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GEOTECHNICAL DESIGN & CONSULTING SERVICES

020405

July 13, 1987

Northern Affairs Program
Water Resources
200 Range Road
Whitehorse, Yukon
Y1A 3E1

Attention: Mr. H.F. McAlpine, P. Eng.

Dear Sir:

RE: Mt. Skukum Gold Mine
Inspection of Tailings Ponds

This letter-report summarizes observations made during the June 15, 1987 site visit of the above mine. The purpose of the site visit was to examine the tailings facilities in detail for surface features which may be indicative of the probable future performance of these structures.

1.0 FACILITIES AND THEIR EXAMINATION

The principal components of the tailings disposal system are:

- Dyke No. 1 (Figure 1) is approximately 300 m long and up to 5 m high. It will eventually impound tailings to elevation 989.5 m. The dyke crest is 5 m wide, the freeboard is 0.5 m and the dyke slopes were designed 1.5:1 (H:V).

- Dyke No. 3, approximately 100 m long and only 2 m high, is blocking a terrain depression at the northeast corner of the designated tailings pond area. The crest is 3 m wide and slopes are 1.5:1.

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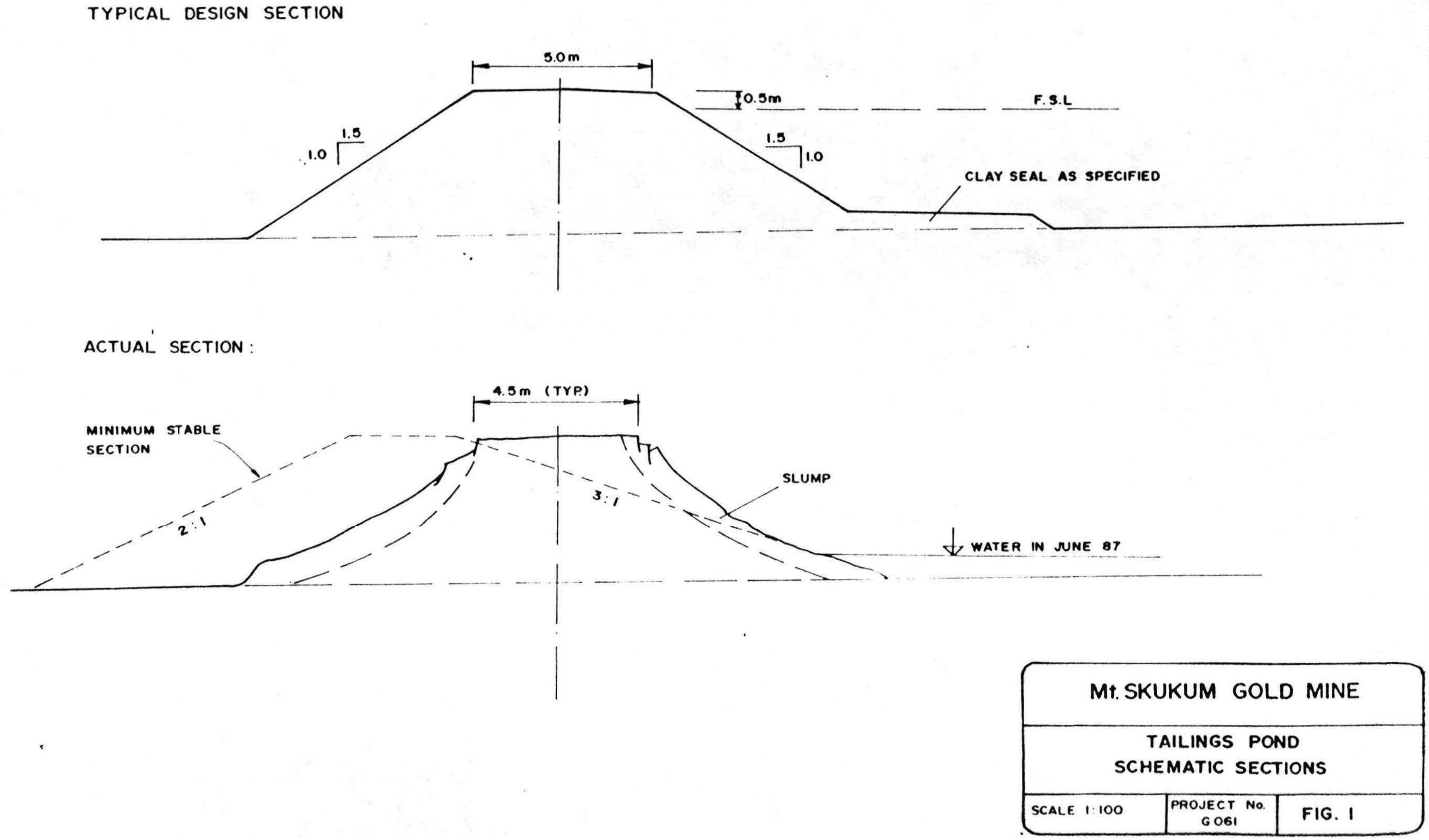

TYPICAL DESIGN SECTION
5.0 m
0.5m
F.S.L
1.5
1.0
1.5
1.0
CLAY SEAL AS SPECIFIED
ACTUAL SECTION:
4.5 m (TYP.)
MINIMUM STABLE
SECTION
SLUMP
2:1
3:1
WATER IN JUNE 87
Mt. SKUKUM GOLD MINE
TAILINGS POND
SCHEMATIC SECTIONS
SCALE 1:100
PROJECT No.
G061
FIG. 1

- Dyke No. 2, approximately 100 m long and some 2 m high, impounds a secondary pond. The crest and slopes are the same as at Dyke No. 3.

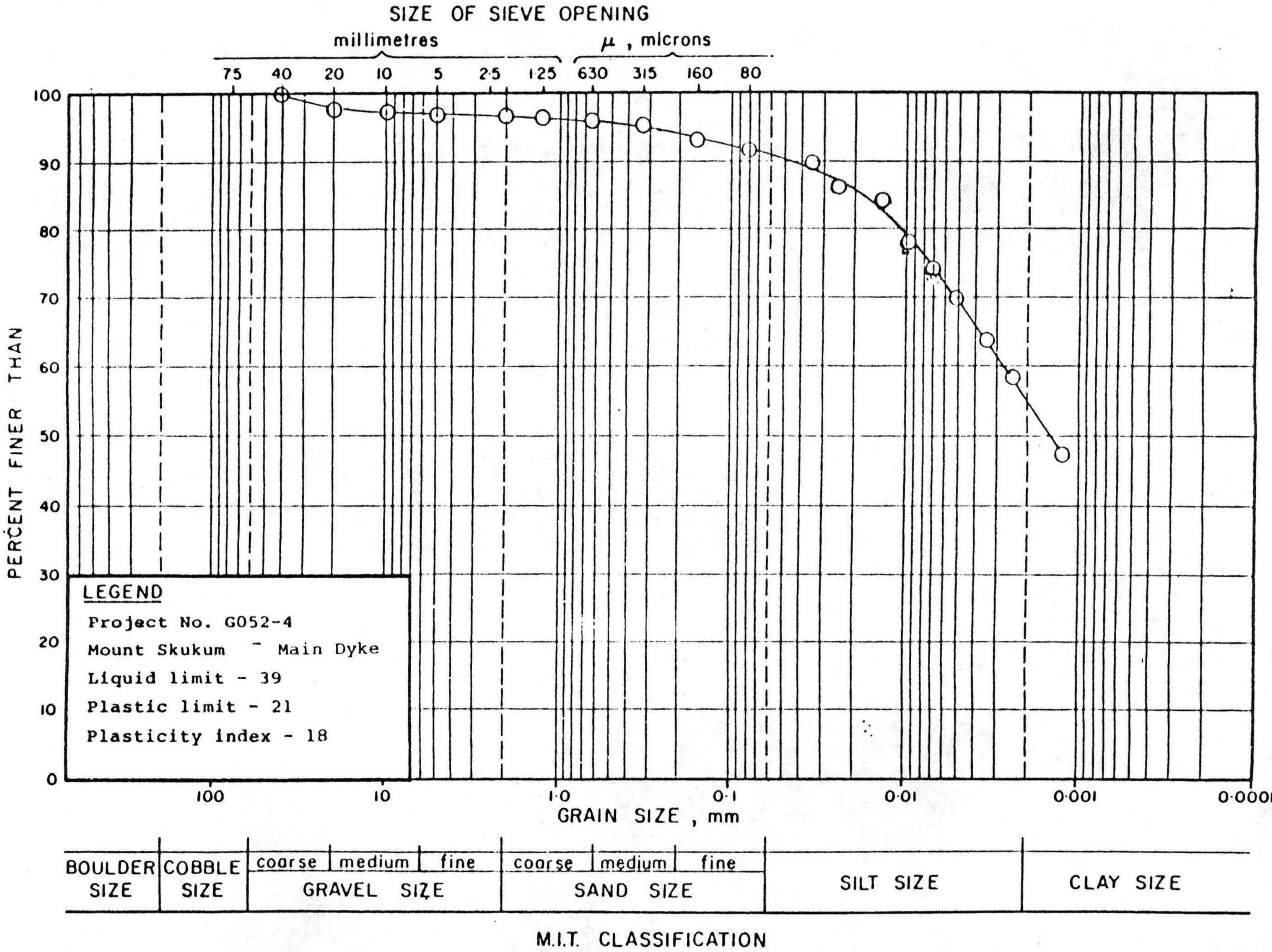
The structures were examined on foot and photographed. The examination was made to review visible cracking associated with settlement, sloughing and/or seepage. A typical sample of soil used for the construction of the dykes was obtained and laboratory analyzed to determine its grain size composition and Atterberg Limits.

2.0 RESULTS OF EXAMINATION

The site location of both ponds is good insofar as the terrain conditions are concerned. The ponds are located within a terrain depression, formerly occupied by a lake. Several soil exposures indicate that this area is comprised of lacustrine silts and clays, ranging from a non-plastic (powdery) consistency to medium plasticity. It is likely that these deposits are underlain by glacial till. There is no evidence of segregated ice or significant (i.e. ice rich) permafrost in the main and secondary dyke areas.

The silt and clay deposits form a suitable foundation for the dykes and a base of low permeability for the pond.

Visual examination of the dykes indicates that they were constructed using local lacustrine deposits, i.e. silts and clays. While silty clay may represent the dominant embankment material, pockets of powdery silt were identified as well. A typical sample obtained from the main dyke was analyzed and the results are shown (together with Atterberg Limits) on Figure 2. As a result, embankment fill is classified as "ML-CI", i.e. ranging from clayey silt of slight plasticity to silty clays of medium plasticity.



GRAIN SIZE DISTRIBUTION

Figure 2

There is some concern about the inclusions or pockets of powdery, non-plastic silts. These silts may become unstable when saturated and have a tendency to "quick." Silts are difficult to compact and as a result, they are highly frost susceptible and may often undergo volume changes (dilatancy).

All dykes have been constructed as homogeneous embankments. While placement of material in compacted lifts was specified, the actual degree of compaction applied could not be established. In some areas, such as Dyke No. 3, the material was apparently dozed in without any benefit from compaction (Photo 4).

The dykes have been designed and constructed with both upstream and downstream slopes 1.5:1 (H:V), i.e. at 35 to 37 degrees gradient. It is our experience that the angle of internal friction for these materials is in the range of 27 to 30 degrees. U.S. Bureau of Reclamation (Design of Small Dams, 2nd Edition, 1977) recommends that slopes for small homogeneous dams constructed from ML-CI type soils should have an upstream slope of 3:1 and a downstream slope of 2.5:1 (H:V). Some other standards (for example, CSN 73 6824) allow downstream slopes to be 2:1 but recommend to cover the slope with sandy gravel 0.5 to 1.0 m thick.

While the depth of impounded water is low (probably less than 1 m at the deepest point of the main pond), the deformations of dyke slopes are already significant.

2.1 MAIN TAILINGS POND DYKE

The top of the dyke is uneven in the longitudinal as well as the perpendicular directions - possibly due to localized settlement.

Fissures and cracks exist on the crest as well as on both dyke faces. Sloughing of saturated material affects the entire upstream side of the dyke. The downstream toe is locally cracked and bulged, indicating slope and/or foundation failure (Photo Nos. 1 and 2).

It is therefore concluded that the dam Factor of Safety against sloughing is likely in the order of unity.

A schematic sketch of current dyke deformations is shown also on Figure 1 together with a dyke configuration which would meet the above guidelines.

The emergency spillway has not been constructed.

2.2 MAIN TAILINGS POND - SECONDARY DYKE

The dyke (Photo 3) was overtopped in 1986 and is currently under reconstruction. A powdery, dry, non-cohesive silt is used for the dyke without compaction (Photo 4). This type of fill should not be used because powdery silt is very difficult to compact and would readily pipe. The dyke slopes are 35 to 37 degrees steep, i.e. in excess of one safe slope gradient for this material.

2.3 AUXILLARY POND DYKE

The dyke is comprised of clayey silt, similar to the material used for the main dyke. Its sideslopes are steep, approximately 1.5:1 (H:V), fissured and cracked. The overall stability of the dyke is marginal (Photo Nos. 5 and 6) and localized dyke sections are currently unstable.

The designed emergency spillway has not been constructed.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Inspection of the dykes forming the tailings disposal facilities reveals that improvements of the existing structures are required.

It appears that the dyke material received little or no compaction; consequently, the embankment densities are probably below those specified by the designer.

Low soil density has an adverse impact on the permeability and stability of the embankment.

The dyke slopes are too steep relative to the shear strength of the fill material. As a result, the dykes experience extensive sloughing. This confirms that the Factor of Safety for the dykes is unity or less.

It is recommended to develop and implement rehabilitation measures which should consist of the following actions:

- placement of additional fill on the downstream side of the dyke to compensate for the poor quality of the embankment fill and achieve a stable downstream slope;
- grading of the upstream dyke faces to achieve a more stable slope;
- placement of additional fill and grading of the dyke crests to achieve the designed grade;
- construction of properly armoured spillways;
- initiation of a regular monitoring program.

We trust that the foregoing summarizes the results of our field inspection. Should you have any questions regarding our evaluation of the observed features, please contact us at your convenience.

Yours truly,

GEO-ENGINEERING (M.S.T.) LTD.

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Principal Consultant

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PHOTOGRAPHS

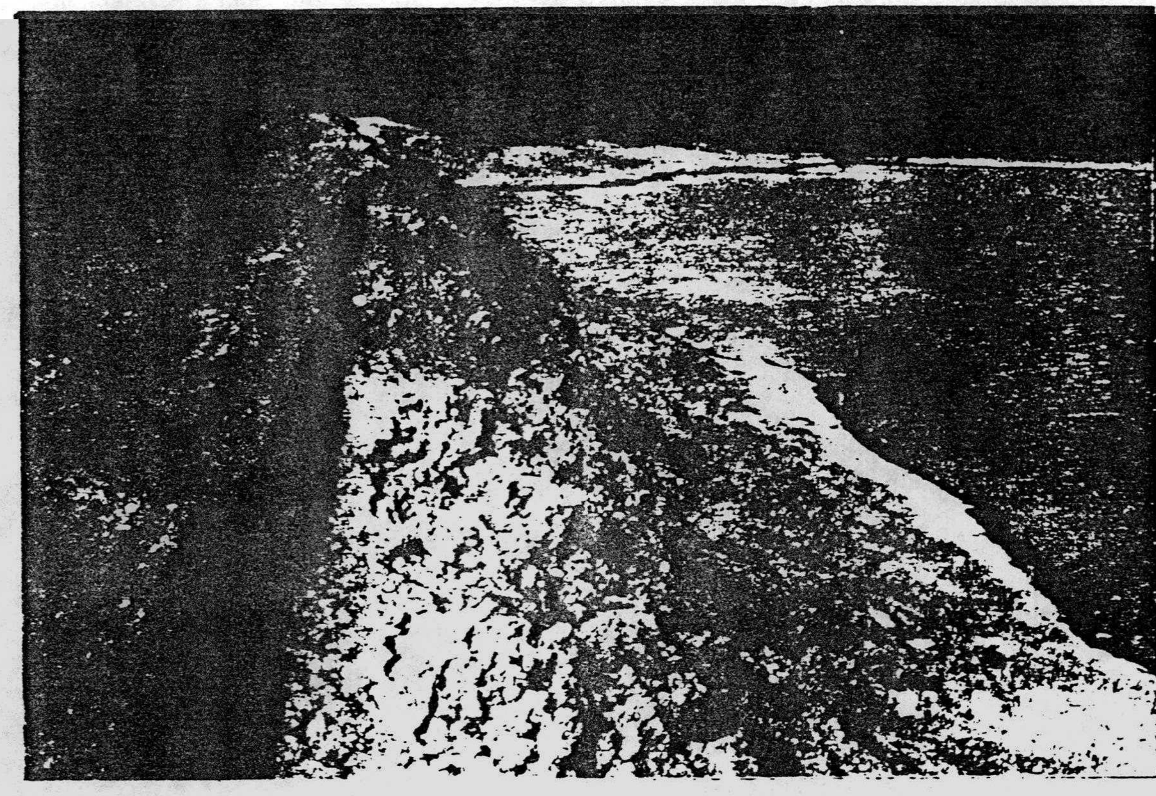

Photo 1: Main dyke, looking west. The instability of the upstream face is manifested by bulging toe and cracks at the crest.

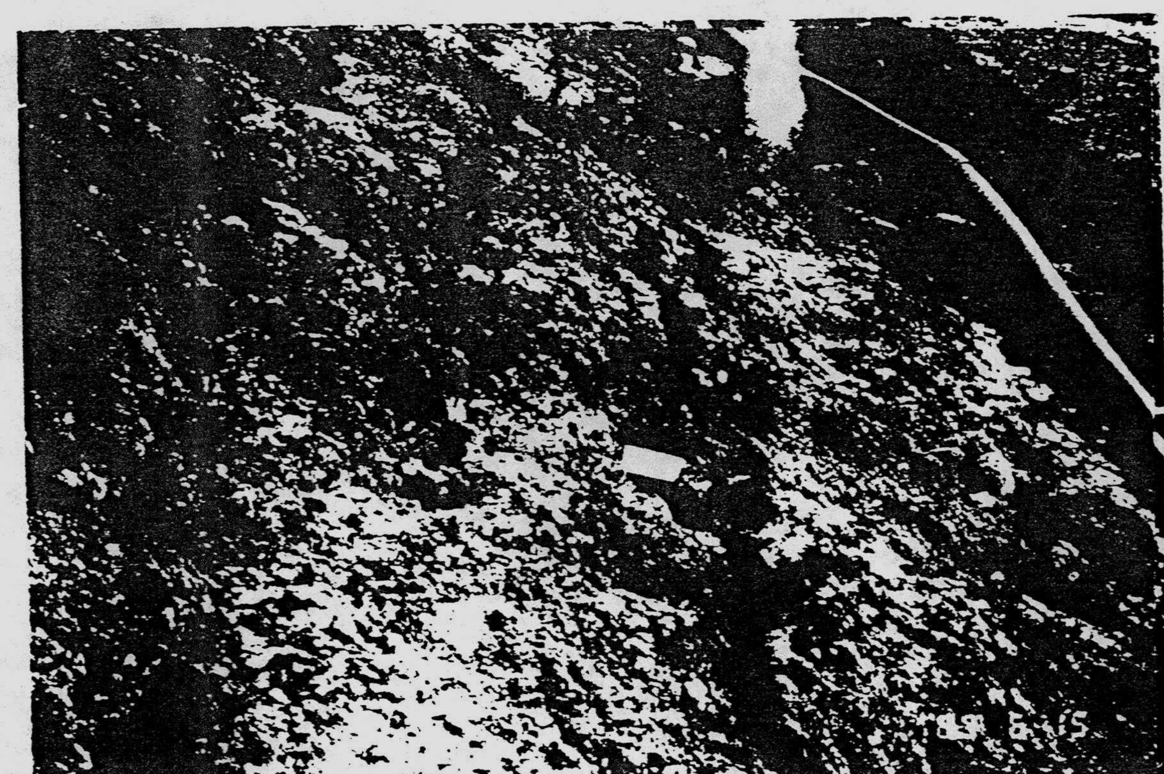

Photo 2: Cracks in the downstream face of the main dyke.

Photo 3: Dyke No. 3 - looking south. Current construction procedure involves pushing and spreading of the fill material (comprising powdery silt) with dozer.

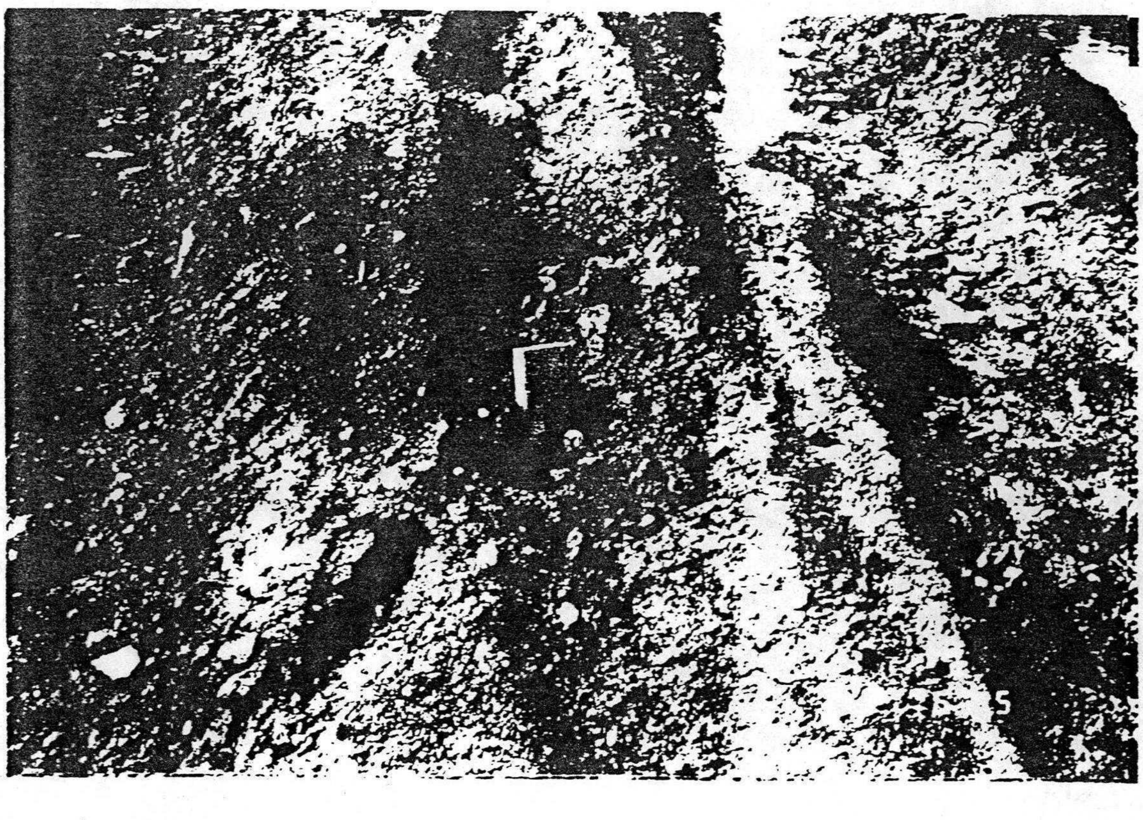

Photo 4: Uncompacted or poorly compacted silt is inherently unstable.

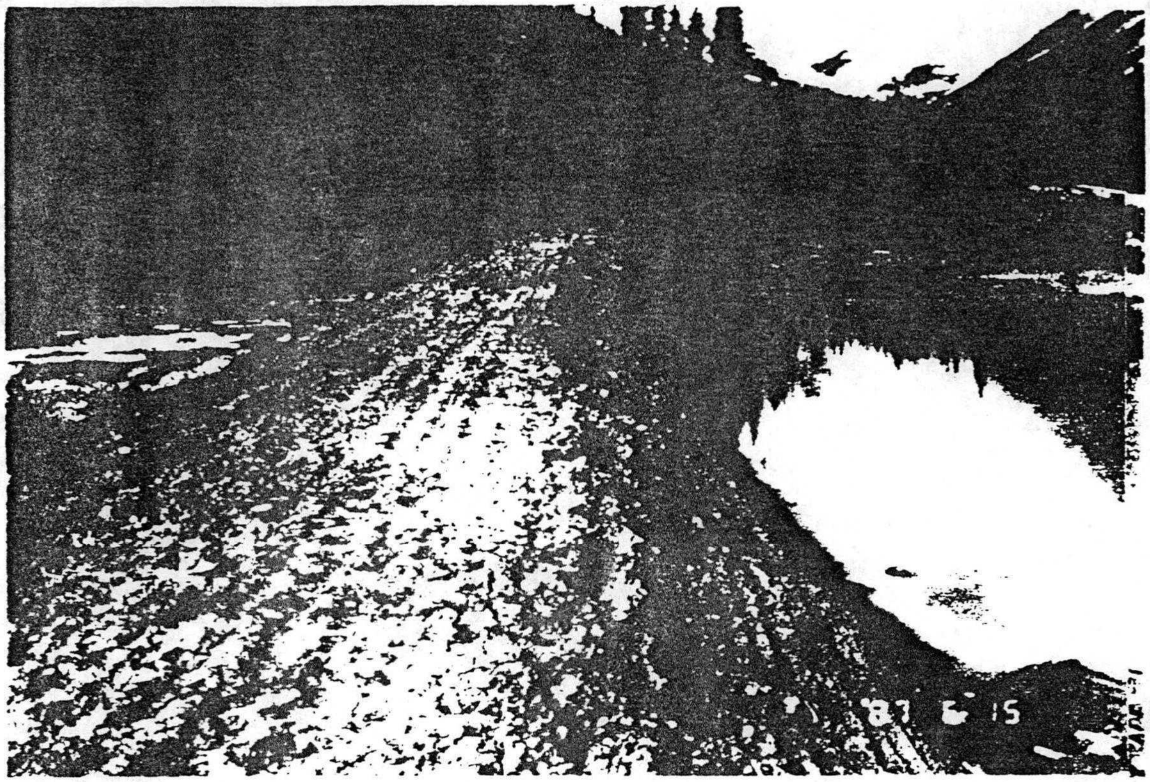

Photo 5: Dyke No. 2 - looking west. Cracks at the crest are caused by the unstable upstream dam slope.

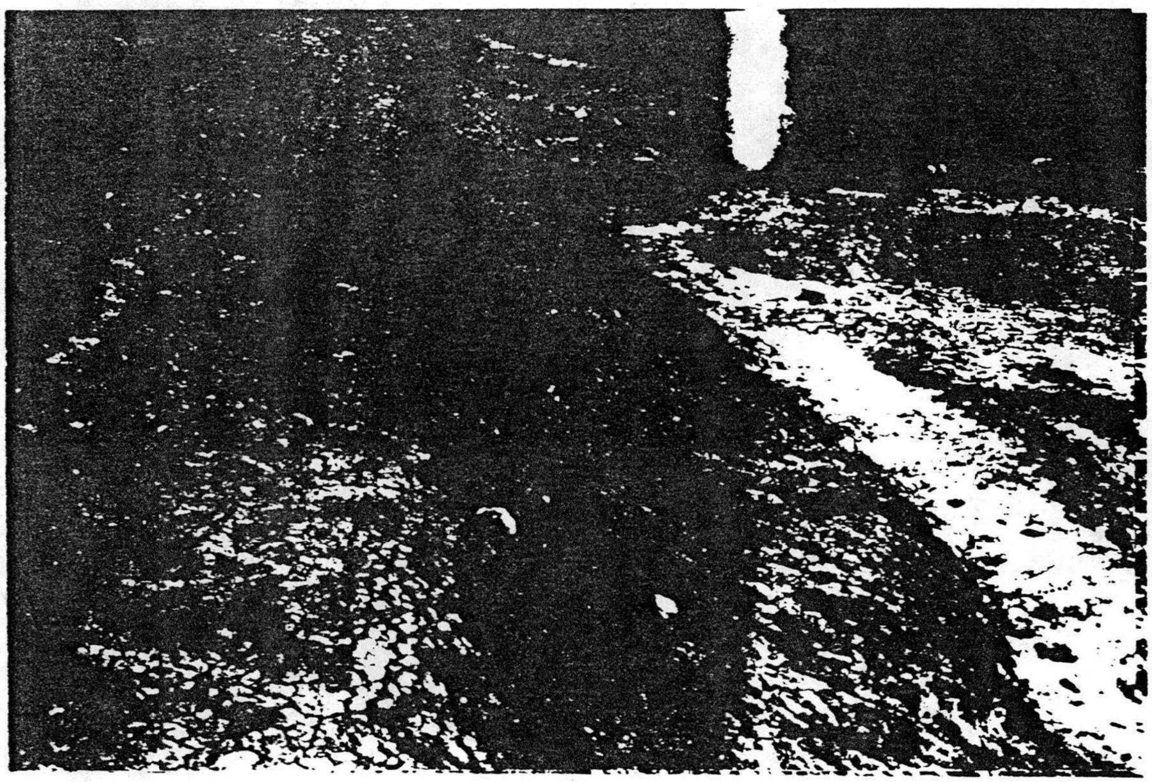

Photo 6: Slide on the downstream face of the auxillary pond dyke. White patches along the toe may be indicative of seepage.