See packet for encl PDR-(1)
(LPDR WM-10 (2)
WM-11 (2)
WM-16 (2)

NUCLEAR WASTE CONSULTANTS INC.
8341 So. Sangre de Cristo Rd., Suite 14
Littleton, Colorado 80127
(303) 973-7495

WM-PES
WM Record File
D1021
NWCI

WM Project 10,11,16
Docket No.
x PDR ✓
x LPDR ✓ (B,N,S)

'87 JUN 29 A11:41

x Distribution:
Pohle
Return to WM, 623-SS)

June 24, 1987

009/2.5/TTI.004
RS-NMS-85-009
Communication No. 171

U.S. Nuclear Regulatory Commission
Division of High-level Waste Management
Technical Review Branch
MS 623-SS
Washington, DC 20555

See Packet for Encl.

Attention: **Mr. Jeff Pohle, Project Officer**
Technical Assistance in Hydrogeology - Project B (RS-NMS-85-009)

Re: **BWIP Technical Description Summaries - Subtask 2.5**

Dear Mr. Pohle:

Attached please find a set of Technical Description Summaries (TDS) prepared by staff of Terra Therma and Nuclear Waste Consultants for ongoing and proposed technical reports under Subtask 2.5 of the current contract. The proposed technical reports address data needs at BWIP that TTI/NWC consider should be addressed by the Staff prior to receipt of the BWIP SCP. Because it is our understanding that the BWIP SCP is currently scheduled for receipt on or about December 31, 1987, the schedule for the proposed technical reports is based on completion of the reports on or before December 31, 1987. The package has been reviewed by Mark Logsdon and Adrian Brown of Nuclear Waste Consultants. Depending on the actual direction from the NRC Staff with respect to the balance of work between this and other subtasks, the proposed scheduling may change over time.

Please note that the set of 25 proposed technical reports includes two (Nos. 10 and 13) that are directed at thermal evaluations. These TDS's were prepared before NWC received the Codell reviews of TTI mini-report 3; Mr. Logsdon has directed TTI to suspend additional work on thermally-related topics pending response to the Codell reviews and additional direction from NWC and the NRC Staff.

4091

If you have any questions about these TDS's or the technical reports that they address, please contact me immediately. TTI and NWC look forward to Staff review and comment on these proposals in the near future so that we may continue our technical efforts under Subtask 2.5 in a timely fashion.

Respectfully submitted,
NUCLEAR WASTE CONSULTANTS, INC.

Mark J. Logsdon

Mark J. Logsdon, Project Manager

Att: **BWIP Technical Description Summaries**

cc: US NRC - Director, NMSS (ATTN PSB)
DHLWM (ATTN Division Director)
Mary Little, Contract Administrator
HLTR (ATTN Branch Chief)

cc: L. Davis, WWL
J. Minier, DBS

bc: M. Galloway, TTI

encl. to June 24, 1987 letter to Pohle from Logsdon

D1021

TERRA THERMA, INC.

WATER CONSULTANTS AND ENGINEERS

8341 S. Sangre de Cristo Rd., Suite 14, Littleton, CO 80127 (303) 973-7492

June 19, 1987

Nuclear Waste Consultants
8341 S. Sangre de Cristo Road
Littleton, Colorado 80127

Att: Mark Logsdon, Project Manager

Re: Subtask 2.5 Technical Description Summaries

Dear Mr. Logsdon:

Terra Therma, Inc. (TTI) personnel have prepared Technical Description Summaries (TDS) for proposed topics to be completed during the remainder of FY 86 and FY 87. The topics have been selected on the basis of data-needs required for competent review of both the pending BWIP SCP and LHS testing. The TDS topics have been divided into categories which are based on TTI conceptual model categories (TTI, 1986). However, because of the immediate importance of LHS testing, a separate group of TDS documents is proposed. The various LHS topics could be subdivided within the conceptual model categories, but can be presented more coherently as a separate group.

We have provided a topic discussion summary for each group of TDS documents, describing the rationale, nature, and schedule of the proposed technical reports. The proposed schedule assumes that the SCP will be received in late December, 1987 and will require review and discussion through June, 1988.

If we can provide any additional information or clarification, please do not hesitate to call us.

Sincerely,
TERRA THERMA, INC.

Michael Galloway
By L Miele

Michael Galloway
Project Manager

ATT

LHS TESTING

This group of TDS documents deals primarily with LHS testing issues. At present, piezometer-seal integrity/vertical leakage is an unresolved issue which could have significant impact on the BWIP LHS testing program, as described in TTI's summary letter to Dr. Tilak Verma of the NRC (TTI, 1987a). Therefore, this issue is central to this group of TDS documents. Other topics include up-hole versus down-hole measurement and a 500 meter convergent tracer test.

These topics are scheduled to be completed by September 30, 1987, depending upon the actual approval date.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 18

Title: Analysis of Flow Interior Responses Observed During Piezometer Development

OBJECTIVE

The purpose of this technical report is to evaluate and analyze hydraulic responses observed within flow interiors during piezometer development at borehole RRL-2C. The results of this analysis can potentially provide values of hydraulic dispersivity of selected flow interiors and/or information regarding the integrity of borehole seals.

TECHNICAL APPROACH

Piezometers within the RRL-2C installation were developed by withdrawal of formation water. During the development of some piezometers within interflows, significant hydraulic responses were observed in adjacent flow interiors. These responses could represent pressure propagation within the flow interior or within the borehole due to an incomplete grout seal. Using a modification to well known consolidation equation, it is possible to develop an analysis which allows calculation of the effective hydraulic diffusivity (ratio of hydraulic conductivity to specific storage) which best reproduces the data. To evaluate the analytical solution, a fully documented computer program will be written in BASIC to operate on an IBM PC microcomputer. If characteristics of the field data closely match the analytical model, it may be concluded that the observed flow interior responses in fact represent properties of dense basalt. In this case, the results can be used to evaluate vertical hydraulic conductivity of the affected flow interior. On the other hand, if field data are inconsistent with the analytical model, integrity of borehole seals may be questioned.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. Included will be the complete theoretical development of the analytical solution and documentation for the computer program used to evaluate the final equations. Detailed technical explanations will be presented to justify the conclusion of whether or not the observed responses are the result of flow interior hydraulic properties.

TASK ASSIGNMENT

This task will be performed by Fred Marinelli. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 18 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Development of analytical solution:		5 hours
Development of computer program:		20
Analysis of field data (assume 2 data sets)		15
Write-up:		15
	Subtotal:	55 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	75 hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 19

Title: Technical Evaluation of a 500 Meter Convergent Tracer Test

OBJECTIVE

The purpose of this report is to evaluate the technical feasibility of performing a 500 meter convergent tracer test as part of the LHS testing program. A tracer test conducted across this distance would provide a relatively large-scale value of effective porosity which may be suitable for performance modeling of the BWIP site.

TECHNICAL APPROACH

For the planned LHS test at borehole RRL-2B, previous TTI analyses have indicated the feasibility of installing observation piezometers at a radial distance of 500 meters for the purpose of hydraulic analysis. This technical report will evaluate the use of such piezometer installations for performing a 500 meter convergent tracer test. Analyses will be performed to evaluate the following factors:

- o Tracer travel time from injection point to the production well.
- o Relative dilution of tracer in water discharged from the production well.
- o Sensitivity study of dispersion effects.
- o Sensitivity study of leakage effects.

Where possible, relatively simple analytical solutions will be used to evaluate the above factors. It is not anticipated that numerical modeling will be required to conduct this preliminary assessment.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. Tracer travel time will be evaluated within the context of time frames currently proposed for LHS testing and tracer dilution will be compared to detection limits of potential conservative tracers. The effects of leakage and dispersion will be presented from the standpoint of sensitivity, with pertinent hydraulic/transport coefficients compared to estimated value ranges at the BWIP site.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 19 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Travel time analysis		10 hours
Tracer dilution analysis		10
Sensitivity study of leakage effects		10
Sensitivity study of dispersion effects		10
Write-up:		15
	Subtotal:	55 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	75 hours

SCHEDULE

The scheduling of this technical report is not dependent on other TTI work proposed or in progress. This report should be completed before DOE's submittal of the BWIP SCP.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 20

Title: Use of Up-Hole Head Measurements for LHS Testing

OBJECTIVE

DOE's proposed plans for LHS testing call for up-hole water level measurements, (rather than down-hole pressures) in many piezometer installations. The purposed of this technical report is to evaluate potential inaccuracies which may result from up-hole head measurements and the degree to which such errors might affect LHS test analysis.

TECHNICAL APPROACH

It is presumed that the primary source of error associated with up-hole water level measurements will result from temporal variations in the fluid density of water inside the piezometer riser pipe. For example, during an LHS test, water levels in the riser pipe will rise and fall, resulting in displacement of water at the bottom of the piezometer into or out of the formation. If the salinity of formation water differs from that inside the riser pipe, it is possible to achieve different water level changes for a given change in formation pressure. In this study, a conservative case will be considered where the salinity difference between the piezometer and formation fluids are assumed to be extreme. For given changes in formation head, the errors introduced by determining hydraulic drawdown/buildup from water level measurements will be computed. If these errors are shown to be insignificant for this conservative case, it can be concluded that the errors will be negligible for the more realistic case where salinity differences are less extreme. If measurement errors for the conservative case are significant, then further analyses will be proposed better evaluate this source of uncertainty.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. The primary analytical result of this study will be a graph showing relative error in water level change vs. the magnitude of formation hydraulic drawdown/buildup. If necessary, additional analyses will be proposed to better evaluate this source of measurement uncertainty.

TASK ASSIGNMENTS

This technical report will be prepared by Barbara Basse. Technical reviews will be completed by Adrian Brown and Fred Marinelli. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 20 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Analysis:		5 hours
Evaluation:		5
Write-up:		10
	Subtotal:	20 hours
Review (technical and QA):		5
Final Preparation:		10
	Total:	35 hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 21

Title: A Computer Program for Simulating LHS Tests in Leaky Aquifers

OBJECTIVE

Sensitivity analyses of proposed LHS tests are required to determine to what extent they will provide relevant site characterization data. The purpose of this technical report is to develop and document a computer program which efficiently evaluates the modified Hantush leaky aquifer solution. This solution is considered appropriate for pre-analysis of BWIP LHS tests.

TECHNICAL APPROACH

A preliminary IBM PC computer program used to evaluate the modified Hantush leaky aquifer solution has been previously developed by TTI for purposes of the current contract. The method is based on numerical inversion of the LaPlace transform solution using the Stelfest algorithm. The current program includes an option to consider one image well. The purpose of this technical work is to rewrite certain portions of the algorithm, fully document the program, provide comment statements in the source code, and benchmark the program against appropriate analytical solutions. The original program will be modified to incorporate any number of image wells so that multiple boundaries and withdrawal/recovery can be simulated. Options will be written into the program to down-load input/output files onto disk and to plot results on a Hewlett Packard mechanical plotter.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. The final report will describe theoretical development of governing equations and the solution algorithm. Computer results will be compared to appropriate analytical solutions and a complete listing of the source code will be provided in an appendix.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli and Barbara Basse. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 21 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Rewrite portions of existing program:		20 hours
Benchmark against analytical solutions:		10
Write-up:		15
	Subtotal:	45 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	65 hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 22

Title: Integrity of Piezometer Seals Based on Placement History and Subsequent Geophysical Logging

OBJECTIVE:

Because recent hydraulic response data from various piezometers indicate that the integrity of these piezometers is in question, the NRC staff should become familar with both the sealing technology used at BWIP and the results of various testing results, such as bond logs. Therefore, the objective of this technical report is to review the actual borehole sealing techniques used, accounts of their actual placement, and the results of any diagnostic testing performed in order to comment on the integrity of those seals on the basis of physical data.

TECHNICAL APPROACH:

This study will be divided into four main areas of investigation, as listed below:

- o Grout permeability
- o Seal placement techniques
- o Seal integrity testing
- o Integrity of existing seals

The initial portions of this investigation will be primarily a brief literature review in an attempt to define the range and success/failure of possible sealing techniques. Documentation of BWIP seal placement activities will be reviewed for comparison with the literature review results. The last two areas of the investigation will deal specifically with the BWIP piezometer seals in an attempt to determine how their integrity could be tested and to comment on the actual integrity. However, any conclusions regarding the integrity will be based on physical evidence such as techniques and verification procedures used and cement bond logs, as opposed to analyzing the hydraulic responses.

PRODUCT DESCRIPTION:

This technical report will consist of one document containing the summary of the data review and results of the BWIP seal review and analysis.

TASK ASSIGNMENT:

This task is to be prepared by Michael Galloway. The technical reviews will be done by Adrian Brown and Fred Marinelli. QA review of the document will be by Catherine Kraeger-Rovey.

Technical Report Number: 22 (continued)

MANPOWER:

Literature Review:		20
Analysis:		10 hours
Write-up:		10 hours
	Subtotal:	40 hours
Review (technical and QA):		10 hours
Final preparation:		10 hours
	Total:	60 hours

SCHEDULE:

Not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 26

Title: Large-Scale Tracer Test: Tracer Detection

OBJECTIVE

In Technical Report # 11, tracer travel time analyses are proposed for evaluating the feasibility of conducting an injection/withdrawal tracer test at scales ranging from 2 to 5 kilometers. The purpose of this technical report is to continue that assessment by evaluating the magnitude of tracer dilution at the production well(s) and to determine if concentrations are likely to be above detection limits. This study will be initiated only if the travel time analyses in Technical Report #12 indicate that a large-scale tracer test is potentially feasible.

TECHNICAL APPROACH

Analyses will be performed to evaluate the following factors:

- Relative dilution of tracer in water discharged from the production well(s).
- Sensitivity study of dispersion effects.
- Sensitivity study of leakage effects.

Where possible, relatively simple analytical solutions will be used to evaluate the above factors. It is not anticipated that numerical modeling will be required to conduct this preliminary assessment. This study will also include a literature review of potential conservative tracers that might be considered for such a large-scale test. Detection limits of the identified tracers will be compared to predicted dilution factors to determine if tracer concentrations in the withdrawal water are measurable.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. Tracer dilution will be compared to detection limits of potential conservative tracers. The effects of leakage and dispersion will be presented from the standpoint of sensitivity, with pertinent hydraulic/transport coefficients compared to estimated value ranges at the BWIP site.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli and Mike Galloway. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 26 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Tracer dilution analysis		15 hours
Sensitivity analysis of dispersion effects		10
Sensitivity analysis of leakage effects		10
Literature search of potential tracers		10
Write-up:		15
	Subtotal:	60 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	80 hours

SCHEDULE

This study will be performed after completion of Technical Report #12 [?] if the results of that report indicate that a large-scale tracer test is potentially feasible. This study should be completed before DOE's submittal of the BWIP SCP.

FRAMEWORK

In reviewing various BWIP documents, it has become apparent that we have no clear indication as to how the geologic correlations have been made with respect to high and low hydraulic conductivity results of the single-hole testing program. Therefore, TDS number 29 is proposed to define our confidence level in the BWIP framework. This document is planned to be completed by the end of December, 1987.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 29

Title: Validation of Geologic Correlations

OBJECTIVE:

The objective of this technical report is to determine whether or not the results of single-hole tests were used to assist in the definition of flow interiors and flow tops. If so, then are the correlations valid with respect to other geologic or geophysical information.

TECHNICAL APPROACH:

The Terra Therma data base will be used to develop a subset of all geologic information for holes that have been tested by single-hole techniques. In addition, it is hoped that recently reviewed data will also be available. A vertical comparison of the single-hole test results and the geologic "picks" will be made. This comparison should provide initial information as to the correlation between hydraulic conductivity and geology. Should the correlation between high and low conductivity and the geology not be convincing, then a more detailed correlation between wells across the site will be made. Although cross-site correlations have been made by DOE, it is not clear as to whether or not the level of detail considers possible errors which may have resulted from use of the hydraulic conductivity data for the "picks".

PRODUCT DESCRIPTION:

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. An additional product of this analysis (which would be presented under the 2.2 Database Update subtask) would be a summary database of geologic, geophysical, hydrologic, and well completion data, organized by well.

TASK ASSIGNMENT:

This task is to be prepared jointly by Michael Galloway and Barbara Basse. The technical reviews will be done by Adrian Brown and Mark Logsdon. QA review of the document will be by Catherine Kraeger-Rovey.

Technical Report Number: 29 (continued)

MANPOWER:

The predominate manpower requirement for this task will be in developing a database which can be used to make the comparisons. It is proposed that this portion of the manpower be performed under the 2.2 subtask heading. Estimated number of hours for developing the database is 40 hours.

Analysis:	20 hours
Write-up:	10 hours
Subtotal:	30 hours
Review (technical and QA):	10 hours
Final preparation:	10 hours
Total:	50 hours

SCHEDULE:

Not dependent on other work proposed or in progress.

PARAMETERIC DATA

This TDS category includes a number of topics which propose to investigate various BWIP parameteric data issues. Generally, these issues are less "dramatic" than those proposed under the LHS testing category, however, they represent unresolved questions which are important to the overall conceptual model and therefore to our review of the BWIP SCP. For example, the probability distribution of effective porosity is considered by TTI to be critical in the application of the GWTT criterion. This group of documents is scheduled to be completed by December, 1987.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 23

Title: Characteristics of the Probability Distribution for Effective Porosity

OBJECTIVE

The objective of this technical report is to conduct a literature review with the intent of determining characteristics of the probability distribution for effective porosity in fractured media. The type of distribution (e.g., normal vs. log normal) is of considerable significance in application of the groundwater travel time (GWTT) criterion.

TECHNICAL APPROACH

To date, numerous studies have appeared in the technical literature in which hypothetical fracture distributions are generated using statistical parameters. These parameters typically involve mean and standard deviation values of fracture orientation, spacing, length, and aperture. Hypothetical fracture sets are generated by computer programs using Monte Carlo or similar techniques. Once a fracture distribution has been generated, it should be possible to estimate the net effective porosity of the medium based ether on the fracture geometries or by applying a groundwater flow/transport model. By producing successive fracture sets and analyzing those sets for effective porosity, characteristics of the probability distribution for effective porosity can be evaluated. The approach taken in this technical report is to conduct a literature search to determine if sufficient information is publicly available to perform the evaluation described above. If so, then interpretations of the probability distribution for effective porosity may be formulated. If data in the literature is lacking, then a technical proposal for a more comprehensive analytical study will be presented.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. If information in the technical literature is sufficient, characteristics of the probability distribution for effective porosity will be formulated. If data is lacking, an in-house technical study for evaluation of the probability distribution will be proposed.

TASK ASSIGNMENTS

This technical report will be prepared by Mike Galloway with support from Barbara Basse and Mark Logsdon. Technical reviews will be completed by Adrian Brown and Fred Marinelli. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 23 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Literature Review:		20 hours
Evaluation of Data:		15
Write-up:		15
	Subtotal:	50 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	70 hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 24

Title: Analysis of Possible Mechanisms for Equalization of Heads Within the RRL

OBJECTIVE

Baseline monitoring data for the Wanapum and Grande Ronde Basalts indicate that hydraulic heads are relatively uniform within the RRL and vicinity. The purpose of this technical report is to evaluate potential hydrologic mechanisms which could cause the observed equalization of heads. Identification of possible mechanisms may have a strong bearing on the importance of obtaining certain types of site characterization data.

TECHNICAL APPROACH

Potential mechanisms which could result in head equalization at BWIP include constant head boundaries to the hydrogeologic system, significant vertical leakage, and the presence of internal structural features of high permeability. Each of these mechanisms will be evaluated using relatively simple analytical solutions. Ranges of hydraulic parameter values required to produce the observed head characteristics will be computed for each case. If the range of values associated with a particular mechanism is clearly outside the BWIP site characterization database, that mechanism will be judged to have little likelihood operating at BWIP. Remaining mechanisms will then be evaluated from the standpoint of determining what site characterization data are required for further analysis and the degree to which these mechanisms have a regulatory concern.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. Hydrologic mechanisms which are not likely to operate at BWIP will be identified. Data needs and regulatory aspects of the remaining mechanisms will be assessed.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli and Catherine Kraeger-Rovey. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Mike Galloway.

Technical Report Number: 24 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Analysis of boundary effects:		10 hours
Analysis of leakage effects:		10
Analysis of internal structures:		10
Data needs and regulatory assessment:		**10**
Write-up:		15
	Subtotal:	55 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	75 hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 25

Title: Ability of Proposed ES Tests to Measure Flow Interior Heterogeneity

OBJECTIVE

In the Draft ESTP, it is proposed that a chamber test and several multiple borehole tests be performed within the emplacement horizon (Cohassett Flow Interior) to measure "large-scale" values of hydraulic conductivity and specific storage. However, due to the apparent low permeability of basalt flow interiors, such tests will not necessarily have a large radius of influence. The purpose of this technical report is to evaluate the ability of such tests to identify the presence of high permeability features existing within the flow interior in the general vicinity of the test location.

TECHNICAL APPROACH

Work performed in this study will essentially constitute a pre-analysis of DOE's proposed ES tests. Analyses will be based on equations developed by the NRC which are presented in NUREG/CR-3065 (Appendix A). Hydraulic responses will first be predicted for a "base case" which assumes the flow interior to be homogeneous and have infinite lateral extent. Subsequent analyses will consider the presence of a high permeability feature (treated as a constant head boundary) at varying distances from the test location. From these analyses it will be determine how close a heterogeneous feature must be to the test site before its presence could be deduced from the test data. To facilitate efficient analysis of several scenarios, governing equations will be evaluated using a computer program written in BASIC for the IBM PC. The program will allow for superposition so that one or more hydrologic boundaries can be simulated. Sensitivity analyses will be performed to evaluate the relationship between lateral influence of the tests and key hydraulic parameters. In this case, the influence of the test will be defined as the distance within which heterogeneous features could be identified by test data.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. The primary analytical result of this study will be a set of graphs describing the lateral influence of the tests for various values of key hydraulic parameters.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 25 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Development of analytical solution:		5 hours
Development of computer program:		15
Sensitivity Analyses		15
Write-up:		15
	Subtotal:	50 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	70 hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 27

Title: Analysis of BWIP Drilling Response Data for FY 87

OBJECTIVE

The purpose of this technical report is to evaluate the new drilling response data which will result from the preparation of the Hanford Site for the planned LHS testing. The results of this analysis may provide confirmation of some of NWC's conceptual model interpretations. Evaluation will also help to assess both past calculations of key hydraulic parameters and the LHS information as it becomes available.

TECHNICAL APPROACH

The methodology for this Technical Report has been developed in Technical Report #5 and utilized in Technical Report #8. Further development of this model is possible to allow for a broader look at boundary conditions.

This analytical technique involves correlation of drilling and completion activities with observed hydraulic responses measured in various piezometers to obtain estimates for bulk hydraulic parameters. These calculated parameters can then be compared to past interpretation of these values and the hydrologic concepts which resulted from past analyses.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. Comparison with past information will be presented.

Further development of the analytical model may be included herein or may result in another technical report.

TASK ASSIGNMENT

This task will be performed by Barbara Basse. Technical reviews will be completed by Fred Marinelli and Mike Galloway. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 27 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Evaluation of Data:		20
Write-up:		15
	Subtotal:	35 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	55 hours

SCHEDULE

Dependent on Hanford Site activity schedule and obtaining current hydrographs and drilling data.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 28

Title: Determination of Specific Storage from Earth Tide Responses

OBJECTIVE

Specific storage of basalt flow interiors and interflows is an important hydraulic parameter required for performance modeling of the BWIP site. In addition, this parameter must be known in order to determine vertical hydraulic conductivity of basalt flow interiors from certain types of the planned LHS tests. The purpose of this technical report is to estimate specific storage, based on earth tide responses observed in piezometers at the BWIP site.

TECHNICAL APPROACH

Hydrographs of down-hole pressure at the BWIP site typically exhibit earth tide responses. These are recognized as sinusoidal pressure fluctuations with periods of 12 and 24 hours. Under appropriate conditions, it is possible to estimate in situ specific storage from the characteristics and magnitude of the observed earth tide responses. Several papers are available in the technical literature which outline procedures for performing this analysis. These techniques will be evaluated and applied to down-hole pressure data at the BWIP site. It is anticipated that specific storage values of basalt flow interiors and interflows are obtainable using these methods. Characteristics of piezometer completions and local hydrogeology will be evaluated to assess the reliability of the computed values and/or to predict if the resulting specific storages should be considered upper or lower bound values. This study will require use of a publicly available computer program from the National Bureau of Standards (NBS) which computes earth tide potential for a given time and location.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. Specific storage values for several data sets will be presented in tabular form. An evaluation will be made as to whether the computed values represent upper or lower bounds based on assumptions inherent in the analysis.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 28 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Evaluation and reduction of BWIP pressure data:		15 hours
Bring NBS program on-line:		5
Analysis (assume 4 data sets):		15
Write-up:		15
	Subtotal:	50 hours
Review (technical and QA):		10
Final Preparation:		10
	Total:	70 hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 30

Title: Applicability of Hydraulic Head for the Variable Density Flow System at BWIP

OBJECTIVE

Under appropriate conditions, the hydrodynamics of a groundwater flow system can be accurately described using a scaler potential quantity known as hydraulic head. The objective of this study is to evaluate the applicability of hydraulic head for conditions existing at the BWIP site. If hydraulic head is not strictly applicable at BWIP, the study will evaluate the relative errors imposed by using the head concept.

TECHNICAL APPROACH

For hydraulic head to exist as a potential (i.e., scaler) quantity, the change in head between any two points in a flow system must be path independent. To evaluate the path independence of hydraulic head at BWIP, a vertical cross-section of the site will be discretized by a rectangular grid of elements. Each element will be assigned a value of fluid pressure and density to conform with the expected spatial distribution of these parameters at BWIP. The change in hydraulic head between two arbitrary points in the system will then be computed in a finite difference manner by summing the individual head changes across each element along the chosen path. It is anticipated that a computer algorithm will be developed to perform the necessary calculations. Path dependence is evaluated by comparing the net change in hydraulic head along several different paths between the two points. If the net change in head is the same regardless of path, the concept of hydraulic head will be considered valid. If head changes exhibit significant variation, the relative error imposed by using the concept of head will be evaluated.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. The final report will describe theoretical development of governing equations and the solution algorithm. Computer results will be compared to appropriate analytical solutions and a complete listing of the source code will be provided in an appendix.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli and Barbara Basse. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 30 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Review of site data for pressure and density:	5	hours
Theoretical development of governing equations:	5	
Development of computer algorithm:	15	
Analysis of two cases with different parameter distributions:	10	
Write-up:	15	
Subtotal:	50	hours
Review (technical and QA):	10	
Final Preparation:	10	
Total:	70	hours

SCHEDULE

This technical report is not dependent on other work proposed or in progress.

STIMULUS/RESPONSE

The four TDS's included in this set addressing the stimulus/response category of the 1986 Terra Therma report are TTI's first efforts at identifying hydrologic data needs linking repository and site hydraulics to radionuclide transport, the "response" of the system that is of principal regulatory concern. TTI proposes to extend the three-reservoir conceptualization of TTI Report #4 in these technical reports. Reservoir No. 1 can be considered to be the engineered barrier system (EBS), Reservoir 2 to be the subsurface portion of the controlled area, and Reservoir 3 to be the accessible environment or a significant source of groundwater. Thus, a release of radionuclides to Reservoir 3 can be limited by source term (i.e., release from Reservoir 1), by flow and transport processes in Reservoir 2, or by a combination of both.

The approach is similar in some respects to the approach of Bailey and Marine (DP-1555, 1980) or Sandia National Labs (NUREG/CR-3235, 1983), but with the intent of assessing hydraulic and hydrogeochemical data needed to refine the hydrology of the undisturbed performance of the BWIP repository, using the currently available, site-specific hydrogeologic data for BWIP.

TASK DESCRIPTION SUMMARY

Technical Report No.: 31

Title: Limitation on Mass Flux through Repository Needed to Control Radionuclide Flux to EPA Standard: I. Compliance at the EBS Boundary

OBJECTIVE:

The objective of this report is to determine the sensitivity of cumulative releases of radionuclides to the accessible environment (40 CFR 191.13) to limitations on mass flux of water through the repository for the case that the standard is to be met at the boundary of the EBS.

TECHNICAL APPROACH:

The framework of the conceptual model considered for radionuclide transport consists of a repository in a homogeneous, isotropic geologic setting which is semi-infinite in extent. The domain is radially symmetric, with a radius of L (which can be considered as 5 km). The flow regime is considered to be steady-state, one-dimensional Darcy flow through an equivalent porous medium (EPM) which is homogeneous and isotropic, and the flow system is modeled deterministically.

For simplicity in computation, the analysis assumes that only one radionuclide is released at a time, though the computations will be performed for a set of radionuclides taken from 40 CFR 191 and will account for the principal decay chains. This allows computations of cumulative fluxes on a species-by-species basis, consistent with 40 CFR 191 and with the data needs for the individual protections requirements.

PRODUCT DESCRIPTION:

Calculation of mass flux of water through the repository that would limit a range of source-term releases to the EPA limits at the boundary of the EBS. The required mass flux will be related to average hydraulic conductivity that would produce the limiting flux for a gradient that can be related to the temperature at 1,000 years.

TASK ASSIGNMENT:

Lead: Mark Logsdon
Technical review: Adrian Brown; Fred Marinelli
QA review: Barbara Basse

MANPOWER:

The technical approach has already been completed in draft. Predominant manpower requirement is automation of calculations in a spreadsheet.

Analysis: 20 hours
Write-up: 10 hours

Review: 10 hours

Final preparation: 5 hours

Total: 45 hours

SCHEDULE:

Not dependent on other work proposed or in progress.

TASK DESCRIPTION SUMMARY

Technical Report No.: 32

Title: Limitation on Mass Flux through Repository Needed to Control Radionuclide Flux to EPA Standard: II. 1000-Year Advective Transport and Radioactive Decay

OBJECTIVE:

The objective of this report is to determine the sensitivity of cumulative releases of radionuclides to the accessible environment (40 CFR 191.13) to limitations on mass flux of water through the repository for the case that the post-closure transport period is 1,000 years, assuming only advective transport and radioactive decay.

TECHNICAL APPROACH:

The framework of the conceptual model considered for radionuclide transport consists of a repository in a homogeneous, isotropic geologic setting which is semi-infinite in extent. The domain is radially symmetric, with a radius of L (which can be considered as 5 km). The flow regime is considered to be steady-state, one-dimensional Darcy flow through an equivalent porous medium (EPM) which is homogeneous and isotropic, and the flow system is modeled deterministically.

For simplicity in computation, the analysis assumes that only one radionuclide is released at a time, though the computations will be performed for a set of radionuclides taken from 40 CFR 191 and will account for the principal decay chains. This allows computations of cumulative fluxes on a species-by-species basis, consistent with 40 CFR 191 and with the data needs for the individual protections requirements.

PRODUCT DESCRIPTION:

Calculation of mass flux of water through repository that would limit a range of source-term releases to the EPA limits at the accessible environment for the case that the post-closure transport period is 1,000 years, assuming only advective transport and radioactive decay between the EBS and the accessible environment.

TASK ASSIGNMENT:

Lead: Mark Logsdon
Technical review: Adrian Brown; Fred Marinelli
QA review: Barbara Basse

Technical Report Number: 32 (continued)

MANPOWER:

The technical approach has already been completed in draft. Predominant manpower requirement is automation of calculations in a spreadsheet.

Analysis: 20 hours
Write-up: 10 hours

Review: 10 hours

Final preparation: 5 hours

Total: 45 hours

SCHEDULE:

Report 31 is prerequisite, but lag can be minor.

TASK DESCRIPTION SUMMARY

Technical Report No.: 33

Title: Sensitivity of Radionuclide Flux at Accessible Environment to Source-Term Limitations for Advective Transport With and Without Radioactive Decay

OBJECTIVE

The objective of this report is to determine the sensitivity of cumulative releases of radionuclides to the accessible environment (40 CFR 191.13) to limitations on source term for selected radionuclides, assuming only advective transport and radioactive decay for transport periods of 100, 1000, 5000 and 9000 years.

TECHNICAL APPROACH

The framework of the conceptual model considered for radionuclide transport consists of a repository in a homogeneous, isotropic geologic setting which is semi-infinite in extent. The domain is radially symmetric, with a radius of L (which can be considered as 5 km). The flow regime is considered to be steady-state, one-dimensional Darcy flow through an equivalent porous medium (EPM) which is homogeneous and isotropic, and the flow system is modeled deterministically.

For simplicity in computation, the analysis assumes that only one radionuclide is released at a time, though the computations will be performed for a set of radionuclides taken from 40 CFR 191 and will account for the principal decay chains. This allows computations of cumulative fluxes on a species-by-species basis, consistent with 40 CFR 191 and with the data needs for the individual protections requirements.

PRODUCT DESCRIPTION:

Calculation of the source term limitation required to meet a 10,000-year cumulative flux limit for selected radionuclides for a range of Reservoir 2 mass fluxes, assuming advective transport with and without radioactive decay. The calculated source-term limitations will be compared with existing data on solubility (and/or leach) limits for the selected radionuclides to determine potential data needs for radionuclide solubility.

TASK ASSIGNMENT:

Lead: Mark Logsdon
Technical Review: Adrian Brown; Fred Marinelli
QA review: Barbara Basse

Technical Report Number: 33 (continued)

MANPOWER:

The technical approach has already been completed in draft. Predominant manpower requirements are evaluation of results of Reports 31 and 32 and automation of calculations in a spreadsheet.

Analysis: 40 hours
Write-up: 10 hours

Review: 10 hours

Final preparation: 5 hours

Total: 65 hours

SCHEDULE:

Reports 31 and 32 are prerequisite.

TASK DESCRIPTION SUMMARY

Technical Report No.: 34

Title: Sensitivity of Radionuclide Flux at Accessible Environment to Effective Retardation Factors for Selected Radionuclides

OBJECTIVE:

The objective of this report is to determine the sensitivity of cumulative releases of radionuclides to the accessible environment (40 CFR 191.13) to limitations on effective retardation for selected radionucluides, assuming ranges of solubility limits taken from the available literature as source terms and considering transport periods of 100, 1000, 5000 and 9000 years.

TECHNICAL APPROACH:

The framework of the conceptual model considered for radionuclide transport consists of a repository in a homogeneous, isotropic geologic setting which is semi-infinite in extent. The domain is radially symmetric, with a radius of L (which can be considered as 5 km). The flow regime is considered to be steady-state, one-dimensional Darcy flow through an equivalent porous medium (EPM) which is homogeneous and isotropic, and the flow system is modeled deterministically.

For simplicity in computation, the analysis assumes that only one radionuclide is released at a time, though the computations will be performed for a set of radionuclides taken from 40 CFR 191 and will account for the principal decay chains. This allows computations of cumulative fluxes on a species-by-species basis, consistent with 40 CFR 191 and with the data needs for the individual protections requirements.

PRODUCT DESCRIPTION:

Assuming a range of solubility limits (and or leach limits) taken from the available literature as source terms, calculation of effective retardation factors needed to meet EPA Standard for a range of Reservoir 1 hydraulic performances and Reservoir 2 fluxes.

TASK ASSIGNMENT:

Lead: Mark Logsdon
Technical review: Adrian Brown; Fred Marinelli
QA review: Barbara Basse

Technical Report No.: 34 (continued)

MANPOWER:

The technical approach has already been completed in draft. Predominant manpower requirements are evaluation of results of Reports 31-33 and automation of calculations in a spreadsheet.

Analysis: 40 hours
Write-up: 10 hours

Review: 10 hours

Final preparation: 5 hours

Total: 65 hours

SCHEDULE:

Reports 31-33 are prerequisite.

MISCELLANEOUS

This final group of TDS documents describes miscellaneous reports in progress and nearly complete, as listed in the cover letter to the Subtask 2.5 Update (TTI, 1987b). These reports will be completed in approximately the next 60 days.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 9

Title: BWIP Groundwater Levels: Will Further Stabilization Significantly Reduce Uncertainty?

OBJECTIVE:

The objective of this mini-report is to determine whether or not further stablization of the water levels at BWIP will significantly reduce uncertainty in establishing baseline conditions.

TECHNICAL APPROACH:

To meet the objective, the analysis considers all available water level data from two specific piezometer nests, DC-19C and DC-20C. Straightline extrapolations of hydrographs are used to determine water level changes per year and total expected change between April, 1986 and January, 1992. The extrapolated changes are then compared to uncertainties in the water level data. The primary result of the analysis is that the yearly changes in water level data, as determined by extrapolation, are small compared to uncertainties in the data. The total expected water level change between April, 1986 and January, 1992 are comparable to the uncertainties.

PRODUCT DESCRIPTION:

This analysis has resulted in a single technical report (Mini-Report Number 9). The results, however, can be used in additional analyses of horizontal and vertical gradients.

TASK ASSIGNMENTS:

The document has been prepared by Michael Galloway and reviewed by Barbara Basse, Fred Marinelli, and Mark Logsdon.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 10

Title: Effects of Geothermal Heat and Groundwater Salinity on Pre-Emplacement Heads

OBJECTIVE

The objective of this technical report is to perform a simple numerical groundwater flow analysis which incorporates the affects of variable density fluids for pre-emplacement conditions at BWIP. Once the flow system has been quantified, various techniques for expressing hydraulic head are compared to determine their usefulness in describing groundwater flow direction and flux rate.

TECHNICAL APPROACH

In this evaluation, the variable density finite difference model proposed in Technical Report #7 is used to simulate vertical flow in Grande Ronde and Wanapum Basalts for pre-emplacement conditions. Fluid density is specified apriori, based on input values of temperature and salinity. Once the numerical solution is achieved, the model calculates fresh water heads, environmental heads, piezometer water levels, and heads based on the theoretical definition (true heads) at each node within the finite difference mesh. Boundary conditions at the bottom of the mesh are adjusted until the piezometer water levels conform to field data obtained at the RRL and vicinity. Finally, a comparison is made between the various techniques for expressing head and the actual flow direction and flux rate computed by the model.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. An evaluation will be made regarding the resolution in hydraulic head afforded by the Baseline Monitoring Program in current operation at BWIP. Furthermore, the results of this study will be used to help interpret piezometer water levels observed at the BWIP site.

TASK ASSIGNMENTS

This technical report will be prepared by Fred Marinelli. Technical reviews will be completed by Adrian Brown and Mark Logsdon. QA review of the document will be performed by Catherine Kraeger-Rovey.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 11

Title: Evaluation of Feasibility of Large-Scale Tracer Tests

OBJECTIVE:

The objective of this mini-report is to determine the feasibility of performing tracer tests at "full scale", which is defined as a distance approaching the 5 km accessible environment boundary required by the Groundwater Travel Time (GWTT) criterion.

TECHNICAL APPROACH:

To meet the objective, the analysis is divided into 4 interrelated steps, as listed below:

1. Determination of likely horizontal flow-path, based on effects of thermal build-up.

2. Define a feasible tracer test configuration, using hydraulic parameters related to a flow-path determined in step 1.

3. Calculate likely tracer travel time.

4. Assess significance of vertical leakage to results of step 3.

The thermal analysis results in the selection of a likely horizontal flow-path above the repository horizon. Hydraulic characteristics of this flow top are then used in a well-field simulator to optimize a "push-pull" tracer test configuration. The resulting configuration will be "tested" to produce hydraulic gradients which would be sufficient to transport a tracer over the required distances and reasonable time-periods. The leakage analysis would assess the impacts of vertical leakage on a tracer test performed at the scale indicated.

PRODUCT DESCRIPTION:

This task will result in a single document which presents the technical approach, results, conclusions, and discussion.

TASK ASSIGNMENTS:

This study is to be performed jointly by Michael Galloway and Fred Marinelli. Mr. Marinelli will be responsible for the thermal and leakage analyses and Mr. Galloway will be responsible for developing the actual tracer test configuration and determining the travel time. Technical reviews will be performed by Barbara Basse and Mark Logsdon. The QA review will be performed by Catherine Kraeger-Rovey.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 13

Title: Effect of Repository Heat on Groundwater Flux

OBJECTIVE

The objective of this technical report is to evaluate the effect of repository heat on groundwater flux through the emplacement horizon for post-emplacement conditions at BWIP. If repository heat is found to be a significant factor controlling groundwater flux rates, thermal properties of basalt and repository heat loads may be of considerable importance in evaluating post-emplacement regulatory criteria such as the EPA Standard.

TECHNICAL APPROACH

In this evaluation, the variable density finite difference model proposed in Technical Report #7 will be used to compute groundwater flux rates through the emplacement horizon (Cohassett Flow Interior) at BWIP. For pre-emplacement conditions (geothermal gradient), the lower boundary of the model will be adjusted to provide zero vertical flux through the emplacement horizon. While retaining this boundary condition, temperature distributions for various times after emplacement will then be input into the model and the resulting groundwater flux through the emplacement horizon will be computed. Post-emplacement temperature distributions will be determined using the one-dimensional analytical heat flow model proposed in Technical Report #3. Post-emplacement groundwater flux rates through the repository horizon will be compared with characteristic pre-emplacement values determined in proposed Technical Report #10. If post-emplacement flux rates are larger than or comparable to the pre-emplacement values, additional analyses (in future Technical Reports) will be required to determine if repository heat needs to be considered in evaluating of post-emplacement regulatory criteria.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. The report will provide predicted groundwater flux rates through the emplacement horizon at various times after emplacement and assess the relative increase in flux rate attributed to repository heat.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 14

Title: Significance of Lateral Boundary Conditions on Hydrologic Phenomena of Regulatory Significance at the RRL.

OBJECTIVE:

The objective of this report is to determine the significance of head variations caused by lateral boundaries as a function of distance from the RRL.

TECHNICAL APPROACH:

The effect of variations in head on gradient through the RRL is assumed to be directly proportional to distance of the point at which head is measured from the center of the RRL, i.e. a one-meter head variation could change the gradient through the RRL by .001 if that head variation occured at a lateral distance of 1 km from the center of the RRL; if the distance instead were 10 km, the effect of a one-meter head variation on gradient would be only .0001. Thus, the analysis consists of plotting head variations for "significant" variations in gradient through the RRL versus distance of the measuring point from the center of the RRL.

PRODUCT DESCRIPTION:

For the analysis of lateral boundary effects, a plot will be generated showing distance from the RRL versus ratio of head variation to gradient change at the RRL. This analysis will result in a single technical report which presents the technical approach, results, conclusions, and discussion.

TASK ASSIGNMENT:

This study has been conducted by Catherine Kraeger-Rovey, with technical assistance from Adrian Brown and a single document has been produced. This document has been reviewed by Michael Galloway, Mark Logsdon, and Barbara Basse.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 15

Title: Significance of Vertical Boundary Conditions on Hydrologic Phenomena of Regulatory Significance at the RRL.

OBJECTIVE:

The objective of this report is to determine significance of boundary effects above and below the emplacement horizon as a function of vertical distance.

TECHNICAL APPROACH:

For the analysis of significance of vertical boundaries, a "pipe model" approach is proposed. The thermal gradient induced by the heat of the repository produces an upward mass flux; conservative estimates of the rate of flux were produced in Technical Report #13. The flowrate will be input as the source term to the pipe model, which distributes flow through branching pipes, each pair of which represents a flow top and the flow interior just above it. Each pipe "loop" consists of two horizontal branches, representing flow tops, and a vertical branch representing the intervening flow interior. The loop is completed with a fourth branch having an arbitrary head drop. This branch represents a background gradient; the head drop can be assigned any value, including zero. Sensitivity analyses will be conducted with varying input flowrates, ratios of vertical to horizontal hydraulic conductivities, and background gradients.

The proposed analysis will be conducted using measured and estimated parameter values from zones above the repository horizon. However, the sensitivity analysis will address anticipated ranges of parameter values in zones below the repository horizon as well, so as to provide results that are applicable for assessing the importance of locating lower boundaries at the RRL.

PRODUCT DESCRIPTION:

As a result of the modeling effort, an estimate will be made of the horizon above, or below, the repository horizon, at which vertical flows are no longer significant, relative to the source outflow from the repository that is input to the model.

TASK ASSIGNMENT:

This study will be conducted by Catherine Kraeger-Rovey, with technical assistance from Adrian Brown and Fred Marinelli. A single document will result. Technical review will be performed by Michael Galloway and Mark Logsdon, and QA review by Barbara Basse.

Terra Therma, Inc.

Technical Report Number: 15 (continued)

MANPOWER:

Analysis:	15 hours
Write-up:	5 hours
Subtotal:	20 hours
Review (technical and QA):	5 hours
Final preparation:	5 hours
Total:	30 hours

SCHEDULE:

Not dependent on other work proposed or in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 16

Title: Pre-Emplacement Gradients: Has Baseline Been Achieved?

OBJECTIVE:

The objective of this technical report is to define and compare the uncertainties of gradients calculated from "present-day" water level data and from "stablized" water level data.

TECHNICAL APPROACH:

Using the results of Technical Report Number 9, vertical and horizontal gradients will be calculated using the extrapolated water levels for a specific date. Since TTI has only recently received additional water level data that encompasses a portion of the time period which was originally extrapolated, gradients will be calculated using actual data for the same specific date. The gradients based on extrapolated data will be compared to gradiens based on actual data and errors determined. The errors will be assessed in the context of known data uncertainties and impact to the GWTT calculation.

PRODUCT DESCRIPTION:

This analysis will result in a brief document which presents the technical approach, results, and conclusions of this study.

TASK ASSIGNMENTS:

This study is to be performed by Michael Galloway. Fred Marinelli and Barbara Basse will provide the technical review. Catherine Kraeger-Rovey will perform the QA review.

Technical Report Number: 16 (continued)

MANPOWER:

Analysis:		10 hours
Write-up:		5 hours
	Subtotal:	15 hours
Review (technical and QA):		10 hours
Final preparation:		10 hours
	Total:	35 hours

SCHEDULE:

Preparation of this document is not dependent upon any other work in progress.

TECHNICAL DESCRIPTION SUMMARY

Technical Report Number: 17

Title: Drilling Response Observations

OBJECTIVE

The objective of this technical report is to qualitatively evaluate lateral hydraulic continuity of basalt interflows.

TECHNICAL APPROACH

This Technical Report will utilize new information as well as data gathered for Technical Reports #5 and #8 in order to correlate drilling/completion activities with hydraulic responses measured in observation wells/piezometers.

This information will be analyzed noting magnitude, direction, and distance of any observed responses. Absence of responses where expected will also be noted. Evidence of vertical leakage and any relative differences in transmissivity of basalt interflows will be reviewed.

PRODUCT DESCRIPTION

This task will result in a single document which presents the technical approach, results, conclusions, and discussion. This report will present a qualitative assessment of overall lateral hydraulic continuity noting any evidence of vertical communication throughout the RRL and vicinity.

Furthermore, the results of this study may lead to further analyses in a quantitative manner.

TASK ASSIGNMENTS

This technical report will be prepared by Barbara Basse. Technical reviews will be completed by Fred Marinelli and Michael Galloway. QA review of the document will be performed by Catherine Kraeger-Rovey.

Technical Report Number: 17 (continued)

MANPOWER

Estimated manpower requirements for this task are summarized below:

Analysis:		12
Write-up:		12
	Subtotal:	24 hours
Review (technical and QA):		4
Final Preparation:		6
	Total:	34 hours

SCHEDULE

Not dependent on other work proposed or in progress

REFERENCES

Bailey, C.E. and Marine, I.W., 1980, Parametric Study of the Geohydrologic Performance Characteristics for Geologic Waste Repositories: E.I. Dupont de Nemours & Co. - SRL, Report DP-1555, November, 1980.

Sandia National Laboratories, 1983, Technical Assistance for Regulatory Development: Review and Evaluation of the Draft EPA Standard 40 CFR 191 for Disposal of High-Level Waste: NUREG/CR-3235 (six volumes), April, 1983

Terra Therma, Inc., 1986, BWIP Conceptual Model Evaluations (Subtask 2.4), NWC Communication #35.

Terra Therma, Inc., 1987a, Letter to T. Verma Concerning Vertical Leakage at BWIP, NWC Communtication #164.

Terra Therma, Inc., 1987b, Semi-Annual Update of BWIP Numerical Evaluation Report (Subtask 2.5), NWC Communication #165.