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EVALUATING THE EFFECTS OF ALTERNATIVE CONCEPTUAL MODELS FOR GROUNDWATER FLOW IN THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR YUCCA MOUNTAIN, NEVADA

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ABSTRACT

The Draft Environmental Impact Statement (DEIS) for Yucca Mountain high-level waste project includes an evaluation of environmental consequences (in terms of dose) of alternative repository design concepts and alternatives. The conclusion drawn from the results of these evaluations is that compliance is achieved. There is. however, evidence that casts doubt on the validity of the conclusions and these compliance assessments in light of the Nuclear Waste Policy Act (NWPA) and National Environmental Policy Act (NEPA) requirements. This evidence is related to the choice of groundwater pathways selected for the analyses. The DEIS, in failing to evaluate credible alternative models fails to comply with NEPA and the NWPA.

INTRODUCTION

The Draft Environmental Impact Statement (DEIS) for the Yucca Mountain high-level waste project was issued in August 1999 and included an evaluation of environmental consequences (in terms of dose) of alternative repository design concepts. The impacts evaluation assumed the same groundwater flow paths that were used to characterize the performance behavior of Yucca Mountain in the DOE Viability Assessment document. Because of this, the impacts in terms of dose to the Critical Group may be misrepresented. This is because not all data sets that were available have been utilized by the DOE when developing these groundwater pathways.

At Yucca Mountain, the primary exposure pathway is through ingestion of ground water. There are most likely several different groundwater pathways for radionuclide travel to consider in the compliance determination. These flow path directions range from approximately 90^{o} east to 180^{o} south, roughly. The flow pathways are complicated to model accurately, because they are diverse, chemically and hydrologically and could be significantly different in terms of calculating radionuclide transport via the groundwater and concentrations at a given point.

There has been considerable debate over the actual flow paths that would be followed by the radionuclides released from the repository. Modeling results performed by the State of Nevada (1,2) indicate major differences may exist in flow path direction, velocity, and sorptive capability compared to that used in the latest assessments by the DOE, and used as the basis for impact evaluation in the DEIS, when all data sets are utilized. The use of an incorrect flow field may have significant impacts on dose calculations, as the dose is quite sensitive to flow field variables, especially ground water velocity, ground water flux, effective porosity, and sorption behavior of the flow field. These characteristics are vastly different depending on whether you have a fractured rock system or a porous matrix flow system.

By failing to evaluate credible alternative models of, or opposing views of the saturated zone, the DOE is not in compliance with NEPA or the NWPA. The DEIS fails to summarize, discuss, or use important data sets or to adequately evaluate credible opposing viewpoints. Furthermore, the DOE does not propose testing to reduce uncertainty in the choice between alternative conceptual flowpaths.

FLOW PATHS USED IN THE DEIS

The DOE has utilized flow modeling in the DEIS based on one-dimensional or two-dimensional hydrologic models which are only calibrated to hydraulic head measurements. Other data sets have been available, some since the late 1980's that could help the DOE better constrain and define the actual pathways taken by radionuclides from the repository to the receptors. These data sets include temperature, geochemistry and geologic structures.

The State of Nevada-funded studies utilized hydraulic head, temperature and structure explicitly in their 3-D modeling efforts. These studies have shown significant differences in flowpaths and are additionally supported by more recent geochemistry data sets. The flowpath evaluated by the DOE is shown as Figure 1. By utilizing this hydraulic head generated flow path one obtains a flowpath that is initially moving eastward and then southeastward. This flowpath allows the radionuclides to move quickly from the fractured tuffs of Yucca Mountain into the Valley Fill sediments of Forty Mile Wash. This flow path allows the radionuclides to be in contact with "alluvium" (modeled as fine-grained sediments), which naturally are expected to have high sorptive capability for radionuclides, for very long distances. Thus, traveling on the DOE pathway, sorption and dispersion would act to retard and disperse the radionuclides of concern, and yield minimal doses to affected populations.

On the other hand, if the preferred radionuclide pathway is as modeled by Lehman and Brown, (1994 and 1995), then it is likely significant increases in calculated dose could occur. First, the State of Nevada flow path is shown as Figure 2. Comparing this flow path to the DOE flow path, a radionuclide would travel first south and then southeast or even possibly southwest for some time in the fractured tuff rock before emerging into the Valley Fill sediments south or southeast of the mountain block. This is important as the fractured tuff rock yields little in terms of sorption capability. Further velocities in the fractured tuff are expected to be orders of magnitude faster than those of the Valley Fill sediments (3). The pathway through the Valley Fill would also be much shorter via this route, which then minimizes sorption and dispersion of radionuclides. These effects combine to yield higher doses.

ENVIRONMENTAL DOCUMENTATION REQUIREMENTS

The Nuclear Waste Policy Act requires that an EIS, consistent with the National Environmental Policy Act (NEPA) be prepared and accompany a recommendation for site approval. While the amended NWPA requires consistency with NEPA, provisions in the 1987 amendments do not require the DOE consider:

- the need for the repository,
- alternatives sites to Yucca Mountain, or
- nongeological alternatives.

All other provisions of NEPA apply (NWPA Section 114(f)). Compliance with NEPA suggests that the DOE is required to consider effects of this alternative model in the DEIS. While NEPA regulations, amended in May, 1986, eliminated the worst case analysis requirement, it did not eliminate the requirement that agencies evaluate the reasonably foreseeable significant adverse impacts of an action, even if information is unavailable or incomplete. Rather, it specified that the evaluation must be carefully conducted, based on credible scientific evidence, and must consider those reasonably foreseeable significant adverse impacts which are based on scientific evidence. Furthermore, NEPA regulations (40 CFR Part 1502) require disclosure of all credible scientific evidence, including responsible opposing views which are supported by theoretical approaches or research methods generally accepted in the scientific community.

The Figure 2 flowpath, developed by Lehman and Brown (1994 and 1995) is now considered the most likely radionuclide release flow path (need a reference here). Since the actual flow path of the radionuclides is highly uncertain, the analyses of dose must be calculated under the most likely of these flow path scenarios and along other credible flow pathways. To date, PA analyses and those in the DEIS have not looked at the Figure 2 flow paths, even though they are considered more likely. The DOE and the USGS are currently revising the saturated zone flow models to better analyze these pathways in the future. However, until these analyses have been done and alternatives assessed, no credibility can be claimed for impacts calculated in the DEIS.

While the DEIS recognizes differing viewpoints regarding groundwater flow (Section 3.1.4.2 and Section 5.2.3.4) and references the State of Nevada studies, there is no evaluation of the impacts. In fact, the DEIS states that the extent to which the different viewpoint would affect the impacts is unknown but speculates the effects would be minimal. However, this may not be the case, and in terms of doses to populations of the State of Nevada, any credible alternatives must be evaluated. In order to comply with NEPA provisions, this alternative flowpath, which is supported by accepted approaches and research methods and which could result in significantly different impacts, must be considered and analyzed in the DEIS. NEPA regulations (40 CFR 1502.22) not only require agencies to disclose the fact of incomplete or unavailable information when evaluating reasonably foreseeable significant adverse impacts, it requires that information be obtained unless costs of obtaining the information are exorbitant or the means to obtain the information are not known. If this is the case, the agency is required to:

- disclose the fact such information in unavailable,
- explain the relevance of the unavailable information,
- summarize the existing credible scientific evidence that is relevant to the evaluation of impacts,
- and evaluate the impacts based on theoretical approaches or research methods accepted in the scientific community.

The DEIS states that information used in determining the groundwater flow model is incomplete or unavailable however, the exiting credible scientific evidence which is relevant to evaluating reasonably forseeable significant adverse impacts has not been summarized nor has it been used in developing flowpaths. The DOE has only referenced the alternative model and has failed to consider the alternative model in impact evaluations even though the information is available, is supported by accepted scientific methods, and is relevant to the impact evaluation.
Whatever group, groups or individuals are to be analyzed for compliance against the proposed EPA standard, they must be representative of the existing population and exposure pathways at Yucca Mountain in order to be credible. Since the EPA standard is a unique standard, specific to

Yucca Mountain, the unique features of the site geology and hydrology need to be considered in determining the exposure scenarios and locations of the representative group(s) or individual(s).

COMPLIANCE BOUNDARY

In this region, there are at least two existing groups, which are at risk for exposure, perhaps simultaneously, along these pathways. These are the rural-residential group at Lathrop Wells and the subsistence and commercial farmers in Amargosa Valley. The subsistence farming community at Amargosa Valley had previously been defined as the Critical Group.

In addition, there is the possibility of someone living or farming at a 5-km distance down gradient of the repository in the Forty Mile Wash area, after any institutional control period or when the test site boundary is no longer enforced. These groups should all be analyzed as part of the compliance procedure. Meeting the standard in these places under differing life styles and expected hydrologic conditions should be required and the more ways compliance can be shown, the more credible will be the result. Further they should not all be lumped into one representative group, but rather each group farmer or resident should be represented as accurately as possible.

While recognizing differing viewpoints regarding groundwater flow, the DEIS fails to analyze flow paths from a full data set that considers this information. Because all data that have been generated are not considered in the impacts evaluation, there may be significant differences in the groundwater impacts projected in the DEIS. Unless these analyses are considered, impacts projected in the DEIS are inadequate and their credibility questionable. Furthermore, failure to incorporate these available, credible scientific data in the impacts evaluation, the DEIS does not fully comply with NEPA and the NWPA.

REFERENCES

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2. Lehman, L.L. and T.P. Brown. "An Alternative Conceptual Model for the Saturated Zone at Yucca Mountain Nevada." Proceedings of Waste Management '95, Tucson, February (1995).

3. Miller, Gov. Robert and Kenneth Guinn, Gov. Elect. Letter to Secretary of Energy Bill Richardson, transmitting Appendix A, Report on the Significance of Ground Water Travel Time, December 4 (1998).

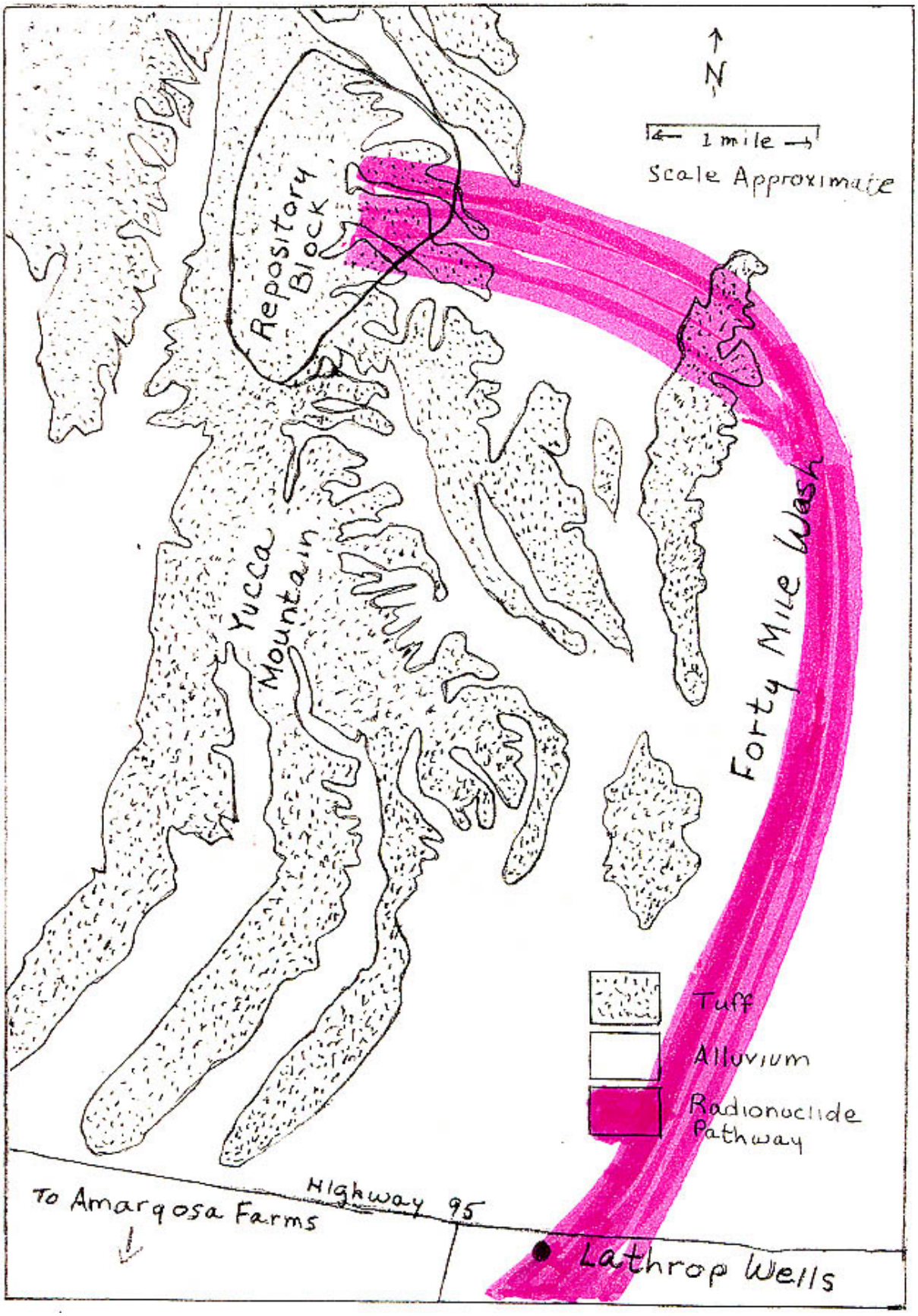

Figure1. DOE Pathway

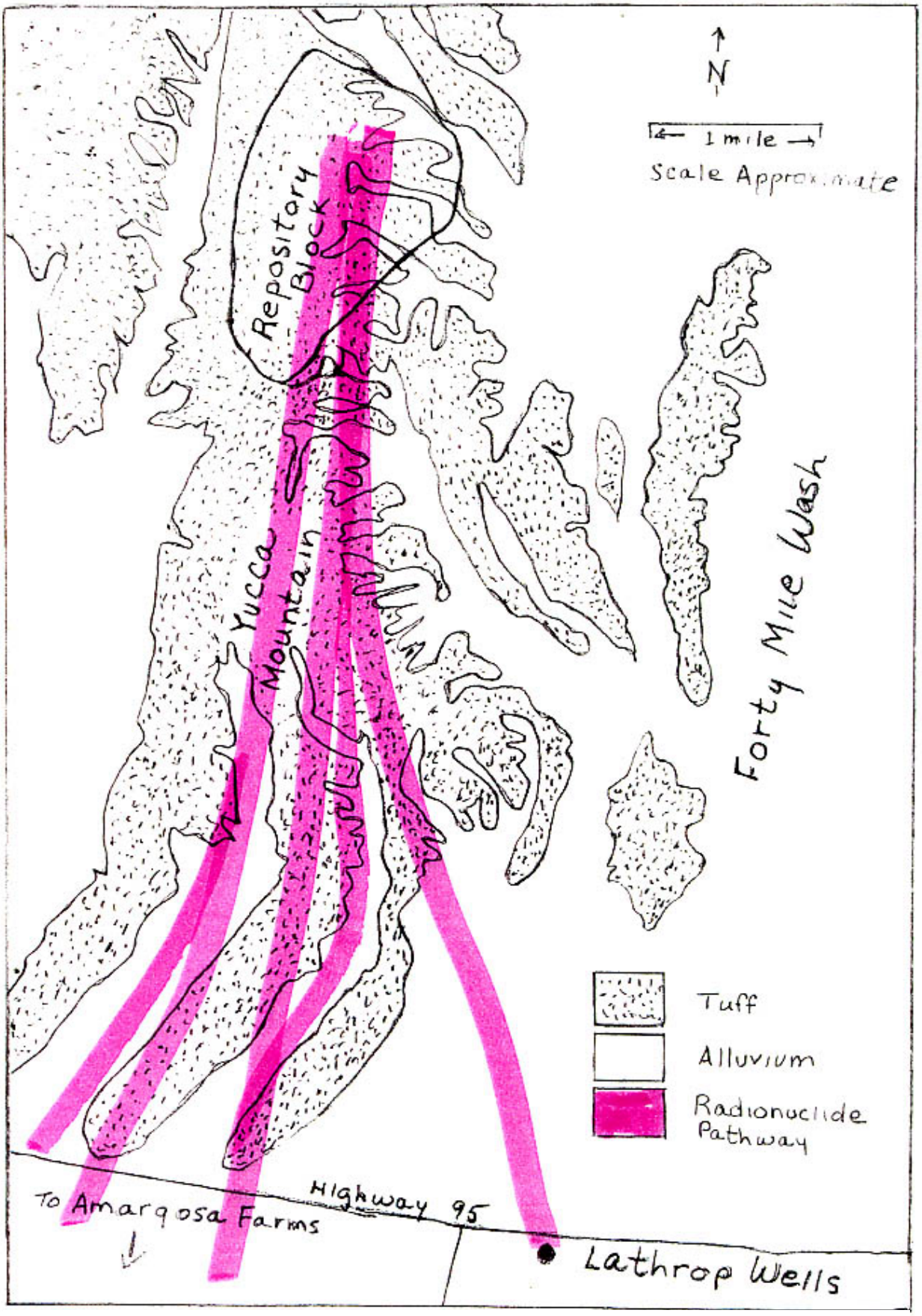

Figure 2. State of Nevada Pathways