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MEMORANDUM

DRC-2019-010131

TO: File

THROUGH: Phil Goble, Manager PR6 9/4/2019

FROM: Tom Rushing, P.G. JR 9/4/2019

DATE: September 4, 2019

SUBJECT: Review of the Energy Fuels Resources (USA) Inc., White Mesa Uranium Mill, Blanding, Utah June 27, 2019 Source Assessment Report for MW-11 and MW-24 Ground Water Discharge Permit No. UGW370004 (Permit)

Summary

An Energy Fuels Resources (USA) Inc. ("EFR") Source Assessment Report ("SAR"), dated June 27, 2019, for wells/parameters in out-of-compliance status ("OOC") was received by the Director of the Division of Waste Management and Radiation Control (DWMRC) on July 2, 2019. The SAR is for Manganese in Monitoring Well MW-11 and Beryllium, Cadmium, Fluoride, Nickel, Thallium and pH in Monitoring Well MW-24 at the White Mesa Uranium Mill (Mill). The SAR was submitted for review and approval of proposed revised Ground Water Compliance Limits ("GWCLs") for the parameters listed.

Monitoring well MW-11 is located on the southern berm of the Mill Tailings Cell 3 and is hydraulically downgradient from portions of Cells 2 and 3; and from the Mill processing areas. Monitoring well MW-24 is located on the southwest corner of Evaporation Cell 1 and is hydraulically downgradient from Evaporation Cell 1.

The SAR is broken up into four primary sections, 1. Categories and Approach for Analysis, 2. Results of the Analysis (e.g. site-wide decreasing pH, Sorption Analysis), 3. Statistical evaluation and calculation of revised GWCL's, and, 4. Conclusions and recommendations.

Figures below depict the concentration trends in monitoring well MW-11 and MW-24 for the source assessment parameters using all available historical data.

Figure - Manganese Data Plot of Historical Data at MW-11

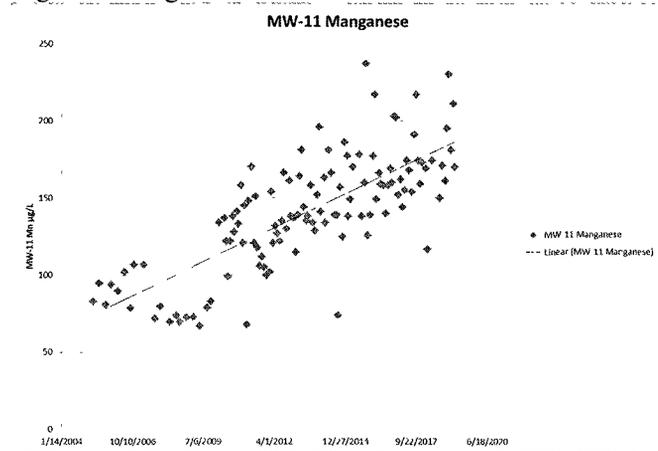


Figure - pH Data Plot of Historical Data at MW-24

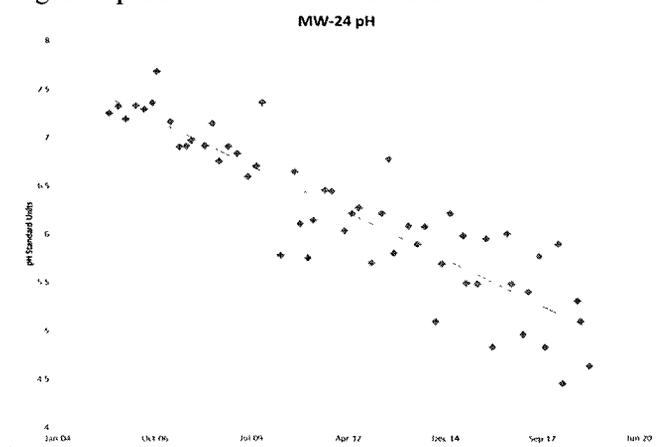


Figure - Cadmium Data Plot of Historical Data at MW-24

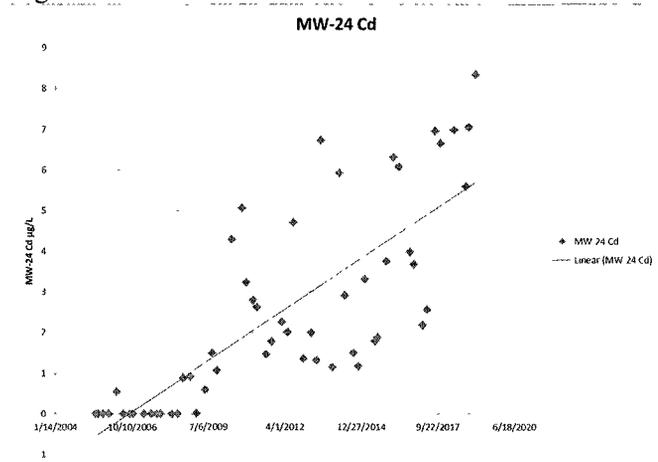


Figure – Thallium Data Plot of Historical Data at MW-24

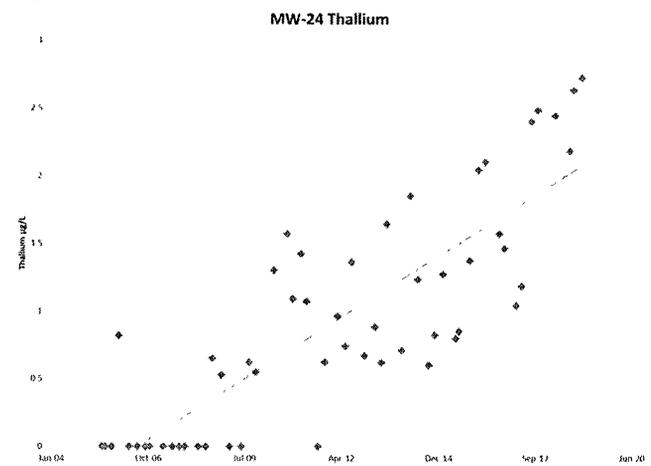


Figure – Beryllium Plot of Historical Data at MW-24

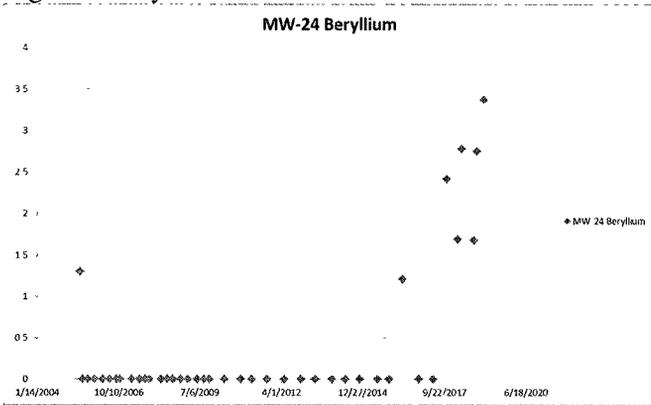


Figure – Nickel Plot of Historical Data at MW-24

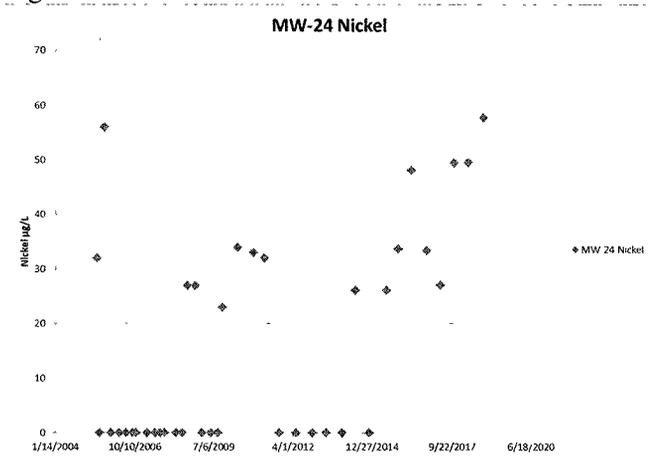
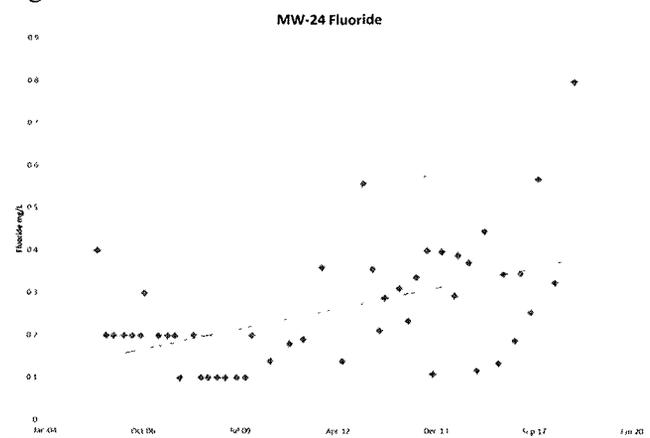


Figure – Fluoride Plot of Historical Data at MW-24



Per review of the data plot for MW-11 manganese, it appears that an ongoing increasing trend has been occurring since installation of the monitoring well and was identified at the time of the background report.

Per review of the data plots for MW-24, it was noted that recent increasing trends for certain parameters has resulted in out-of-compliance status warrants further investigation. A proposed path forward is found below in the Conclusion section of this memorandum.

#### **DWMRC Review of Compliance Data and Trends for Manganese in MW-11**

**MW-11 (Manganese)** – DWMRC notes that manganese concentrations in MW-11 have been indicating an increasing trend since the beginning of monitoring for the parameter at the monitoring well. DWMRC notes that the trend is more evident starting in 2012 when a new laboratory and more sensitive methods of analysis were implemented. Per the SAR, the complete historical dataset for Mn shows a normal distribution of data. A review of other indicator parameters does not indicate that the increasing Mn or decreasing pH is being caused by the release of tailings solution. Monitoring well MW-11 was part of the University of Utah Study and findings indicated that the monitoring well was unaffected by Mill activities. The SAR discusses that the increasing trend is potentially related to dissolution of manganese in clays and carbonate minerals in the aquifer in the region of MW-11.

#### **DWMRC Review of Compliance Data and Trends for SAR Constituents in MW-24**

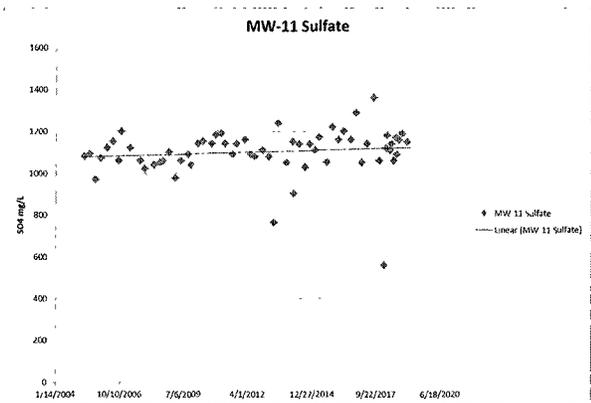
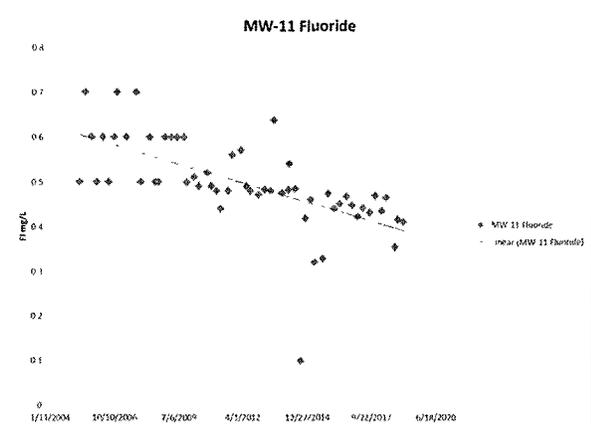
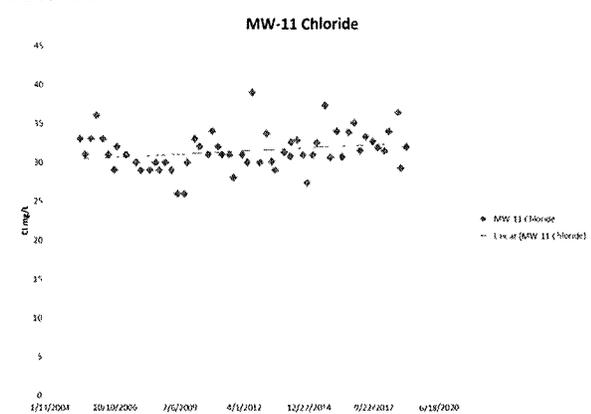
**MW-24 (Beryllium, Cadmium, Nickel, Thallium, Fluoride, pH)** – DWMRC notes that beryllium, cadmium, nickel, thallium and fluoride are showing increasing trends at MW-24 and that pH is showing a significant decreasing trend. Recent pH values at MW-24 have been as low as 4.45. The SAR discusses that the rising concentrations of metals is potentially due to desorption of minerals from hydrous ferric oxides due to decreasing pH and/or the dissolution clay and sulfide minerals in the Brushy Basin and Burro Canyon Formations. Based on review of the groundwater data, including tailings wastewater indicator parameters the SAR discusses that the trends do not appear to be associated with Mill activities; however, recent increasing trends for certain parameters has resulted in out-of-compliance status warrants further investigation. A proposed path forward is found below in the Conclusion section of this memorandum.

**EFR Investigations of Potential Sources of Report Increasing Trends at Monitoring Wells MW-11 and MW-24**

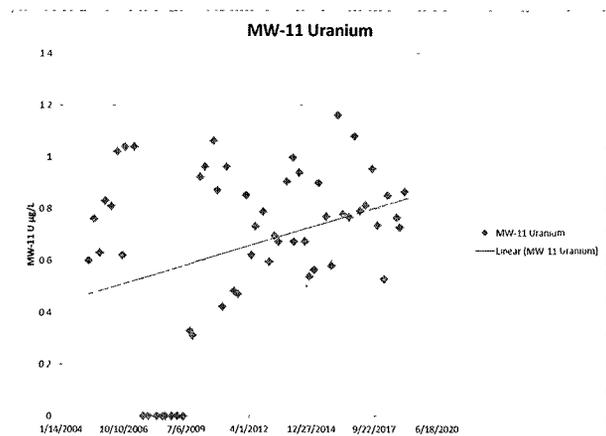
***1. Tailings Solution Groundwater Indicator Parameters at Monitoring Wells MW-11 and MW-24***

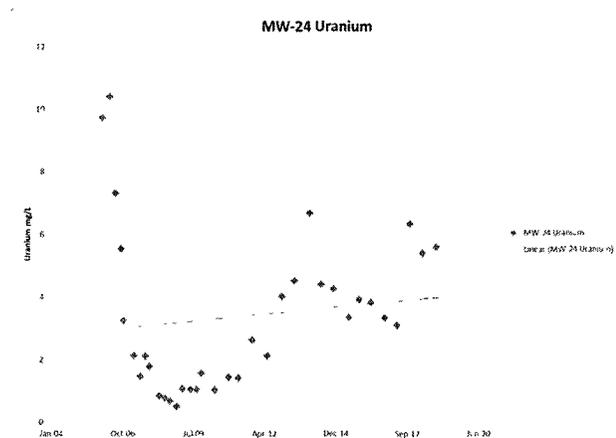
The SAR Section 3.5 discusses four primary indicator parameters (Chloride, Fluoride, Sulfate and Uranium) which would be detected in ground water in the event of a discharge from the Mill tailings cells. DWMRC plots of these parameters are included below for monitoring well MW-11 and MW-24:

**MW-11**



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Note that fluoride at MW-24 is one of the current SAR parameters and is not reviewed as an indicator parameter.

MW-11 DWMRC Analysis: Chloride Flat, Fluoride Decreasing, Sulfate Flat, Uranium Increasing (Note that if uranium is plotted starting in 2012 there is no trend. Per review of the indicator parameters for MW-11 it does not appear that trends or concentrations are indicative of a tailings wastewater release to the groundwater. Per review of other monitoring parameters at MW-11 it is noted that pH is showing a slight decreasing trend, no other trends noted in the data.

MW-24 DWMRC Analysis: Chloride Flat, Sulfate Flat, Uranium Increasing (Early data appears unreliable in the data set). Field pH is showing a strong decreasing trend, MW-24 has been noted to have higher percentages of pyrite and other sulfuric minerals in core materials than other cores examined. Per review of indicator parameters and other parameters in MW-24, it does not appear that groundwater is impacted by the release of tailings wastewater.

## 2. University of Utah Study

Monitoring well MW-11 was included in a University of Utah study conducted at the White Mesa Uranium Mill during 2007 (Final Report of Study Findings Dated May, 2008). Based on groundwater age dating at monitoring well MW-11 [chlorofluorocarbon (“CFC”) analysis], the groundwater was found to exhibit CFC recharge dates which predate the construction of the Mill in 1980. Manganese concentrations in MW-11 were showing an upward concentration trend at the time of the study.

## 3. Sorption/Desorption Modeling for MW-24

The SAR section 3.2, 3.4, and Appendix F (Electronic Only) provide a summary and input/output files for a ferrihydrite sorption model for beryllium, cadmium, nickel, and thallium in MW-24. The model was created in the Geochemist’s Workbench software (v. 11.0.8) using the React module and the minteq and FeOH\_minteq databases. Overall, the model showed that desorption of cadmium and nickel bound to ferrihydrite would occur at pH values lower than 5.5 (lower pH would result in less sorption and higher groundwater concentrations). Model findings for beryllium and thallium did not produce a definitive conclusion regarding an effect of pH on desorption from ferrihydrite, and other potential causes of rising concentrations for these metals is discussed in the SAR. Beryllium and thallium may be desorbed from clay or sulfide minerals. In general the model helps to support EFR claims that the increasing trends are caused by lowering pH in MW-24 but does not definitively determine this as a source for exceedances.

#### **4. Pyrite Oxidation**

Section 3.1 of the SAR discusses findings and previous studies and findings regarding pyrite oxidation and site-wide decreasing pH at multiple groundwater monitoring locations, including upgradient and far downgradient monitoring wells. Per past studies and reports (Pyrite Report, 2012) it was determined that monitoring well MW-24 contained the highest observable pyrite percentage among the samples analyzed. It has been observed that the pH in monitoring well MW-24 is among the lowest at the site and it is expected that the lowering pH will have a geochemical response in the aquifer mineralogy and groundwater. Per the SAR this is proposed as a cause for the individual parameters studied. Probable minerals noted in the onsite formations were identified in the SAR.

#### **5. Source Assessment Conclusions**

Based on DWMRC review of the SAR, it appears that Mill activities are not influencing SAR concentrations at monitoring well MW-11. This is based on the findings of several lines of evidence in the SAR including: 1. Decreasing pH effects on geochemistry in MW-11: 2. Evaluation of tailings solution indicator parameters (chloride, sulfate, fluoride and uranium) for MW-11 and evaluation of the historical data at MW-11: 3. Potential effects of pyrite oxidation releasing selenium and other trace metals into solution, and: 4. Findings of the 2007/2008 University of Utah Groundwater Study Regarding MW-11.

Per DWMRC review, these findings are consistent with previous EFR SAR's and it does not appear that the GWCL exceedances and/or manganese trends at monitoring well MW-11 are being caused by mill activities. Based on the increasing trend, adjustment of the GWCL for manganese in the Permit is appropriate.

In the case of SAR parameters at monitoring well MW-24 it was noted that recent increasing trends for certain parameters has resulted in out-of-compliance status warrants further investigation. Based on DWMRC review findings and a conference call discussion with EFR on September 3, 2019 it was decided that additional source assessment needs to be conducted for monitoring well MW-24. EFR mentioned during the call, that there is a potential that monitoring well construction could be the cause of the out of compliance parameters and that additional evaluation to determine if this is the cause could include the construction of a nearby monitoring well and subsequent tandem sampling of the two wells to determine if well construction is an issue. Based on discussion this was determined to be a useful and reasonable evaluation of the non-compliance. Consideration is given that based on a review of indicator parameters and the comprehensive historical data record, the parameter trends and out-of compliance do not appear to be caused by a tailings wastewater source.

#### **EFR Proposed Modified GWCL Statistical Evaluation of Data:**

##### **Proposed Modified Approach GWCL's:**

Appendix B-1 of the SAR summarizes the statistical evaluation and proposed GWCL's for the SAR wells and parameters.

Per the DWMRC approved statistical flow chart for the White Mesa Mill groundwater monitoring wells, it was noted that if an upward trend is apparent and is related to rising background concentrations for an analyte then a modified approach should be considered. The modified approach should allow for a GWCL which considers the increasing concentrations. Based on this, EFR calculated a proposed modified GWCL

for manganese at monitoring well MW-11 according to the highest historical value (HHV). DWMRC reviewed the proposed modified GWCL to ensure that it is reflective of the collected data and provides for a continuing regulatory mechanism.

In the case of monitoring well MW-24 it was recognized that two of the data sets have significant early time not detected values (83% non-detects for beryllium and 58% for nickel), and that cadmium and thallium also have a high amount of non-detects in the early time (24% and 28% respectively). Fluoride also shows a period of relative stable readings in the early time followed by a rising trend. This anomalous data does not clearly establish pre-identified trends and it appears that trends began at various times after well construction. Per additional discussion above and below, it was agreed that the rising trends will need more investigation prior to potential GWCL modification.

The table below summarizes the EFR calculations and rationale for the proposed modified manganese GWCL for monitoring well MW-11.

**Table of EFR Proposed Revised GWCL for Selenium and Uranium at Monitoring Well MW-30:**

Well Number	Parameter	Current GWCL	EFR Proposed GWCL Revision	Method to Determine GWCL	DWMRC Finding – Is Proposed GWCL in Conformance with the Statistical Flow Chart?	DWMRC Discussion of EFR Modified Approach
MW-11	Manganese	164.67 µg/L	237 µg/L	HHV	Increasing trend and non-normal data set, 120 data points. HHV value appears to be appropriate. HHV is an October 2015 sample analysis result. No non detects in data set.	EFR modified approach proposes a limit based on fraction of the GWQS, however, the value is high and out of range with the measured data regardless of the increasing trend.

**Conclusions:**

Per review of the SAR Sections and tables regarding proposed modifications to the GWCL's and statistical analysis of the data, and a telephone conference amongst DWMRC representatives and EFR representatives on September 3, 2019, it was agreed that the MW-11 Manganese GWCL will be modified in the White Mesa Uranium Mill Ground Water Permit as summarized on the table below:

Well Number	Parameter	Current GWCL	Modified GWCL	Method of Analysis
MW-11	Manganese	164.67 µg/L	237 µg/L	Highest Historical Value

The modified GWCL will not be effective until future issuance of a revised Groundwater Discharge Permit, and that the modifications will be subject to formal public notice and public participation requirements. This is expected to take place in the winter of 2019. A letter will be sent to EFR, clarifying the approval and future requirements of the MW-11 modified manganese GWCL.

During the September 3, 2019 telephone conference call with EFR, it was discussed that based on review of the GWCL exceedances at MW-24 and well data, it does not appear that tailings wastewater is the

source. However, beryllium was measured as non-detectable from July 2005 until April 2016, and likewise nickel shows a significantly large amount of non-detect data until the recent rising trend. Based on these data anomalies it was discussed that problems with the well (e.g. design and installation) may be the cause of the out-of-compliance status for the SAR parameters. EFR suggested that in order to determine whether the well is the cause, an additional well, screened at the same well interval will be placed close-by the existing MW-24, and monitored in tandem. This is similar to the approach used at other wells which showed similar anomalous data. Until conclusion of the tandem well monitoring the GWCL's will remain the same in the Permit with recognition that the exceedances are being actively investigated. This will allow more monitoring data to be collected at MW-24 for better evaluation of data trends.

A letter will be sent to EFR requiring that a plan for the new monitoring well installation be submitted to the Director for review and approval on or before 30 calendar days from receipt of the letter.

### **References**

<sup>1</sup> Energy Fuels Resources (USA) Inc., June 27, 2019, *Transmittal of Source Assessment Report for MW-11 and MW-24, White Mesa Mill Groundwater Discharge Permit UGW370004*

<sup>3</sup> Energy Fuels Resources (USA) Inc., May 14, 2019, *White Mesa Uranium Mill Ground Water Monitoring Quality Assurance Plan (QAP), Revision 7.5*

<sup>4</sup> Energy Fuels Resources (USA) Inc., October 12, 2012, *Source Assessment Report*, Prepared by Intera

<sup>5</sup> Energy Fuels Resources (USA) Inc., November 9, 2012, *pH Report*, Prepared by Intera

<sup>6</sup> Hurst, T.G., and Solomon, D.K. University of Utah, 2008, *Summary of Work Completed, data Results, Interpretations and Recommendations for the July 2007 Sampling Event at the Denison Mines, USA White Mesa Uranium Mill Near Blanding, Utah*, Prepared by Department of Geology and Geophysics

<sup>7</sup> Hydro Geo Chem, December 7, 2012, *Pyrite Investigation Report*

<sup>8</sup> Intera, 2007, *Groundwater Data Preparation and Statistical Process Flow for Calculating Groundwater Protection Standards, White Mesa Mill Site, San Juan County, Utah*

<sup>9</sup> United States Environmental Protection Agency, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance EPA530/R-09-007*

<sup>10</sup> Utah Department of Environmental Quality, January 19, 2018, Modified on March 19, 2019, *Utah Division of Radiation Control, Ground Water Discharge Permit, Permit No. UGW370004, Energy Fuels Resources (USA) Inc.*