ENCLOSURE A

TVA

EDGEMONT URANIUM MILL DECOMMISSIONING

REPORT NO. 1

PRELIMINARY RESULTS OF GEOTECHNICAL INVESTIGATION PROPOSED DISPOSAL AREA

OCTOBER 1982

MacLAREN ENGINEERS INC.

In Association With

GOLDER ASSOCIATES

ARIX, ENGINEERS ARCHITECTS PLANNERS

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PRELIMINARY RESULTS OF GEOTECHNICAL INVESTIGATION PROPOSED DISPOSAL SITE

INTRODUCTION

As part of the detailed engineering studies for the decommissioning of the Edgemont uranium mill, supplementary geotechnical investigations have been carried out to determine the extent and engineering properties of contaminated material in the area of the existing mill site and the engineering characteristics of the soil and rock forming the sides and bottom of the proposed disposal area. This report summarizes the preliminary results of the geotechnical investigation carried out at the disposal area and briefly discusses the significance of the results and their potential impact on the design of the site.

SITE DESCRIPTION AND GEOLOGY

The proposed disposal area for the Edgemont decommissioning project is located approximately 2 miles southeast of the Town of Edgemont in Sections 8 and 17, Township 9 South, Range 3 East of Fall River County, South Dakota. The site is located at the head of an ephemeral drainage system within the Cheyenne River basin. The ground surface elevation in the immediate vicinity of the site varies between about elevation 3600 and 3675. Vegetation in the area generally consists of grasses and sagebrush. A stock pond exists within the southern portion of the site.

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The disposal area lies on the southwestern edge of the Black Hills uplift. Sedimentary rocks in the area range in age from Cretaceous to more recent Quaternary and Tertiary age sediments. Based on geologic mapping, the site is underlain by shales of the Lower Greenhorn Formation.

PROCEDURE

The field work for this investigation was carried out between August 6 and September 13, 1982 and comprised a series of fourteen boreholes and several shallow test pits. The approximate locations of the boreholes and test pits are shown on Figure 1. All of the boreholes were drilled using a truck-mounted Mobile B-53 drilling machine supplied and operated by Francis-Meador-Gellhaus Inc.

It should be noted that the majority of the boreholes put down during the course of the present investigation were located along the perimeter of the proposed disposal area as the results of a previous investigation by Francis-Meador-Gellhaus in 1981 (Ref. 1) had indicated that the base of the site was underlain at fairly shallow depth by shale of low permeability.

Within the overburden portion of each hole the borings were advanced using hollow-stem augers and samples were obtained using conventional split spoon and thin walled tube samplers. Within the shale, the borings were advanced and continuous samples obtained by rotary core drilling (NX wireline equipment). Following completion of drilling, in situ pressure packer tests were carried out at 5 ft. increments of depth to assess the hydraulic conductivity (permeability) of the

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shale. Subsequently, standpipes and/or piezometers were installed to permit monitoring of the groundwater level at the site and to facilitate future permeability testing in the boreholes.

SUBSURFACE CONDITIONS

Simplified stratigraphic sections along the eastern and western perimeters of the proposed disposal area and along the proposed containment dam alignment are shown on Figure 2. In addition to inferred stratigraphic boundaries, the results of the in situ permeability testing carried out in the weathered and unweathered shale at each borehole location are summarized on the sections.

Soil Conditions

While the soil conditions vary substantially around the perimeter of the disposal area they can generally be summarized as follows:

(i) East Perimeter

Boreholes 105, 106, 107 and 102, drilled along the eastern perimeter of the disposal area, generally encountered some 20 to 30 ft. of loose to compact sandy silt and sand overlying weathered shale at between elevations 3628 and 3637. The sandy silt stratum typically extends from the ground surface to a depth of about 12 to 19 ft. and is underlain by some 2 to 12 ft. of compact brown fine sand.

(ii) West Perimeter

Along the western perimeter of the disposal area the ground surface varies between about elevation 3650 and 3680. All of the boreholes drilled along this perimeter (Boreholes 101, 109, 103, 108 and 104) encountered between 4 and 27 ft. of very stiff to hard desiccated brown silty clay overlying the weathered shale unit. In the upper portion of the basin (Boreholes 104 and 108), occasional layers of fine sand or silt were encountered within the silty clay stratum. In Boreholes 101, 103 and 109, the upper surface of the underlying weathered shale unit was encountered at between about elevations 3656 and 3669. In Boreholes 104 and 108, the upper surface of the weathered shale unit was encountered at between about elevations 3631 and 3635.

(iii) Containment Dam Alignment

With the exception of the east abutment area (Borehole 102 and 113), all of the boreholes drilled along the proposed dam alignment encountered very stiff to hard brown silty clay from the ground surface. The silty clay varies from 6 to 28 ft. in thickness and is underlain by weathered shale at between about elevations 3656 and 3590.

Bedrock Conditions

All of the boreholes put down around the perimeter of the proposed disposal area encountered soft, black shale bedrock of the Lower Greenhorn Formation. Based on examination of the recovered cores and the results of the in situ permeability testing, it is apparent that a very distinct and well defined weathering pattern has developed within the upper sections of the shale. While the weathering profile is gradational from "highly weathered" to relatively "fresh" shale, for discussion purposes the shale has been sub-divided into "weathered" and "unweathered" zones.

(i) Weathered Shale

Visual examination of the rock core indicated that the upper weathered portion of the shale unit is fractured and desiccated. Some infilling of the joints with gypsum has occurred and iron and sulphur staining was noted in the joints and fissures. Occasional seams or layers of bentonite were encountered throughout the depth of investigation but the frequency and thickness of the bentonite seams tends to be greater within the upper weathered portion of the shale. Random limestone bands were also encountered within the shale.

As shown on the simplified sections presented on Figure 2, the weathered portion of the shale typically varies between about 10 and 20 ft. in thickness around the perimeter of the disposal area. However, in the area of Borehole G113, it is estimated that the upper weathered portion of the shale unit is approximately 40 ft. thick.

The results of the in situ permeability testing indicate that the permeability of the weathered portion of the shale unit varied from about 10^{-2} to 10^{-5} cm/sec. The largest permeabilities were recorded in those sections of the weathered shale where significant gypsum deposits were encountered.

(ii) Unweathered Shale

Below the upper weathered zone of the shale the strength of the rock increases slightly, there is little desiccation or fissuring, and the permeability of the rock mass decreases significantly.

In an attempt to establish a rational definition of "unweathered" shale for engineering design purposes, the results of the visual core logging and in situ packer testing shown on Figure 2 were reassessed on a borehole-by-borehole basis. Based on this reassessment, an upper boundary of relatively unweathered, intact and relatively impermeable shale was established. The location of this boundary at each of the boreholes put down during the course of this investigation is shown on Figure 2 and the results of the in situ packer tests relative to (i.e. above or below) this boundary are summarized on Figure 3.

As indicated on Figures 2 and 3, with one exception the coefficient of permeability within the unweathered shale is consistently less than about 5×10^{-7} cm/sec. (generally less than 1×10^{-7} cm/sec.) and is typically at least one to two orders of magnitude less than the permeability of the overlying weathered shale.

Based on the results of the present investigation, the borehole records from the previous (1980) Francis-Meador-Gellhaus investigation (Ref. 1) were reinterpreted and the combined results of the two investigations were used to develop the inferred topographic contours of the upper surface of unweathered, "impermeable" shale shown on Figure 1.

As indicated on Figure 1, weathering of the Lower Greenhorn Formation has resulted in the development of a buried "valley" in the upper surface of the unweathered shale. This valley, while slightly 'S' shaped, generally follows the alignment of the existing drainage course. The "floor" of the buried valley underlies the existing ground surface at a depth of some 30 to 50 ft. and slopes down from about elevation 3615 in the north to as low as about elevation 3565 beneath the proposed containment dam. While the unweathered shale rises to elevation 3650 or higher to the northeast and southwest, weathering has extended to as deep as about elevation 3600 in the southeast corner of the proposed disposal area. It should be noted that existence of this overburden/weathered shale "window" in the southeast corner of the disposal area (indicated by Boreholes 102, 113 and F.M.G.'s Test Hole 1) was confirmed by observation of the exposed shale contact on the east face of the ridge forming the east wall of the disposal area (Figure 1).

Groundwater Conditions

While all of the drill water has not as yet (October 1982) drained out of the deeper drillholes, all of the evidence available to date indicates that the regional groundwater level in the Lower Greenhorn shale is below the maximum depth of investigation; no evidence of groundwater seepage towards the disposal area was found.

Within the base of the existing valley, a local perched groundwater condition was encountered in the overburden and weathered shale. This perched groundwater level appears to be due to seepage OUT of the existing stock pond which is recharged by surface water runoff.

SIGNIFICANCE OF SUBSURFACE CONDITIONS AND REVIEW OF DISPOSAL PLAN OPTIONS

The tailings disposal plan proposed in the Final Environmental Statement (F.E.S.) (Ref. 2) comprises the following elements:

- hydraulic transport of the bulk of the tailings sand; and

- excavation of the basin into the existing overburden soils and shale to a base elevation of about 3600 (see Figure 4).

One of the requirements noted in the F.E.S. in the evaluation of the tailings disposal plan was that "the native soils and shale exposed in the impoundment excavation....provide adequate seepage control". Adequate seepage control is interpreted in the F.E.S. to mean "a permeability of about 1 x 10^{-7} cm/sec across the entire bottom and sidewalls of the impoundment excavation.

A comparison of the "proposed" impoundment excavation contours with the inferred contours of the top of the unweathered, low permeability (k, less than about 10^{-7} cm/sec.) shale (see Figure 4) indicates that virtually the entire base of the excavation will terminate in overburden or weathered shale and could, in some locations, be as much as about 30 ft. above the unweathered shale contact.

Based on the above, it is our opinion at this point that the options available for consideration in a final disposal plan comprise the following:

a) Placement of the entire tailings mass using the methods outlined in the F.E.S. within the unweathered shale. This would require lowering the entire tailings basin about 50 ft. (i.e. the top of the tailings would have to be maintained below elevation 3600 to avoid potential seepage to the southeast). This is not considered to be a practical solution.

b) Placement of the tailings mass using the methods and excavation plan outlined in the F.E.S. with the addition of a compacted clay liner across the entire base and sides of the disposal area. Alternatively, with only minor modifications to the F.E.S. excavation plan, it may be possible to expose unweathered shale and thus avoid the necessity of lining in the southwestern portion of the disposal area. However, in view of the testing requirements to confirm the competency of the shale, potential problems associated with "tying" a liner to the shale and restrictions which would be placed on the overall disposal scheme, it is questionable whether this would be a practical alternative.

   With regard to the liner itself, it appears that either the silty clay overburden or the weathered shale, if properly handled, will be suitable as a liner material. However, this must be confirmed by the laboratory testing program which is currently underway.

c) Abandonment of the hydraulic transport system as proposed in the F.E.S. and adoption of a "dry" materials handling, transport and disposal site design and operation scheme. Such a plan would avoid the introduction of excess free water during placement of the wastes and essentially eliminate the potential for groundwater seepage out of the disposal area and thus the requirement for construction of costly underdrainage and liner systems.

SUMMARY

The results of the recent field investigation indicate that the upper surface of the unweathered, low permeability (k less than 10^{-7} cm/sec) shale occurs at a lower elevation than was previously anticipated. Consequently, to meet the requirements outlined in the F.E.S., it will be necessary to consider an alternative to the tailings disposal plan proposed in the F.E.S. It is anticipated that the overall objectives of the regulatory agencies can be met with the use of a dry materials handling and disposal site design and operation plan. This is discussed further in a subsequent report (Ref. 3).

REFERENCES

1. Francis-Meador-Gellhaus Inc., Subsurface Soil Exploration for Proposed Edgemont Uranium Waste Disposal Site, prepared for Silver King Mines Inc., June 1980.

2. U.S. Nuclear Regulatory Commission (NUREG-0846), Final Environmental Statement related to the decommissioning of the Edgemont Uranium Mill, Tennessee Valley Authority, June 1982.

3. MacLaren Engineers Inc., Golder Associates, Arix, Edgemont Mill Decommissioning Report No. 2, Contaminated Materials Handling and Disposal Considerations, prepared for Silver King Mines Inc., October 1982.

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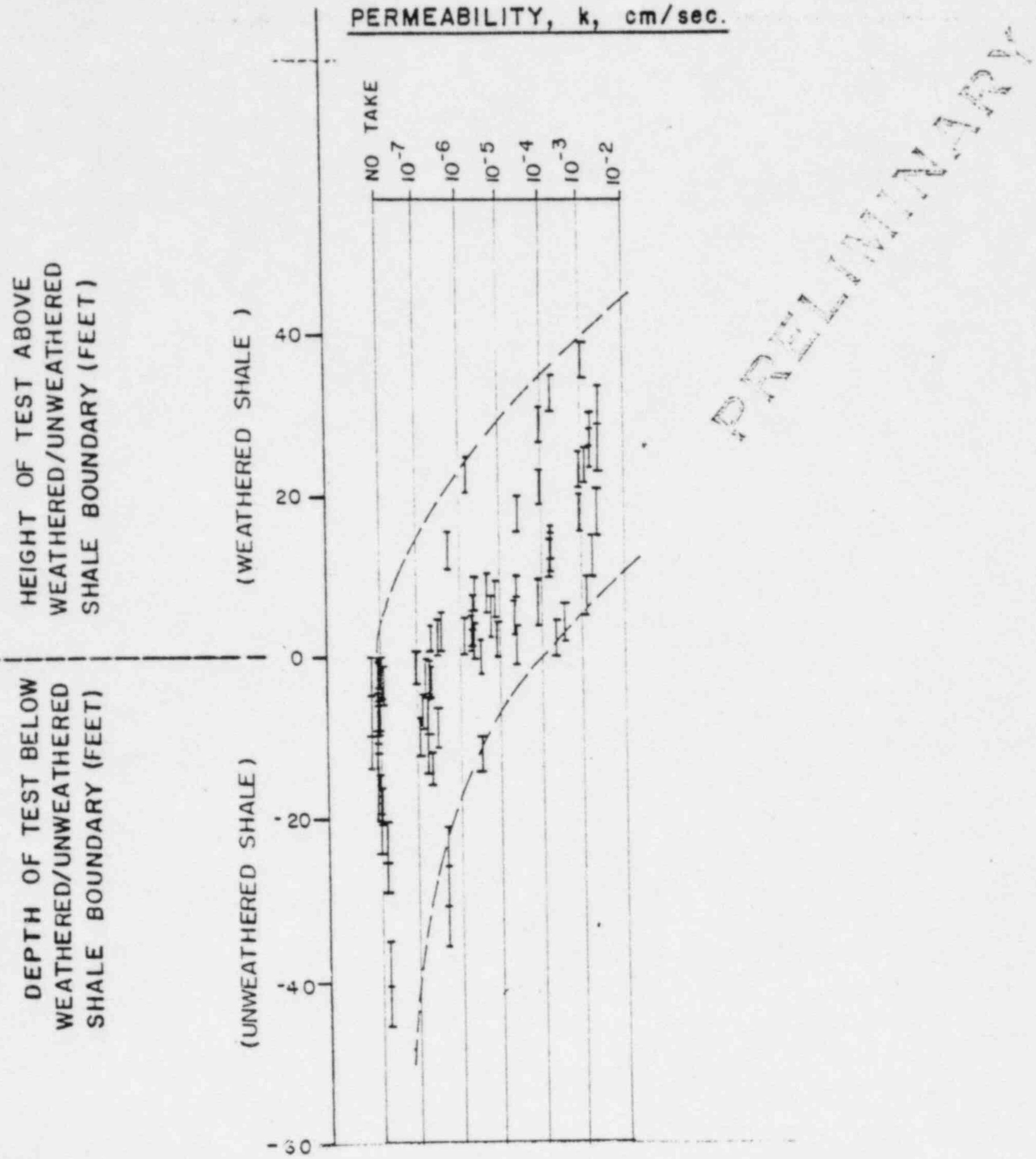
FIGURE 3: PERMEABILITY PROFILE RELATED TO ELEVATION OF UNWEATHERED SHALE CONTACT — DISPOSAL AREA



SPECIAL NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT.

Date OCT. 4, 1982
Project 821-1169

Golder Associates

Drawn C.W.
Chkd.