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Department of Energy
Washington, D.C. 20545

JUL 15 1982

Trubit for miller. due 7/26

review major points w/me; are we off base?

JM 7/19

Mr. John Martin, Director
Division of Waste Management
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Martin:

Enclosed are the Department's comments on the draft NRC document on far-field groundwater modeling. This document was provided by Robert J. Wright's April 20, 1982, transmittal letter to R. A. Deju.

We feel NRC has misunderstood some aspects of our groundwater modeling and as a result has drawn some conclusions that are unsupportable. We offer the enclosed comments in hope that the NRC report can be corrected before being published.

We hope these comments will be of use and we appreciate the opportunity we had to review the report.

Sincerely,

J W Bennett, for
W. Wade Ballard, Jr., Acting Director
Division of Waste Repository Deployment
Office of Terminal Waste Disposal
and Remedial Action
Office of Nuclear Energy

Enclosure

00203

ATTACHMENT
May 19, 1982
R. C. Arnett

Review of NRC Draft Document

COMMENTS ON NRC DRAFT DOCUMENT ON BASALT FAR-FIELD MODELING

who coordinated on this letter?

On April 20, 1982 page 8 and pages 37-42 of a draft document were received with a cover letter from Robert J. Wright, Senior Technical Advisor, High Level Waste Technical Development Branch, Division of Waste Management, Nuclear Regulatory Commission to R. A. Deju, Director of the Basalt Waste Isolation Project. The material from the NRC draft report addressed Rockwell's far-field modeling and compared Rockwell and Pacific Northwest Laboratory far-field modeling conditions, assumptions and results. It was provided in response to a Rockwell request for specifics regarding a statement in an NRC trip report that inconsistencies existed between the Rockwell conceptual and mathematical modeling. Apparently, the NRC has performed some modeling studies using both the Rockwell and the PNL model input.

First, a misunderstanding has occurred which should be cleared up. On page 8, paragraph 2 of the NRC draft report, it is stated that according to RHO-BWI-LD-44, "It can be seen that along the eastern boundary a recharge condition is shown to exist in the conceptual model." This is incorrect. Figure 2-6 of LD-44 shows horizontal inflow to the Pasco Basin. The mathematical model shows a horizontal head gradient which is consistent with inflow to the Pasco Basin along this boundary. The NRC statement continues that "head values in the simulation, however, indicate either horizontal flow (head constant with depth) or discharge, i.e., head increasing with depth." Near the north-eastern boundary (but not on it) there is shown irrigation recharge to the upper (Saddle Mountain) layer in the conceptual model. This was input into the computational model as a source term and not as a boundary condition. The vertical head profiles in the Rockwell model show decreasing head with depth in this area for that reason. A discharge type boundary is assigned to the eastern boundary near the Snake River on the opposite side of the basin from the Horse Heaven Hills. This boundary together with specified heads on the top of the model along the reaches of the Columbia and Snake Rivers results in an upward head gradient throughout most of the southeastern portion of the model.

inflow

where is this shown?

Starting on Page 37 of the draft NRC report, the NRC's perception of the major differences between the Rockwell and PNL models are identified. The NRC comes to some conclusions regarding the impact of some of the Rockwell boundary condition specifications which are not supported by our model results. It would be helpful to present the actual conditions produced by Rockwell model in several areas in order to clarify the relationships between boundary conditions and head gradients.

1. On Page 37 the NRC draft report states that "The Rockwell model used a recharge boundary condition along the northwest corner of the grid

for approximately 25 miles. The pressure head (1,099 feet above mean sea level) was significantly higher than anywhere else in the model. So high, in fact, that it caused all water to flow away from this area, across the basin, and out the eastern boundary. The eastward flow of water was exactly opposite to that of PNL, who had primarily a westward and upward flow component.

PNL used a no-flow boundary condition along the same 25 mile area, and had only small amounts of precipitation as recharge".

High heads west of the Hanford Site are a documented fact. Several large volume irrigation wells completed in the Priest Rapids (upper Wanapum) exist in the Cold Creek Valley just west of the Hanford Site. These wells exhibit heads in the range of 900 or more feet above mean sea level. The NRC comment appears to indicate that all flow from this western area moved entirely eastward. This is not the case for the Rockwell model. In the area above the Columbia River, a substantial southward component exists.

2. The second major difference was described on Page 37 and 39 as follows: "Rockwell set the head at the bottom of the Grande Ronde to 550 ft. above sea level for approximately 42 miles along the northern basin boundary. No-flow boundaries were assigned to all units above this; thereby restricting flow from entering the basin from the north. PNL assigned a flow boundary along this same area. Head values ranged from 675 to 880 feet above sea level - increasing to the east. No-flow boundaries were assigned to the Saddle Mountains Formation only. The head difference between the two models ranged from 125 feet to 330 feet."

Recently we have uncovered some very pertinent hydraulic head data deep in the Grande Ronde Basalts at Borehole DH-5 (see attached Figure 1). A single piezometer tube was set at a depth of 4854 feet below land surface. Bottom of the hole was 5002 feet below land surface. Head measurements were taken in 1972 and 1973 by the USGS and in 1975 and 1976 by the Atlantic Richfield Hanford Company (predecessor of Rockwell). In all cases the head was steady at 548 feet MSL. By comparison, the Rockwell model reported in LD-44 showed a head at the DH-5 location of 549 feet MSL whereas the PNL model showed a head value of 614 feet MSL. The bottom of both models were at somewhat higher elevations than the borehole measurement interval.

DID WE SEE THIS DATA?

The reason for establishing a no-flow boundary along the upper formations of the Saddle Mountains is the same as that for establishing no-flow boundaries along the Rattlesnake Hills and Horse Heaven Hills. These mountain ridges are flow divides in the upper formations. Setting no-flow boundaries along the Rattlesnake Hills and Horse Heaven Hills restricts flow into or out of the southern boundary of the model as well.

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3. On Page 39 of the NRC draft report it is stated that "the RHO model does not permit an upward gradient in [the southwestern corner of the Pasco Basin, and therefore] no upward discharge can exist. This is significant to RHO's conclusion that particles do not leave the Grande Ronde formation."

The Rockwell model does produce an upward gradient in all formations in the area east of the Columbia River. A small upward gradient exists in the Grande Ronde formation even somewhat west of the Columbia River. This is true even with recharge conditions assigned to the Horse Heaven Hills boundary.

4. On page 41 of the NRC report, the following statement is made. "In the RHO model, in the area beginning just west of Wallula Gap and continuing clockwise around the southwestern boundary for approximately 30 miles, a recharge boundary condition was imposed. Heads in this area drop from 700 ft in the upper units, 500 ft in the lower units. This created a significant downward gradient, which was strong enough to be felt across the entire width of the basin (approximately 24 miles). The recharge effect forced water downward in the Wallula Gap area, instead of upward as would be expected in a discharge area."

The Rockwell model analysis showed that the effects of the recharge boundary along the Horse Heaven Hills were restricted to a limited zone on the west side of the Columbia River. Again, an upward head gradient existed along the path of the streamlines east of the Columbia River to within one node of the termination point. Why the NRC concluded a downward gradient throughout the area would result from using the Rockwell boundary conditions is uncertain. Perhaps large nodal spacing in the NRC model is influencing the NRC results.

We have agreed that the concept of a no-flow boundary in the upper formations together with rainfall recharge along the Horse Heaven Hills is more consistent with the procedure for dealing with mountain ridges elsewhere in the model. This was agreed to at the last meeting with NRC in January 1982. At that time the results of the Rockwell model with no-flow boundary conditions in the upper formations along the Horse Heaven Hills were presented. They varied little from the results presented in LD-44. If the recharge boundary along the Horse Heaven Hills is causing a downward gradient throughout the southeastern corner of the basin in the NRC model they should rerun their model using no-flow conditions in the Saddle Mountain, Wanapum and upper Grande Ronde Basalts with a fixed head of 152 meters above MSL along the bottom of the Grande Ronde basalts which has been the situation in our model since January, 1982.

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In our meetings with the NRC we have presented the position that the boundary conditions must be consistent with the head measurements within the model boundaries. This is particularly important with regards to the Grande Ronde Basalt head values. At the time the PNL study was performed, some of the key data used in the Rockwell study were not available. However, it should be noted that PNL did include an interpreted Grande Ronde Basalt potential surface in their report. This surface is presented on Page 4-111 (PNL Figure 27) of the March 1981 draft of the PNL report. If the head measurements at the top of the Grande Ronde formation form boreholes DC-7/8, DC-6, DC-12, DC-14, and DC-15 are plotted on that surface, a somewhat reasonable match is obtained except at borehole DC-12 (see attached Figure 2). However, if the interpreted potential surface (PNL Figure 27) is compared to the PNL predicted head surface at the top of the Grande Ronde (PNL Figure 41, Page 4-146) the model heads are substantially higher than the interpreted surface. The PNL model computed heads at the top of the Grande Ronde are more than 100 feet higher than the measurements taken subsequent to the PNL study (see attached Figure 3). Thus even with much higher ratios of vertical to horizontal hydraulic conductivity in the PNL model, it predicted much higher heads in the Grande Ronde than either the interpreted potential surface or observed heads. It seems clear that specified heads along some boundaries in the PNL model, particularly for the Grande Ronde formation, are too high. This resulted in vertical head gradients which are also much higher than observed in the central portion of the Hanford Site.

This points up the Rockwell concern that boundary conditions for the Pasco Basin are not a known quantity. While we recognize the convenience and value to the Pasco Basin modeling effort of being able to assign a single set of boundary conditions for the basin and proceed to match observed heads by varying the hydraulic conductivities, it is clear that no procedure, however elaborate, can obscure the fact that uncertainty exists in the definition of the boundary conditions for the Pasco Basin. This is particularly true of the Grande Ronde formation. Also, boundary conditions as well as hydraulic conductivity distributions must be consistent with field measurements. PNL calibrated by varying the ratio of vertical to horizontal conductivity with boundary conditions fixed. Rockwell essentially calibrated by varying boundary conditions with unchanged conductivities. Neither method is complete. For this reason we are in the process of conducting an extensive parameter and sensitivity analysis wherein the variability of both parameters will be investigated. ~~It is also useful to~~ note that the USGS believes that insufficient data exists to properly calibrate a regional model. This judgement is based upon their experience in attempting to perform regional modeling on the Columbia Plateau similar to PNL's effort. PNL was aware of the limited data available for a regional modeling effort, but proceeded with a regional model in line with their objective which was to demonstrate methodology. It is very important to recognize that the PNL effort was not to evaluate the Hanford basalt site,

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but to develop and demonstrate methodology. We would prefer to be able to rely upon boundary conditions generated by a regional model or some other methodology. The evidence is such, however, that the boundary conditions produced by the present PNL model cannot be accepted as adequate representations of the boundary conditions affecting the central Hanford Site. In particular, the high heads in the Grande Ronde Basalts generated by the boundary conditions strongly influence both the vertical head gradient and the vertical to horizontal conductivity ratio, both of which are key to the different streamline orientations.

At the same time, we do not claim that the boundary conditions used in LD-44 are completely correct or unique. Both the Rockwell and the PNL models are preliminary and both have served useful purposes. Currently, a modeling task force has been organized which includes Rockwell, PNL and the USGS to examine the various model assumptions and inputs and to resolve differences. Based upon early meetings of the task force, good progress has been made in an environment of cooperation and mutual learning. The differences in the preliminary models have served as a useful catalyst in focusing upon important areas of uncertainty.

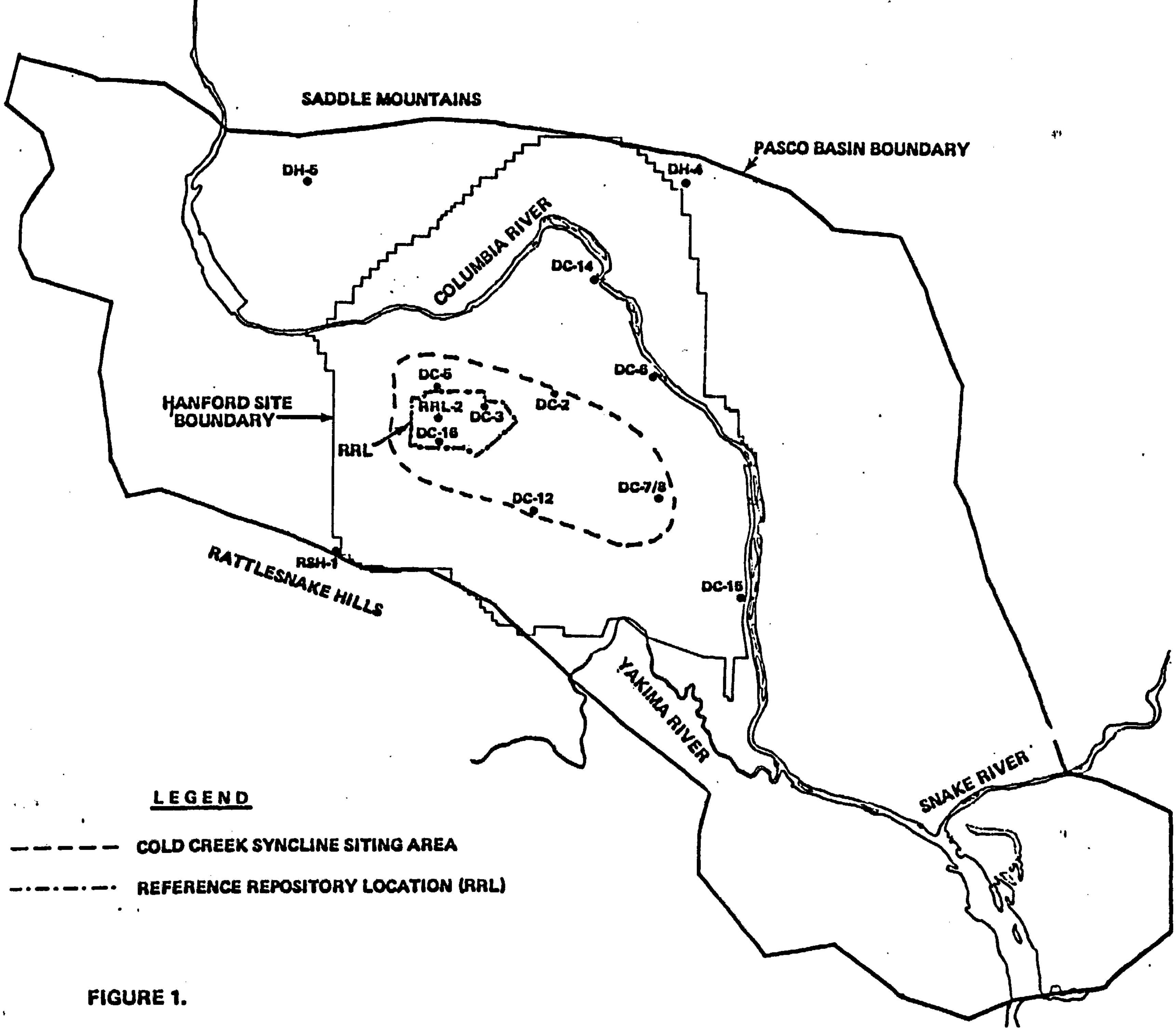
SADDLE MOUNTAINS
PASCO BASIN BOUNDARY
DH-5
DH-4
COLUMBIA RIVER
DC-14
DC-6
DC-5
DC-2
RRL-2
DC-3
DC-16
HANFORD SITE BOUNDARY
RRL
DC-7/8
DC-12
RSH-1
RATTLESNAKE HILLS
DC-15
YAKIMA RIVER
SNAKE RIVER
LEGEND
COLD CREEK SYNCLINE SITING AREA
REFERENCE REPOSITORY LOCATION (RRL)

FIGURE 1.

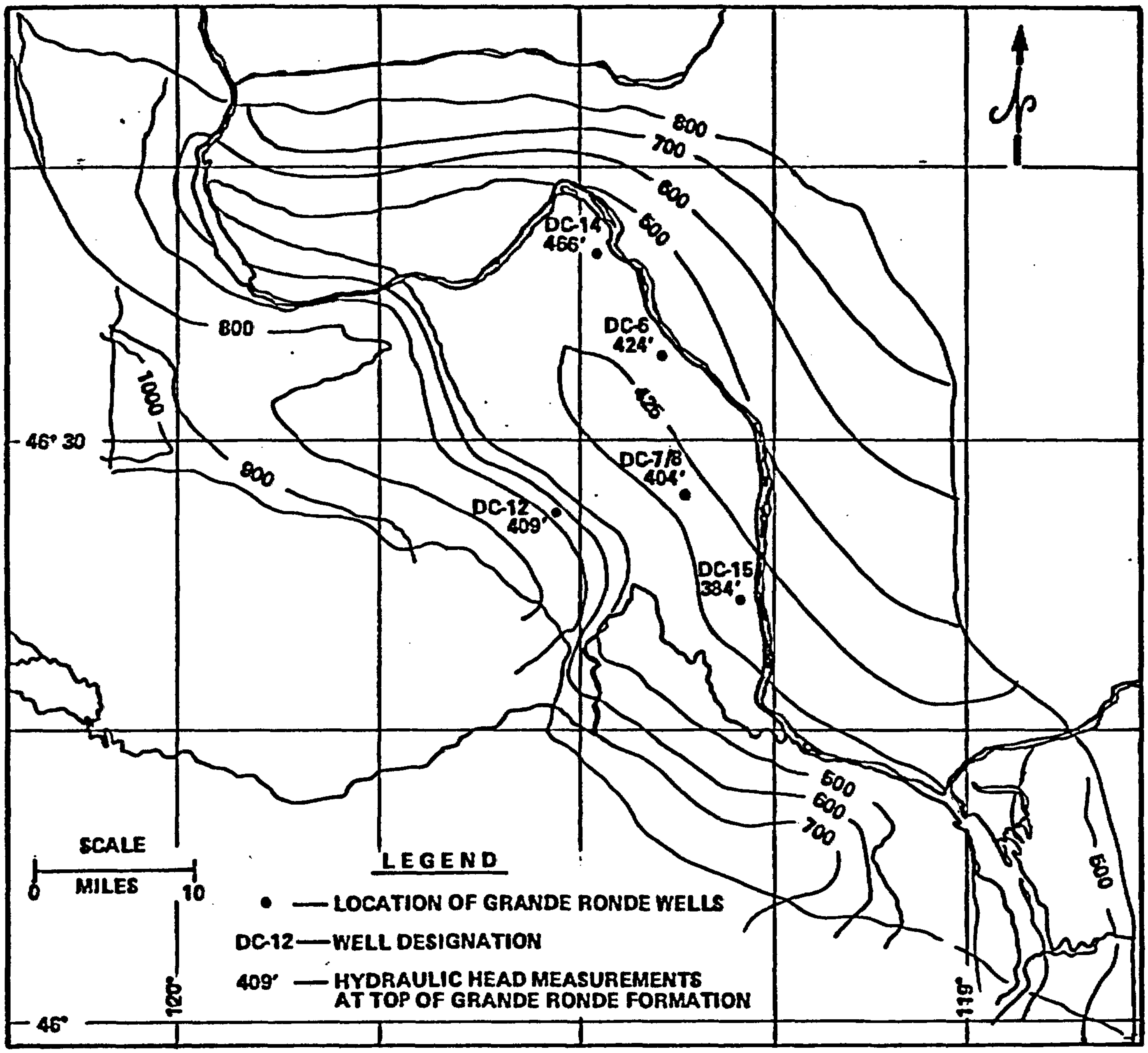

FIGURE 2. DIGITIZED POTENTIAL SURFACE FOR THE GRANDE RONDE BASALT. CONTOUR LEVELS ARE IN FEET ABOVE MSL.

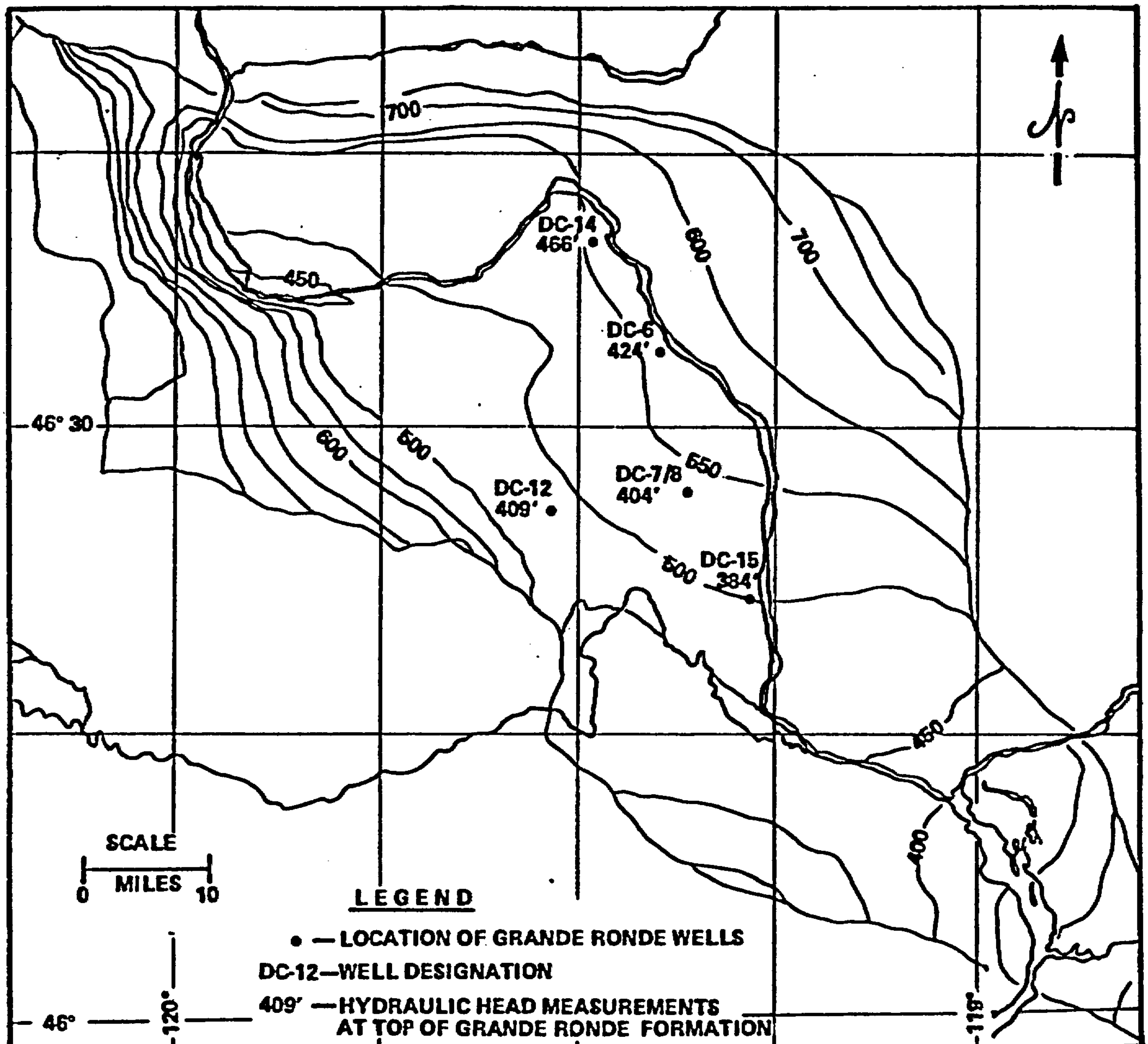

FIGURE 3. MODEL PREDICTED HEADS FOR THE TOP OF THE GRANDE RONDE FOR THE BASE CASE (RUN 4) FOR THE CURRENT CONDITIONS SCENARIO. HEADS ARE REFERENCED TO MSL.