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DIVISION OF WASTE MANAGEMENT
AND RADIATION CONTROL

Douglas J. Hansen
Director

June 23, 2023

Vern C. Rogers, Director of Regulatory Affairs
Energy*Solutions*, LLC
299 South Main Street, Suite 1700
Salt Lake City, UT 84111

RE: Federal Cell Facility Application Request for Information

Dear Mr. Rogers:

The Division of Waste Management and Radiation Control (Division) hereby provides Requests for Information (RFI) regarding the Federal Cell Facility Application dated August 4, 2022. Each individual paragraph in the attached document is numbered and represents an issue discovered in a review of the application. When responding to an RFI, please use the assigned number representing the question. The Division will track all responses and provide regular updated information to the public and reviewers.

The current review does not represent a comprehensive evaluation of the Application's merit and additional RFI's will follow where appropriate.

If you have any questions regarding this letter, please call Otis Willoughby at 385-622-2213.

Sincerely,

Douglas J. Hansen, Director
Division of Waste Management and Radiation Control

DJH/JK/jk

Enclosure: Federal Cell Application Review, Requests for Information

c: Jeff Coombs, EHS, Health Officer, Tooele County Health Department
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Federal Cell Application Review

Request for Information or Updates to the Application (RFI)

General

- Each RFI has been assigned an identifier with a numbering convention as follows:
  - Application/Appendix Section
    - Section/Appendix Subsection
      - Section/Appendix Subsection (when applicable)
        - Sequential numbering

Example: A question in Section 1, subsection 1, subsubsection 1 -The first RFI#1 would be 1.1.1-1., the next question in that section/subsection would be numbered 1.1.1-2

Please refer to the assigned RFI number when submitting a response.

Appendix O – Erosion Modeling

- **O-36 *SIBERIA Sole Modeling***

In past DU PA submittals, Energy*Solutions* relied on multiple lines of evidence for predicting erosion, including both RUSLE and REHM to calculate rill or sheet erosion. In a previous Interrogatory response (provided below), the position was that SIBERIA was not the sole or primary basis for demonstrating embankment stability.

Interrogatory and EnergySolutions' response is quoted from NAC-108_R0, Erosion Responses for Clive DU PA Model, February 23, 2018:

2.8 Interrogatory CR R313-25-25(4)-202/1: Use of SIBERIA to Model Federal Cell Erosion Interrogatory Statement: The Division is concerned that the SIBERIA model referenced in DU PA v.1.4 discussions assume a modeling-realm geometry inconsistent with that of the proposed Federal Cell. The Federal Cell embankment is approximately 30 feet high (height of waste under top slope and above grade) compared to the model analog height of 10 feet. Also, the SIBERIA model allows for several hundred meters of ground surface upslope from the sloping pit face, but that ground surface only has a 0.3% (0.003) grade in the model. By contrast, as described in Appendix 3 to the DU PA v.1.4, the waste under the top slope above and upslope from the side slopes of the embankment has a grade of up to 2.4%. This is about eight times greater. EnergySolutions needs to explain how these differences affect the results and how the Federal Cell modeling results can be reconciled against similar modeling studies conducted by Smith and Benson (2016) for the Grand Junction Uranium Mill Tailings Disposal Site.

2.8.1 Interrogatory Response SIBERIA is employed in the DU PA model as a supplementary line of evidence for embankment stability. If SIBERIA results were the sole or primary basis for demonstrating embankment stability, the distinctions noted in the interrogatory could be relevant; however, LEMs such as SIBERIA are acknowledged to be subject to further development before their results should be considered conclusive in licensing situations. See also the response to UDEQ Interrogatory 199/1.

Please explain the change in approach from past DU PA submissions using multiple lines of evidence for predicting and demonstrating embankment stability, to the current which relies solely on SIBERIA, and therefore contrary to what is represented in Energy*Solutions'* February 23, 2018, interrogatory response. Include a description of material changes in the erosion analysis that have occurred since 2018 that justifies relying solely on SIBERIA for demonstrating long term stability of the embankment cover system.

- **O-37** ***Model Reproducibility and Transparency***

Each analysis performed to support the application must be transparent and reproducible. Attempts to compile the code and reproduce the SIBERIA results by a qualified analyst failed and indicate it will be difficult to achieve these performance criteria. Furthermore, SIBERIA has a limited user-base, with only one custodian and developer (Greg Hancock, University of Newcastle). SIBERIA was originally developed over 30 years ago and has limited use in modern applications, and there is limited code support for repairs or enhancement. It is understood that the equations and algorithms that comprise different versions of SIBERIA are similar. However, the Division is concerned that digital landform evolution models (LEM) do not have a well-defined 'benchmark' and therefore may require a judicious evaluation of any new code version.

Given the infrequent updates and support maintenance of SIBERIA code, please explain the plan for future analysts' ability to compile the same version of code and verify that the DU PA model inputs result in the same DU PA output. Include plans to reproduce analysis in the event the utilized code version becomes obsolete.

- **O-38** ***Stochastic-Threshold Processes***

The processes that lead to the rill-gully-channelization spectrum of landforms are stochastic and driven by threshold events. In short, an event must exceed some critical shear stress (controlled by the slope and magnitude of water flowing over the surface) to initiate erosion (Howard and Kerby, 1983; Tucker, 2004). Once that is exceeded, the local slope increases, driving further incision that can propagate up a hillslope and lead to a new erosional regime. Predicting when such a threshold and erosion will occur requires constraints on both the magnitude of the threshold (i.e., the shear stress required to initiate channelization processes) and the distribution of storm events responsible for exceeding that threshold.

Thresholds are controlled primarily by vegetation and soil properties. Vegetation can influence the threshold precipitation events responsible for initiating channelization in three important ways: 1. Impact the hydrology through (mostly) interception and evapotranspiration processes. 2. Vegetation roots can increase the resistance of the land surface to erosion through enhancing cohesion of the soil material. 3. Influence surface roughness experienced by overland flow. Other biotic and abiotic processes can also influence thresholds in geomorphic systems. For example, disturbances by fauna (burrowing, foraging, etc.) can roughen the surface and reduce the effective cohesion due to plants. Human activities (e.g., vehicle tracks left during or after construction) are another well-known factor that leads to gullying in modern landscapes.

Precipitation driven by storm events, often occurring over time periods of less than a day, are likely responsible for the majority of geomorphic work on these landscapes. As such, sub-hourly to daily precipitation magnitudes are necessary to constrain the events responsible for gullying and erosion.

SIBERIA uses the same rainfall/discharge magnitude in each timestep, which is stated by Neptune as a 2-yr. recurrence event, yet gullying is a threshold dominated process driven by stochastic storm events that are accentuated by the particularly rare and large events.

- Please explain how the uncertainty on the gullying processes is accounted for and quantified in such a framework.

- Please describe what tests have been performed to ensure that a single 2-yr. recurrence event can appropriately capture the stochastic nature of the weather events that drive erosion in this region.

- Please clarify over what timescale the 2-yr. recurrence interval is based on (e.g., 15 min, 1 hr., daily, weekly, monthly precipitation).

- Please justify why a 2-yr. recurrence interval will provide satisfactory results throughout a compliance period of 10,000 years.

References

Howard, A, and Kerby, G.; Channel changes in badlands. *GSA Bulletin* 1983 94(6) 739-752
Link: Channel changes in badlands | GSA Bulletin | GeoScienceWorld
Tucker, 2004. Drainage basin sensitivity to tectonic and climatic forcing: implications of a stochastic model for the role of entrainment and erosion thresholds. *Earth Surface Processes and Landforms* - 29(2), 185-205.
Link: Drainage basin sensitivity to tectonic and climatic forcing: implications of a stochastic model for the role of entrainment and erosion thresholds - Tucker - 2004 - Earth Surface Processes and Landforms - Wiley Online Library

- **O-39** ***Model parameterization***

Geomorphic models are not derived from first principles and thus require care when parameterizing. Coefficients and exponents are not known *a priori* for different landscapes and encapsulate many different scaling parameters and processes. Different material properties, vegetation, climate regimes (both precipitation types – rain vs. snow– and distributions), hydrologic regimes, etc. all impact these parameterizations.

The landform models contained within SIBERIA were developed for large scale (mountain/watershed scale) landscape evolution modeling, yet the proposed site is on the order of a single hillslope (hundreds of meters). In particular, the channel erosion model of SIBERIA is most applicable to establish river network erosion modeling. For example, the 'effective geomorphic event' of 2.33 years outlined in the SIBERIA manual was defined for large, alluvial rivers such as the Wabash and White Rivers of Indiana (Dury, 1961) and not necessarily applicable to hillslope runoff and gullying (Wolman and Miller, 1960).

An important outcome of landscape evolution modeling is the ability to quantify the changing morphology over time. A consequence of a changing landscape is that a precipitation event of a given magnitude will have varying impacts on a landscape as the system evolves.

- Please describe how the uncertainty in translating parameter values calibrated from a site in Los Alamos to the proposed Federal Cell at Clive is being addressed.

- Please explain how well the large-scale landform evolution models capture the small scale (sub-grid) features that are responsible for routine but significant erosion at the Clive site.

- Please indicate what confidence can be assigned to the 2.33-year event continuing to be the effective geomorphic event as the landscape evolves over time.

- Given uncertainty in model parameterization on these models, explain whether calibration on a particular modern morphology and precipitation regime will be sufficient to predict the erosional response at a different location and a different morphology and precipitation regime over the next 10,000 years.

- Please discuss the impact that parameter sensitivity will have on the calibration to a modern morphology and precipitation regime.

- Please clarify why the erosion predictions (on the order of 11 centimeters over 10,000 years) are not consistent with the observed values (on the order of feet over several weeks to several years).

- Quantitatively provide results from SIBERIA that clearly indicate and contrast the improved performance of the cover design as a result of varying the material composition and material properties of the cover material.

References

G. H. Dury (1961) Bankfull Discharge: An Example of its Statistical Relationships, International Association of Scientific Hydrology. Bulletin, 6:3, 48-55, DOI: 10.1080/02626666109493230
Link: https://www.tandfonline.com/doi/abs/10.1080/02626666109493230
Wolman and Miller 1960. Magnitude and Frequency of Forces in Geomorphic Processes. The Journal of Geology, Vol. 68, No. 1 (Jan. 1960), pp. 54-74 Published by: The University of Chicago Press.
Link: Magnitude and Frequency of Forces in Geomorphic Processes (asu.edu)

- **O-40** ***Model initial conditions***

The initial condition (e.g., roughness) of a modeled surface can have important implications for the initiation and progression of erosion processes. This is because small amplitude randomness across a landscape can disrupt overland flow, causing convergence (and divergence) of fluid flow. In areas of convergence, shear stresses are enhanced, increasing the likelihood of overcoming detachment thresholds, and initiating channelization. Once this channelization starts, a positive feedback process ensues in which the local topographic depression draws in more flow and further enhances erosion. The dampening feedback is due to other nearby gullies competing for this same flow.

- Please indicate what the initial conditions are of the modeled surface.

- Please indicate what the roughness/patterns are and how they influence the channelization/gullying process.

- Please indicate the basis for the assigned roughness/patterns.

Please provide a reference to mathematics describing the physics and any constitutive relationships by which the initial conditions initiate the gully process.