INFORMAL MEMO

To: Rusty Lundberg, Marty Letourneau, Chris Grossman, Christopher Thomas, Paul Black, Pat Cone, Peter Jenkins, Dick Codell, and Chip Cameron
From: Steve Nelson[1]
Date: Nov. 12, 2010
Re: Nov. 10, 2010 DRC PA Workshop

I offer my congratulations again to Rusty for organizing the workshop. I was pleased with the substance and the tone of the meeting.

I am offering the following as feedback on the meeting while things are fresh in my mind. I admit I am forwarding this to a rather *ad hoc* group at this point. In particular, I hope that Rusty or Peter will share this with the Board.

Attached to this is the document I submitted to the Radiation Control Board in April of 2010 as comment on the proposed rule. It contains documentation for much of what I've provided below. It also includes comments provided to NRC a year ago. I have annotated that document in red to reflect some additional thoughts. In the remainder of this memo, I highlight in bullet form a summary of issues in the form of statements or rhetorical questions arising from the Nov. 10 workshop.

- The Great Salt Lake and Lake Bonneville are not separate entities. They are endmembers of a temporally dynamic system, and it seems no one seriously disputes the return of a lake to the elevation of Clive. Given the demonstrable effects of waves in the Lake Bonneville record, the site cannot be seriously considered for DU disposal on three grounds:
    - The geologic setting at Clive disqualifies the location on site stability grounds. Simply put, it fails. Will there be an attempt to "engineer around a bad site?" Certainly engineering solutions are not intended to replace site stability are they?
    - It violates the principles of ALARA. We can "reasonably" foresee flooding today. Placing a DU disposal facility in a more stable geologic setting is certainly "reasonably achievable." If we really believe in ALARA, we simply won't dispose DU at Clive. In fact, if we believe in ALARA, we will dispose it in salt. Experience at WIPP precludes needing to reinvent the wheel. Salt disposal is far more than reasonably achievable—it has already been accomplished—and there is a lot of it around the country.
    - Common sense.

- During flooding there will be a large fetch. Piles sitting up tens of feet above the valley floor will focus refractive wave energy onto the piles. In this manner the landfill design is inherently flawed.

- Sedimentation rates are probably very low. As I mentioned in the meeting, my colleague Alan Mayo has recently dated peat recoverd from beneath the Pilot Valley at a depth of about 2.5 meters. The calibrated ^{14}C age for this material is 26 ka for a sedimentation rate of just 0.01 mm/yr. Lacustrine sediment is not likely to add any protection to a pile, even in the extremely unlikely event that is survives flooding.

- Full pluvial conditions can return the lake to 4740', or a nearly 500' water depth at Clive with all of the attendant negative effects of differential compaction, complete saturation, etc. However, much smaller climate variations can return the lake to the elevation of the site. Since 1700 AD alone, water levels have varied by 25' (I misspoke during the meeting when I cited 30'), leading to the following:

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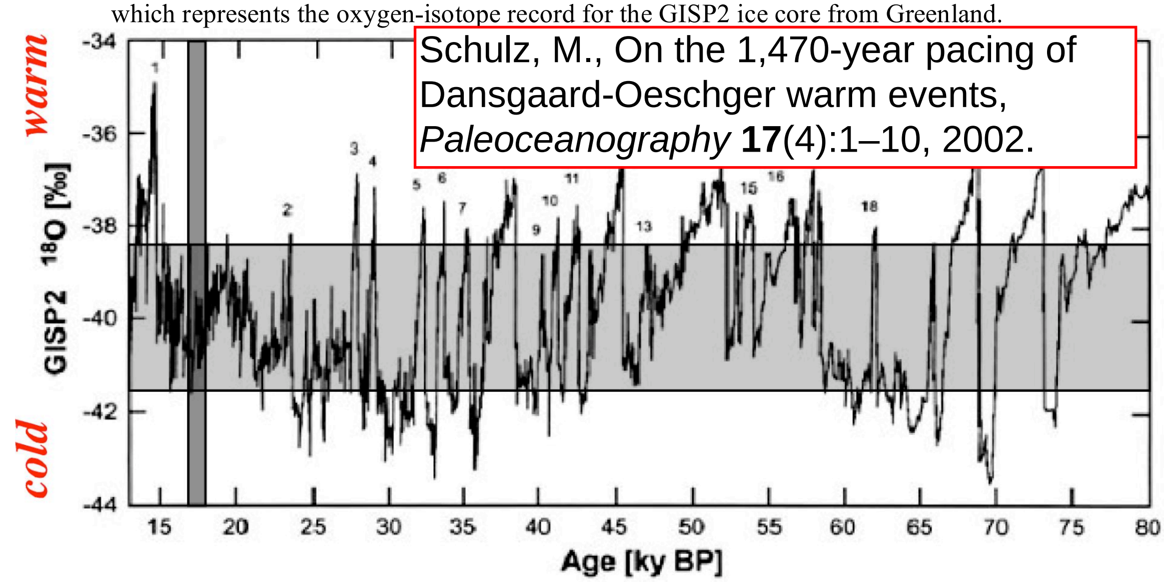
[1] *Because this memo addresses public-policy issues, and although both the scientific and public policy issues are within my area of expertise and experience, I emphasize that my view are my own and not those of my employer.*

- Since the capture of the Bear River into the Great Basin 50,000 years ago (I erroneously stated 30,000 in the meeting), the surface drainage area feeding the lake has increased dramatically—about 33%. Lake level rise is now much more sensitive (and permanently so) to small climate variations than it was prior to this.
- The lake system reached and maintained maximum depths during the collapse of the last ice age, not during its maximum. Flooding will not just occur at Clive during glacial maxima, but during both the run up to and collapse from glacial maxima. Piles will be impacted by both transgressive and regressive phases (actually, only during the first transgression—common sense dictates it will be obliterated at this time).
- Flooding is also likely to occur repeatedly during subordinate high-frequency fluctuations recorded in ice core during the run up to full glacial conditions. It will be very easy to underestimate the rate of return of shorelines to Clive. This is illustrated in the figure, which represents the oxygen-isotope record for the GISP2 ice core from Greenland.



An ice core in Greenland is, admittedly, a poor proxy for Lake Bonneville elevations. But it nonetheless illustrates the frequency and magnitude of potential climate variations in the northern hemisphere, and thereby the frequency of climate events that might drive lake level rise. The vertical shaded bar represents the time span of the Bonneville stage of the lake, when it was deepest. It ***ignores*** the Stansbury and Provo stages when the Clive site was also deeply inundated. The horizontal shaded bar represents the range of climate conditions prevalent during the Bonneville stage.

Note that high-frequency climate variations, with return intervals on the order of just a few thousand to a few hundred years, cross the horizontal bar on both the warm and cold sides ***dozens of times*** over the last 80 ka. No wonder we see so many shorelines in the Bonneville basin at elevations above and below Clive.

- I too am concerned over the definitions of "qualitative" and "quantitative" in the Utah regulation. However, flooding and disruption is hardly outside the ***minimum*** quantitative time frame of 10^4 years. 10,000 years ago the Gilbert shoreline nearly reached Clive. The lake was at the elevation of Clive several times since the penultimate glaciation. The probability is <1 that the lake will return to Clive within the ***minimum*** quantitative time frame. However, the probability is orders of magnitude greater than 10^{-8} yr^{-1} (10^{-4} in 10^4 yr), the typical cutoff for disruptive events.

- Will an iterative PA process will "dial the knobs" on the model until a satisfactory (to the client) result is achieved?
  - I am aware that PA models are the best tool we have for this type of decision making. However, when I look at 350' wave-cut platforms (into bedrock) at Wendover, or up to 1700' benches in Draper (Ashland, F.X., 2008, Utah Geological Survey Open File Report

519; attached to this memo), I have a very difficult time envisaging that a PA with a pile surviving can pass the laugh test.

- The waste form poses many challenges inconsistent with surface or near surface disposal:
  - There is an enormous quantity of it.
  - It is long-lived and increases in activity with time.
  - It has chemical toxicity that may exceed its radiological hazard.
  - UO_3 and U_3O_8 powders are relatively soluble, have high reactive surface areas, and can be chemically and advectively dispersed quite readily by wind and waves as solid particulates, colloids, and dissolved species. A regressive lake could distribute adsorbed DU on sediment or soluble DU-salts throughout the biosphere. And now we are talking about readily bio-available uranium, not the uranium locked up in zircon in granite.

- The public should know more about the Quality Assurance program under which data were collected, reviewed, model development, validation and verification of software, etc.

- High level waste is regulated to 1 million years. Since the mass-based activity of DU approaches that of high level waste by that time, I am left seriously confused:
  - Why does high-level waste, with approximately $1/10^{th}$ the mass, require geologic disposal, whereas DU does not?

Although I understand the historical context that has lead to this, I am nonetheless perplexed that DU disposal at Clive is even under consideration.