Revised with letter dtd 2/6/92

YMP/CM-0011

U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

PROJECT BASELINE DOCUMENT

YUCCA MOUNTAIN SITE CHARACTERIZATION PROGRAM BASELINE (SCPB)

VOL. 1 OF 5

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q

UNITED STATES DEPARTMENT OF ENERGY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE 103.8

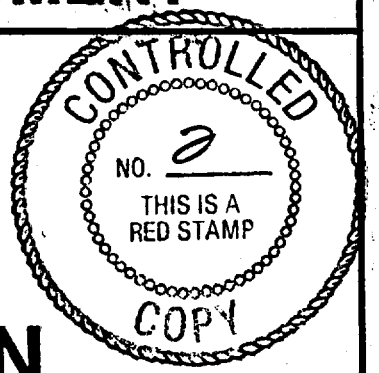
U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Document No. YMP/CM-0011
Revision 3
CI No. CI.11.0000/CI.13.0000
Date 2/07/92
WBS No. 1.2.3
QA Level Yes

PROJECT BASELINE DOCUMENT



YUCCA MOUNTAIN SITE CHARACTERIZATION PROGRAM BASELINE (SCPB) VOLUME 1

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q

UNITED STATES DEPARTMENT OF ENERGY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE

YMP-035-R0
4/22/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
DOCUMENT CHANGE NOTICE (DCN) RECORD

[1] Document Title:

Site Characterization Program Baseline

[2] Document Number: YMP/CM-0011

NOTE: This document is revised by Section.

The document identified in Blocks 1 and 2 has been changed. The changed pages attached to this DCN are identified in Block 7 opposite the latest DCN number in Block 3. The original issue of this document as modified by all applicable DCN's constitutes the current version of the document identified in Blocks 1 and 2.

[3] DCN NO.	[4] CR NO.	[5] DOCUMENT Rev./ICN #	[6] CR TITLE	[7] AFFECTED PAGES	CHANGE	ADD	DELETE	[8] DATE
0	91/018	0	Initial Issue	All		X		2/22/91
1	91/052	1	Submit SCPB, Rev. 1 for CCB Control (complete revision of information related to ESF design)	All	X			4/5/91
2	91/110	2	Revision to Section 8.3.1.14 of the SCPB to Reflect Updated Plans in Study Plan 8.3.1.14.2	Table of Contents pages iii through xii Pages 8.3.1.14-1 through 8.3.1.14-52	X			10/2/91
3	91/096	3	Surface Dust Suppression water will not be tagged with chemical tracers	Table of Contents pages iii through xii for all 5 vols. 8.4.2-87		X		2/07/92
3	91/113	3	Addition of three large hydraulic gradient boreholes to the Yucca Mountain SCPB and add map (attachment 1)	8.3.1.2-251 8.3.1.2-253		X X		2/07/92
3	92/009	3	Change in objectives for Activities 1 and 4 of YMP-USGS Study Plan 8.3.1.2.1.4 (Regional Hydrologic System Synthesis and Modeling)	8.3.1.2-124 8.3.1.2-128	X X			
3	92/010	3	Change in title of Study 8.3.1.2.2.2 in SCPB	8.3.1.2-156	X			2/07/92

YMP-035-R0
4/22/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
DOCUMENT CHANGE NOTICE (DCN) RECORD

Document Title:

Site Characterization Program Baseline

Note: This document is revised by Section.

[2] Document Number: YMP/CM-0011

The document identified in Blocks 1 and 2 has been changed. The changed pages attached to this DCN are identified in Block 7 opposite the latest DCN number in Block 3. The original issue of this document as modified by all applicable DCN's constitutes the current version of the document identified in Blocks 1 and 2.

[3] DCN NO.	[4] CR NO.	[5] DOCUMENT Rev./ICN #	[6] CR TITLE	[7] AFFECTED PAGES	CHANGE	ADD	DELETE	[8] DATE
3	92/020	3	Change title of activity 8.3.1.2.3.2.3	8.3.1.2-285	X			2/07/92
3	92/021	3	Change in objectives for activity 8.3.1.2.3 of YMP-USGS Study Plan 8.3.1.3.2 (Saturated zone hydrochemistry)	2.4 8.3.1.2-286	X			2/07/92

Y-AD-057
9/90

YUCCA MOUNTAIN PROJECT
CHANGE DIRECTIVE (CD)

1 CR No. 91/018
Page 1 of 2

SECTION I. IDENTIFICATION

2 Title of Change:
PROPOSED BASELINING OF THE YM SITE CHARACTERIZATION PROGRAM (SCP CHP. 8, PART B, VOL. IV-VIII)

3 Change Classification:
☐ Class 1 ☐ Class 3
☒ Class 2

SECTION II. DISPOSITION

4 CR Disposition:
☐ Approved
☐ Disapproved
☒ Approved with Conditions

5 Conditions: *(if applicable)*

1. Review of all Project Office controlled documents will be completed to identify references to the:
   - Technical Planning Basis (TPB): SCP Yucca Mountain Site, Nevada Research and Development Area, YMP/CC-0005, Rev. 0, 9/90.
   - Test and Evaluation Planning Basis (T&EPB), Volumes 1-4, YMP/90-23, Rev. 0, 8/90.

   The references will be replaced by references to the Site Characterization Program Baseline (SCPB).

2. The Director, RSED will ensure, prior to issuance, that the following changes have been incorporated into the SCPB:

(See Change Documentation Continuation Page 2)

6 Implementation Direction: *(if applicable)*

1. CR 91/018 is approved with the above conditions as the "Yucca Mountain Site Characterization Program Baseline (SCPB)" and is assigned document number YMP/CM-0011, Rev. 0, (Configuration Identification number CI.13.0000). YMP/CM-0011 supersedes YMP/CC-0005, Rev. 0 and replaces the need for the T&EPB.

2. The CCB Secretary shall ensure that the Cover Page and Title Page for Document YMP/CM-0011, Rev. 0 are updated to reflect this approved change.

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

7 Quality Assurance Organization Concurrence

Name: D. G. Horton (print) Org.: PQA (print)
Signature: N Voltura for Date: 12/14/90

8 Disposition Authority

Name: M. B. Blanchard (print) Title: Acting DPM (print)
Signature: Maxwell Blanchard Date: 12-14-90

9 Effective Date: 12/14/90

5 Condition (continued)

- SCP Sections 8.5 and 8.6 will be excluded.
- All milestones, schedules, decision points, and procedures in the SCP will be excluded.
- Changes identified in CR 90/031 will be incorporated.
- The errata sheet for references to the SCP will be incorporated.
- The Glossary in Volume VIII of the SCP will be appended to the SCPB prior to controlled distribution.

6 Implementation Direction (continued)

3. The RSED Director will provide a print ready copy of YMP/CM-0011 to the CCB Secretary for processing upon completion of Condition #2. A revised Table of Contents will also be included. The document number and revision number will be identified on each page of the publication ready document (YMP/CM-0011, Rev. 0).

4. In addition to all affected Project Participants, the PCB Chief will complete an Affected Document Notice [(ADN) Form Y-AD-001, 4/90] after review of all project plans, APs, QMPs, and BTPs to meet Condition 1.

5. In addition to all affected Project Participants, the Directors of EDD, P&OCD, and RSED will complete an ADN after review of all technical requirements documents under their cognizance to meet Condition 1.

6. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect this approved addition of Document YMP/CM-0011.

7. Any changes to Document YMP/CM-0011 will require submission of a CR to the Project CCB.

Y-AD-057
9/90

YUCCA MOUNTAIN PROJECT
CHANGE DIRECTIVE (CD)

[1] CR No. 91/052
Page 1 of 2

SECTION I. IDENTIFICATION

[2] Title of Change:

Submittal of the "Site Characterization Program Baseline, Rev. 1," for CCB Control

[3] Change Classification:

☐ Class 1 ☐ Class 3
☒ Class 2

SECTION II. DISPOSITION

[4] CR Disposition:

☐ Approved ☐ Disapproved
☒ Approved with Conditions

[5] Conditions: *(if applicable)*

The next revision of this document should incorporate the following items:

1. The term "Exploratory Shaft Facility" should be replaced by "Exploratory Studies Facility" throughout the document.

2. The term "repository" should be replaced by "potential repository" throughout the document.

(See Change Documentation Continuation Page ___)

[6] Implementation Direction: *(if applicable)*

1. This Change Request (CR) is approved for CCB Baselining as the "Site Characterization Program Baseline, Revision 1," and is assigned Controlled Document number YMP/CM-0011.

2. The Director, Regulatory and Site Evaluation Division is responsible for ensuring the above listed conditions are incorporated into the next revision of Document YMP/CM-0011.

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

[7] Quality Assurance Organization Concurrence

Name: D. G. Horton (print) Org.: PQA (print)
Signature: N Voldura for DG Horton Date: 3/28/91

[8] Disposition Authority

Name: M. B. Blanchard (print) Title: CCB Chrprsn (print)
Signature: Robert V Fortuna For Maxwell Blanchard Date: 3/28/91

[9] Effective Date:

3/28/91

6 Implementation Direction (continued)

3. The CCB Secretary shall ensure that the Cover Page and the Title Page for Document YMP/CM-0011, Revision 1, are prepared.

4. The Document Originator shall provide a Print Ready Copy of YMP/CM-0011, Revision 1, to the CCB Secretary. The Document Number and Revision Number will be identified on each page of the Publication Ready Document, YMP/CM-0011.

5. The CCB Secretary shall ensure that YMP/CM-0011, Revision 1, is prepared in accordance with this Change Directive (CD). The CCB Secretary shall ensure the Document Change Notice (DCN), indicating changes made in the document, is prepared. The DCN will be attached to the front of the Print Ready Copy of the document. The CCB Secretary shall also prepare a Controlled Document Issuance Authorization (CDIA) to transmit this CD, the DCN, and YMP/CM-0011, Revision 1, to the Project Document Control Center (DCC) in accordance with AP-1.5Q.

6. Per AP-3.3Q, each TPO and Project Office Division Director will complete an Affected Document Notice (ADN) as notification of completion of implementation planning for this CD.

7. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect Revision 1 to YMP/CM-0011.

8. Any changes to document YMP/CM-0011, Revision 1, will require submittal of a CR to the Project CCB.

9. Upon release of YMP/CM-0011, Revision 1, all Project Participants will be required to use YMP/CM-0011, Revision 1, in performing duties applicable to this document.

YMP-034-R0
4/22/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CHANGE DIRECTIVE (CD)

[1] CR No. 91/096
Page 1 of 2

SECTION I. IDENTIFICATION

[2] Title of Change:

SCPB Revision: Surface Dust Suppression Water will not be tagged wtih a Chemical Tracer

[3] Change Classification:

☐ Class 1 ☐ Class 3
☒ Class 2

SECTION II. DISPOSITION

[4] CR Disposition:

☐ Approved ☐ Disapproved
☒ Approved with Conditions

[5] Conditions: *(if applicable)*

1. The revision to the SCPB Document must undergo a QMP-06-04 Management, QA and Technical review.

(See Change Documentation Continuation Page ___)

[6] Implementation Direction: *(if applicable)*

1. This Change Request (CR) for the Site Chararacterization Program Baseline, Revision 3," Document Number YMP/CM-0011 is approved with the condition listed in Block 5 of the CD.

2. The CCB Secretary shall ensure that the Title Page for Document YMP/CM-0011 Revision 3, are prepared.

3. The Document Originator shall provide a Print Ready Copy of YMP/CM-0011,

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

[7] Quality Assurance Organization Concurrence

Name: D. G. Horton (print) Org.: PQA (print)
Signature: Catherine Hampton for Date: 8-21-91

[8] Disposition Authority

Name: M. B. Blanchard (print) Title: CCB Chrprsn (print)
Signature: M. Blanchard Date: 8-21-91

[9] CD Effective Date

8/21/91

6 Implementation Direction (continued)

Revision 3, to the CCB Secretary. The Document Number and Revision Number will be identified on each page of the Publication Ready Document, YMP/CM-0011. The Document Originator shall also provide a Document Change Notice (DCN) indicating changes made to the document.

4. The CCB Secretary shall ensure that YMP/CM-0011, Revision 3, is prepared in accordance with this Change Directive (CD). The CCB Secretary shall prepare a Controlled Document Issuance Authorization (CDIA) to transmit this CD, the DCN, and YMP/CM-0011, Revision 3, to the Project Document Control Center (DCC) in accordance with AP-1.5Q.

5. Per AP-3.3Q, each TPO and Project Office Division Director will complete an Affected Document Notice (ADN) as notification of completion of implementation planning for this CD.

6. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect Revision 3 to YMP/CM-0011.

7. Any changes to document YMP/CM-0011, Revision 3, will require submittal of a CR to the Project CCB.

8. Upon release of YMP/CM-0011, Revision 3, all Project Participants will be required to use YMP/CM-0011, Revision 3, in performing duties applicable to this document.

INFORMATION COPY

YMP-034-R1
9/16/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CHANGE DIRECTIVE (CD)

[1] CR No. 91/113
Page 1 of 2

SECTION I. IDENTIFICATION

[2] Title of Change:

Addition of Three Large Hydraulic Gradient Boreholes to the Yucca Mountain Site Characterization Program Baseline

[3] Change Classification:

☐ 0 ☒ 2
☐ 1 ☐ 3

SECTION II. DISPOSITION

[4] CR Disposition:

☐ Approved ☒ Approved with Conditions ☐ Disapproved

[5] Conditions: *(if applicable)*

1. Cost and Schedule impacts and changes to planning documents for implementing the proposed work shall be prepared and approved prior to commencement of work.

2. Grading Packages for proposed work must be prepared and approved prior to the commencement of proposed work.

(See Change Documentation Continuation Page ___)

Implementation Direction: *(if applicable)*

1. CR:91/113, is approved with the above conditions as the "Yucca Mountain Site Characterization Program Baseline (SCPB)" Document Number YMP/CM-0011, Rev 5.

2. The CCB Secretary shall ensure that the cover page and Title page for Document YMP/CM-0011, Rev 5 are updated to reflect this approved change.

3. The Director, RSED shall provide a print ready copy of YMP/CM-0011 to the CCB Secretary for processing upon the completion of condition #1. A

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

[7] Quality Assurance Organization Concurrence

Name: R. E. Spence (Print) Org.: PQA (Print)
Signature: R E Spence Date: 10/31/91

[8] Disposition Authority

Name: M. B. Blanchard (Print) Title: CCB Chrprsn (Print)
Signature: Date: 10/31/91

[9] CD Effective Date

10/31/91

6 Implementation Direction (continued)

revised table of contents will also be included. The document number and revision number will be identified on each page of the publication ready document YMP/CM-0011, Rev 5.

4. The Director, RSED will ensure the integration of the three new boreholes into the integrated drilling schedule.

5. REECo and USGS will assess the cost and schedule impacts for the three new boreholes and initiate C/SCRs as appropriate in accordance with AP-3.7.

6. In addition to all affected Project Participants, the PCB Chief, the Directors of EDD, P&OCD, RSED and YMSO will complete an Affected Document Notice (ADN) for implementation planning.

7. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect this approved addition of Document YMP/CM-0011.

8. Any changes to Document YMP/CM-0011 will require submission of a CR to the Project CCB.

YMP-034-R2
11/13/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CHANGE DIRECTIVE (CD)

1 CR No. 92/009
Page 1 of 2

SECTION I. IDENTIFICATION

2 Title of Change:

Change in Objectives for Activities 1 and 4 of YMP USGS Study Plan 8.3.1.2.1.4 (Regional Hydrologic System Synthesis and Modeling)

3 Change Classification:

☐ 0 ☒ 2
☐ 1 ☐ 3

SECTION II. DISPOSITION

4 CR Disposition:

☒ Approved ☐ Approved with Conditions ☐ Disapproved

5 Conditions: *(if applicable)*

None

(See Change Documentation Continuation Page ___)

6 Implementation Direction: *(if applicable)*

1. CR:92/009, is approved as the "Yucca Mountain Site Characterization Program Baseline (SCPB)" Document Number YMP/CM-0011, Revision 3.

2. The CCB Secretary shall ensure that the Cover page and Title page for Document YMP/CM-0011, Revision 3, are updated to reflect this approved change.

3. The Director, RSED shall provide a print ready copy of YMP/CM-0011, Revision 3, to the CCB Secretary for processing. A revised Table of Contents will

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

All signatures below constitute procedural compliance. I have read, understood, and complied with Procedure _____, Rev. ___, ICN # ___, in accomplishing my responsibilities in this procedure.

7 Quality Assurance Organization Concurrence

Name: R. Spence (Print) Org.: YMQAD (Print)

Signature: R. E. Spence Date: 12/12/91

8 Disposition Authority

Name: for M. B. Blanchard (Print) Title: CCB Chrprsn (Print)

Signature: Robert F. Burton Date: 12/12/91

9 CD Effective Date

6 Implementation Direction (continued)

also be included. The document number and revision number will be identified on each page of the Publication Ready Document YMP/CM-0011, Revision 3.

4. In addition to all affected Project Participants, the PCB Chief, the Directors of EDD, P&OCD, RSED and YMSO will complete an Affected Document Notice (ADN) for implementation planning.

5. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect this approved addition of Document YMP/CM-0011, Revision 3.

6. Any changes to Document YMP/CM-0011, Revision 3, will require submission of a CR to the Project CCB.

YMP-034-R2
11/13/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CHANGE DIRECTIVE (CD)

1 CR No. 92/010
Page 1 of 2

SECTION I. IDENTIFICATION

2 Title of Change:
Change of Title of Study 8.3.1.2.2.2 in SCPB

3 Change Classification:
☐ 0 ☒ 2
☐ 1 ☐ 3

SECTION II. DISPOSITION

4 CR Disposition:
☒ Approved ☐ Approved with Conditions ☐ Disapproved

5 Conditions: *(if applicable)*
None

(See Change Documentation Continuation Page ___)

6 Implementation Direction: *(if applicable)*

1. CR:92/010, is approved as the "Yucca Mountain Site Characterization Program Baseline (SCPB)" Document Number YMP/CM-0011, Revision 3.

2. The CCB Secretary shall ensure that the Cover page and Title page for Document YMP/CM-0011, Revision 3, are updated to reflect this approved change.

3. The Director, RSED shall provide a print ready copy of YMP/CM-0011, Revision 3, to the CCB Secretary for processing. A revised Table of Contents will

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

All signatures below constitute procedural compliance. I have read, understood, and complied with Procedure QAP-03-24 Rev. 3, ICN #1/2 in accomplishing my responsibilities in this procedure.

7 Quality Assurance Organization Concurrence

Name: R. Spence (Print) Org.: YMQAD (Print)
Signature: R. C. Spence Date: 12/10/91

8 Disposition Authority

Name: M. B. Blanchard (Print) Title: CCB Chrprsn (Print)
Signature: Robert M Barton Date: 12/12/91

9 CD Effective Date
12/12/91

6 Implementation Direction (continued)

also be included. The document number and revision number will be identified on each page of the Publication Ready Document YMP/CM-0011, Revision 3.

4. In addition to all affected Project Participants, the PCB Chief, the Directors of EDD, P&OCD, RSED and YMSO will complete an Affected Document Notice (ADN) for implementation planning.

5. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect this approved addition of Document YMP/CM-0011, Revision 3.

6. Any changes to Document YMP/CM-0011, Revision 3, will require submission of a CR to the Project CCB.

YMP-034-R2
11/13/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CHANGE DIRECTIVE (CD)

[1] CR No. 92/020

SECTION I. IDENTIFICATION

[2] Title of Change:

Activity 8.3.1.2.3.2.3 Title Change

[3] Change Classification:

☐ 0 ☒ 2
☐ 1 ☐ 3

SECTION II. DISPOSITION

[4] CR Disposition:

☒ Approved ☐ Approved with Conditions ☐ Disapproved

[5] Conditions: *(if applicable)*

None

(See Change Documentation Continuation Page ___)

[6] Implementation Direction: *(if applicable)*

1. CR:92/020, is approved as the "Yucca Mountain Site Characterization Program Baseline (SCPB)" Document Number YMP/CM-0011.

2. The CCB Secretary shall ensure that the Cover page and Title page for Document YMP/CM-0011 are updated to reflect this approved change.

3. The Director, RSED shall provide a print ready copy of YMP/CM-0011, to the CCB Secretary for processing. A revised Table of Contents will also be included. The document number and revision number will be identified

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

All signatures below constitute procedural compliance. I have read, understood, and complied with Procedure AP-3.3Q, Rev. 4, ICN # 2, in accomplishing my responsibilities in this procedure.

[7] Quality Assurance Organization Concurrence

Name: R. E. Spence (Print) Org.: YMQAD (Print)

Signature: R. E. Spence Date: 12/30/91

[8] Disposition Authority

Name: M. B. Blanchard (Print) Title: CCB Chrprsn (Print)

Signature: Robert M. Blanchard Date: 12/30/91

[9] CD Effective Date

12/30/91

6 Implementation Direction (continued)

on each page of the Publication Ready Document YMP/CM-0011.

4. In addition to all affected Project Participants, the PCB Chief, the Directors of EDD, P&OCD, RSED and YMSO will complete an Affected Document Notice (ADN) for implementation planning.

5. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect this approved addition of Document YMP/CM-0011.

6. Any changes to Document YMP/CM-0011 will require submission of a CR to the Project CCB.

INFORMATION

YMP-034-R2
11/13/91

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CHANGE DIRECTIVE (CD)

1 CR No. 92/021
Page 1 of 2

SECTION I. IDENTIFICATION

2 Title of Change:

Change in objectives for activity 8.3.1.2.3.2.4 of YMP-USGS SP 8.3.1.2.3.2 (saturated-zone hydrochemistry)

3 Change Classification:

☐ 0 ☒ 2
☐ 1 ☐ 3

SECTION II. DISPOSITION

4 CR Disposition:

☒ Approved ☐ Approved with Conditions ☐ Disapproved

5 Conditions: *(if applicable)*

None

(See Change Documentation Continuation Page ___)

6 Implementation Direction: *(if applicable)*

1. CR:92/021, is approved as the "Yucca Mountain Site Characterization Program Baseline (SCPB)" Document Number YMP/CM-0011.

2. The CCB Secretary shall ensure that the Cover page and Title page for Document YMP/CM-0011 are updated to reflect this approved change.

3. The Director, RSED shall provide a print ready copy of YMP/CM-0011, to the CCB Secretary for processing. A revised Table of Contents and Document Change Notice will also be included. The document number and revision

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

All signatures below constitute procedural compliance. I have read, understood, and complied with Procedure QP-03-01, Rev. 3, ICN # 1/2, in accomplishing my responsibilities in this procedure.

7 Quality Assurance Organization Concurrence

Name: R. E. Spence (Print) Org.: YMQAD (Print)
Signature: R E Spence Date: 11/4/92

8 Disposition Authority

Name: for M. B. Blanchard (Print) Title: CCB Chrprsn (Print)
Signature: Robert W Barton Date: 11/4/92

9 CD Effective Date

11/4/92

QMP-03-09

6 Implementation Direction (continued)

number will be identified on each page of the Publication Ready Document YMP/CM-0011.

4. In addition to all affected Project Participants, the PCB Chief, the Directors of EDD, P&OCD, RSED and YMSO will complete an Affected Document Notice (ADN) for implementation planning.

5. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect this approved addition of Document YMP/CM-0011.

6. Any changes to Document YMP/CM-0011 will require submission of a CR to the Project CCB.

YMP/CM-0011, Rev. 3

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* Includes figures and tables

YMP/CM-0011, Rev. 3

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8.3.1.2.1.4 Study: Regional hydrologic system synthesis and modeling

The objectives of this study are (1) to synthesize the available data into a model and make a qualitative analysis of how the system is functioning and, (2) to represent qualitative observations of hydrogeologic data pertaining to the ground-water flow system in a comprehensive numerical model of ground-water. Four activities are planned to analyze and integrate the data in order to satisfy these objectives: (1) conceptualization of regional hydrologic flow models, (2) subregional two-dimensional areal hydrologic modeling, (3) subregional two-dimensional cross-sectional hydrologic modeling, and (4) regional three-dimensional hydrologic modeling.

Results from these modeling activities are not intended to directly estimate ground-water travel time from the repository to the accessible environment. Rather, the modeling results will be used as a basis for specifying boundary conditions for more detailed models of ground-water flow at the site.

8.3.1.2.1.4.1 Activity: Conceptualization of regional hydrologic flow models (Rev. 3)

Objectives

The objectives of this activity are to synthesize available data into a conceptual model that incorporates alternative hypotheses and(or) existing hypotheses, and to make a qualitative analysis of how the regional and subregional ground-water flow systems function.

The primary result of this activity will be a complete, concise, qualitative description of the regional saturated-zone ground-water flow system, given the limitations of the data incorporated into the conceptual model.

Parameters

The parameters of this activity are

1. Spatial distribution of hydraulic conductivity.
2. Hydraulic gradient.
3. Ground-water flux.
4. Recharge.
5. Discharge.
6. Hydrogeologic properties of the saturated-zone rock units.
7. Potentiometric-surface configuration.

Description

All reliable data (hydrologic, geologic, and geophysical) and reasonable interpretations of it will be assimilated into a description of the regional ground-water flow system. This description will include the physical and hydraulic characteristics of the rock units and structural features, as well as the likely ways that the flow system operates within this framework. The data will contain information obtained from the published literature and site

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characterization activities. This conceptual description of the flow system will be used to update a regional ground-water flow model originally developed by Waddell (1982). This updated model will be used as the baseline condition for regional ground-water flow at the site.

8.3.1.2.1.4.2 Activity: Subregional two-dimensional areal hydrologic modeling

Objectives

The objective of this activity is to improve estimates of regional ground-water flow, by updating an existing two-dimensional, subregional, parameter-estimation model through the incorporation of additional hydrogeologic data.

Parameters

The parameters of this activity are

1. Spatial distribution of hydraulic conductivity.
2. Hydraulic gradient.
3. Water flux.
4. Recharge.
5. Discharge.
6. Hydrogeologic properties of the saturated zone rock units.
7. Potentiometric-surface configuration.

Description

A subregional model of two-dimensional ground-water flow has been developed by Czarnecki and Waddell (1984) for estimating ground-water flow. Since the development of the model, numerous additional studies and data-collection activities have occurred and are planned in and around the modeled area (Figure 8.3.1.2-10). Additional drillholes have been and will be constructed in the study area yielding potentiometric data and hydraulic properties. Potentiometric data will be used, in part, as a basis for model calibration and as an indicator of variations in hydraulic properties, based on variations in hydraulic gradients.

The refined two-dimensional model will be a highly simplified representation of a complex three-dimensional system, but it is expected to be useful for various applications. These include preliminary evaluations of the effects of potential future pumping on the hydrologic system (Activities 8.3.1.9.3.2.1 and 8.3.1.16.2.1.4). The model will also be used to help guide development of more rigorous three-dimensional models (Activity 8.3.1.2.1.4.4), which will be used to test the impacts of future ground-water development, tectonic events, and climatic changes on the saturated-zone hydrologic system.

The use of a two-dimensional model for these purposes is warranted because, on a regional scale, vertical flux probably is small relative to horizontal flux. This concept will be tested as new data are obtained and by

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The cross-sectional line shown in Figure 8.3.1.2-11 is based on a potential flow path estimated by Czarnecki and Waddell (1984) using a two-dimensional areal ground-water flow model. The flow line depicted in the figure enters the region at the northern boundary, passes beneath the repository perimeter drift, continues south, and is diverted to the southeast around the Funeral Mountains barrier to discharge at an altitude 606 m at the Franklin Lake playa. One of the basic assumptions made in using the areal model was that ground-water flow was strictly horizontal. By modeling along a cross section, this assumption can be tested, particularly from the repository block to the accessible environment. If the vertical component is minor, then the two-dimensional areal modeling approach may be valid instead of using a fully three-dimensional model. A vertical component of ground-water flow would also lengthen the flow path in the zone of saturation, although it would not necessarily increase travel time.

8.3.1.2.1.4.4 Activity: Regional three-dimensional hydrologic modeling (Rev. 3)

Objectives

The objective of this activity is to construct a three-dimensional model of the regional ground-water flow system of Yucca Mountain and vicinity.

Subordinate objectives of the activity are:

1. to evaluate alternative hypotheses of how the ground-water flow system functions;

2. to provide a synthesis of the hydrogeological framework and boundary conditions for site models;

3. to improve estimates of the direction and magnitude of regional ground-water flow and estimates of the hydraulic properties of geologic materials using a numerical model; and

4. to perform sensitivity analyses for the purpose of identifying key ground-water flow-system parameters, for the purpose of directing future data-collection activities.

The three-dimensional hydrologic model will also be used, as part of other studies, for predictive simulations that will be used to evaluate the response of the ground-water flow system to changes in climate, human interference, and tectonic deformation.

Parameters

The parameters of this activity are

1. Spatial distribution of transmissivity.
2. Hydraulic gradient.
3. Water flux.
4. Recharge.
5. Discharge.
6. Hydrogeologic properties of the saturated zone rock units.
7. Potentiometric levels.

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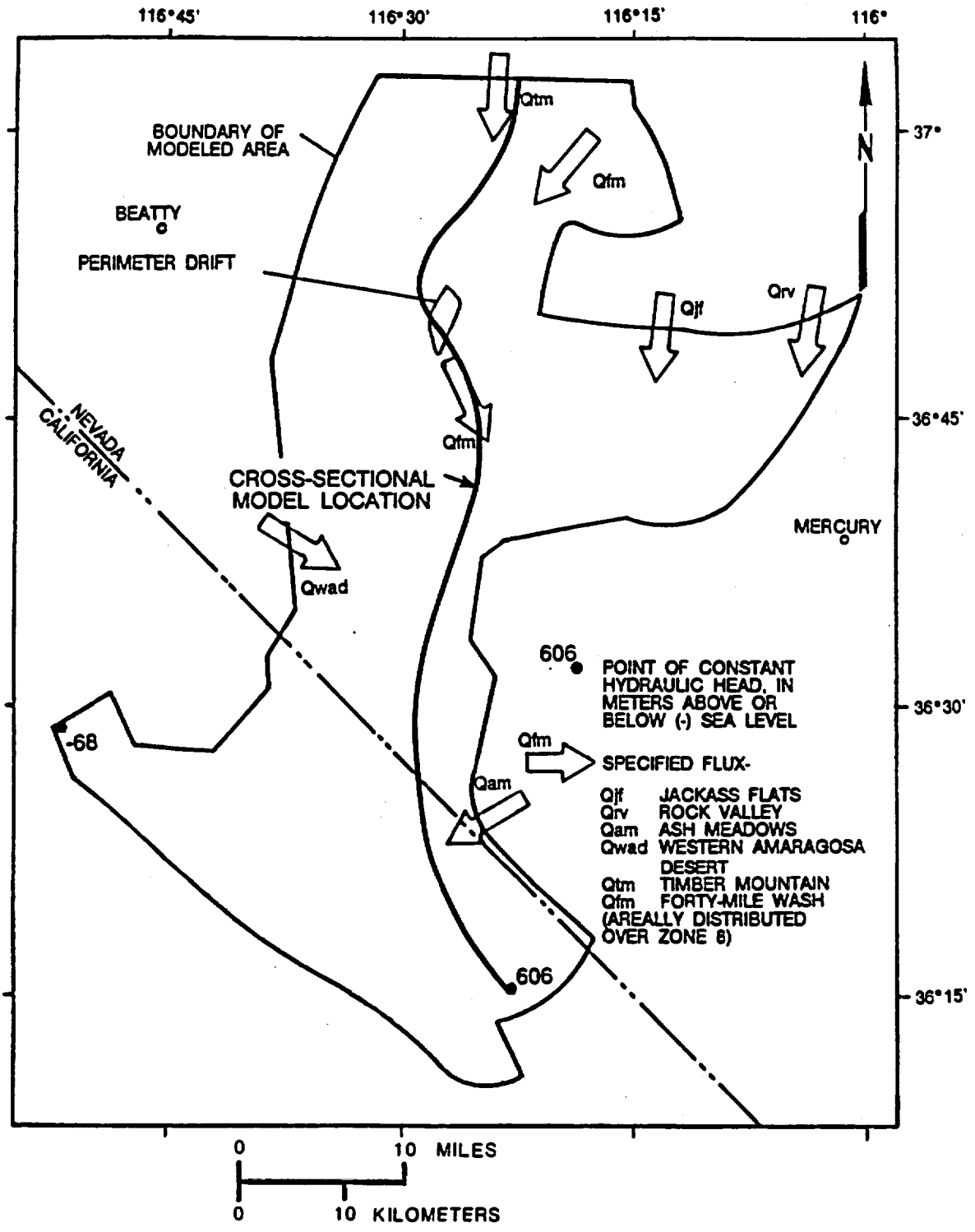

Figure 8.3.1.2-11. Location of the flow line for the subregional two-dimensional cross section of hydrologic model (modified from Czarnecki and Waddell, 1984).

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Description

A numerical, quasi-three-dimensional ground-water flow model of the saturated zone of the Yucca Mountain region will be constructed and calibrated. Because of the highly complex geologic structure and stratigraphy in the region, it is presently feasible to define only broad hydrogeologic units. Because of the sparseness of hydraulic-property data, particularly vertical hydraulic conductivity values for individual units, only a quasi-three-dimensional model is warranted at this time for simulation of the regional saturated-zone flow system. In this model, a leakance layer is used to simulate vertical flow between layers (see following description), and detailed knowledge of the distribution of vertical flow properties is not required. If feasible, a fully three-dimensional model will be developed for the site saturated-zone flow system (Study 8.3.1.2.3.3).

Initially, the model will contain two layers that simulate horizontal flow in each of two major hydrogeologic units in the study area: (1) a combination of the Plio-Pleistocene deposits and the Miocene volcanic rocks and (2) the Paleozoic carbonate rocks. In areas where one of these units is missing, only a single layer will be used in the model. Vertical flow between the two hydrogeologic units will be simulated by a leakance layer in the model. The leakance layer will represent the composite effects of upper and lower layer thicknesses, vertical hydraulic conductivities, and any low-permeability zones present. The technical basis for using the leakance layer in the quasi-three-dimensional model is discussed in McDonald and Harbaugh (1984). With the existing data base, use of more than two layers to represent the regional ground-water-flow system is not expected to be justified because of a sparsity of data on the three-dimensional hydrogeologic properties of the system. This quasi-three-dimensional (or layered) simulation of the saturated zone is needed because of the differences in hydraulic properties between the two major hydrogeologic units and the differences in potentiometric head (50 to 60 ft (16 to 20 m)) between the two units. These differences in hydraulic properties and potentiometric head could not be simulated with a single-layered, two-dimensional model.

The USGS modular three-dimensional finite-difference ground-water flow code (McDonald and Harbaugh, 1984) is the numerical technique that will be used to simulate the ground-water flow system in the Yucca Mountain region. The USGS three-dimensional code allows ground-water flow simulations both in two and three dimensions and, therefore, provides considerable flexibility for simulating complex geohydrologic systems.

The model will be constructed using hydrogeologic data from previous studies of the Yucca Mountain and Nevada Test Site areas. Data will be compiled from previous drilling programs, geologic reports, well-scheduling efforts, the regional and site characterization studies (8.3.1.2.1.3 and 8.3.1.5.2.1.3), the USGS Great Basin Regional-Aquifer System Analysis (Sun, 1986), and the USGS WATSTORE data base. Remote sensing studies (Activity 8.3.1.5.2.1.3) will provide information on possible ground-water flow paths from recharge to discharge areas. Initial model simulations will use the transmissivity distributions, recharge, and boundary conditions described by Waddell (1982) and Czarnecki and Waddell (1984) for a previously constructed two-dimensional ground-water flow model of the study region. Leakage from the unsaturated zone will be simulated as areal recharge to the

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saturated zone in upland areas, which have wetter and cooler climatic conditions, and in lowland areas, such as Fortymile Wash, where periodic surface runoff is believed to be a source of recharge. Where arid conditions prevail, leakage from the unsaturated zone is considered negligible on a regional scale and available data do not justify simulation. However, model simulations of the saturated zone at the site scale in the immediate vicinity of Yucca Mountain (Study 8.3.1.2.3.3) will consider leakage from the unsaturated zone.

Virtually no information exists regarding vertical hydraulic conductivity of the hydrogeologic units. An extensive testing program to determine values for this parameter probably is not warranted. The units will be modeled as isotropic with respect to hydraulic properties, and sensitivity analysis will be conducted to evaluate the impacts of this assumption.

The model will be calibrated for steady conditions based on water-level data contained in Winograd and Thordarson (1975), Waddell (1982), and Czarnecki and Waddell (1984), and collected from Activities 8.3.1.2.1.3.2 and 8.3.1.2.3.1.2. Model calibration will consist of successive adjustment of hydraulic properties (transmissivity, recharge, and vertical leakage) within reasonable ranges to minimize the difference between observed and simulated potentiometric head. The most significant adjustments are expected to be for transmissivity in the vicinity of the steep-gradient area northeast of the proposed repository site and for recharge along Fortymile Wash. Sensitivity analyses will be made to address uncertainties, including model boundaries, parameters, and fluxes. As an ongoing activity, the model will be updated and recalibrated using data from the regional and site characterization studies and other geological studies. As the data base improves, an attempt may be made to improve the regional simulation by adding several additional layers (such as the saturated alluvium) to the model in order to simulate flow in the saturated zone in more detail as more hydrogeologic data become available.

As a part of other activities (8.3.1.5.2.2.3 and 8.3.1.8.3.1.2), the regional quasi-three-dimensional ground-water flow model will be used to test the impacts of possible future ground-water developments, tectonic activity, and climatic changes on the saturated hydrologic system. Future movement along faults in the vicinity of Yucca Mountain could change hydraulic properties so as to either impede or enhance ground-water flow. The impact of such changes will be evaluated using the model. Future climate in the study area could be considerably wetter than the present climate and produce corresponding greater amounts of ground-water recharge. Increased recharge will be simulated using the model to predict the impact on ground-water levels under the site of the proposed repository at Yucca Mountain.

8.3.1.2.2 Investigation: Studies to provide a description of the unsaturated zone hydrologic system at the site

Technical basis for obtaining the information

Link to the technical data chapters and applicable support documents

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natural rainfall, compared with infiltration-runoff data from LPRS plots during simulated rainfall, will help establish the relationship between natural and simulated rainfall. The LPRS control plots are also important components of the natural infiltration monitoring program.

Both control and test LPRS plots will be instrumented similarly to the SPRS plots discussed previously. These instruments plus various geophysical logging techniques will be used to monitor moisture movement beneath these plots in response to both natural and artificial rainfall.

Parameters will also be measured at each site for water budget calculations of infiltration. Meteorological data will be collected at each site for evapotranspiration calculations. Runoff and sediment yield as a function of rainfall will be determined by monitoring flumes. The meteorologic and runoff data will be collected as part of Studies 8.3.1.2.1.1 and 8.3.1.2.1.2.

8.3.1.2.2.2 Study: Water movement test
(Rev. 3)

The objective of this study is to obtain information from isotopic measurements of soil, tuff, and water samples collected from Yucca Mountain that is pertinent for assessing the performance of a nuclear waste repository. Measurements of chlorine isotopic distributions will help characterize the percolation of precipitation into the unsaturated zone. The chlorine-36 in the unsaturated zone occurs from atmospheric fallout of chlorine-36 produced by cosmic-ray secondaries reacting with argon-40 and, to a lesser extent, with argon-36 and as global fallout from high-yield nuclear weapons tests conducted at the Pacific Proving Grounds between 1952 and 1963. When chloride ions at the surface are washed underground by precipitation, the radioactive decay of the chlorine-36 in the chloride can be used to time the rate of water movement. The chlorine-36 half-life of 301,000 yr permits the detection of water movement in the range of approximately 50,000 yr to 2 million years. These data are part of the input for developing numerical models of ground-water flow at this site.

Chlorine-36 is just one of many natural isotopes that could be used to evaluate infiltration, mixing, ground-water sources, and alternative models of possible upwelling of deep water. In fact, various stable isotopes will be analyzed as part of Activity 8.3.1.2.2.7.2 (aqueous-phase chemical investigations). In addition, however, the natural isotope technetium-99 could be used as an alternative or as a supplement to work already planned. Laboratory methodologies regarding the analysis of technetium-99 are available. Analyses of the noble gases helium, argon, and neon could also be used as a powerful tool to evaluate the mixing of waters (i.e., source determination, upwelling). These isotopes could provide a distinct reservoir signature. If a need is established to utilize natural isotopes other than those previously identified, technical plans will be developed and included in an SCP progress report, and the study plan will be revised to include a new activity.

8.75 in. (22 cm). Drillhole USW WT-8 will penetrate about 150 to 270 ft (50 to 90 m) of the saturated zone; USW WT-9 will penetrate about 240 to 390 ft (80 to 130 m) of the saturated zone. East of the Solitario Canyon fault on the ridge crest of Yucca Mountain, a hydrologic test drillhole, tentatively designated USW H-7, will be drilled in the same manner as previously drilled hydrologic test drillholes at Yucca Mountain. The depth of this drillhole will be about 3,000 ft (914 m); it will penetrate about 450 to 600 ft (150 to 200 m) of the saturated zone and will have a diameter of about 8.75 in. (22 cm). Drillhole locations are shown in Figure 8.3.1.2-19. Drilling of these drillholes will be integrated and coordinated with the drillholes planned under Section 8.3.1.4.1.

Geophysical and television surveys will be run in each of the drillholes. The logging programs will include a gyroscopic survey, vibroseis survey, optical television survey, and dielectric, spectral gamma-caliper, fluid density, electric, density, and epithermal neutron logs. After downhole geophysical logs are completed in each water-table drillhole, a small-capacity pump will be hung in the drillhole on tubing, and the pump will be run for about a week to obtain water samples for chemical and isotopic analyses. The pump will be removed, and the tubing reinstalled to enable measurements of the water levels.

After the initial development and testing of drillhole USW H-7, including a borehole-flow survey, a long-term test (perhaps as much as 30 days) will be conducted. This test will consist of pumping drillhole USW H-7 at an expected rate of 25 L/s or more while observing hydraulic responses in water-level monitoring drillholes located throughout Yucca Mountain, especially those located across (west of) the fault, such as drillholes USW H-6 and the proposed USW WT-8 (Figure 8.3.1.2-22). It will be necessary to disperse or transport the pumped water a substantial distance away from drillhole USW H-7 to prevent disturbance of local infiltration studies.

After the pumping test at drillhole USW H-7 is complete, it may be determined appropriate to pump drillhole USW H-6 while observing responses in drillhole USW H-7 and other drillholes east of the fault. By observing the responses of wells across the fault, it should be possible to determine if the Solitario Canyon fault acts as a barrier to eastward flow.

8.3.1.2.3.1.2 Activity: Site potentiometric-level evaluation (Rev. 3)

Objectives

The objectives of this study are to

1. Refine time and configuration of the spatial dependence of the potentiometric surface.

2. Measure water-level variations with time in existing borehole and calculate average levels, as input data for hydraulic gradient calculations.

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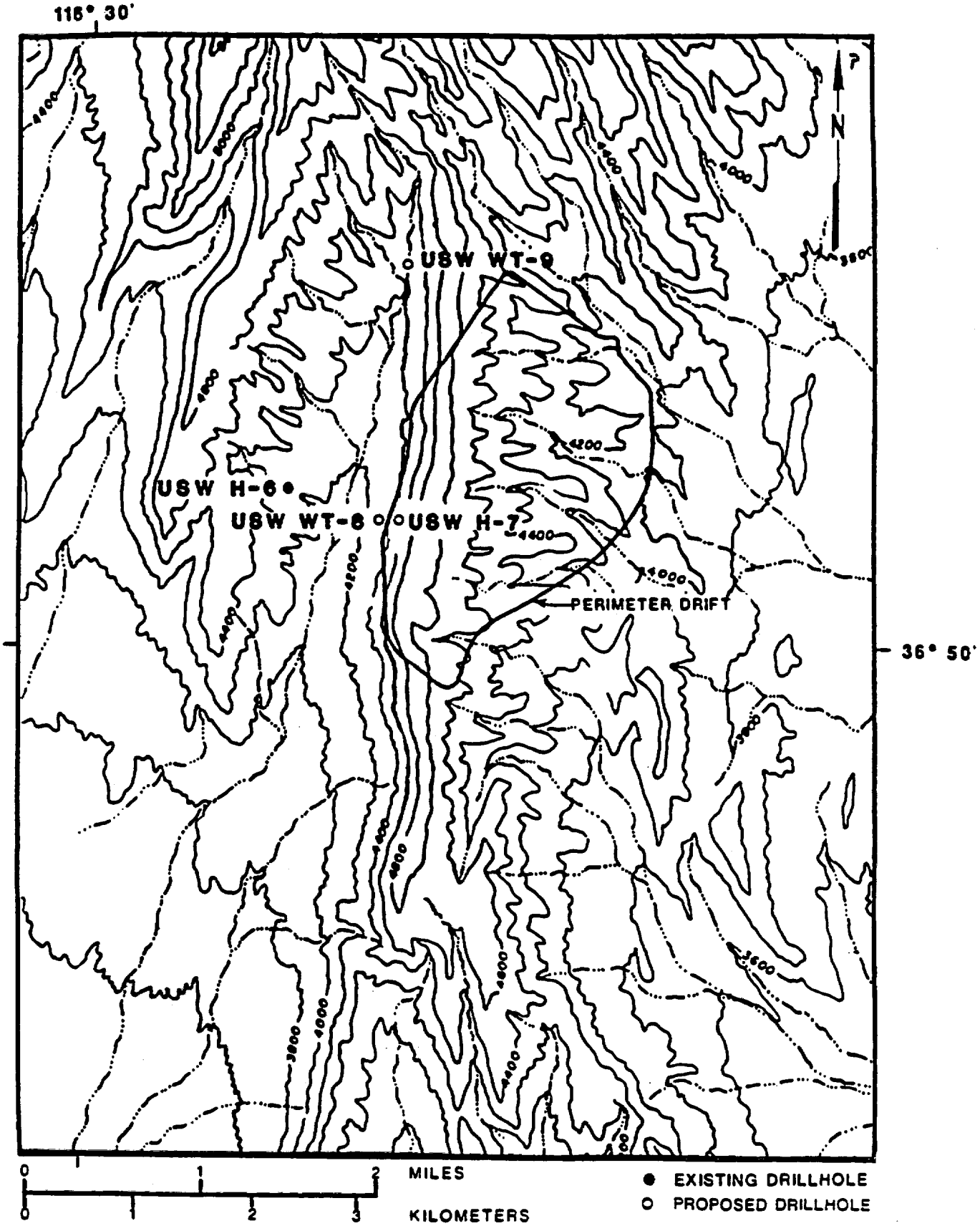

Figure 8.3.1.2-19. Location of the proposed drillholes for the Solitario Canyon fault study in the vicinity of perimeter drift.

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3. Analyze the character and magnitudes of water-level fluctuations to determine their causes, and, if possible, to estimate formation elastic and fluid-flow properties.

Parameters

The parameters for this activity are

1. Physical characteristics of the hydrogeologic units.

2. Hydraulic gradients.

3. Hydraulic diffusivity storage coefficients, hydraulic conductivity, aquifer compressibility.

Description

About 25 geologic, hydrologic, and water-table drillholes are part of an existing monitoring network near the site (Figure 8.3.1.2-8). Water levels in 15 holes have been measured periodically during onsite visits about every two weeks. Ten drillholes have pressure transducers installed below the water surface and connected to digital equipment at the surface; electrical output from the transducers is automatically recorded every hour. The periodically measured drillholes in the network are being converted to this automated monitoring system. Raw data from these field installations are taken to the office, and water-level depths or altitudes are calculated, following a process of conversions, adjustments, and determination and verification of equipment calibrations.

Proposed new test drillholes to be added to the water-table monitoring network include water-table drillholes in the USW holes WT-8, WT-9, WT-21, WT-22, WT-23, WT-24, WT-25, WT-26, and WT-27; and UE-25 holes WT#19 and WT#20 (Figure 8.3.1.2-20). Water-table drillholes USW WT-8 and USW WT-9 will be located near the Solitario Canyon fault to help determine the hydraulic nature of that structural feature, as discussed in Activity 8.3.1.2.3.1.1 (Solitario Canyon fault study in the saturated zone). Water-table holes USW WT-21 and USW WT-22 are considered under Activity 8.3.1.2.1.3.2 (regional potentiometric distribution and hydrogeolgoic framework studies). The drilling of these drillholes will be coordinated with the drilling program described in Section 8.3.1.4.1.

Water table drillholes USW WT-23 and USW WT-24 will be located to the north near Drill Hole Wash to obtain additional data on the steep gradient in this area. Water-table drillhole USW WT-23 will be located in Drill Hole Wash northwest of drillhole USW UZ-1. This drillhole will be drilled to a probable depth of about 670 m. Drillhole USW WT-24 will be located between drillholes USW G-2 (Figure 8.3.1.2-24) and UE-25 WT#18, and will also be about 670 m deep. Both of these drillholes will have diameters of about 22 cm, and will be constructed and completed in the same manner as previously drilled water-table drillholes. The lithologic and geophysical logs will be analyzed and compared with those of other drillholes near Yucca Mountain to determine if the permeability of the rocks in this area is significantly lower than elsewhere, so as to produce a steeper hydraulic gradient than to the south near the Yucca Mountain repository block. Proposed geologic

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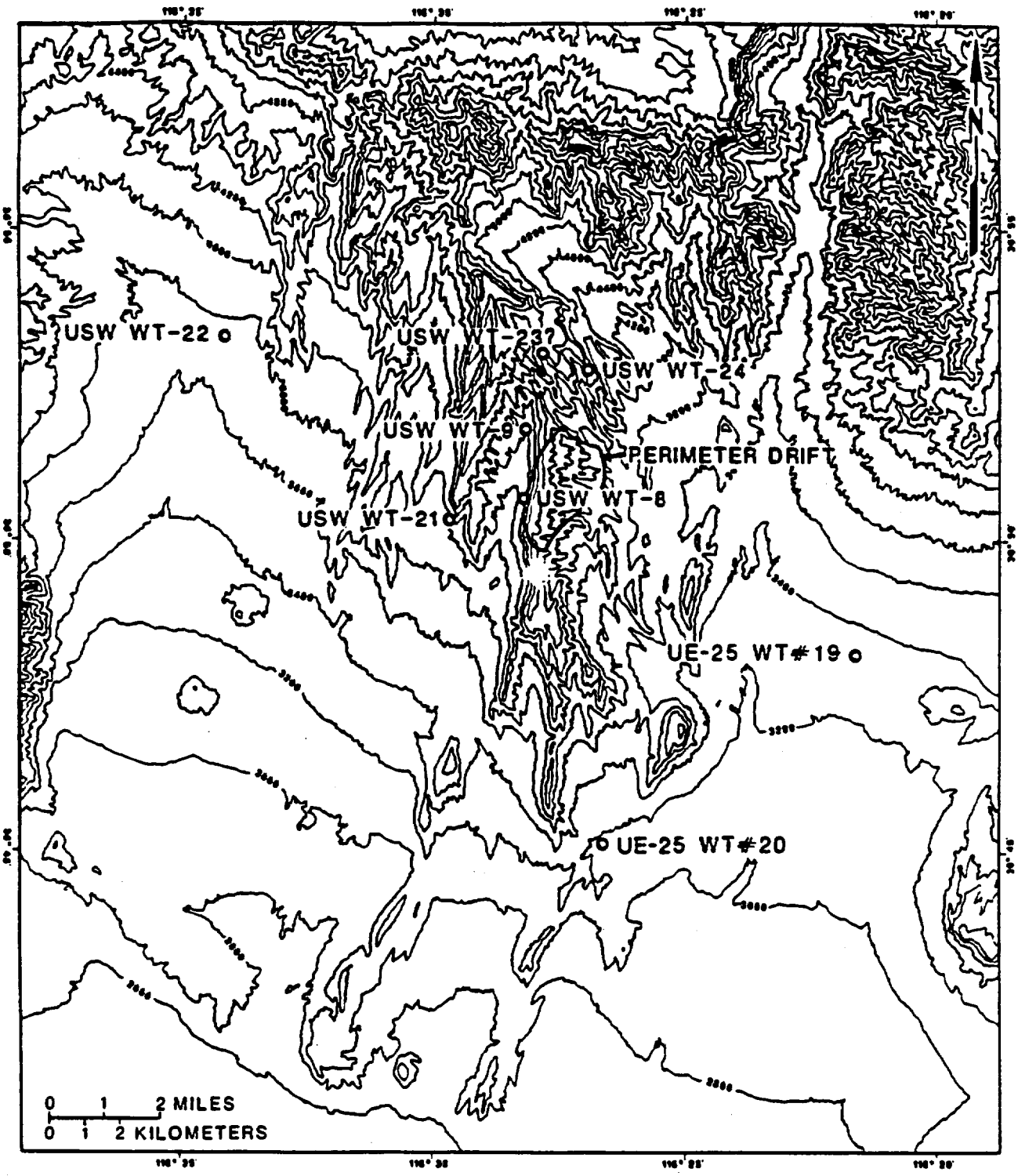

Figure 8.3.1.2-20. Locations of the proposed water-table holes for the site potentiometric-level evaluation

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drillhole USW G-5 (Figure 8.3.1.2-21), located generally north of Yucca Mountain, is expected to provide stratigraphic and other relevant information that will be used to help determine the probable cause and nature of the steep hydraulic gradient. Water-level measurements will also be used to help determine if the gradient is linear though steep, or is stepped.

Water table drillholes UE-25 WT#19 and UE-25 WT#20 will be drilled to determine the potentiometric levels to the south and east of the repository site (Figure 8.3.1.2-23). Drillhole UE-25 WT#19 will be located 3 km east of well J-13 and will be drilled to a depth of about 1,100 ft (335 m). Drillhole UE-25 WT#20 will be located 5 km southwest of well J-13 and will be drilled to a depth of about 1,100 ft (350 m). The drilling, construction, logging, and water sampling of these drillholes will be similar to previously drilled water table drillholes.

Three additional boreholes are proposed for the area just North and Northwest of Yucca Mountain. A description of the three wells and the tests to be performed in them is as follows:

Description of the wells

Well	Depth	Location
WT-25	600-800m	36°55′ Latitude 116°29′ Longitude
WT-26	400-600m	36°49′ Latitude 116°29′ Longitude
WT-27	300-600m	36°57′ Latitude 116°35′ Longitude

The wells would be 12¼" diameter if drilled dry and between 8" and 9" diameter if drilled wet.

Well USW WT-25 should be drilled near the topographic divide between Yucca Wash and Beatty Wash. Topography permitting, the ideal site would be at Pinyon Pass just west of Pinnacles Ridge. It should be placed very early in the schedule; the recommended placement in the schedule is between USW WT-23 and USW WT-24.

Well USW WT-26 should be drilled about one mile south of Beatty Wash at an approximate altitude of 1475 meters.

Well USW WT-27 should be drilled on the topographic divide between Crater Flat and Beatty Wash. The exact location would depend on a reconnaissance of the topography of the area, but the ideal location would be a Sec. 23, Town. 11S, Range 48E. It may be scheduled near the end of the drilling schedule.

Final locations, probable depths to be drilled, whether wet or dry drilling will be employed, and other construction features of these wells will be determined later, upon approval in concept and addition to the drilling schedule.

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Tests to be Performed in these three Boreholes:

The tests to be performed in the wells and samples to be taken are as follows:

- Standard cutting descriptions
- Bottom Hole Core
- Standard suite of logs, such as gamma gamma, caliper, resistivity, etc.
- Injection slug tests (Falling head injection tests).
- Pumping to clean hold and provide hydrochemical and isotopic samples.
- Long term water level monitoring.
- Temperature logging for heat flow.

Figure 8.3.1.2-21a shows approximate locations of the three proposed wells.

Water-level data from the monitoring program will be plotted to show variations and trends with time. Seasonal trends will be evaluated and the data will be averaged over appropriate periods (e.g., annually) so that hydraulic gradients and probable ground-water flow paths can be determined more accurately, especially in areas where the water table is nearly flat.

Water-level responses in observation wells during pumping of other wells will be analyzed in terms of general hydraulic connectivity and, where appropriate, the permeability of the rocks will be evaluated. Responses among the observation wells will be compared, with the purpose of estimating the areal anisotropy of the hydraulic parameters that may be controlled by faults or fractures.

Analysis will be made of water-level fluctuations in wells that occur in response to volume/strain changes in the aquifer(s). Two broad categories of water-level response will be evaluated: dynamic and static responses. The dynamic response, due to passage of a seismic wave from earthquakes or underground nuclear explosions, will be monitored and analyzed to determine the relation between formation fluid pressure and strain, and to provide estimates of formation elastic properties. Water levels in wells may also respond to lower frequency volume/strain changes (the static response), such as those due to earth tides and atmospheric loading. These responses are readily identifiable in most wells in the potentiometric-level network, and are currently being evaluated in the UE-25c-holes and UE-25p#1 (Activity 8.3.1.2.3.1.3). Water levels may also exhibit a coseismic or aseismic low-frequency response to earthquakes. These phenomena are variously referred to as slow earthquakes or fault creep events. Concurrent measurements of strain are necessary to confirm the occurrence of aseismic fault creep. Strain measurements are also needed to improve the analysis of earth tidal effects.

To address this problem, volumetric strain meters or dilatometers will be installed in boreholes in at least three localities near Yucca Mountain.

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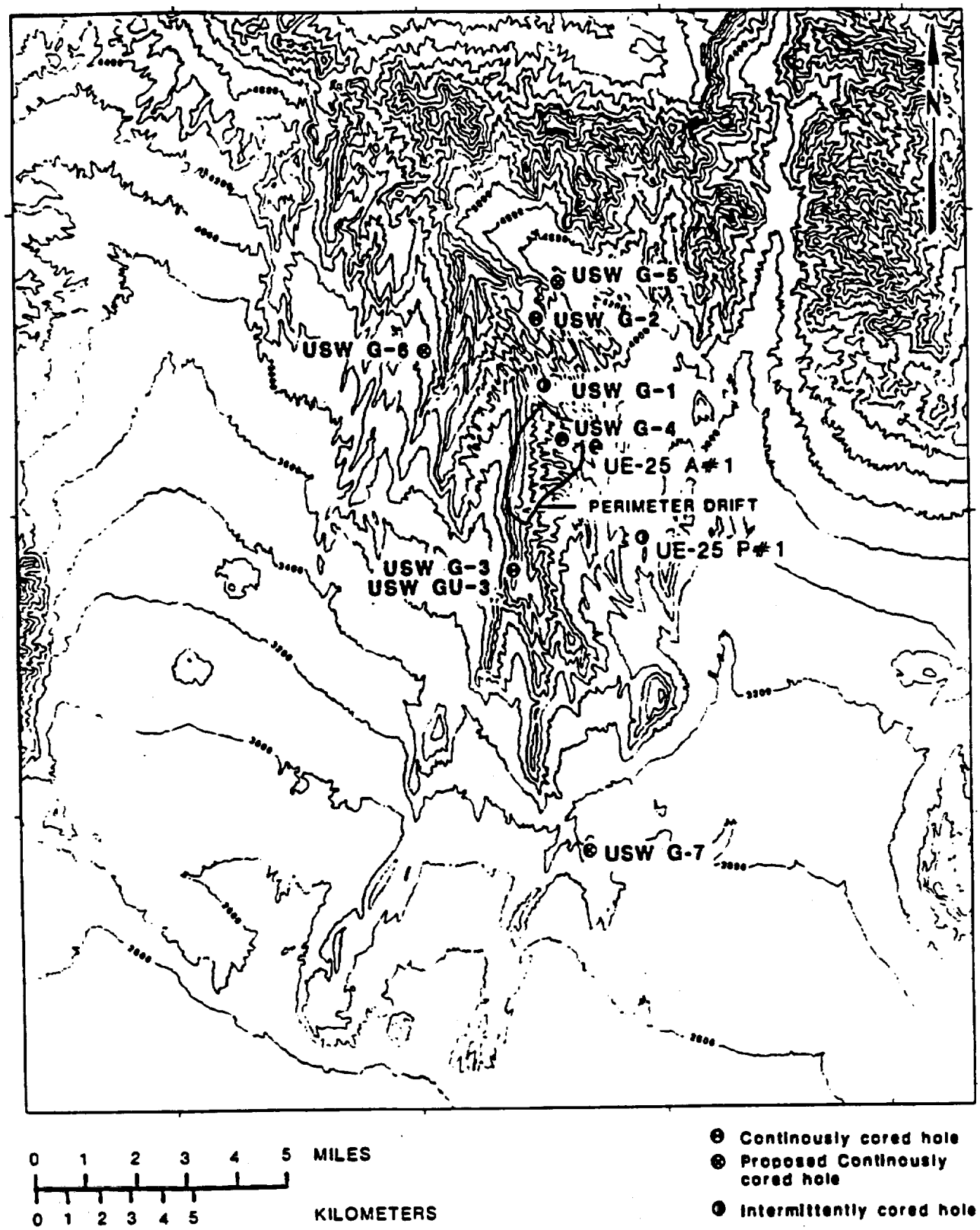

Figure 8.3.1.2-21. Location of existing and proposed geologic drillholes

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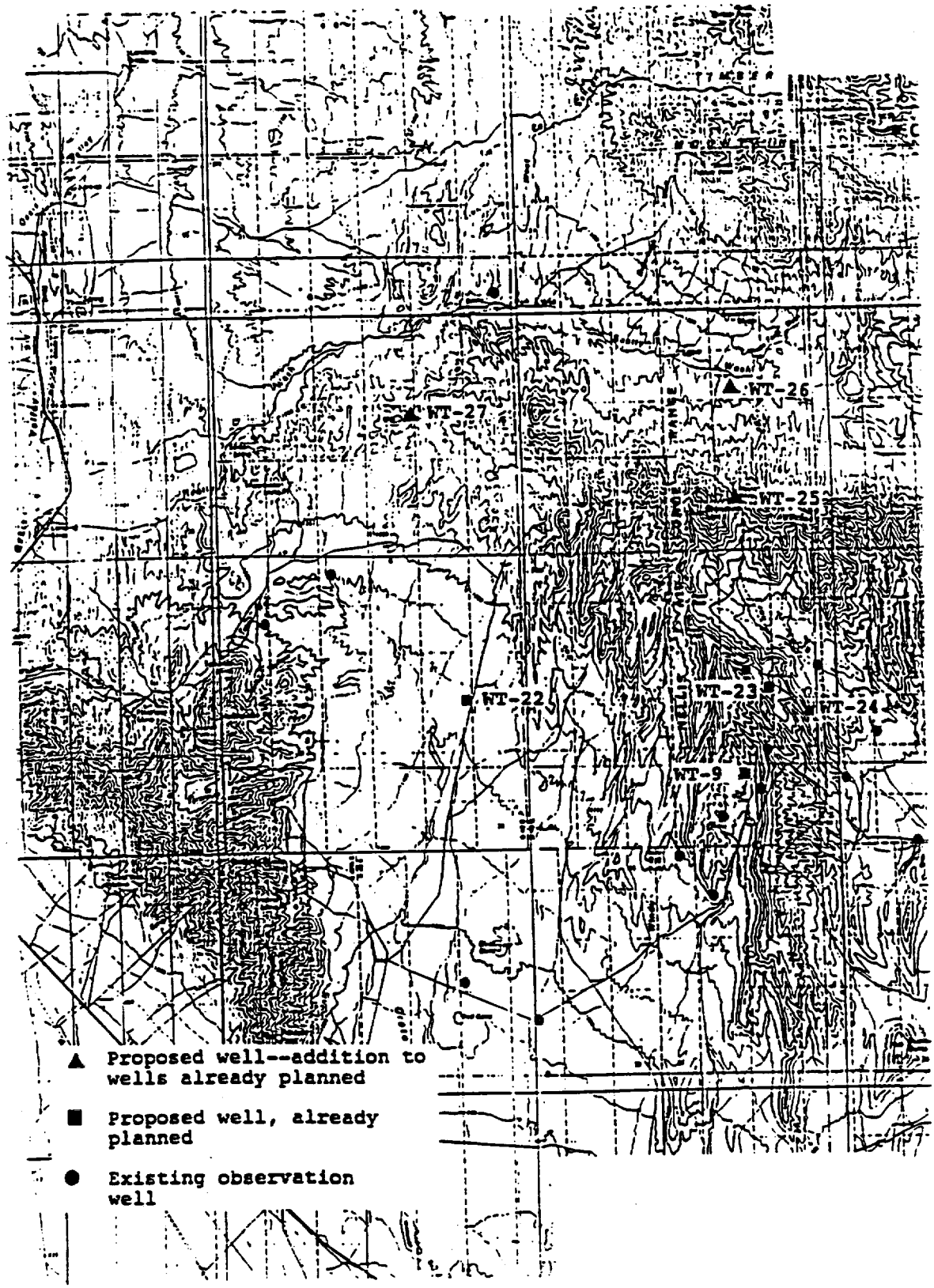

Figure 8.3.1.2-21a. Locations of the three proposed wells.

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To assess the effects of terrain on the detection of horizontal tectonic displacement or strain, emplacement sites will be located on the crest, flank, and on the flat adjacent to Yucca Mountain. The array location will be coordinated to optimize the detection of explosively induced strain changes, and to complement the hydrologic studies of earth tides and apparent fault creep responses. At each locality, existing boreholes may be used or boreholes will be drilled and cored to facilitate the emplacement of strain meters. For redundancy, strain meters will be installed in two adjacent holes in at least one site. The selection of borehole sites and the criteria for well construction will be coordinated with the development of Yucca Mountain Project drilling plans (Investigation 8.3.1.4.1).

Because strain meters are temperature-sensitive, the depth of emplacement must be sufficient to minimize the effects of annual changes in surface temperature. Every effort will be made to ascertain the temperature-depth field at each locality before emplacement. Monitoring of climatic factors such as barometric pressure and rainfall will be made on a continuous basis and will be coordinated with other meteorological monitoring at the site (Study 8.3.12.1.2). The output from all strain meters at each locality will be monitored using intelligent data logging systems. Satellite (GOES) telemetry will be used to transmit the data to the office for immediate analysis so that detectable low-frequency strain changes may be observed and an appropriate response for additional field measurements may be initiated.

Currently Sacks-Evertson strainmeters, or Carnegie meters are being considered for use in this activity, because they are relatively simple and robust dilatometers that are readily available. When properly installed, they are capable of sensing strain changes of the order 10^{-10} or greater. The Carnegie meters have been used successfully by the USGS in studies on the San Andreas Fault in California.

8.3.1.2.3.1.3 Activity: Analysis of single- and multiple-well hydraulic-stress tests

Objectives

The objectives of this activity are to

1. Determine intraborehole flow profiles for each of the C-holes during static conditions and while pumping.

2. Correlate lithology, fractures, and intraborehole flow rates.

3. Characterize the type of flow (linear, radial, spherical, fracture, porous) that is occurring between boreholes.

4. Determine the causes of the apparent deviant pressure transients observed in slug tests in UE-25c#1.

5. Identify the nature of significant hydraulic boundaries present at the scale of the tests. This information will be especially important in designing multiple-well interference tests and tracer tests at the C-holes.

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Caliper, epithermal-neutron porosity, magnetometer, magnetic, susceptibility, and possibly other experimental and supporting logs will be run from total well depth to land surface in each of the extent WT wells. These data will (1) aid in the evaluation of physical formation properties, (2) aid in stratigraphic correlations, and (3) determine vertical profiles of water content in the unsaturated zone. This data-collection activity will be carried out under Activity 8.3.1.4.2.1.3 (borehole geophysical surveys), and will precede sampling if it is logistically more efficient.

8.3.1.2.3.2.3 Activity: Regional hydrochemical tests and analyses (Rev. 3)

Objectives

The objective of this activity is to describe regional spatial variations in ground-water chemistry in the saturated zone by collecting representative water samples from wells and springs within the region and by studying their chemical and isotopic compositions.

Parameters

The parameters of this activity are

1. Chemical concentration.
2. Stable-isotope ratio.
3. Radioisotope activity.

Description

Water samples will be collected from selected springs and extant wells within the Nevada Test Site and the surrounding region. As appropriate, newly drilled wells will be sampled, but no drilling is proposed for this activity. Sites selected will include some of those where alternative conceptual models of the regional geohydrologic system will be tested by Study 8.3.1.2.1.3 (characterization of the regional ground-water flow system), particularly with regard to ground-water flow rates and directions, and to support the designation of flow-system boundaries. Hydrochemical data from these sites will also provide insight as to the origin of anomalous features in the regional potentiometric surface.

Water samples will be analyzed in the field for unstable constituents and intensive properties. They will be analyzed in USGS and contract laboratories for inorganic chemical concentrations; activities of elected radioisotopes, including tritium, carbon-14, and chlorine-36; and ratios of selected stable isotopes, including those of carbon, hydrogen, oxygen, strontium and sulfur. Water-level drawdown and recovery data will be collected from wells during and after sampling, and used by Study 8.3.1.2.1.3 (characterization of the regional ground-water flow system) to estimate saturated hydraulic conductivities.

Hydrochemical data will be combined with existing data (Walker and Eakin, 1963; Schoff and Moore, 1964; Robinson and Beetem, 1965; Naff, 1973; Winograd and Thordarson, 1975; Benson et al., 1983; Classen, 1985) to

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describe the spatial compositional variations in regional ground-water chemistry. Radioisotope data will enable estimates of ground-water ages and flow rates. Stable isotope and inorganic concentration data will provide insight as to the origins, evolution, and mixing of ground waters, and will aid in comparison of site-specific data in order to delineate possible flow paths. These data will also be used by Activity 8.3.1.2.3.2.4 (synthesis of saturated-zone hydrochemistry) to identify the chemical and physical processes that influence ground-water chemistry; to aid in the identification and/or quantification of ground-water travel times, flow paths, and fluxes to, from, and within the saturated zone; and to estimate climatic conditions during periods of recharge. The data will also be part of the information base used by Study 8.3.1.3.1.1 (ground-water chemistry model).

8.3.1.2.3.2.4 Activity: Synthesis of saturated-zone hydrochemistry (Rev. 3)

Objectives

The objectives of this activity are to

1. Describe the saturated-zone hydrochemistry.
2. Identify the chemical and physical processes that influence ground-water chemistry.
3. Relate compositional variations to water/rock interactions and the physical nature of the ground-water flow system to aid in the identification and/or quantification of ground-water travel times; climatic conditions during periods or recharge; flow paths; and fluxes to, from, and within the saturated zone.

Parameters

The parameter for this activity is geochemical reaction modeling.

Description

Graphical methods will be used to describe spatial distributions of selected chemical and isotopic data. Variations will be integrated with extant information describing ground-water flow directions, spatial distributions of secondary minerals, spatial petrologic variations, and whole-rock and mineralogic compositions, in order to identify sources and sinks of dissolved materials, to infer sources and areas of recharge, and to estimate ground-water flow paths, flow rates, and residence times.

The geochemical modeling code EQ3NR/EQ6 (Wolery, 1979; 1983) will be used with the bases of hydrochemical and mineralogic data to (1) calculate the specifications of dissolved materials, (2) determine the saturation states of relevant solid phases, and (3) test plausible water-rock reaction models. The results of these efforts will aid in the identification of the geochemical process that have combined with ground-water flow to determine the present ground-water chemistry. Process identification will also contribute to an understanding of the paleohydrology of the region, and to

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general resolution of ground-water flow paths, residence times, and recharge conditions. The analytical and process data will also comprise part of the geochemical base needed by performance and design issues 1.1 through 1.12, as addressed by Section 8.3.1.3.

The information generated by this activity will constitute "nonhydraulic" tests of alternative conceptual models of the ground-water flow system.

8.3.1.2.3.3 Study: Saturated-zone hydrologic system synthesis and modeling

The objectives of this study are to (1) synthesize the available data into a model and make a qualitative analysis of how the system is functioning and (2) represent quantitative observations of hydrogeologic data pertaining to the ground-water flow system in a comprehensive flow model. Three activities are planned to analyze and integrate the data in order to satisfy these objectives. The planned activities are the conceptualization of the saturated-zone flow models within the boundaries of the accessible environment; the development of a fracture network model; and the calculation of flow paths, fluxes, and velocities within the saturated-zone.

8.3.1.2.3.3.1 Activity: Conceptualization of saturated-zone flow models within the boundaries of the accessible environment

Objectives

The data objectives of this activity are to synthesize the available hydrogeologic data to develop a conceptual model and make a qualitative analysis of how the site saturated-zone hydrogeologic system is functioning.

Parameters

The parameters for this activity are spatial distribution of the hydrogeologic units and their hydraulic properties, including

1. Hydraulic conductivity.
2. Hydraulic gradient.
3. Effective porosity.
4. Flux.
5. Water chemistry.
6. Storage properties.
7. Potentiometric surface configuration.

Description

All reliable data and reasonable interpretations of these data will be assimilated into a description of the saturated-zone flow system within the boundaries of the accessible environment. This description will include the physical and hydraulic characteristics of the rock units and structural features, as well as the likely flow-system operation within this framework.

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SITE CHARACTERIZATION
PROJECT

PROJECT BASELINE DOCUMENT

YUCCA MOUNTAIN SITE CHARACTERIZATION PROGRAM BASELINE (SCPB)

VOL. 2 OF 5

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q

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QA Level Yes

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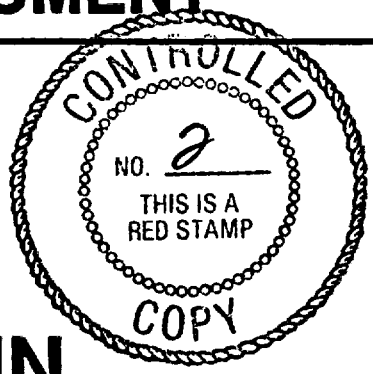
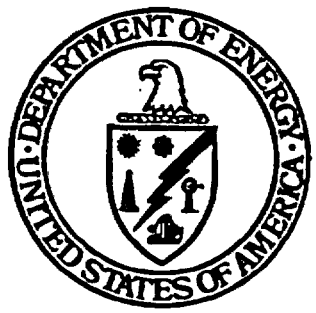


YUCCA MOUNTAIN SITE CHARACTERIZATION PROGRAM BASELINE (SCPB) VOLUME 2

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q



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YUCCA MOUNTAIN SITE CHARACTERIZATION PROGRAM BASELINE (SCPB)

VOL. 3 OF 5

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q

UNITED STATES DEPARTMENT OF ENERGY
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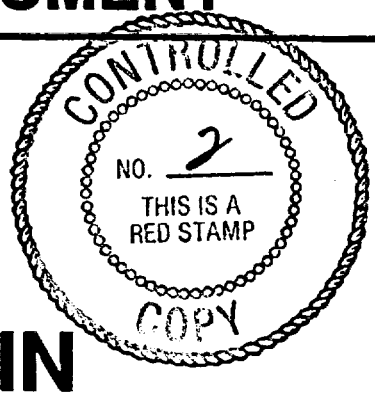

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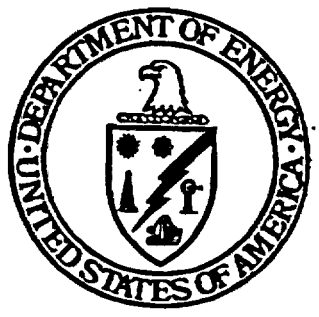

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YUCCA MOUNTAIN

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

PROJECT BASELINE DOCUMENT

YUCCA MOUNTAIN SITE CHARACTERIZATION PROGRAM BASELINE (SCPB)

VOL. 4 OF 5

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q

UNITED STATES DEPARTMENT OF ENERGY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE

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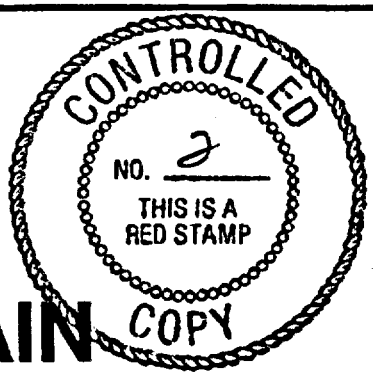

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YUCCA MOUNTAIN SITE CHARACTERIZATION PROGRAM BASELINE (SCPB)

VOL. 5 OF 5

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q

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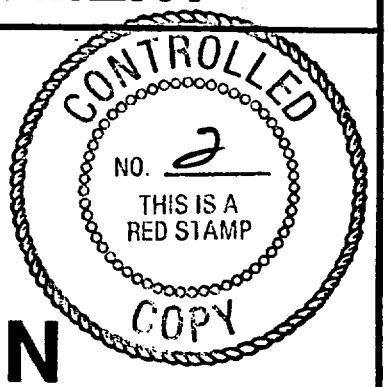

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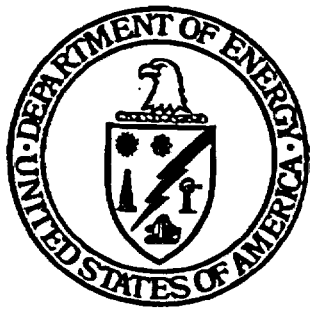

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Most of the fluid that has been lost to the formation contains a conservative tracer, primarily lithium chloride, but lithium bromide has also been used. These salts were mixed with drilling water to produce a solution of approximately 20 ppm. The majority of boreholes drilled at or near Yucca Mountain (including all boreholes within the CPDB or in the immediate vicinity) used lithium chloride as a tracer. Several of the water-table drillholes used lithium bromide and a few boreholes drilled early in the site-selection process and located away from the CPDB (e.g., USW G-1) were drilled without the use of a tracer.

8.4.2.2.3 Surface-based test interference (Rev. 3)

Interference with surface-based testing is limited, principally because these activities are widely separated. Many surface-based testing activities such as mapping, trenching, and geophysical surveys are concerned with durable characteristics of the site that generally are unaffected by interference. Hydrologic monitoring activities in the unsaturated zone, such as the site vertical boreholes study (Activity 8.3.1.2.2.3.2) or the gas-phase circulation study (Activity 8.3.1.2.2.6.1), may detect the influence of hydrologic stress tests such as pneumatic packer testing from neighboring boreholes, but this would be unexpected because the various test locations are far apart. Similarly, potentiometric-level interference caused by pumping tests in the saturated zone is possible and will be investigated. The events that could lead to this type of interference in the unsaturated or the saturated zone are under experimental control and can be knowingly evaluated if interference effects are suspected. The types of activities that have the most potential to produce interference effects are, therefore, (1) artificial introduction of water or gas wherever planned tests are located close together, thereby facilitating possible communication, and (2) disturbance to the structural characteristics of the site such that natural hydrologic processes are disturbed, producing interference with the measurements of those processes.

Possible interference from water use

The planned use of water in testing could potentially produce test-to-test interference if different activities are located close enough together, which is most likely in the immediate site area. The only significant testing-related use of water planned within the CPDB or the immediate vicinity is for the artificial infiltration tests, for which a total of up to 400,000 gallons of tagged water will be used within the CPDB. These tests are planned in conjunction with the natural infiltration monitoring program and are widely separated from infiltration monitoring installations that could be adversely impacted. The other possibility is that water used in artificial infiltration testing could percolate deep into the unsaturated zone, thereby affecting measurements of the natural moisture state there, specifically in the site vertical boreholes study (Activity 8.3.1.2.2.3.2). Significant vertical and lateral movement of introduced water would be required, because the potentially interfering activities are widely separated. The evaluation reported in Section 8.4.3.2 indicates that moisture pulses from such sources may travel slowly. Furthermore, the chemically tagged water used in artificial infiltration testing could be identified

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during drilling of any borehole where such water is intercepted in sufficient quantity to significantly interfere with characterization of in situ matrix moisture conditions. This type of tracer detection strategy is relied upon in the multipurpose borehole activity (Activity 8.3.1.2.2.4.9) and the radial boreholes test in the ESF (Activity 8.3.1.2.2.4.4). In summary, the use of tagged water for artificial infiltration studies appears unlikely to interfere with planned natural infiltration monitoring or testing and monitoring in the deep unsaturated zone. However, the available information is inconclusive, so the potential for interference will be reevaluated as new information on lateral fluid mobility becomes available.

The other significant planned use of water within the CPDB or immediate vicinity is for dust suppression on roads. Water used for dust suppression on roads will not be tagged with a chemical tracer to avoid evaporative concentration and remobilization of the tracer during meteorological precipitation events. As discussed in Section 8.4.2.2.2, the dust control methods used previously at the site call for application of 1 to 2 mm of water, typically twice per day, under meteorologic conditions conducive to evaporation. This amount of water is not sufficient to produce significant runoff. Successive applications of water, however, could possibly produce saturation buildup in the road bed and underlying strata, which could conceivably interfere with natural infiltration monitoring, or with testing and monitoring in the deep unsaturated zone. Because road and pad surfaces are highly compacted and because of relatively large evaporative losses, dust suppression is unlikely to cause test interference. Natural infiltration study locations for monitoring undisturbed conditions are separated from roads and drill pads. For studies in the deep unsaturated zone, test interference depends on the mobility of moisture through the overlying drill pad and near-surface rock or alluvial material. This flow probably is restricted to the matrix of these materials and is, therefore, unlikely to penetrate to monitoring locations in the deep unsaturated zone in the time frame of site characterization. Further analysis of test interference, including the effects of watering for dust suppression, will be part of the study plans for the activities that may be affected.

Possible interference from disturbance to hydrologic processes

Construction of roads and drill pads alters the surface infiltration, runoff, and evapotranspiration characteristics of the site. For existing and planned roads at Yucca Mountain, this effect is associated primarily with devegetation and compaction of natural materials used for the road bed. Runoff from roads and pads is significantly increased for precipitation events that range from light events that cause runoff only from sloping road surfaces to heavy events that cause runoff from undisturbed surfaces. This type of runoff generally flows onto and infiltrates alluvium-filled, shallow gradient areas at lower elevations. Increased runoff associated with surface disturbance probably tends to increase the saturation of near-surface materials in these infiltration areas. As this occurs, the capacity for infiltration into those materials decreases, thus extending the distance traveled by runoff. This effect is unlikely to interfere with infiltration measurements in upland areas, but may affect measurements in the canyons and washes of Yucca Mountain. Because of the distribution of natural-infiltration monitoring installations, some will probably register increased infiltration and the remainder will be unaffected. The impact of using affected information in

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site performance assessment is not currently understood, but the hydrologic characteristics of the areas disturbed by roads and pads are likely to return to pre-disturbance conditions relatively quickly, as a result of natural processes and eventual reclamation activities. This is a complex issue for which current understanding of site conditions and processes does not permit immediate resolution. Controls will be applied in the construction and maintenance of the features involving significant disturbance as discussed in Section 8.4.2.2.2, to reduce the magnitude of the interference effect to the extent practicable during site characterization. Knowledge that the effect probably exists will be applied throughout site characterization in the interpretation of infiltration data.

The other type of potential hydrologic interference involves the effect of borehole penetrations through the unsaturated zone on the natural movement of gas and vapor. Air has been observed to flow into and out of deep, open boreholes on the crest of Yucca Mountain (e.g., USW UZ-6), various neutron-access holes, and several of the WT-series boreholes. This flow is driven by seasonal and diurnal fluctuations in air density and local barometric pressure, and probably occurred in some form before construction of the boreholes. The flow generally involves inhalation of dry air and exhalation of moist air. All the existing boreholes at the site have surface casing and have been shut in except for intermittent observation periods. The significance of these observations to this discussion is that in situ hydrologic conditions will support appreciable flow (e.g., 10 ft/s in a 20-in. diameter hole) in response to potential gradients produced by atmospheric effects. No information is yet available on internal gas or vapor flow in shut-in boreholes.

Currently, five penetrations through the unsaturated zone exist within the CPDB at Yucca Mountain; of these, one is uncased and the remainder have tubing or casing installed throughout the unsaturated zone without cement (other than what was used to "tack" the lower end). A comparable number of existing holes stand uncased or uncemented through the unsaturated zone, in the immediate vicinity of the site. The casing is not fully cemented in boreholes in the vicinity of Yucca Mountain so that it can be readily removed for borehole sealing. Planned drilling for site characterization will produce at least 10 additional penetrations through the entire unsaturated-zone section within the CPDB, of which only three will be completed in such a way as to occlude flow in the open bore or the casing annulus. About 20 similar penetrations are planned for the surrounding vicinity (the exact number depends on the area considered). The same controls on casing cementation will apply to the planned program. The result will be boreholes spaced approximately 3,000 ft apart over the site area, and clusters of more closely spaced holes at the ESF location, near the USW UZ-6 location, and southeast of the CPDB near planned borehole USW UZ-9. The interference concern is that once the site vertical boreholes (Activity 8.3.1.2.2.3.2) are instrumented and stemmed for long-term monitoring, internal circulation in the unsaturated-zone penetrations will affect the data collected.

Planned investigations are expected to provide the information needed to evaluate the extent of interference. Several studies are planned to evaluate the effects of air circulation through Yucca Mountain, and in open boreholes, to characterize test interference and the effect on repository performance, if any. One of the objectives for Study 8.3.1.2.2.6 (characterization of

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gaseous-phase movement in the unsaturated zone) is to describe the pre-waste-emplacement gas-flow field and identify the structural controls on fluid flow. Activity 8.3.1.2.2.6.1 plans to reconstruct the history of artificial effects on air circulation in the repository block and to relate flow rates to barometric pressure and air temperature changes. Flow-rate measurements will be made with a hot-wire anemometer under both open-hole and shut-in conditions. This information will be used with numerical simulation techniques to determine the volume of rock affected and the time required for the rock mass to return to pre-disturbance conditions. Gas flux and gaseous transport will also be investigated in Study 8.3.1.2.2.7 (hydrochemical characterization of the unsaturated zone).

8.4.2.3 Subsurface-based activities

The subsurface-based activities that are part of the site characterization program at Yucca Mountain consist of both the testing to be performed in the exploratory studies facility and the associated construction and operations activities necessary to support the testing. This section briefly describes the planned testing, the supporting facility design, operations, and construction activities, as well as evaluates the layout for the operations that assess potential interference between activities.

The exploratory studies facility (ESF) is illustrated conceptually in Figure 8.4.2-3. The ESF consists of surface facilities and underground excavations. The surface facilities include such items as shops, a warehouse, offices and laboratories, an electrical substation, integrated data system acquisition facility, waste water treatment systems, and a muck-storage area. The underground excavations consist of two ramps (one in the north, one in the south) constructed to the Topopah Spring (TS) level, where the potential repository horizon would be located. These ramps would be connected by a drift, and would also include some lateral drifting. The main test level (MTL) core area would also be located at the TS level for both site characterization and performance confirmation testing. The north and south ramps will contain two turnouts for two ramps leading down to the Calico Hills (CH) unit, which would also be connected by a drift, including lateral drifts. An optional shaft in the north, from the surface to the TS level, is also planned.

As shown in Figure 8.4.2-3, the ESF design, construction, and testing will be conducted in phases, to allow information from early testing to influence construction and testing of ongoing/following phases. The overall strategy for ESF development is to get access to the CH level as soon as possible, in order to obtain the information needed on the characteristics of this primary barrier. The design priorities and sequence which will be followed during the preparation of the design packages for construction and testing (shown in Figure 8.4.2-3), are as follows:

1. Site Preparation and Portal of North Ramp
2. North Ramp from Portal to Topopah Spring (TS) Level
3. Site Preparation and Portal of South Ramp
4. South Ramp from Portal to TS Level
5. North Ramp from Calico Hills (CH) Turnout to CH Level