United States Nuclear Regulatory Commission Official Hearing Exhibit			
In the Matter of:	CROW BUTTE RESOURCES, INC. (Marsland Expansion Area)		
ASLBP #:	13-926-01-MLA-BD01		
Docket #:	04008943		
Exhibit #:	OST010-00-BD01	**Identified:**	10/30/2018
Admitted:	10/30/2018	**Withdrawn:**	
Rejected:		**Stricken:**	
Other:			

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	Docket No. 40-8943-MLA-2
CROW BUTTE RESOURCES, INC.	ASLBP No. 13-926-01-MLA-BD01
(Marsland Expansion Area)	

Hearing Exhibit

Exhibit Number: OST010

Exhibit Title: Dr. LaGarry Opinion Submitted With OST Petition Jan 29 2013

EXPERT OPINION ON THE ENVIRONMENTAL SAFETY OF IN-SITU LEACH MINING OF URANIUM NEAR MARSLAND, NEBRASKA

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INTRODUCTION

I am offering this expert opinion regarding Crow Butte Resources' proposed in-situ leach (ISL) uranium mining near Marsland, Nebraska because I am concerned that this mining will lead directly to the transmission of lixiviant and spilled waste water into the High Plains Aquifer, the Niobrara River, and the White River. I am not against uranium mining in fact or principle. My concerns stem from the fact that northwestern Nebraska and the entire northern Plains region is currently experiencing what may be an extended period of drought and water shortages. These water shortages increase the agricultural and municipal demands for water extracted from wells in the High Plains Aquifer which will likely be contaminated by the proposed mining operations. This issue isn't about the uranium, it is about protecting the region's water supply and the future inhabitability and agricultural viability of northwestern Nebraska. In this document, I will briefly explain the basis for my concerns. In a previous expert opinion I proposed a series of studies that could clarify whether or not Crow Butte Resources is contaminating the region's water, and if so, how much. However, because ISL mining near Marsland will require drilling much deeper to reach uranium-bearing rocks, such studies are not feasible in this situation. Therefore, I have no choice but to oppose the proposed activity.

PROFESSIONAL BACKGROUND

I have 25 years of experience studying the rocks and fossils of northwestern Nebraska. From 1988-1991 I collected fossils from northern Sioux County for my dissertation work. From 1991-1996 I led field parties from the University of Nebraska State Museum while mapping the fossils and geology of the Oglala National Grassland in Sioux and Dawes Counties. From 1996-2006 I led a team of geologists from the Nebraska Geological Survey that mapped in detail the surficial geology of most of northwestern Nebraska (a total of 80 1:24,000 quadrangles). This mapping included the entire Pine Ridge area and the area between Crawford, Nebraska and Pine Ridge, South Dakota. These maps, including digital versions (ArcInfo) and supporting field notes, are available from the University of Nebraska-Lincoln School of Natural Resources. As a direct consequence of this mapping, I have published peer-reviewed articles on the Chadron Formation (Terry & LaGarry 1998), the Brule Formation (LaGarry 1998), the mapping of surficial deposits (Wysocki & others 2000, 2005), and local faults (Fielding & others 2007). In future, we also intend to revise and reclassify the remaining rocks and surficial sediments of northwestern Nebraska and adjacent South Dakota.

Since 2008 I have been employed by Oglala Lakota College (OLC) on the Pine Ridge Reservation. I was hired to join the Department of Math and Science and teach geology, write grants, and study uranium and stratigraphy in Nebraska and South Dakota. In 2010 I became co-chair of the department, and since 2012 have been sole chair of the department. In this capacity, I am responsible for the activities 18 faculty and staff, analytical chemistry and aerospace engineering laboratories, digital research archives, and a biological, geological, and archeological specimen repository. Since joining OLC, I have continued to study the uranium contamination (Botzum and others 2010, Bhattacharyya and others 2012, LaGarry and Yellow Thunder 2012) and the stratigraphy of local aquifers (LaGarry and others 2012). I manage an international network of 11 academic collaborators in all areas of science (including uranium), and have received funding from the National Science Foundation (TCUP, PEEC, EPSCoR) and the United States Department of Agriculture (NIFA TCEP) to pursue this research.

STRATIGRAPHY OF WATER-BEARING ROCKS IN NORTHWESTERN NEBRASKA

The rocks of northwestern Nebraska range from Cretaceous to Pleistocene in age (Figure 1), and consist entirely of sedimentary rocks. These rocks vary in thickness and geographic extent, and are described as follows (see LaGarry & LaGarry 1997, Terry 1998).

Pierre Shale – underlies all other units, generally 1000′-2000′ thick. Contributes small amounts of sulfer and arsenic to overlying surface aquifers (e.g. modern White River alluvium) and water in streams and impoundments. Generally impermeable, except where fractured. Joints and faults within this unit contain minerals deposited by water movement in the geological past. In the Marsland are these rock are in subsurface only.

Chamberlain Pass Formation – formerly ‘basal Chadron sandstone,’ base of White River Group, overlies Pierre Shale, underlies Chadron Formation. Channel sandstones within this unit are a local aquifer and are mined for uranium. Water from this unit is typically used for residential and livestock supplies. Unit was deposited in an ancient paleovalley oriented generally from Crawford in the N-NW and Bayard to the S-SE. Joints and faults within this unit contain minerals deposited by water movement in the geological past. In the Marsland area these rocks are subsurface only.

Chadron Formation – middle of White River Group, overlies Chamberlain Pass Formation, underlies Brule Formation and modern river alluvium. Generally impermeable, except where fractured. Many faults and joints contain minerals deposited by water movement in the geologic past. In the Marsland area these rocks are subsurface only.

Brule Formation – top of White River Group, overlies Chadron Formation, underlies Arikaree and Ogallala groups (High Plains Aquifer) and modern river alluvium. Generally impermeable, except where fractured. Where fractured, has enough water to be included with overlying High Plains Aquifer. Used locally for residential and low-intensity agricultural supplies. Secondary porosity in Brule can transmit water up to 1500′ day. Many faults and joints contain minerals deposited by water movement in the geologic past. In the Marsland area these rocks are in the subsurface only. However, they are exposed along the headwaters of the Niobrara River.

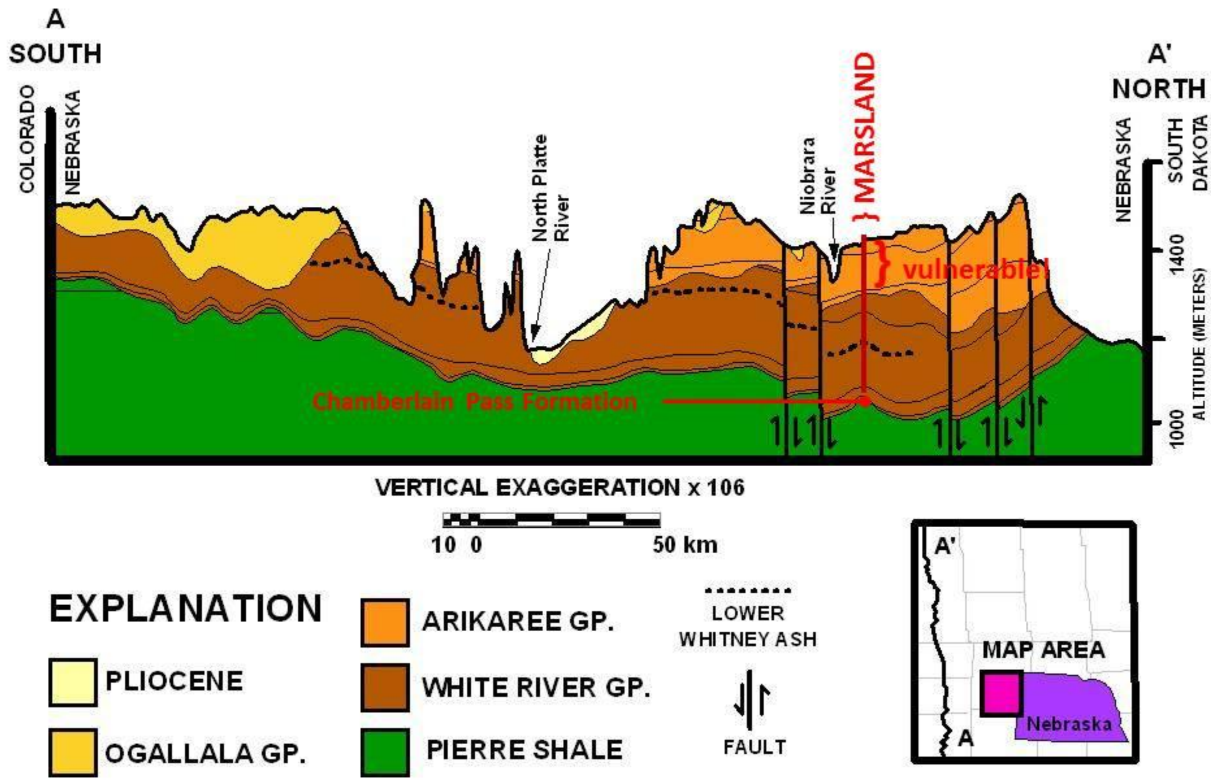

Figure 1. Geologic cross-section of far western Nebraska showing proposed drilling near Marsland, the stratigraphic position of the Chamberlain Pass Formation, the positions of known faults, and the vulnerable portion of the high Plains Aquifer. After Swinehart and others (1985).

Arikaree Group – base of High Plains Aquifer, overlies Brule Formation of the White River Group, underlies Ogallala Group and modern river alluvium. Consists of moderately porous and permeable sandstones and silty sandstones. Coarser sandstone beds deposited along preexisting fault traces. Unit highly faulted and jointed along Pine Ridge Escarpment. Water supplies springs that feed local creeks, and is used for high-capacity irrigation wells. Water is used for high-capacity irrigation wells. In the Marsland are these rocks are exposed at the land surface and in the valleys of the White and Niobrara rivers. These rocks are a primary aquifer in northwestern Nebraska.

Ogallala Group – upper part of High Plains Aquifer, overlies Arikaree Group, underlies modern river alluvium and sand dunes. Consists of highly porous and permeable sandstones and conglomerates, Coarser sandstone beds deposited along preexisting fault traces. Unit highly faulted and jointed along Pine Ridge Escarpment. Water is used for high-capacity irrigation wells. In the Marsland are these rocks are exposed at the land surface and in the valleys of the White and Niobrara rivers. These rocks are a primary aquifer in northwestern Nebraska.

Pliocene, Pleistocene, and Holocene river alluvium – overlies all bedrock units at one place or another. Consists of layers of silt, sand, and coarse gravel. Unit also overlies major fault zones. Unit is used as aquifer, and supplies water to residences, livestock, and in the case of the White River, supplies water to the cities of Crawford, Nebraska and Pine Ridge, South Dakota, among others. In the Marsland area these sediments are exposed at the land surface, are extremely porous and permeable, and include at least three terraces of the Niobrara River.

The recent mapping of the geology of northwestern Nebraska has shown that the simplified, "layer cake" concept applied by pre-1990′s workers is incorrect, and overestimates the thickness and areal extent of many units by 40-60%. Many units' distributions are heavily influenced by the contours of the ancient landscapes onto which they were deposited. For example, when considered to be the 'basal Chadron sandstone,' the Chamberlain Pass Formation was assumed to have a distribution equal to that of the overlying Chadron Formation. However, the Chamberlain Pass Formation is 1-1.5 million years (Ma) older than the Chadron Formation, and has a distribution determined by the ancient topography weathered into the Pierre Shale prior to deposition of the Chamberlain Pass Formation. The Chadron Formation was then deposited later on a different landscape.

CONTAMINANT PATHWAYS

In-situ leach mining in the Marsland area would likely contribute toxic heavy metal contaminants, including but not limited to uranium, through three pathways: (a) surface leaks and spills, (b) underground leaks and spills (excursions), and (c) lack of containment. Once in the aquifer, contaminants would (d) migrate laterally through porous and permeable sandstones into the White and Niobrara rivers (Figure 1).

Surface leaks and spills. The soils in western Nebraska are thin, and directly overly permeable, porous bedrock. The rocks exposed at the surface near Marsland are either the Anderson Ranch Formation of the Arikaree Group or the Runningwater Formation of the Ogallala Group. Both are sandstone. Any leaks or spills onto the landscape would be transmitted directly into the High Plains Aquifer within a few years. There are no confining layers within this aquifer, and in some areas the water table is within 20 meters of the surface. Figure 1 shows the interval of the aquifer vulnerable to surface leaks and spills.

Underground leaks and spills (excursions). In order to reach the uranium in the Chamberlain Pass Formation, injection and extraction wells will need to be drilled through the Anderson Ranch, Harrison, Coffee Mill Butte, Monroe Creek, and Ash Creek formations of the Arikaree Group. All of these contain water, and an excursion into any of them would be catastrophic, with contaminants quickly spreading thoughout the entire section of the aquifer. Under these rocks are the less permeable siltstones of the Brule and Chadron formations, which may contain useable water if sufficiently fractured (otherwise not). Below these are the uranium bearing rocks of the Chamberlain Pass Formation. Figure 1 shows the interval of the aquifer vulnerable to underground excursions.

Lack of containment. Diffendal (1994) showed that there are several potential faults in the Marsland area, and Swinehart and others (1985) show known faults both north and south of Marsland. These faults may allow the transmission of mining fluids to travel upward into the aquifer and laterally into adjacent areas to the west and east. The faults shown in Figure 1 are those that were large enough to be discovered by Swinehart and others (1985) who compiled data from ~12,500 drilling records in western Nebraska and conducted new drilling at 5 mile intervals along the transect shown. My work over the past 25 years has shown that there are likely hundreds more that are too small to be shown on such a diagram.

Lateral migration. Water in underground aquifers does not stay in the same place. It moves around laterally following the contours of the ancient landscapes the aquifer sediments were deposited onto. This water is also draw to wells (such as center pivots and stock tanks), springs (such as those that spawn the White River), and groundwater-fed rivers (such as the close-by Niobrara River). If contaminants were to escape into the High Plains Aquifer, within a few hears it could be drawn out of the ground and sprayed onto crops by center pivots, or be drawn to the surface by stock tanks placed to water cattle and horses. It would likely migrate eastwards (down gradient) and contaminate the White River, which supplies the towns of Glenn, Crawford, Whitney, and Pine Ridge with water. It could quickly find its way into the Niobrara River, which is a National Scenic River used by thousands of people for recreation every year (Figure 1).

CONCLUDING REMARKS

Based on the arguments presented above, it is my expert opinion that ISL mining in the Marsland, Nebraska area should not be allowed. Of greatest concern is its proximity to the Niobrara River (a National Scenic River), which is used for recreation by thousands of people each year. Unfortunately, if the High Plains Aquifer were to become contaminated, the effects would be irreversible and catastrophic for the local agricultural economy. It would likely lead to the depopulation of the region.

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