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MEMORANDUM FOR: Robert Johnson, Project Manager
Salt Team, WMRP

THRU: Mike Fliegel, Section Leader
Hydrology Section, WMGT

FROM: Barbara Cooke, WMGT
Fred Ross, WMGT
Bill Ford, WMGT
Dan Goode, WMGT

SUBJECT: MAJOR SALT HYDROLOGY EA REVIEW COMMENTS; AND STATUS ON SALT HYDROLOGY EA REVIEW PLAN TASKS

Attached please find the complete (updated from 10-12-84) set of preliminary major EA comments for the Browning briefing (Attachment I), and a detailed outline of the hydrology salt team status on the pre-EA tasks listed in the EA review plan (Attachment II). At the end of the EA task status are items which we have considered adding to our scoping review, but to which we may not yet be committed.

/s/
Barbara Cooke, WMGT

/s/
Bill Ford, WMGT

/s/
Fred Ross, WMGT

/s/
Dan Goode, WMGT

Attachments:
As Stated

OFC	WMGT	WMGT	WMGT	WMGT	WMGT		
NAME	BCooke	FRoss	DGoode	MFliegel	WFord		
DATE	84/10/22	84/10/23	84/10/23	84/10/23	84/10/23		

ATTACHMENT I

DOMES
INTRODUCTORY STATEMENT

Only Cypress Creek Draft 4 of the Environmental Assessments has been reviewed in detail. Vacherie and Richton Domes have yet to be reviewed by W.H. Ford in detail. These domes are being reviewed by consultants and are scheduled to be reviewed by W.H. Ford.

SITE: Cypress Creek Dome and Possibly the Other Dome Sites
Guideline 960.4-2-1
Concern Catagorie: Inadequate Consideration of Alternative Interpretations and Analysis, Inadequate Consideration of Uncertainties in Data analysis.
E.A. Section 6.3.1.1.2 page 6-94

The Environmental Assessment (Draft 4) states that "Inorder to develope conceptual models, it is assumed that hydraulic properties of the geohydrologic units can be averaged over a regional scale." Furthermore the Draft 4 Environmental Assessment states that "Because no data exist at this time to suggest upward flow along the interface at Cypress Creek Dome, assumed travel paths outside the salt stock are based on the regional modeling results."

The concern with these statements is that it is more conservative to use local values rather than average regional values, when the local values are worse than the average regional values. The importance of this observation is that only one model of groundwater flow is assumed in the Environmental Assessment, whereas more defensible models could be assumed.

The resolution of this concern is to assume and use local data when it is worse than average regional values.

SITE: ALL DOMES
Guideline 960.4-2-1
Concern Catagorie: Inadequate Consideration of Data Uncertainties
E.A. Section 6.3.1.1.2 page 6-93

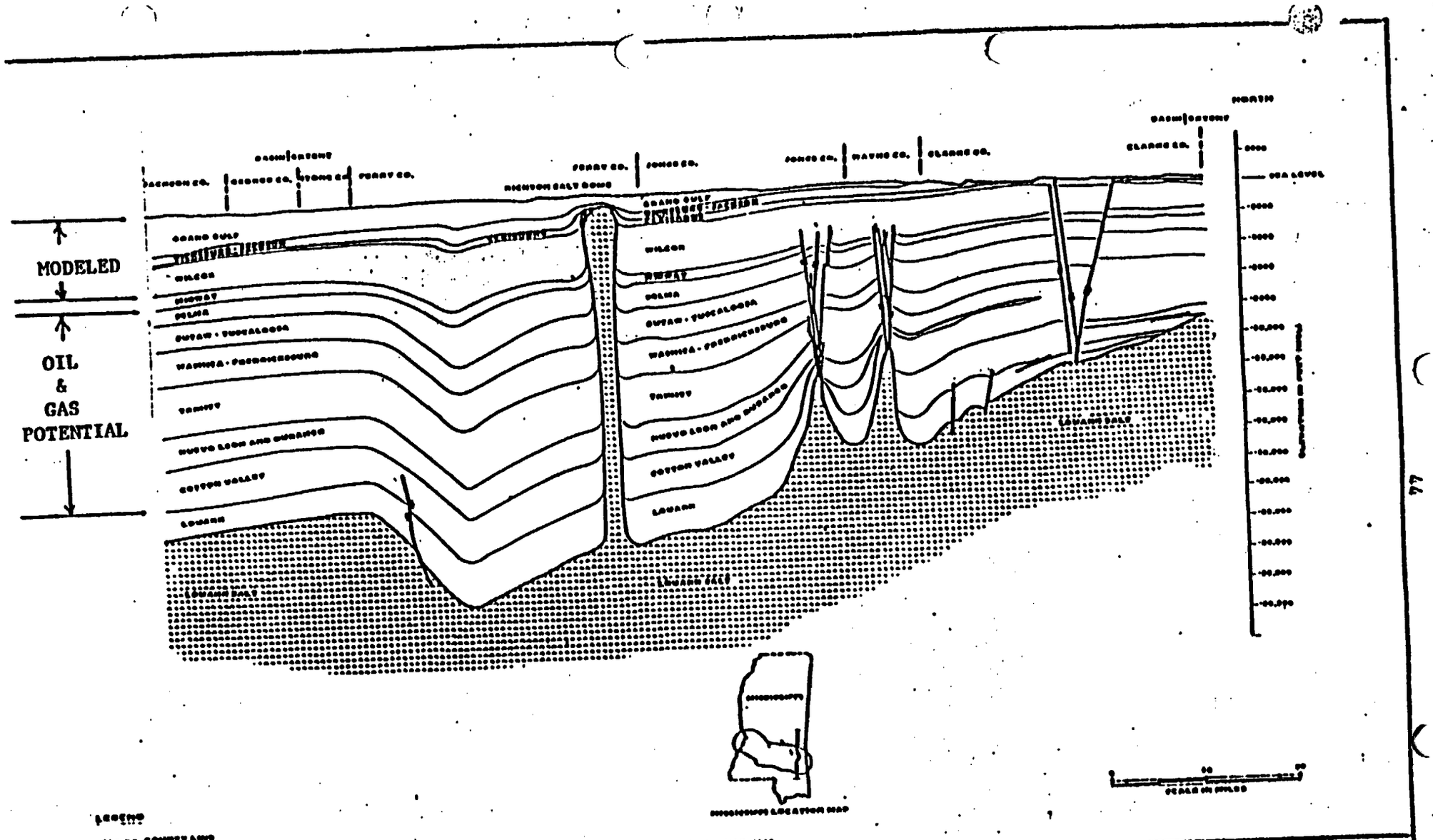
In the Cypress Creek Environmental Assessment (Draft 4) it is stated that laboratory measurements of hydraulic properties using salt core samples are suspect because the nature of the salt can result in relaxation of the crystalline structure once the confining pressures of the surrounding rock are relieved. Thus unrepresentatively high permeability estimates may be measured from such core samples.

The concern with this statement is that core studies measure micro effects on permeability and not macro effects, such as faults, fractures, bulk permeability, etc. Therefore, the importance of this observation is that core data cannot supply information on the major form of water movement through salt.

The resolution of this concern is to address macro hydrologic effects or recognize this problem as a data gap that can only be resolved during site characterization.

SITE: CYPRESS CREEK DOME AND POSSIBLY OTHER DOME SITES
Guideline 960.4-1
Concern Catagorie: Inadequate Consideration of Alternative Assumptions
E.A. Section 3.32.2, Page 3-93 to 3-97

Cypress Creek repository will be placed at the Clairborne Formation horizon, which is above the Wilcox Formation. The Environmental Assessment (Draft 4) states that groundwater flow was modeled down to the Wilcox Formation. However no deeper units were included in the modeling, even though deeper units could also be pathways to the accessible environment from oil and gas production. This is particularly true for Cypress Creek Dome, which has an oil and gas field in on its flanks. The importance of this observation is that the model does not consider all alternative pathways. The resolution is to explain why deeper units do not have to be considered or to model deeper units.


MODELED
OIL
&
GAS
POTENTIAL
NORTH
SEA LEVEL
GRAND GULF
WILCOX
MIDWAY
SELMA
EUTAW - TUSCALOOSA
WASHITA - FREDERICKSBURG
TAYLOR
NACOGDOCHES AND SUBLEGO
COTTON VALLEY
LOUANN
LOUANN SALT
LEGEND
COUNTY LINE
CAPROCK
SALT
FAULT
DEPTH OF MODELING AND OIL AND GAS POTENTIAL
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
MISSISSIPPI BASIN GEOLOGIC CROSS SECTION
JOB NO MV9700
FIGURE 3-7

SITE: Palo Duro Basin, Swisher County

GUIDELINE: 960.4-2-1

CONCERN CATEGORIES: Inadequate consideration of uncertainties with respect to data collection, analyses, and interpretation; Inadequate consideration of alternative interpretations; Inadequate consideration of available data.

E.A. SECTION 6.3.1.1

Knowledge of ~~the~~ components to the pre-emplacement groundwater travel time analysis is fundamental to addressing the hydrogeologic siting guidelines. In turn, the groundwater travel time analysis is underpinned by the conceptual model(s) of groundwater flow in that all travel time calculations are based on assumed conditions of groundwater flow including flow mechanisms and likely flow paths from the repository to the accessible environment. Finally, conceptual groundwater flow models are developed from geologic as well as hydrologic interpretations of data and must account for stratigraphic and structural features likely to control groundwater flow. Inherent in the process of developing conceptual models and computing groundwater travel times are major sources of uncertainty related to data collection, analysis, and interpretation. Problems with uncertainty are particularly acute when only a limited amount of regional data are available to address guidelines related to a specific site. Therefore, any reasonably conservative and defensible calculation of groundwater travel time should include consideration of ~~the~~ uncertainties. Use of alternative flow models, assumptions and interpretations to bound travel time calculations is expected.

In developing and presenting the travel time analysis in the Swisher County E.A., DOE has inadequately considered the uncertainties in data collection, analysis, and interpretation resulting in an unbounded estimate of pre-emplacement groundwater travel time from the repository to the accessible environment of 907,000 years. Sources of uncertainty are specifically related to:

1) Applying regional data to the site.
2) Applying generic data to the site.
3) Assuming simplistic geologic conditions.
4) Assuming results from in-situ and laboratory hydraulic tests represent large-scale hydraulic behavior.
5) Assuming Darcy flow in salt.
6) Assuming a single likely groundwater flow path from the repository to the accessible environment.

- <u>Applying regional and generic data to the site</u>.

Because little or no site specific hydrogeologic data exists at the sites within the Palo Duro Basin, the staff realizes that geohydrologic analyses will have to depend on regional and perhaps generic data. However, in applying this data to the Swisher County site, DOE has not considered all available data presented in the E.A. in selecting hydraulic property values to perform travel time calculations, nor have they adequately described representativeness of the selected values to the site. Travel time calculations are performed assuming that the site is best fitted to averages from a limited set of regional and generic data, whereas use of "upper-end" values from the broader range of all available data is more conservative and defensible.

o <u>Assuming simplistic geologic conditions.</u>

From comments made by the staff geologists, it is evident that in addressing the hydrologic siting guidelines, DOE has not adequately accounted for the potential effects of stratigraphic and structural discontinuities. (faults, fractures, joints or permeable interbeds) and interior salt dissolution on groundwater flow.

o <u>Assuming results from in-situ and laboratory hydraulic tests represent large-scale hydraulic behavior.</u>

A major source of uncertainty exists in using single well and laboratory tests to measure bulk permeability of low permeability materials, such as salt, shale, and dolomite, found in the evaporite sequence. These tests don't measure water movement along large-scale features such as faults, fractures or joints. Thus, they will not supply information on a potentially important form of water movement through salt.

o <u>Assuming Darcy flow through salt.</u>

Because it is presently unknown how to best characterize groundwater movement through salt, a major source of uncertainty exists in calculating groundwater travel times under the single assumption that water moves through salt by Darcy flow. The DOE recognizes that such calculations are conservative if fracture-flow is the dominant mechanism of water movement through salt.

o Assuming a single likely groundwater flow path.

The groundwater travel time analysis presented in the E.A. indicates a single likely groundwater flow path; downward from the repository to the upper Wolfcamp dolomite, and then horizontally to the accessible environment. The analysis is based on the conceptual groundwater flow model proposed by Bassett and others (1981) that the originators describe as a preliminary model for regional groundwater flow in the Palo Duro Basin. However, in the E.A., discussions of regional flow are presented without considering the preliminary nature of the flow model or the limitations of the regional data ~~from~~ on which it is based. In fact, the regional flow analysis gives the impression that regional hydrostratigraphy and groundwater flow is reasonably well understood. Therefore, because flow conditions at the Swisher site may be considerably different from those assumed to grossly characterize the region, plausible alternative conceptual flow models should be considered in the travel time analysis.

Based on the above comments it can be concluded that more comprehensive bounding estimates of the groundwater travel time could have been provided. However, based on available data more "precise" or "accurate" calculations are not possible prior to site characterization.

PARADOX

INTRODUCTORY STATEMENT

The following three comments on the Paradox Basin can be taken as summarized under one point. The most fundamental concern is not one of gross technical errors, but of reaching findings and conclusions with an inappropriate level of confidence, and with little or no treatment of the quantitative and qualitative uncertainties. Most frequently the uncertainties are mentioned, but are then not incorporated into such broadly-based matters as the groundwater travel time.

BAC/COMMENT 1

SITE: Lavender Canyon (probably Davis too)
Guideline: 960.4-2-1
Concern Categories: Inadequate Consideration of Alternative Interpretations;
Inadequate Consideration of Uncertainties in Data Collection Techniques
Available Data Not Considered
E.A. Section 6.3.1.1.2 p.6-112

In making the groundwater travel time calculation, the first leg of the journey is considered to be vertical downward from the center of the repository horizon to the first interbed. (Since the computations referenced are now-blank tables in Chapter 3, one must reference the Information Sheets for this computation. Only the results are present in Chap. 6. However, the result in Chap. 6 is the same as that in the Information Sheet.) In the Info. Sheet the gradient is defined as "0.085, obtained by taking the head difference of the aquifers above [HSU A] and below [HSU C] the salt [HSU B] and dividing by the distance between the aquifers.

A first concern is that uncertainties for this value for hydraulic gradient are not provided given the known uncertainties associated with head values derived from DST data. Elsewhere in this section of the EA, it is stated that the error inherent from determining head values from DST data can be as much as 200' (61m). They authors had the uncertainty information, but it was not used to bound the gradient values and thus the groundwater travel time calculation. In this case, adding that much range to the head values could broaden the groundwater travel time by an order of magnitude. (Unfortunately, I can't demonstrate this exactly until I determine what head values and aquifer spacing they did use, as they did not state this explicitly, and it's difficult to re-invent their caluculation as the boundaries of these "aquifers" and "HSU's" are a little hazy. They did not state at what depth they considered the aquifers to be.)

A second concern is one of inadequate consideration of alternative interpretations of the data. This calculation gives the potential drop between two points; one each in the overlying and underlying aquifers. This does not proscribe the gradient profile between those points in HSU B. The pressure gradient may be linear form HSU A to HSU C, but the pressure may also vary lithostatically in HSU B (and perhaps influenced by stress loss emanating from the basement - see Geology Section's comment about §6.3.1.7 p. 167 of EA), and not and there may be little of no communication with the head values in HSU A and HSU C. (In fact the head values in HSU B at GD-1 were found to be erratic with respect to each other and with respect to the units above and below as shown in ONWI-290 and ONWI-491; this is a case of available data not considered.)

There is nothing wrong with assuming a linear profile in order to develop one of the possible alternative conceptual models, especially considering the

limited amount of data available. However, those alternatives precluded by the one chosen for detailed consideration should be mentioned as well as the possible effect those other alternatives would have on the final groundwater travel time magnitude and direction.

BAC/COMMENT 2

SITE: Lavender Canyon (probably Davis too)
Guideline: 960.4-2 (c)(3)
Concern Categories: Inadequate use of availabe data
E.A. Section: 6.3.1.1.4 p. 6-121,2

Under the potentially adverse condition referring to the presence in the geologic setting of stratigraphic or structural features such as dikes, sills, faults, shear zones, fold, dissolution effects or brine pockets which could significantly contribute to the difficulty of characterizing or modeling the geohydrologic system, the statement is made that:

> "Structural features such as faults, folds....(Sections 3.2.5.1.....respectively) are found within the geologic setting. However, because of the distance of known features such as these from the site and their generally widespread occurrence within the geologic setting, it is judged that they will not significantly add to the difficulty of characterizing and/or modeling the geohydrologic system.

The authors make inadequate use of available data even though they do make passing reference to it in the parenthetical Chapter 3 references. The most significant omission from explicit mention under this potentially adverse condition is the NW trending basement faulting and associated NE discordant faulting that lies beneath Lavender Canyon. It is certainly near the site. Perhaps the faulting is considered a no-never-mind because it is presumed to dissipate in the Paradox Formation. If this displacement originating in the Leadville dies out in the lower Paradox due to the plastic deformation of salt (the scenario presented in Section 3.2.5.1), it could nevertheless provide likely pathways in the Pinkerton, Molas and Leadville directly below the repository horizon.

The liklihood that salt does not always deform to dissipate tectonic stresses from the basement has also been accepted earlier in the investigations of the Paradox Basin made by WCC for ONWI. In particular, ONWI-290, Vol. II, Figure 5-19, shows an inferred fault with offset that extends up through the bottom six cycles of the salt in the Paradox Formation [about 1600' (500m) below salt cycle 6 which is the repository horizon at the site location] but there presumably may be reason to believe that this fault or others like it may extend further up into the Paradox Formation.

SITE: Lavender Canyon (probably Davis too)
Guideline: 960.4-2 (b)(4)i
Concern Categories: Available data not considered
Inadequate consideration of alternative interpretations
EA Section: 6.3.1.1.3 p. 119

Under the favorable condition requiring that the host rock and surrounding strata have low hydraulic conductivities, the low (matric) hydraulic conductivities of salt, anhydrite, etc., were provided. However the possibility of secondary permeabilites due to brecciation, fracturing, dissolution and faulting cannot be discounted.

Some examples of available data (or information) not considered which require a broadening of range of possible interpretations are:

* There is faulting beneath the salt sequence in Lavender Canyon. Though it is presumed to die out in the Paradox (salt) Formation, it could nevertheless provide likely pathways in the Pinkerton, Molas and Leadville Formation, and perhaps even in the Paradox Formation, below the repository horizon. (See BAC/Comment 2).

* The host unit (Paradox) and surrounding units (Pinkerton and Honaker trail) include such materials as limestone and dolomite which can have karst features or brecciation respectively.

* There is a high potential for dissolution in Cycle 6, as indicated by the following discussion of the drill core in ONWI-290 (Vol. II, p. 5-3): "Another unusual characteristic of salt Cycle 6 is the presence of numerous dissolution pits in the core recovered from GD-1 between 3,145 and 3,175 feet. These pits usually occur immediately beneath laminar anhydrite bands and are the result of dissolution of highly soluble minerals by drilling fluid."

ATTACHMENT VI

Task 1. Data Inventory

1.1) Search/Obtain Documents

Has been done	To be done
99 %	1 % (ongoing, as needed)

This task was effectively completed with the Data Orientation Visit to ONWI in May. Continues as new reference lists are developed.

1.2) (Scoping) review and identify key documents (See also Task 5)

Has been done	To be done
90 %	10 %

Majority of key documents are identified and have undergone scoping reviews. Detailed key document review now in progress (see Task 5). Key documents list is updated as new reference lists are developed by ONWI and NRC staff and contractors.

1.3) Develop inventory of existing data

Has been done	To be done
95 %	5 %

Status is the same as for Task 1.1. No further work on this until after EA's.

Task 2. Develop key scenarios and conceptual models

Has been done (models only)	To be done (models only)
60 %	40 % (approx. 10 man-days)

Key scenarios were postponed by RP. Regional groundwater conceptual models are complete or under revision in draft form.

Individual Model	Status
Palo Duro	Final (for pre-EA use)
Paradox	Under revision
Cypress Creek	Under revision
Vacherie	Not yet initiated
Richton	Not yet initiated

Task 3. Conduct sensitivity modeling

Has been done	To be done
0 %	0 %

This task was deleted by the team.

Task 4. Develop preliminary issues

Has been done	To be done
100 %	0 % (prior to EA's)

Draft STP's have been completed. No more work will be done on Issues STP's until after the EA's.

Task 5. Conduct data and document reviews

Has been done	To be done
20 %	80 %

Detailed review of key documents is now in progress. Much of the work is assigned to contractors; in-house work includes review and coordination of contractors' reviews. Approximately 12 documents are out for detailed review with contractors at this time. Significantly larger number of documents have received scoping reviews by contractors and NRC staff under Tasks 1.2 and 6 of this review plan.

5.1) Modeling documents are being reviewed with special attention to the manner in which modeling results are being used in the EA's.
5.2) Raw data documents are being reviewed with review form which includes question related to how data is being used in the EA's.
5.3) Information documents are also being reviewed with respect to EA's.

Task 6 Scoping review of preliminary EA draft

Has been done	To be done
50 %	50 %

6.1) General familiarization - taking note of problem areas, inconsistencies in use of data, poor referencing, etc.

Palo Duro - 100% done
Paradox - 40% done
Domes - 30% done

6.2) Groundwater Travel Time Calculation Overview -
i) Summarizations - Summarization of groundwater travel time calculations used in all salt EA's to catalog for each case: the conceptual model used, data considered, data referencing, etc. (Summarizations thus far completed are for Swisher, Deaf Smith, Lavender and Cypress Creek sites.)

Has been done	To be done
40-60 staff hours	undetermined

ii) TENTATIVE Calculations - Calculate thumbnail groundwater travel time calculations based on alternatives, using data and assumptions no more speculative than DOE's. If defensible groundwater travel times are less than DOE's, finalize them for comments in response to EA's.

Has been done	To be done
Very little	undetermined

6.3) Other Items under Consideration - These items are being considered by hydrology section salt team members as potentially useful in our EA review preparation, and may be considered for formalization in our review plan, or may be incorporated into tasks listed above.

6.3.1) Conceptual Model Focus - Certain conceptual models (see Task 2) will be pared down to be incorporated into subsequent EA review comments as alternatives to those conceptual models provided for the GWTT calculations in the EA's. Those models finalized will be those which are equally defensible as DOE's, given the existing data bases.

6.3.2) Back-tracking of references - In specific cases for all three regions, the EA's contain many instances of inconsistant, unclear, or inappropriate referencing. Certain cases will be identified for a detailed tracking to the base of their particular data tree. Only a limited number of cases will be traced, as we understand that the poor referencing in draft 4 of the Draft EA's has been identified by DOE and is being remedied.

6.3.3) Palo Duro - Data table depicting formations and extent of intervals tested for DOE wells in the Palo Duro Basin.

6.3.4) Paradox - Technical note summarizing technical matters which bear on our ultimate positions on the need for further testing in Canyonlands.

6.3.5) Domes - Detailed review and categorization of pump test data.

6.3.6) Domes - Historical review of salt mine water problems; also collect case histories or salt dome dissolution.