

PHASE I REVIEW
CHARACTERIZATION OF THE YUCCA MOUNTAIN
SATURATED-ZONE HYDROCHEMISTRY
STUDY PLAN 8.3.1.2.3.2

by

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Introduction

This study plan describes the methods that will be used to provide the hydrochemical information needed in geohydrological and geochemical site characterization efforts. Work in this study will determine water chemistry in the saturated, and immediately adjacent unsaturated rocks beneath and adjacent to Yucca Mountain and in the saturated rocks within the surrounding region. The study is subdivided into four activities:

8.3.1.2.3.2.1 Assessment of saturated-zone hydrochemical data

8.3.1.2.3.2.2 Hydrochemical characterization of water in the upper part of the saturated zone

8.3.1.2.3.2.3 Regional hydrochemical characterization, and

8.3.1.2.3.2.4 Synthesis of saturated-zone hydrochemistry

Gas-phase samples, hydrochemical data, and liquid-phase samples will be collected at wells and springs throughout the site and region. The data will include water temperature, specific electrical conductance, concentrations of selected dissolved inorganic and organic constituents, selected dissolved radioisotopes and stable isotope ratios, concentrations, radioisotope activities and stable isotope ratios of selected gaseous elements and compounds. Most new data will be collected close to Yucca Mountain. New regional information will be collected from Gold Flat south to Silurian Valley, and from Death Valley east to the Spring Mountains.

The data will be used to help identify plausible solid phases and chemical processes that contribute to the spatial compositional variations in the saturated-zone waters. Data will provide insight to the physical nature of the geohydrologic system, the

identification and quantification of fluxes, the existence of hydrologic boundaries, and residence times within the saturated and unsaturated zones. The data are also required to describe the transport and fate of radionuclides within the near and far field.

The objectives of Activity 8.3.1.2.3.2.1 - Assessment of saturated-zone hydrochemical data are 1) to compile and evaluate extant hydrochemical data for the saturated zone at site and regional scales, and 2) identify data deficiencies and potential sampling sites and assemble requisite materials and field-data collection.

The objectives of Activity 8.3.1.2.3.2.2 - Hydrochemical characterization of water in the upper part of the saturated zone are to 1) describe the hydrochemistry of the upper part of the saturated zone by collecting representative water samples from intervals within the upper 100 meters, within and adjacent to the site area, and studying their chemical and isotopic compositions, and 2) estimate flux to or from the saturated zone by collecting interstitial water and gas samples from immediately above the water table in the site area and studying their chemical and isotopic compositions.

The objective of 8.3.1.2.3.2.3 - Regional hydrochemical characterization is to describe regional spatial variations in ground-water chemistry in the saturated zone by examining extant data and by collecting representative water samples from wells and springs within the region and studying the chemical and isotopic compositions.

The objectives of 8.3.1.2.3.2.4 - Synthesis of saturated-zone hydrochemistry are to 1) describe the saturated-zone hydrochemistry, 2) identify chemical and physical processes that influence the ground-water chemistry, and 3) relate compositional variations to water/rock interactions and physical nature of the ground-water flow system to aid in identification and quantification of ground-water travel times, climatic conditions during periods of recharge, flow paths, and fluxes, to, from, and within the saturated zone.

A Phase I review of Revision I of the study plan was done with respect to (A) DOE/NRC agreements on the content of study plans, (B) Identification of objections, (C) Closure of NRC open items, and (D) The Need for a Detailed Review (See Review Plan for Staff Review of DOE Study Plans, Revision I, 12/6/90).

Evaluation of Study Plans Relative to the Agreement and to the Responsible DOE Contractor's QA Program (Objectives 1 and 5)

Criterion 1 The content of the study plan under review is reasonably consistent, as appropriate for the activities, tests and analyses described, with the Agreement (NRC-DOE meeting on the level of detail

for site characterization plans (SCP) and study plans, May 7-8, 1986)

Staff Review: In general, the content of the study plan is reasonably consistent with the NRC/DOE agreements on the content of study plans (See Attachment 1). However, not all of the technical procedures have been provided in the study plan. Some have yet to be written. Some prototype tests have yet to be developed and tested.

Criterion 2 All study plan references have been provided when the study plan was issued.

Staff Review: All references have not been provided. The study plan lists 39 references and of these eight are considered not readily obtainable by the U.S. NRC library. Attachment 2 is a copy of the list of references from the study plan with all references marked either SCP (referenced in the Site Characterization Plan), AA (assumed to be available), or NAA (not assumed to be available). DOE should provide copies of all references marked NAA to the NRC. References marked AA may be requested later if they turn out to be not readily obtainable and are needed for future reviews or technical exchanges.

Criterion 3 Open items relative to the QA program of the DOE contractor responsible for the study plan that could call into question the quality of the study plan have been resolved.

Staff Review: Based on a note from J. Spraul (QA) to C. Abrams, there currently are no QA inadequacies that have to be resolved before the work begins.

Identification of Objections (Objectives 2 through 6)

Criterion 1 Potential adverse effects on repository performance;

Staff Review: The analytical activities described in this study plan will have little or no impact on the natural-state site conditions, and no adverse effect on the ability of Yucca Mountain to isolate waste. The proposed work should not affect the site in terms of either exploratory shaft or repository design. The planned work for Activities 8.3.1.2.3.2.2 and 8.3.1.2.3.2.3 does include extensive sampling from both existing and planned boreholes. However, the boreholes are located outside the perimeter drift. Ground-water withdrawals will be of a relatively small magnitude and will not significantly impact the potentiometric surface beyond the immediate vicinity of the boreholes.

Criterion 2 Potential significant and irreversible/unmitigatable effects on characterization that would physically

preclude obtaining information necessary for licensing;

Staff Review: No effects of this type have been identified. It is stated that because some of the tests are still in the developmental stage, the possibility that one of these tests may fail in achieving the desired objectives is recognized. The use of various methods for determining parameters increases confidence that the failure or partial failure of one or more tests will not severely inhibit the ability of the characterization activities to provide the information required. Sampling needs of other studies will be coordinated with respective investigators and support contractors to ensure that there is no interference between sampling requirements.

Criterion 3 Potential significant disruption to characterization schedules or sequencing of studies that would substantially reduce the ability of DOE to obtain information necessary for licensing.

Staff Review: No significant disruption in schedules is expected. The schedule of this study has taken into account how the study will be affected by contributions of data or interferences from other studies, and also how the present study will contribute or may interfere with other studies. It is stated that the sampling of the saturated zone for chemical analyses will depend on the drilling schedules of the water-table holes.

Criterion 4 Inadequacies in the QA program which must be resolved before work begins.

Staff Review: Based on a note from J Spraul (QA) to C. Abrams, there currently are no QA inadequacies that have to be resolved before the work begins.

Closure of NRC Open Items (Objectives 8 and 11)

Criterion 1 If DOE has proposed that one or more NRC open items be closed on the basis of the material in the study plan, determine whether those items can be closed.

Staff Review: The DOE has not proposed to close any open items with this study plan.

Need for Detailed Technical Review

A study plan is a candidate for detailed technical review if it meets any of the following criteria from step 6 of part 4.2 of the Review Plan. This study plan is a candidate for a detailed technical review based on criteria 1, 2, and 3.

Criterion 1 The study plan may be related to one or more key

site related issues.

Staff Review: This study plan may provide information to address key site-specific issues. The results of this study will be used in the resolution of performance and design issues concerned with fluid flow within the saturated zone beneath Yucca Mountain. Information derived from the study will support the performance determinations of pre-emplacment groundwater travel time (Issue 1.6) and the predictions of radionuclide releases to the accessible environment (Issue 1.1). Unsaturated zone water chemistry data from immediately above the water table may be used to indirectly support analyses of waste-package performance (Issue 1.10). The results from this study can support evaluations related to favorable or adverse effects on repository performance (Issue 1.8).

Criterion 2 The study plan pertains to some NRC open items.

Staff Review: In this review, open items are defined as SCA comments and questions and comments and questions from other study plan reviews. This study plan describes activities that could address Comments 21 and 22 of the SCA. Comment 21 recommends that technetium-99 and iodine-129 be added to the list of radioisotopes to be analyzed. The study plan states these two isotopes will be determined in the first two or three sites. If their activities are below detection limits, only 10 to 15% of subsequent samples will include analyses of these isotopes as described in the Radiological Monitoring Plan (DOE, 1988). If, however, the first samples have significant I-129 and Tc-99 activities, additional determinations will be made on the subsequent samples. Comment 22 recommends collecting water samples as close as possible to the water table. The method of collecting water immediately above and below the water table is described in the study plan.

Criterion 3 The study plan describes unique, state-of-the-art tests or analysis methods that therefore do not have a supportive scientific history of providing data usable in licensing.

Staff Review: The testing to be performed under this study does consist of state-of-the-art methods. Prototype testing will be performed as a part of this study.

Criterion 4 The study plan describes a study critical to the evaluation of site performance that cannot be repeated for a number of years due to its disruption of the natural baseline.

Staff Review: There should be no disruption of the natural baseline by performing this study. However, drilling will cause disruption from which the system will require some

period of time to recover. Monitoring the concentrations of tracers such as sulfur hexafluoride introduced in the drilling fluid will be used to indicate a return to ambient conditions.

Criterion 5 The study has some other critical relationship to potential licensing concerns.

Staff Review: Although the study plan describes general relationships between this and other studies including performance assessment, there is no explicit discussion of an overall program of iterative performance assessment, or discussion of the timing of this study relative to such a program. This kind of assessment is a systematic, iterative approach to identifying the information and analyses needed to support a license application. Such an approach was recommended in NRC's SCA Comment #1.

Reference

U.S. Department of Energy, 1988, Radiological Monitoring Plan for the NNWSI Project, DOE/NV-10576-6.

ATTACHMENT 1
Phase I Checklist for Study Plan 8.3.1.2.3.2

**Characterization of the Yucca Mountain Saturated-Zone
Hydrochemistry**

I. Purpose and Objective

Is the information to be obtained in the study described?
Yes No N/A

Is the rationale for information to be obtained provided?
Yes No N/A

II. Rationale for Study/Investigation

Does the study plan provide the rationale for tests and analysis, indicating alternatives considered and options, advantages, and limitations?
Yes No N/A

Alternative tests are not described, as the tests listed are generally accepted as standard procedures. However, the results of the tests will be applied to alternative conceptual models of the hydrologic system.

Does the study plan provide the rationale for the number, location, duration, and timing of tests, considering uncertainty, and identify obvious alternatives?
Yes No N/A

Does the study plan describe the constraints for the study?
Yes No N/A

In describing the constraints for the study, does the study plan consider potential site impacts?
Yes No N/A

In describing the constraints for the study, does the study plan consider the need to simulate repository conditions?
Yes No N/A

In describing the constraints for the study, does the study plan consider the required accuracy and precision?
Yes No N/A

In describing the constraints for the study, does the study plan consider the limits of analytical methods?
Yes No N/A

In describing the constraints for the study, does the study plan consider the capability of analytical methods?
Yes No N/A

In describing the constraints for the study, does the study plan consider the time required vs. time available?

Yes No N/A

In describing the constraints for the study, does the study plan consider the scale of phenomena and parameters?

Yes No N/A

In describing the constraints for the study, does the study plan consider the interference among tests?

Yes No N/A

In describing the constraints for the study, does the study plan consider the interference between tests and ES?

Yes No N/A

III. Description of Tests and Analysis

For each type of test does the study plan describe the general approach that will be used?

Yes No N/A

For each type of test does the study plan describe key parameters that will be measured in the test and the experimental conditions under which the test will be conducted?

Yes No N/A

For each type of test does the study plan indicate number of tests and locations?

Yes No N/A

For each type of test does the study plan summarize the test methods if non-standard procedure, summarize steps of test, how it will be modified, and reference technical procedure?

Yes No N/A

For each type of test does the study plan indicate the level of QA and provide rationale for any tests not QA level one?

Yes No N/A

This study plan was reviewed by J. Spraul from the Quality Assurance Section and found to adequately address this question.

For each type of test does the study plan reference the applicable specific QA requirements applied to the test?

Yes No N/A

This study plan was reviewed by J. Spraul from the Quality Assurance Section and found to adequately address this question.

For each type of test does the study plan specify the tolerance, accuracy, and precision required in the test?

Yes No N/A

For each type of test does the study plan indicate the range of expected results and the basis for those results?

Yes No N/A

For each type of test does the study plan list the equipment requirements, briefly describing special equipment?

Yes No N/A

For each type of test does the study plan describe the techniques to be used for data reduction and analysis?

Yes No N/A

For each type of test does the study plan describe the representativeness of test, indicating limitations and uncertainties that apply to use of results?

Yes No N/A

For each type of test does the study plan provide illustrations of test locations?

Yes No N/A

For each type of test does the study plan discuss the relationship of the test to set performance goals and confidence levels?

Yes No N/A

For each type of analysis does the study plan state the purpose of analysis, indicate conditions to be evaluated and describe any uncertainty analysis?

Yes No N/A

For each type of analysis does the study plan describe the methods of analysis, including analytical expressions and numerical models to be used?

Yes No N/A

For each type of analysis does the study plan reference the technical procedures document that will be followed during analysis?

Yes No N/A

However, some procedures have yet to be written. The study plan includes prototype testing indicating the procedures require further development.

For each type of analysis does the study plan indicate levels of QA applied?

Yes No N/A

This study plan was reviewed by J. Spraul from the Quality Assurance Section and found to adequately address this question.

For each type of analysis does the study plan identify data input requirements?

Yes___ No___ N/A_x_

For each type of analysis does the study plan describe the expected output and accuracy?

Yes_x_ No___ N/A___

For each type of analysis does the study plan describe the representativeness of analytical approach, indicating limitations and uncertainties that apply to results?

Yes___ No_x_ N/A___

However, this information is expected to be provided in the document produced as a result of this activity.

IV. Application of Results

Does the study plan briefly discuss where results from study will be used for support of other studies?

Yes_x_ No___ N/A___

Does the study plan refer to specific performance assessment analyses?

Yes_x_ No___ N/A___

Does the study plan describe where information from the study will be used in construction equipment and engineering system design and development?

Yes_x_ No___ N/A___

Does the study plan describe where information from study will be used in planning other characterization activities?

Yes_x_ No___ N/A___

V. Schedules and Milestones

Does the study plan provide durations of and interrelationships among principal activities associated with this study?

Yes_x_ No___ N/A___

Does the study plan list key milestones including decision points associated with study activities?

Yes_x_ No___ N/A___

Does the study plan describe the timing of the study relative to other studies and other program activities?

Yes_x_ No___ N/A___

Does the study plan provide dates for activities for the study plans: reference section 8.5 in SCP?

Yes_x_ No___ N/A___

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