 2010, and December 2010. These maps show a consistent northeast flow direction and consistent gradient in the shallow aquifer beneath the eastern half of the CAN embankment. Well GW-138 is cross-gradient from the Vitro embankment, and that cell therefore cannot be a potential source. Based on travel-time considerations, the Class A embankment also cannot be a potential source. In addition, contamination from the Class A embankment would be detected in monitoring wells located north of Class A, and selenium concentrations have remained below the GWPL in these wells.

Class A waste is currently disposed in the CAN embankment upgradient of well GW-138. The closest waste to GW-138 is approximately 570 feet southwest of the well. The average freshwater horizontal hydraulic gradient for the CAN embankment during 2010 was 5.67×10^{-4} ft/ft. The hydraulic gradient and effective porosity values used in the infiltration and transport model for CAN were 2.17 feet per day and 0.29, respectively. Using these values, the average horizontal linear velocity of groundwater in the shallow aquifer beneath the CAN embankment is 1.55 feet per year, and the travel time from the closest waste to well GW-138 for an unretarded constituent is approximately 360 years. Because waste disposal operations at the CAN embankment began in 2001, it is highly unlikely that CAN waste is the source of selenium detections at well GW-138.

Given the information above, it appears that selenium concentrations in groundwater at well GW-138 represent background levels.

Assessment of the Extent of Contamination: There are no data to indicate the presence of selenium contamination at well GW-138 from any disposal embankment or associated facility. Concentrations of selenium in adjacent wells GW-137 and GW-139 are less than the universal GWPL of 0.05 mg/L.

Evaluation of Potential Remedial Actions: No remedial actions are warranted at this time. Energy*Solutions* will continue monthly monitoring of selenium in GW-138 until the DRC review of our request to adjust the GWPL is complete.

Please contact me at 801-649-2000 with any questions regarding this submittal.

Sincerely,

Sean McCandless
Director of Compliance and Permitting

enclosures

cc: Phil Goble, DRC (w/ encl.)
John Hultquist, DRC (w/ encl.)
Tom Rushing, DRC (w/ encl.)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering, the information the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

ATTACHMENT 1

Statistical Evaluation Technical Memorandum

TECHNICAL MEMORANDUM

To: Sean McCandless

From: Robert Sobocinski

Subject: Statistical Evaluation of Selenium Results from Monitoring Well GW-138

Date: January 26, 2012

Introduction

Groundwater monitoring at well GW-138 indicates that the background selenium concentration in groundwater is greater than the universal Ground Water Protection Level (GWPL) of 0.05 milligrams per liter (mg/L) established in the Ground Water Quality Discharge Permit (GWQDP). Therefore in accordance with Part I.B.1 of the GWQDP, the mean plus two standard deviations of the background activity concentration is calculated and proposed as a GWPL exception for selenium in groundwater at GW-138. The remainder of this discussion summarizes the statistical process used to develop the GWPL exception and the results of the process.

Methodology

The methodology is identical to that submitted by Energy*Solutions* to the Utah Division of Radiation Control (DRC) on February 2, 2009 and October 7, 2009, except that duplicate results were averaged rather than removed. This methodology is as follows:

1) Define the data set for statistical evaluation (identify and remove outliers and calculate average duplicate results).
2) Perform statistical tests to demonstrate normality.
3) Calculate the proposed GWPL exception as the mean plus two standard deviations of the data set.

Selenium results have been obtained from groundwater samples collected at well GW-138 from November 2009 to January 2012 (Table 1-1). All results were analyzed by American West Analytical Laboratories (AWAL) by U.S. EPA method SW-846 6020A. Duplicate results were averaged, resulting in a data set consisting of 10 selenium results (Table 1-1). No outliers were removed.

The statistical tests performed to demonstrate the normality of the GW-138 selenium data were identical those given in the Enchemica LLC (2009) methodology, which was submitted to the DRC on February 2, 2009, and identical to those submitted to the DRC for gross alpha in I-1-30 on October 7, 2009. The tests include:

1) Comparison of skewness and kurtosis to values expected from a normal distribution
2) Calculation of Filliben's statistic (probability plot correlation coefficient) and comparison to a critical value
3) The Shapiro-Wilk test
4) The Anderson-Darling test.

Details of these normality tests are provided in Enchemica LLC (2009) and are not included here.

Results

The results normality testing are summarized in Table 1-1. The absolute values of skewness and kurtosis are less than respective critical values, the Filliben's and Shapiro-Wilk statistics are greater than the critical value for each test, and the Anderson-Darling statistic is less than its critical value (Table 1-1). Based on these results, the selenium data from well GW-138 are normally distributed.

The mean and standard deviation were calculated for the GW-138 selenium data set and were used to develop the proposed GWPL exception of 0.061 mg/L (Table 1-1). None of the selenium results in the data set exceeds this value.

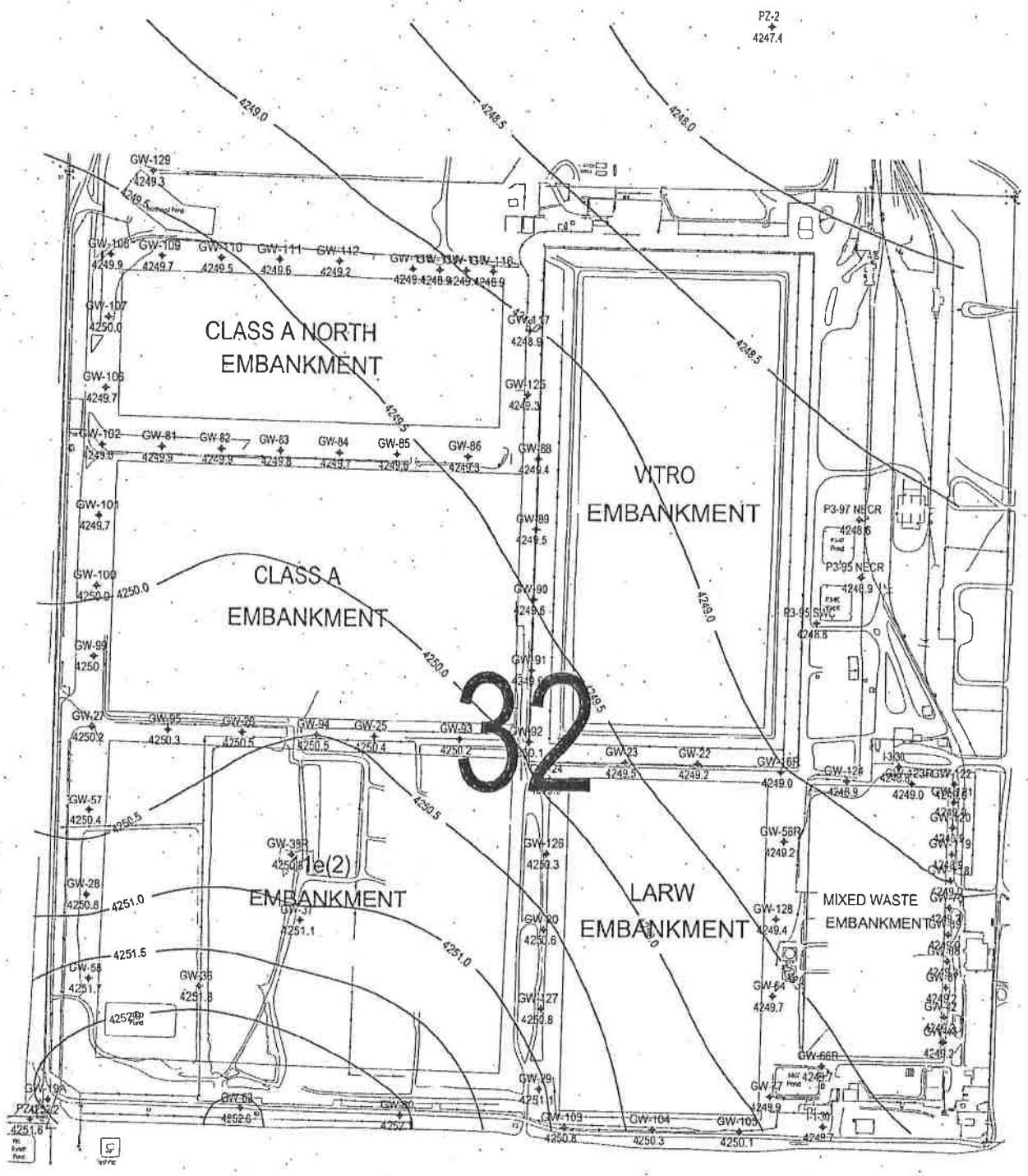
Table 1-1 - Well GW-138 Selenium Data and Statistical Evaluation

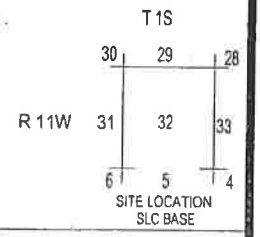
Well ID	Date	Lab	Used in Stat. Eval	Selenium (mg/L)	Selenium [a] (mg/L)
GW-138	11/5/2009	AWAL	Y	0.0520	0.0520
GW-138	2/16/2010	AWAL	Y	0.0510	0.0510
GW-138	4/28/2010	AWAL	Y	0.0500	0.0500
GW-138	7/22/2010	AWAL	Y	0.0518	0.0518
GW-138	10/19/2010	AWAL	Y[a]	0.0421	0.0419
GW-138 Dup.	10/19/2010	AWAL	Y[a]	0.0417	
GW-138	3/22/2011	AWAL	Y	0.0462	0.0462
GW-138	5/3/2011	AWAL	Y	0.0482	0.0482
GW-138	7/14/2011	AWAL	Y	0.0550	0.0550
GW-138	12/15/2011	AWAL	Y[a]	0.0567	0.0571
GW-138 Dup.	12/15/2011	AWAL	Y[a]	0.0574	
GW-138	1/10/2012	AWAL	Y[a]	0.0575	0.0580
GW-138 Dup.	1/10/2012	AWAL	Y[a]	0.0584	
Number of samples					10
Minimum					0.0419
Maximum					0.0580
Median					0.0514
Mean					0.0511
Standard Deviation					0.0049
Variance					2.41E-05
Mean + 2 standard deviations					0.0609
Skewness					-0.394
2 x standard error of skewness (SES)					1.549
Kurtosis					-0.021
2 x standard error of kurtosis (SEK)					3.098
Filliben's Statistic (probability plot correleation coefficient)					0.9860
Critical value of Filliben's Statistic ($\alpha = 0.05$)					0.9173
Shapiro-Wilk test statistic					0.9704
Shapiro-Wilk test critical value ($\alpha = 0.05$)					0.842
Anderson-Darling test statistic (adjusted)					3.8378
Anderson-Darling test critical value ($\alpha = 0.01$)					3.9270
Number of analyses greater than proposed GWPL exception					0
Pecent of analyses greater than proposed GWPL exception					0%

[a] For samples with duplicates, the original and duplicate analysis were averaged
AWAL = American West Analytical Laboratories
NA = not available

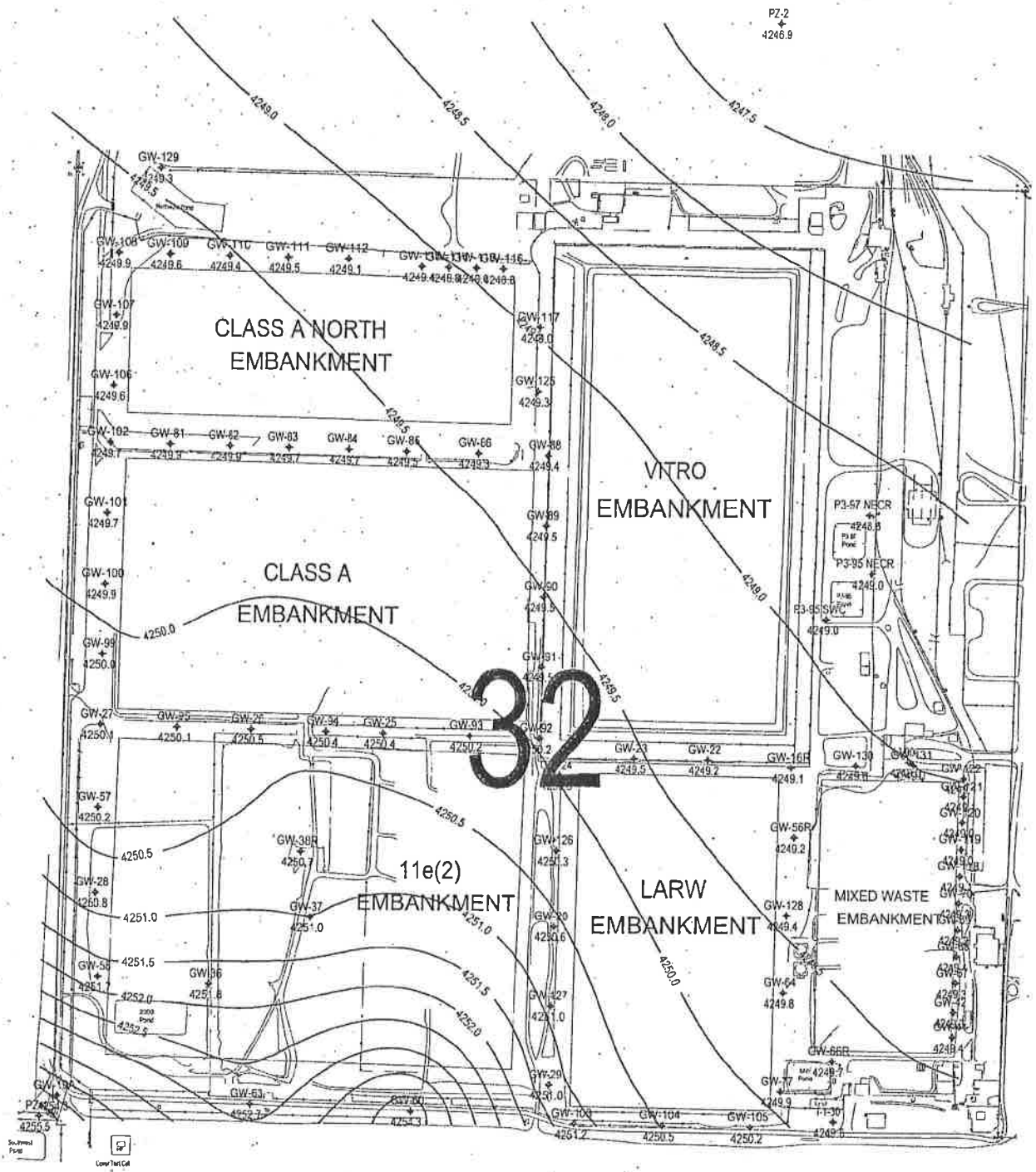
ATTACHMENT 2

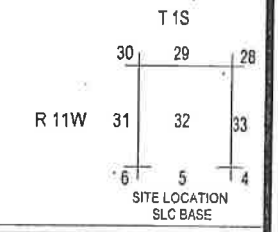
Groundwater Contour Maps





DRAWN BY J. LOW	SECTION 32	SCALE 1 in. = 833 ft.
CHECKED BY	GROUNDWATER CONTOUR MAP	DATE 2/17/10
APPROVED BY: B. SOBOCINSKI	FRESH WATER	DECEMBER 2009 WATER LEVELS
	CLIVE, UTAH	





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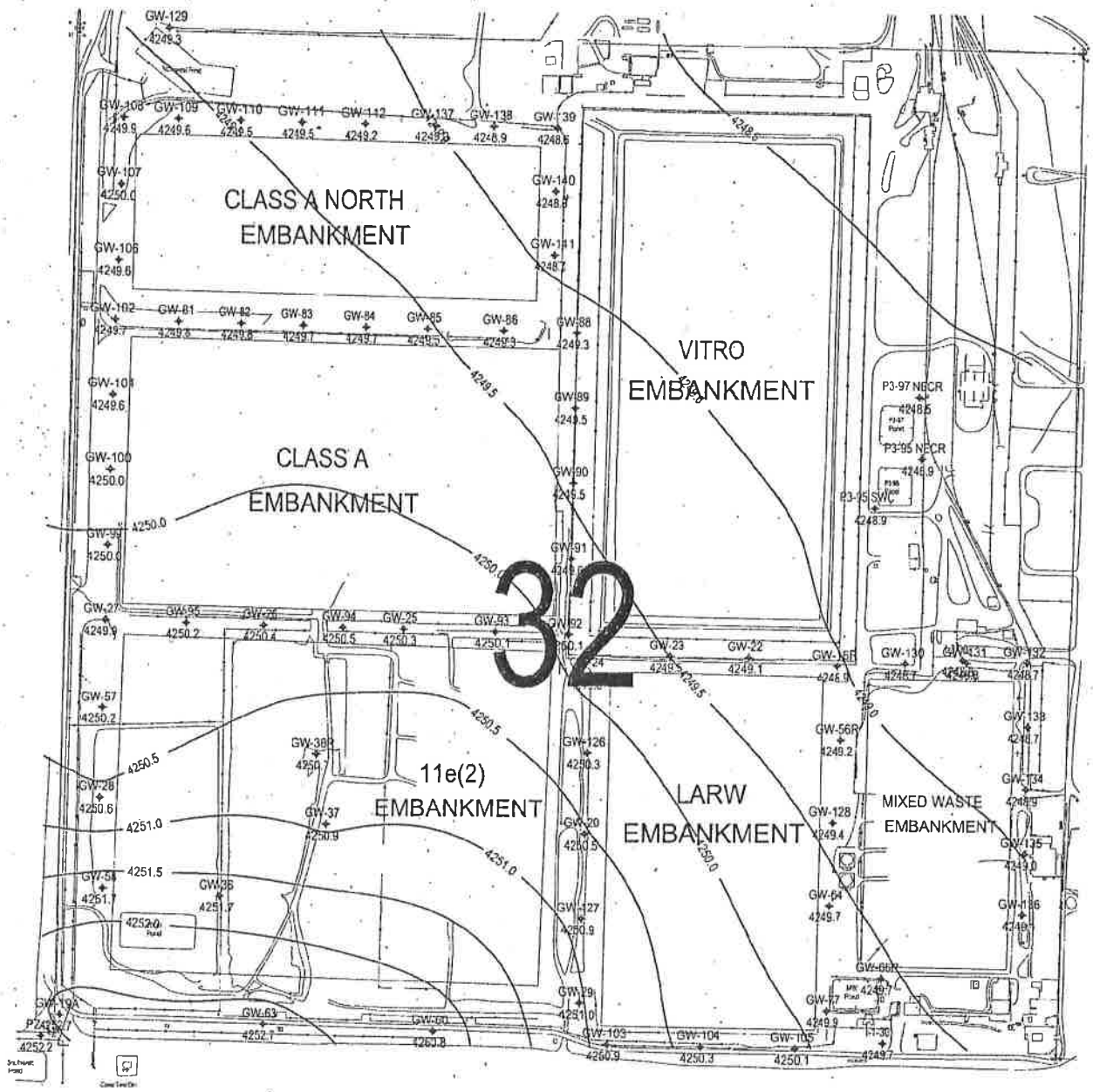
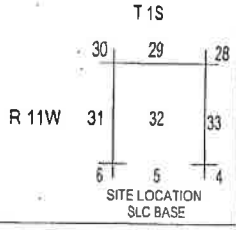
	CHECKED BY B. SOBOCINSKI	GROUNDWATER CONTOUR MAP	DATE 7/1/10
	APPROVED BY B. SOBOCINSKI	FRESH WATER	MAY 2010 WATER LEVELS
		CLIVE, UTAH	





DRAWN BY J. LOW	SECTION 32	SCALE 1 in. = 833 ft.
CHECKED BY B. SOBOCINSKI	GROUNDWATER CONTOUR MAP	DATE 2/20/11
APPROVED BY B. SOBOCINSKI	FRESH WATER, LOWEST GW-60 DTW	DECEMBER 2010 WATER LEVELS
	CLIVE, UTAH	

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ENERGYSOLUTIONS

February 29, 2012 CD12-0055

Rusty Lundberg, Co-Executive Secretary
Utah Water Quality Board
195 North 1950 West
P.O. Box 144850
Salt Lake City, UT 84114-4850

Re: Groundwater Quality Discharge Permit (GWQDP) UGW450005: Source and Contamination Assessment Study Plan for Radium at Monitoring Well GW-137 – Request for Permit Modification

Dear Mr. Lundberg:

This letter provides the Source and Contamination Assessment Study Plan for the presence of background levels of radium-226 (Ra-226) and radium-228 (Ra-228) in groundwater at compliance well GW-137. Well GW-137 is located north of the Class A North (CAN) embankment. Combined radium (Ra-226 + Ra-228) exceeded the universal groundwater protection level (GWPL) of 5 picoCuries per liter (pCi/L) in a sample collected on December 15, 2011 and in the next quarterly sample collected on January 10, 2012. Notification of the out-of-compliance (OOC) status was provided to the Division of Radiation Control (DRC) by Energy*Solutions* via e-mail on February 16, 2012, and written notification was provided to DRC on February 17, 2012 (CD12-0042). Table 1 provides the timeline for sampling, detection, and notification of the groundwater exceedences.

Table 1
Timeline for Radium Exceedences at GW-137

Date	Event
6/15/2011	E-mail notification of POOC
7/14/2011	3rd Qtr 2011 POOC sample collected (results < GWPL)
12/15/2011	4th Qtr 2011 POOC groundwater sample collected
1/10/2012	1st Qtr 2012 POOC groundwater sample collected
1/23/2012	4th Qtr 2011 results received, exceedence observed
2/15/2012	1st Qtr 2012 results received, second consecutive exceedence observed
2/16/2012	E-mail notification of OOC
2/17/2012	Written notification of OOC

Well GW-137 was installed in July 2009 and had been sampled for Ra-226 and Ra-228 for four consecutive quarters from 4th quarter 2009 to 3rd quarter 2010 and also for four consecutive quarters from 2nd quarter 2011 to 1st quarter 2012 (total of eight quarters). Combined radium concentrations have ranged from 2.42 to 5.53 pCi/L (Table 1-1, Attachment 1) and appear to be representative of background levels in shallow groundwater (see Source Assessment discussion below).

Energy*Solutions* hereby requests a modification of the GWQDP to provide an exception to the universal GWPL for combined radium in well GW-137. Energy*Solutions* proposes an adjusted GWPL of 6.10 pCi/L. The Technical Memorandum provided as Attachment 1 presents pertinent information on the statistical basis for this exception request, including: GW-137 radium data, descriptive statistics, normality testing, and calculation of the GWPL exception. The balance of this submittal addresses the requirements of the Source and Contamination Assessment Study Plan listed in Part 1.G.3.b of the GWQDP.

Source Assessment: Attachment 2 consists of shallow groundwater elevation contour maps for December 2009, May 2010, and December 2010. These maps show a consistent northeast flow direction and consistent gradient in the shallow aquifer beneath the eastern half of the CAN embankment. Well GW-137 is cross-gradient from the Vitro embankment, and that cell therefore cannot be a potential source. Based on travel-time considerations, the Class A embankment also cannot be a potential source. In addition, contamination from the Class A embankment would be detected in monitoring wells located north of Class A, and radium concentrations have remained below the GWPL in these wells.

Background levels of combined radium in the shallow aquifer in the vicinity of well GW-137 are slightly greater than the universal GWPL of 5 pCi/L. Background-based GWPL exceptions ranging from 5.04 to 7.77 pCi/L are in place for combined radium in wells GW-84, GW-85, GW-86, GW-88, and GW-112. Former CAN compliance monitoring well GW-113, which was located near GW-137, had a combined radium background-based GWPL of 6.61 pCi/L.

Class A waste is currently disposed in the CAN embankment upgradient of well GW-137. The closest waste to GW-137 is approximately 365 feet southwest of the well. The average freshwater horizontal hydraulic gradient for the CAN embankment during 2010 was 5.67×10^{-4} ft/ft. The hydraulic gradient and effective porosity values used in the infiltration and transport model for CAN were 2.17 feet per day and 0.29, respectively. Using these values, the average horizontal linear velocity of groundwater in the shallow aquifer beneath the CAN embankment is 1.55 feet per year, and the travel time from the closest waste to well GW-137 for an unretarded constituent is approximately 235 years.

Because waste disposal operations at the CAN embankment began in 2001, it is highly unlikely that CAN waste is the source of observed Ra-226 and Ra-228 concentrations at well GW-137.

Given the information above, it appears that the radium concentrations in groundwater at well GW-137 represent background levels.

Assessment of the Extent of Contamination: There are no data to indicate the presence of radium isotope contamination at well GW-137 from any disposal embankment or associated facility. An area of combined Ra-226 and Ra-228 background concentrations slightly greater than 5 pCi/L is observed in the shallow aquifer on the eastern side of the CAN embankment.

Evaluation of Potential Remedial Actions: No remedial actions are warranted at this time. Energy*Solutions* will continue monthly monitoring of Ra-226 and Ra-228 in well GW-137 until the DRC review of our request to adjust the GWPL is complete.

Please contact me at 801-649-2000 with any questions regarding this submittal.

Sincerely,

Timothy L. Orton

for Sean McCandless
Director of Compliance and Permitting

enclosures

cc: Phil Goble, DRC (w/ encl.)
John Hultquist, DRC (w/ encl.)
Tom Rushing, DRC (w/ encl.)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering, the information the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

ATTACHMENT 1

Statistical Evaluation Technical Memorandum

TECHNICAL MEMORANDUM

To: Sean McCandless

From: Robert Sobocinski

Subject: Statistical Evaluation of Radium Results from Monitoring Well GW-137

Date: February 22, 2012

Introduction

Groundwater monitoring at well GW-137 indicates that the background combined radium (Ra-226 + Ra-228) concentration in groundwater is greater than the universal Ground Water Protection Level (GWPL) of 5 picoCuries per liter (pCi/L) established in the Ground Water Quality Discharge Permit (GWQDP). Therefore in accordance with Part I.B.1 of the GWQDP, the mean plus two standard deviations of the background activity concentration was calculated and proposed as a GWPL exception for combined radium in groundwater at GW-137. The remainder of this discussion summarizes the statistical process used to develop the GWPL exception and the results of the process.

Methodology

The methodology is identical to that submitted by Energy*Solutions* to the Utah Division of Radiation Control (DRC) on February 2, 2009 and October 7, 2009. This methodology is as follows:

1) Define the data set for statistical evaluation (identify and remove outliers and remove duplicate results).
2) Perform statistical tests to demonstrate normality.
3) Calculate the proposed GWPL exception as the mean plus two standard deviations of the data set.

Ra-226 and Ra-228 results have been obtained from groundwater samples collected at well GW-137 from November 2009 to January 2012 (Table 1-1). All results were analyzed by TestAmerica in Richland, Washington (TAR) by method RL-RA-001 Rev. 2, which is the equivalent of U.S. EPA methods 903.1 (Ra-226) and 904.0 (Ra-228). Three duplicate results were removed, resulting in a data set consisting of eight combined radium results (Table 1-1). No outliers were removed.

The statistical tests performed to demonstrate the normality of the GW-137 combined radium data were identical those given in the Enchemica LLC (2009) methodology, which was submitted to the DRC on February 2, 2009, and identical to those submitted to the DRC for gross alpha in I-1-30 on October 7, 2009. The tests include:

1) Comparison of skewness and kurtosis to values expected from a normal distribution
2) Calculation of Filliben's statistic (probability plot correlation coefficient) and comparison to a critical value
3) The Shapiro-Wilk test
4) The Anderson-Darling test.

Details of these normality tests are provided in Enchemica LLC (2009) and are not included here.

Results

The results of normality testing are summarized in Table 1-1. The absolute values of skewness and kurtosis are less than respective critical values, the Filliben's and Shapiro-Wilk statistics are greater than the critical value for each test, and the Anderson-Darling statistic is less than its critical value (Table 1-1). Based on these results, the combined radium data from well GW-137 are normally distributed.

The mean and standard deviation were calculated for the GW-137 combined data set and were used to develop the proposed GWPL exception of 6.10 pCi/L (Table 1-1). None of the combined radium results in the data set to date exceeds this value.

Reference

Enchemica LLC, 2009. *Statistical Evaluation of Groundwater Data.* Technical Memorandum from Janet Schramke to Daniel B. Shrum, January 30, 2009. Submitted to DRC on February 2, 2009 (CD09-0031).

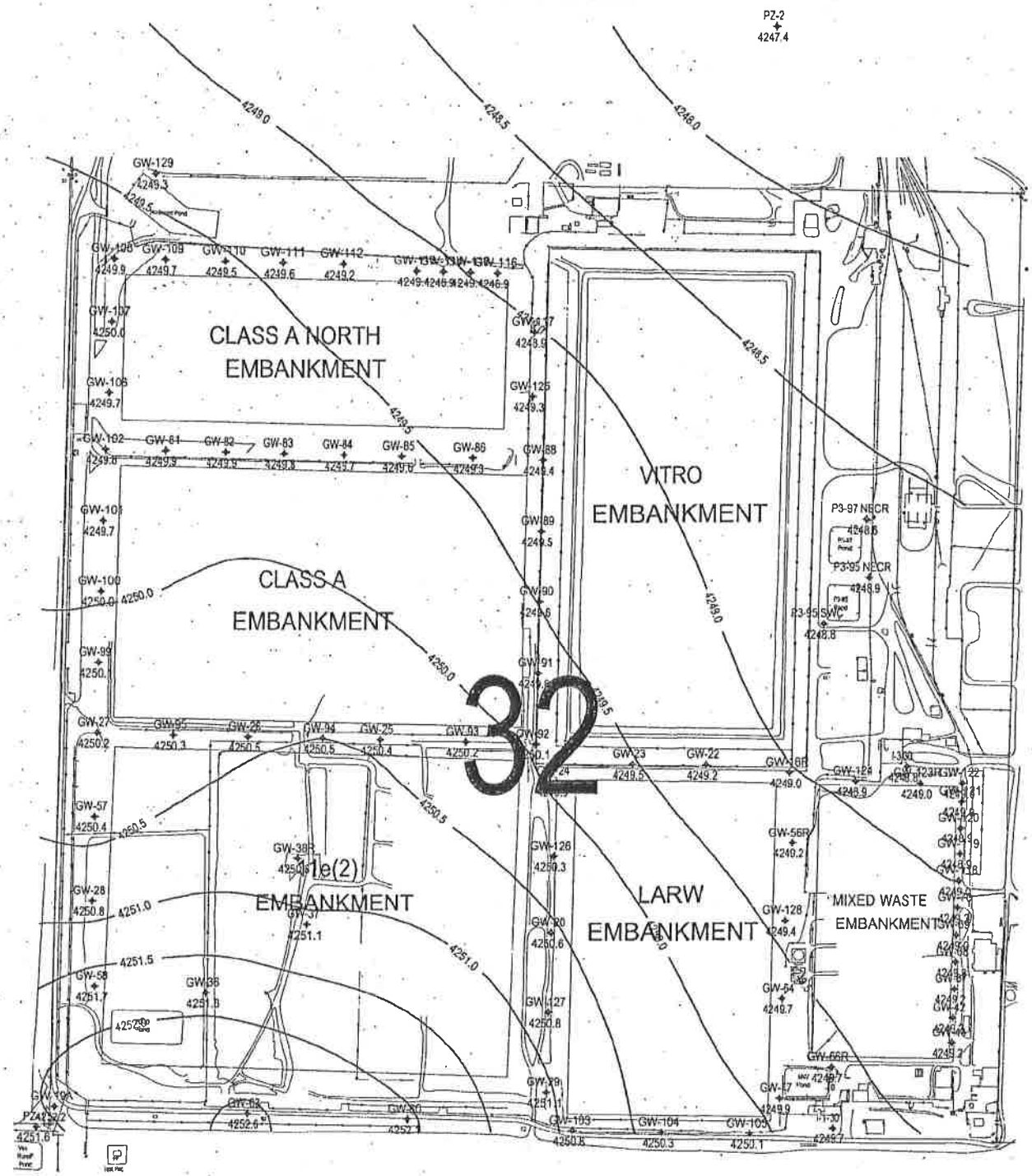
Table 1-1 - Well GW-137 Radium Data and Statistical Evaluation

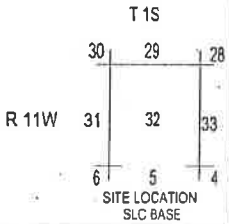
Well ID	Date	Lab	Used in Stat. Eval	Radium-226 (pCi/L)	Radium-228 (pCi/L)	Combined Radium (pCi/L)
GW-137	11/5/2009	TAR	Y	1.83	< 0.59	2.42
GW-137 Dup.	11/5/2009	TAR	N	2.37	1.52	3.89
GW-137	2/16/2010	TAR	Y	2.31	1.35	3.66
GW-137	4/28/2010	TAR	Y	2.17	1.76	3.93
GW-137	7/22/2010	TAR	Y	2.65	1.63	4.28
GW-137	5/3/2011	TAR	Y	3.40	1.73	5.13
GW-137	7/14/2011	TAR	Y	2.79	1.65	4.44
GW-137	12/15/2011	TAR	Y	3.07	2.46	5.53
GW-137 Dup.	12/15/2011	TAR	N	2.44	1.93	4.37
GW-137	1/10/2012	TAR	Y	2.91	1.39	4.30
GW-137 Dup.	1/10/2012	TAR	N	2.98	2.16	5.14
Number of samples						8
Minimum						2.42
Maximum						5.53
Median						4.29
Mean						4.21
Standard Deviation						0.94
Variance						0.89
Mean + 2 standard deviations						6.10
Skewness						-0.64
2 x standard error of skewness (SES)						1.73
Kurtosis						1.19
2 x standard error of kurtosis (SEK)						3.46
Filliben's Statistic (probability plot correleation coefficient)						0.968
Critical value of Filliben's Statistic ($\alpha = 0.05$)						0.904
Shapiro-Wilk test statistic						0.952
Shapiro-Wilk test critical value ($\alpha = 0.05$)						0.818
Anderson-Darling test statistic (adjusted)						0.270
Anderson-Darling test critical value ($\alpha = 0.05$)						2.495
Number of analyses greater than proposed GWPL exception						0
Percent of analyses greater than proposed GWPL exception						0%

pCi/L = picoCuries per liter
TAR = TestAmerica Richland, Washington

ATTACHMENT 2

Groundwater Contour Maps





	DRAWN BY J. LOW	SECTION 32	SCALE 1 in. = 833 ft.
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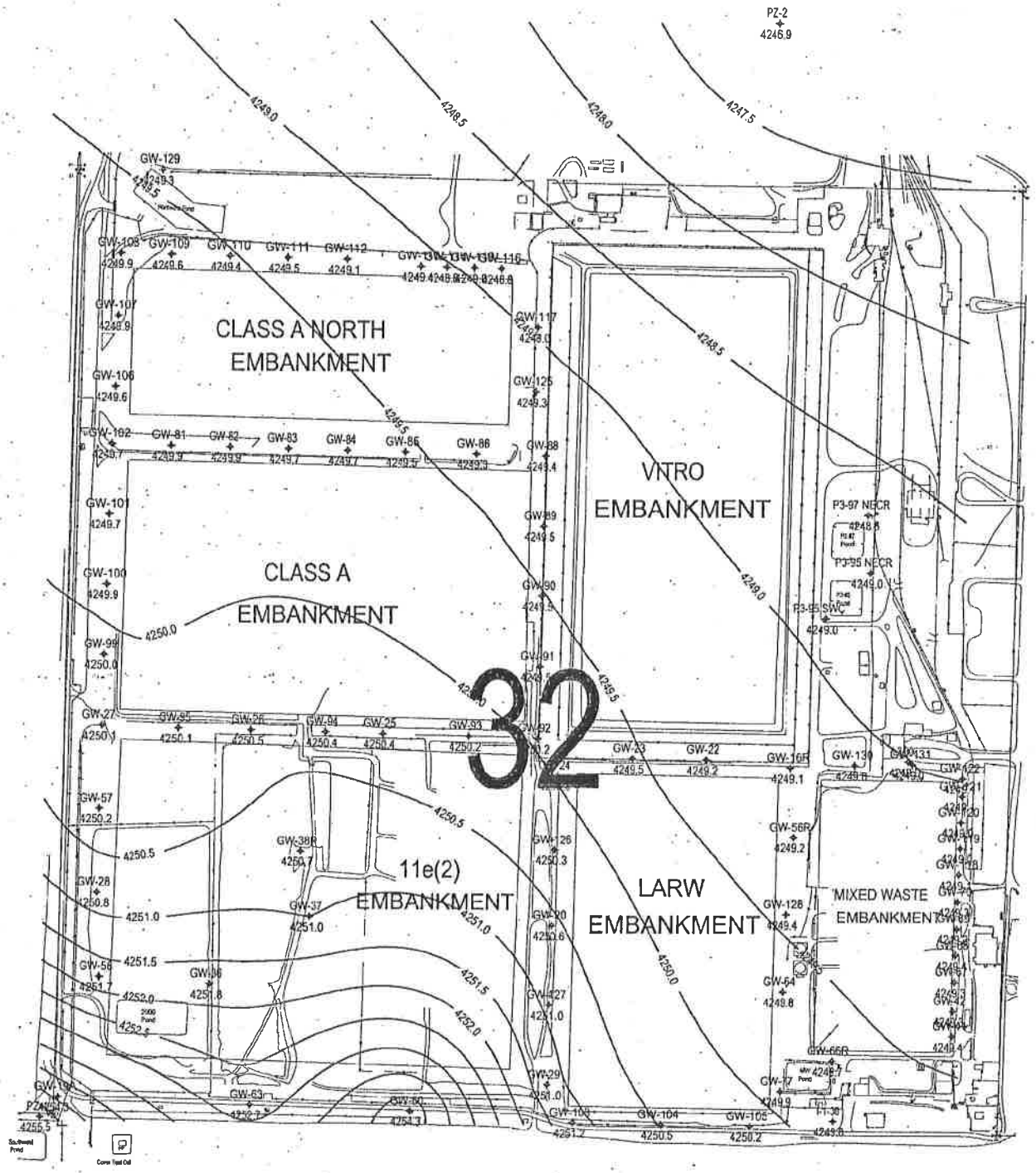
	APPROVED BY B. SOBOCINSKI	FRESH WATER	DECEMBER 2009 WATER LEVELS
		CLIVE, UTAH	



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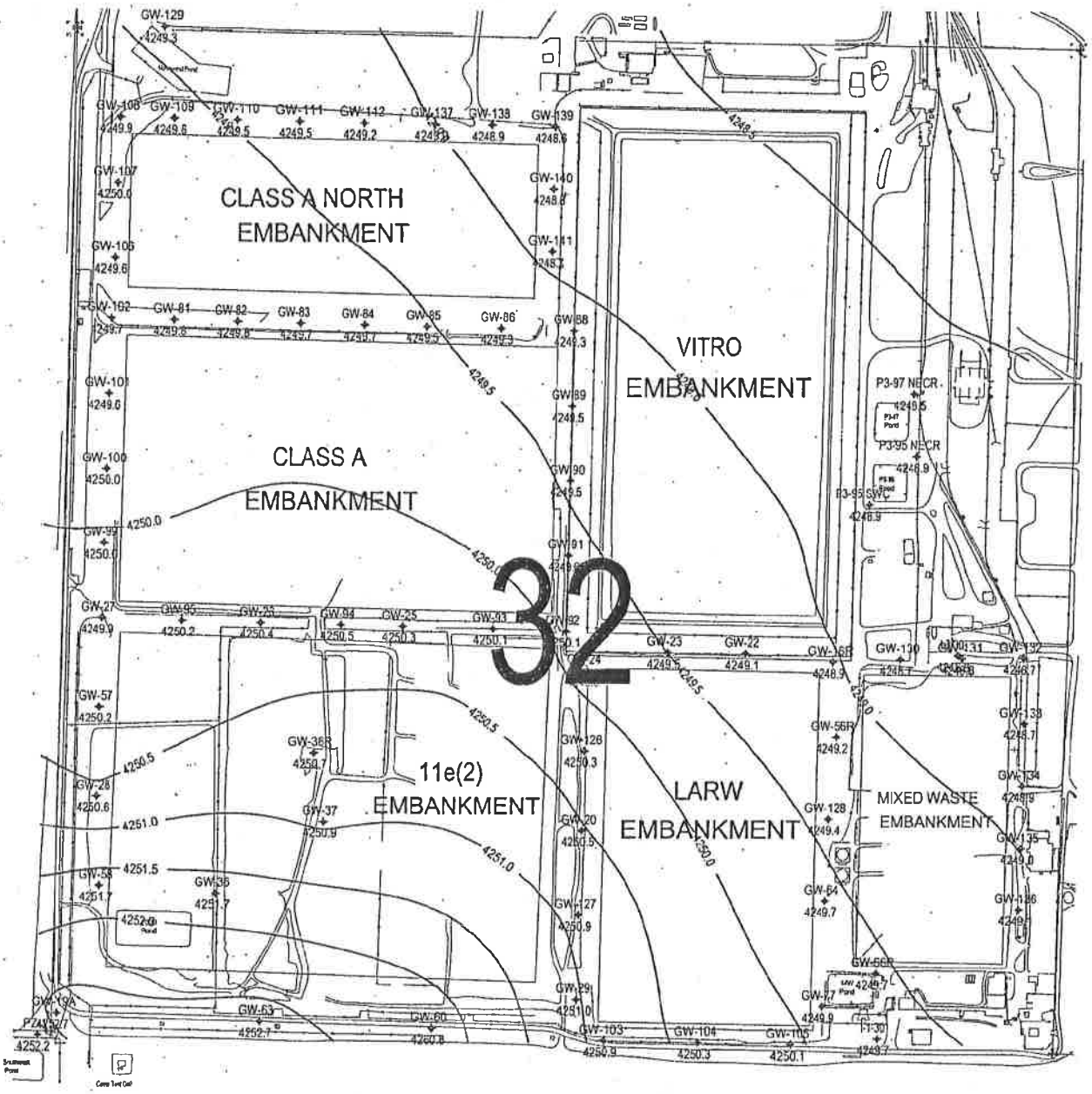
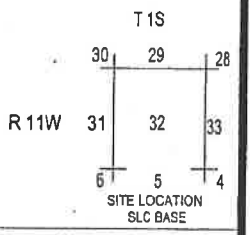
APPROVED BY B. SOBOCINSKI	FRESH WATER	MAY 2010 WATER LEVELS
	CLIVE, UTAH	





DRAWN BY J. LOW	SECTION 32	SCALE 1 in. = 833 ft.
CHECKED BY B. SOBOCINSKI	GROUNDWATER CONTOUR MAP	DATE 2/20/11
APPROVED BY B. SOBOCINSKI	FRESH WATER, LOWEST GW-60 DTW	DECEMBER 2010 WATER LEVELS
	CLIVE, UTAH	

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ENERGYSOLUTIONS

CD12-0297

November 27, 2012

Rusty Lundberg, Co-Director
Utah Division of Water Quality
195 North 1950 West
P.O. Box 144850
Salt Lake City, UT 84114-4850

Re: Groundwater Quality Discharge Permit (GWQDP) UGW450005: Source and Contamination Assessment Study Plan for Total Uranium at Monitoring Well GW-137

Dear Mr. Lundberg:

This letter provides the Source and Contamination Assessment Study Plan for the presence of background levels of total uranium in groundwater at well GW-137. Pertinent data are summarized in Table 1.

Table 1 – Total Uranium in GW-137

Sample Date	Total Uranium Concentration (mg/L)
11/5/2009	0.023
11/5/2009	0.024
2/16/2010	0.018
4/28/2010	0.015
7/22/2010	0.018
5/3/2011	0.027
4/23/2011	**0.035**
9/19/2012	0.029
9/19/2012	**0.032**
10/29/2012	**0.0331**
10/29/2012	0.0279

Bold results exceed the universal groundwater protection level of 0.03 mg/L

Well GW-137 is located on the north side of the Class A West embankment and is one of the wells that will be abandoned due to this embankment. Verbal notification of the out-of-compliance (OOC) status for total uranium was provided to the Division of Radiation Control (DRC) by Energy*Solutions* on October 30, 2012, and written notification was provided to DRC on November 1, 2012 (CD12-0282). Table 2 provides the timeline for sampling, detection, and notification of the groundwater exceedances.

Table 2
Timeline for Exceedances

Date	Event
4/23/2012	Annual sampling
5/18/2012	Annual sampling results received, first exceedance
6/13/2012	E-mail notification of POOC sent to DRC
9/19/2012	3rd Qtr 2012 POOC samples collected
10/26/2012	3rd Qtr 2012 results received, second consecutive exceedance
10/29/2012	Monthly sampling
10/30/2012	E-mail notification of OOC
11/1/2012	Written notification of OOC

Source Assessment: Figures 1, 2, and 3 are shallow groundwater elevation contour maps for April 2010, April 2011, and April 2012, respectively. These maps show a consistent northeast flow direction and consistent gradient in the shallow aquifer beneath the eastern half of the Class A North (CAN) embankment. Well GW-137 is cross-gradient from the Vitro embankment, and therefore, that cell cannot be a potential source. Based on travel-time considerations, the Class A embankment also cannot be a potential source. In addition, contamination from the Class A embankment would be detected in monitoring wells located north of Class A, and total uranium concentrations have remained below the GWPL in these wells.

Background levels of total uranium in some shallow aquifer wells in the vicinity of well GW-137 are slightly greater than the universal GWPL of 0.03 mg/L. Background-based GWPL exceptions ranging from 0.032 to 0.146 mg/L are in place for total uranium in wells GW-25, GW-26, GW-27, GW-36, GW-58, GW-94, GW-95, and GW-100. Former CAN compliance monitoring well GW-113, which was located near GW-137, had a total uranium background-based GWPL of 0.0354 mg/L.

Class A waste is currently disposed in the CAN embankment upgradient of well GW-137. The closest waste to GW-137 is approximately 365 feet southwest of the well. The average freshwater horizontal hydraulic gradient for the CAN embankment during 2011 was 5.55×10^{-4} ft/ft. The hydraulic conductivity and effective porosity values used in the infiltration and transport model for CAN were 2.17 feet per day and 0.29, respectively. Using these values, the average horizontal linear velocity of groundwater in the shallow aquifer beneath the CAN embankment is 1.52 feet per year, and the travel time from the closest waste to well GW-137 for an unretarded constituent is approximately 240 years.

Because waste disposal at the CAN embankment began in 2001, it is highly unlikely that CAN waste is the source of observed total uranium concentrations at well GW-137.

Given the information above, it appears that the total uranium concentrations in groundwater at well GW-137 represent background levels.

Assessment of the Extent of Contamination: There are no data to indicate the presence of total uranium contamination at well GW-137 from any disposal embankment or associated facility. An area of total uranium background concentrations slightly greater than 0.03 mg/L is observed in the shallow aquifer on the eastern side of the CAN embankment.

Evaluation of Potential Remedial Actions: No remedial actions are warranted.

CAN and Class A embankment wells GW-85, GW-86, GW-137, GW-138, and GW-141 are currently in accelerated monitoring for various parameters. They and several other wells will be plugged and abandoned in preparation for the construction of the Class A West embankment. Because the exceedences are background levels, the data generated as a result of accelerated monitoring would be used to calculate GWPL exceptions. However, since these wells will be removed, data for background-based GWPL exceptions are not needed and Energy*Solutions* requests that the sampling frequency for GW-85, GW-86, GW-137, GW-138, and GW-141 be returned to annual.

Please contact me at 801-649-2000 with any questions regarding this issue.

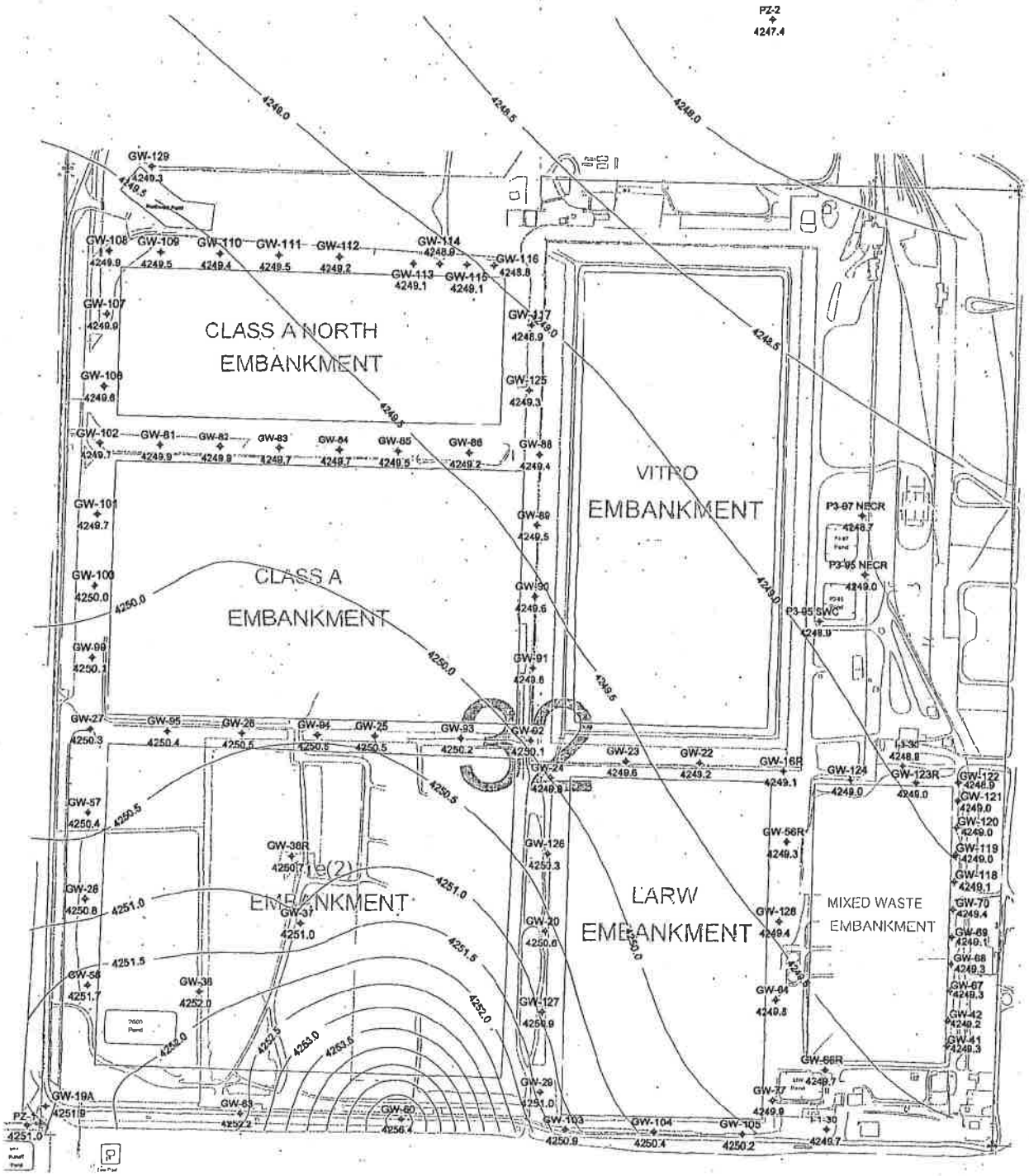
Sincerely,

Sean McCandless
Manager, Compliance and Permitting

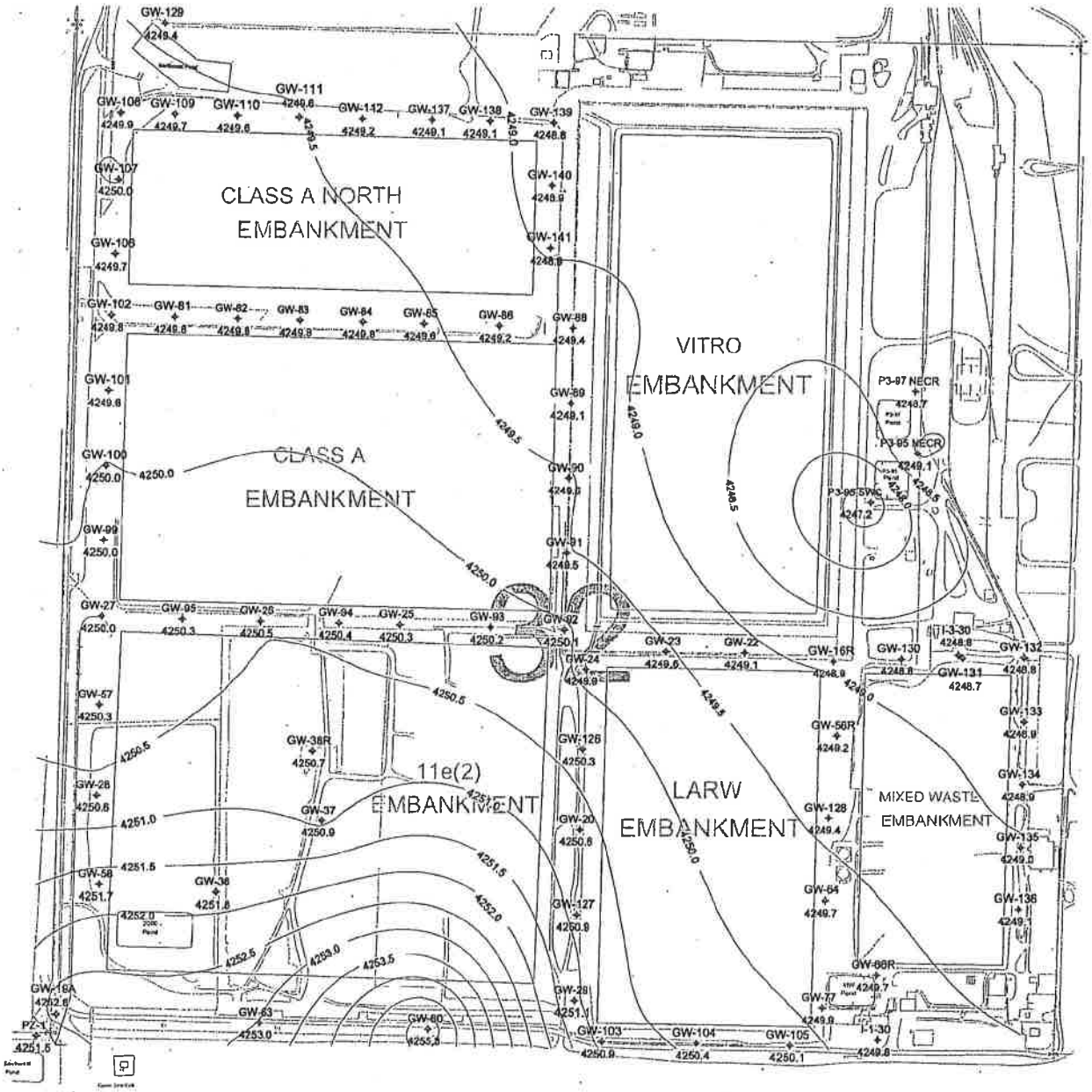
enclosure

cc: Phil Goble, DRC (w/ encl.)
Tom Rushing, DRC (w/ encl.)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.



ENERGYSOLUTIONS	DRAWN BY J. LOW	SECTION 32	SCALE 1 in. = 833 ft.
	CHECKED BY B. SOBOCINSKI	GROUNDWATER CONTOUR MAP	DATE 6/18/10
	APPROVED BY B. SOBOCINSKI	APRIL 2010 FRESH WATER	FIGURE 1
		CLIVE, UTAH	



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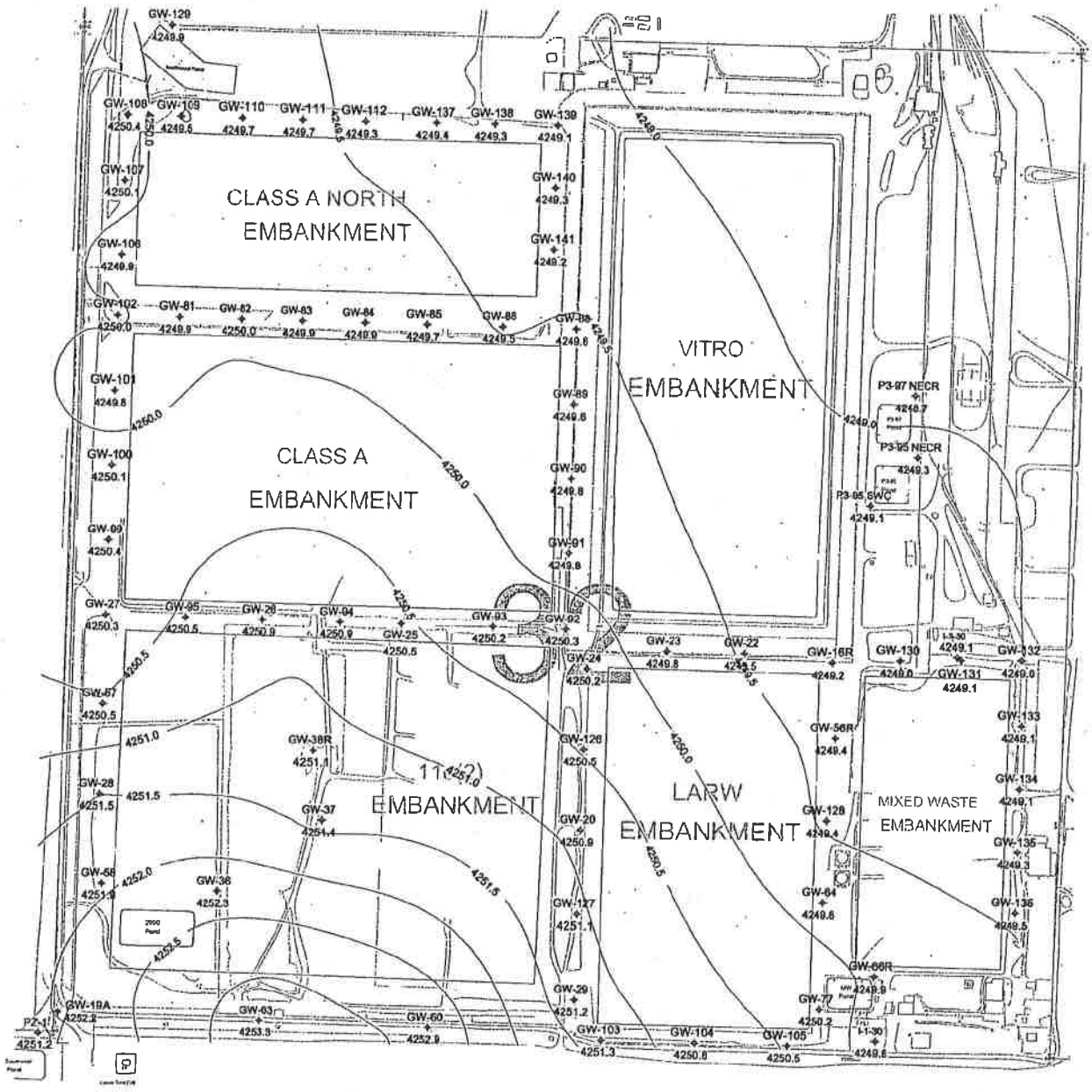
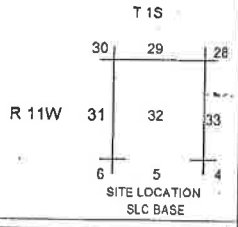
	APPROVED BY B. SOBOCINSKI	APRIL 2011 FRESH WATER	Figure 2
		CLIVE, UTAH	





ENERGYSOLUTIONS	DRAWN BY J. LOW	SECTION 32	SCALE 1 in. = 833 ft.
	CHECKED BY B. SOBOCINSKI	GROUNDWATER CONTOUR MAP	DATE 8/1/12
	APPROVED BY B. SOBOCINSKI	APRIL 2012 FRESH WATER	Figure 3
		CLIVE, UTAH	

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ENERGYSOLUTIONS

October 26, 2012 CD12-0278

Rusty Lundberg, Co-Director
Utah Water Quality Board
195 North 1950 West
P.O. Box 144850
Salt Lake City, UT 84114-4850

Re: Groundwater Quality Discharge Permit (GWQDP) UGW450005: Source and Contamination Assessment Study Plan for Thallium at Monitoring Wells GW-26 and GW-100, and Selenium at Monitoring Wells GW-103 and GW-141

Dear Mr. Lundberg:

This letter provides the Source and Contamination Assessment Study Plan for the presence of background levels of thallium in groundwater at wells GW-26 and GW-100, and background levels of selenium in groundwater at wells GW-103 and GW-141. Wells GW-26 and GW-100 are located on the south and west sides, respectively, of the Class A embankment. Well GW-103 is located near the southwest corner of the LARW embankment, and well GW-141 is located on the east side of the Class A North embankment. Verbal notification of the out-of-compliance (OOC) status for these exceedances was provided to the Division of Radiation Control (DRC) by Energy*Solutions* on October 5, 2012, and written notification was provided to DRC on October 9, 2012 (CD12-0263). Table 1 provides the timeline for sampling, detection, and notification of the groundwater exceedances.

Table 1
Timeline for Exceedances

Date	Event
6/13/2012	E-mail notification of POOCs sent to DRC
9/17 and 9/18/2012	3rd Qtr 2012 POOC samples collected
10/4/2012	3rd Qtr 2012 results received, second consecutive exceedances observed
10/5/2012	E-mail notification of OOC
10/9/2012	Written notification of OOC

Source Assessment: Figures 1, 2, and 3 are shallow groundwater elevation contour maps for April 2010, April 2011, and April 2012, respectively. These maps show a relatively consistent flow direction over the time period for each of the four monitoring wells. The source assessment for each well is provided below.

GW-26 – To date, only three groundwater samples from well GW-26 have been analyzed for thallium. Groundwater flow is from the south-southeast to the north-northwest. Flow in the area appears to have been impacted by historical mounding in the vicinity of wells GW-37 and GW-38R. Waste has not been stored or disposed upgradient of GW-26. The current footprint of 11e.(2) waste is not upgradient of GW-26. The universal Groundwater Protection Level (GWPL) and reporting limit (RL) for thallium are 0.002 milligrams per liter (mg/L). The exceedances (0.0024 and 0.0023 mg/L) likely reflect naturally occurring levels of thallium in groundwater, and may possibly be related to analytical uncertainty, since the GWPL and RL are the same value.

GW-100 – To date, eight groundwater samples from well GW-100 have been analyzed for thallium. Groundwater flow is from the south-southeast to the north-northwest. As with GW-26, flow at GW-100 appears to have been impacted by historical mounding in the vicinity of GW-37 and GW-38R. Under these flow conditions, the Class A embankment is upgradient of GW-100. Based on the shortest distance from the edge of waste to GW-100, travel times are approximately 58 years for groundwater and approximately 106 years for thallium in groundwater. The travel times are calculated using the April 2011 average hydraulic gradient for the Class A embankment provided in the 2011 Annual Groundwater Monitoring Report (March 1, 2012) and the hydraulic conductivity, effective porosity, soil density, and thallium distribution coefficient provided in the Class A West Infiltration and Transport Modeling Report (November 28, 2011). The Class A embankment has received waste for approximately 12 years, and therefore, given the travel times above, it is highly unlikely the embankment is the source of thallium exceedances in groundwater at GW-100. Given the low value of the universal GWPL and the limits for analytical detection of thallium in saline water, the exceedances observed (0.0034 and 0.0029 mg/L) likely reflect naturally occurring levels in groundwater combined with analytical uncertainty.

GW-103 – Groundwater samples from well GW-103 have been analyzed for selenium from 1999 to present. Increasing selenium concentrations may be correlated with increasing groundwater elevations; however, some of the variation in selenium concentration at GW-103 may be due to changes over time in analytical methods and

instrumentation. Groundwater flow is from the west-southwest to the east-northeast. The influence on flow directions of the mound at GW-60 is exaggerated in Figures 1 and 2. Regardless, waste has not been stored or disposed upgradient of well GW-103. The GWPL for selenium at GW-103 is the universal value of 0.05 mg/L. The exceedances (0.067 and 0.055 mg/L) likely reflect naturally occurring levels of selenium in groundwater. Selenium concentrations may be influenced by geochemical reactions (e.g., dissolution, ion exchange, desorption) associated with infiltration of surface water in the vicinity of well GW-103.

GW-141 – To date, seven groundwater samples from well GW-141 have been analyzed for selenium. Groundwater flow is from southwest to northeast. The closest waste is 500 feet upgradient of GW-141 in the Class A embankment. Waste is not yet present in the Class A North embankment in the area upgradient of GW-141. Travel times from GW-141 to the edge of the Class A embankment are approximately 340 years for groundwater and over 2,000 years for selenium in groundwater. The calculations are similar to those described above for GW-100. Given these travel times, selenium concentrations in GW-141 groundwater are not contamination, but rather, represent naturally occurring levels.

Assessment of the Extent of Contamination: There are no data to indicate the presence of contamination at wells GW-26, GW-100, GW-103, and GW-141. The wells are either upgradient of waste disposal embankments or travel-time considerations eliminate the embankments as sources. The observed concentrations of thallium and selenium in groundwater are naturally occurring. At well GW-103, the selenium concentration may have been slightly modified by the presence of recharge from localized areas of surface water infiltration near the well.

Evaluation of Potential Remedial Actions: No remedial actions are warranted at this time. Energy*Solutions* will continue monthly monitoring of thallium at GW-26 and GW-100 and selenium at GW-103 and GW-141 until sufficient data are collected to support preparation of a background-based GWPL exception or until Energy*Solutions* proposes an alternative action.

ENERGYSOLUTIONS

Please contact me at 801-649-2000 with any questions regarding this submittal.

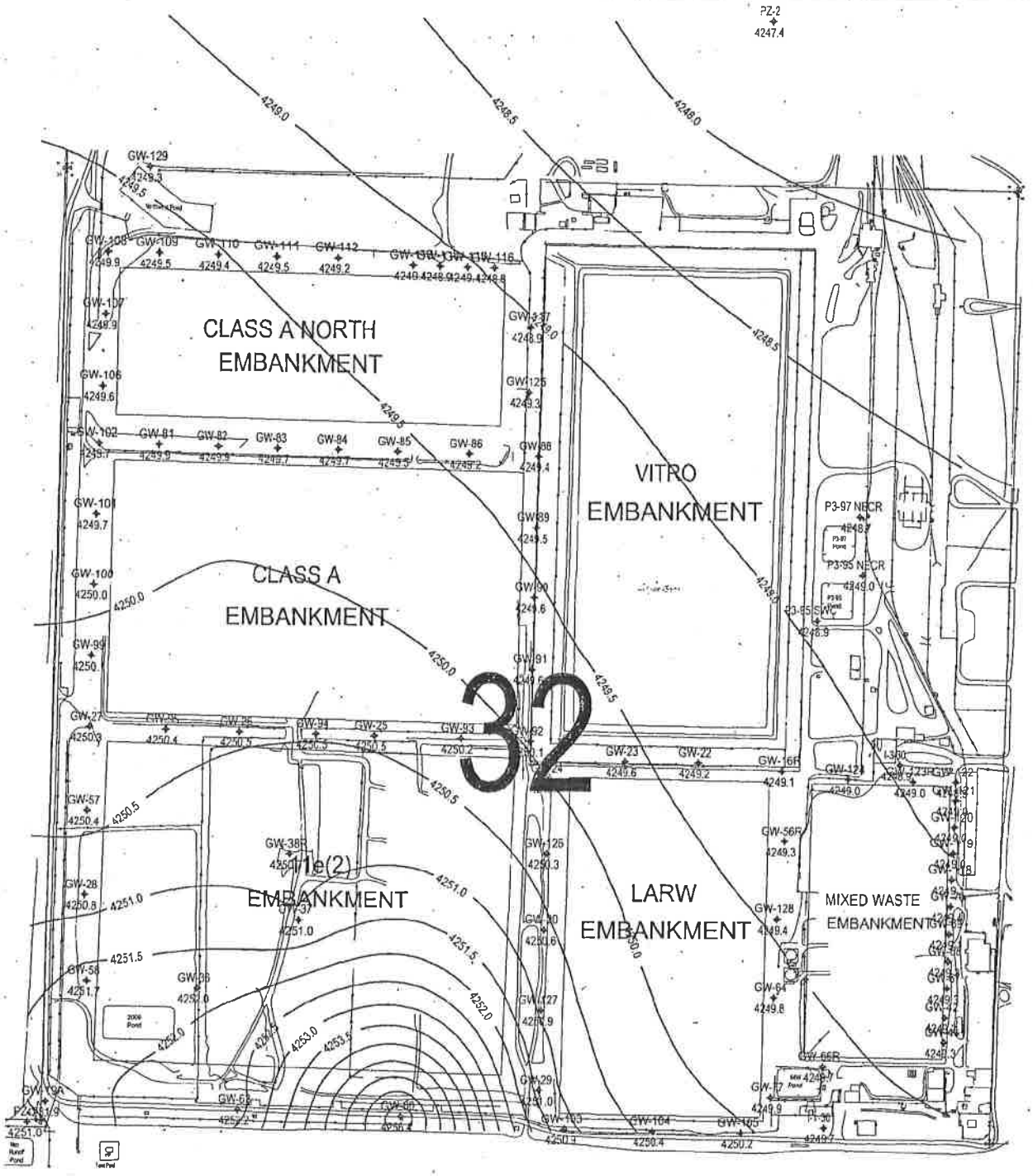
Sincerely,

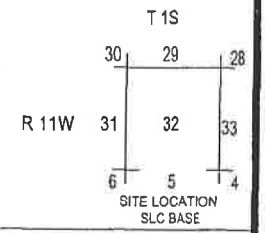
Sean McCandless
Director of Compliance and Permitting

enclosures

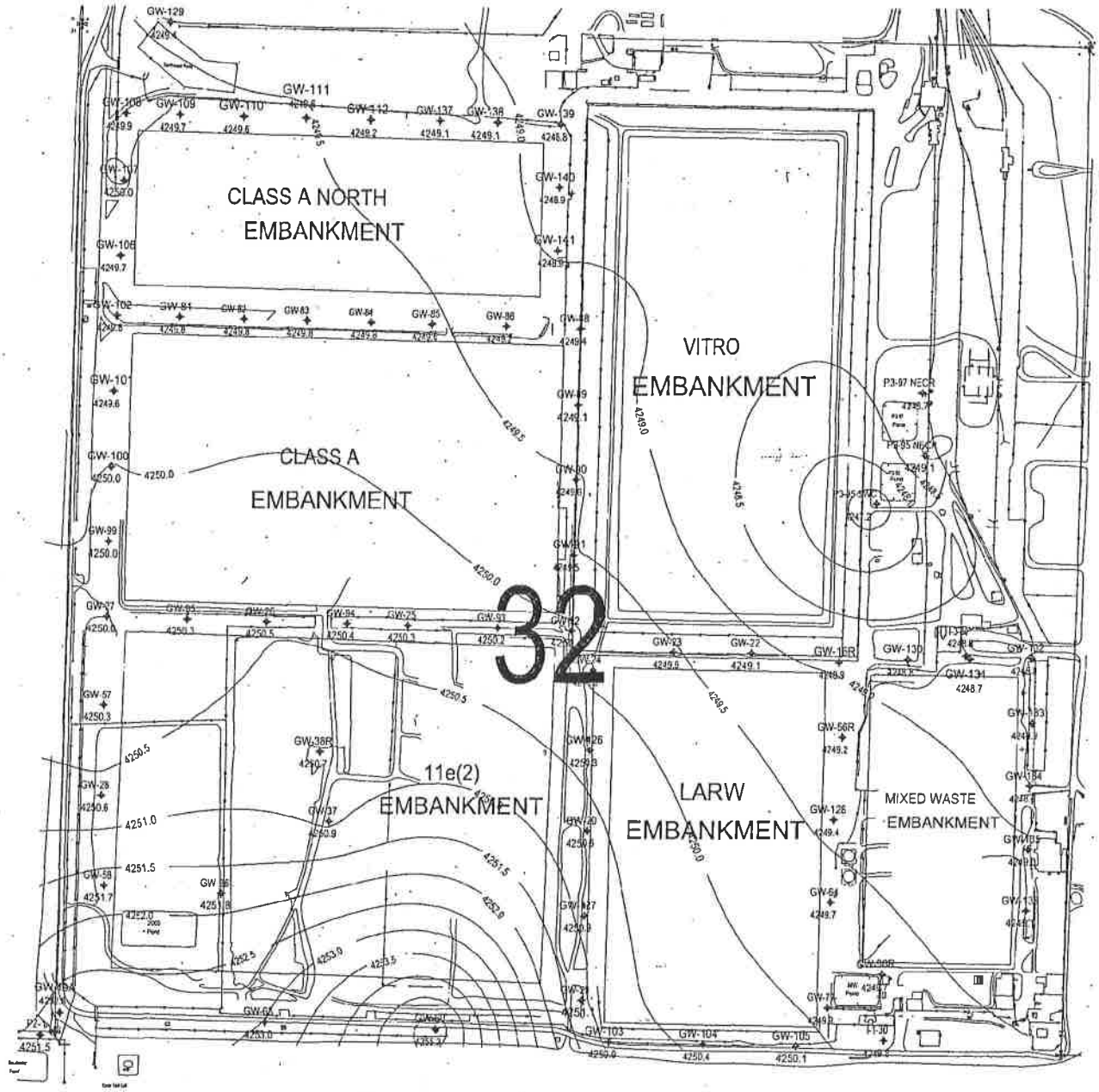
cc: Phil Goble, DRC (w/ encl.)
Tom Rushing, DRC (w/ encl.)

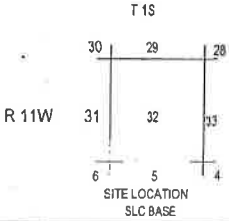
I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering, the information the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.





	DRAWN BY J. LOW	SECTION 32	SCALE 1 in. = 833 ft.
	CHECKED BY B. SOBOCINSKI	GROUNDWATER CONTOUR MAP	DATE 6/18/10
	APPROVED BY B. SOBOCINSKI	APRIL 2010 FRESH WATER	Figure 1
		CLIVE, UTAH	





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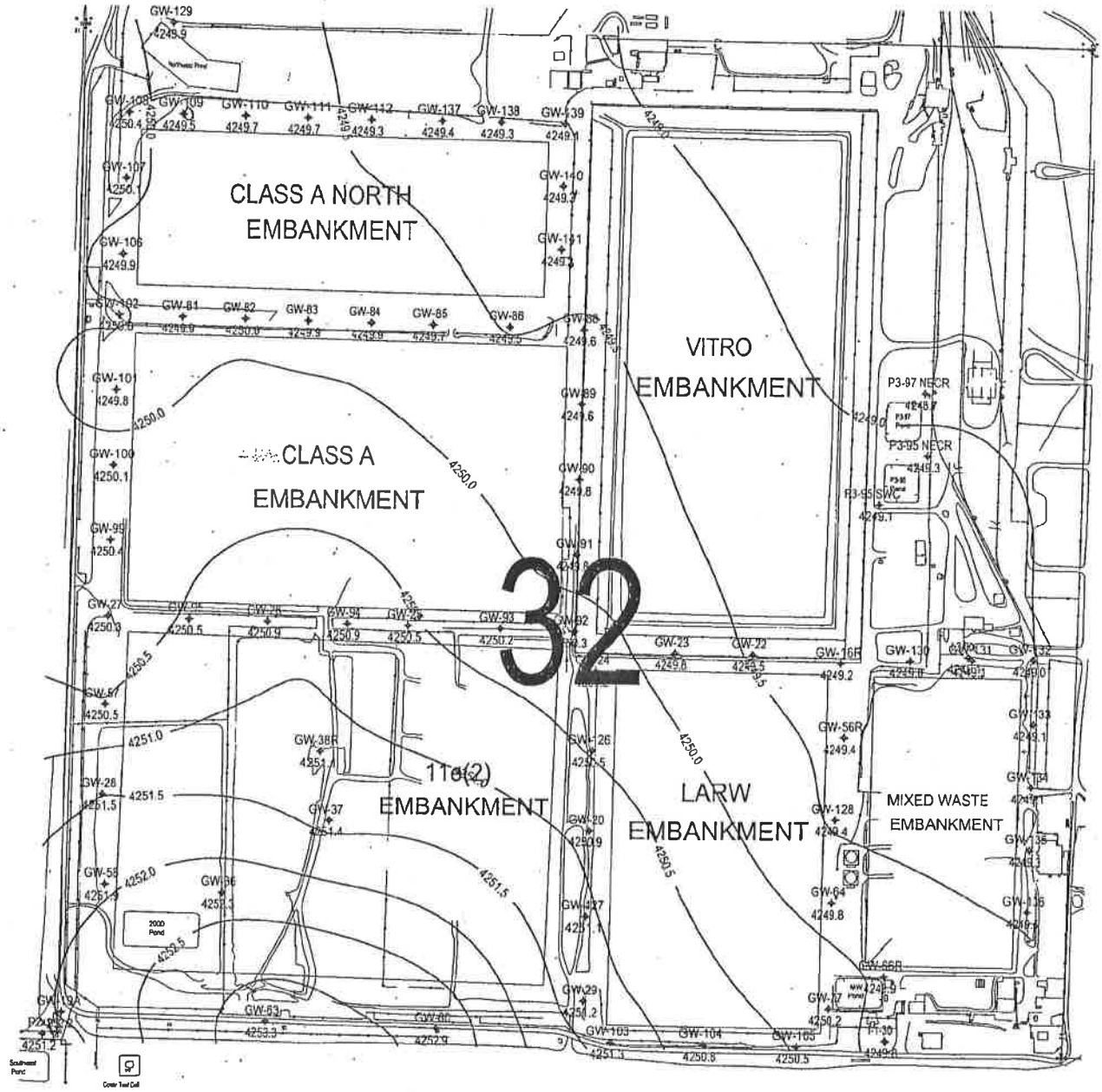
		CLIVE, UTAH	



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	APPROVED BY B. SOBOCINSKI	APRIL 2012 FRESH WATER	Figure 3
		CLIVE, UTAH	

Attachment D – Copy of ES December 26, 2013 Request

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DRC-2013-003794

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December 26, 2013

CD13-0358

RECEIVED
DEC 26 2013
DEPARTMENT OF
ENVIRONMENTAL QUALITY

Rusty Lundberg, Co-Director
Utah Division of Water Quality
195 North 1950 West
P.O. Box 144850
Salt Lake City, UT 84114-4850

Re: Groundwater Quality Discharge Permit (GWQDP) Number UGW450005: Request for Compliance Status Change and Request for Modification of Groundwater Protection Levels (GWPLs)

Dear Mr. Lundberg:

This letter requests a return to baseline monitoring status for several wells presently in probable out-of-compliance (POOC) and out-of-compliance (OOC) status. This letter also requests modification of GWQDP UGW45005 to include new or revised background-based GWPL exceptions. Table 1 lists each well and parameter included in this request, the current status, and the rationale for the return to baseline status.

Table 1 – Summary of Compliance Status Change Request

Well	Parameter	Current Status	Reason for Return to Baseline Status
GW-24	Selenium	POOC	revised background-based GWPL exception
GW-26	Thallium	OOC	background-based GWPL exception
GW-100	Thallium	OOC	background-based GWPL exception
GW-103	Selenium	OOC	background-based GWPL exception
GW-137	Ra-226+Ra-228	OOC	background-based GWPL exception
GW-137	Total Uranium	OOC	background-based GWPL exception
GW-138	Ra-226+Ra-228	POOC	background-based GWPL exception
GW-138	Selenium	OOC	background-based GWPL exception
GW-141	Selenium	OOC	background-based GWPL exception
P3-95 NECR	Thallium	POOC	five consecutive quarterly samples below GWPL

With the exception of selenium at well GW-103, all of the above parameters are currently in accelerated monitoring status because:

- They are associated with relatively "new" monitoring wells located north and east of the Class A West embankment. These wells were completed in the summer of 2009, and background-based GWPL exceptions have not yet been established for them. The wells

these "new" wells replaced had similar GWPL exceptions (e.g., GW-113 total uranium and Ra-226+Ra-228).

- They are background levels of thallium. In December 2009, the Division of Radiation Control (DRC) added thallium as a monitoring parameter to the GWQDP because the Utah Water Quality Board had recently established a protection level for it. The drinking-water-based universal GWPL for thallium, 0.002 milligrams per liter (mg/L), is equal to the analytical minimum detection limit (MDL). The combination of background levels of thallium and a universal GWPL established at the limit of detection contribute to the observed thallium exceedances.

As documented in the *Comprehensive Groundwater Quality Evaluation Report*, (CD12-0308; Energy*Solutions*, 2012a), Energy*Solutions* has thoroughly characterized background groundwater quality at the Clive facility. Continued accelerated monitoring of background conditions is not necessary for protection of human health and the environment.

Background-Based GWPL Exceptions

The enclosed technical memorandum provides details regarding the statistical evaluations used to develop GWPL exceptions. The Microsoft *Excel* add-in program *Analyse-it* (Analyse-it Software, Ltd., 2012) was used to identify outliers, perform normality testing, and to calculate the mean and standard deviation. *Analyse-it* is the same statistical package used to perform the statistical evaluation presented in the *Comprehensive Groundwater Quality Evaluation Report*.

For thallium at well GW-26, the Kaplan-Meier method (Kaplan and Meier, 1958) was used to calculate the mean and standard deviation of the dataset. This non-parametric method is used to address left-censored data sets where the frequency of detections is greater than 50%. It is recommended for this purpose in the U.S. EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA, 2009). This method was required because of the number of non-detections in GW-26 thallium dataset.

Table 2 provides a summary of the proposed background-based GWPL exceptions. Energy*Solutions* requests modification of the GWQDP to include these GWPL exceptions.

Table 2 – Summary of Background-Based GWPL Exceptions

Well	Parameter	Current GWPL or GWPL Exception	Proposed GWPL Exception
GW-24	Selenium	0.058 mg/L	0.0634 mg/L
GW-26	Thallium	0.002 mg/L	0.00255 mg/L
GW-100	Thallium	0.002 mg/L	0.00422 mg/L
GW-103	Selenium	0.05 mg/L	0.0580 mg/L
GW-137	Ra-226+Ra-228	5 pCi/L	5.54 pCi/L
GW-137	Total Uranium	0.03 mg/L	0.0371 mg/L
GW-138	Ra-226+Ra-228	5 pCi/L	5.51 pCi/L
GW-138	Selenium	0.05 mg/L	0.0695 mg/L
GW-141	Selenium	0.05 mg/L	0.0705 mg/L

P3-95 NECR Thallium

Monitoring well P3-95 NECR was first sampled for thallium in November 2009. Twelve P3-95 NECR groundwater samples have been analyzed for thallium, and the only result exceeding the universal GWPL of 0.002 mg/L (also the only result exceeding detection) was 0.00283 mg/L in a sample collected on May 24, 2012 as part of the annual event. Subsequently, thallium has been below detection (and below the GWPL) in five consecutive quarterly samples. Energy*Solutions* requests returning P3-95 NECR to baseline monitoring status based on the following:

- The most recent five quarterly thallium results are less than the GWPL. DRC has previously approved requests to return wells to baseline monitoring status based on four and five consecutive quarterly results less than the GWPL (DRC, 2007).

- The POOC status is based on a single detection, and detections near the MDL are often spurious.

- Even if the single detection is a representative concentration, it is within the range of background concentrations observed in other wells where thallium is detected with some consistency.

- It is thallium. The only thallium isotope reported in the facility manifest inventory having a half life greater than 12 days is Tl-204, with a half life of 3.78 years. The inventory of Tl-204 in all embankments combined was reported as 907.7 milliCuries or 2.1 milligrams of thallium (CD12-0318; Energy*Solutions*, 2012b).

Please contact me at 801-649-2000 with any questions regarding this submittal.

Sincerely,

for Sean McCandless
Manager, Compliance and Permitting

cc: Phil Goble, DRC
John Hultquist, DRC

Enclosures

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

References

Analyse-it Software, Ltd., 2012. *Analyse-it for Microsoft Excel.* Version 2.26.

Energy*Solutions*, 2012a. *Comprehensive Groundwater Quality Evaluation Report, Waste Disposal Facility, Clive, Utah.* Submitted to the Utah Division of Water Quality, December 10, 2012. CD12-0308.

Energy*Solutions*, 2012b. *Clive Facility Manifest Radioisotope Inventory Report.* Revision 1 Submitted to the Utah Division of Water Quality, December 19, 2012. CD12-0318.

Kaplan, E.L. and O. Meier, 1958. *Nonparametric Estimation from Incomplete Observations.* Journal of the American Statistical Association. Vol. 53, 457-481.

U.S. Environmental Protection Agency (EPA), 2009. *Statistical Analysis for Groundwater Monitoring Data at RCRA Facilities (Unified Guidance)*, EPA 530/R-09-007, March 2009.

Utah Division of Radiation Control (DRC). "March 1, 2006 Second Semi-Annual Groundwater Monitoring Report for 2005: Closeout Letter and Approval to Return to Baseline Monitoring Frequency," March 26, 2007. Letter from Dane L. Finerfrock, DRC, to Daniel B. Shrum, Energy*Solutions*, LLC.

TECHNICAL MEMORANDUM

To: Sean McCandless

From: Robert Sobocinski RWS

Subject: Statistical Evaluation to Support Development of Groundwater Protection Level (GWPL) Exceptions

Date: December 26, 2013

Introduction

In accordance with Part I.B.1 of the GWQDP, the mean plus two standard deviations of the background concentration was calculated and proposed as a GWPL exception for the following monitoring wells/parameters:

- GW-24 selenium
- GW-26 thallium
- GW-100 thallium
- GW-103 selenium
- GW-137 sum of radiums
- GW-137 total uranium
- GW-138 sum of radiums
- GW-138 selenium
- GW-141 selenium

This memorandum summarizes and documents the statistical process used to develop the GWPL exceptions.

Methodology

The methodology is as follows:

1) Define the data set for statistical evaluation (identify and remove outliers and remove duplicate results).
2) Perform statistical tests to demonstrate normality.
3) Calculate the proposed GWPL exception as the mean plus two standard deviations of the data set.

The statistical tests performed to demonstrate the normality of the background data sets are the following:

1) Comparison of skewness and kurtosis to values expected from a normal distribution,
2) The Shapiro-Wilk test, and
3) The Anderson-Darling test.

Details of the methodology are given in *Statistical Evaluation of Groundwater Data* (Enchemica LLC, 2009), submitted to DRC on February 2, 2009 (CD09-0031). The Microsoft *Excel* add-in program, *Analyse-it* (Analyse-it Software, Ltd., 2012), was used to perform the tests. This same statistical package was used to perform the statistical analyses presented in the *Comprehensive Groundwater Quality Evaluation Report* (Energy*Solutions*, 2012). Copies of *Analyse-it* output files are included in this document.

For thallium at well GW-26, the frequency of detection was 56.3%, and the Kaplan-Meier method (Kaplan and Meier, 1958) was used to calculate the mean and standard deviation. This non-parametric method is used to address left-censored data sets where the frequency of detection is greater than 50%. It is cited for this purpose in the U.S. EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("*Unified Guidance*," EPA, 2009). Normality testing was not performed in this case.

Results

Each monitoring well/parameter is discussed separately in the following sections.

GW-24 Selenium

A background-based Groundwater Protection Level (GWPL) exception of 0.058 milligrams per liter (mg/L) was previously established and approved for selenium in groundwater at GW-24 (Enchemica LLC, 2009). Due to technical issues with analysis of selenium in Clive groundwater, Enchemica LLC used only selenium data collected after January 2005. Because of the identified data issues and to maintain a dataset consistent with the approach used by Enchemica LLC, this analysis considered only GW-24 selenium data from 2005 to 2013.

The dataset, summary statistics, and results of normality testing are provided in Table 1. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic is less than its critical value (Table 1). Based on these results, selenium concentrations in groundwater at GW-24 are normally distributed. No outliers were identified or removed from the dataset.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 0.0634 mg/L (Table 1). One selenium result in the dataset exceeds this value.

GW-26 Thallium

A total of 16 groundwater samples have been collected from GW-26 and analyzed for thallium. Nine of the 16, or 56.3% of total samples, were detections. Per the U.S. EPA *Unified Guidance* (EPA, 2009), the Kaplan-Meier method is used to calculate estimates of the mean and standard deviation that account for the left-censored (non-detected) measurements. Beal (2010) states that because the Kaplan-Meier method is nonparametric; it is more robust with fewer assumptions than Cohen's Adjustment, simple substitution, or maximum likelihood estimators when at least half the samples are detections.

The dataset, summary statistics, and results of the Kaplan-Meier method are provided in Table 2. The Kaplan-Meier mean and standard deviation were calculated and used to develop the proposed GWPL exception of 0.00255 mg/L (Table 2). One thallium result in the dataset exceeds this value.

GW-100 Thallium

GW-100 groundwater has been analyzed for thallium since 2009. All available data were used in the statistical analysis to support the calculation of a background-based GWPL exception. Excluding duplicates, 21 thallium results were available, and 18 of them (85.7%) were greater than detection limits. In accordance with the *Unified Guidance*, because dataset is comprised of less than 15% non-detections, the non-detections were used, and the calculations were performed. For the three non-detections, the reporting limit (RL) was used to represent the results. One-half of the RL, rather than the RL itself, could have been substituted, but the resulting difference in the GWPL is negligible (0.00422 mg/L for the chosen method of using the RL itself vs. 0.00442 mg/L if using ½ the RL).

The dataset, summary statistics, and results of normality testing are provided in Table 3. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic is less than its critical value (Table 3). Based on these results, thallium concentrations in groundwater at GW-100 are normally distributed. No outliers were identified or removed from the dataset.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 0.00422 mg/L (Table 3). One thallium result in the dataset exceeds this value.

GW-103 Selenium

For the reasons discussed above for selenium at GW-24, this analysis considered only GW-103 selenium data from 2005 to 2013.

The dataset, summary statistics, and results of normality testing are provided in Table 4. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic

is less than its critical value (Table 4). Based on these results, selenium concentrations in groundwater at GW-103 are normally distributed.

Analyse-it identified three selenium results (the three highest concentrations in the dataset) as outliers (see Table 4). These results were identified as outliers because they were outside of 1.5 times the interquartile range. They were removed from the dataset prior to statistical analysis.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 0.0580 mg/L (Table 4). Four selenium results in the dataset exceed this value. Three of the four were identified as outliers as discussed above.

GW-137 Sum of Radiums

GW-137 has been sampled for radium-226 and radium-228 since its installation in 2009. All available radium data were used in the statistical analysis to support the calculation of a background-based GWPL exception.

The dataset, summary statistics, and results of normality testing are provided in Table 5. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic is less than its critical value (Table 5). Based on these results, the sum of radium-226 and radium-228 concentrations in groundwater at GW-137 is normally distributed.

Analyse-it identified two results (the highest and lowest concentrations in the dataset) as outliers (see Table 5). These results were identified because they were outside of 1.5 times the interquartile range. They were removed from the dataset prior to statistical analysis.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 5.54 picoCuries per liter (pCi/L) (Table 5). Two sum-of-radiums results in the dataset exceed this value. One of the two was identified as an outlier as discussed above.

GW-137 Total Uranium

GW-137 has been sampled for total uranium since its installation in 2009. All available total uranium data were used in the statistical analysis to support the calculation of a background-based GWPL exception.

The dataset, summary statistics, and results of normality testing are provided in Table 6. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic is less than its critical value (Table 6). Based on these results, total uranium concentrations in groundwater at GW-137 are normally distributed. No outliers were identified or removed from the dataset.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 0.0371 mg/L (Table 6). No total uranium results from GW-137 exceeded this value.

GW-138 Sum of Radiums

GW-138 has been sampled for radium-226 and radium-228 since its installation in 2009. All available radium data were used in the statistical analysis to support the calculation of a background-based GWPL exception.

The dataset, summary statistics, and results of normality testing are provided in Table 7. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic is less than its critical value (Table 7). Based on these results, the sum of radium-226 and radium-228 concentrations in groundwater at GW-138 is normally distributed. No outliers were identified or removed from the dataset.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 5.51 pCi/L (Table 7). No sum-of-radiums results from GW-138 exceeded this value.

GW-138 Selenium

GW-138 has been sampled for selenium since its installation in 2009. All available selenium data were used in the statistical analysis to support the calculation of a background-based GWPL exception.

The dataset, summary statistics, and results of normality testing are provided in Table 8. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic is less than its critical value (Table 8). Based on these results, selenium concentrations in groundwater at GW-138 are normally distributed. No outliers were identified or removed from the dataset.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 0.0695 mg/L (Table 8). Two selenium results in the dataset exceed this value.

GW-141 Selenium

GW-141 has been sampled for selenium since its installation in 2009. All available selenium data were used in the statistical analysis to support the calculation of a background-based GWPL exception.

The dataset, summary statistics, and results of normality testing are provided in Table 9. The absolute values of skewness and kurtosis are less than respective critical values, the Shapiro-Wilk statistic is greater than the critical value, and the Anderson-Darling statistic is less than its critical value (Table 9). Based on these results, selenium concentrations in

groundwater at GW-141 are normally distributed. No outliers were identified or removed from the dataset.

The mean and standard deviation were calculated and used to develop the proposed GWPL exception of 0.0705 mg/L (Table 9). Two selenium results in the dataset exceed this value.

References

Analyse-it Software, Ltd., 2012. *Analyse-it for Microsoft Excel.* Version 2.26.

Beal, D., 2010. *A Macro for Calculating Summary Statistics on Left Censored Environmental Data using the Kaplan-Meier Method.* Paper SDA-09, Proceedings of the Southeast SAS Users Group (SESUG) 2010 Conference.

Enchemica LLC, 2009. *Statistical Evaluation of Groundwater Data.* Technical Memorandum from Janet Schramke to Daniel B. Shrum, January 30, 2009. Submitted to DRC on February 2, 2009 (CD09-0031).

Energy*Solutions*, 2012. *Comprehensive Groundwater Quality Evaluation Report, Waste Disposal Facility, Clive, Utah.* Submitted to the Utah Division of Water Quality, December 10, 2012. CD12-0308.

Kaplan, E.L. and O. Meier, 1958. *Nonparametric Estimation from Incomplete Observations.* Journal of the American Statistical Association. Vol. 53, 457-481.

U.S. Environmental Protection Agency (EPA), 2009. *Statistical Analysis for Groundwater Monitoring Data at RCRA Facilities (Unified Guidance)*, EPA 530/R-09-007, March 2009.

Table 1 - Well GW-24 Selenium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Selenium (mg/L)
GW-24	3/24/2005	AWAL	Y	0.036 J
GW-24	9/22/2005	AWAL	Y	0.036 J
GW-24	3/22/2006	AWAL	Y	0.043
GW-24	9/14/2006	AWAL	Y	0.040
GW-24	3/19/2007	AWAL	Y	0.051
GW-24	5/9/2007	AWAL	Y	0.048
GW-24	7/23/2007	AWAL	Y	0.051
GW-24	8/23/2007	AWAL	Y	0.063
GW-24	9/17/2007	AWAL	Y	0.054
GW-24	10/4/2007	AWAL	Y	0.050
GW-24	11/5/2007	AWAL	Y	0.043
GW-24	12/10/2007	AWAL	Y	0.044
GW-24	1/22/2008	AWAL	Y	0.043
GW-24	2/11/2008	AWAL	Y	0.043
GW-24	3/5/2008	AWAL	Y	0.046
GW-24	4/3/2008	AWAL	Y	0.044
GW-24	5/6/2008	AWAL	Y	0.047
GW-24	6/5/2008	AWAL	Y	0.044
GW-24	7/10/2008	AWAL	Y	0.049
GW-24	8/11/2008	AWAL	Y	0.047
GW-24	9/9/2008	AWAL	Y	0.053
GW-24	10/16/2008	AWAL	Y	0.047
GW-24	11/3/2008	AWAL	Y	0.049
GW-24	12/9/2008	AWAL	Y	0.047
GW-24	1/13/2009	AWAL	Y	0.056
GW-24	2/5/2009	AWAL	Y	0.045
GW-24	3/10/2009	AWAL	Y	0.053
GW-24	4/14/2009	AWAL	Y	0.055
GW-24	5/5/2009	AWAL	Y	0.047
GW-24	6/25/2009	AWAL	Y	0.046
GW-24	7/15/2009	AWAL	Y	0.047
GW-24	8/13/2009	AWAL	Y	0.050
GW-24	9/17/2009	AWAL	Y	0.052
GW-24	10/14/2009	AWAL	Y	0.055
GW-24	11/30/2009	AWAL	Y	0.061
GW-24	12/8/2009	AWAL	Y	0.054
GW-24	1/21/2010	AWAL	Y	0.057
GW-24	2/3/2010	AWAL	Y	0.054
GW-24	3/3/2010	AWAL	Y	0.056
GW-24	4/8/2010	AWAL	Y	0.055
GW-24	5/25/2010	AWAL	Y	0.060

Table 1 - Well GW-24 Selenium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Selenium (mg/L)
GW-24	8/12/2010	AWAL	Y	0.0563
GW-24	10/19/2010	AWAL	Y	0.0538
GW-24	3/22/2011	AWAL	Y	0.0564
GW-24	6/28/2011	AWAL	Y	0.0458
GW-24	9/19/2011	AWAL	Y	0.0543
GW-24	12/15/2011	AWAL	Y	0.0483
GW-24	1/10/2012	AWAL	Y	0.0424
GW-24	4/2/2012	AWAL	Y	0.0511
GW-24	9/18/2012	AWAL	Y	0.0560
GW-24 Dup.	9/18/2012	AWAL	N	0.0600
GW-24	11/15/2012	AWAL	Y	0.0463
GW-24	3/18/2013	AWAL	Y	0.0698
GW-24	4/29/2013	AWAL	Y	0.0507
GW-24	9/10/2013	AWAL	Y	0.0598
Number of samples				54
Minimum				0.0360
Maximum				0.0698
Median				0.0500
Mean				0.0502
Standard Deviation				0.0066
Variance				4.34E-05
Mean + 2 standard deviations				0.0634
Skewness				0.306
2 x standard error of skewness (SES)				0.667
Kurtosis				0.528
2 x standard error of kurtosis (SEK)				1.333
Shapiro-Wilk test statistic				0.981
Shapiro-Wilk test critical value ($\alpha = 0.05$)				0.947
Anderson-Darling test statistic				0.344
Anderson-Darling test critical value ($\alpha = 0.05$)				0.752
Number of analyses greater than proposed GWPL exception				1
Percent of analyses greater than proposed GWPL exception				1.9%

Selenium crit. 0.05

[a] Duplicate results not used in statistical analysis
AWAL = American West Analytical Laboratories

Table 2 - Well GW-26 Thallium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Thallium (mg/L)
GW-26	5/26/2011	AWAL	Y	< 0.00100
GW-26	4/26/2012	AWAL	Y	0.00235
GW-26	9/17/2012	AWAL	Y	0.00231
GW-26	10/29/2012	AWAL	Y	0.00247
GW-26	11/21/2012	AWAL	Y	0.00226
GW-26	12/6/2012	AWAL	Y	< 0.00200
GW-26	1/28/2013	AWAL	Y	< 0.00200
GW-26	2/15/2013	AWAL	Y	< 0.00200
GW-26	3/11/2013	AWAL	Y	0.00236
GW-26	4/2/2013	AWAL	Y	< 0.00200 J
GW-26	5/16/2013	AWAL	Y	0.00203
GW-26	6/4/2013	AWAL	Y	< 0.00200
GW-26	7/9/2013	AWAL	Y	< 0.00200
GW-26	8/12/2013	AWAL	Y	0.00234 J
GW-26	9/9/2013	AWAL	Y	0.00256
GW-26	10/21/2013	AWAL	Y	0.00217
Number of samples				16
Minimum				< 0.00100
Maximum				0.00256
Median				0.00210
Mean[b]				0.00212
Standard Deviation[b]				0.00035
Variance[b]				1.25E-07
Kaplan-Meier Mean				0.00219
Kaplan-Meier Standard Deviation				0.00018
Kaplan-Meier Variance				3.23E-08
Kaplan-Meier Mean + 2 standard deviations				0.00255
Number of analyses greater than proposed GWPL exception				1
Percent of analyses greater than proposed GWPL exception				6.3%

proposed 0.00255 mg/L
current 0.002 mg/L

[a] Duplicate results not used in statistical analysis

[b] Calculation includes non-detections, reporting limit substituted for each non-detectio

AWAL = American West Analytical Laboratories

Table 3 - Well GW-100 Thallium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Thallium (mg/L)
GW-100	12/1/2009	AWAL	Y	< 0.0020
GW-100	3/8/2010	AWAL	Y	< 0.0010
GW-100	4/29/2010	AWAL	Y	< 0.0010
GW-100	8/3/2010	AWAL	Y	0.00182
GW-100	12/8/2010	AWAL	Y	0.00120
GW-100	6/8/2011	AWAL	Y	0.00187
GW-100	5/9/2012	AWAL	Y	0.00335
GW-100	9/18/2012	AWAL	Y	0.00288
GW-100	10/29/2012	AWAL	Y	0.00361
GW-100 Dup.	10/29/2012	AWAL	N	0.00282
GW-100	11/15/2012	AWAL	Y	0.00275
GW-100 Dup.	11/15/2012	AWAL	N	0.00273
GW-100	12/4/2012	AWAL	Y	0.00346
GW-100 Dup.	12/4/2012	AWAL	N	0.00286
GW-100	1/10/2013	AWAL	Y	0.00285
GW-100 Dup.	1/10/2013	AWAL	N	0.00421
GW-100	2/14/2013	AWAL	Y	0.00305
GW-100 Dup.	2/14/2013	AWAL	N	0.00292
GW-100	3/18/2013	AWAL	Y	0.00259
GW-100 Dup.	3/18/2013	AWAL	N	0.00266
GW-100	4/8/2013	AWAL	Y	0.00257
GW-100	5/2/2013	AWAL	Y	0.00267
GW-100 Dup.	5/2/2013	AWAL	N	0.00267
GW-100	6/23/2013	AWAL	Y	0.00439
GW-100 Dup.	6/23/2013	AWAL	N	0.00254
GW-100	7/8/2013	AWAL	Y	0.00255
GW-100 Dup.	7/8/2013	AWAL	N	0.00398
GW-100	8/22/2013	AWAL	Y	0.00202 J
GW-100 Dup.	8/22/2013	AWAL	N	0.00285 J
GW-100	9/10/2013	AWAL	Y	0.00250
GW-100 Dup.	9/10/2013	AWAL	N	0.00241
GW-100	10/24/2013	AWAL	Y	0.00261
GW-100 Dup.	10/24/2013	AWAL	N	0.00257
Number of samples				21
Minimum				0.0010
Maximum				0.0044
Median				0.0026
Mean				0.0025
Standard Deviation				0.0009
Variance				7.33E-07
Mean + 2 standard deviations				0.00422
Skewness				-0.030
2 x standard error of skewness (SES)				1.069
Kurtosis				0.167
2 x standard error of kurtosis (SEK)				2.138
Shapiro-Wilk test statistic				0.963
Shapiro-Wilk test critical value ($\alpha = 0.05$)				0.908
Anderson-Darling test statistic				0.357
Anderson-Darling test critical value ($\alpha = 0.05$)				0.752
Number of analyses greater than proposed GWPL exception				1
Percent of analyses greater than proposed GWPL exception				4.8%

proposed .00422
GWPL .002 mg/L

[a] Duplicate results not used in statistical analysis
AWAL = American West Analytical Laboratories

Table 4 - Well GW-103 Selenium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Selenium (mg/L)
GW-103	3/30/2005	AWAL	N[b]	0.096 J
GW-103 Dup	3/30/2005	AWAL	N	< 0.005
GW-103	10/6/2005	AWAL	Y	0.044
GW-103	4/18/2006	AWAL	Y	0.046
GW-103	10/9/2006	AWAL	Y	0.038
GW-103	4/30/2007	AWAL	Y	0.042
GW-103	10/3/2007	AWAL	Y	0.033
GW-103	4/2/2008	AWAL	Y	0.042
GW-103	9/15/2008	AWAL	Y	0.046
GW-103	3/10/2009	AWAL	Y	0.045
GW-103	12/9/2009	AWAL	Y	0.045
GW-103	7/26/2010	AWAL	Y	0.0428
GW-103	6/13/2011	AWAL	Y	0.0440
GW-103	4/10/2012	AWAL	N[b]	0.0673
GW-103	9/18/2012	AWAL	Y	0.0553
GW-103	10/29/2012	AWAL	Y	0.0479 J
GW-103	11/15/2012	AWAL	Y	0.0446
GW-103	12/4/2012	AWAL	Y	0.0470
GW-103	1/10/2013	AWAL	Y	0.0591
GW-103	2/14/2013	AWAL	Y	0.0408 J
GW-103	3/11/2013	AWAL	N[b]	0.0673
GW-103	4/10/2013	AWAL	Y	0.0424
GW-103	5/9/2013	AWAL	Y	0.0496
GW-103	6/26/2013	AWAL	Y	0.0387 J
GW-103	7/8/2013	AWAL	Y	0.0334
GW-103	8/22/2013	AWAL	Y	0.0517
GW-103	9/11/2013	AWAL	Y	0.0578
GW-103	10/24/2013	AWAL	Y	0.0431
Number of samples				24
Minimum				0.0330
Maximum				0.0591
Median				0.0443
Mean				0.0450
Standard Deviation				0.0065
Variance				4.21E-05
Mean + 2 standard deviations				0.0580
Skewness				0.429
2 x standard error of skewness (SES)				1.000
Kurtosis				0.502
2 x standard error of kurtosis (SEK)				2.000
Shapiro-Wilk test statistic				0.951
Shapiro-Wilk test critical value ($\alpha = 0.05$)				0.916
Anderson-Darling test statistic				0.523
Anderson-Darling test critical value ($\alpha = 0.05$)				0.752
Number of analyses greater than proposed GWPL exception				4
Percent of analyses greater than proposed GWPL exception				16.7%

proposed 0.0580 mg/L
GWPL 0.05 mg/L

[a] Duplicate results not used in statistical analysis

[b] Identified as an outlier, not included in statistical analysis

AWAL = American West Analytical Laboratories

Table 5 - Well GW-137 Sum of Radiums Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Radium-226 (pCi/L)	Radium-228 (pCi/L)	Sum of Radiums (pCi/L)
GW-137	11/5/2009	TAR	N[b]	1.83 ± 0.26	< 0.59 ± 0.21	2.42 ± 0.33
GW-137 Dup.	11/5/2009	TAR	N	2.37 ± 0.34	1.52 ± 0.23	3.89 ± 0.41
GW-137	2/16/2010	TAR	Y	2.31 ± 0.39	1.35 ± 0.24	3.66 ± 0.46
GW-137	4/28/2010	TAR	Y	2.17 ± 0.40	1.76 ± 0.23	3.93 ± 0.46
GW-137	7/22/2010	TAR	Y	2.65 ± 0.34	1.63 ± 0.29	4.28 ± 0.45
GW-137	5/3/2011	TAR	Y	3.40 ± 0.38	1.73 ± 0.38	5.13 ± 0.54
GW-137	7/14/2011	TAR	Y	2.79 ± 0.34	1.65 ± 0.27	4.44 ± 0.43
GW-137	12/15/2011	TAR	Y	3.07 ± 0.66	2.46 ± 0.34	5.53 ± 0.74
GW-137 Dup.	12/15/2011	TAR	N	2.44 ± 0.59	1.93 ± 0.27	4.37 ± 0.65
GW-137	1/10/2012	TAR	Y	2.91 ± 0.72	1.39 ± 0.45	4.30 ± 0.85
GW-137 Dup.	1/10/2012	TAR	N	2.98 ± 0.75	2.16 ± 0.51	5.14 ± 0.91
GW-137	2/27/2012	TAR	Y	2.68 ± 0.52	1.62 ± 0.47	4.30 ± 0.70
GW-137 Dup.	2/27/2012	TAR	N	2.96 ± 0.61	2.71 ± 0.50	5.67 ± 0.79
GW-137	3/15/2012	TAR	N[b]	3.57 ± 0.81	3.23 ± 0.40	6.80 ± 0.90
GW-137 Dup.	3/15/2012	TAR	N	2.67 ± 0.66	2.42 ± 0.32	5.09 ± 0.73
GW-137	4/23/2012	TAR	Y	2.74 ± 0.44	2.14 ± 0.31	4.88 ± 0.54
GW-137	5/8/2012	TAR	Y	2.41 ± 0.43	2.18 ± 0.32	4.59 ± 0.54
GW-137 Dup.	5/8/2012	TAR	N	1.95 ± 0.47	2.33 ± 0.28	4.28 ± 0.55
GW-137	6/28/2012	TAR	Y	3.00 ± 0.57	1.92 ± 0.40	4.92 ± 0.70
GW-137 Dup.	6/28/2012	TAR	N	2.67 ± 0.55	1.11 ± 0.40	3.78 ± 0.68
GW-137	7/26/2012	TAR	Y	2.34 ± 0.70	2.21 ± 0.43	4.55 ± 0.82
GW-137 Dup.	7/26/2012	TAR	N	3.15 ± 0.68	1.51 ± 0.56	4.66 ± 0.88
GW-137	8/24/2012	TAR	Y	2.79 ± 0.61	2.44 ± 0.26	5.23 ± 0.66
GW-137 Dup.	8/24/2012	TAR	N	2.67 ± 0.34	1.81 ± 0.17	4.48 ± 0.38
GW-137	9/19/2012	TAR	Y	2.70 ± 0.47	2.09 ± 0.29	4.79 ± 0.55
GW-137 Dup.	9/19/2012	TAR	N	2.85 ± 0.41	1.97 ± 0.29	4.82 ± 0.50
GW-137	10/29/2012	TAR	Y	2.84 ± 0.40	1.65 ± 0.32	4.49 ± 0.51
GW-137 Dup.	10/29/2012	TAR	N	2.71 ± 0.35	1.59 ± 0.29	4.30 ± 0.45
GW-137	11/15/2012	TAR	Y	3.09 ± 0.38	1.99 ± 0.35	5.08 ± 0.52
GW-137 Dup.	11/15/2012	TAR	N	2.96 ± 0.37	1.89 ± 0.35	4.85 ± 0.51
GW-137	12/4/2012	TAR	Y	3.06 ± 0.42	1.68 ± 0.27	4.74 ± 0.50
GW-137 Dup.	12/4/2012	TAR	N	2.03 ± 0.41	1.80 ± 0.24	3.83 ± 0.48
GW-137	1/10/2013	TAR	Y	3.25 ± 0.49	1.94 ± 0.30	5.19 ± 0.57
GW-137 Dup.	1/10/2013	TAR	N	2.40 ± 0.44	1.89 ± 0.23	4.29 ± 0.50
GW-137	2/26/2013	TAR	Y	2.79 ± 0.46	1.64 J ± 0.32	4.43 ± 0.56
GW-137 Dup.	2/26/2013	TAR	N	2.35 ± 0.39	1.47 J ± 0.24	3.82 ± 0.46
GW-137	3/18/2013	TAR	Y	2.91 ± 0.34	1.58 J ± 0.30	4.49 ± 0.45
GW-137 Dup.	3/18/2013	TAR	N	1.57 ± 0.38	1.75 J ± 0.23	3.32 ± 0.44
GW-137	4/22/2013	TAR	Y	3.16 ± 0.33	1.82 ± 0.40	4.98 ± 0.52
GW-137	5/9/2013	TAR	Y	3.38 ± 0.35	1.88 ± 0.38	5.26 ± 0.52
GW-137 Dup.	5/9/2013	TAR	N	2.54 ± 0.32	2.03 ± 0.41	4.57 ± 0.52

Table 5 - Well GW-137 Sum of Radiums Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Radium-226 (pCi/L)	Radium-228 (pCi/L)	Sum of Radiums (pCi/L)
GW-137	6/26/2013	TAR	Y	2.77 ± 0.30	1.71 ± 0.41	4.48 ± 0.51
GW-137 Dup.	6/26/2013	TAR	N	2.41 ± 0.29	1.86 ± 0.47	4.27 ± 0.55
GW-137	7/8/2013	TAR	Y	2.90 ± 0.32	1.85 ± 0.39	4.75 ± 0.50
GW-137 Dup.	7/8/2013	TAR	N	2.86 ± 0.31	1.69 ± 0.38	4.55 ± 0.49
GW-137	8/22/2013	TAR	Y	2.86 ± 0.34	1.45 ± 0.41	4.31 ± 0.53
GW-137 Dup.	8/22/2013	TAR	N	2.86 ± 0.31	1.46 ± 0.39	4.32 ± 0.50
GW-137	9/10/2013	TAR	Y	3.00 ± 0.32	1.87 ± 0.39	4.87 ± 0.50
GW-137 Dup.	9/10/2013	TAR	N	2.69 ± 0.30	1.87 ± 0.37	4.56 ± 0.48
Number of samples						26
Minimum						3.66
Maximum						5.53
Median						4.67
Mean						4.68
Standard Deviation						0.432
Variance						0.187
Mean + 2 standard deviations						5.54
Skewness						-0.213
2 x standard error of skewness (SES)						0.961
Kurtosis						0.048
2 x standard error of kurtosis (SEK)						1.922
Shapiro-Wilk test statistic						0.980
Shapiro-Wilk test critical value ($\alpha = 0.05$)						0.920
Anderson-Darling test statistic						0.236
Anderson-Darling test critical value ($\alpha = 0.05$)						0.752
Number of analyses greater than proposed GWPL exception						2
Percent of analyses greater than proposed GWPL exception						7.7%

prop: 5.54 pCi/L
GWPL 5 pCi/L

[a] Duplicate results not used in statistical analysis

[b] Identified as an outlier, not included in statistical analysis

TAR = TestAmerica Richland

Table 6 - Well GW-137 Total Uranium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Total Uranium (mg/L)
GW-137	11/5/2009	TAR	Y	0.0230
GW-137 Dup.	11/5/2009	TAR	N	0.0237
GW-137	2/16/2010	TAR	Y	0.0179
GW-137	4/28/2010	TAR	Y	0.0154
GW-137	7/22/2010	TAR	Y	0.0184
GW-137	5/3/2011	TAR	Y	0.0270
GW-137	4/23/2012	TAR	Y	0.0354
GW-137	9/19/2012	TAR	Y	0.0291
GW-137 Dup.	9/19/2012	TAR	N	0.0319
GW-137	10/29/2012	TAR	Y	0.0331
GW-137 Dup.	10/29/2012	TAR	N	0.0279
GW-137	11/15/2012	TAR	Y	0.0358
GW-137 Dup.	11/15/2012	TAR	N	0.0335
GW-137	12/4/2012	TAR	Y	0.0296
GW-137 Dup.	12/4/2012	TAR	N	0.0238
GW-137	1/10/2013	TAR	Y	0.0289
GW-137 Dup.	1/10/2013	TAR	N	0.0253
GW-137	2/26/2013	TAR	Y	0.0241
GW-137 Dup.	2/26/2013	TAR	N	0.0249
GW-137	3/18/2013	TAR	Y	0.0237
GW-137 Dup.	3/18/2013	TAR	N	0.0252
GW-137	4/22/2013	TAR	Y	0.0260
GW-137	5/9/2013	TAR	Y	0.0291
GW-137 Dup.	5/9/2013	TAR	N	0.0240
GW-137	6/26/2013	TAR	Y	0.0212
GW-137 Dup.	6/26/2013	TAR	N	0.0249
GW-137	7/8/2013	TAR	Y	0.0202
GW-137 Dup.	7/8/2013	TAR	N	0.0235
GW-137	8/22/2013	TAR	Y	0.0259
GW-137 Dup.	8/22/2013	TAR	N	0.0245
GW-137	9/10/2013	TAR	Y	0.0218
GW-137 Dup.	9/10/2013	TAR	N	0.0234
Number of samples				19
Minimum				0.0154
Maximum				0.0358
Median				0.0259
Mean				0.0256
Standard Deviation				0.0058
Variance				3.34E-05
Mean + 2 standard deviations				0.0371
Skewness				0.152
2 x standard error of skewness (SES)				1.124
Kurtosis				-0.612
2 x standard error of kurtosis (SEK)				2.248
Shapiro-Wilk test statistic				0.975
Shapiro-Wilk test critical value ($\alpha = 0.05$)				0.901
Anderson-Darling test statistic				0.167
Anderson-Darling test critical value ($\alpha = 0.05$)				0.752
Number of analyses greater than proposed GWPL exception				0
Percent of analyses greater than proposed GWPL exception				0.0%

proposed 0.0371 mg/L

GWPL 0.03 mg/L

[a] Duplicate results not used in statistical analysis
TAR = TestAmerica Richland

Table 7 - Well GW-138 Sum of Radiums Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Radium-226 (pCi/L)	Radium-228 (pCi/L)	Sum of Radiums (pCi/L)
GW-138	11/5/2009	TAR	Y	2.34 ± 0.24	2.25 ± 0.40	4.59 ± 0.47
GW-138	2/16/2010	TAR	Y	1.91 ± 0.24	1.77 ± 0.38	3.68 ± 0.45
GW-138	4/28/2010	TAR	Y	2.17 ± 0.25	2.46 ± 0.44	4.63 ± 0.51
GW-138	7/22/2010	TAR	Y	1.77 ± 0.24	1.91 ± 0.38	3.68 ± 0.45
GW-138	5/3/2011	TAR	Y	1.68 ± 0.24	2.09 ± 0.39	3.77 ± 0.46
GW-138	4/23/2012	TAR	Y	2.52 ± 0.31	2.64 ± 0.48	5.16 ± 0.57
GW-138	9/19/2012	TAR	Y	2.49 ± 0.29	2.16 ± 0.44	4.65 ± 0.53
GW-138	11/15/2012	TAR	Y	2.35 ± 0.33	2.57 ± 0.42	4.92 ± 0.53
GW-138	3/18/2013	TAR	Y	1.86 ± 0.25	1.80 ± 0.42	3.66 ± 0.49
GW-138	4/22/2013	TAR	Y	1.05 ± 0.21	2.11 ± 0.39	3.16 ± 0.44
GW-138 Dup.	4/22/2013	TAR	N	2.10 ± 0.26	2.25 ± 0.41	4.35 ± 0.49
GW-138	9/10/2013	TAR	Y	2.48 ± 0.29	2.04 ± 0.40	4.52 ± 0.49
Number of samples						11
Minimum						3.16
Maximum						5.16
Median						4.52
Mean						4.22
Standard Deviation						0.646
Variance						0.418
Mean + 2 standard deviations						5.51
Skewness						-0.169
2 x standard error of skewness (SES)						1.477
Kurtosis						-1.348
2 x standard error of kurtosis (SEK)						2.954
Shapiro-Wilk test statistic						0.911
Shapiro-Wilk test critical value ($\alpha = 0.05$)						0.850
Anderson-Darling test statistic						0.547
Anderson-Darling test critical value ($\alpha = 0.05$)						0.752
Number of analyses greater than proposed GWPL exception						0
Percent of analyses greater than proposed GWPL exception						0.0%

pCi/L
5.51 pCi/L
GWPL
5 pCi/L

[a] Duplicate results not used in statistical analysis
TAR = TestAmerica Richland

Table 8 - Well GW-138 Selenium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Selenium (mg/L)
GW-138	11/5/2009	AWAL	Y	0.0520
GW-138	2/16/2010	AWAL	Y	0.0510
GW-138	4/28/2010	AWAL	Y	0.0500
GW-138	7/22/2010	AWAL	Y	0.0518
GW-138	10/19/2010	AWAL	Y	0.0421
GW-138 Dup.	10/19/2010	AWAL	N	0.0417
GW-138	3/22/2011	AWAL	Y	0.0462
GW-138	5/3/2011	AWAL	Y	0.0482
GW-138	7/14/2011	AWAL	Y	0.0550
GW-138	12/15/2011	AWAL	Y	0.0567
GW-138 Dup.	12/15/2011	AWAL	N	0.0574
GW-138	1/10/2012	AWAL	Y	0.0575
GW-138 Dup.	1/10/2012	AWAL	N	0.0584
GW-138	2/27/2012	AWAL	Y	0.0487
GW-138 Dup.	2/27/2012	AWAL	N	0.0475
GW-138	3/15/2012	AWAL	Y	0.0464
GW-138 Dup.	3/15/2012	AWAL	N	0.0474
GW-138	4/23/2012	AWAL	Y	0.0586
GW-138	5/8/2012	AWAL	Y	0.0681
GW-138 Dup.	5/8/2012	AWAL	N	0.0554
GW-138	6/28/2012	AWAL	Y	0.0642
GW-138 Dup.	6/28/2012	AWAL	N	0.0768
GW-138	7/26/2012	AWAL	Y	0.0724
GW-138 Dup.	7/26/2012	AWAL	N	0.0663
GW-138	8/24/2012	AWAL	Y	0.0596
GW-138 Dup.	8/24/2012	AWAL	N	0.0596
GW-138	9/19/2012	AWAL	Y	0.0584
GW-138	10/29/2012	AWAL	Y	0.0491 J
GW-138 Dup.	10/29/2012	AWAL	N	0.0498 J
GW-138	11/15/2012	AWAL	Y	0.0428
GW-138 Dup.	11/15/2012	AWAL	N	0.0445
GW-138	12/4/2012	AWAL	Y	0.0494
GW-138	1/10/2013	AWAL	Y	0.0620
GW-138	2/26/2013	AWAL	Y	0.0560
GW-138	3/18/2013	AWAL	Y	0.0605
GW-138	4/22/2013	AWAL	Y	0.0456
GW-138 Dup.	4/22/2013	AWAL	N	0.0474
GW-138	5/9/2013	AWAL	Y	0.0549
GW-138	6/26/2013	AWAL	Y	0.0425 J
GW-138	7/8/2013	AWAL	Y	0.0344

Table 8 - Well GW-138 Selenium Data and Statistical Evaluation

GW-138	8/22/2013	AWAL	Y	0.0528
GW-138	9/10/2013	AWAL	Y	0.0605
GW-138	10/24/2013	AWAL	Y	0.0499
Number of samples				31
Minimum				0.0344
Maximum				0.0724
Median				0.0520
Mean				0.0531
Standard Deviation				0.0082
Variance				6.65E-05
Mean + 2 standard deviations				0.0695
Skewness				0.156
2 x standard error of skewness (SES)				0.880
Kurtosis				0.267
2 x standard error of kurtosis (SEK)				1.760
Shapiro-Wilk test statistic				0.991
Shapiro-Wilk test critical value ($\alpha = 0.05$)				0.929
Anderson-Darling test statistic				0.158
Anderson-Darling test critical value ($\alpha = 0.05$)				0.752
Number of analyses greater than proposed GWPL exception				2
Percent of analyses greater than proposed GWPL exception				6.5%

prop. 0.0695 mg/L
0.05 mg/L

[a] Duplicate results not used in statistical analysis
AWAL = American West Analytical Laboratories

Table 9 - Well GW-141 Selenium Data and Statistical Evaluation

Well ID	Date	Lab	Used in Stat. Eval[a]	Selenium (mg/L)
GW-141	11/5/2009	AWAL	Y	0.0530
GW-141	2/16/2010	AWAL	Y	0.0470
GW-141 Dup.	2/16/2010	AWAL	N	0.0450
GW-141	4/28/2010	AWAL	Y	0.0490
GW-141 Dup.	4/28/2010	AWAL	N	0.0490
GW-141	7/27/2010	AWAL	Y	0.0433
GW-141 Dup.	7/27/2010	AWAL	N	0.0452
GW-141	5/3/2011	AWAL	Y	0.0479
GW-141	4/23/2012	AWAL	Y	0.0566
GW-141	9/19/2012	AWAL	Y	0.0581
GW-141	10/29/2012	AWAL	Y	0.0547 J
GW-141	11/15/2012	AWAL	Y	0.0496
GW-141	12/4/2012	AWAL	Y	0.0546
GW-141 Dup.	12/4/2012	AWAL	N	0.0592
GW-141	1/10/2013	AWAL	Y	0.0667
GW-141 Dup.	1/10/2013	AWAL	N	0.0714
GW-141	2/14/2013	AWAL	Y	0.0581
GW-141 Dup.	2/14/2013	AWAL	N	0.0585
GW-141	3/18/2013	AWAL	Y	0.0699
GW-141 Dup.	3/18/2013	AWAL	N	0.0725
GW-141	4/24/2013	AWAL	Y	0.0493
GW-141	5/9/2013	AWAL	Y	0.0523
GW-141 Dup.	5/9/2013	AWAL	N	0.0588
GW-141	6/26/2013	AWAL	Y	0.0421 J
GW-141 Dup.	6/26/2013	AWAL	N	0.0451 J
GW-141	7/8/2013	AWAL	Y	0.0419
GW-141 Dup.	7/8/2013	AWAL	N	0.0411
GW-141	8/22/2013	AWAL	Y	0.0629
GW-141 Dup.	8/22/2013	AWAL	N	0.0609
GW-141	9/10/2013	AWAL	Y	0.0674
GW-141 Dup.	9/10/2013	AWAL	N	0.0647
GW-141	10/24/2013	AWAL	Y	0.0573
GW-141 Dup.	10/24/2013	AWAL	N	0.0581
Number of samples				20
Minimum				0.0419
Maximum				0.0699
Median				0.0538
Mean				0.0541
Standard Deviation				0.0082
Variance				6.76E-05
Mean + 2 standard deviations				0.0705
Skewness				0.366
2 x standard error of skewness (SES)				1.095
Kurtosis				-0.568
2 x standard error of kurtosis (SEK)				2.191
Shapiro-Wilk test statistic				0.957
Shapiro-Wilk test critical value ($\alpha = 0.05$)				0.905
Anderson-Darling test statistic				0.266
Anderson-Darling test critical value ($\alpha = 0.05$)				0.752
Number of analyses greater than proposed GWPL exception				2
Percent of analyses greater than proposed GWPL exception				10.0%

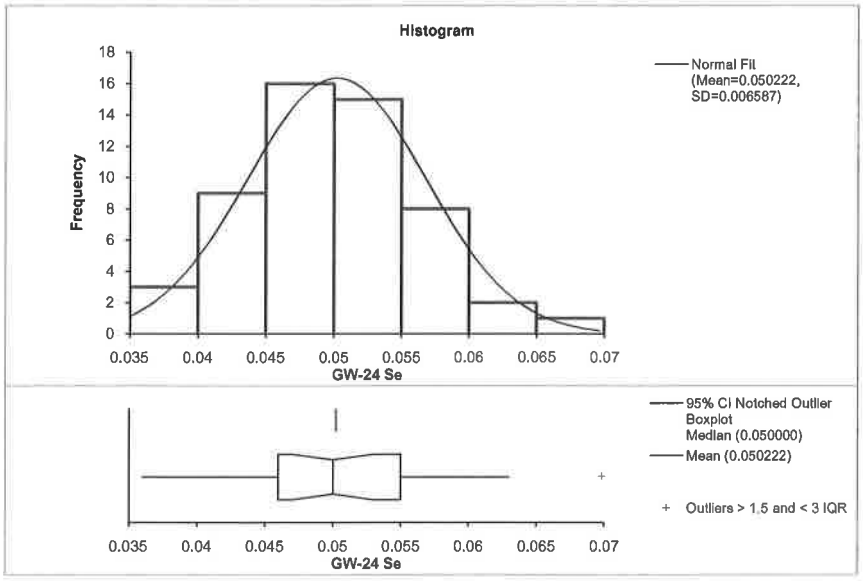
- proposed 0.0705 mg/L
GWPL 0.05 mg/L

[a] Duplicate results not used in statistical analysis
AWAL = American West Analytical Laboratories

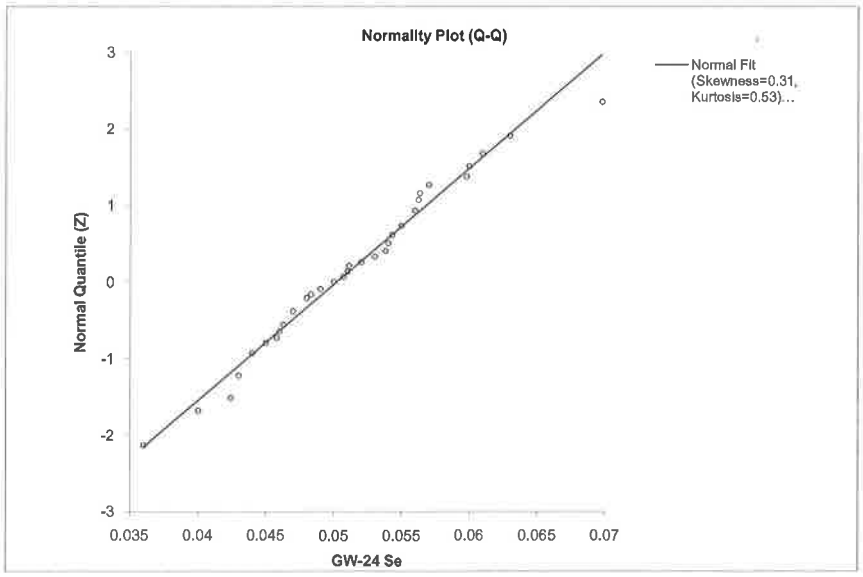
Analyse-it

Output Files

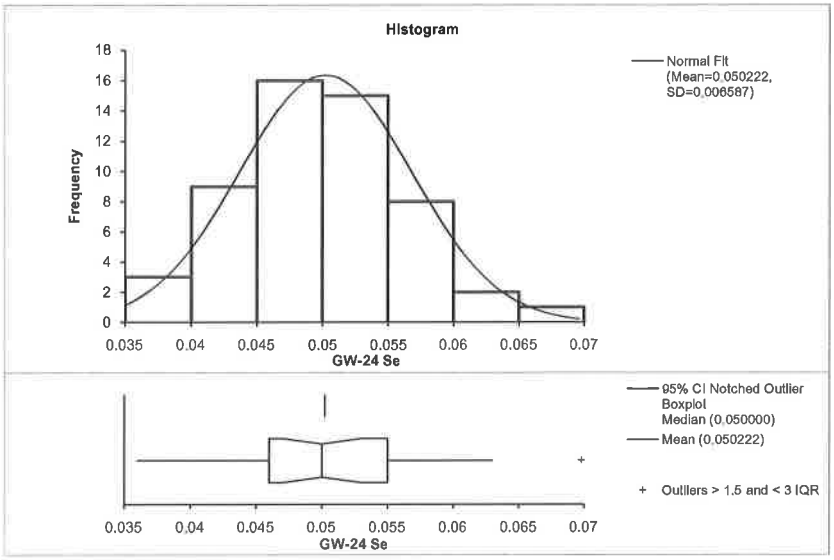
Test	**Describe - Summary** GW Exceptions GW-24 Se
Performed by	rwsobocinski
Date	5 November 2013



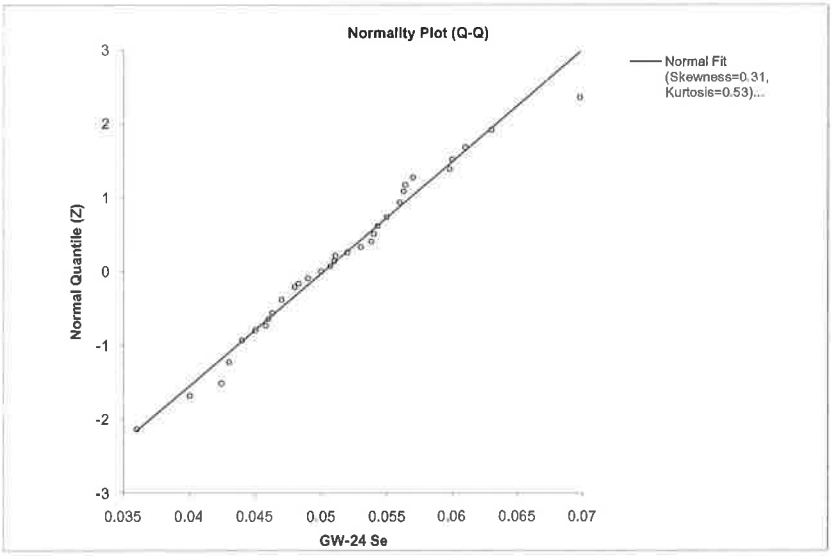
n	54		
Mean	0.050222	Median	0.050000
95% CI	0.048424 to 0.052020	96.0% CI	0.047000 to 0.053000
SE	0.0008964		
		Range	0.03380
Variance	0.000043	IQR	0.009017
SD	0.006587		
95% CI	0.005537 to 0.008132	**Percentile**	
		0th	0.036000 (minimum)
CV	13.1%	25th	0.045983 (1st quartile)
		50th	0.050000 (median)
Skewness	0.31	75th	0.055000 (3rd quartile)
Kurtosis	0.53	100th	0.069800 (maximum)
Shapiro-Wilk W	0.98		
p	0.530		



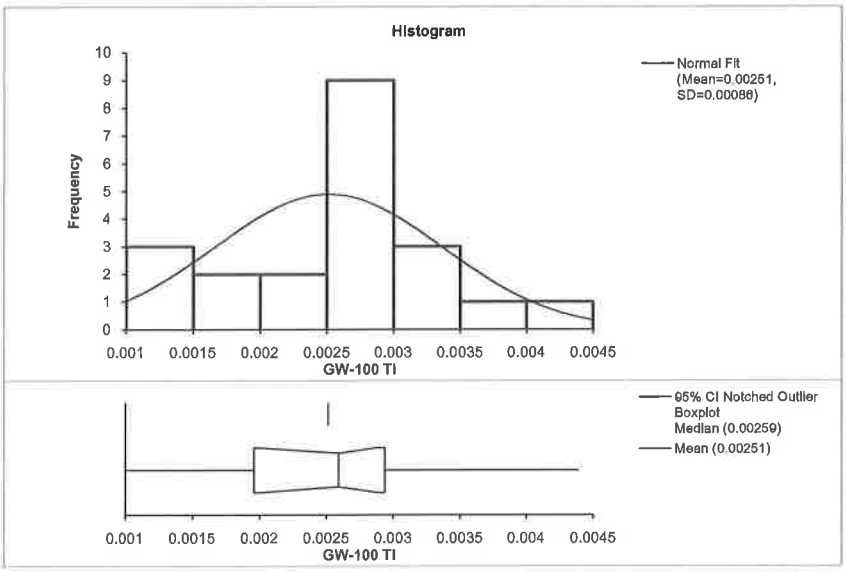
Test	**Describe - Summary**
	GW Exceptions
	GW-24 Se
Performed by	rwsobocinski
Date	5 November 2013



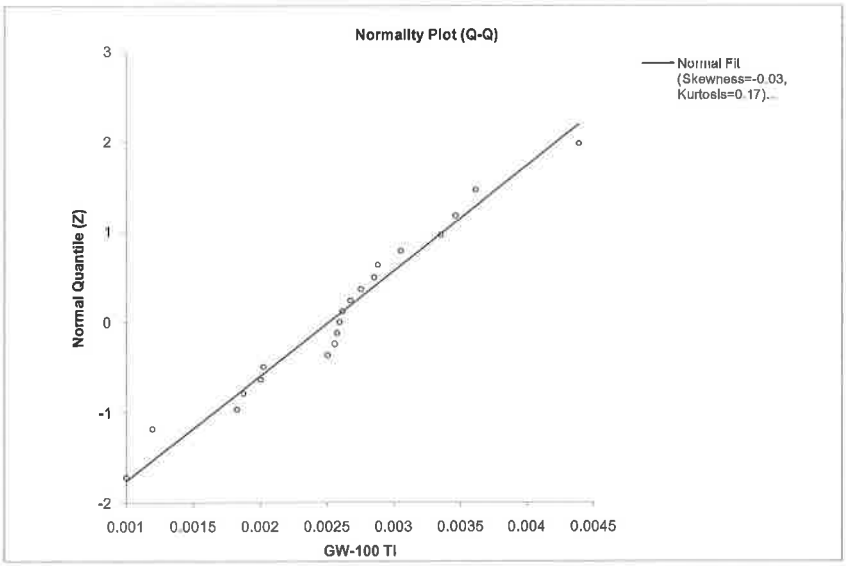
n	54		
Mean	0.050222	Median	0.050000
95% CI	0.048424 to 0.052020	96.0% CI	0.047000 to 0.053000
SE	0.0008964		
		Range	0.03380
Variance	0.000043	IQR	0.009017
SD	0.006587		
95% CI	0.005537 to 0.008132	Percentile	
		0th	0.036000 (minimum)
CV	13.1%	25th	0.045983 (1st quartile)
		50th	0.050000 (median)
Skewness	0.31	75th	0.055000 (3rd quartile)
Kurtosis	0.53	100th	0.069800 (maximum)
Anderson-Darling A^2	0.34		
p	0.476		



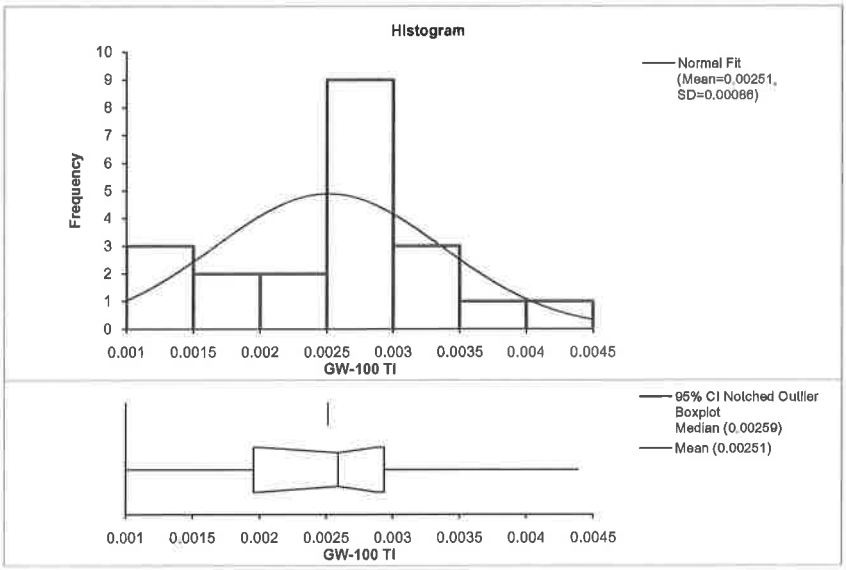
Test	**Describe - Summary** Exception Analysis GW-100 TI
Performed by	rwsobocinski
Date	11 November 2013



n	21		
Mean	< 0.00251	Median	< 0.00259
95% CI	< 0.00212 to < 0.00290	97.3% CI	< 0.00200 to < 0.00288
SE	< 0.000187		
		Range	< 0.0034
Variance	< 0.00000	IQR	< 0.00098
SD	< 0.00086		
95% CI	< 0.00066 to < 0.00124	**Percentile**	
		0th	< 0.00100 (minimum)
CV	34.1%	25th	< 0.00196 (1st quartile)
		50th	< 0.00259 (median)
Skewness	-0.03	75th	< 0.00294 (3rd quartile)
Kurtosis	0.17	100th	< 0.00439 (maximum)
Shapiro-Wilk W	0.96		
p	0.584		



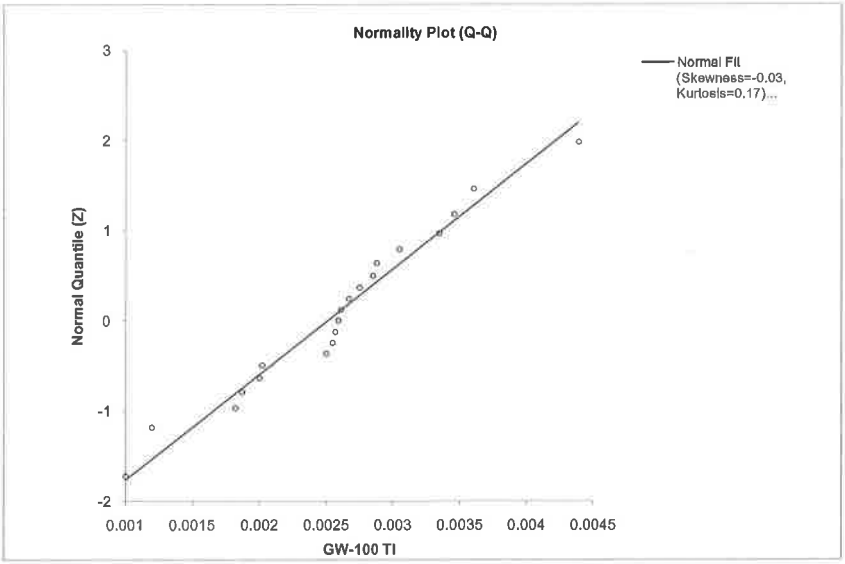
Test	**Describe - Summary** Exception Analysis GW-100 Tl
Performed by	rwsobocinski
Date	11 November 2013



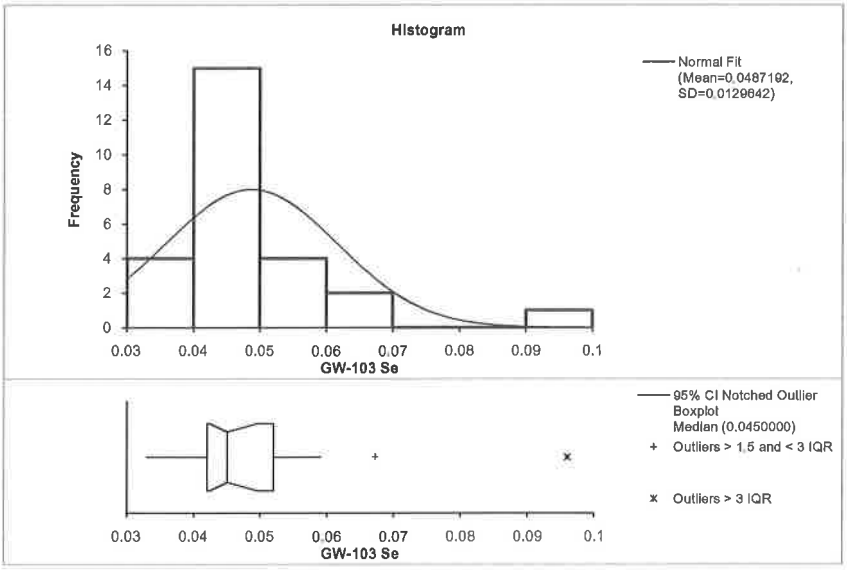
n	21
Mean	< 0.00251
95% CI	< 0.00212 to < 0.00290
SE	< 0.000187
Variance	< 0.00000
SD	< 0.00086
95% CI	< 0.00066 to < 0.00124
CV	34.1%
Skewness	-0.03
Kurtosis	0.17
Anderson-Darling A^2	0.36
p	0.423

Median	< 0.00259
97.3% CI	< 0.00200 to < 0.00288
Range	< 0.0034
IQR	< 0.00098

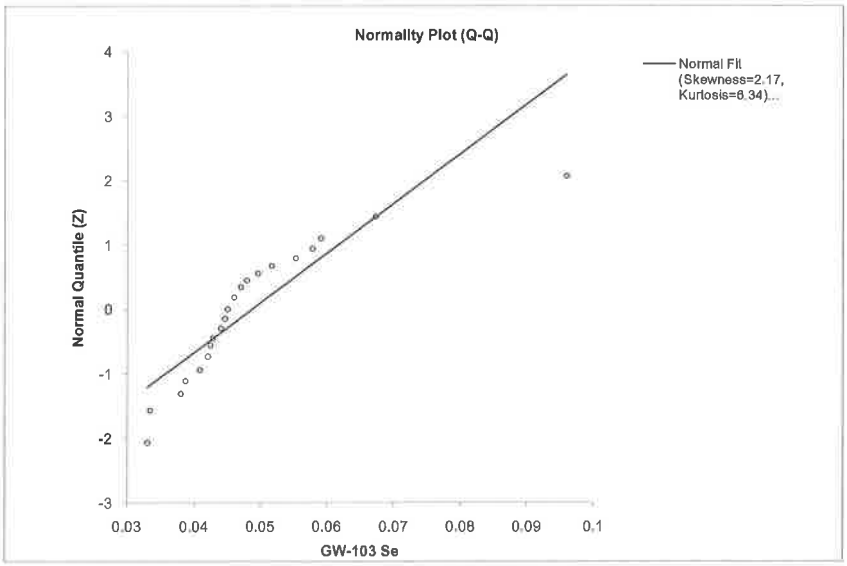
Percentile		
0th	< 0.00100	(minimum)
25th	< 0.00196	(1st quartile)
50th	< 0.00259	(median)
75th	< 0.00294	(3rd quartile)
100th	< 0.00439	(maximum)



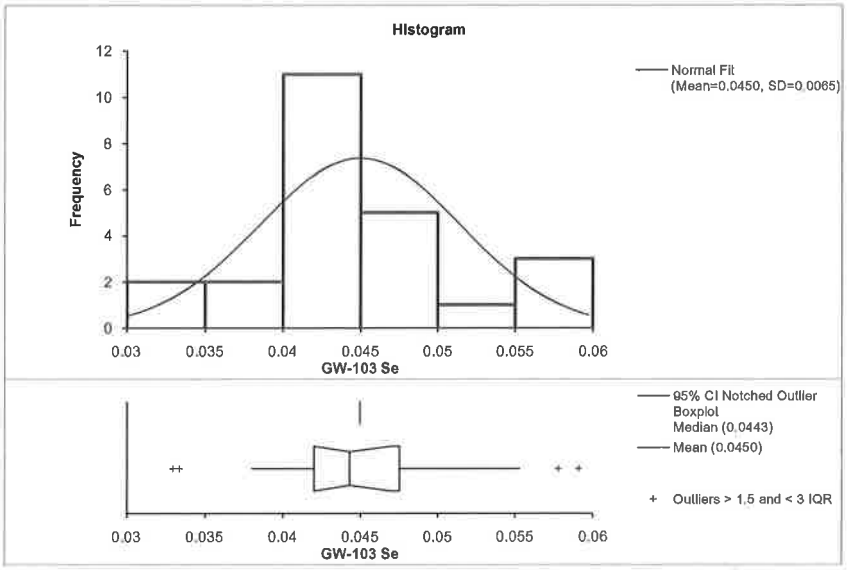
Test	**Describe - Summary** GW Exceptions GW-103 Se w/ outliers
Performed by	rwsobocinski
Date	5 November 2013



n	26		
Mean	0.0487192	Median	0.0450000
95% CI	0.0434829 to 0.0539556	97.1% CI	0.0424000 to 0.0496000
SE	0.00254249		
		Range	0.063000
Variance	0.0001681	IQR	0.0100000
SD	0.0129642		
95% CI	0.0101673 to 0.0178959	Percentile	
		0th	0.0330000 (minimum)
CV	26.6%	25th	0.0420000 (1st quartile)
		50th	0.0450000 (median)
Skewness	2.17	75th	0.0520000 (3rd quartile)
Kurtosis	6.34	100th	0.0960000 (maximum)
Shapiro-Wilk W	0.80		
p	0.000		

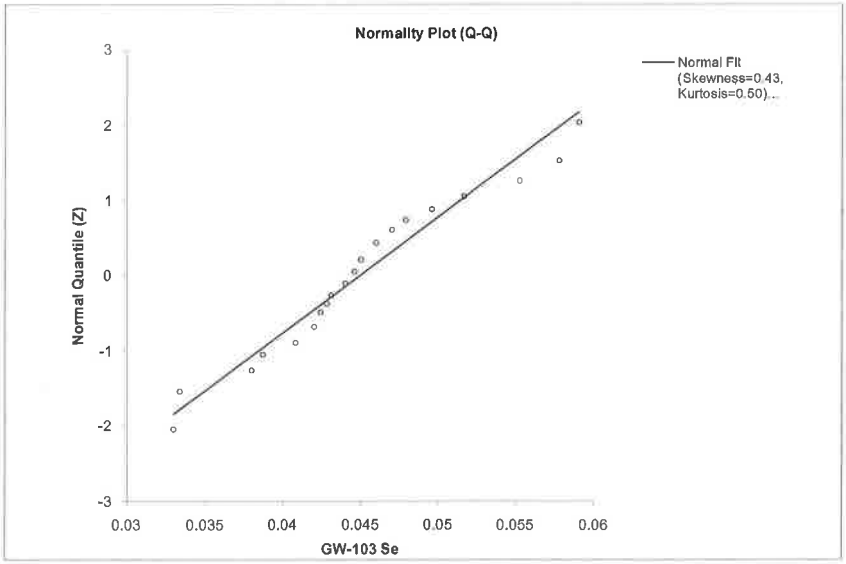


Test	**Describe - Summary** GW Exceptions GW-103 Se
Performed by	rwsobocinski
Date	11 November 2013

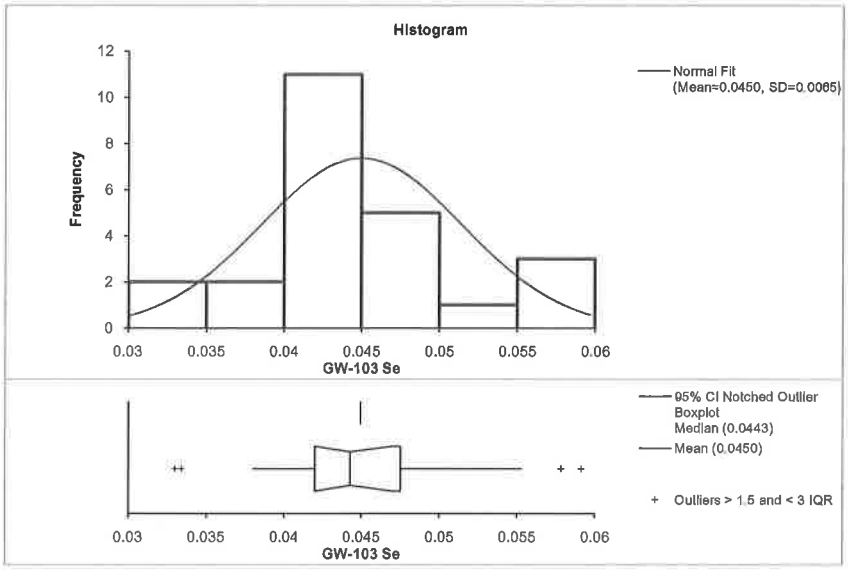


n	24		
Mean	0.0450 J	Median	0.0443 J
95% CI	0.0422 J to 0.0477 J	97.7% CI	0.0420 J to 0.0470 J
SE	0.00133 J		
		Range	0.026 J
Variance	0.0000 J	IQR	0.0055 J
SD	0.0065 J		
95% CI	0.0050 J to 0.0091 J		
CV	14.4%		
Skewness	0.43		
Kurtosis	0.50		
Shapiro-Wilk W	0.95		
p	0.285		

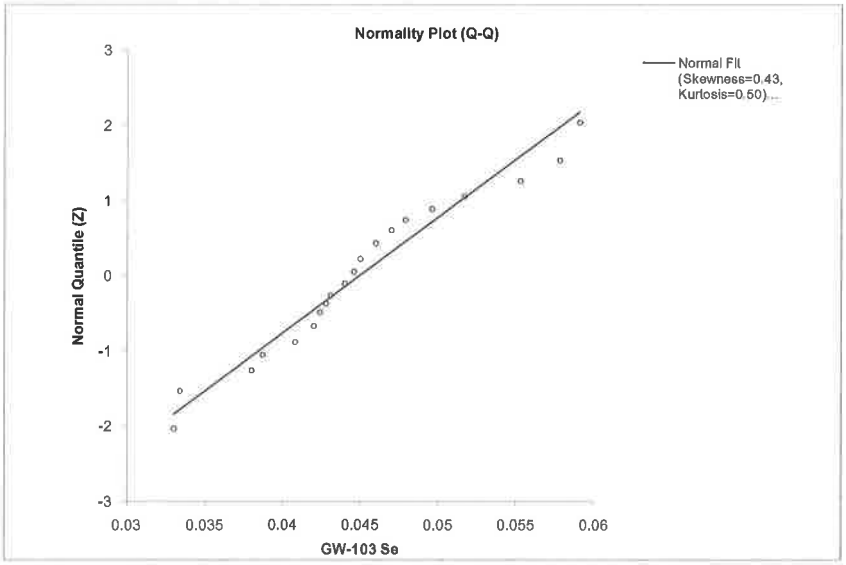
Percentile		
0th	0.0330 J	(minimum)
25th	0.0420 J	(1st quartile)
50th	0.0443 J	(median)
75th	0.0475 J	(3rd quartile)
100th	0.0591 J	(maximum)



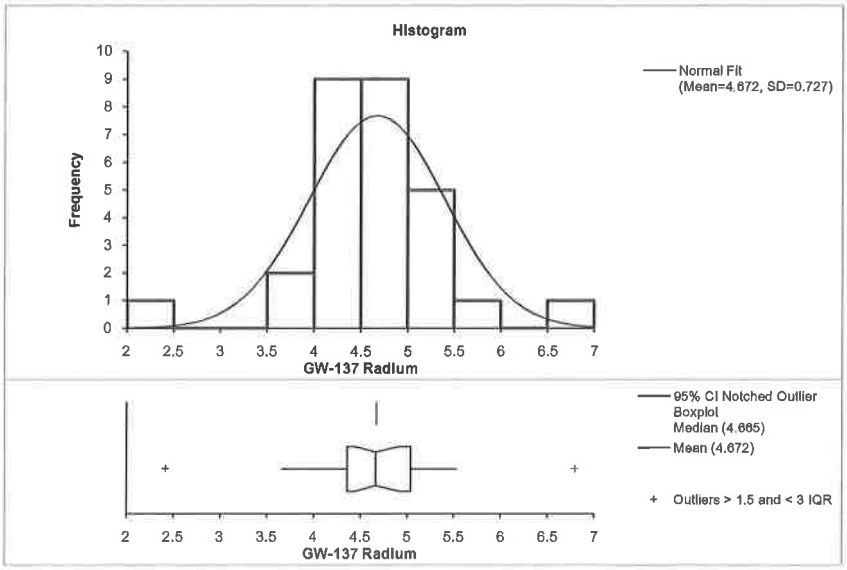
Test	**Describe - Summary** Exception Analysis GW-103 Se
Performed by	rwsobocinski
Date	11 November 2013



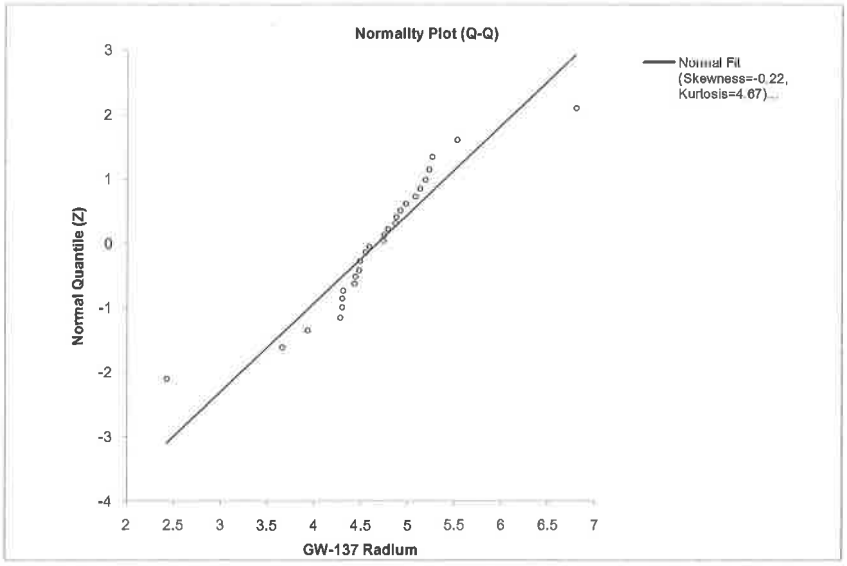
n	24		
Mean	0.0450 J	Median	0.0443 J
95% CI	0.0422 J to 0.0477 J	97.7% CI	0.0420 J to 0.0470 J
SE	0.00133 J		
		Range	0.026 J
Variance	0.0000 J	IQR	0.0055 J
SD	0.0065 J		
95% CI	0.0050 J to 0.0091 J	Percentile	
		0th	0.0330 J (minimum)
CV	14.4%	25th	0.0420 J (1st quartile)
		50th	0.0443 J (median)
Skewness	0.43	75th	0.0475 J (3rd quartile)
Kurtosis	0.50	100th	0.0591 J (maximum)
Anderson-Darling A^2	0.52		
p	0.165		



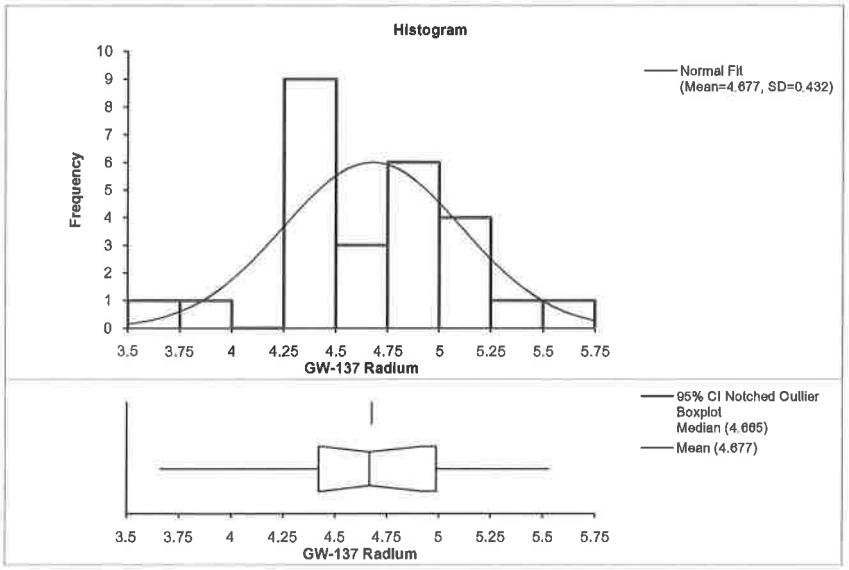
Test	**Describe - Summary** GW Exceptions GW-137 Radium w/ outliers
Performed by	rwsobocinski
Date	5 November 2013



n	28		
Mean	4.672	Median	4.665
95% CI	4.390 to 4.954	96.4% CI	4.440 to 4.920
SE	0.1374		
		Range	4.38
Variance	0.528	IQR	0.678
SD	0.727		
95% CI	0.575 to 0.989	Percentile	
		0th	2.422 (minimum)
CV	15.6%	25th	4.360 (1st quartile)
		50th	4.665 (median)
Skewness	-0.22	75th	5.038 (3rd quartile)
Kurtosis	4.67	100th	6.800 (maximum)
Shapiro-Wilk W	0.89		
p	0.007		

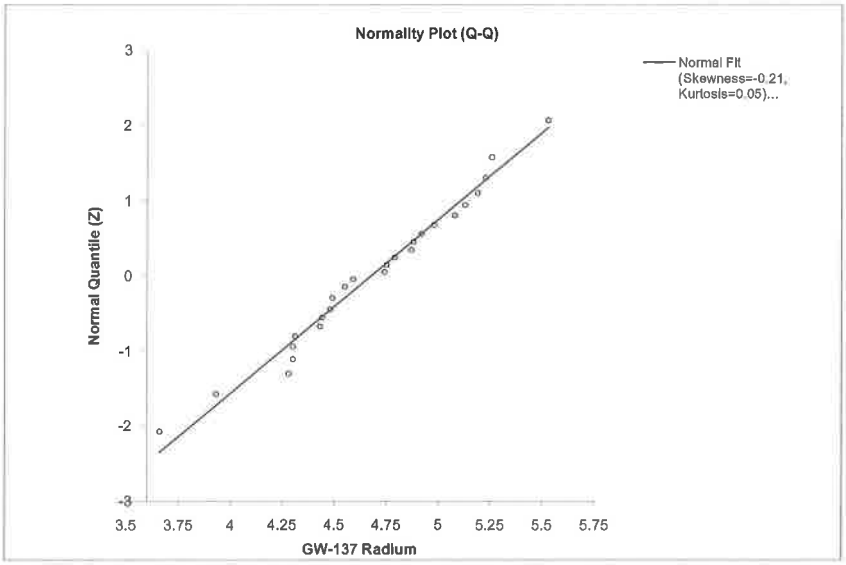


Test	**Describe - Summary** GW Exceptions GW-137 Radium
Performed by	rwsobocinski
Date	5 November 2013

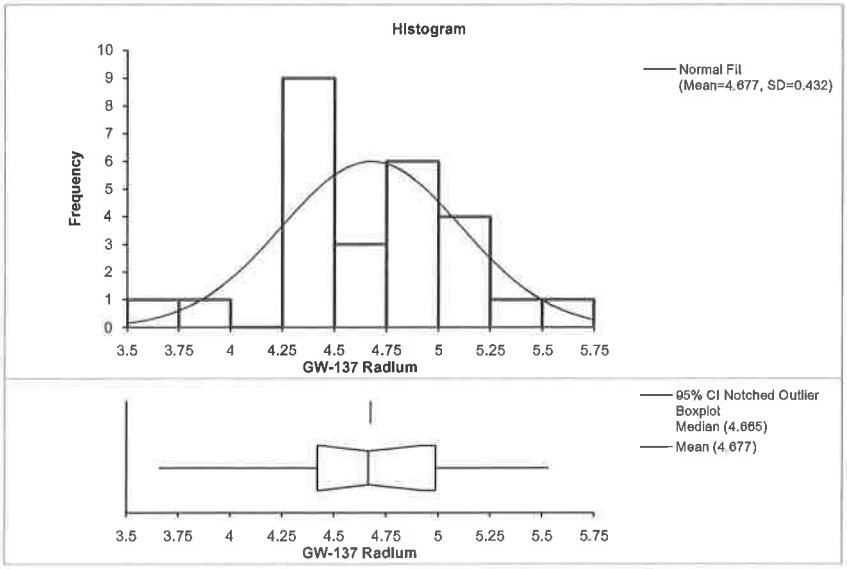


n	26		
Mean	4.677	Median	4.665
95% CI	4.502 to 4.852	97.1% CI	4.440 to 4.920
SE	0.0848		
		Range	1.87
Variance	0.187	IQR	0.568
SD	0.432		
95% CI	0.339 to 0.597		
CV	9.2%		
Skewness	-0.21		
Kurtosis	0.05		
Shapiro-Wilk W	0.98		
p	0.881		

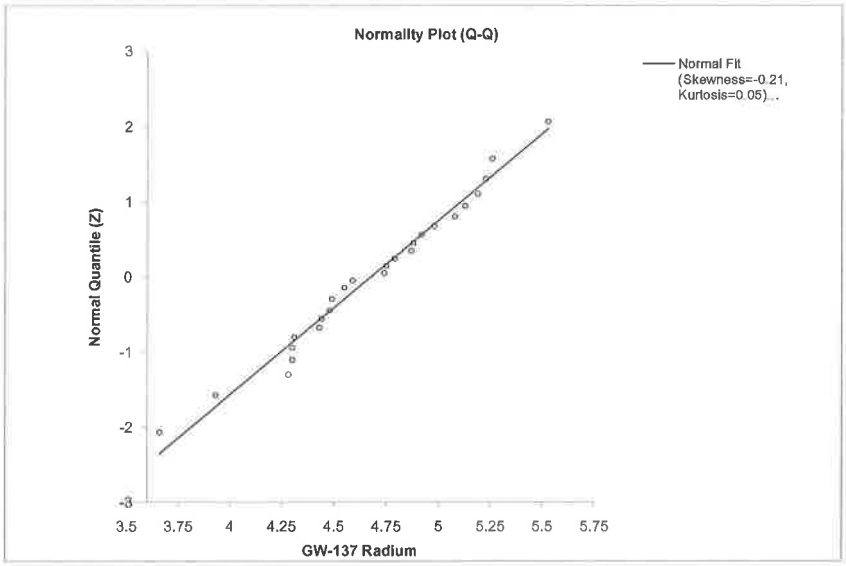
Percentile	
0th	3.660 (minimum)
25th	4.420 (1st quartile)
50th	4.665 (median)
75th	4.988 (3rd quartile)
100th	5.530 (maximum)



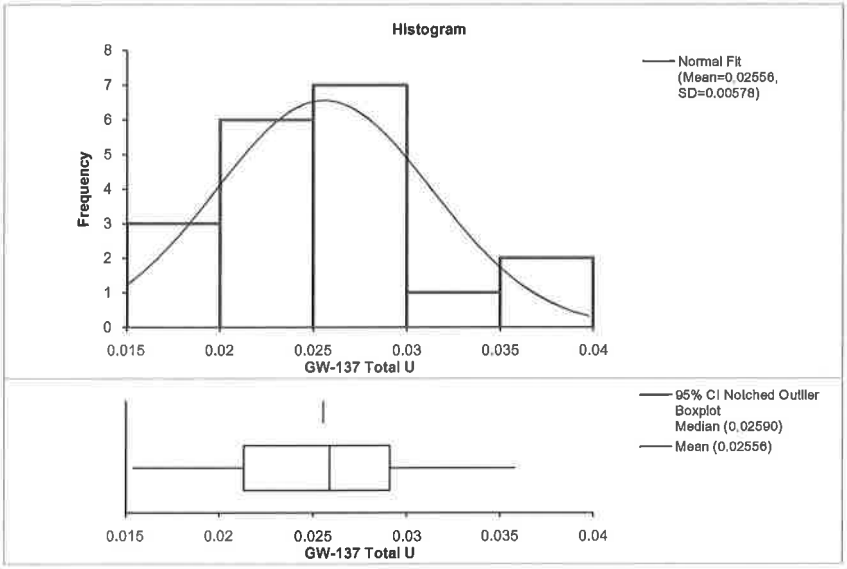
Test	**Describe - Summary** GW Exceptions GW-137 Radium
Performed by	rwsobocinski
Date	5 November 2013



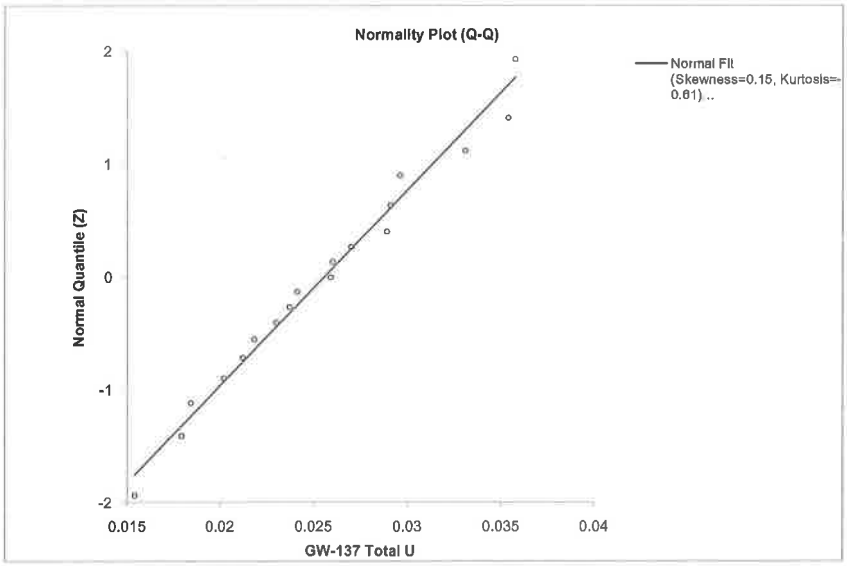
n	26		
Mean	4.677	Median	4.665
95% CI	4.502 to 4.852	97.1% CI	4.440 to 4.920
SE	0.0848		
		Range	1.87
Variance	0.187	IQR	0.568
SD	0.432		
95% CI	0.339 to 0.597	Percentile	
		0th	3.660 (minimum)
CV	9.2%	25th	4.420 (1st quartile)
		50th	4.665 (median)
Skewness	-0.21	75th	4.988 (3rd quartile)
Kurtosis	0.05	100th	5.530 (maximum)
Anderson-Darling A^2	0.24		
p	0.765		



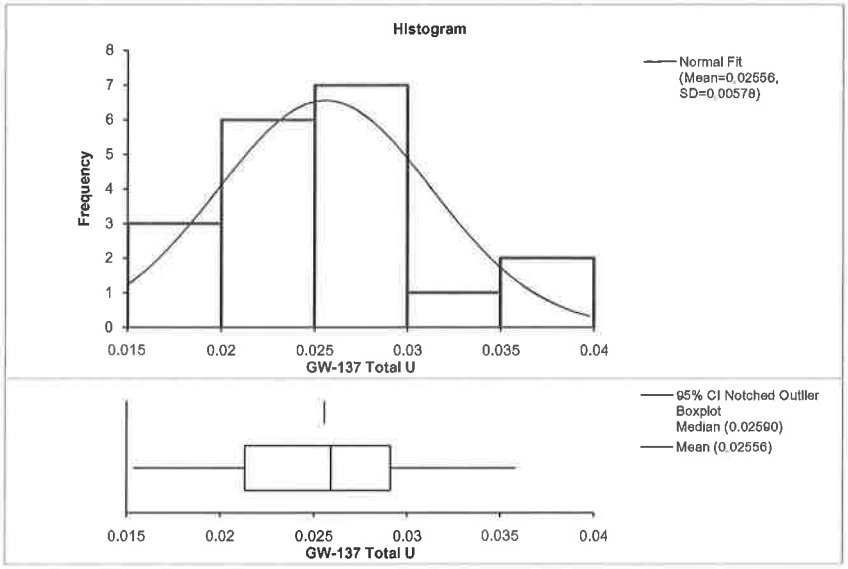
Test	**Describe - Summary** GW Exceptions GW-137 Total U
Performed by	rwsobocinski
Date	5 November 2013



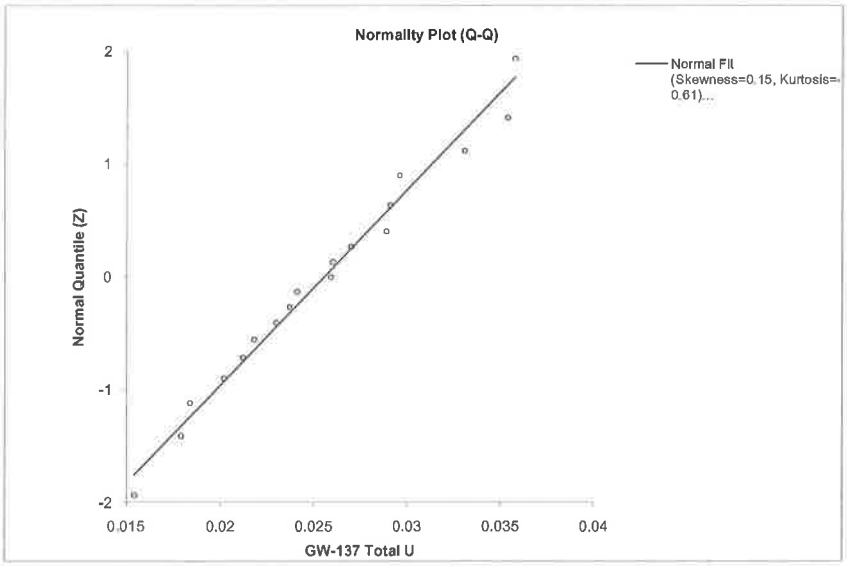
n	19		
Mean	0.02556	Median	0.02590
95% CI	0.02277 to 0.02834	98.1% CI	0.02120 to 0.02910
SE	0.001325		
		Range	0.0204
Variance	0.00003	IQR	0.00780
SD	0.00578		
95% CI	0.00436 to 0.00854	Percentile	
		0th	0.01540 (minimum)
CV	22.6%	25th	0.02130 (1st quartile)
		50th	0.02590 (median)
Skewness	0.15	75th	0.02910 (3rd quartile)
Kurtosis	-0.61	100th	0.03580 (maximum)
Shapiro-Wilk W	0.97		
p	0.866		



Test	**Describe - Summary** GW Exceptions GW-137 Total U
Performed by	rwsobocinski
Date	5 November 2013

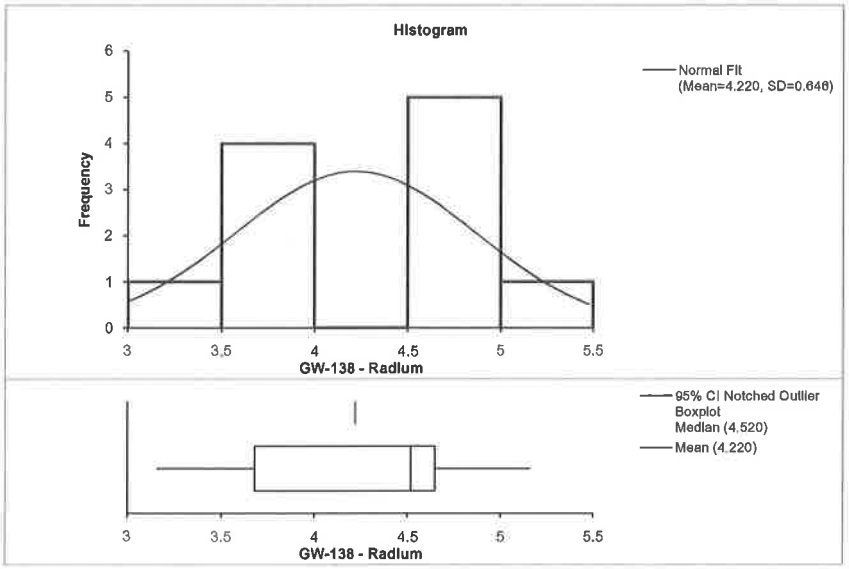


n	19		
Mean	0.02556	Median	0.02590
95% CI	0.02277 to 0.02834	98.1% CI	0.02120 to 0.02910
SE	0.001325		
		Range	0.0204
Variance	0.00003	IQR	0.00780
SD	0.00578		
95% CI	0.00436 to 0.00854	Percentile	
		0th	0.01540 (minimum)
CV	22.6%	25th	0.02130 (1st quartile)
		50th	0.02590 (median)
Skewness	0.15	75th	0.02910 (3rd quartile)
Kurtosis	-0.61	100th	0.03580 (maximum)
Anderson-Darling A^2	0.17		
p	0.926		



Analyse-it v2.26

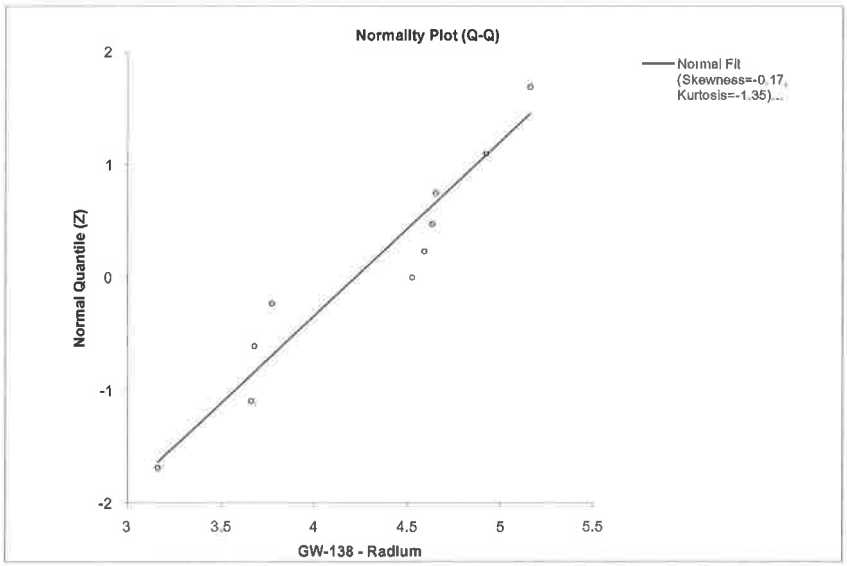
Test	**Describe - Summary**
	GW Exceptions
	GW-138 - Radium
Performed by	rwsobocinski
Date	5 November 2013



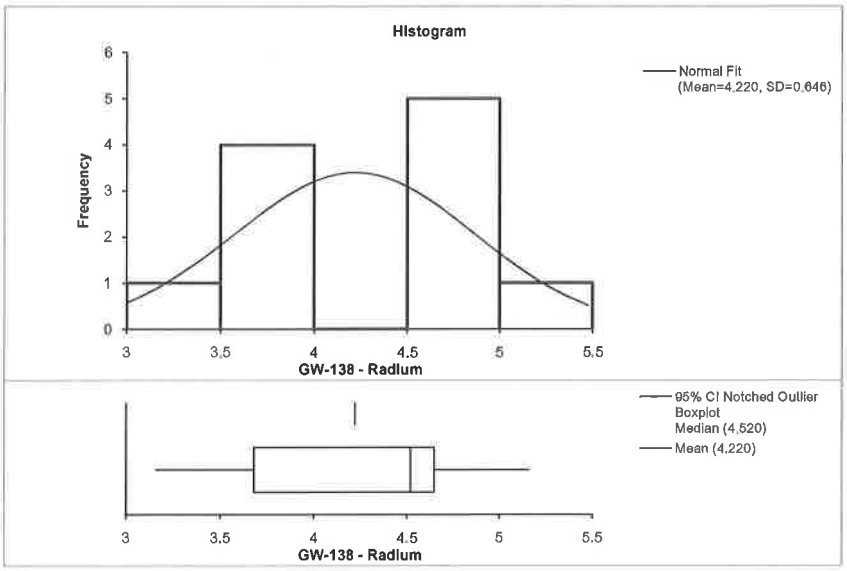
n	11
Mean	4.220
95% CI	3.786 to 4.654
SE	0.1949
Variance	0.418
SD	0.646
95% CI	0.452 to 1.134
CV	15.3%
Skewness	-0.17
Kurtosis	-1.35
Shapiro-Wilk W	0.91
p	0.249

Median	4.520
98.8% CI	3.660 to 4.920
Range	2.00
IQR	0.967

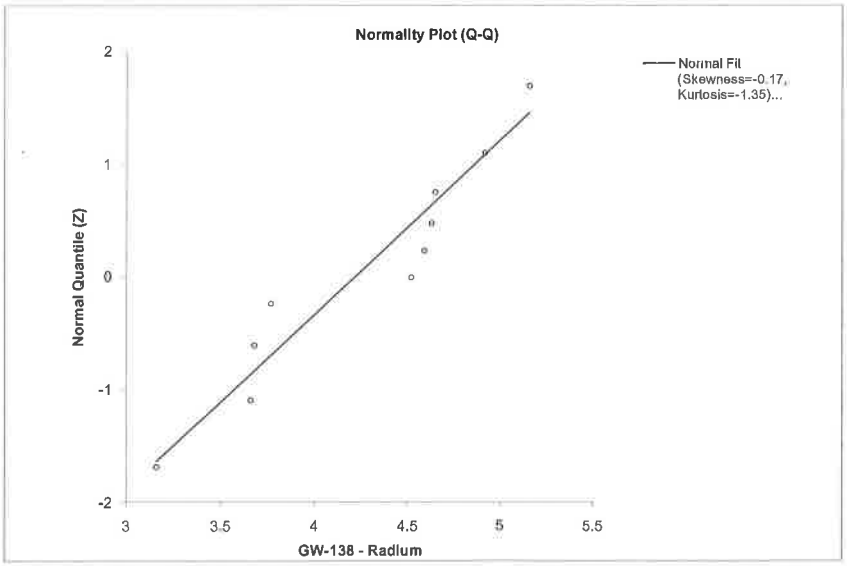
Percentile	
0th	3.160 (minimum)
25th	3.680 (1st quartile)
50th	4.520 (median)
75th	4.647 (3rd quartile)
100th	5.160 (maximum)



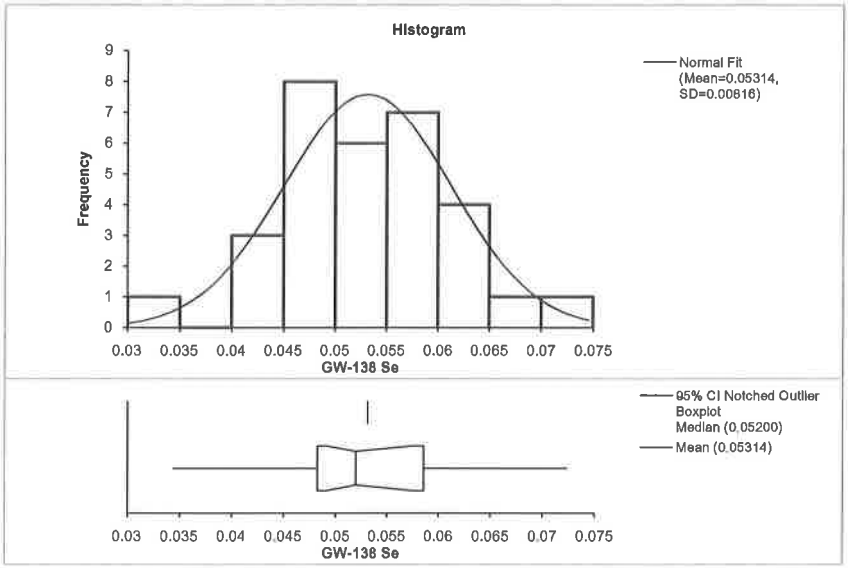
Test	**Describe - Summary**
	GW Exceptions
	GW-138 - Radium
Performed by	rwsobocinski
Date	5 November 2013



n	11		
Mean	4.220	Median	4.520
95% CI	3.786 to 4.654	98.8% CI	3.660 to 4.920
SE	0.1949		
		Range	2.00
Variance	0.418	IQR	0.967
SD	0.646		
95% CI	0.452 to 1.134	Percentile	
		0th	3.160 (minimum)
CV	15.3%	25th	3.680 (1st quartile)
		50th	4.520 (median)
Skewness	-0.17	75th	4.647 (3rd quartile)
Kurtosis	-1.35	100th	5.160 (maximum)
Anderson-Darling A^2	0.55		
p	0.121		

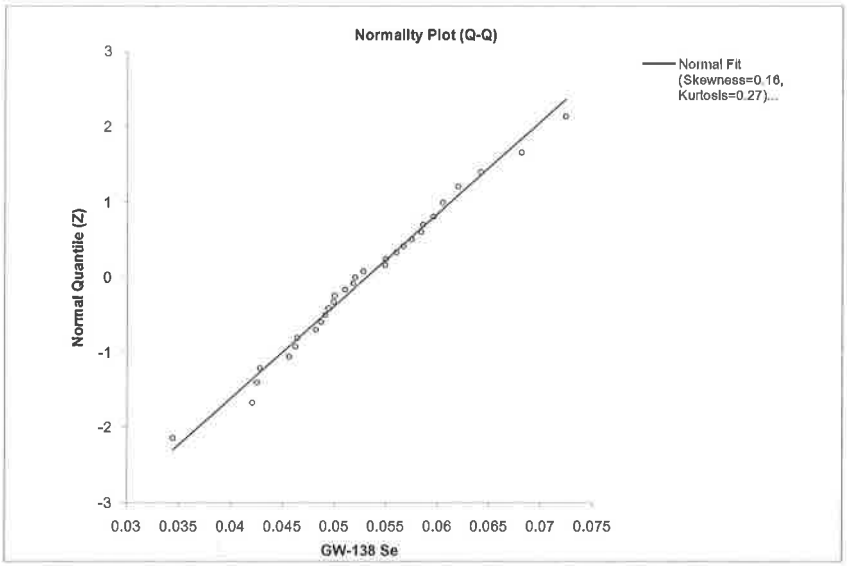


Test	**Describe - Summary** Exception Analysis GW-138 Se
Performed by	rwsobocinski
Date	11 November 2013

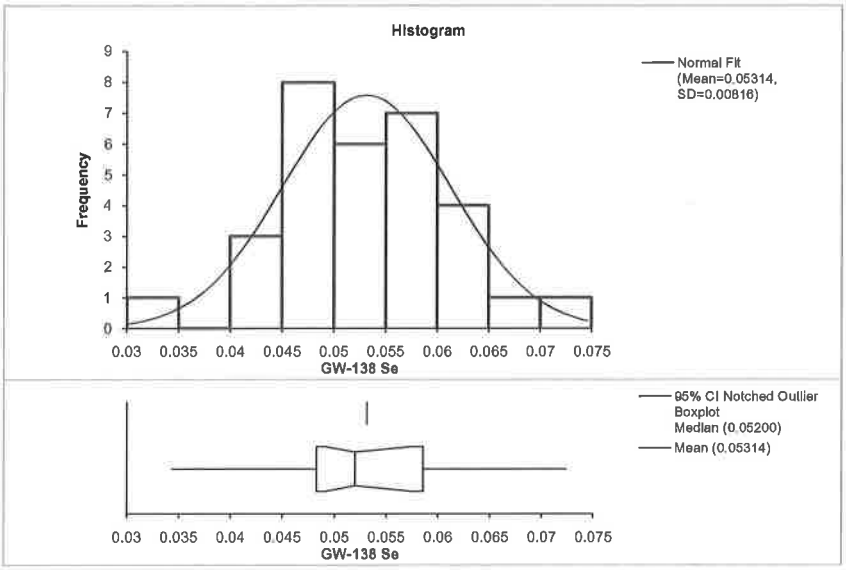


n	31		
Mean	0.05314	Median	0.05200
95% CI	0.05015 to 0.05613	97.1% CI	0.04910 to 0.05750
SE	0.001465		
		Range	0.0380
Variance	0.00007	IQR	0.01028
SD	0.00816		
95% CI	0.00652 to 0.01090		
CV	15.3%		
Skewness	0.16		
Kurtosis	0.27		
Shapiro-Wilk W	0.99		
p	0.993		

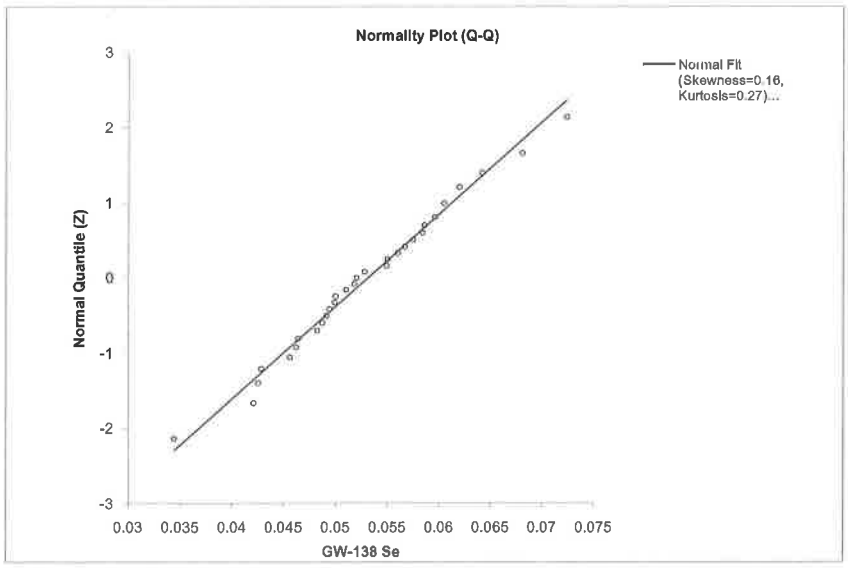
Percentile		
0th	0.03440	(minimum)
25th	0.04828	(1st quartile)
50th	0.05200	(median)
75th	0.05857	(3rd quartile)
100th	0.07240	(maximum)



Test	**Describe - Summary** Exception Analysis GW-138 Se
Performed by	rwsobocinski
Date	11 November 2013

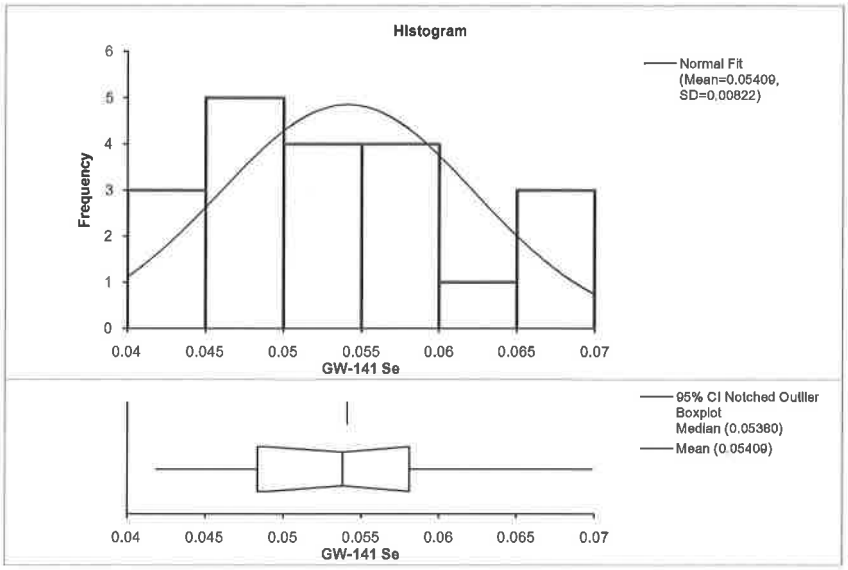


n	31		
Mean	0.05314	Median	0.05200
95% CI	0.05015 to 0.05613	97.1% CI	0.04910 to 0.05750
SE	0.001465		
		Range	0.0380
Variance	0.00007	IQR	0.01028
SD	0.00816		
95% CI	0.00652 to 0.01090	Percentile	
		0th	0.03440 (minimum)
CV	15.3%	25th	0.04828 (1st quartile)
		50th	0.05200 (median)
Skewness	0.16	75th	0.05857 (3rd quartile)
Kurtosis	0.27	100th	0.07240 (maximum)
Anderson-Darling A^2	0.16		
p	0.946		

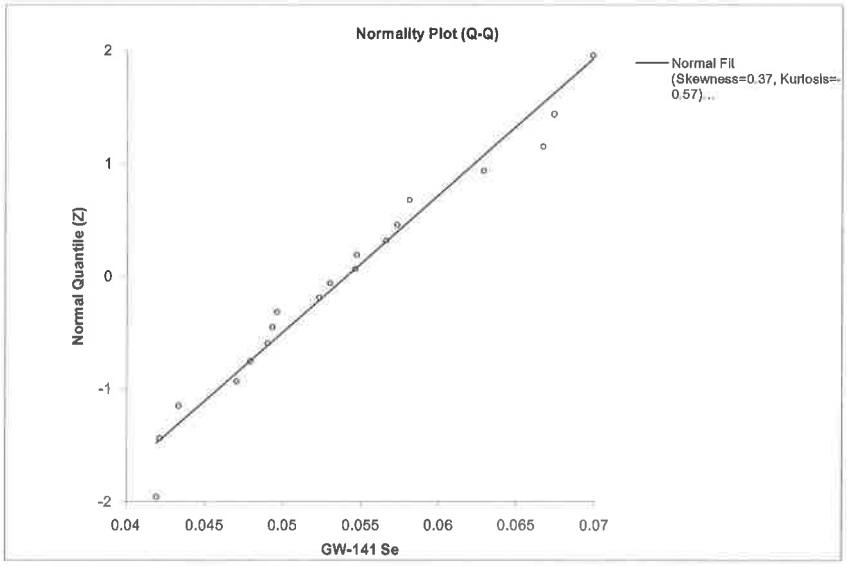


Analyse-it v2.26

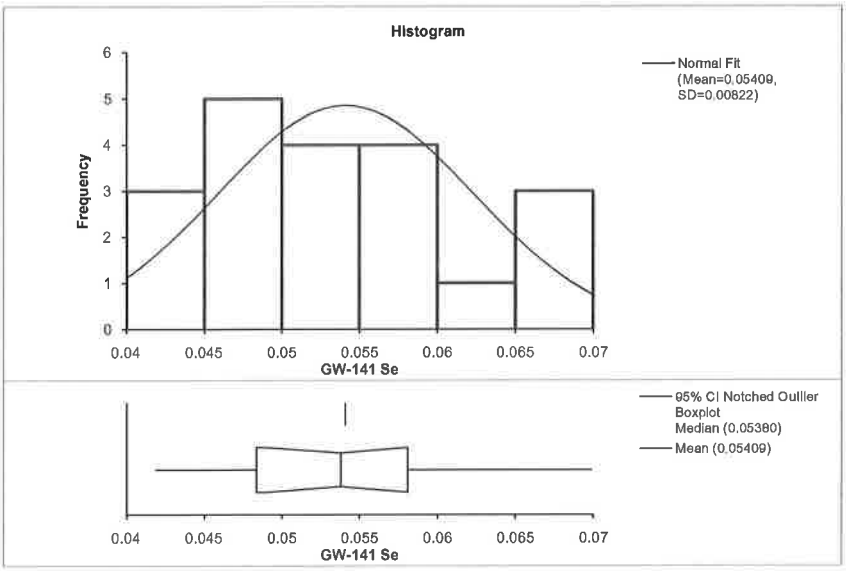
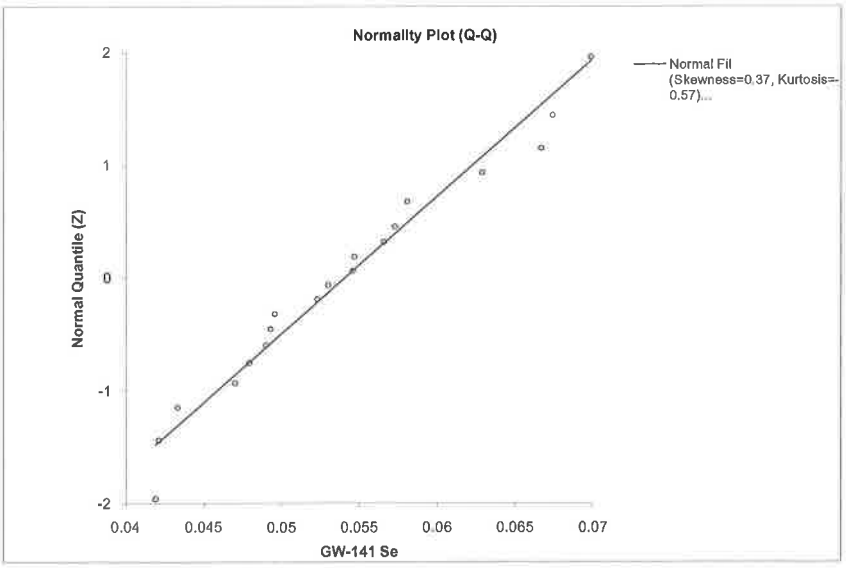
Test	**Describe - Summary** Exception Analysis GW-141 Se
Performed by	rwsobocinski
Date	11 November 2013



n	20		
Mean	0.05409	Median	0.05380
95% CI	0.05024 to 0.05793	95.9% CI	0.04900 to 0.05810
SE	0.001838		
		Range	0.0280
Variance	0.00007	IQR	0.00974
SD	0.00822		
95% CI	0.00625 to 0.01201	Percentile	
		0th	0.04190 (minimum)
CV	15.2%	25th	0.04836 (1st quartile)
		50th	0.05380 (median)
Skewness	0.37	75th	0.05810 (3rd quartile)
Kurtosis	-0.57	100th	0.06990 (maximum)
Shapiro-Wilk W	0.96		
p	0.493		



Test	**Describe - Summary** Exception Analysis GW-141 Se
Performed by	rwsobocinski
Date	11 November 2013



n	20		
Mean	0.05409	Median	0.05380
95% CI	0.05024 to 0.05793	95.9% CI	0.04900 to 0.05810
SE	0.001838		
		Range	0.0280
Variance	0.00007	IQR	0.00974
SD	0.00822		
95% CI	0.00625 to 0.01201	Percentile	
		0th	0.04190 (minimum)
CV	15.2%	25th	0.04836 (1st quartile)
		50th	0.05380 (median)
Skewness	0.37	75th	0.05810 (3rd quartile)
Kurtosis	-0.57	100th	0.06990 (maximum)
Anderson-Darling A^2	0.27		
p	0.652