APPENDIX C

P. O. Box 15
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January 29, 1982

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U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
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Dear Dr. Wright:

This letter constitutes my trip report for our site visit to the Basalt Waste Isolation Project on January 11 through 13, 1982. By way of introduction, I would like to comment on the working relationships among the various technical groups at the site, as well as that between Rockwell, DOE and NRC personnel. For purposes of licensing it seems to me to be very important to have all technical groups understand and agree on the testing program as it progresses. The individual professional integrity of a scientific investigator is placed on the line in any controversial licensing issue. The support and input of the members of each technical group for each others decisions is important in the defense of any proposed licensing action. This support can be achieved only by the free interaction and communication of technical personnel within and among different groups. It seems to me that the Basalt Waste Isolation Project has evolved a long way in that direction since our September site visit. The continuing and improving integration of activities of the different groups is encouraging. It is encouraging also that the technical staff is now encouraged to interact freely with the licensing agency technical personnel. If this were not the case, it would be impossible for technical individuals associated with the licensing agency to

obtain the in depth view of issues necessary for the defense of the technical bases of the licensing proposal at the appropriate time.

I have, at times in the past, been placed in the position of having to defend proposed licensing actions wherein technical data gaps have existed. When a technical expert, acting as an expert witness in court or at a public hearing in defense of the licensing agency's proposed action, encounters such a situation he is placed in a position that either threatens the licensing action or threatens his professional integrity. He must either admit to the technical data gaps which weakens the technical defense of the proposed action or he must attempt to brush them over. Few technical experts are willing to follow the latter path. It is for this reason that I compliment Rockwell and DOE on the improvement in atmosphere that has occurred since our September visit.

The following paragraphs express my views about the technical issues as they were affected by our September site visit and by our January site visit to BWIP.

When we visited the site in September, we were presented essentially with spot saturated hydraulic conductivity testing data conducted in single bore holes in the Grande Ronde formation. We were told that all existing drill holes except four were not suitable for multiple well testing. We were told that drill holes 7 and 8 and 4 and 5 were suitable for multiple hole testing in the Grande Ronde because of their close spacing. However, all four of these drill holes were cased to the Grande Ronde and testing could not be conducted in the upper layers including the Wanapum or the Saddle Mountains or the interbeds. Little emphasis

was placed on any multiple well testing that had been conducted at the time of our visit. Apparently one of the double hole tests had just been conducted and the data on the other test were not emphasized during our site visit. Our September site visit zeroed in essentially on the Umtanum formation and the pulse testing that had been conducted in it. Under these circumstances, my impression of the Grande Ronde formation was that it could have contained permeable aquifers but this was a question. I was reasonably well convinced that the Umtanum formation itself reflected very low values of saturated hydraulic conductivity as indicated by the pulse tests and slug tests conducted in single drill holes. Under these circumstances, I concluded in my trip report that the characterization of the hydraulic properties and hydrogeologic characteristics of the aquifers above the Umtanum could not be tied down prior to the planned initiation of the sinking of an exploratory shaft in early 1983. Consequently, I recommended that the shaft itself be the primary aquifer characterization vehicle for the hydrostratigraphic units above the Umtanum in the vicinity of the RRL. I proposed that the shaft sinking proceed with the understanding that this procedure would constitute certain risks that might not ordinarily be taken by a mining company, but that as long as those risks were out in the open that this was not particularly negative to the objective of the project. Taking such risks certainly ought not constitute a threat to any licensing action. I recommended also in my trip report that the drifting to be conducted at the bottom of the shaft constitute a primary testing procedure for the Umtanum unit itself. At that time (September) I viewed the properties

of the Umtanum that would be determined in the drifting and testing procedure to be somewhat uncertain. We received two pieces of information during the January 11-13 site visit that now make me somewhat more optimistic about what the drifting and testing program will encounter. These two pieces of information are the results of paired hole pump tests in drill holes 7 and 8 and drill holes 4 and 5. These pump tests apparently were conducted throughout the uncased hole extending from the top of the Grande Ronde to some distance below the bottom of the Umtanum. The results of the pump test presented to us in January indicate that the entire Grande Ronde is somewhat less permeable than I thought it might have been after our September site visit. It apparently has an average saturated hydraulic conductivity in the order of 10^{-7} cm/sec, according to the pump test data in the open portion of the holes. Admittedly some units within the Grande Ronde may be more permeable than this but apparently these units are fairly thin thereby precluding high values of transmissivity (saturated hydraulic conductivity multiplied by the thickness of the lense being tested). These test results are a technological plus for the possible licensing of the Grande Ronde (Umtanum unit) as a repository. It should be pointed out, however, that the holes were drilled with mud. My experience with mud drilling in basalt is that K values can be lowered irreversibly by fracture invasion. I have not raised this issue in the past because until recently mud drilling was state of the art at these depths. Recently, however, the reverse air rotary technology has become available in the west and it

should be considered for future wells in order to minimize having a possibly unnecessary technological weak point in the defense of future licensing actions.

These two tests shed light on some of our recommendations in the main NRC report prepared subsequent to our September visit. The data presented to us on the two paired hole tests (disregarding mud invasion) suggest that our impressions of well spacing and pumping rates in future tests should be altered. Our impression was that it might have been possible to pump the Grande Ronde at a much higher rate than it probably is possible to pump it on the basis of the two paired hole test results. Similarly, our view of well spacing was that pump wells and observation wells should be spaced farther apart than existing wells 7 and 8 and existing wells 4 and 5. This probably is not a correct view. Well spacings much greater than those of 7 and 8 and 4 and 5 probably would not yield drawdowns in the observation wells as a result of the pumping wells.

In addition to implications with respect to our recommendations on well spacing and pumping rate, the results of the test indicate that testing of the Umtanum unit by pumping the first permeable aquifer above the Umtanum or below the Umtanum unit and monitoring pressures in the opposite aquifer and within the Umtanum unit may not be successful. Ordinarily this procedure would be used as one of the techniques for determining saturated hydraulic conductivity of the low permeability layer between two aquifers. The test results available from the multiple well test indicate that perhaps the Umtanum may be too impermeable to yield

pressure reductions during such a test, especially in view of the fact that the entire Grande Ronde is apparently much less permeable than we originally perceived and that it will not sustain as high a pumping rate as we perceived. Rockwell is now in a position of having to decide about the importance of running these tests to obtain vertical saturated hydraulic conductivity of the Umtanum in view of the risk that the tests may not be successful. Personally, I would recommend that the tests be implemented as proposed at the January site visit because the absence of such tests constitutes a data gap that may be difficult to defend. This could be more important than a test that might not prove successful.

The paired hole test data in the Grande Ronde also yielded information that can be translated via the Theis equation into synthetic distance drawdown curves for the Grande Ronde formation. These data are based on the assumption that the time drawdown test curves followed a theoretical Theis curve. We did not look at these data but I assume that this was the case. Consequently, I am assuming that the synthetic distance drawdown curves constitute a valid planning basis for the spacing of holes and for pumping rates and pump test durations.

My view on the status of the test program above the Grande Ronde formation has not changed as a result of the January site visit. It appears to me that on the basis of information presented by the Hydrology Group that virtually all tests, particularly multiple hole pump tests, have centered on the Grand Ronde formation or on very shallow hydrostratigraphic units, probably above the basalts or in the first basalt beneath the alluvium. The status of the testing program in the Wanapum and the

Saddle Mountains was the basis for my comments about the risks involved with blind boring the exploratory shaft. However, the program proposed to us in our January site visit should rectify this situation if carried out properly. In order to be carried out properly it will be necessary for hydrologists involved in the project to delineate those hydrostratigraphic units that should be lumped for multiple hole testing. This lumping process should be based on bore hole geophysical logs and on core. Once the units are lumped for hydraulic testing, it should be possible to determine their storativity and transmissivity by standard pump test techniques.

It is apparent however that the interbeds will pose a problem for hydraulic testing. The remarks of the Hydrology Group at the January site visit indicate that the interbeds will cave if uncased or unscreened. This fact makes it difficult to test hydraulically an interbed in a multiple hole test because a screen or slotted casing will be required for the test. The installation of a screen makes difficult the continuation of drilling and testing to greater depths. Therefore, in order to test an interbed properly, it is essentially necessary to slot casing opposite the interbed and inject the grout back through the slots after testing. Drilling could then continue through the grout plug. It may be technically feasible to screen and test and subsequently continue drilling, but I have not seen such a drilling and testing program implemented. The Hydrology Group feels that the interbeds are not sufficiently permeable to merit testing. They may very well be correct and from a licensing point of view, they might not be of concern. However, it

seems to me that at least one set of hard data should be acquired to support this point of view, so that it can be defended by technical experts under public scrutiny.

The January meeting also dealt, to some extent, with boundary conditions and discontinuities. The expanded drilling program plan presented to us should shed some light on the potential boundary to the west of the RRL. It is possible that pump tests in the shallower aquifers (above the Grande Ronde) will reflect a structural barrier boundary at the location where water level measurements are discontinuous with distance. But perhaps the most valuable information on boundaries or the absence thereof will be obtained from pump testing the more permeable units such as the Priest Rapids formation. Theoretically these pump test curves should follow either a Theis equation or one of the leaky equations. Deviation from one of these sets of curves ordinarily suggests that recharge boundaries, such as faults, exist. It is important to have such curves available because of the importance of showing hydraulically that such boundaries do not exist. In my opinion, one of the risks of drifting in the proposed repository is the fact that a fault gouge zone might be encountered. These are difficult to detect by any mechanism other than geophysics or hydraulic testing. Since the geophysics program probably will not shed much light on this issue, it is important that a hydraulic testing program be utilized as much as possible to ascertain the absence of such features for purposes of licensing.

I do not expect that the expanded drilling program proposed at the January meeting will shed much new light on boundary conditions on

a regional scale for purposes of regional mathematical modeling. Personally, I am of the opinion that this does not constitute an important gap in the data base because even short flow paths (equal to or less than 10 kilometers) should not exit to the biosphere in 10,000 years if the hydraulic properties determined by the expanded pump test program prove to be adequate.

Sincerely,

Roy E. Williams

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Registered in Idaho

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