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Review of Sandia National Laboratories/New Mexico Evapotranspiration Cap Closure Plans for the Mixed Waste Landfill

Citizen Action (through New Mexico Community Foundation)

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The following report was made possible with a grant from the Monitoring and Technical Assessment Fund (MTA) to assist in performing independent technical studies of the Mixed Waste Landfill (MWL), a hazardous legacy waste site located at Sandia National Laboratories (SNL). The funding, established as a part of a $6.25 million court settlement between the U.S. Department of Energy (DOE) and 39 nonprofit and environmental groups, assists tribes and other non-governmental organizations in conducting their own independent technical studies of sites at DOE facilities.

Citizen Action commissioned Dr. Tom Hakonson, a former environmental scientist with Los Alamos National Laboratory, to perform an independent peer review of the cap design proposed for the MWL. A copy of Dr. Hakonson's curriculum vitae and published papers is included in his report.

"I am willing to state, unequivocally, that most of the environmental processes discussed in this report will, without doubt, affect the long-term distribution and transport of contaminants in the MWL."

- T.E. Hakonson

Summary of Review

Biointrusion is important in that it represents the major mechanism leading to vertical transport of contaminants to the ground surface and through the drying effect of plant transpiration on cover soils plays a major role in the evolution of volatile contaminants from the ground surface. Vertical transport by biota may be small over a short time scale; however, over many decades these processes may become dominant in mobilizing buried waste (7).

Burrowing by animals and insects have the potential to access buried waste several meters below ground surface which may lead to chemical and radiation exposures to organisms and physical transport of waste upward in soil profile to ground surface, to biota, and across the landfill surface to offsite areas. These processes are enhanced by erosion (wind/water), transport of animals moving on/off landfill, deposition of soil particles on biological surfaces from rain splash and wind re-suspension, and wind transport of senescent vegetation to offsite areas. The use of an evapotranspiration (ET) cover proposed by SNL for the MWL is justified; however, SNL's proposal ignores the potential effects of biological processes in mobilizing buried contaminants and the consequences of this transport on future changes in contaminant concentrations in surface soils.

Animal burrowing has been conclusively documented at the MWL, but studies of specific species, number of animals, extent of burrowing, contamination to animals, and consequences relative to transport of waste to ground surface of MWL have not been conducted (33). It has been noted by observers visiting the MWL site that Kangaroo rats may currently be responsible for the hundreds of burrows seen in the surface of the MWL. Some species of Kangaroo rats are known to burrow to depths of 25-175+ cm below the ground surface (36). Insects have the ability to tunnel deeply into a landfill cap. Certain species of ants develop tunnel systems to depths of 6m and have been responsible for significant increases in contaminant levels found on the surfaces of landfills (34-36).

The activities of pocket gophers can account for the transport of large quantities of buried waste to the ground surface and have been shown to have a wide range of both positive and negative effects on the integrity of ET covers. Studies of pocket gophers on LLW sites at Los Alamos National Laboratory brought 11,255 kg of material to the ground surface over a 14-month period. This resulted in large areas of void space in the landfill (34). Macropores (void spaces leftover by decaying roots and animal passages) also provide direct conduits for water movement into the soil profile (34).

Plant roots can reach several meters or more into landfill and successfully penetrate the cap proposed for the MWL. The term "shallow rooted" used by SNL cap designers is inappropriate given that the grass species they propose to re-vegetate the soil cap all have the capability to send roots several meters into soil (4). There is no information published on the MWL that quantifies or characterizes the fauna or flora present in the area of the MWL, the amount and consequences of biological intrusion, subsidence, and soil erosion on contaminant distribution and transport (3). Relevant data on contaminants in

vegetation, animals, and soils cats to the surface by burrowing animals at the MWL does not exist (7)

While an ET cover will minimize soil moisture in landfill it can also contribute to an increase in vapor phase transport of volatiles such as tritium (5, 6). Releases of tritium to the ground surface at the MWL are most certainly related to presence of burrowing animals and vegetation present on surface of landfill and related to the effects these organisms have on soil moisture status and soil porosity (4). Without a doubt, tritium, if sampled, will be found concentrated in the tissues of flora and fauna at the MWL (6). The addition of less than 2 meters of clean soil during ET cap construction will not ensure that problems with biointrusion will go away. The long-term effects of biotransport of contaminants on human health over very long time frames is not well known; however, results from a modeling study show that estimated dose to man resulting from biological transport of radionuclides at two LLW dumps was the same as dose calculated from a human intrusion scenario (4).

Fire, disease, and *drought* in combination with erosion can affect integrity of soil cover resulting in increased percolation of water into landfill. Modeling results based in average soil rates may under-represent actual long-term rates of deflation of cover soils (5). There is no post-closure monitoring plan for the MWL, and details regarding reassessment of the MWL at a future point in time are "vague at best." Additionally, SNL's proposed plan for the MWL lacks a decision criteria for possible corrective actions should the soil cap and/or other monitoring systems fail (9). SNL has only proposed to monitor tritium in the vadose zone a few years post-closure; therefore, changes occurring in contaminant concentrations in surface soils and biota will go undetected if they are not monitored (4). Deficiencies found in the area of biotransport far outweigh the minor deficiencies in the two cap designs (Dwyer et al/SNL et al) reviewed (7). However, the technical aspects of the cap SNL's methodology for using a neutron moisture gauge (NMG) does not describe how the monitoring data would be used to conclude that percolation was or was not occurring. Furthermore, it must be noted the NMG is labor intensive (requiring a financial commitment) and difficult to calibrate. It provides only instantaneous estimates of soil moisture (impractical), integrates moisture content over a large area that changes as soil moisture changes, and is limited to volumetric water contents above 5% (50, 51). This may or may not be a hindrance to successful long-term monitoring.

While SNL may believe the MWL has been characterized sufficiently to answer questions about present and future transport of contaminants, important questions remain unanswered (3). The proposed ET cap *will not* be 100% effective in isolating contaminants from the MWL to the environment over long periods of time (8).

Recommendations

- Plants and animals should be sampled for a suite of both rad and non-rad contaminants; this data is important in determining the potential for biological intrusion in mobilizing waste at the MWL.

- Thermoluminescent dosimeters (TLDs) can be implanted or attached to free ranging animals to calculate doses to biota in the area of the MWL (6).
- New soil samples of undisturbed areas should be conducted to examine pathways of biological transport as soil samples taken by SNL in 1990 (Phase 2 RFI) provides little usable information that can be used to answer questions re: effects of biointrusion in transporting contaminants to the environment from ground surface (6, 7).
- Pan lysimeters should be placed beneath cover to get an absolute measurement of water flux through ET cover (51).
- ET cap will only provide adequate protection against percolation of contaminants to ground water only by diligent monitoring of site accomplished through a financial assurance mechanism *assuming a surface pathway involving biota proves to be unimportant in contributing doses to nearby populations (7).*
- Long-term data on success of ET covers to prevent transport of buried contaminants over extended times periods is not available; therefore, a comprehensive monitoring program of air, ground water, soil, and biota will provide necessary baseline data, identify potential problems, and verify validity of initial closure assumptions (8).
- A financial commitment is crucial to ensuring that all post closure monitoring activities will be carried out as planned (7).