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To: Distribution- - see below
From: H. F. McAlpine

Date: October 22 1999
Subject: Dam Safety Assessment of the Mt. Nansen Tailings Dam

Attached is a letter report submitted by Klohn-Crippen Consultants Ltd and EBA Engineering Consultants Ltd, that is the initial phase of the Dam Safety Assessment being undertaken by the Department of Indian Affairs and Northern Development (DIAND) pursuant to the requirements of the water licence for the Mt Nansen mine site. The report was written subsequent to an recent site inspection and provides the consultants observations together with some issues related to safety and integrity of the structures that require immediate attention. This report is sent only for your information, however if you should have any questions please do not hesitate to call myself at 667 3225 or Mr David Sherstone at 667 3145.

The final report is to be submitted to the Yukon Territory Water Board by December 31 1999.

Distribution: Yukon Territory Water Board
Yukon Conservation Society
Little Salmon Carmacks First Nation
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Geo-Engineering Ltd

Canada

KLOHN-CRIPPEN

ISO 9001 REGISTERED KPMG Registration No 1304

October 19, 1999

Indian and Northern Affairs
Water Resources Division
310-300 Main Street
Whitehorse, Yukon Territory
Y1A 2B5

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

Dear Mr. McAlpine:

BYG Tailings Dam, Mount Nansen, YT - Site Visit Report

The purpose of this letter is to provide a general impression of the current condition of the BYG Tailings Impoundment (see Photo 1 and Figure 1 for site plan) as well as to identify some issues related to the safety and integrity of the dam that require immediate attention. On September 16, 1999 our Robert Lo visited the site together with yourself, Mr. Cord Hamilton of EBA and Mr. Milos Stepanek of Geo-engineering. This report is based mainly on our observations and discussions on site together with a preliminary review of some recent site monitoring data provided to us through EBA. The letter was prepared in consultation with Mr. Cord Hamilton of EBA. We will carry out a more thorough review as stipulated earlier, but this must not delay initiation of improvement measures given in this letter.

1. BACKGROUND

Our site visit was carried out as part of an assignment by Water Resources Division of DIAND - Yukon Region to EBA and Klohn-Crippen to complete a dam safety assessment of the existing tailings dam at BYG's Mount Nansen Mine. The following brief discussion on the history of the tailings impoundment is to provide some perspective for evaluating its current condition.

The final design of the tailings impoundment was completed in August 1995. The Main Tailings Dam (Dam 1) and Seepage Control Dam (Dam 2) were constructed mainly of natural sandfill borrowed from various borrow pits upstream and downstream of the Main Dam. The construction of the Main Tailings Dam, Seepage Control Dam, North Diversion Ditch and Emergency Spillway were completed in the fall of 1996. Piezometers and thermistors were installed during this construction season for ongoing

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monitoring of dam performance. The impoundment was used for tailings storage from approximately the late fall of 1996 to the spring of 1999 with a brief shutdown of about 3.5 months in the winter of 1997-1998.

In the spring of 1997, the North Diversion Ditch was extended along the west perimeter of the tailings impoundment. Later in the summer, a toe buttress berm was added to control seepage that was exiting on the downstream slope of the Main Dam with accompanied internal "piping" erosion of damfill materials. The Emergency Spillway channel was also repaired. Some of the existing dam instrumentation were destroyed during the berm construction.

In the spring of 1998 new piezometers and thermistors were installed to replace the non-functional and damaged original instrumentation. The North Diversion Ditch was also repaired.

The tailings pond level record indicates that the pond level rose steadily from Mar. 13, 1997 at El. 1145.7 m to Aug. 13, 1997 at El. 1150.03 m, except for minor brief drops. The pond level dropped to El. 1149.73 m on Aug. 27, 1997 and stayed in a narrow range between El. 1149.55 m to El. 1149.88 m until Jan. 20, 1999. There was an exceptionally low pond level reading of El. 1149.16 m on Feb. 8, 1999. The pond level rose from El. 1149.77 m on Apr. 21, 1999 to El. 1150.1 m on July 4, 1999 and essentially stayed around El. 1150 m until Aug. 27, 1999, the date of the last reading in the record reviewed by us.

2. SITE OBSERVATIONS

2.1 Tailings Impoundment

During our site visit, the pond level was very high relative to the crest elevation (design crest at El. 1151.5 m) of the Main Dam, with some tailings beach showing above the pond level at the south end and middle portion of the dam (see Photos 2 and 3). It is worth noting that the original design envisaged a 50-m wide continuous tailings beach, and this criteria was not met at the time of our site visit.

No water was observed spilling from the emergency spillway channel, which has an inlet invert elevation set at El. 1149.7 m at its upstream end. It is not known whether the pond level actually dropped from the recorded El. 1150.04 m on Aug. 27, 1999 to below El. 1149.7 m on September 16, 1999 during our visit. Or, there is potential inconsistency in the site records. Some water was observed ponding in a section of the spillway inlet

channel downstream of its upstream end. A pump was set up at this location for returning the ponded water into the tailings pond.

We understand that the water treatment plant was operating during our visit, and the treated water was being returned to the tailings pond.

2.2 Main Tailings Dam

The Main Tailings Dam, in general, appeared to be in good condition (see Photos 2 to 4). Outlined in the following are some observations in specific areas:

- The downstream slope of the buttress berm near the right (south) abutment has local depressions and extensive cracks (see Photos 5 to 7).

- Ongoing erosion was observed at a downstream diversion trench located at the south abutment, starting from the south end of the Main Dam and continuing beyond the south end of the Seepage Control Dam (see Photo 4). We understand that the trench was originally formed by a bulldozer during dam construction.

- Seepage was observed daylighting along the downstream toe of the Main Dam buttress berm (see Photo 4). The seepage was concentrated on the south abutment side and in the middle of the berm toe. At both points it was flowing clear through the coarse rock fill that forms the toe of the buttress berm. We understand that suspended solids in the seepage recovery pond have been higher than current.

2.3 Seepage Control Dam

The general appearance of the Seepage Control Dam (see Photos 4, 8 and 9) was similar to that of the Main Dam. Some water was impounded in the Seepage Recovery Pond, and reddish stains were visible (see Photo 8). A vertical culvert was also observed leaning (see Photo 4). Downstream of the Seepage Control Dam, seepage was observed to exit from its downstream toe at three locations. At the leftmost seepage exit location near the left (north) abutment, a pump set-up was observed, presumably for returning the seepage to the tailings pond (see Photo 9). We understand that downstream of the Seepage Control Dam heaves of the creek bed were observed in the winter of 1998-1999, possibly due to freezing of seepage under the surficial frozen zone.

2.4 North and West Diversion Ditches

The North Diversion Ditch diverts Dome Creek from the northwest corner of the tailings impoundment (see Photo 14) along its north perimeter (see Photos 13 and 12) and returns

the flow back into Dome Creek downstream of the Seepage Recovery Pond. Its downstream segment shares the channel with the Emergency Spillway outlet channel (see Photos 10 and 11). The extended West Diversion Ditch picks up additional surface runoff along the west perimeter of the tailings impoundment (see Photo 14).

Sand and silt sediments generally covered the channel bottom along the West Diversion Ditch and the upstream segment of the North Diversion Ditch (see Photos 13 and 14). As the gradient increases along the downstream segment of the North Diversion Ditch, the riprap protection reduces the downcutting of the ditch invert. Ongoing erosion and side slope adjustment as well as the maintenance of the slope protection were visible (see Photos 10 and 11).

3. DAM SAFETY ISSUES

3.1 Seepage-Induced Dam and Foundation Internal Erosion

The tailings impoundment has experienced high pond levels during most of its operation life since 1997. Since the shutdown of mining operation in the spring of 1999, the pond level rose and stayed at the maximum level of around El. 1150 m. This is a higher sustained pond level than during mining operation when the pond was only briefly at this level for about a week in mid-August, 1997. At that time a downstream buttress berm was implemented to arrest the threat of seepage-induced internal erosion of damfill.

This practice of maintaining high pond levels has contravened the original design premise of maintaining a significant width of tailings beach as the main defense against seepage through the dam and its foundation and abutments. As a result, the dam itself has to rely more on the performance of a Geosynthetic Clay Liner, which is originally intended as a temporary seepage barrier acting as a second line of defense against seepage. The lack of significant width of tailings beach also exacerbates the seepage through the dam foundation and abutments due to much shorter seepage paths than originally intended. There are indications that the foundation permafrost has been degraded, since the operation of the tailings impoundment in 1996-1997.

For these reasons, seepage flow has exceeded the original design estimates. The ongoing seepage not only increases the potential for internal erosion; it also accelerates the ongoing degradation of the foundation permafrost. The degradation process transforms the upper portion of the stable, relatively impervious permafrost foundation into thawed, less stable and more pervious and erodible silt-sand materials. As the permafrost thaws, the seepage zone will be enlarged with an ensuing increase in foundation and abutment seepage, which will further degrade the permafrost foundation.

The number of site staff has been drastically reduced to a few since the shutdown of the mining operation. The limited and poor condition of the equipment left on site and the existing infrastructure are inadequate to cope with any significant dam-related emergency situations. It is, therefore, critically important to increase the safety margin against a seepage-induced dam incident or even failure by increasing substantially the width of the prevailing tailings beach.

3.2 Dam Overtopping

The present defense against dam overtopping is the emergency spillway. Its proper functioning during flood events will be critical for preventing dam overtopping and ensuing breach of the tailings pond.

3.3 Recommended Actions

To reduce the above two threats against the tailings dam, particularly during the spring freshet next year, we recommend that the following actions be taken as early as practical:

1. Lower the tailings pond level to maintain a tailings beach with a minimum width of about 50 m at all times.

2. Install a flow meter at the pump located at the Seepage Recovery Pond to improve the ongoing seepage monitoring.

3. Investigate the existing condition of the emergency spillway channel to check what improvements to the slope protection of the channel may be required. This investigation should be carried out to a downstream point, where the Main Dam will no longer be threatened if the flow jumps out from the spillway channel. A thorough review of the site record and discussion with personnel familiar with the past mine operation by EBA would be a useful initial step.

4. Carry out a survey on the Main Dam including the downstream buttress berm, emergency spillway, the North and West Diversion Ditches and accessible tailings beach above water as well as the Seepage Control Dam. This survey would provide a reliable reference for future dam inspections. EBA could provide detailed assistance on the survey requirements.

We trust that this letter fulfills your requirements at this time.

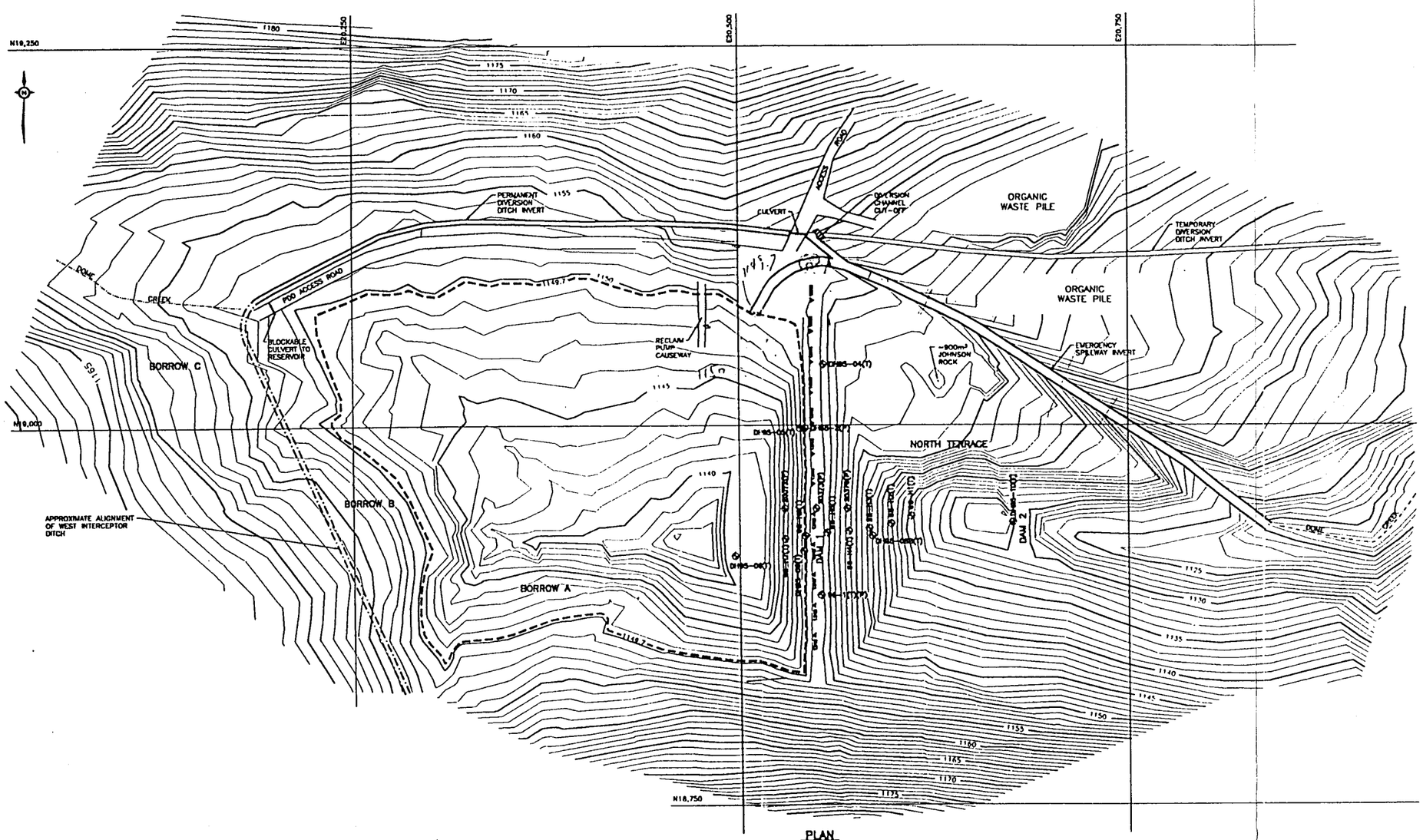
Yours truly,

KLOHN-CRIPPEN CONSULTANTS LTD.

Robert C. Lo, P.Eng.
Project Manager

cc: Mr. Cord Hamilton, EBA Engineering Consultants Ltd.

Attach: Figure 1
Photographs



PLAN

LEGEND

- LOCATION
- LABEL
- INDICATES PNEUMATIC PIEZOMETER
- INDICATES THERMISTOR
- SETTLEMENT PINS

TO BE READ WITH KLOHN CRIPPEN REPORT DATED _____

SCALE: (1:1500) 0 30 60m

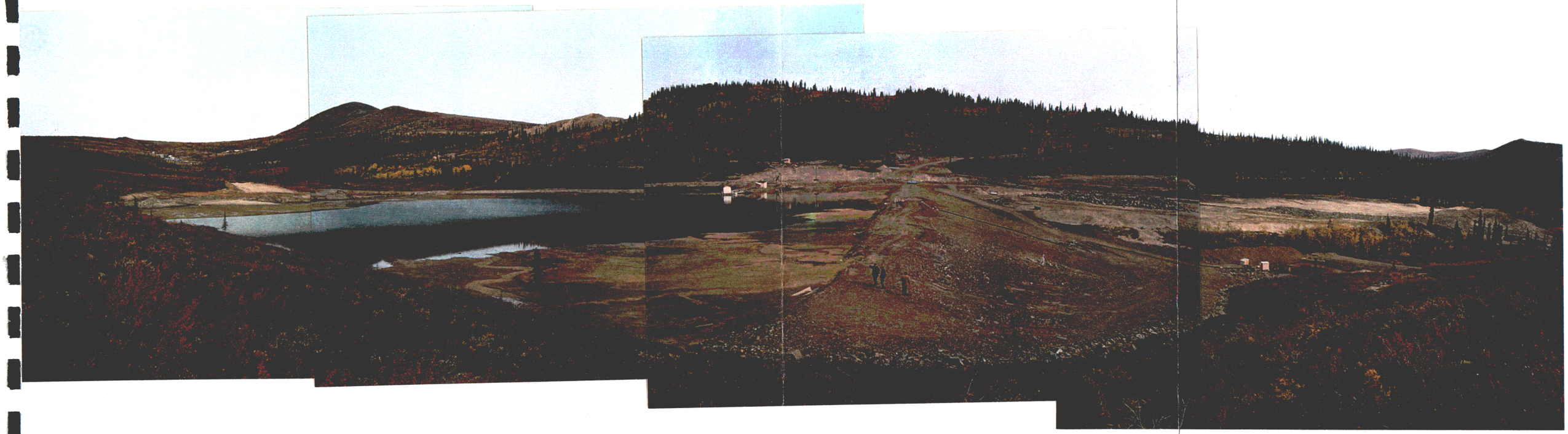
KLOHN-CRIPPEN

CLIENT: B.Y.G. NATURAL RESOURCES INC.

Figure 1

REV.	DATE	REVISION DETAILS
DESIGN	DRAWN: C. P. B.	DATE: DEC 1996
PROJECT	MT. NANSEN TAILINGS FACILITY	
TITLE	SITE PLAN	
DATE OF ISSUE: JUNE 1997	PROJECT No.: PM 5314.08	DWG. No.: 5314-08-02
APPROVED		REV.

Photograph 1 Bird's eye view of Tailings Impoundment - looking southeast.



Photograph 2 Panoramic View of Tailings Impoundment - from south abutment of Tailings Dam.

Photograph 3 Panoramic View of Tailings Impoundment - from north end of Tailings Dam crest.

Photograph 4 Tailings Dam Downstream Slope and Seepage Recovery Pond.

Photograph 5 Downstream Slope of Buttress Berm - looking upward towards south abutment.

Photograph 6 Downstream Slope of Buttress Berm - looking downward towards Seepage Recovery Pond.

Photograph 7 Close-up of local depressions on buttress berm slope.

Photograph 8 Seepage Recovery Pond and Seepage Control Dam - looking northeast.

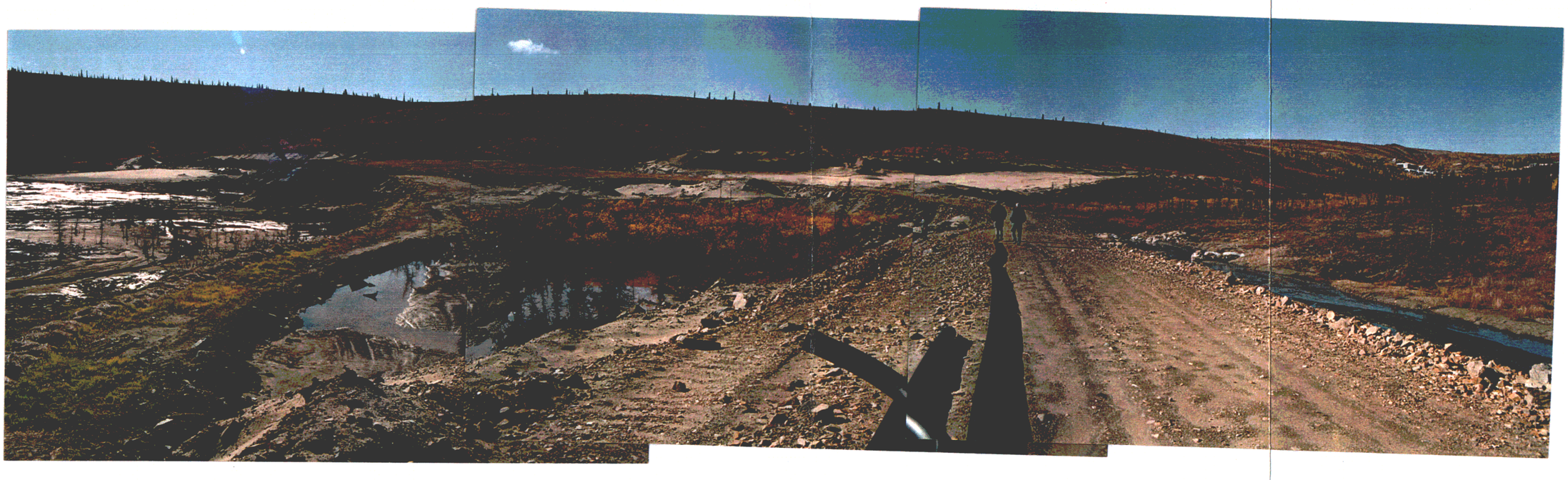
Photograph 9 Seepage Control Dam downstream slope - looking northeast (observable seepages exiting from the toe).

Photograph 10 Emergency Spillway Channel - lower segment (used also for conveying water from North Diversion Ditch).

Photograph 11 Emergency Spillway Channel - upper segment (used also for conveying water from North Diversion Ditch).

Photograph 12 Bridge construction in progress - across North Diversion Ditch.

Photograph 13 North Diversion Ditch - looking west (pipelines crossings in background).



Photograph 14 North and West Diversion Ditches - looking north and northwest.