United States Nuclear Regulatory Commission Official Hearing Exhibit			
In the Matter of:	CROW BUTTE RESOURCES, INC. (License Renewal for the In Situ Leach Facility, Crawford, Nebraska)		
ASLBP #:	08-867-02-OLA-BD01		
Docket #:	04008943		
Exhibit #:	NRC-071-00-BD01	**Identified:**	8/18/2015
Admitted:	8/18/2015	**Withdrawn:**	
Rejected:		**Stricken:**	
Other:			

Table 3
Complexity Summary: Distance Measured from Mapped Fault Trace to Observed Surface Rupture

Complexity	Mean (m)	One-Sided Standard Deviation (m)	Two-Sided Standard Deviation On Fault (m)
Simple, concealed	36.58	49.96	61.92
Simple, inferred	31.49	38.29	49.57
Complex, concealed	90.31	73.12	116.2
Complex, inferred	83.23	81.30	116.35

for the assessment, (2) the fault trace could not be identified or was misinterpreted from the geomorphic features, and (3) the rupture did not occur along the same fault strands that ruptured in previous events.

For assessing off-fault secondary rupture hazard, we followed the methodology of Youngs *et al.* (2003) and digitized the off-fault rupture and displacement data up to 12 km from the fault rupture. The probability of rupture was assessed by calculating the number of cells that contain ruptures and the total number of cells. In contrast to Youngs *et al.* (2003), who use a set 500×500 m cell size, we used a variety of square cells that range from 25 to 200 m on a side (Tables 4 and 5) in order to better represent the range of areas upon which structures will be built. Many of the displacements beyond 2-km distances are triggered ruptures on other faults. We have removed these triggered ruptures for this analysis but recognize that adjacent faults are an important source of fault-rupture hazard and should be considered in the analysis separately. These displacement data form the basis of all the PDFs needed for the analysis.

Published Data and Regression Equations for Fault-Rupture Hazard Analysis

In this section, we describe published equations that are needed for a typical fault-rupture hazard assessment. Many of the inputs used to calculate the fault rupture hazard may be obtained from published ground-motion hazard studies. For example, the USGS and CGS have produced seismic ground-shaking hazard models for the U.S. that define potential sizes, locations, and rates of earthquakes on a fault (Frankel *et al.*, 2002; Petersen *et al.*, 1996; 2008). These fault rupture models may be used to construct the PDFs for magnitude and rupture source, $f_{M,S}(m, s)$, and the earthquake rate parameter α (see Data and Resources). For site-specific analyses, however, we would recommend obtaining a large-scale map (at least 1:24,000 scale) to define the location of the fault trace or perform a geologic investigation to analyze the fault location and rupture characteristics. We encourage that site-specific studies be performed on observed historic and paleoseismic displacements on a fault.

Another important input for the assessment is a function that describes the likelihood of a particular-size earthquake reaching the surface. For our analysis, we applied the global empirical formulation developed by Wells and Coppersmith (1993). Their equation for calculating the probability of surface rupture is given by a logistic regression model (commonly applied when the dependent variable is dichotomous) that provides the conditional probability of surface rupture:

$$P[sr \neq 0|m] = \frac{e^{(a+bm)}}{1 + e^{(a+bm)}}, \quad (5)$$

where $sr \neq 0$ implies that the surface rupture is nonzero, m is moment magnitude, and constants a and b are -12.51 and 2.053, respectively. This equation implies a probability of 87% that an M 7 earthquake will rupture to the surface and 95% that an M 7.5 earthquakes will rupture up to the surface. Other relationships could be based on local/regional data for surface-rupturing events if these data are available.

To calculate the average on-fault displacements, D_{ave}, which is needed for the normalized regressions, we have applied the Wells and Coppersmith (1994) equation for strike-slip faults. They derived the formula

$$\log_{10}(D_{\text{ave}}) = a + bm \pm \varepsilon, \quad (6)$$

where D_{ave} is in meters; a is -6.32; b is 0.90; and ε, the standard deviation in $\log_{10}$ units, is 0.28. This analysis analyzed displacements from earthquakes with M 5.6 to 8.1. The average displacement data that we used in this study are consistent with the Wells and Coppersmith (1994) data

Table 4
Probability of Distributed Fault Rupture for Different Cell Sizes

Cell Size (m^2)	$a(z)$	$b(z)$	σ (standard deviation)
25×25	1.1470	2.1046	1.2508
50×50	0.9000	0.9866	1.1470
100×100	1.0114	2.5572	1.0917
150×150	1.0934	3.5526	1.0188
200×200	1.1538	4.2342	1.0177

Table 5
Probability of Distributed Fault Rupture Interpolation Points

Cell Size (m^2)	p_0 (%)	p_1 (%)	p_2 (%)	r_1 (m)	r_2 (m)
25×25	74.541	7.8690	2.0108	100	200
50×50	87.162	4.8206	2.6177	100	200
100×100	90.173	18.523	6.6354	100	200
150×150	87.394	19.592	7.0477	150	300
200×200	92.483	18.975	7.4709	200	400