Memorandum

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Subject: Additional Information from Black Range Minerals
Date: May 10, 2016

In July 2015, Black Range Minerals submitted a white paper describing the Ablation Mining Technology applied to uranium deposits (AMT) and asked the Department to make a determination on how this technology would be regulated under the *Colorado Rules and Regulations Pertaining to Radiation Control*. The Department requested additional information from Black Range Minerals in August 2015, and received a response from Black Range Minerals in April 2016.

After reviewing the April 2016 response, I conducted two phone calls on May 2 and 6, 2016, and various email exchanges between April 29 and May 6, 2016, with Patrick Siglin from Black Range to obtain clarification on the materials presented in the April 2016 response and other additional information. This memo is to document the information provided via these two phone calls and emails, using the Q & A format: "Q" denotes the questions I asked, and "A" denotes the answers or additional information provided by Black Range.

Attachment 2.4 – Water in the AMT Operation

Q: On Page 2, last two paragraphs, it talks about a 960 gph of system charge water replenishment that may be needed. This will result in 9600 gallons of waste water per one 10-hour working day. What does "system charge water replenishment" mean and where will the 9600 gallons per day of water go? How does Black Range plan to handle the residuals if the water will be treated?

A: Black Range anticipates recycling the water in the AMT system for a number of times until the quality of the water (such as Total Dissolved Solids) reaches a level that might cause negative effects to the system, such as corrosion, so that the water needs to be replenished. This defines the system charge replenished water. Attachment 2.4 indicates 20 cycles as a typical number in the industry; however, Black Range will test run the water in the AMT machine to determine how many cycles the water can run through the AMT system before it needs to be replenished, prior to operation. Assuming 20 cycles, there will be up to 6750 to 16350 gallons of waste water that needs to be handled at the end of each working day (again, assuming 10 working hours per day). Black Range has not decided whether the waste water will be recycled back to the system, stored in the facility, treated, shipped to other mills, or disposed of in a way that follows applicable regulations. Black Range has not decided how it will handle the residuals.

Q: Will the mine water get pre-treated or pre-filtered before being introduced into the AMT system?

A: Black Range has not decided the water quality needed before being introduced into the AMT system. More tests will be needed to make this determination prior to operation. Pre-

treating or pre-filtering the mine water might or might not be necessary, depending on the needed water quality.

Attachment 2.4 – Laboratory Sample Results from the October Ore Pilot Testing

Q: What is the difference between the "October Post Ab" and "ABT October Post Screen" sample ID in Table 1?

A: The "ABT October Post Screen" is the water sample taken from the water that immediately came out from the AMT system; therefore, this water contains all post-AMT solids and the water that ran through the system. The "October Post Ab" is the water sample taken after all post-AMT sands (solids with size larger than -400) have been screened out; therefore, this water only contains the post-AMT ores and the water that ran through the system.

Q: Was the mine water treated or filtered before running through the pilot AMT system?

A: Yes; however, there was no sample taken from the pre-AMT water and the water quality after treated or filtered is unknown. Black Range believes that the water might have been treated or filtered to near the pure water quality.

Q: How many cycles did the water get run in the pilot AMT system to result in the water quality shown in the lab results?

A: The October Ore pilot testing used 40 gallons of water with 60 gpm capacity. The test was run for two hours to obtain the needed screening size for the post-AMT ores. The water was run for 160 cycles.

Q: What are the resulting mass fractions of the post-AMT ores and the post-AMT waste sands?

A: The October Ore pilot testing used 21772.4 grams of pre-AMT ROM materials and resulted in 4001.77 grams of post-AMT ores (18.4%) and 16104.1 grams of post-AMT waste sands (74%). See Table 1 below. From this specific pilot test, there was 1666.53 grams of solids that did not get recovered; a small amount of them might be left in the ore hopper, and most of them might be left in the waste water due to the way this pilot test was conducted. However, it is Black Range's goal to recover as much as solids as possible.

Q: Based on the October ore lab results, the uranium in the post-AMT ores is only about 62% of the ones in the pre-AMT ROM. This is not consistent with 90% of uranium recovery rate as indicated in the July 2015 white paper, or the 85%-95% of uranium recovery rate as shown in Attachment 2.2 of the April 16 response. Please explain.

A: Table 1 details the mass and uranium contents in the pre-AMT ROM, post-AMT waste sands (with different screening sizes), and post-AMT ores (with screening size of -400):

Table 1: Results compared to Original ROM Mass

	mass (g or mL)	mass (%)	U (ppm)	U (g)	U mass (%)
ROM	21772.40	100.00%	1350	29.39	
+50/60	2344.20	10.77%	214	0.50	1.71%
-50/60+100	10800.00	49.60%	80	0.86	2.94%

-100+200	2016.00	9.26%	157	0.32	1.08%
-200+270	518.80	2.38%	321	0.17	0.57%
-270+325	268.60	1.23%	417	0.11	0.38%
-325+400	156.50	0.72%	454	0.07	0.24%
-400	4001.77	18.38%	4590	18.37	62.49%
Solids recovered	20105.87	92.35%		20.40	69.40%
post ab water (mL)	350000		8.31	2.91	9.90%
total				23.31	79.30%

Table 1 shows 62.49%, 6.92%, and 9.9% of uranium in the post-AMT ores, waste sands, and water, respectively. However, it also shows that there is 20.7% of uranium that did not get recovered. Black Range thinks that the missing 20.7% of uranium within the missing 1666.53 grams of solids are dominated by the size of -400 particles (i.e., post-AMT ores), because the uranium grade of these missing solids is 3650 ppm, much similar to the 4590 ppm of the -400 post-AMT ores than the post-AMT waste sands with different screening sizes. It is Black Range's goal to recover as much as solids as possible during operation. From other tests conducted in-house for the Sunday Mine ores, Black Range dried the post separation fractions which allows for more accurate mass balance estimation. These in-house results also suggested that AMT can reach 90% recover rate for uranium. Overall, Black Range believes that AMT can recovery >90% of uranium, if accounting for the uranium in most of the missing solids and in the post-AMT water. Black Range thinks that the uranium in the post-AMT water is recoverable.

Attachment 1.1 – "Microshield and MCNP5 Modeling of Natural Uranium Ore Mined Using Ablation Technology"

Q: In Table 2, how were the values in the Columns "Dry Equivalent Mass of Ore or Slurry (kg)" and "Density of Ore or Slurry (g/cc)" obtained?

A: The former column includes the mass of ore or slurry when the specific component gets filled to its capacity instead of to the total volume. The values in the latter column were obtained by assuming the following:

- The density of the sandstone is 2 g/cc and the density of water is 1 g/cc.
- Once into the mix tank module and through the impact modules, the solids to water ratio is 20:80.
- The solids to water ratio decreases through the separation portion of the system as coarse material is removed from the system.
- At "Orival Filter" component, the solids to slurry mass ratio is assumed to be 10:90 after removing some of the coarse materials.
- At "Centrifuge" component, the solids to slurry mass ratio is assumed to be 5:95 after removing the remainder of the coarse materials.
- Upon filtering the final slurry, a 70:30 soilds to slurry mass ratio is assumed.

Q: Why is the waste water storage not included as one source component in the dose model?

A: It is anticipated that the radon emission in the waste water storage will be insignificant, and the water storage location might not be inside the building where the AMT system is. Black Range has not decided on the location.