PROPOSAL
EVALUATION OF GROUND WATER IMPACTS
PROPOSED SUBSURFACE DISPOSAL PROJECT
WEST GAS HILLS, WYOMING
FOR FEDERAL AMERICAN PARTNERS

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March 3, 1980

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CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

March 3, 1980

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Gentlemen:

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We are pleased to submit herein our proposal to evaluate the technical and environmental aspects of several seepage control systems for subgrade tailings disposal for Federal American Partners, West Gas Hills, Wyoming. The purpose and scope of work outlined herein were developed in discussions between Mr. Dana Adams of Kaiser Engineers and Mr. Larry Murdock of Dames & Moore. It should be noted that the scope presented herein will be dependent on the results of regulatory agency reviews of preliminary alternatives presently being submitted. We have assumed that the Sagebrush-Tablestakes open-pit mine will be a suitable disposal area. Because of these assumptions, a reevaluation of cost and scheduling estimates may be advisable after regulatory agency reviews are completed and a more definite course of action is established. This proposal is, therefore, intended to serve as a useful guide to the scope of work and time requirements to complete a seepage study directed towards satisfying regulatory agency permitting requirements.

PURPOSE AND SCOPE

The purpose of the proposed study is to quantitatively evaluate the amounts and quality of seepage from selected subgrade disposal schemes and evaluate the corresponding impact on the existing ground water system. This work will supplement studies being prepared by Kaiser Engineers for submittal to State of Wyoming and Federal agencies for review.

The work will include review of existing information contained in previous reports; a field and laboratory data collection program to supplement existing information; development of a mathematical model to predict seepage quantity and quality; and preparation of a final report. We have assumed that plans for subgrade disposal alternatives will be supplied by Kaiser Engineers. We would be pleased to assist in developing conceptual designs but have not included this in the scope of work proposed herein.

WORK PLAN

The proposed work has been divided into four tasks as outlined in the following descriptions:

Task 1 - Review Existing Data

Field and laboratory data from previous reports will be compiled and evaluated for use in the proposed mathematical model. This task has been partially completed previously for the preparation of our report, "Ground Water and Clay Source Investigation."

Useful data that have been collected by Dames & Moore and F. M. Fox consist of field and laboratory measurements of horizontal and vertical permeability in the upper and lower facies of the Wind River Formation, laboratory permeability measurements of the proposed recompacted liner material with water and acid, clay mineralogy determinations and evaluation of cation exchange capacity. In addition, we expect to make some use of data generated in modelling studies performed for other projects in the area.

The data collected thus far has defined many of the physical parameters required to quantitatively evaluate seepage quantity and quality from the proposed disposal area. There are, however, several data deficiencies, especially in parameters defining soil-effluent chemical interactions. We have defined a field and laboratory testing program designed to obtain data in the deficient areas as discussed in the next section.

Task 2 - Field and Laboratory Testing Program

It is our opinion that the data generated by the proposed field and laboratory program will be required to satisfy permitting requirements. We have had discussions of a general nature with members of the Nuclear Regulatory Agency (NRC) that have strongly indicated that a computer model of contaminant transport will be required to evaluate the effects of the disposal operations on the ground water system. The field and laboratory data collection program is designed to obtain the parameters required for modelling. The data to be collected will address three existing deficiencies:

1) Integrity of the basal mudstone layer. The vertical permeability and continuity of the basal mudstone layer in the Sagebrush pit has been the subject of some controversy. We propose that pumping tests be performed to evaluate the degree of interconnection between the upper unconfined and lower confined aquifer.

2) Soil-effluent chemical interactions. No data has been obtained to date to estimate the mobility of selected chemical ions, soil buffering capacity, and cation exchange capacity. We propose a moderately extensive laboratory testing program to determine the above-mentioned parameters.

3) Physical constants for unsaturated flow. Estimates of permeability as a function of moisture content and effective porosity are necessary to calculate flow rates in a partially

saturated zone. We propose to estimate these parameters in laboratory measurements.

The field program will consist of the following:

a) Installation of six to ten wells.
During drilling, representative samples will be collected for laboratory determinations of vertical permeability, effective porosity and soil-fluid chemical interactions.

Baseline monitoring of water quality and continued monitoring during disposal operations will be required. Monitoring will verify the modelling predictions and forewarn of any potential problems. We have assumed that Federal American Partners personnel will obtain water samples and that water quality analyses will be performed in their laboratory.

The wells installed as part of this project can be used as monitoring wells and/or dewatering wells.

b) Pumping tests.
Pumping tests will be performed in three to four of the new wells installed or in existing wells capable of being pumped. The purposes of the pumping tests will be to obtain information on the hydraulic conductivity of the Wind River aquifer in both the unconfined portion above the mudstone layer at elevation 6,400 and the confined portion below, as well as establishing any interconnection between the two aquifers, if any.

In addition to estimating vertical anisotropy of the porous media, estimates of horizontal (directional) anisotropy will also be performed when feasible. The deposi-

tional trend of the Wind River Formation suggests that permeability parallel to the regional gradient is greater than the permeability transverse to the gradient. These anisotropies are present on a macroscopic scale and are, therefore, suitably measured from pumping tests in the field rather than solely from laboratory data.

c) Collection of bulk samples of lining material.
These samples will be collected for testing chemical interactions with tailing liquor as described in the laboratory testing program and additional permeability tests to supplement previous data.

The laboratory testing program will consist of the following:

a) Permeability tests on core samples.
These tests will be performed on two to three samples to verify the results of packer tests.

b) Determination of unsaturated permeability, porosity and density of selected rock samples.
These parameters are required to model flow in the unsaturated zone. This work will be subcontracted to Utah State University.

c) Distribution coefficient determinations for representative rock and soils.
These tests are designed to quantify the chemical reactions between pond solutions and aquifer materials. Distribution coefficient determinations in four pH environments will be performed to effectively model soil buffering reactions. This work will be subcontracted to Battelle Northwest Laboratories. During this analysis chemical properties of the tailing liquor would also be determined.

d) Additional geochemical tests including cation exchange capacity, exchangeable cations, soil pH, buffering capacity, and clay mineral identification.

The data obtained in the field and laboratory investigations combined with previous data will be used to provide input parameters for the contaminant transport modelling effort.

Task 3 - Modelling

Analyses of seepage losses from the disposal area are required to assess the potential environmental impacts in terms of local ground water quality initially, and the long-term transport of contaminants. In the case of a reasonably complex hydrological situation in which variable and/or directionally dependent material properties are known to exist, a numerical model is the only feasible method providing reasonably accurate long-term predictions.

The proposed Sagebrush-Tablestakes disposal area is situated over or in saturated aquifers, which can be analyzed as fully saturated porous media. However, disposal above the water table would result in temporary unsaturated flow conditions immediately adjacent to the pit. It is proposed that analytical methods developed specifically to provide engineering estimates of seepage in partially saturated zones (McWhorter and Nelson, 1978) be applied if necessary.

This method of analysis allows time dependent predictions of the movement of the seepage front through the accumulated tailings slimes and adjacent porous media to be made. Flow velocities and quantities through the unsaturated zone will be predicted, if necessary. Seepage will eventually cause the porous media to become fully saturated. Previous applications of this procedure have shown that reasonably accurate engineering estimates may be obtained without the requirement of impractical quantities of input data.

The major modelling effort is concerned with the analysis of the transport of contaminants from the disposal area once they have reached the local phreatic surface. Dispersion is dependent upon ground water velocities and aquifer properties. The ground water velocities will be influenced by the local open pit mines and the regional hydraulic gradient. Aquifer characteristics include possible hydraulic connections between layers, variable and directionally-dependent permeabilities, porosities, and distribution coefficients, and time-varying geometry in terms of backfilling at adjacent open pits.

In order to account for all these effects and to provide reliable predictions of contaminant transport during the project, continuing until concentrations of insignificant magnitude are produced, a comprehensive mathematical model will be utilized. The model proposed for use has been developed and modified through use on a number of projects by Dames & Moore (Sharma, 1979).

This model, named TARGET, is capable of providing predictions of water quality as a function of time and space accounting for all the factors previously identified as being pertinent.

The following work strategy is proposed: After field and laboratory data collection is complete, the data will be cast into a form usable by the model, with a portion of the historical data reserved for calibration purposes. We have assumed that three cases will be analyzed: disposal below the water table with dewatering of the aquifer around the pit, disposal below the water table without dewatering, and disposal completely above the water table. It is also assumed that the geometry of the pit and operation[illegible]lans for the three disposal plans will be supplied by Kaiser Engineers.

On the basis of laboratory results for distribution [illegible]efficient determinations, six to eight chemical species covering the range of "least mobile" to "most mobile," would be used to predict contaminant transport. Isocons would be displayed at four time intervals: midway through disposal operations, at the end of disposal operations, and two long term times based on the results of the earlier time intervals.

We have budgeted 120 computer runs for this study. This is believed to be sufficient for calibration purposes, modelling of contaminant migration as a function of time, modelling contaminant migration for various seepage control designs and computer plotting of results.

References

1. McWhorter, D.B., and Nelson, J.D., "Drainage of Earthen Lined Tailings Impoundments," presented at the Symposium on Uranium Mill Tailings Management, Fort Collins, Colorado, November 1978.

2. Sharma, D., 1979. A comprehensive mathematical model (TARGET) capable of predicting flow and chemical-species transport in porous media. Dames & Moore Advanced Technology Group Report under preparation.

Task 4 - Preparation of Final Report

At the completion of the modelling studies, a final report will be prepared containing the following:

a) A summary of relevant data from previous reports used in the seepage analysis.

b) A summary of field data including locations of samples collected and wells, pumping test data and monitoring data collected prior to report preparation.

c) A summary of laboratory data obtained with a detailed description of methodology.

d) A thorough discussion of mathematical modelling techniques employed to describe contaminant transport, any simplifying assumptions used and presentation of estimated seepage quantities and concentration profiles for key chemical constituents.

e) Our recommendations for best disposal alternative and any additional ground water control measures which may be required after operations cease on the basis of the field, lab and modelling results.

We have assumed that 50 copies of the report will be required.

ESTIMATED COSTS

We propose to perform the work for a fee based on time and expenses in accordance with the attached Schedule of Charges and General Conditions. The following cost estimate includes the fees of all subcontractors.

Task 1 - Review Existing Data	$2,000
Task 2 - Field and Laboratory Testing Program	
Field	45,000
Laboratory	18,000
Task 3 - Seepage Modelling	
Office Analysis of Task 2	10,000
Mathematical Modelling	60,000
Task 4 - Report Preparation	10,000
	$145,000

An estimated schedule to perform the tasks outlined above is presented in Figure 1.

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We appreciate the opportunity to submit this proposal for a very interesting and challenging project. We hope that we may be of further service to you.

Very truly yours,

DAMES & MOORE

L. T. Murdock
Associate

WRH:LTM/si

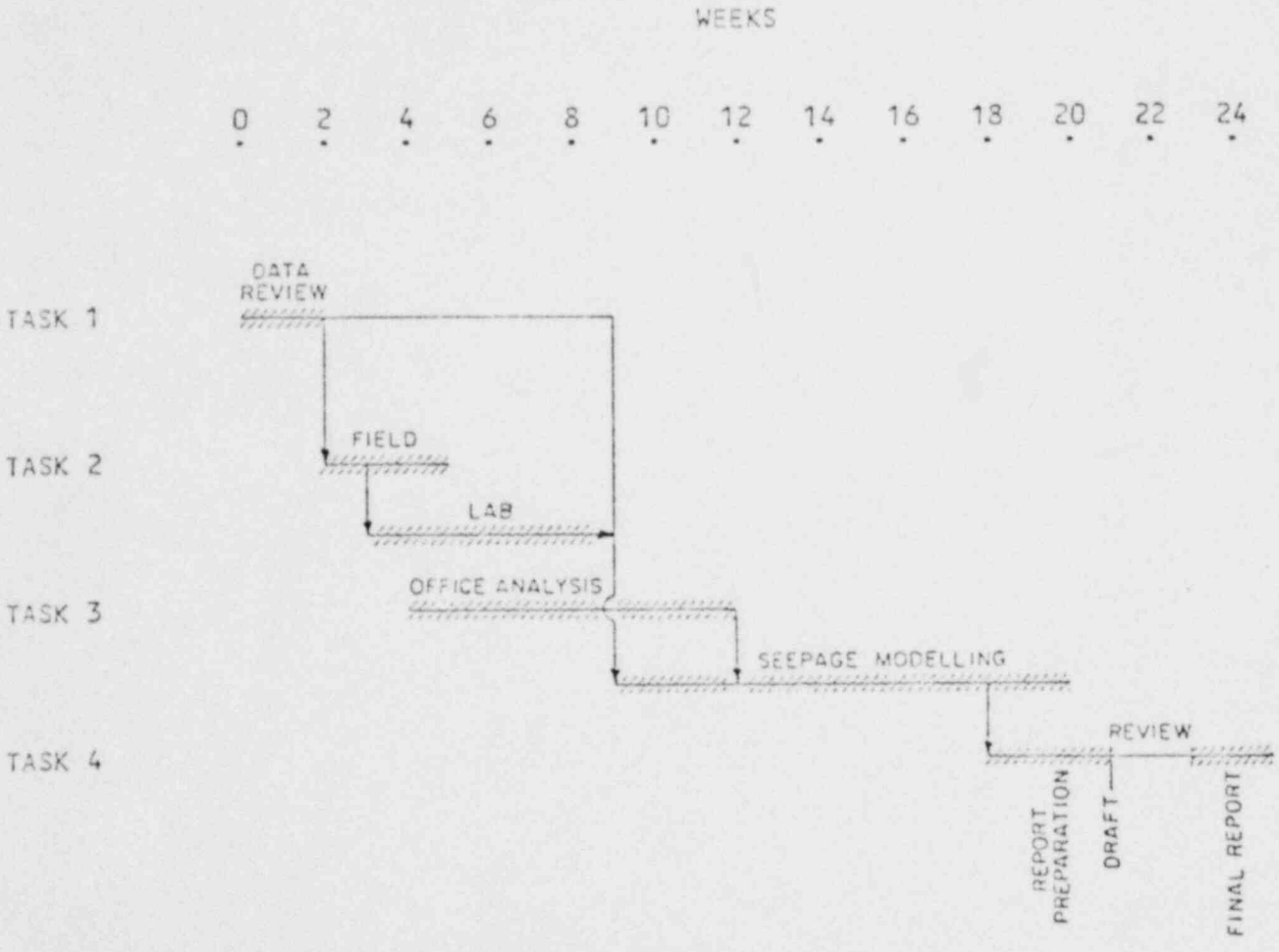

FIGURE 1 - ESTIMATED SCHEDULE