State of Utah
SPENCER J. COX
Governor

DEIDRE HENDERSON
Lieutenant Governor

Department of
Environmental Quality

Kimberly D. Shelley
Executive Director

DIVISION OF WASTE MANAGEMENT
AND RADIATION CONTROL

Douglas J. Hansen
Director

DRC-2022-004486

MEMORANDUM

TO: File

THROUGH: Phil Goble, Manager *Phillip Goble* 04/19/2022

FROM: Tom Rushing, P.G. *Thomas Rushing* 04/19/2022

DATE: April 19, 2022

SUBJECT: Review of the Energy Fuels Resources (USA) Inc. (EFR), White Mesa Uranium Mill, Blanding, Utah January 28, 2022, Source Assessment Report for Uranium and Selenium in Monitoring Well MW-30
Ground Water Discharge Permit No. UGW370004 (Permit)

Summary

A January 28, 2022, Source Assessment Report ("SAR") for uranium and selenium in Monitoring Well MW-30 at the White Mesa Uranium Mill (Mill) was submitted to the Director by Energy Fuels Resources (USA) Inc. ("EFR") and received by the Utah Division of Waste Management and Radiation Control on February 2, 2022. The SAR was submitted for review and approval of source assessment investigation findings and proposed revised Ground Water Compliance Limits (GWCLs) for uranium and selenium in the monitoring well.

Monitoring well MW-30 is located on the southern berm of the Mill Tailings Cell 2 and is hydraulically downgradient from portions of Cell 2 and from the Mill processing and storage areas (including ore storage).

Monitoring well MW-30 has been subject to two previous SARs for uranium/selenium (2012 and 2019) due to the recognized increasing trends. Comprehensive Division reviews of the previous MW-30 SARs were conducted and documented, and those reviews were also considered when reviewing the current SAR. The Division found, based on review of the previous SAR's that the Permit Ground Water Compliance Limit (GWCL) exceedances were not due to impacts by the Mill, and revised GWCLs were subsequently approved for inclusion in the Permit. The geochemical behavior is in general the same for the current conditions with the exception that the reversal of the pH trend from decreasing to increasing is now more evident and based on a larger set of data. The reversal of the pH data trend supports the other multiple lines of evidence finding that tailing solution is not the source of the uranium and selenium GWCL exceedances.

Per the SAR, MW-30 is within the boundaries of the nitrate/chloride plume. Geochemical influences of the plume on MW-30 groundwater were discussed in the previous SARs for MW-30. The Division notes that the use of chloride as a primary indicator for a tailing solution source is problematic due to MW-30 being screened within the chloride plume. In any case, the concentrations and trends of indicator parameters are used as one line of evidence when evaluating a potential Mill source of GWCL exceedances and when reviewed in conjunction with mass balance analysis (tailings wastewater concentrations vs. groundwater concentrations) there are substantial, order of magnitude differences, in current groundwater concentrations and what would be expected for a tailings solution source.

Per the review summarized below, upward trending concentrations of uranium and selenium in MW-30 do not appear to be consistent with a tailing solution or other Mill source. State and Federal guidance, as well as Mill specific agreements support the modification of the uranium and selenium GWCLs in MW-30 according to data review and statistical evaluation per the approved statistical decision flow chart agreed upon for evaluation of groundwater data.

SAR Review

The SAR is broken up into four primary sections: 1. Categories and approach for analysis; 2. Results of the analysis; 3. Statistical evaluation and calculation of revised GWCL's for trending constituents, and; 4. Conclusions and recommendations.

The figures below depict the time/concentration plot for uranium and selenium in monitoring well MW-30 (data through the 4th Quarter 2021).

Figure – Uranium Data Plot of Historical Data at MW-30

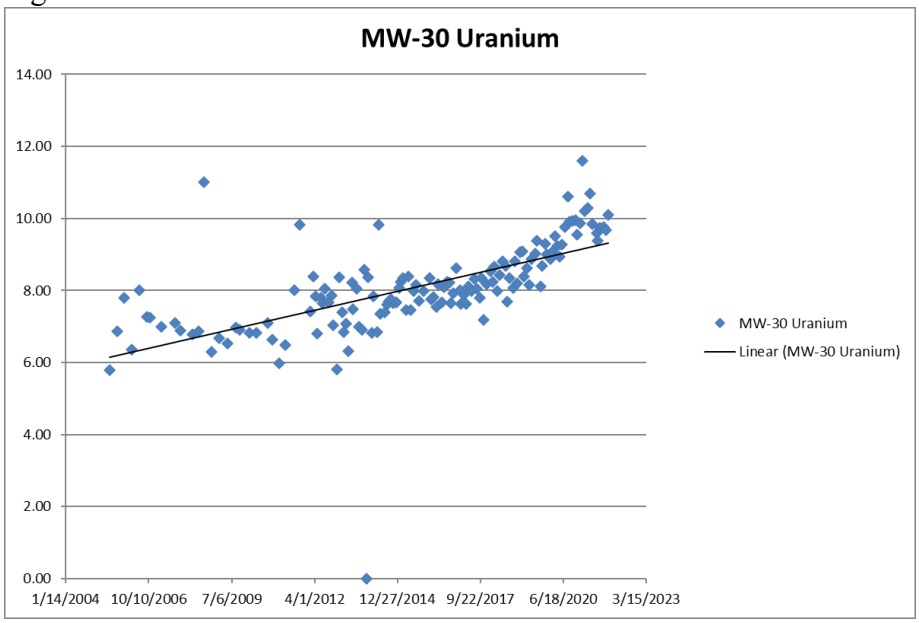
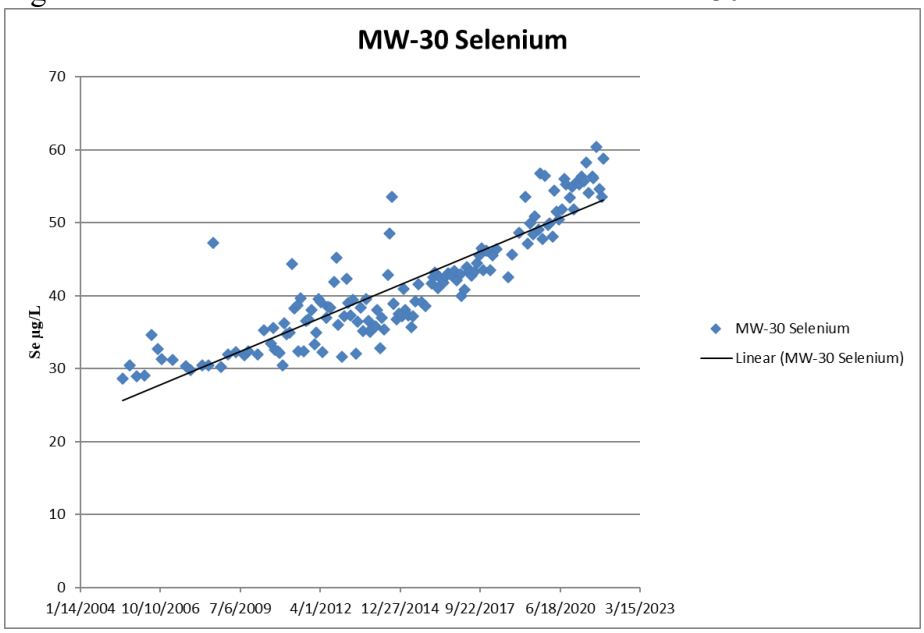


Figure – Selenium Data Plot of Historical Data at MW-30



Both data sets (uranium and selenium) depict long-standing significant rising trends.

EFR Investigations of Potential Sources of Report Increasing Trends at Monitoring Well MW-30

1. Tailings Solution Groundwater Indicator Parameters at Monitoring Well MW-30

The SAR Section 3.4 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.

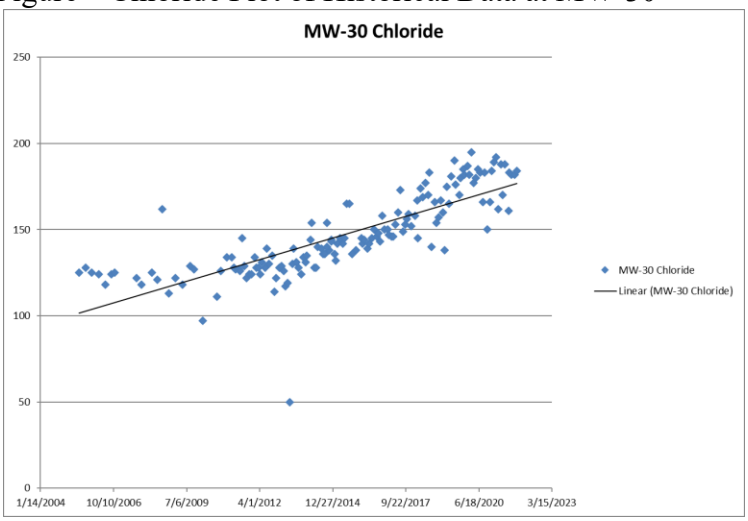
Per the SAR it was noted "*chloride concentrations in MW-30 exhibit a statistically significant increasing trend. MW-30 is located within the nitrate/chloride plume, which is actively being remediated according to the Corrective Action Plan. Groundwater in this well is being impacted by that plume; therefore, chloride is not an appropriate indicator parameter for potential tailings seepage in MW-30. Sulfate and fluoride concentrations exhibit stable to decreasing trends, and uranium concentrations, although relatively low for the Mill site, exhibit a statistical significant increasing trend.*" The SAR additionally presents data plots of historical data and evaluation of the indicators per historical data and as evaluated in the New Wells Background Report. Additional evaluation by DWMRC is included below:

Chloride

Per the SAR, the use of chloride as an indicator parameter in the case of monitoring well MW-30 is complicated by the fact that MW-30 is screened within the nitrate/chloride plume, and chloride is therefore above background and is not a reliable primary indicator of cell leakage for MW-30.

Chloride at monitoring well MW-30 is showing a significant increasing trend. The chloride plume has been delineated based on concentrations and plots clearly show that the plume originates hydraulically upgradient from the mill tailings cells and is not attributed to tailings cell leakage based on groundwater flow data and mass balance calculations. A plot of historical chloride data in MW-30 is below:

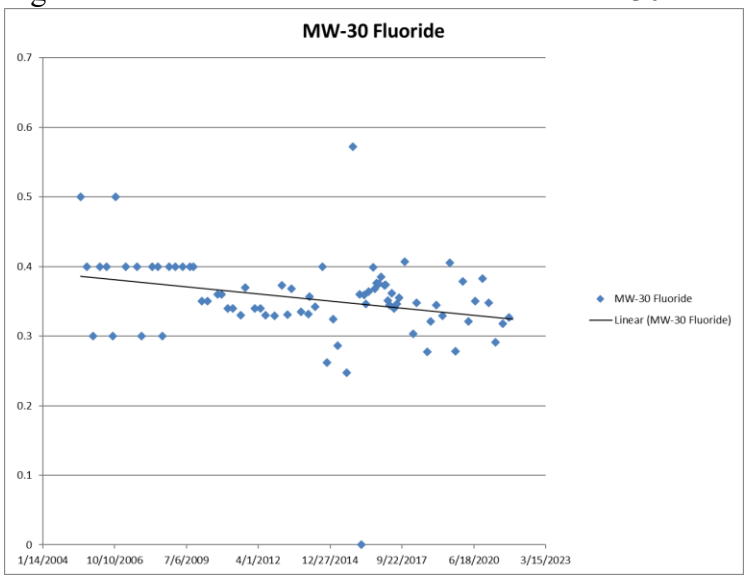
Figure – Chloride Plot of Historical Data at MW-30



Fluoride

Fluoride is highly concentrated in tailings wastewater and per literature and mill groundwater transport modeling has been shown to be highly mobile in the vadose zone and groundwater beneath the tailing cells. Per the figure below, fluoride is showing a decreasing concentration trend in MW-30.

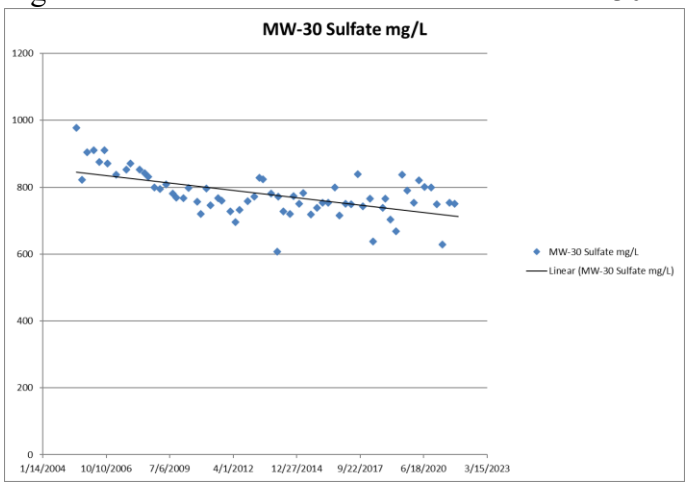
Figure – Fluoride Plot of Historical Data at MW-30 – Decreasing Trend



Sulfate

Sulfate is also abundant in the tailings wastewater and is a relatively mobile constituent in groundwater. Per the figure below sulfate is showing a decreasing trend in MW-30.

Figure – Sulfate Plot of Historical Data at MW-30 – Decreasing Trend



Additionally, sulfate concentrations in MW-30 are very low in comparison with other wells at the site. The average value of sulfate using all historic data is 784 mg/L. This concentration is compared with highest historical values of other site monitoring wells (nearby MW-30) on the table below:

Monitoring Well No.	Location Relative to Tailings Cells	Average Sulfate Concentration (Complete Data Set) (mg/L)
MW-30	Downgradient Cell 2	784
MW-1	Upgradient	837
MW-18	Upgradient	1,828
MW-19	Upgradient	669
MW-20	Far Downgradient	3,526
MW-03A	Far Downgradient	3,568
MW-29	Downgradient Cells 1 and 2	2704
MW-11	Downgradient Cells 2 and 3	1,105

In the case of MW-30, the relatively low concentration of sulfate and decreasing trends in sulfate and fluoride indicates that tailings wastewater is not the source of the uranium exceedances.

Uranium

Uranium concentrations in monitoring well MW-30 are like sulfate concentrations in that site-wide they are low. This is additionally evaluated by box plot evaluation comparing uranium concentration in MW-30 to all monitoring wells site wide (Appendices B-7, B-8, and B-9 of the SAR).

Indicator parameter analysis supports the SAR finding that selenium and uranium exceedances and upward trends are not due to tailings cell leakage.

2. University of Utah Study

Monitoring well MW-30 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-30 [chlorofluorocarbon ("CFC") analysis], the groundwater was found to exhibit CFC recharge dates which predate the construction of the Mill in 1980.

3. Source Assessment Conclusions

In addition to those above, the SAR discussed several lines of evidence to support that mill activities are not the source of the selenium and uranium GWCL exceedances in monitoring well MW-30, including 1. Decreasing pH effects on monitoring well geochemistry; 2. Evaluation of tailings solution indicator parameters (chloride, sulfate, fluoride and uranium); 3. Mass balance calculations for fluoride, sulfate and uranium 3. Previous findings in the EFR Existing Wells Background Report that the SAR parameters showed long standing upward trends; 4. Potential effects of pyrite oxidation releasing selenium and other trace metals into solution; 5. Location of MW-31 within the nitrate/chloride plume, and, 6. Findings of the 2007/2008 University of Utah Groundwater Study.

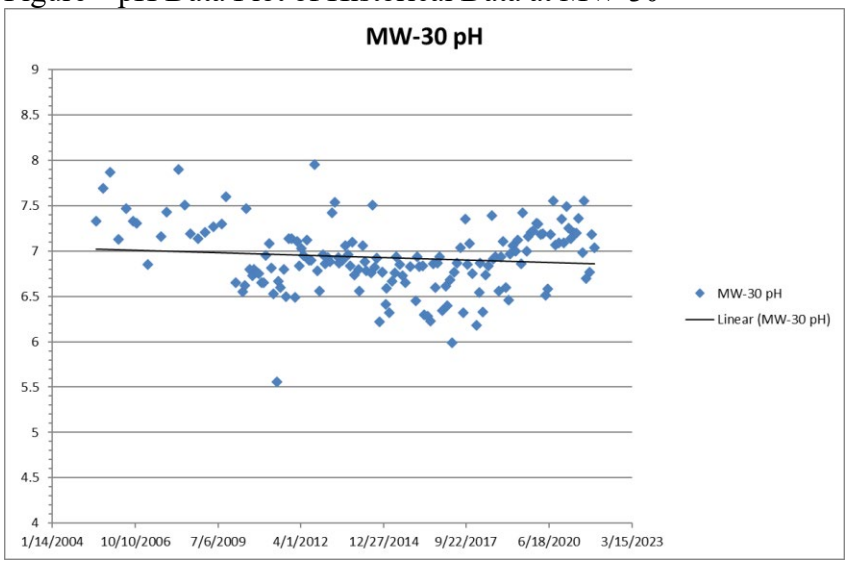
As discussed above, these evaluations have been conducted per two previous EFR SARs. Per DWMRC review of the current SAR findings, these findings are consistent with previous EFR SARs, and it does not appear that the GWCL exceedances are being caused by Mill activities. Based on the increasing trends, adjustment of the GWCL's for selenium and uranium in the Permit is appropriate. Evaluation of the comprehensive list of monitoring parameters and evaluation of data by EFR and the Division at monitoring well MW-30 is ongoing.

EFR Proposed Modified GWCL Statistical Evaluation of Data:

Based on Division review of the SAR statistical analysis it was noted that analysis was conducted for the complete historic data set for MW-30 and for a post 2016 data set. DWMRC notes that per the MW-30 pH concentration plot there is an apparent reversal in the pH trend from downward to upward at around 2016. The SAR discusses that the increases in pH at MW-30 since 2016 are also accompanied by increases in bicarbonate and calcium. Per SAR discussion, the pH changes are reflective of a shift in the data which warrants use of the modified data set as allowed by the

U.S. Environmental Protection Agency Statistical Guidance.[8] A plot of historical data for pH in MW-30 is below, the 2016 pH trend reversal is evident per review of the plot:

Figure – pH Data Plot of Historical Data at MW-30



EFRI Statistical methods used in the SAR included: 1. Descriptive statistics for the complete and modified data sets; 2. Mean and Standard Deviation Calculation; 3. Shapiro-Wilk Test for normality; and 4. Mann-Kendall Trend Analysis (non-normally distributed data sets) and Linear Trend Analysis. Proposed GWCL's were calculated based on Mean + 2σ of the complete and post 2016 data sets, Highest Historical Value, Fraction of the Groundwater Quality Standard, and Mean X 1.5. The calculations and findings are summarized on a table in the SAR (Appendix B-1 of the SAR).

Per the SAR Section 4.2, EFRI proposed that GWCL's be adjusted according to 1.5 times the uranium and selenium background (Mean X 1.5) for the post 2016 data sets. The Division approved statistical flow chart for the White Mesa Mill groundwater monitoring wells clarifies that if an upward trend is apparent for a constituent, then a modified approach should be considered. The modified approach should allow for a GWCL which considers the increasing concentrations. The Division notes that calculations by 1.5 X Background are the highest proposed GWCL's and are reflective of the increasing uranium and selenium trends.

The table below summarizes the EFR calculations and rationale for the proposed modified GWCL's.

Table of EFR Proposed Revised GWCL for Uranium and Selenium 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?
MW-30	Uranium	9.8 µg/L	13.11 µg/L	1.5 X Background*	Increasing Trend allows for modified approach on Flow Chart. The revised 1.5 X Background value appears appropriate based on review of data. A post 2016 data set was used based on the reversal of the pH trend at that time.
MW-30	Selenium	53.6 µg/L	72.52 µg/L	1.5 X Background*	Increasing Trend allows for modified approach on Flow Chart. The revised 1.5 X Background value appears appropriate based on review of data. A post 2016 data set was used based on the reversal of the pH trend at that time.

*Based on 1.5 X background of the Selenium background data mean of the post 2016 data set for monitoring well MW-30

Conclusions:

Based on DWMRC review of the background statistics and confirmation that the proposed parameters for GWCL modifications are showing increasing trends not apparently associated with contamination from the Mill, it is appropriate to set GWCL's for these parameters at highest historical values. This review is consistent with the Director approved statistical flowchart which appreciates that a modified approach is appropriate for parameters showing upward trends.

Based on review a letter will be sent to EFR of initial approval of the modified GWCL's on the table below. The letter will include notification that the modifications are subject to public notice and public participation requirements, and that the modifications will not be effective until formal issuance of a modified Permit.

Well Number	Parameter	Current GWCL	Modified GWCL	Method of Analysis
MW-30	Uranium	9.8 µg/L	13.11 µg/L*	1.5 X Background*
MW-30	Selenium	53.6 µg/L	72.52 µg/L*	1.5 X Background*

*Based on 1.5 X background of the Selenium background data mean of the post 2016 data set for monitoring well MW-30

References

[1] Energy Fuels Resources (USA) Inc., January 28, 2022, *Transmittal of Source Assessment Report for MW-30 White Mesa Mill Groundwater Discharge Permit UGW370004*

[2] Energy Fuels Resources (USA) Inc., August 15, 2017, *White Mesa Uranium Mill Ground Water Monitoring Quality Assurance Plan (QAP), Revision 7.4*

[3] Energy Fuels Resources (USA) Inc., October 12, 2012, *Source Assessment Report*, Prepared by Intera

[4] Energy Fuels Resources (USA) Inc., November 9, 2012, *pH Report*, Prepared by Intera

[5] 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

[6] Hydro Geo Chem, December 7, 2012, *Pyrite Investigation Report*

[7] Intera, 2007, *Groundwater Data Preparation and Statistical Process Flow for Calculating Groundwater Protection Standards, White Mesa Mill Site, San Juan County, Utah*

[8] United States Environmental Protection Agency, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance EPA530/R-09-007*

[9] 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.*

[10] Utah Department of Environmental Quality, January 19, 2018, Modified on March 8, 2021, *Utah Division of Radiation Control, Ground Water Discharge Permit, Permit No. UGW370004, Energy Fuels Resources (USA) Inc.*