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'85 MAR -5 A10:21

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WM Project 10
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MEMORANDUM FOR: Malcolm R. Knapp, Chief
Geotechnical Branch
Division of Waste Management

THRU: Leon Reiter, Acting Chief
Geosciences Branch
Division of Engineering

FROM: Stephan J. Brocoum, Leader
Geology Section
Geosciences Branch, DE

SUBJECT: GSB COMMENTS - DRAFT ENVIRONMENTAL ASSESSMENT

As we discussed by telephone, and requested in your letter of February 14, 1985, I have attached the Geosciences Branch's impressions and comments resulting from GSB's evaluation of the DOE's December, 1984 Draft Environmental Assessment (EA) of the Reference Repository Location, Hanford Site, Washington. This evaluation is cursory (involving approximately five calendar work days) due to the constricted schedule allotted to NMSS for the Draft EA review.

The Draft Environmental Assessment is a comprehensive, logically-arranged document presenting an extremely complex subject in a manner and language readily understood by the scientist as well as by the layman. The DOE is to be commended for this product.

Depending upon the purpose or audience for which this document (EA) is intended, some of the following comments and impressions (both general and specific) may more appropriately be considered relevant for consideration in the not-yet-submitted Site Characterization Report, rather than in the Environmental Assessment.

Because of our extensive nuclear facility siting experience (over 13 years) on the Hanford Reservation and vicinity, the Geosciences Branch welcomes the opportunity to provide further assistance to NMSS in the review of repository-related documents such as the Site Characterization Report.

Stephan J. Brocoum

Stephan J. Brocoum, Acting Chief
Geosciences Branch
Division of Engineering

Attachment:
As stated

cc: See next page

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FEB 27 1985

cc: w/attachment
S. Brocoum
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GEOSCIENCES BRANCH'S COMMENTS ON THE
ENVIRONMENTAL ASSESSMENT REPORT FOR THE
HANFORD REFERENCE WASTE REPOSITORY

GENERAL COMMENTS AND IMPRESSIONS*

1. The report appears to be a thorough summary of the environmental aspects of the Hanford site Reference Repository location.

2. Based on current knowledge of the physiographic and structural characteristics of the Pasco Basin, it appears that selection of the relatively flat lying and little deformed Cold Creek Syncline for the repository site offers the best chance of success in validating a reference repository site at Hanford. The screening process that led to this, along with the one that led to the selection of the Cohasset Flow and the three alternate flows as the candidate horizons is very commendable.

3. The report is an honest discussion in that it calls attention to the unfavorable aspects as well as those that are favorable to repository siting at the Hanford site. However, it steps short in several discussions about the post-sealing period, of indicating what will be done about those problems to maintain the integrity of the facility through the long term isolation period.

4. The most important single earth science feature that can effect the long term integrity of this repository is geohydrology, and yet it appears from information in the report, that this is the subject about which the least is known.

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*Depending on the purpose or audience for which this document (EA) is intended, some of the following comments and impressions (both general and specific) may more appropriately be considered relevant for consideration in the not-yet-submitted Site Characterization Report, rather than in the Environmental Assessment.

5. The EA is replete with statements such as "A final conclusion on the postclosure qualifying condition for tectonics (as an example) cannot be made based on currently available data." This statement, should have additional explanatory text. A general statement could be made, for example, either indicating that investigations are currently underway attempting to resolve the matter or that uncertainties will always exist no matter how comprehensive the investigations are.

6. Considerable research has been done during the past decade regarding repository siting at Hanford at a great deal of expense. Ongoing and proposed projects including: (1) the sinking of test shafts; (2) construction of test drifts; (3) pilot hole drilling; and (4) in-situ and laboratory testing, all constitute an extremely expensive construction project. Great care, self discipline, and courage must be exercised both by the DOE and the NRC to insure that the past expenditures and the momentum of such an undertaking does not cause an overriding of safety and environmental considerations that are unknown or unanticipated right now, but may appear after the project is well underway. Unforeseen circumstances occurring during construction are inevitable in any major underground project where there are significant unknowns regarding geohydrology and tectonics. There must always be the flexibility to drastically alter current plans, even to the extent of abandoning the project if there is no longer reasonable assurance that the integrity of the repository can be preserved.

7. The geologic favorability of the Cold Creek Syncline as a reference repository is defended repeatedly throughout the EA. While it is most likely true that a synclinal location is preferable to an anticlinal location, it should be recognized that the possibility exists that many more faults than now anticipated may be encountered in the repository excavations. It may be advisable, in addition to acknowledging the possibility of encountering faults, to discuss the approaches to be employed in defining the hazards (if any) that the faulting could represent to the repository. The faults, if encountered, for instance, could represent localized rupture associated with the deposition of the

individual basalt horizon. This type of fault could be handled by applying appropriate engineering techniques and would therefore pose no hazard (no disqualifying condition) to the reference repository.

8. The extent to which the surface facilities and equipment and shaft and mine machinery are to be designed to withstand extreme external phenomena, such as the maximum probable earthquake, should be addressed in greater detail. Consideration should be given to the potential safety and environmental impacts of a failure of such facilities during an earthquake or other extreme external phenomena. Justification should be provided for not designing the above facilities for such events, or discussions should be provided describing to what extent these facilities have been designed along with the bases for the design. If a significant safety impact exists in the event of the failure of the above facilities, given the relatively long term of operation of these facilities (years of packaging and storage of the fuel plus 50 years before final sealing), then these facilities should be designed with the capability to withstand the appropriate extreme external event. In seismic design, for example, this could range from a Safe Shutdown Earthquake as defined for nuclear power plants located on the Hanford Reservation to the current Uniform Building Code, depending on the acceptable levels of risk.

9. We suggest that ground motion effects from a magnitude M_s 6.5 earthquake on the Rattlesnake-Wallula lineament 10 kilometers from the site be evaluated. In addition, ground motions from shallow, nearby swarm-type earthquakes should be considered (NRC, 1982, WPPSS-2).

10. According to the EA, no instrumentally located seismic events have yet been associated with the Gable Mountain faults. However, the possibility should be acknowledged that this association may be demonstrated at some time in the near future. It should also be recognized that future studies made either at the Hanford site or another geographic location (for example, the Meers Fault in Oklahoma) may demonstrate that a geologic structure with evidence suggesting recent activity but lacking an

association with historic seismicity, should be considered, for evaluation purposes, capable of generating an earthquake.

11. The report is excessively repetitious, with sections covering a specific topic being included in several different chapters. It is understood that certain basic information must appear in different chapters for the benefit of reviewers of different disciplines, but to the reader of the entire report, the repetition detracts from the overall purpose of the report.

12. Two recent NRC Safety Evaluation Reports, one relating to the Skagit/ Hanford Nuclear Project (Supplement No.'s 1 and 3), the other to the WPPSS Nuclear Project No. 2 (Supplement No. 3), have been published as NUREG's and address in detail several significant geologic subjects either not addressed or addressed only minimally in the EA. These subjects include: (1) thickness estimates of volcanic ashfall at the Hanford site resulting from postulated future eruptions of Cascades volcanoes and the operability and reliability of nuclear power plant systems and equipment resulting from the design basis ashfall, and (2) the Geosciences Branch positions regarding the May Junction Monocline and the Southeast Anticline. Both the monocline and the anticline are structurally related to Gable Mountain. Evaluation of these subjects should probably be included in future reference repository location documents.

SPECIFIC COMMENTS

SEISMICITY

1. Page 2-12, Section 2.1.1.3. Earthquake swarms occur in a short time frame (a few days to several months) in a relatively confined area. There may be 4 to 100 locatable events of magnitude 1.0 to 3.5.

   a. The EA should assess the potential for earthquake swarms at the reference repository including such occurrences at burial depths of high level wastes.

b. Page 3-54, Section 3.2.4. A swarm of 4 earthquakes is referenced at the northern boundary of the repository yet only one event is shown at that location on Figure 3-24, page 3-55.

c. At least 6 events (magnitudes 1.0 to 2.5) are shown to have occurred ≤4 km depth beneath the site area. A discussion should be included addressing the possibility of similar or greater events occurring beneath the site, and an analysis should be made to determine the effects, if any, of future earthquakes on the repository integrity.

2. Page 6-211. The third paragraph states that the SSE for nuclear power plants at Hanford is 0.25g and that value is less than the SSE's for nuclear plants in Western Washington and Oregon. This value is less than WNP-3 (0.35g) but equal to Trojan (0.25g).

3. Page 3-54, Section 3.2.4. Since 1969 swarm earthquakes have been instrumentally located in close proximity to the repository location. At the reference repository location, swarm earthquakes occur at depths of 0-3 km (WPPSS-2 SER page 2-27). Although swarm earthquakes have not been located within the reference repository, the Geosciences Branch's position on nuclear power plant sites at Hanford suggests (lacking a defensible source model for such occurrences) that such events could occur near the reference repository location. The EA Figure 3-24 depicts three swarm areas with focal depths less than 4 km. Does the possibility that swarm earthquakes could occur near the reference repository location pose a hazard to the repository? Will this be addressed in the Site Characterization Report? Why should this possibility not be addressed in the EA?

4. Page 6-130, Section 6.3.1.7.5. Potentially adverse condition. The statement is made that the largest historical earthquake, if it recurred, is not expected to affect waste containment or isolation. Supporting evidence should be presented in the EA document as well as in the Site Characterization Report.

TECTONICS

5. Page 6-128. Final analyses of disruptive event scenarios involving tectonic effects "remain to be resolved." Some estimate of the time frame of resolution of the tectonic effects should be given.

6. Page 6-129. "The age of development" and "last movement of many faults remain to be clearly determined." While it is not geologically realistic to presume that sufficient evidence will exist at each fault, because of a lack of sufficient, datable cover, to conclusively determine the absence or presence of continuing fault activity, credit should be given to the fact that through regional structural relationships, such as that demonstrated at the Southeast Anticline, some confidence can be reached that faulting in the reference repository region is perhaps no younger than middle to late Miocene. In the case of the buried, faulted Southeast Anticline (a southeastern extension of the Gable Mountain structure), sufficient geologic evidence was encountered in the overlying Ringold formation (late Miocene) to demonstrate the non-capability of the fault (Skagit/Hanford SSER 3, p. 2-28).

7. Page 6-129. "Little or no deformation appears to occur in synclinal troughs like the Cold Creek Syncline." It can be argued that, because of their nature (down folding), the troughs are deeply buried, making detailed scrutiny (with deep borings and other investigative tools) more difficult.

8. Page 6-78, Section 6.3.1.1.10 and Sections 3.2, 3.3, 4.1 and 6.4.2 indicate that the presence of stratigraphic or structural features could contribute to the difficulty of characterizing the geohydrologic system. Plans of how such features will be allowed for in site characterization and modeling and how they will be handled when actually encountered during construction of the facility should be discussed.

9. Pages 2-12 through 2-15 describe microearthquakes that have been recorded in the Pasco Basin in the vicinity of the repository. Page 6-132 describes the possible fault characteristics that might generate these types of earthquakes. As the repository is located within similar

geologic media as the ones in which the earthquakes are occurring, the impact on the integrity of the repository due to displacement on a fault similar to the one described within the repository should be assessed.

10. Page 3-24 mentions pinchout of the Esquatzel Member near the crest of Rattlesnake Mountain. Is this a confirmed pinchout or could this truncation be evidence for faulting along the northern extremity of the Rattlesnake-Wallula Lineament?

11. Page 3-46. Figure 3-23 should be updated to show most recent information on faults in the region. For example, faulting has been documented on Toppenish Ridge (Campbell and Bentley, 1981) north slope of Saddle Mountain, Wallula Gap and sections of the Rattlesnake-Wallula Lineament southeast of the Columbia River (Bingham and others, 1970).

12. Page 3-51, second paragraph mentions a fault mapped in the buried saddle of the Yakima Anticline. Based on the trend of this fault and proximity to the candidate site, this fault should be addressed in greater detail.

13. Page 3-51, paragraph 3.2.3.5. There is an apparent error in the last sentence of this paragraph. Benson Ranch Syncline and Yakima Ridge Anticline continue southeast, instead of southwest, into the central portion of the basin.

14. Page 6-21. The first paragraph discusses engineering fixes, such as applying rock supports when an active fault is encountered during excavation. It would appear that a section of the tunnel that encounters an active fault would be permanently sealed and abandoned.

15. Page 2-18, Section 2.1.2. One should not assume a stress regime resulting in uniform displacement throughout geologic time, or that the cited average displacement at Gable Mountain (yearly average of 0.01mm) would represent that experienced during a seismic event on that structure. Displacement through geologic time is more likely to have been episodic. For example, greater displacement might have occurred during a single seismic event or during an earthquake sequence than the calculated yearly average displacement (0.01mm). This activity might have been proceeded

and then followed by periods of quiesence. The cycle might have been repeated many times through geologic time.

16. Pages 6-136 through 6-146, Sections 6.3.1.7.11 through 6.3.1.8.12. Conclusion in Qualifying Condition - "a final conclusion on the postclosure qualifying condition for tectonics cannot be made based on currently available data." This statement, along with similar words is interspersed throughout the EA. Some qualifying statement such as "no evidence is available now, nor will it be, to emphatically rule out the possibility of either a disqualifying condition or, on the other hand, that the site is, or ever will be, completely satisfactory." A general statement should be made to indicate why a final conclusion cannot be made. If it can be made, a statement should be made as to when this would be available.

17. Page 6-129, Section 6.3.1.7.4. Potentially Adverse Condition. To be complete, the discussion on Gable Mountain faulting should be expanded to include the five separate faults identified by discussions in the Skagit/ Hanford Safety Evaluation Report, Supplement No 3. In its present form the EA discusses and identifies only the Central Fault.

18. Page 6-124. Potentially Adverse Condition., "Existing fault...could compromise the safety of repository personnel because of water flow..." This section deals with what may be encountered in the tunnel, shaft excavation and the effects on the repository. It does not indicate that faults will be encountered or that they have been during the exploratory program. Some acknowledgement should be made that faults, shear zones, etc. may be encountered in the repository and what this means to long term repository integrity.

GEOHYDROLOGY

19. Page 6-135, Section 6.3.1.7.8. Large-scale surface water impoundment could affect the regional groundwater flow system. Can impoundment that would inundate the repository effect the site?

20. Page 6-130, Section 6.3.1.8.3. Favorable Condition. The first paragraph should be reworded (revised) to reflect the significance (or non significance as the case might be) of the shallow potable groundwater resources. Are they valuable, and if so, are they of limited quantity and can it be extracted, considering the isolation of the site?

21. Page 3-72. Is it possible (or desirable) to determine the approximate "age" of groundwater within the candidate horizons to aid in calculating migration rates?

22. Page 3-90, Figure 3-1. Definition of the Cold Creek hydrologic barrier west of the site may provide essential information concerning the tectonics of the Pasco Basin and about the geohydrology of the deeper basalt flows.

23. Chapter 4 discusses many of the investigative techniques to be utilized during the repository site characterization phase of the program. Caution should be used to limit the number of penetrations into the repository area and to adequately seal all penetrations. It may be useful to permanently seal some penetrations early and test the effectiveness of the seals and seal material at the end of the 50 year recoverability period to check for degradation. This provision is more than likely part of the long-term program, but should be discussed in the environmental report.

24. Page 2-6 states that fractures will be logged. Describe the techniques that will be used to log fractures encountered in the tunnels and those sections of the shafts for which logging is planned.

25. Numerous exploratory borings have been drilled throughout the Hanford Reservation. More than likely only those drilled specifically for this repository site have penetrated the deeper candidate flows.

    a. What assurance is available that there are no unidentified borings that have been drilled into any of the 4 candidate flows? If there are pre BWIP deep borings, how will they be handled?

b. How will the exploratory and test borings be sealed when all activities cease, to maintain the long-term integrity of the repository?

26. Page 3-24 states that several flows have colonnade and entablature intraflow structures that do not correlate from core boring to core boring. Comparisons of these features from flow to flow should be made vertically to determine whether or not these lack of correlations could indicate the presence of faults that could be avoided during mining operations.

27. Pages 6-65, 6-76 and 6-117, Sections 6.3.1.14, 6.3.1.1.8 and 6.3.1.4.6 state that the hydrology of the Pasco Basin has been essentially the same for 1.8 million years and is expected to, although not currently quantified, remain unchanged for another 100,000 years. Any potential hydrologic impacts, such as a repeat of the Quaternary scabland Missoula floods, would be transient, localized, and shallow phenomena. The effects on pore pressures in water bearing strata within the deeper basalts of sudden impoundment of floodwaters in the Pasco Basin, and sudden drawdown should be analyzed, along with potential impact on the stored waste.

28. Pages 6-79 through 6-82, sections 6.3.1.1.11.1 discuss the results of several independent numerical model analyses of groundwater travel times conducted with regard to the reference repository. Long travel times of radionuclides calculated by most analysts are most likely correct, however, as illustrated by the NRC study (20 years to 40,000 years), a single unanticipated conduit, such as an open fault, etc., could invalidate the most careful model study. These analyses are essential, but, needless to say, the results should not be taken entirely at face value.

VOLCANISM

29. Page 6-130, Section 6.3.1.7.4. The Columbia Plateau is considered to have been volcanically inactive during the Quaternary, however, the volcanoes in the Cascade Range to the west are currently active. What could be the effect of ashfall from a large scale Cascade volcano eruption, such as

the 1980 Mount St. Helens eruption. Pages 6-190 and 6-191 discuss the necessity of ventilation and refrigeration systems to maintain a healthy environment for workers in the mine due to high temperatures or the presence of gas at that depth. Because of the necessity to maintain ventilation and cooling systems and of the potential for clogging air filter systems of surface machinery, it is important to analyze maximum probable thicknesses and rates of ashfall from potentially explosive volcanoes in the Cascade Range, and design ways to mitigate such an occurrence.

ENGINEERING GEOLOGY

30. The report acknowledges that faults and other discontinuities that were previously unknown will be encountered during excavation. It discusses methods that will be used to stabilize these discontinuities to protect workers in the mine. Discussions should also be presented in this document to indicate how these discontinuities will be stabilized and sealed during the life of the repository to inhibit the migration of radionuclides to the environment. It is recognized that this will be accomplished during site validation activities, however, engineering fixes and/or rerouting the tunnel, or other alternatives should also be discussed in the environmental evaluation.

31. Pages 6-195 and 6-196 describe engineering fixes that will be taken to protect workers when unstable zones such as vesicular or brecciated zones, flow top breccias, or palagonite zones are encountered during excavation. A plan should also be included describing the engineering fixes etc. when these features are penetrated, to insure the integrity of the repository during long term storage.

32. Page 6-173. The favored technique for constructing the shafts is the blind hole drilling method. It is important to obtain geologic data on the strata through which the hole is drilled. There is no indication that rock core will be obtained and the drill hole will be filled with drilling mud ruling out a visual examination of the shaft walls. A description of

the method that geologic information will be logged as the shaft is advanced should be provided.

33. Pages 6-154 through 6-156 and Table 6-11. Within this discussion of the size of the excavations within the repository versus the thicknesses of the candidate flows, it is indicated that the flows vary considerably in thickness and elevation. A description of the techniques by which the proper minimum thickness of dense basalt that surrounds the storage vaults and access tunnels is maintained should be included.

34. Page 6-169. Sufficient time between excavation of the tunnels and storage vaults and rockbolting and shotcreting should be allowed for detailed photography and geologic mapping of the exposed rock. Rock supports most likely will have to be applied quickly. In that case, detailed mapping can be accomplished from the photographs and preliminary maps or logs.

REFERENCES

Bingham, J. W., E. T. Londquist, and E. H. Baltz, 1970, Geologic Investigation of Faulting in the Hanford Region, Washington (with a section on the Occurrence of Micro-earthquakes, by A. M. Pitts); U. S. Geological Survey Open-File Report 7-27, 104 pp.

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U. S. Nuclear Regultory Commission, 1982, Safety Evaluation Report Related to the Operation of WPPSS Nuclear Project No. 2, Supplement No. 1, Docket 50-397, August, 1982.

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U. S. Nuclear Regulatory Commission, 1982, Safety Evaluation Report Related to the Construction of Skagit/Hanford Nuclear Project, Units 1 and 2, Supplement No. 3; Docket Nos. 50-522/523, December, 1982.