Waste Isolation Pilot Plant

Compliance Certification Application

Reference 668

Wallace, M.G., Beauheim, R., Stockman, C., Martell, M.A., Brinster, K., Wilmot, R., and Corbet, T. 1995.
FEPs Screening Analysis, NS-1: Dewey Lake Data Collection and Compilation. Record Package submitted to SWCF-A:1.1.6.3:PA:QA:TSK:NS1. Sandia National Laboratories, Albuquerque, NM WPO 30650.

Submitted in accordance with 40 CFR §194.13, Submission of Reference Materials.

WPO 30650

INFORMATION ONLY

FEPs Screening Analysis

NS-1: Dewey Lake Data Collection and Compilation

WBS No. 1.1.6.3

SWCF-A: 1.1.6.3:PA:~~NQ~~:TSK: NS-1

QA ADS 12/21/95

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List of files must include:
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PLAN OF WORK

This document describes the process for conducting sidebar calculations. This work was planned, conducted, and documented in accordance with the FEP Management Plan titles "Features, Events, and Processes (FEP) and Assumption Screening: Procedural Aspects, Documentation QA" Revision 5.1, effective 5/11/1995.

A set of screening analyses has been performed to evaluate the sensitivity of the Waste Isolation Pilot Plant (WIPP) repository performance to the FEP Screening Issue NS-1: Dewey Lake Data Collection and Compilation

This records package provides background information on the process used for conducting the screening analysis and summarizes the scenarios considered, identifies the computer codes and input and output files used in the calculations, and describes the performance measures that are used to help establish FEPs screening decisions. The statement of recommended screening decision for this FEP is provided in the Summary Memo of Record.

PLANNING MEMOS OF RECORD (PMoR)

The Planning Memo of Record for NS-1, *Dewey Lake Data Collection and Compilation* is provided in the following pages.

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NS-1: DEWEY LAKE DATA COLLECTION AND COMPILATION
Planning Memo of Record

DATE: **June 12, 1995**

TO: **D. R. Anderson**

FROM: **R. Beauheim**

SUBJECT: FEP Screening Issue NS-1

STATEMENT OF SCREENING ISSUE

There are two basic screening issues regarding the Dewey Lake redbeds:

- Is there now, or will there be at any time over the next 10,000 years, a laterally continuous water table within the Dewey Lake? If so, it can conceivably be argued that, because of the relatively pure nature of Dewey Lake waters where they have been encountered, that: a) this water table should be monitored during the active-institutional-control phase of the WIPP; and b) from a regulatory standpoint, potable water does exist within the WIPP site area.

- Is there any significant potential for radionuclide release through the Dewey Lake to the accessible environment (i.e. across the site boundary) under either undisturbed or human-intrusion conditions? If so, then contaminant/radionuclide transport within the Dewey Lake might need to be explicitly included in future repository-evaluation calculations.

The revised "baseline" position for contaminant transport within the Dewey Lake, as of 2/95, is that: a) there is no laterally continuous "water table" within the unit in the site area; and b) there will be no contaminant transport through the Dewey Lake to the accessible environment, under either undisturbed or human-intrusion conditions. This approach is based on the assumed completion of this activity. If this effort is not completed, it will be necessary to return to a position in which any (or at least a portion of any) radionuclides partitioned into the Dewey Lake in calculations of brine flow are assumed to be releases to the accessible environment.

APPROACH
Calculation Design

The Dewey Lake evaluation study consists of several small efforts. These include:

- Compilation of existing lithologic, stratigraphic, and hydrologic data for the Dewey Lake and Dockum Group.

- Analysis of existing Dewey Lake core from the core library.

- Analysis of Dewey Lake core to be collected at the H-19 pad.

These three closely-coordinated efforts will lead directly to:

- Development and documentation of a conceptual flow and transport model for the Dewey Lake.

- Definition of a reasonable sorption-distribution coefficient for the Dewey Lake (K_d), using existing literature values, and considering colloid transport.

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- Performing a short pumping test at the WQSP-6a well, in order to obtain site-specific hydraulic data, and performing a 1D infiltration calculation through the WIPP unsaturated zone.

These last efforts, combined with the conceptual model derived from the first steps, will provide both literature-based and site-specific information required for:

Use of the regional-scale 3D model in one-dimensional vertical calculations to calculate the effects of climate change on water levels and hence any distribution of a water table within the Dewey Lake.

Completion of lateral one-dimensional contaminant-transport calculations to assess the feasibility of radionuclide releases through the Dewey Lake quantitatively.

Resource Estimate for NS-1: DEWEY LAKE DATA COLLECTION AND COMPILATION

Total cost: $150 K

Duration: one year to final reporting.

Reporting of conceptual and numerical model requirements to PA: 9/95.

Final reporting of required PA parameters and distributions for evaluation of Dewey Lake: 3/96.

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SOFTWARE

Title and version of software used:

Microsoft Excel Version 5.0
spreadsheet

Copy of Software Abstract for all software that is not commercially available: None; Microsoft Excel 5.0 is commercially available

Source listing of Macros and other application software codes: None

PLATFORM

List of hardware and operating system (title and version) on which each code was run:

Hardware: Compaq Deskpro 386/20
Operating System: Microsoft Windows version 3.1

INPUT DATA SET

Data set and information files used, including name and version of all databases, libraries, and data files:

- There are no data input files per se, as computer codes were not used in this analysis, only hand calculations.
- A complete development of the data is included in Appendix 2, "Proposed Conceptual Model of Dewey Lake Formation Hydrogeology."
- A page of supplementary data/information is included here (see Table 6-20, "Dewey Lake Parameters for the BRAGFLO Model" on the following page. This table is in the DCCA, which is listed in the References section).
- A note from R. Beauheim is also included.
- Three additional memos that were examined for relevant data.
    1. SREMR from Bob Diaz to many recipients on 3-2-95.
    2. Memo from Sarah Bigger to J. Mewhinney on 10-18-94.
    3. Fax from Larry Modl (Westinghouse) to Sarah Bigger on 10-18-94.

Documentation of deviations from baseline data set including rationale:

A primary purpose of this FEP was to explore the need of incorporating new data and/or concepts into the next round of PA calculations. Therefore, there are deviations from the baseline data set, by necessity. See Section 6, Summary Memo of Record in this records package for the related documentation and rationale.

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Table 6-20. Dewey Lake Parameters for the BRAGFLO Model

Parameter	Maximum	Minimum	Median or Constant[a]
Permeability (m^2)	—	—	9.33×10^{-16}
Porosity (%)	—	—	15
Pore compressibility (1/Pa)	—	—	6.67×10^{-8}
Two-phase flow: Brooks-Corey	—	—	1.0
P_t (Pa)			0
S_{br}			0.2
S_{gr}			0.2
λ			0.7
Thickness (m)	—	—	149.3
Initial Pressure	—	—	hydrostatic, water table at 980 m, 43.3 m below top of formation
Initial pressure, atm, 20% liquid saturation, above water table	—	—	1

[a]Parameters with no maximum and minimum values are treated as constants in the performance assessment.

CALCULATIONS

List of parameters required, including units:

V = average linear velocity of ground water [m/s]
V_c = average velocity of dissolved contaminant [m/s]
ρ_b = bulk density of matrix [g/m^3]
η = porosity of matrix
K_d = distribution coefficients [ml/g]
dh/dl = hydraulic gradients
K = hydraulic conductivity [m/s]
l = length of travel path [m]
t = time to travel l [s]; actually, this is what I solve for.

Rationale for selection of models used in calculation:

See "Approach" section in the Summary Memo of Record for NS-1, included in this records package.

Assumptions:

1. 1-D Analysis:
This assumption is more conservative than an analysis of greater dimensions.

2. Selected Hydraulic Conductivity:
The maximum hydraulic conductivity from the literature is used.
Were this FEP to be screened in, Ks could justifiably be sampled on, significantly reducing the estimated impact.

3. Magnitude of hydraulic gradient:
Conservative, according to the reasons given in the Approach section
Were this FEP to be screened in, hydraulic gradients could justifiably be sampled on, significantly reducing the estimated impact.

4. Minimum Kd value used:
Far greater Kd values could likely be supported. Were this FEP to be screened in, Kds could justifiably be sampled on, significantly reducing the estimated impact.

5. Steady state flow:
These analyses, being steady state, have the implicit conservative assumptions that a well has always been pumping and will continue to pump through the time frame of concern. Were this FEP to be screened in, transient factors could justifiably be sampled on, significantly reducing the estimated impact.

6. Other issues related to assumptions:
Were this FEP to be screened into the next PA, it would be utilized in conjunction with a host of other sampled parameters that play important roles with respect to the movement of contaminants into and through the Culebra. Among these parameters are such issues as the timing of the occurrence of a repository intrusion event. In this context, an interconnection could exist for 10,000 years (and be in the most potentially damaging location within the 'fastest' T-field) and still have little impact on contaminant transport, if an intrusion does not occur until late in the time horizon, or even after 10,000 years.

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Name of analyst: Michael G. Wallace

Dates Analysis Conducted: June through September 1995.

Instructions from Lead Staff Member or other memos of instruction, if applicable: No additional instructions were needed.

Diagram of data flow describing among computer codes: None

List of Input and output files and files of plots, tables, and figures data files generated during the analysis. List of files must include:

Name and extension of WIPP archive file: None

Hardcopy of input and output files (optional) which are identified by name and extension of archive file: None

Plots, tables, and figures synthesizing results: see Summary Memo of Record for NS-1 and SMoR Appendix 2

Documentation of deviations from analysis plan, including rationale for deviations:

The actual analysis omitted several of the proposed steps outlined in the Planning Memo of Record (see section 1.0 of this Records Package). Those steps omitted were:

- Analysis of existing Dewey Lake core from the core library
- Analysis of existing Dewey Lake core to (sic) collected at the H-19 pad.
- Pump test work
- 1-D vertical infiltration calculations
- Use of the regional-scale 3D model in 1-D vertical calculations to evaluate climate change effects on water levels and distributions.

The NS-1 Summary Memo of Record included herein documents how the analysis actually was performed. Along with the numerous bounding assumptions, sufficient reliable information was collected in the first data compilation activity to develop calculations which effectively screened out transport through the Dewey Lake as an issue. The work omitted above was not performed because it was found to be unnecessary.

Statement indicating if calculation was or was not successfully completed: Calculation was successfully completed.

List of bound notebooks if used to document analysis: None

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SUMMARY MEMO OF RECORD

The SMOR includes the following:

- Statement of recommended screening decision
- Statement of screening issue(s)
- Approach (as performed, not planned)
- Results and discussion
- Basis for recommended screening decision

SMoR Appendix 1: Velocity Field Performance Metric Concept
SMoR Appendix 2: Proposed Conceptual Model of Dewey Lake Formation Hydrogeology

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Summary Memo of Record for NS-1:
PA Conceptualization of Dewey Lake
Lead Staff Member: M. Wallace, RE/SPEC Inc. (6115)

Recommended Screening Decision:

It would be conservative to screen out NS-1. This FEP should be classified as a 'reserve' FEP; one whose inclusion into the PA would be advantageous for the development of a compliance case.

Statement of Screening Issues:

Is there any significant potential for radionuclide release through the Dewey Lake to the accessible environment under either undisturbed or human-intrusion conditions? Should calculations of radionuclide transport within the Dewey Lake be explicitly included in future PAs?

Approach:

This approach falls under the category of a Velocity field based screening Effort (VE, see Appendix 6.1). As such it relies on a strategy of using the hydrogeologic information obtained to generate a bounding velocity field within the Dewey Lake Formation in the area of concern. A series of simple one-dimensional hand calculations were employed towards this objective.

The hydrogeologic information used in these analyses is described in detail in Appendix 6.2, "Proposed Conceptual Model of Dewey Lake Formation Hydrogeology". Conclusions developed in that sidebar documentation include the following.

Groundwater flow in the Dewey Lake is believed to be directed from the northeast to the southwest. The elevation of the water table in the WIPP area is within the Dewey Lake horizon at approximately 980 m amsl. The Dewey Lake dips in that area from the west to the east. At the southwest corner of the LWB, the elevation of the bottom of the Dewey Lake is approximately 920m amsl. The hydraulic conductivity distribution is poorly characterized, but there appears to be a relatively narrow band of relatively high-K Dewey Lake sediments stretching from the southwest corner of the waste panel area to the southwest corner of the LWB.

The Dewey Lake sediments appear to have an extremely high sorption potential, normally characterized by the Kd (distribution coefficient). The minimum Kd identified for the suite of actinides of concern for this type of environment (not accounting for many factors which would likely raise it significantly), is 10, for Uranium. The Kd for plutonium in this environment is over 1,000.

Given the current level of understanding of the Dewey Lake, a simple 1-D flow analysis was the most appropriate approach. In this approach a path was postulated from the center of the waste panel area to the southwest corner of the LWB, in accordance with the perceived groundwater flow direction and the high K zone believed to exist there. A path length of 2500 m was assumed, with a constant K assignment of 1e-6 m/s (high end value for Dewey Lake-type sediments).

The maximum rate a well could pump from the Dewey Lake at the southwest end of this path would be a rate sufficient to lower the water table to the bottom of the formation. This would be an extremely high and historically unjustifiable pumping rate. This rate is approximated in the analysis by the assignment of head at the southern end of the model equal to the elevation of the bottom of the Dewey Lake elevation, and the assignment of head at the northern end of the model equal to the perceived elevation of the water table. That yields a hydraulic gradient of approximately 0.024 m/m. The current regional hydraulic gradient in that direction is estimated to be approximately 0.008 m/m. Such a gradient has also been simulated in this exercise.

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A K_d of 10 was used in this analysis. Porosity was assumed to equal 0.15 or 0.35, and bulk density was assumed to equal 2.1 g/cc.

Darcy's Law was used to estimate average linear groundwater velocities. Then the relations:

$Vc = V/R$

$R = (1 + (\rho_b/\eta) K_d)$

where:

Vc=avg. linear velocity of contaminant
V = avg. linear velocity of groundwater
ρ_b=bulk density of matrix
η= porosity of matrix

were used to estimated mean travel times for contaminants.

Summary information for the three cases sampled are shown in Table NS1.1:

Table NS1.1: Summary Information

Case #	Hydraulic Gradient	Ratio Of Bulk Density To Porosity
case 1	0.008	14
case 2	0.008	6
case 3	0.024	6

Results and Discussion for NS1

Table NS1.2 depicts the VE metric for this calculation. As shown, the mean travel times from the center of the waste panel boundary to the LWB range from roughly 30,000 to over 200,000 years. Those travel times are far longer than the fastest (or even the mean) travel times from the 92PA w/out climate standard series of velocity fields.

Table NS1.2 Predicted Travel Times in Years for the Path of a Neutrally Buoyant Particle from the Center of the WIPP Waste Panel Area to the WIPP Land Withdrawal Boundary Within the Dewey Lake, Given a Universal K_d of 10ml/g (and other assumptions).

Case 1	Case 2	Case 3	shortest 92PA without climate change travel time	Shortest NS8-b travel time
211,000	91,200	30,000	7,640	2,309

Reviewers are encouraged to read the Assumptions section of this report, in which conservative assumptions behind the design of these calculations are described.

Basis for Recommended Screening Decision

Based on the calculations provided in this memo, NS-1 is screened out.

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SMoR Appendix 1

Velocity Field Performance Metric Concept

Contaminants migrate through the Culebra due to processes of advection and dispersion. Modeling and other exercises have shown both processes to be potentially significant. In the models used to evaluate contaminant transport for WIPP, there is a one-way coupling from velocities (advection) to the other contaminant transport (and retardation) processes. In other words, advection is the base process, upon which the other contaminant processes are appended (and somewhat dependant on). Therefore, for screening purposes, a velocity field can be viewed as an indicator parameter. Then, changes in the characteristics of a velocity field can analyzed and interpreted (to some degree) with regard to ultimate releases of contaminants to the AE.

That is the basis for the approach adopted in this screening effort and a number of related screening efforts. For convenience of discussion they are collectively referred to here as the "Velocity field based screening Effort"s, or VEs. A velocity field from the 92PA model (or from the 95 DCCA model) is designated as the 'standard'. The fep evaluated in the VE screening effort leads to a new velocity field. This field is compared to the standard through particle tracking. A single neutrally bouyant particle originates at the geographic center of the waste panel area (yet within the Culebra) and is tracked up to its exit past the LWB. The time of travel of such a particle is then simply compared to the time of travel for a particle within the standard velocity field (alternatively, a series of standard fields may be developed, and compared to a series of VE fields).

Velocity fields provide an integrated means to depict the combined effects of a number of different processes and features, including formation material properties and boundary conditions. The VE s all share, at least in part, implementation of different boundary conditions (both internal and external) to aquifer models. Conveniently, velocity fields are also input indirectly into the PA compliance model (via SECOTP) as a sampled vector. As a result, the PA compliance model integrates the myriad aquifer hydraulic and material parameters into the velocity field metric.

Because of this, a screening argument bounding concept can be applied to VE s that only differ with regard to boundary conditions. For example, given a certain transmissivity (T) field and other constants, one VE could concern an injection process, while another could concern a water withdrawal process. The VE that generated the shortest particle travel time of the two could then serve as the metric by which to compare to the standard flow field. If that VE travel time was shorter than the standard time, then that sidebar issue might be screened in. If that were the case, then the other VE sidebar could be immediately screened out, as it would now be implicitly accounted for in PA.

On the other hand, if the 'faster' VE was still slower than the standard case, then both VE sidebars could be immediately screened out.

Note: Concerns have been raised that this bounding strategy could be co-opted when one considers combinations of feps occurring. These concerns can be addressed, considering the following:

The VE feps have been consistently designed to identify the highest consequence scenario(s) under their descriptions. These scenarios accordingly have extremely low probabilities (although these probabilities cannot be currently quantified). Assuming that each VE fep is an independant process (or that some VE feps are mutually exclusive), then the probability of the combination of two (or more) of these high consequence scenarios occurring simultaneously is likely to be infinitesimal.

There are arguably substantial sample domains (were all these feps to be screened in separately) where the impact to compliance of such combinations would be nil or beneficial. Also, some combinations of VE feps would make no sense. Arguments can be readily developed to support these claims, if necessary.

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SMoR Appendix 2

Proposed Conceptual Model of Dewey Lake Formation Hydrogeology

This paper summarizes the geology of the Dewey Lake and presents an outline of the hydrogeological data and a conceptual model of flow.

Geology

The Dewey Lake (also known as the Dewey Lake Redbeds or the Quartermaster Formation) comprises mudstones, siltstones, silty claystones, and reddish-brown fine sandstones of late Permian age. The Dewey Lake and lateral equivalents are found throughout much of the Permian Basin. Because of the paucity of some types of data from the WIPP region, data from these lateral equivalents has been used where necessary in this data compilation.

In the WIPP region the Dewey Lake overlies the Forty-Niner Member of the Rustler Formation. East of the center of the WIPP site, it is overlain by undifferentiated Triassic rocks, including the Dockum Group. Figures NS-A1.1, NS-A1.2, and NS-A1.3 depict the Dewey Lake bottom elevation, top elevation, and thickness[1] contours, respectively.

The Dewey Lake is composed of interbedded unfossiliferous reddish-orange to reddish-brown claystone, siltstone, and fine-grained sandstones with varying sedimentary structures (Schiel, 1987). It is subdivided into upper and lower sequences on the basis of grain size and sedimentary structures (Holt and Powers, 1990). The depositional environment of the upper sequence is interpreted to be a region of ephemeral streams, and the lower sequence is interpreted to represent a saline mud flat environment.

A petrographic study (Miller, 1966) showed that the red color of the Dewey Lake formation is due to a "thin hematite coating on the surface of the sand and silt grains and from disseminated hematite-stained clay." The hematite was deposited after deposition and prior to cementation. The most common cement minerals are gypsum, calcite and hematite. The Dewey Lake is distinguished from other red beds in the region by scattered greenish-gray reduction spots, and by locally abundant fractures filled with fibrous gypsum (Holt and Powers, 1993).

Hydrogeology

Hydrogeological data for the Dewey Lake has been extracted and interpreted from over fifty wells in the WIPP region (Table NS1-A1). The principal objective of this effort was to develop greater understanding with regard to the water table and the hydraulic conductivity distribution.

Until recently it has commonly been assumed that, in certain areas, the Dewey Lake is unsaturated over significant intervals. This assumption was based on the fact that for many boreholes which penetrated the entire thickness of the Dewey Lake, there were no measurable flows from that unit into the borehole. The alternative assumption adopted here is that these boreholes penetrated portions of the Dewey Lake that were saturated, but that had hydraulic conductivities too low to support measurable flows over the periods of observation.

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1 Note that the isopach map on Figure NS1-A3 also includes units above the Dewey Lake where these are present.

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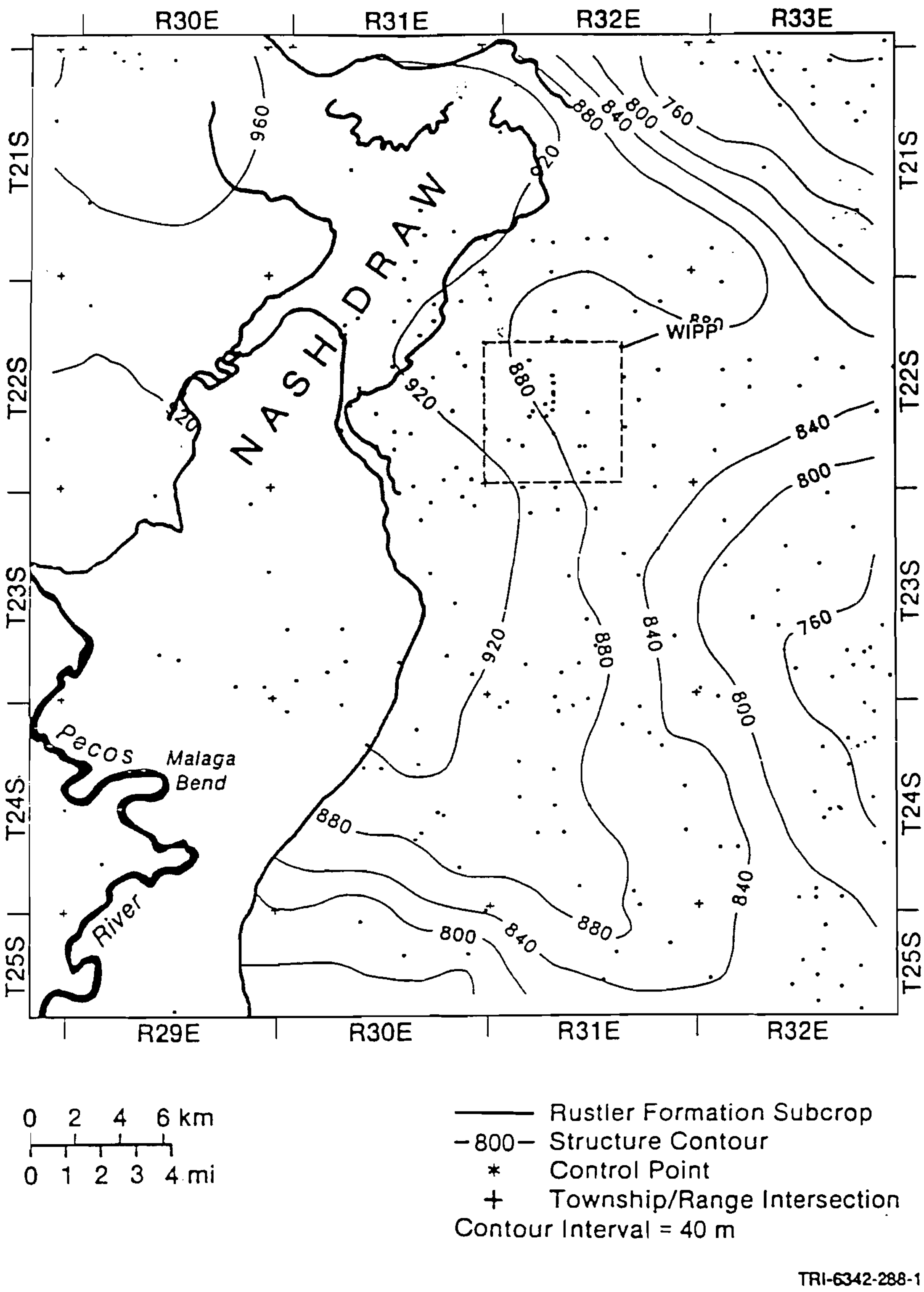

Figure NS-A1.1 Structure Contours on Top of the Forty-niner Member (from Brinster, 1991)

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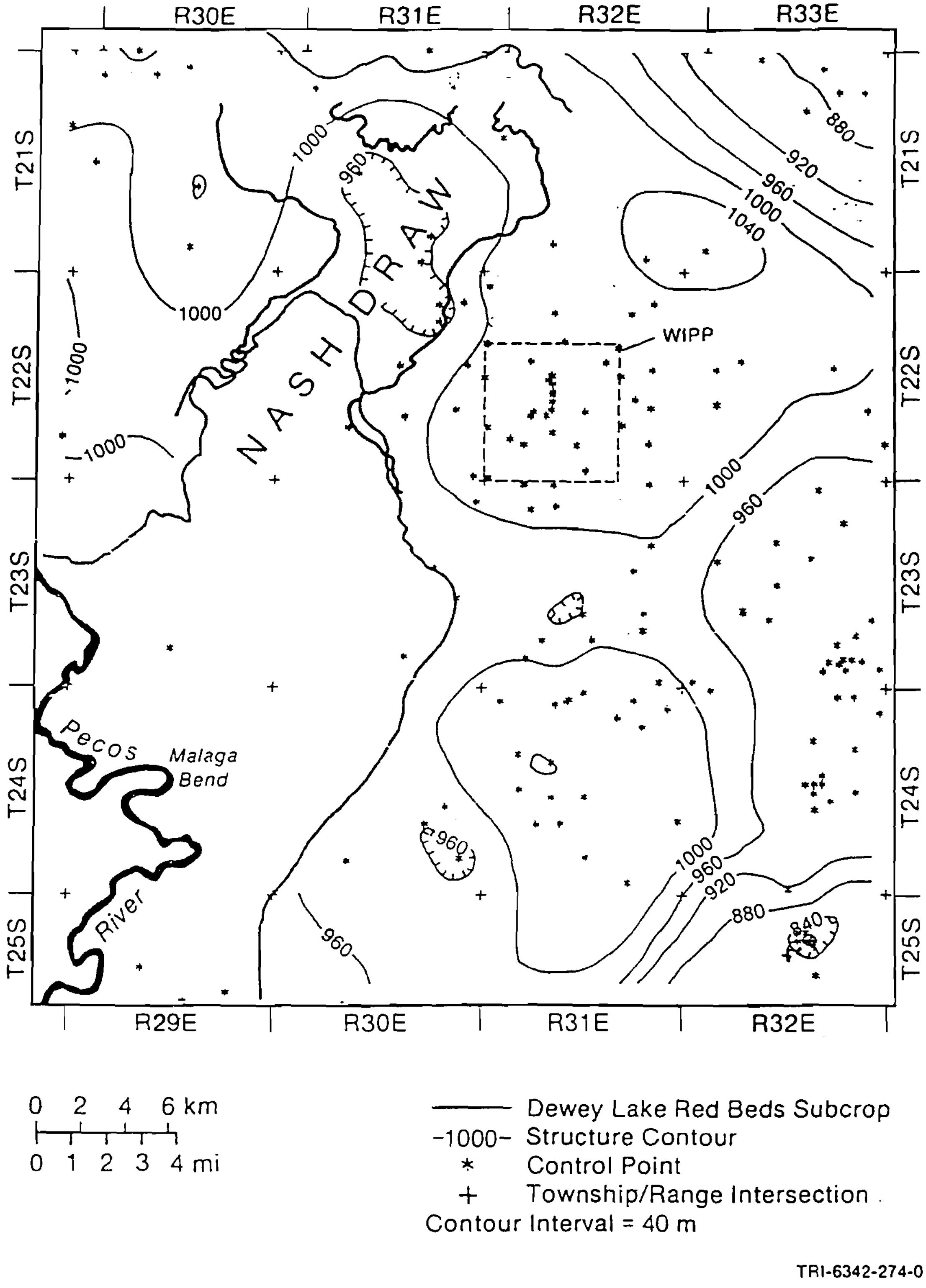

Figure NS-A1.2 Structure Contours on Top of the Dewey Lake Red Beds (from Brinster, 1991)

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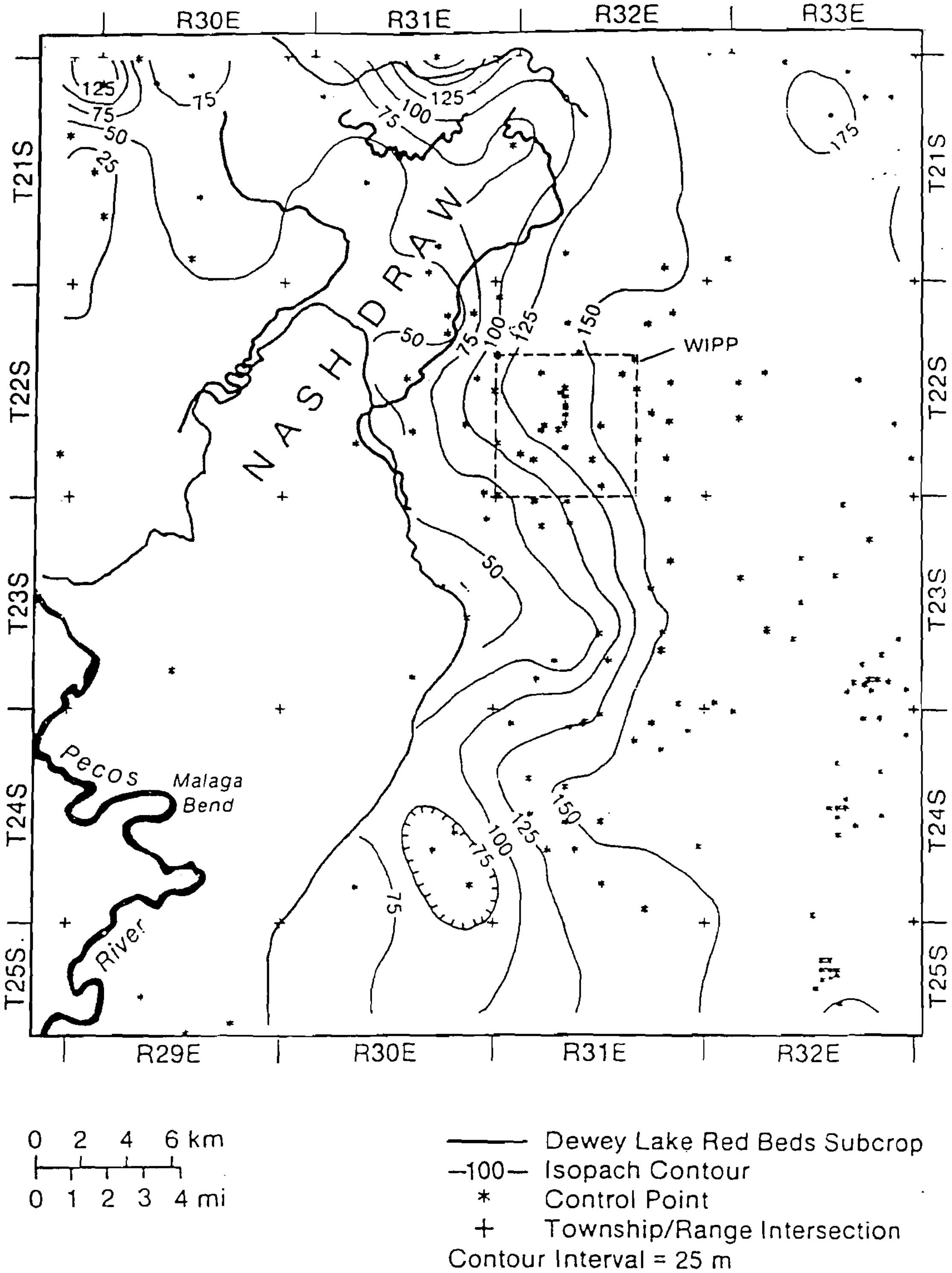

Figure NS-A1.3 Isopach Map of the Dewey Lake Red Beds (from Brinster, 1991)

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Table NS1-A1

WELL	XUTM	YUTM	elevm	Comments: wc=well completed, lc=lost circulation, gdl=gypsum, elevation is from log of lithologic description, P well elevations come form lith. description and e-logs.
W26	604005	3581161	960.7022	wc 9/78, also lc at 255'(77.7m) SAND79-0280
W25	606389	3584037	979.173	wc9/78,also lc at 90-108 and 522-526, gdl, SAND79-0279
ERDA10	606684	3570523	1027.542	wc 10/77,SAND79-0271
H7	608087	3574631	964.2348	wc 9/79, WRI82-38
H8	608658	3563540	1046.378	wc 8/79, WRI82-4118
P14	609083	3581973	1023.549	wc 10-76, air drilled, hit water at 589, OF 78-592
W33	609630	3584018	1012.921	wc 6/79,SAND80-2011
P12	610455	3583452	1029.005	wc 10/76, lc at 742 (226)low R, and 813'(248m)in S,OF78-592,wt is ?,OF78-592
P13	610530	3585075	1019.678	wc 9/76 air drilled, water at 630'(192m) OF78-592
P6	610617	3581129	1022.147	wc 9/76, OF78-592
P15	610624	3578792	1008.797	wc 9/76, air, no gyp in dl, hit water @ 225'(68.6m),OF78-592
H18	612261	3583164	1040.404	wc 9/87,gdl,SAND89-0204
P7	612306	3578476	1015.502	wc 7/76
P1	612338	3580338	1019.495	wc 9/76, OF78-592,gdl
H14	612342	3580352	1019.739	wc 10/86 gdl, SAND89-0202
W13	612651	3584240	1037.945	wc 8/78, gdl, SAND79-0273
P16	612698	3577315	1012.789	wc 9/76, gdl, OF79-592
P3	612799	3581908	1030.925	wc 9/76, OF79-592
W14	613080	3585103	1045.159	wc 6/81, gdl, SAND82-1783
H16	613374	3582215	0	
P5	613684	3583540	1058.205	wc 9/76, OF79-592
DOE2	613686	3585292	1041.913	wc 9/84, air mist, SAND860611
ERDA9	613696	3581957	1039.021	wc 5/78,gdl,hole history data wpo4126
W12	613709	3583524	1058.113	wc 12/78,gdl,SAND82-2336
W30	613718	3589700	1044.714	wc 9/78, gdl, SAND79-0284
W18	613730	3583178	1053.532	wc 3/78, SAND79-0275
W19	613730	3582781	1046.418	wc 5/78,gdl, SAND79-0276
W21	613746	3582318	1041.502	wc, 5/78, gdl,SAND79-0277
W22	613746	3582652	1044.193	wc 5/78,gdl,SAND79-0278
W11	613789	3586475	1044.275	wc 3/78,gdl,SAND79-0272
P8	613828	3578466	1016.935	wc 9/76,air drilled
P17	613929	3577464	1017.88	wc 10-76, air drilled, water at 265' (81m)and at 600' (183m),gdl
H9	613966	3568232	1037.844	wc 8/79,gdl,WRI82-4111
W34	614334	3585140	1046.378	wc 9/79,gdl,SAND81-2643
P4	614935	3580323	1048.878	wc 9/76,air drilled,water at 259'(78.9m)
H15	615315	3581858	1060.765	wc 10/86,SAND89-0202,
P2	615315	3581850	1060.003	wc 9/76,OF79-592,air drilled
H11	615350	3579130	1040.191	wc 1/84,gdl,SAND 89-0200
P9	615360	3579125	1038.941	wc 9/76,water at 220'(67m)
H17	615722	3577509	1031.443	wc 9/87,gdl,SAND89-0204
P21	616895	3584849	1069.909	wc 10/76,gdl,air drilled, water at 525'(160m)
P11	617014	3583456	1068.568	wc 10/76,gyp from elog(increase por,decrease density)
H12	617022	3575457	1044.239	wc 10/83,gyp from description, SAND89-0201
P10	617079	3581201	1069.36	wc 10/76
AEC8	617522	3586435	1076.554	wc 5/74,gyp form lith. descpription,SAND79-0269
P19	617686	3582410	1080.912	wc 11/76, gdl,
ERDA6	618226	3589011	1079.053	wc 9/75, air mist,SAND79-0267
P18	618366	3580351	1060.308	wc 11/76,gdl

QA ARS 12/21/95 mbw 12-20-95

Table NS1-A1 (continued)

P20	618534	3583768	1082.924	wc 10/76, air drilled,gdl
AEC7	621118	3589387	1114.209	wc 4/74,gdl,SAND79-0268
H10	622978	3572448	1123.761	wc 8/79,gdl,WRI83-4124
H1	613419	3581686	1035.622	SAND82 82-0080
H2	612662	3581662	1029.569	From hole history wpo3313
H3	613734	3580895	1033.114	SAND82 82-0080
H4	612403	3578496	1015.871	SAND82 82-0080
H5	616898	3584802	1068.675	From hole history wpo3370 6/78
H6	610608	3585026	1020.245	SAND82 82-0080

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For boreholes with no measurable flow from the Dewey Lake that were air-drilled, drillers' logs often contain information on the first encounter of wet or moist cuttings. The elevation of this first encounter is interpreted to represent the height of the water table. For a number of other boreholes with no flow, geophysical logs (gamma logs) have provided evidence for the first encounter of saturation.

Information from driller's logs and borehole records was also sought for boreholes that did encounter transmissive saturated portions of the Dewey Lake. These transmissive units do not necessarily represent the actual water table, which may lie in a higher, less transmissive section. There were also many holes for which circulation losses in the Dewey Lake during drilling were reported. These losses have been used in the interpretation of hydraulic conductivity distributions but, since mud was used during drilling (and no additional pertinent information was available), it is not certain whether or not these zones were water saturated.

Information on the height of the water table from these various sources is presented in Table NS1-A2. The boreholes were drilled over a period of more than twenty years, but most were drilled in the late 1970s and the data are considered valid for the purpose of defining a regional water table. Figure NS-A1.4 depicts the new interpreted general water table surface. The figure indicates that the water table slopes down from the northeast to the southwest, with an approximate gradient of 0.01. The elevation of the water table above the WIPP waste panel area is roughly 980 meters (amsl).

The 3-D Regional Groundwater Modeling effort included the modeling of flow in the Dewey Lake, as well as in the Rustler Formation. The model was necessarily conceptual in nature, particularly with regard to the Dewey Lake (given the lack of data). A number of runs were made for that study, in which hydraulic conductivity and recharge patterns were systematically varied.

The model run that was most representative of present-day Rustler hydrologic conditions was examined in this study under the premise that its conceptualization of flow through the Dewey Lake may also be representative of real conditions. That run (Run b135) suggested that flow in the Dewey Lake is directed towards the southwest and that the water table elevation in the WIPP waste panel area is somewhere between 950 and 975 meters amsl (Figure NS-A1.5). The majority of other model runs also showed flow in the Dewey Lake towards the southwest or west, and a water table located within the Dewey Lake (rather than within the overlying Dokum Group).

A comparison of the water table derived from borehole data and that based on the results of 3-D groundwater modeling shows some differences, but there is a consistency between the two results that lends confidence to the water table surface presented here (Figure NS-A1.4).

Data from boreholes through the Dewey Lake have been used to develop a qualitative description of the hydraulic conductivity distribution within the unit. Figure NS-A1.6 depicts the interpreted qualitative hydraulic conductivity distribution. The region has been subdivided into two zone types. The high-K zones contain boreholes into which water from the Dewey Lake was observed to flow or boreholes in which circulation losses during drilling (through the Dewey Lake) occurred. The low-K zones contain the boreholes (which fully penetrate the Dewey Lake) into which water was not observed to flow and in which circulation losses were not reported.

The absence of quantitative data and the variable standard of information recorded on driller's logs means that the intrepretation of the well data and the delineation of the zones was subjective. If the interpretations are correct, then it would appear that the Dewey Lake is a unit of generally low K within which there are a number of NE to SW- trending, relatively narrow, high-K zones. The two southern high K zones shown in Figure NS-A1.6 may be unconfined.

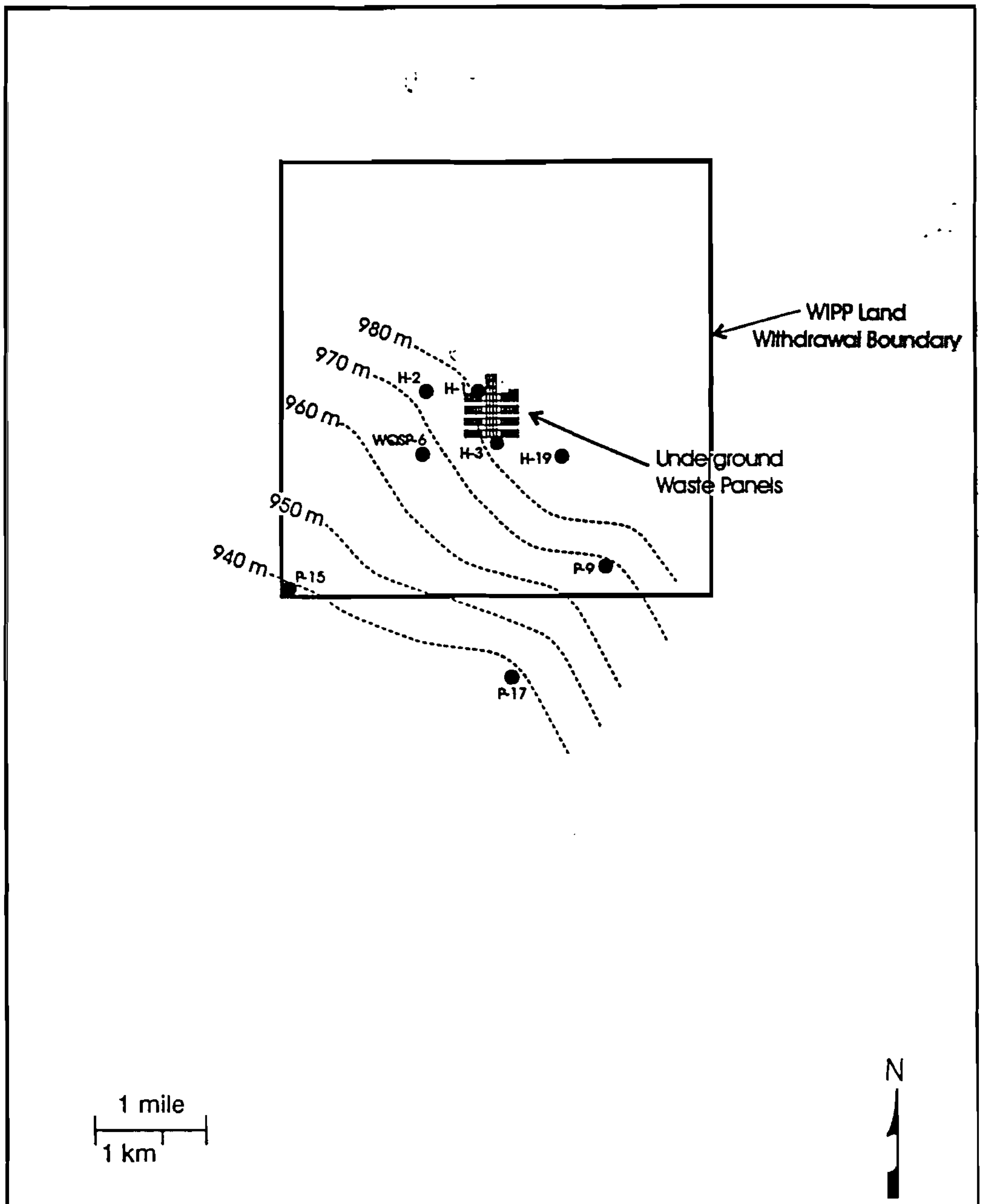
QA AES 12/21/95 MBW 12-20-95

SWCF-A: 1.1.6.3:PA:NQ:TSK: NS1

QA AES 12/21/95
MBW 12-20-95

Table NS1-A2

Borehole or Well I.D.	XUTM (m)	YUTM (m)	Land Surface Elev. (ft)	Land Surface Elev. (m)	Depth to Moist Cuttings or gamma spike	Estimated Water Table Elevation (m)	Approx Date of recording of depth to water	Hydraulic Conductivity (K) Designation	Depth to 'flowing' water (m) (only for high K zones)	Elevation of top of 'flowing' water zone (m)	Thickness of 'flowing' water zone (m)
P2	615315	3581850	3477.7	1060.003			Sep-76	low			
P4	614935	3580323	3441.2	1048.878			Sep-76	low			
P8	613828	3578466	3336.4	1016.935			Sep-76	low			
P9	615360	3579125	3408.6	1038.941			Sep-76	high	67	971.941	
P15	610624	3578792	3309.7	1008.797			Oct-76	high	69	939.797	
P17	613929	3577464	3339.5	1017.88			Oct-76	high	81	936.88	
H1	613419	3581686	3397.71	1035.622	55	980.622	Jun-76	low			
H2	612662	3581662	3377.85	1029.569	56	973.569	Feb-77	low			
H3	613734	3580895	3389.48	1033.114	53	980.114	Aug-76	low			
H19			3418	1041.8	53.2	988.6	May-95	low			
wqsp1								low			
wqsp2								low			
wqsp3 not drilled yet?											
wqsp4								low			
wqsp5								low			
wqsp6				1024				high	55.5	968.5	7.9



Note: The wells shown are the ones used to develop this surface.

Fig. NS-A1.4 Interpreted General Water Table Surface
(meters above mean sea level)

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QA AES 12/21/95 MBW 12-20-95

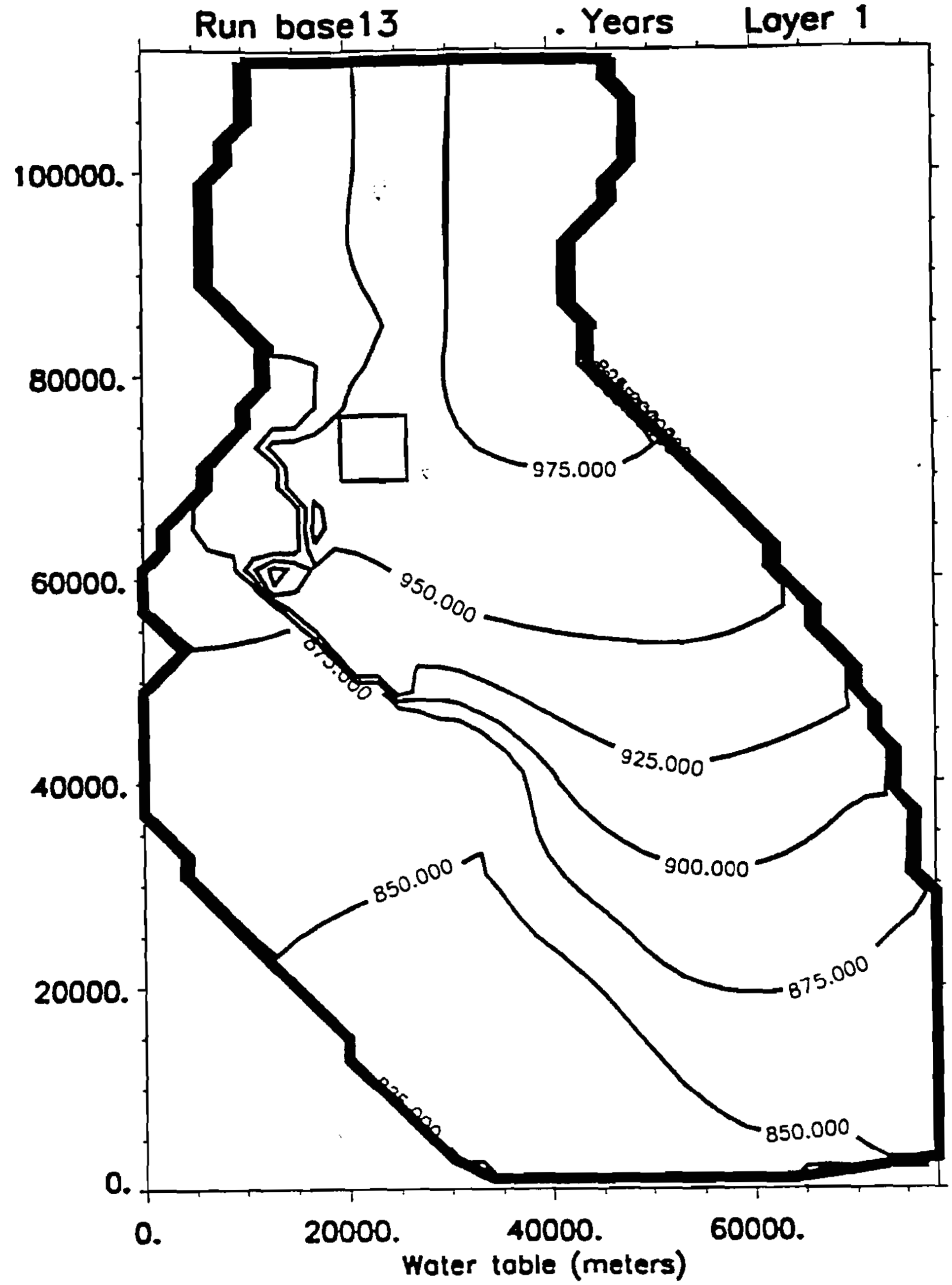

Figure NS-A1.5 Water Table Elevations as simulated by a run from the WIPP 3-D Regional Modeling Effort. (WIPP Land Withdrawal Boundary shown as a square in the figure)

QA ART 12/21/95 mbw 12-20-95

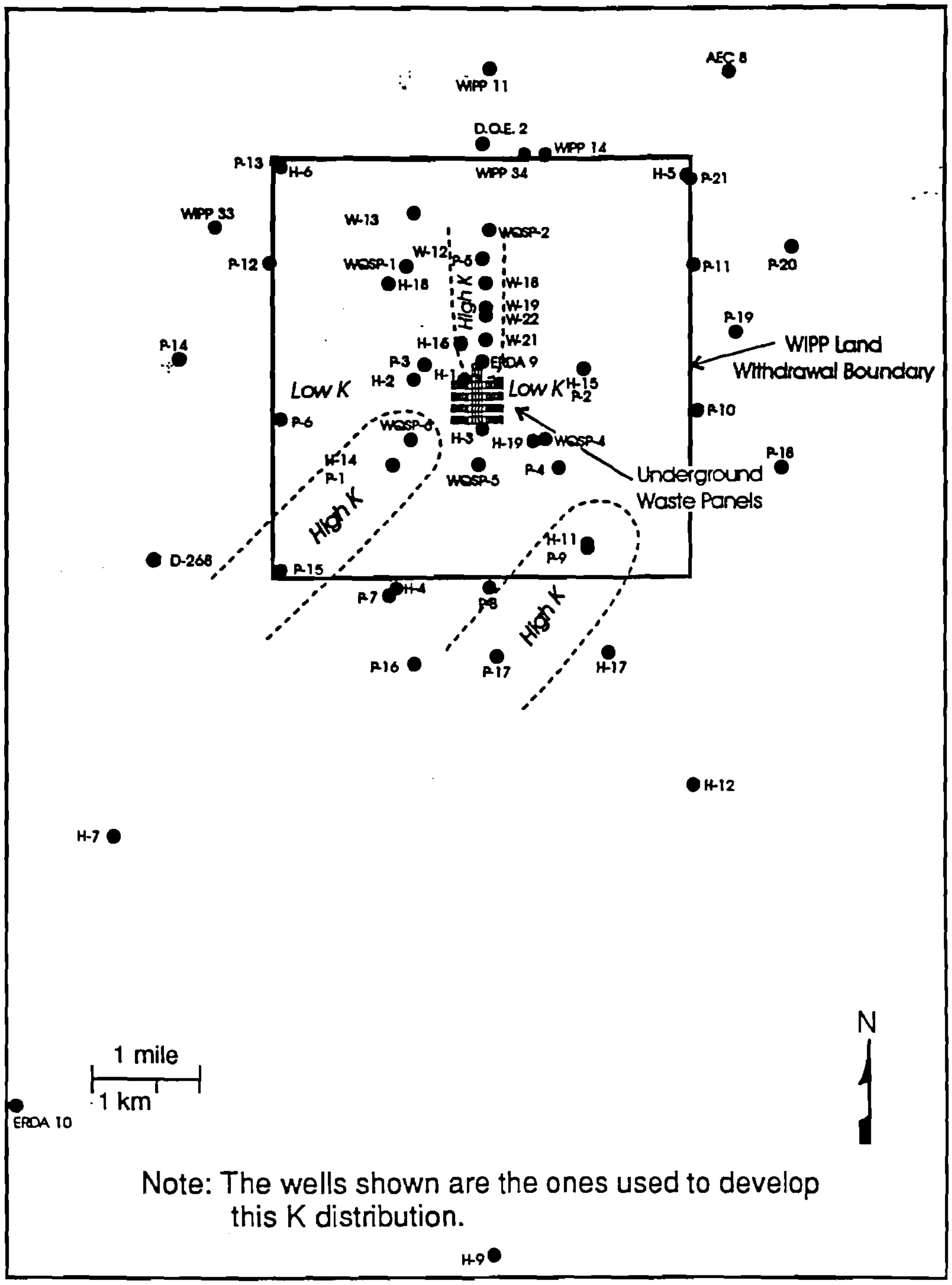

Fig. NS-A1.6 Interpreted Qualitative Dewey Lake
Hydraulic Conductivity (K) Distribution

QA ABS 12/21/95 12-20-95
mbw

P:\Corel\Wallace\NS1_5&6.cdr

The pattern of hydraulic conductivity shown in Figure NS-A1.6 is consistent with the interpretation of the depositional environment for the Dewey Lake. Fluvial deposits are commonly composed of linear sand bodies, representing channel deposits, within silts or clays deposited outside the channels. Periodic shifts of the channel give rise to a series of sand deposits which may be poorly connected.

Geochemistry

PA calculations, as well as evaluations of the significance of pumping from the Dewey Lake, require an estimate for the sorption coefficient (K_d). The sorption coefficient is a measure of the extent to which radionuclides in the water are sorbed to pore surfaces. There are no measurements of sorption coefficients for the Dewey Lake, so values have been compiled from a literature search.

On the basis of Dewey Lake hydrogeological data, it is assumed that most flow takes place through the high-K zones and that these zones are composed primarily of sandstones. The literature search for K_ds was thus restricted to sandstones, sand and sandy soils. Even though magnetite and ilmenite are the most abundant heavy minerals in the red beds, oxidizing conditions are assumed throughout the formation. This is a conservative assumption, as K_ds for the radionuclides of concern are higher under reducing conditions.

Table NS1-A3 presents the K_ds compiled from a literature search for saline waters in sands and sandy soils. A range of values is presented for each radionuclide. The low end of the range is representative of clean sands. Many naturals sands, however, have iron oxy-hydroxide coatings on mineral grains and these are represented by values towards the high end of the range.

Table NS1-A3. K_ds (mL/g) compiled from a literature search for sand/sandy soil in saline waters.

Element	Range
U	10 - 1600
Pu	100 - 100,000
Am	200 - 10,000
Np	10 - 1000
Ra	5 - 5000
Cm	300 - 10000
Pb	3 - 1000
Th	150 - 3200

References

Holt, R.M. and Powers, D.W., 1990. Geologic Mapping of the Air Intake Shaft at the Waste Isolation Pilot Plant. DOE/WIPP 90-051. December, 1990.

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QA APS 12/20/95 12-20-95 hbw

Schiel, K.M., 1987. Investigations of the Dewey Lake Formation, Delaware Basin, New Mexico. El Paso Geological Society Guidebook 18, 1987, pp. 149-156.

Vandergraaf, T. T. and K. V. Ticknor. A Compilation and Evaluation of Sorption Coefficients Used in the Geosphere Model of SYVAC for the 1990 Assessment of the Whiteshell Research Area. AECL-10546, COG-92-59. Whiteshell Laboratories Pinawa, Manitoba ROW 1L0 1994.

QA ARS 12/21/95 mbw 12-20-95

CERTIFICATION AND TRAINING

List of individuals responsible for significant steps of the FEP screening process, including the names of technical reviewers and lead staff members.

Lead staff member:	Michael Wallace
Contributors:	Ken Brinster (SNL Org 6741); Christine Stockman, Mary Elena Martell, Roger Wilmot
Technical reviewers:	Wendell Weart (6000) and Mel G. Marietta (6821)

Statement that copies of certification of personnel qualifications are on file in the SWCF. Documentation indicating that personnel were trained on QAPs prior to screening effort:

Copies of certification of personnel qualifications for the above staff are on file in the SWCF. All staff were trained on QAPs prior to completion of the screening effort.

CORRESPONDENCE

Copies of correspondence follow starting on page 27.

REFERENCES

List of references cited in the records package documentation:

"Draft Compliance Certification Application." July Update, CAO Approval Draft, July 21, 1995. DRAFT-DOE/CAO-2056. (Note: Feb 10, 1995 most current draft in NWM Library.)

Holt, R.M., and D.W. Powers. 1990. *Geologic Mapping of the Air Intake Shaft at the Waste Isolation Pilot Plant.* DOE/WIPP 90-051. Carlsbad, NM: Westinghouse Electric Corporation.

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Miller, D.N. Jr. 1966. "Petrology of Pierce Canyon Redbeds, Delaware Basin, Texas and New Mexico," *American Association of Petroleum Geologists Bulletin.* Vol. 50, no. 2, 283-307.

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Tien, P-L., F.B. Nimick, A.B. Muller, P.A. Davis, R.V. Guzowski, L.E. Duda, and R.L. Hunter. 1983. *Repository Site Data and Information in Bedded Salt: Palo Duro Basin, Texas.* SAND82-2223, NUREG/CR-3129. Albuquerque, NM: Sandia National Laboratories.

Schiel, K.M. 1987. "Investigations of the Dewey Lake Formation, Delaware Basin, New Mexico," *Geology of the Western Delaware Basin, West Texas and Southeastern New Mexico, El Paso Geological Society Guidebook 18, 1987.* Eds. D.W. Powers and W.C. James. 149-156.

QA 12/21/95 mbw 12-20-95

Vandergraaf, T.T., and K.V. Ticknor. 1994. *A Compilation and Evaluation of Sorption Coefficients Used in the Geosphere Model of SYVAC for the 1990 Assessment of the Whiteshell Research Area.* AECL-10546, COG-92-59. Pinawa, Manitoba: Atomic Energy of Canada Ltd., Whiteshell Laboratories.

Brinster, K. 1991. *Preliminary Geohydrologic Conceptual Model of the Los Medaños Region Near the Waste Isolation Pilot Plant for the Purpose of Performance Assessment.* SAND89-714. Albuquerque, NM: Sandia National Laboratories.

VERIFICATION AND ASSESSMENTS

No independent assessments occurred; therefore, no corrective Action Reports were produced.

Comments on this FEP follow starting on page 41. Responses to comments begin on page 46.

The signature page attached at the front of this package indicates the signatures and dates of technical, management, editorial, and lead staff reviews.

QA AEJ 12/21/95 mbw 12-20-95

H-1961

elev. 988.6m

Dewey Lake moist from 174.6 - 188.0 ft
cement change at 201 ft

location: 1535' FSL, 2460' FWL, Sec. ~~18~~ 28, T22S, R31E
L.S. elev: 3418' amsl

A hand-written note from
Rick Beauheim to Mike Wallace
~August 1995

I used this information to help develop the
water table map in the SMOR (fig. NS-A1.4)

QA ARS 12/21/95 MGW 12-20-95

MEMORANDUM

Dewey Lake

DATE: March 2, 1995

TO:
Rick Beauheim, 6115/2230
Tom Corbet, 6115/2216
Bob Diaz, SAIC
Peter Davies, 6115/2218
Robert Holt, 6115/216
Al Lappin, 6115/2224
Jeff McCann, SAIC
Hans Papenguth, 6119/2104
H. V. Ravinder, UNM
Kate Trauth, 6747/2310
Palmer Vaughn, 6342/2309

FROM:
Bob Diaz, Lead Recorder
Marilyn Borich, Coordinator

SUBJECT: Supplemental Revised Elicitation Meeting Record (EMR) for the Non-Salado Flow and Transport Model

The subject meeting record is attached for your review and comment. If you have any questions concerning this report, please call Bob Diaz at 842-7818 or Jeff McCann at 842-7827.

If you wish to have your comments incorporated into this EMR, please fax your marked up EMR to Marilyn Borich at fax number 842-7878. If more convenient, you may call her at 842-7831, and she will arrange for your comments to be picked up. In either instance, comments will be included in the EMR and a revised supplemental meeting record distributed to persons on the above distribution list.

Attachment: One Supplemental EMR

QA AES 12/21/95 mbW 12-20-95

DRAFT

SNL WIPP PROJECT
SYSTEM PRIORITIZATION METHOD-2
SUPPLEMENTAL ELICITATION MEETING RECORD

Subject Area: Non-Salado Flow and Transport	**Date of Meeting: 24 February 1995**
Elicitor: Kate Trauth assisted by H. V. Ravinder	**PI: Tom Corbet assisted by Rick Beauheim, Robert Holt, and Hans Papenguth**
Place of Meeting: BDM 2105	**Recorders: Bob Diaz and Jeff McCann**

Persons Present: Kate Trauth, Palmer Vaughn, H. Ravinder, Al Lappin, Tom Corbet, Peter Davies, Rick Beauheim, Robert Holt, Hans Papenguth, Jeff McCann, and Bob Diaz

SUPPLEMENTAL MEETING OBJECTIVE

The purpose of this supplemental meeting was to re-elicit the Dewey Lake Formation radionuclide transport information of Activities 1, 2, and 3. The approach recorded in the previous Non-Salado Elicitation Meeting (December 1994) focused on a release factor for the Dewey Lake Formation. However, the Salado technical group focused on a mass storage factor for the interbeds of the Salado Formation. To be consistent with the Salado position, the Non-Salado technical group refocused from a release factor for the Dewey Lake Formation to a mass storage factor.

BACKGROUND

The Dewey Lake Formation (alternatively called the Dewey Lake Red Beds) is a stratigraphic unit that lies immediately above the Rustler. The Formation consists predominately of reddish-brown fine sandstone, siltstone, or silty claystone. The Dewey Lake Formation is extensively fractured, and portions of it are known to contain water. The Formation is important in performance assessment as a potential pathway for the migration of fluid (radionuclide-contaminated brine) across the WIPP site boundary. Past performance assessment had assumed that any radionuclides that reached the Dewey Lake Formation were released across the site boundary.

From the earlier elicitation, the three activities that could help quantify radionuclide releases through the Dewey Lake Formation across the WIPP site boundary were as follows:

- A paper study and low-effort field activities on the Dewey Lake Formation (Activity 1);
- A lab study of transport within the Dewey Lake Formation (Activity 2); and
- A field study of transport within the Dewey Lake Formation (Activity 3).

QA ARJ 12/21/95 mbw 12-20-95

DRAFT

For Systems Prioritization Method-2 (SPM-2), the results of these activities were elicited in terms of a performance measurement called the Dewey Lake release factor (DLRF). The DLRF was expressed as a probability that a percentage of the volume of radionuclide-contaminated brine entering the Dewey Lake Formation would reach the regulatory boundary. The DLRF, as elicited for Activity 1, provides a 95 percent probability that 25 percent of material reaching the Dewey Lake Formation will be released across the regulatory boundary.

During subsequent management review of the SPM-2 baseline, it became apparent that the instantaneous release of radionuclides that reached the Dewey Lake Formation (although a conservative assumption) was unrealistic because it failed to account for known processes such as sorption and storage. A decision was reached to redefine the baseline to take credit for the expected results of Activity 1, i.e., to move the expected results of Activity 1 into the baseline (with the assumption that the activity would be funded and completed). In addition, it was noticed that the Salado group, during its elicitation, had dealt with the same concept (contaminated brine transport) but had treated it differently.

The Salado group had handled the issue of contaminated-brine transport in terms of a mass storage factor that provided a value for the amount of brine that could be stored in the interbeds, thus avoiding the assumption of instantaneous transport and release. The Salado group's method of dealing with contaminated-brine transport, which was based on hydrogeologic rock properties, appeared preferable to the more arbitrary release-factor approach that was being used for transport through the Dewey Lake Formation.

In the interest of consistency, it was decided to re-elicit the performance measurement for contaminated-brine transport through the Dewey Lake Formation in terms of a mass storage factor as had been done with the Salado. This record reports the results of that re-elicitation.

REGULATORY INTERFACE

Information needed for demonstrating compliance of the WIPP with applicable regulatory requirements can be categorized by (1) the parts of the disposal system the information relates to (natural barriers or repository design and engineered barriers), (2) the effects of the wastes (waste interactions), or (3) significant events affecting the disposal system (human intrusion). The flow and transport properties of the Dewey Lake Formation are categorized as natural barriers and fall under 40 CFR Part 191 (long-term performance).

ACTIVITIES

The activities for this elicitation are described generally in the background section of this report. However, Activity 1 was modified slightly during this elicitation, as explained below.

QA AES 12/21/95 mbW 12-20-95

DRAFT

Release of radionuclides through the Dewey Lake Formation across the WIPP site boundary requires fluid flow over long distances through a unit with a large potential for storage. Because of these factors, it is possible to calculate, using a one-dimensional transport calculation, the minimum sorption distribution coefficient (K_d) that would be required before any release might occur across the WIPP site boundary, regardless of whether the Dewey Lake Formation is saturated or unsaturated. This calculated minimum K_d value is expected to be far less than the defensible sorption distribution coefficient (another K_d value) for the Dewey Lake Formation that Activity 1 is expected to produce. Thus, Activity 1 was redefined during this elicitation to include a one-dimensional transport calculation.

In addition, Papenguth was of the opinion that Activity 3 would probably be unnecessary once Activities 1 and 2 were completed.

BASELINE MODEL

The initial baseline had assumed that any radionuclides which reached the Dewey Lake Formation were instantaneously transported across the WIPP site boundary. The initial baseline was later redefined to include the DLRF elicited for Activity 1, thus reducing releases through the Dewey Lake Formation to a fraction of the volume of contaminants that reached the Formation. The elicitation reported here was intended to redefine the DLRF in terms of a Dewey Lake storage factor.

ELICITED OUTCOMES

Assuming that Activity 1 is (a) expanded to include the one-dimensional transport calculation described above and (b) funded and completed, the baseline parameter for radionuclide transport through the Dewey Lake Formation and across the regulatory boundary will be zero. In other words, the baseline will reflect that, of the radionuclides that reach the Dewey Lake Formation, none will be released across the site boundary.

LIMITATIONS/SIDE ISSUES

PA modeling of the Dewey Lake Formation: Current PA modeling of Dewey Lake Formation transmissivities fails to account for a change in permeability that occurs with a change in cementitious material (at between 164.5 and 210 feet) and underestimates brine inflow into Dewey Lake by a factor of about 10.

QA AES, 12/21/95 MBL 12-20-95

SWCF-A: 1.1.6.3:PA:NQ:TSK: NS/1

DRAFT

COST AND SCHEDULE ESTIMATE

This information was not elicited.

Elicitor/Date

White Paper Lead/Date

PA Team Lead/Date

QA ARS 12/21/95

MIW 12-20-95

Dewey Lake

Sandia National Laboratories

Albuquerque, New Mexico 87185-1345

date: October 18, 1994

to: Dr. Jim Mewhinney,
Carlsbad Area Office

from: Sarah E. Bigger (signed: Sarah)

subject: Impact on PA and SPM of the Recent Discovery of Water in the Dewey Lake in WQSP-6

The following are thoughts compiled by Peter Swift on the how the recent discovery of water in the Dewey Lake in WQSP-6 will impact PA/SPM. These ideas result from a conversation between Rick Beauheim, Tom Corbet, Peter Swift and myself.

Conceptual Model

- The discovery of water in the Dewey Lake Formation at WQSP-6 does not contradict the Project's basic understanding of Dewey Lake hydrology, nor does it pose an insurmountable problem for PA.

- The conceptual model for the Dewey Lake used in regional 3-D modeling has been that it is a unit of uncertain hydraulic conductivity with a continuous zone of saturation below a water table of uncertain location. In 3-D analyses, the position of the water table is a model result which depends mainly on the values assumed for the conductivity of the Dewey Lake and the rate of recharge.

- Relatively little is known about the flow field and transport characteristics of the Dewey Lake. We do not know what the spatial distribution of hydraulic conductivity is, and we therefore cannot say with confidence that water could or could not be produced from wells drilled above the panels. We are confident that water cannot be produced from the region immediately adjacent to the shafts. Productive water wells, such as at the Mills Ranch and now at WQSP-6, have intersected zones of higher conductivity than those encountered in unproductive wells or in the shafts. We do not know which way water moves in the Dewey Lake, nor at what rate.

Where is this?

Should be revised how 8-8-95

QA APS 12/21/95 mbw 12-20-95

PA Modeling

- PA does not have a computational model to describe flow and transport in the Dewey Lake. PA does, however, have the computational tools to estimate releases into the Dewey Lake from an intrusion borehole, using the current implementation of BRAGFLO. Calculation of releases into the Dewey Lake will require assumptions about the permeability and porosity of the unit, and about the elevation of the water table.

Possible Implementation in SPM2

THESE ARE PRELIMINARY SUGGESTIONS ONLY. SPM2 IMPLEMENTATION MAY DIFFER.

- An appropriate baseline assumption for SPM2 would be to treat all radionuclide releases into the Dewey Lake as releases to the accessible environment. This approach would take no credit for flow and transport processes within the Dewey Lake (i.e., it would take no credit for diffusion or sorption, and would assume instantaneous transport to the boundary). Assumptions about appropriate values to use in BRAGFLO for Dewey Lake porosity and permeability and the location of the water table (taking into account the possibility of climate change) will be developed during elicitation for SPM2.

- Several activity sets are suggested for consideration in SPM2 that have the potential to allow for alternative treatments of releases into the Dewey Lake.

  - Development of a simple, one-dimensional flow model for the Dewey Lake. This model could be based on simple, bounding assumptions about flow path, conductivity, and gradient. It would be based on the limited information presently available. Its primary purpose would be to provide a basis for transport modeling. The activity could be done quickly. Releases calculated with this model would differ little from those calculated for the baseline unless the model were coupled with an activity designed to demonstrate actinide sorption in the Dewey Lake.

  - Literature research to support modeling of actinide sorption and colloid transport in the Dewey Lake. SNL geochemists indicate that available literature data supports large amounts of actinide sorption in red beds. This activity could be done quickly, and has the potential to have a large impact on compliance. Present speculation is that even with bounding assumptions about a potential flow path, sorption in the Dewey Lake could greatly reduce or prevent releases of dissolved species through that unit. Releases resulting from colloid transport would depend in part on the ionic strength of the water.

QA ARS 12/21/95 MOW 12-20-95

- Laboratory work to support modeling of actinide sorption in the Dewey Lake. This work could not be done quickly. It could be appropriate if literature information is insufficient to support actinide sorption in red beds, or if regulators determined that site-specific data was required. Note that the C&C Agreement requiring site-specific data refers only to the Culebra, and that the arguments for using literature data are stronger for red beds than for dolomite.

- Additional use of the regional 3-D model to evaluate possible effects of changes in future recharge on the position of the water table, given various assumptions about recharge rates and hydraulic properties of the Dewey Lake. This activity could be done quickly, and could provide a basis for establishing the position of the water table in the BRAGFLO analyses.

- Field work to support more detailed modeling of flow in the Dewey Lake. Additional well data is required to model flow using other than bounding assumptions. This activity could not be done quickly.

cc:
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6347 Dayfile
SWCF-A: 1.1.7.2: CO/SPM; PA/CO

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need info on other P wells in area
P1, P3, P6, P-14, P12, P5, P7, P-16
H4 and all others

EXAMINATION OF RANDOM BOREHOLES FOR OCCURRENCES OF WATER IN THE DEWEY LAKE Redbeds ON THE SOUTHERN HALF OF THE WIPP SITE

Exploratory Potash Borehole P-2

Drilling commenced on August 25, and was completed on September 2, 1976, at 1,895 ft. below land surface in Section 28, Township 22 South, Range 31 East, 125 ft FNL and 172 ft FEL. This borehole was drilled with air foam to casing point at 1,038 ft below land surface. No water was reported by the driller for the Dewey Lake Redbeds.

Exploratory Potash Borehole P-4

Drilling commenced on August 28, and was completed on September 4, 1976, at 1,857 ft. below land surface in Section 28, Township 22 South, Range 31 East, 146 ft FSL and 1,487 ft FEL. This borehole was drilled with air foam to 958 ft below land surface. No water was reported by the driller for the Dewey Lake Redbeds.

Exploratory Potash Borehole P-8

Drilling commenced on September 8, and was completed on September 15, 1976, at 1,660 ft. below land surface in Section 4, Township 23 South, Range 31 East, 642 ft FNL and 96 ft FWL. This borehole was drilled with air mist to 493 ft below land surface. No water was reported by the driller for the Dewey Lake Redbeds.

Exploratory Potash Borehole P-9

Drilling commenced on September 16, and was completed on September 25, 1976, at 1,796 ft. below land surface in Section 33, Township 22 South, Range 31 East, 1,493 ft FSL and 143 ft FEL. This borehole was drilled with air foam to 738 ft below land surface. Water was reported by the driller for the Dewey Lake Redbeds at 220 ft below land surface, making about 25 gallons per minute .

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Hydrologic Test Well H-3

Drilling commenced on July 27, and was completed on ???, 1976, at 894 ft. below land surface in Section 29, Township 22 South, Range 31 East, 3,200 ft FNL and 140 ft FEL. This borehole was rotary drilled with air to 570 ft and air mist to 894 ft. Moist cuttings were encountered in the Dewey Lake Redbeds at 175 ft. but no water was reported.

New Hydrologic Monitoring Wells

On September 26, 1994 fresh water was encountered in the Dewey Lake Redbeds, while drilling an environmental monitoring well. The well, designated as WQSP 6, is located in Section 29, Township 22 South, Range 31 East, 1,667 FSL and 1,329 FWL.

The water was encountered at a depth of 182-208 feet below ground level while drilling through fine grained mudstone and sandstone. The mist pump on the drilling rig was shut off and the well was pumped for approximately 15 minutes using the air compressor on the drilling rig to force the water from the Dewey Lake Redbeds to the surface. A flow rate of 30 gallons per minute was determined by using a stopwatch and a five gallon container to estimate the discharge. Drilling continued using a combination of air mist with foaming agents, brine water, and drilling mud to the total completion depth of 616 feet in the Culebra member of the Rustler formation. The well was cased and the annulus was cemented, sealing off the interval of the Dewey Lake Redbeds where the water was encountered.

No further tests were performed on the Dewey Lake Redbeds due to time constraints incurred by the fact that the well bore was not cased (additional time would cause the bore wall to slough off and result in the loss of the well) and contractual agreement. A second well will be drilled at the WQSP 6 location that will be completed in the Dewey Lake Redbeds. This well will be used to perform water quality analysis and to determine the extent of saturation. Additionally, no significant moisture in the Dewey Lake Redbeds was encountered at the four additional wells that have been drilled on the WIPP site (WQSP 1,2,4, and 5 - See attached map). WQSP 3 has not been drilled as of October 13, 1994.

QA APS 12/21/95 mbw 12-20-95

Exploratory Potash Borehole P-15

Drilling commenced on October 4, and was completed on October 14, 1976, at 1,465 ft. below land surface in Section 21, Township 22 South, Range 31 East, 398 ft FSL and 184 ft FWL. This borehole was drilled with air to 405 ft below land surface. Water was reported by the driller for the Dewey Lake Redbeds at 225 ft below land surface.

Exploratory Potash Borehole P-17

Drilling commenced on October 18, and was completed on October 26, 1976, at 1,660 ft. below land surface in Section 4, Township 23 South, Range 31 East, 1,351 ft FSL and 395 ft FWL. This borehole was drilled with air to 265 ft and with air foam to 695 ft. below land surface. Water was reported by the driller for the Dewey Lake Redbeds at 265 ft below land surface.

Hydrologic Test Well H-1

Drilling commenced on May 20, and was completed on June 8, 1976, at 848 ft. below land surface in Section 29, Township 22 South, Range 31 East, 1,084 ft FEL and 620 ft FNL. This borehole was rotary drilled with air to 592 ft and air mist to 842 ft. The hole was then reamed to a 9 7/8-inch diameter to 848 feet. Moist cuttings were encountered in the Dewey Lake Redbeds at 180 ft. The open hole was then monitored for liquid entry for nine hours, but remained dry.

Hydrologic Test Well H-2a

1977?

Drilling commenced on February 27, and was completed on February 19, 1977, at 563 ft. below land surface in Section 29, Township 22 South, Range 31 East, 720 ft FNL and 3,584 ft FEL. This borehole was rotary drilled with air to 188 ft and air mist to 563 ft. Moist cuttings were encountered in the Dewey Lake Redbeds at 185 ft. The hole was monitored for five hours with very little water being detected. Wells H-2b and H-2c were drilled on the same well pad and only encountered moist cuttings in the Dewey Lake Redbeds at a depth of 181-185 ft.

29 ?

Since hole only drilled with air to ~188', there is no way to determine if Dewey Lake is dry below that depth. Likely it is still saturated below.

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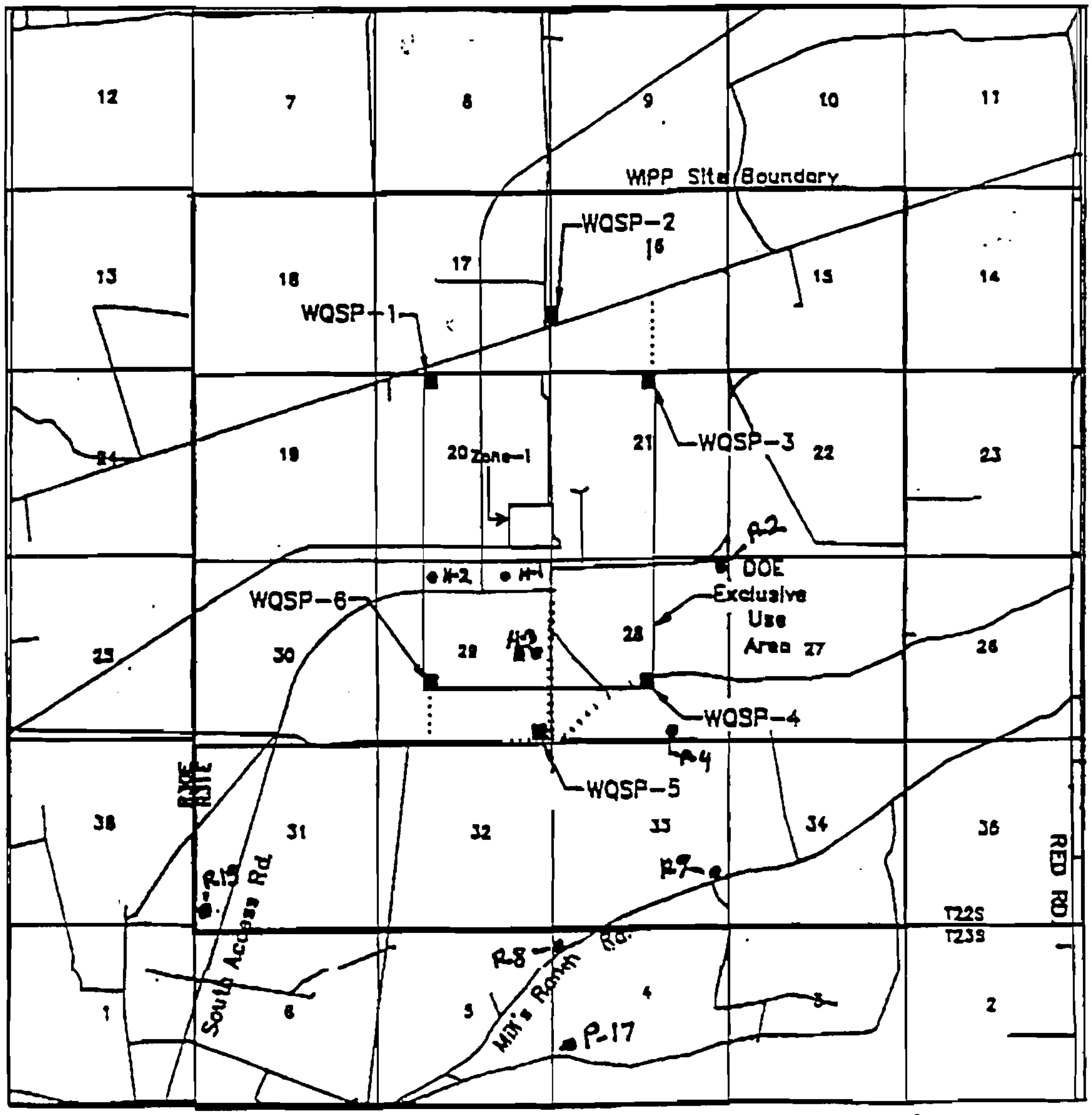

RANDOM ~~SELECTED~~ EXAMINATION OF THE DEWEY LAKE REDBEDS

~~PROPOSED NEW MONITORING WELL LOCATIONS~~

□ ~~PROPOSED NEW~~ Monitoring WELL LOCATIONS

~~EXISTING ACCESS ROADS~~

~~PROPOSED NEW ACCESS ROADS~~

WQSP-1	WQSP-2	WQSP-3
50 FNL 1464 FWL	1650 FSL 100 FEL	50 FNL 2213 FEL
WQSP-4	**WQSP-5**	**WQSP-6**
1612 FSL 2275 FEL	300 FSL 350 FEL	1667 FSL 1329 FWL

● Other wells & Boreholes

QA APS 12/21/95 mbw 12-20-95

add Foot Print of ...

WIPP PROJECT

FACSIMILE TRANSMITTAL ROUTING SHEET
TELEFAX NUMBER (505) 887-1077

Peter
Rick
Tom
Hans
Mel
Palm

Pages: 5 **Date:** 10/18/94 **Time:** 9:00
(Including cover)

To: Sara Bigger

Location:

Phone #: 848-0884

From: Larry Madl

Location: WIPP Site

Phone/Fax#: 234-8400 Fax: 234-8854

Ron Richardson: 234-8395

Special Instructions: ______________________

QA AEJ 12/21/95 MOW 12-20-95

WASTE ISOLATION PILOT PLANT

FEP Screening Comment Form
FEP ID# NS-1
Author: Sharla Bertram (6747)
Date: September 27, 1995

I. Comment on Recommended Screening Decision for FEP NS-1.

It is recommended that this FEP be screened in or out. At this point in the compliance process it may appear as though the DOE is unsure of the FEPs that should be included in assessing repository performance. While discussion of FEP screening decisions should contain analysis of both the strong and the weak points of the screening decision, a conclusive screening decision should be provided as well.

II. Alternative Recommended FEP Screening Decision

This FEP should be screened either out or in but not held in reserve.

III. Rebuttal Arguments that Support Alternative FEP Screening Decision

At this point in the compliance process it is necessary for screening decisions on FEPs to be made. If FEPs are presented to the EPA as "reserve" FEPs it is likely that the Agency will require that the DOE include these FEPs in Performance Assessment calculations.

QA AES 12/21/95 mbw 12-20-95

SWCF-A 1.1.6.3:PA:~~NQ~~:TSK:NS/1

FEP Screening Comment Form
FEP ID# NS-1
Author: Sharla Bertram (6747)
Date: September 20, 1995

I. Comment on Recommended Screening Decision for FEP NS-1.

A regulatory basis exists for narrowing the focus of this FEP. It is not necessary to devote significant effort to the evaluation of sources of potable water within the controlled area.

II. Alternative Recommended FEP Screening Decision

This FEP should not focus on whether or not there is potable water within the controlled area but rather should focus on the connections to existing USDWs in the accessible environment.

III. Rebuttal Arguments that Support Alternative FEP Screening Decision

From a regulatory standpoint the existence of potable water within the controlled area is not relevant. The controlled area is considered a sacrifice zone within which "there is essentially no protection of ground water . . . ." (NRDC v. EPA, First Circuit Court of Appeals, July 17, 1987, 824 F.2d 1272). In support of this theory the EPA stated that:

> The release limits apply to radionuclides that are projected to move into the "accessible environment" during the first 10,000 years after disposal. The accessible environment includes all of the atmosphere, land surface, surface waters, and oceans. However, it does not include the lithosphere (and the ground water within it) that is below the "controlled area" surrounding a disposal system. The standards are formulated this way because the properties of the geologic media around a mined repository are expected to provide much of the disposal system's capability to isolate these wastes over these long time periods. Thus, a certain area of the natural environment is envisioned to be dedicated to keeping these dangerous materials away from future generations and may not be suitable for certain other uses. In the final rule, this "controlled area" is not to exceed 100 square kilometers and is not to extend more than five kilometers in any direction from the original emplacement of the wastes in the disposal system. The implementing agencies may choose a smaller area whenever appropriate. (50 FR 38071 September 19, 1985)

It is apparant that the EPA did not intend for an implementing agency to assess the potability of water within the controlled area.

QA 12/21/95 MBW 12-20-95

SWCF-A 1.1.6.3:PA:~~NQ~~:TSK:NS/1

A laterally continuous water table within the Dewey Lake need only be considered, therefore, with regard to its ability to enhance radionuclide transport to the accessible environment. Issues that should be assessed are whether or not radionuclides will reach the Dewey Lake and if so will they migrate beyond the controlled area in quantities that constitute a release. If a release is predicted to occur then the impacts upon existing USDWs[1] need to be addressed. Migration to the Dewey Lake should not be assumed to constitute a release to the accessible environment.

---

[1]In 40 CFR Part 191 the EPA fails to discuss potable water. The Agency does, however address USDWs. The EPA defines an USDW as follows:

Underground source of drinking water means an aquifer or its portion which:

(1) Supplies any public water system; or
(2) Contains a sufficient quantity of ground water to supply a public water system; and

(i) currently supplies drinking water for human consumption; or
(ii) contains fewer than 10,000 milligrams of total dissolved solids per liter. (40 CFR section 191.22)

QA ARS 12/20/95

mbw 12-20-95

FEP Screening Comment Form
FEP ID# NS-1
Author CORBET
Date: 27 SEPT. 1995

I. *Comment on RecommendedScreening Decision for FEP* NS-1

SEE ATTACHED PAGE

II. *Alternative Recommended FEP Screening Decision*

(not to be more that a few sentences)

III. *Rebuttal Arguments that Support Alternative FEP Screening Decision*

MBW 12-20-95

SWCF-A 1.1.6.3:PA:~~NQ~~:TSK: NS-1
QA ABJ (FEP ID #)
12/21/95

Comments on the SMOR for NS-1, PA conceptualization of the Dewey Lake

T. Corbet

27 September 1995

- This SMOR forms the skeleton of a defensible argument for screening releases from the Dewey Lake and Dockum Gp. The authors have made real progress on this issue. However, more information will have to be added before the documentation of this FEP can be considered to be completed. Specifically, the conceptual model presented here must be made compatible with the conceptual model already published in the SPM Non-Salado flow and transport position paper. For example, we need discussions about the importance of cement types in determining the hydrologic characteristics of the Dewey Lake and the possible role of fracturing.

- The approach section notes that this FEP falls under the "VE" screening argument. This is not true and should be corrected in a final draft to file.

- This analysis assumes, without explanation, a large porosity representative of a porous media. The non-Salado position paper documents field evidence that, at least in some areas, flow occurs in fractures. Calculated travel times would be much shorter if fracture porosities were used.

- We should make it clear in this argument that, as was documented in the position paper, retardation is at the heart of this screening argument. Flow velocity considerations are of secondary importance.

QA AES 12/21/95 MW 12-20-95

Comments on the SMOR for NS-1, PA conceptualization of the Dewey Lake

T. Corbet

27 September 1995

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3. This analysis assumes, without explanation, a large porosity representative of a porous media. The non-Salado position paper documents field evidence that, at least in some areas, flow occurs in fractures. Calculated travel times would be much shorter if fracture porosities were used.

4. We should make it clear in this argument that, as was documented in the position paper, retardation is at the heart of this screening argument. Flow velocity considerations are of secondary importance.

Response to Comments Concerning NS-1:
PA Conceptualization of Dewey Lake

Comments #1 and #3

The PA Conceptualization of the Dewey Lake is based somewhat on the development of new information (from existing sources) that was not available at the time of the SPM paper cited. Therefore, it should not be held hostage to old views, should such views be superseded by that information. Yet in this case, that does not seem to be a problem. The PA Conceptualization of Dewey Lake is very consistent with that paper.

For example, the expected position of the water table published in the SPM paper is consistent with my independently derived water table position. The expected direction of flow in the Dewey Lake is also very consistent with the 3-D Regional Model (which was used to help write much of the SPM paper). That direction was independently (as much as possible, at least) derived as well.

In particular, some concern has been expressed about the fact that the D. L. has fractures and cements in it. Here is a qualitative treatment of this issue.

First, I believe a distorted picture of Dewey Lake hydraulic properties has gained a foothold in the project. the SPM supplemental elicitation meeting memo on the D.L. radionuclide transport information (3-1-95), states: "The Dewey Lake is extensively fractured and portions of it are known to contain water." Also, in SPM Non-Salado Flow and Transport Paper, it is stated: "The Dewey Lake Red Beds contain a productive zone of saturation, probably under water table conditions .... This zone ... appears to derive much of its transmissivity from open fractures". Notably, there is no supporting documentation provided to back up that last claim. I presume that claim is based on the WQSP6 borehole videos, in which fractures were observed.

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That is almost all the project had to say about the relationships between D. L. fractures and groundwater flow. These statements imply that the D.L. could have similar flow and transport characteristics to the Culebra, regarding the dual porosity issue.

That seems very unlikely to me, for the following reasons:

- On a general level, I am not aware of any lithified sediments that don't have some fractures in them. Even unconsolidated sediments have some fissuring. Is the project implying that any sedimentary structure through which water flows may have important dual porosity characteristics?

- Most of the fractures in the Dewey Lake, in the saturated zone, appear to be filled with gypsum. The gypsum-filled fractures may actually be less permeable than a significant portion of the surrounding matrix, particularly the sandstones. Regarding these sandstone layers, or lenses, the evidence of cementation doesn't directly imply these rocks are impermeable, only that they are more rock-like than not, as is any sandstone.

- There is some evidence that the non-gypsum-filled, or open fractures, that have been observed in the saturated portions of the D.L. are artifacts of the drilling and sampling process. The open fractures observed in the cores seem to have a correlation with the core ends, for example. Most of the open fractures are horizontal. The geologic mapping report of the AIS by Holt and Powers contains photographs showing many gypsum-filled fractures but no open fractures, and they state that gypsum filling of fractures increases downwards.

- Although fractures were observed in WQSP6, water cannot have been observed to flow out of them (see the videotape), and as mentioned earlier, these open fractures may be an artifact of the drilling process.

- An uncased hole in the D.L. cannot stay open for more than a day or two without collapsing. This is evidence that the formation is not well consolidated, making it somewhat like an unconsolidated formation, and as should be clear, less and less like the Culebra.

At this point, there does not seem to be any documentation to support the loaded sentence of the SPM Non-Salado paper cited above. I see no reason why this sidebar issue should be forced to adhere to a fracture flow position without further compelling evidence.

A conceptual model that seems more plausible to me, given the current data, is one that treats the Dewey Lake as a porous medium. The bulk of flow occurs through the sediments having higher hydraulic conductivity. The fractures are, if anything, barriers to flow and not conduits.

Comment #2

So noted. Yet this screening argument is velocity based, and does follow the spirit of the VE screening argument, if not the letter.

Comment #4

I'm not sure why this is a concern. The importance of retardation in this approach should be apparent to any reviewer. On the other hand, if high Kds were not defendable, there might be other plausible approaches to screen out the Dewey Lake.

QA AES 12/21/95 MLW 12-20-95