Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

A REPORT TO
CYPRUS ANVIL MINING
summarizing the

DOWN VALLEY TAILINGS CONTAINMENT PROJECT 1980-81 CONSTRUCTION

Faro Yukon

Volume I of III

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Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

February 22, 1981

Cyprus Anvil Mining Corporation
P.O. Box 1000
Faro, Yukon Territory
Y0B 1K0

Attention: Mr. N.G. Cornish, P.Eng. Superintendent
of Environmental Control

Dear Sir:

It is with considerable pleasure that we are providing Cyprus Anvil Mining Corporation with this documentation of construction of the Down Valley Tailings Project. It was initially examined in July 1979, investigated and designed during the period July, 1979 to June, 1980 and the project was tendered in August of 1980. Construction took place during a twelve month period beginning in October, 1980. Throughout this period, Golder Associates' work on the project was greatly aided by Mr. N.G. Cornish and other members of the CAMC staff through their continuing interest, involvement and constructive criticism of our work. Assistance during construction was greatly appreciated, as was the cooperation of General Enterprises, the Yukon based project Contractor. Their experience of both winter construction and the local materials proved to be invaluable to the project.

We look forward to monitoring the performance of the project during its operational life, and to a continuation of the excellent relationship which has existed with CAMC throughout the period of project inception, design and construction.

Respectfully submitted

GOLDER ASSOCIATES

Dave Goodall

D.C. Goodall, P.Eng.

H.G. Gilchrist, P.Eng.

/mp

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1.0 SUMMARY

Cyprus Anvil Mining Corporation has completed initial construction of the Down Valley Tailings Containment Project as a prerequisite to the discharge of tailings immediately downstream of the existing tailings containment area. The project is located in the Rose Creek Valley near Faro, Yukon, and near to the Company's open pit lead/zinc mine on the north wall of the valley. It is required as a consequence of the Company's acquisition of nearby ore bodies and of mill modifications which will result in diminished tailings deposit density.

The work was performed by General Enterprises, a Whitehorse, Yukon construction company which was awarded the unit price contract by Cyprus Anvil after reviewing the competitive bids submitted by eight major construction companies.

Contract administration and constuction supervision were provided on behalf of Cyprus Anvil by Golder Associates who also prepared the Contract Documents and design reports for the Down Valley Project.

The project work included the construction of a relatively flat gradient 3.8 km long Diversion Canal to relocate Rose Creek to a position along the south valley wall to keep it outside intended tailings storage area. Two cross valley dams were also constructed. The Intermediate Dam is upstream of the Cross Valley Dam and it is intended to retain tailings upstream of its location in the valley bottom. The Cross Valley Dam was constructed about 400 m downsteam of the Intermediate Dam and is intended to provide 60 day retention of tailings spigot waters which are decanted across the Intermediate Dam. The Intermediate Dam will be raised in stages to provide increase of tailings storage capacity as required.

An interceptor ditch was constructed along the north wall of the valley to prevent north wall runoff from entering the tailings area. An access road was also constructed along the north wall to convey the tailings pipeline and to provide general access to the completed works.

Construction began on October 17, 1980 and continued, except for a Christmas shutdown, through to October 14, 1981 on a two shift per day basis. Winter activity concentrated on the construction of the Diversion Canal which involved the excavation of about 55,000 cu.m of rock plus about 690,000 cu.m of discontinuously frozen valley well colluvium and organic materials and glacial till.

Canal lining and dyke construction was also initiated during the winter. Together with later placement, approximately 151,000 cu.m of sand and gravel dyke and thermal lining material were placed. Valley bottom terrace deposits were the source placed. Riprapping of the canal was achieved using 87,000 cu.m of sorted rock from canal rock excavation and quarry sources. With the onset of thawing conditions in March, April and May, 55,000 cu.m of glacial till seepage liner was installed along the canal dyke using unfrozen material from borrow areas adjacent to the canal.

Diversion of Rose Creek was made on May 11, 1981 with the canal dyke subsequently being raised from the minimum 10 year flood level required for diversion to the full 500 year design flood elevation.

Preparation of the dam foundation areas was also undertaken during winter conditions. The water level in the dam foundation areas was lowered using the valley bottom Drainage Ditch concept offered by the Contractor with his tender. About 166,000 cu.m of subexcavation was completed preparatory to commencing placement of the earth zones of the dams.

Construction of the dams was undertaken between late May and the end of general construction in October. The dams wre constructed with relatively impermeable till cores protected by upstream transition and downstream drainage chimney filters. The design of the water retaining Cross Valley Dam included the construction of an upstream till blanket placed for the benefit of foundation seepage reduction. About 490,000 cu.m of fill was required for the Cross Valley Dam and about 340,000 cu.m for the Intermediate Dam. This material was taken from valley bottom terrace area borrow pits except for about 250,000 cu.m of glacial till which was taken from borrow pits on the north valley wall.

An emergency spillway/decant system was constructed at each dam. The spillways are designed to carry the full 500 year Rose Creek flood flow. A total of about 10,000 cu.m of riprap was placed at the two spillways.

Extensive instrumentation was designed and installed by Golder Associates at the end of construction. Monitoring of this instrumentation and visual inspection and maintenance of the constucted work, is recommended to promote successful long term operation of the facility.

2.0 INTRODUCTION

2.1 General

In May, 1979 Cyprus Anvil Mining Corporation introduced the Down Valley Tailings Project as a long term plan for containment of tailings from both existing and newly acquired reserves at or near their Faro, Yukon lead-zinc mine (for location see Figure 2-1). The project involved the deposition of tailings in the Rose Creek valley downstream of the existing facility and, as such, is essentially an expansion of the existing facility. The expansion required the construction of an extension to the diversion canal which diverted Rose Creek from its valley bottom, a tailings retention structure to immobilize the tailings (Intermediate Dam), and an effluent retention structure to ensure acceptable downstream water quality (Cross Valley Dam). Minor construction elements included access roads and interceptor ditches. This construction is generally shown on Figure 2-2.

Golder Associates on behalf of Cyprus Anvil undertook feasibility and subsequently design studies pertinent to the project in the last half of 1979. A preliminary design report was issued on October 31, 1979. A test excavation was constructed in March 1980. The final design report was issued in June 1980.

2.2 Tender Documents

In July and August, 1980 tender documents were finalized by Golder Associates assisted by Mr. D. J. Buckland of D.J. Buckland and Associates and Mr. H. K. Matthews.

The documents provided for the construction of the Down Valley Tailings Project on primarily a unit price basis. However, it was anticipated that a significant proportion of the work would more appropriately be measured on an hourly basis; therefore an estimate of the amount of such work was made and entered on the Schedule of Quantities and Prices as a provisional item. A factor equal to the ratio of the Tenderer's

proposed hourly rates to the British Columbia Department of Highways rates was required as a bid item and this factor was applied to the provisional items on the Schedule of Quantities and Prices for determination of Contract price at the bid opening.

A bonus/liquidated damages clause was incorporated into the documents to ensure that the work was completed on a timely basis. The work was scheduled to begin October 15, 1980 (or later if contract award was delayed) and to be substantially complete by October 1, 1981. Liquidated damages for later completion were to be $10,000 per day. The bonus for earlier completion was assessed as $10,000 per day in advance of October 1, 1981 with a maximum limit of $250,000.

The tender documents also featured a bid bond in the amount of 10 percent of the contract price. This bid bond could be cashed by Cyprus Anvil if a tenderer would not execute a contract if his tender were accepted or if the successful tenderer could not obtain the required "Performance and Labour and Materials Bonds".

2.3 Pre-Construction Design Modifications

During the preparation of the Detailed Specifications of the Tender Documents a number of design modifications and additions were made to the June 1980 design. Although, these modifications were made for practical construction reasons they generally resulted in improved design. Indeed many of the concerns raised by the Yukon Territory Water Board in Faro on September 3, 1980 were satisfied by these modifications.

A summary of the significant design differences contained in the Tender Documents is provided by a telex to Mr. G. Whitley of the Yukon Territory Water Board on September 8, 1980. This telex is reproduced in Appendix I.

2.4 Selection of Contractor

As early as August 1979, Golder Associates canvassed construction companies which were considered capable of performing the work. A list of those which responded positively at that time or subsequently is shown on Table 2-1.

Several construction companies (as shown on Table 2-1) visited the site in late September 1979. A project description package which had been prepared by Golder Associates was given to the site visitors at that time. Much useful information with respect to construction and contract organization was exchanged between Cyprus Anvil, Golder Associates and the attending companies during the site visit.

It became clear by December 1979 that construction startup in February 1980 was not feasible and the potential contractors were notified accordingly.

Most of the potential contractors (see Table 2-1) visited the site during the excavation of the test excavation in March, 1980. At that time they were advised by Golder Associates of the summer, 1980, 15 ft. dyke raising proposed for the existing tailings pond and of the probable autumn startup of the Down Valley Tailings Project. A general update of the project was also provided.

In May, 1980 the 15 ft. dyke raising for the existing tailings pond was tendered publicly as a separate contract by Cyprus Anvil with the assistance of Golder Associates. General Enterprises were selected as the Contractor for this work.

Golder Associates maintained continued contact with the potential contractors over the summer of 1980. Draft contract documents, design reports and the Test Excavation observations were made available in advance of the actual tendering period. Several companies visited the site on their own initiative in preparation for bidding.

On August 14, 1980, tender documents were shipped to the 9 construction companies indicated on Table 2-1. All of these attended the compulsory prebid meeting in the Cyprus Anvil administration building at the minesite. At this meeting Golder Associates and Cyprus Anvil reviewed the tender documents in detail with the group. It was emphasized that project startup was contingent on approval of the project by the Yukon Territory Water Board and the successful negotiation of a contract between Cyprus Anvil and their union.

Three addenda to the initial tender documents were issued to the Tenderers. All of these pertained to clarification of the documents. The pre-bid meeting on site had also revealed some concerns about Article 24 Section (f)(i) of the General Conditions; this was clarified by Addendum No. 3.

A public opening of the Tenders was held at Cyprus Anvil's Vancouver office on September 15, 1980 at 13:00 hours. Eight tenders were received as indicated on Table 2-1. Immediately following the opening Golder Associates and Cyprus Anvil began to analyze the tenders particularly those of the three low bidders: General Enterprises, Whitehorse, Yukon; Chinook Construction and Engineering Ltd., Vancouver, B.C.; and Northern Construction Co. Ltd., Vancouver, B.C. Cyprus Anvil awarded the contract to General Enterprises; it was signed on October 14, 1980 at Cyprus Anvil's minesite administration building. A copy of the conformed documents (addenda incorporated into tender documents and spelling errors corrected) is appended to this report in Appendix No. IX.

2.5 Contractor Alternative

At the time of the prebid meeting and prior to the bid opening it had been indicated to the tenderers that alternative procedures for dam foundation subexcavation would be considered. General Enterprises submitted an alternative on a unit price basis with their tender which involved the construction of a drainage ditch to dewater the main dam

foundations. This proposal was refined by Golder Associates and Cyprus Anvil and submitted in a letter to the Yukon Territory Water Board on October 8, 1980, (A copy of the letter is presented in Appendix II.) Cyprus Anvil subsequently accepted the concept and terms of General Enterprises' bid alternative. This meant that the spoil retainer dyke items which had previously been included in the Contract were not necessary; instead a 10,000 cu.m. sedimentation pond was provided at the downstream end of the drainage ditch to contain suspended solids resulting from upstream construction activity (For location see Figure 2-2).

2.6 Construction Administration

Golder Associates generally administered the construction according to the following terms of reference:

To manage and supervise the successful completion of the construction of the Down Valley Tailings Containment Project and generally to include but not be limited to the following:

(1) To supervise the Contractor to insure proper performance of the contract, including adherence to schedules, specifications and design.
(2) Inspection, testing, and laboratory work.
(3) Design modifications and preparation of related drawings.
(4) Maintenance of administration records.
(5) Preparation of progress records, costs estimates and quantity estimates.
(6) Provide reference lines and survey measurements of quantities for payment (using the services of a capable surveying company).
(7) Preparation of an "as-constructed" report and related drawings.
(8) To fulfill the responsibilities of the "Engineer" as variously described in the Contract binding Cyprus Anvil Mining Corporation and General Enterprises Ltd. concerning construction of the Down Valley Tailings Containment Project.

Golder Associates retained UnderHill Engineering Ltd. of Whitehorse, Yukon to perform all surveying duties.

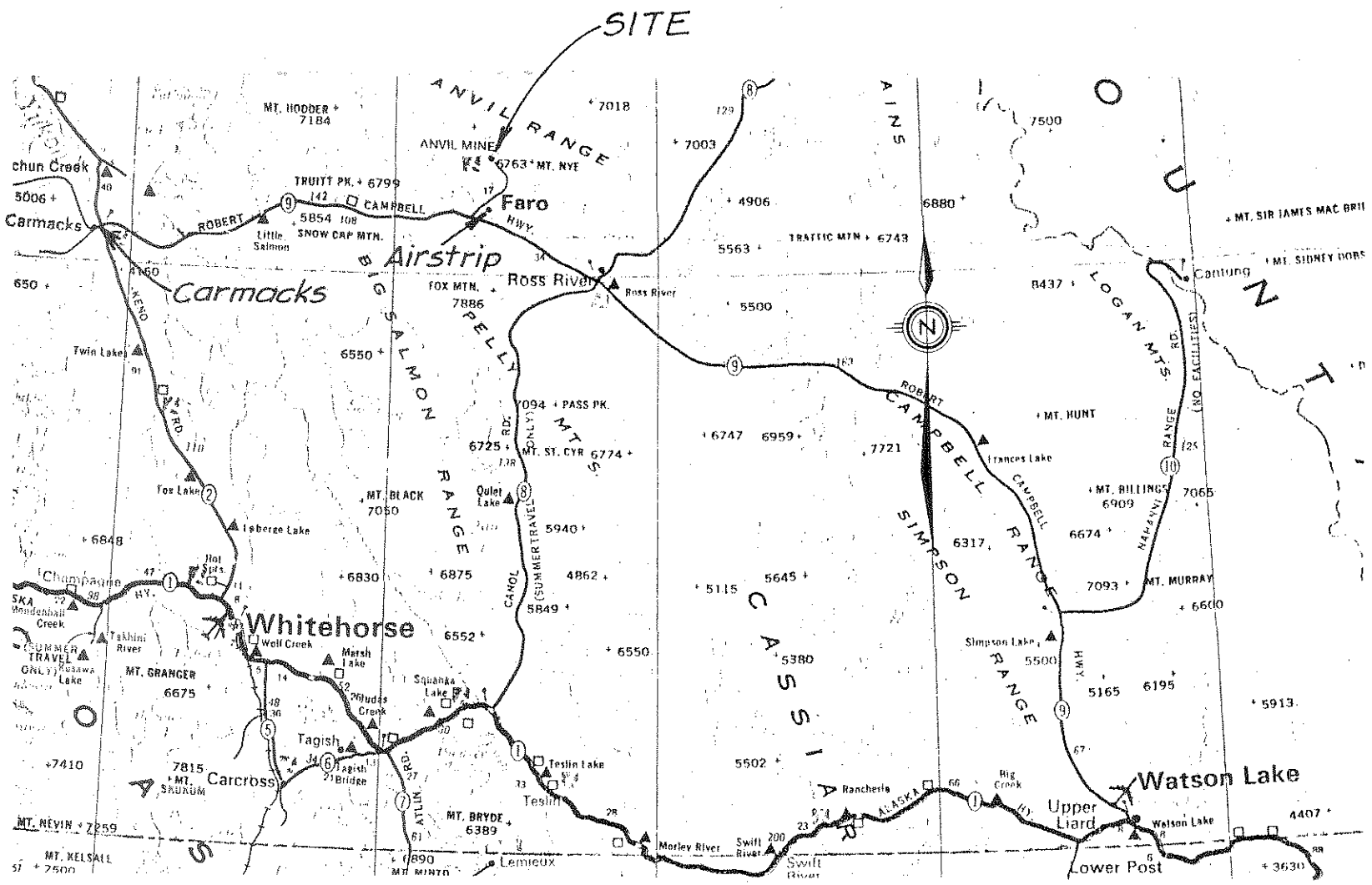
TABLE 2-1

List of Construction Companies
Interested in Down Valley Tailings Project

Construction Company Name	Site Visit Sept./Oct. 1979	Test Excavation Visit March, 1980	Tender Documents	Attended Compulsory Site Prebid Mtg. Aug. 20/80	Tendered at Public Opening Vancouver Sept. 15, 1980
Attachie Construction Ltd., Fort St. John, B.C.					
BACM Construction Co. Ltd., Winnipeg, Man.	X	X			
C.A. Pitts Construction, Toronto, Ont.					
Commonwealth Construction Co. Ltd., Burnaby, B.C.					
Chinook Construction & Engineering Ltd., Vancouver, B.C.	X		X	X	X
Dawson Construction Ltd., Vancouver, B.C.	X	X	X	X	X
Dillingham Corporation, Vancouver, B.C.					
Emil Anderson Construction Co. Ltd., Hope, B.C.	X	X	X	X	X
Goodbrand Construction, Vancouver, B.C.					
General Enterprises, Whitehorse, Yukon	X	X	X	X	X
Loram International Ltd., Calgary, Alta.	X	X	X	X	
North American Construction Ltd., Edmonton, Alta.			X	X	X
Northern Construction Co. Ltd., Vancouver, B.C.	X	X	X	X	X
PCL Engineering Construction, Edmonton, Alta.					
Peter Kiewit Sons Co. Ltd., Richmond, B.C.	X	X	X	X	X
Wimpey Western, Calgary, Alta.			X	X	X

Note: Other construction companies were also contacted. Those shown are the ones who responded positively and were considered capable of undertaking a project of this scope.

Project No. 792-2025 Drawn RK Reviewed — Date 18 Sep 79



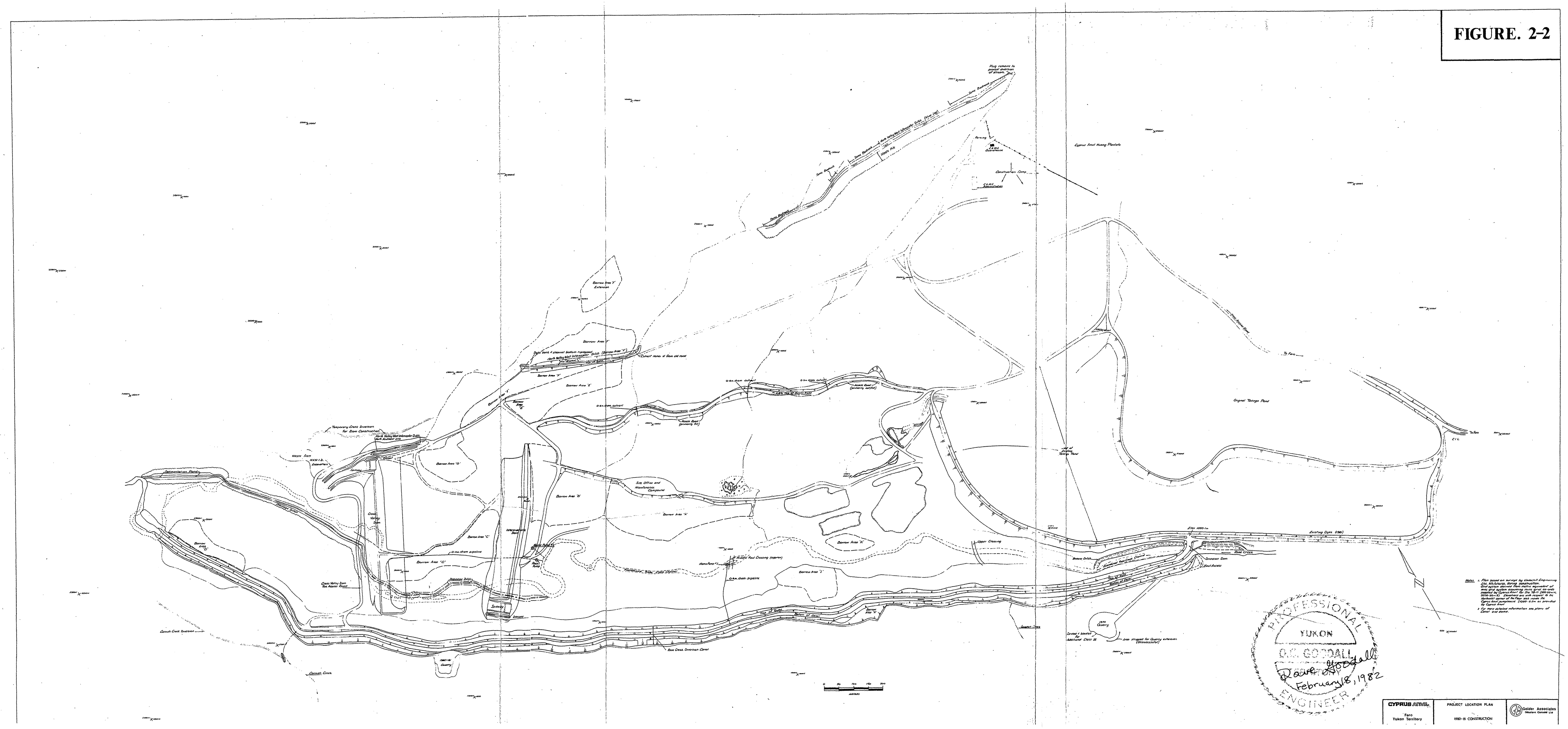
SCALE: 1 in. to 40 mi.

LOCATION PLAN

Figure 2-1

Golder Associates

FIGURE. 2-2


Plug cement to prevent diversion of stream flow
Cyprus Anvil Mining Property
Construction Camp
Barrow Area 'F' Extension
Barrow Area 'F'
Barrow Area 'E'
Barrow Area 'G'
Barrow Area 'B'
Barrow Area 'A'
Barrow Area 'C'
Barrow Area 'D'
Barrow Area 'I'
Barrow Area 'H'
Site Office and Maintenance Compound
Temporary Creek Diversion for Dam Construction
Main Valley RF Tailings Dam
Main Valley Dam
Canada Creek Diversion
Canada Creek
Original Tailings Pond
Upper Crossing
Existing Dyke (Elev)
Access Road (permanently realigned)
Access Road (permanently left)
Access Road to Airport
Access Road to Quarry
Quarry
Borrow Area
Diversion Canal
Road Access
Bus Creek Diversion Canal
Bus Creek
Haul Road
Haul Road to Airport
Haul Road to Quarry
Haul Road to Upper Crossing
Haul Road to Canada Creek Diversion
Haul Road to Bus Creek Diversion
Haul Road to Main Valley Dam
Haul Road to Tailings Pond
Haul Road to Site Office
Haul Road to Barrow Area 'A'
Haul Road to Barrow Area 'B'
Haul Road to Barrow Area 'C'
Haul Road to Barrow Area 'D'
Haul Road to Barrow Area 'E'
Haul Road to Barrow Area 'F'
Haul Road to Barrow Area 'G'
Haul Road to Barrow Area 'H'
Haul Road to Barrow Area 'I'
Haul Road to Barrow Area 'F' Extension
Haul Road to Canada Creek Diversion
Haul Road to Bus Creek Diversion
Haul Road to Quarry
Haul Road to Upper Crossing
Haul Road to Site Office
Haul Road to Main Valley Dam
Haul Road to Tailings Pond

3.0 CONSTRUCTION OVERVIEW

3.1 Site Administration Personal

3.1.1 Cyprus Anvil Mining Corporation (Owner):

Mr. N. G. Cornish, Superintendent, Environmental Control, CAMC represented the Owner in correspondence with the Engineer and at job meetings with the Engineer and the Contractor (usually held on site every two weeks).

In the absence of Mr. Cornish, Mr. J. K. Carrington, Manager of Operations, CAMC represented the Owner.

3.1.2 General Enterprises (Contractor):

Mr. R. K. Byram, partner in the Firm, attended most job meetings but was generally not on site and maintained contact with his field crew from Whitehorse. Mr. N. Kelly also attended most job meetings and acted as General Enterprises' Project Engineer; he also resided in Whitehorse for most of the construction period.

Mr. N. Johnston served as the Contractor's site superintendent from October 1980 to December 1980 and from May 12, 1981 until completion of all work on about December 1, 1981. Mr. J. Masson replaced Mr. Johnston between January 1, 1981 and May 12, 1981.

In general the Contractor employed one foreman for each of the day and night shifts. At exceptional times as many as three foremen (including a blasting foreman) worked on the day shift.

General Enterprises also retained Yukon Drilling and Blasting as a subcontractor for rock and riprap excavation. Mr. Dennis Rennelli represented this firm on site (November 1, 1980 to December 1, 1980; January 12, 1981 to June 1, 1981 approx.).

3.1.3 Golder Associates (Engineer):

Mr. J. B. Mitchell acted as Resident Engineer from the beginning of the project in October until March 6, 1981. Mr. D. C. Goodall served as Project Engineer until March 6, 1981 and subsequently replaced Mr. Mitchell as Resident until project completion.

The balance of Golder Associates site staff was composed of engineers and technicians with a range of experience and training.

In general one site inspector was assigned to each of the day and the night shifts. Mr. P. Vianello served as chief inspector between March 22, 1981 and July 2, 1981 when considerable activity was underway for canal completion or for dam foundation backfilling. Additional inspectors were also provided for special projects such as the Rock Trench.

Mr. B. Walker served as the main project surveyor for Underhill Engineering over the entire construction period.

3.2 Site Staff and Accommodation

3.2.1 Contractor Staff:

The Contractor's staff on site peaked at about 85 men during the completion of the canal at the end of April/beginning of May 1981. Typically about 70 men were on site during canal construction. During the summer (1981) when the dams were being constructed a staff of about 50 men was maintained. No staff of consequence was on site between December 12, 1980 and January 5, 1981.

Room and board was made available to the Contractor by Cyprus Anvil at the construction camp adjacent to the Cyprus Anvil minesite construction camp during this period (except Golder's J. Mitchell who resided in Faro).

3.2.2 Engineer's Staff

From January to May 1981, Golder Associates staff ranged from about 7 to 9 typically. Underhill's staff was maintained at about 5 for January and February and then decreased to 2 thereafter except on extraordinary occasions. Except for a brief period in January the staff from both companies resided at the Faro Catering no. 2 camp in Faro to allow the Contractor to keep his staff together at the minesite camp.

From May until October, Golder Associates staff decreased from 7 to 3, reflecting the decreasing amount of planning necessary for supervising the work. Underhill staff was maintained at a 2 man crew with an additional 2 man crew providing assistance in October for final survey. The staff of both companies resided at the minesite camp during this period.

3.3 Contractor Equipment

The amount of equipment on site varied with construction activity. Canal construction involved considerable dozer activity for ripping common excavation, mucking rock, sorting riprap, stripping and clearing. Once the canal was nearly completed and the borrow pits for dam construction had been cleared, grubbed and stripped, the dozer activity fell off significantly.

Following is a Table which summarizes the major equipment which the Contractor had on site during the months noted.

Equipment	November 1980	February 1981	May 1981	July 1981
Cat D9 dozers	8	8	6	4
Cat D8 dozers	3	4	3	1
Cat 631 scrapers	11	13	8	9
Cat 14G graders	2	2	2	2
Off highway 35 ton rock trucks	2	3	3	0
Dynapac CA25 Compactors	2	4	3	2
Dynapac CA51 Compactors	0	0	0	1
Ingersoll Rand SP60 Compactor	0	0	0	1
Cat 815 sheepsfoot packer	1	1	1	1
Cat 988B F Loader	0	1	1	0
Cat 988 Load	0	0	1	0
Cat 966C Load	0	1	1	0
Cat 235 Backhoe	1	1	1	1
Airtracks	1	1	3	0
Compressors	1	1	3	0
Wabco Water Truck	0	0	0	1

It must be understood that all of the above equipment did not operate at the same time. Typically about 6 or 7 scrapers operated with the balance of the scrapers standing by, being repaired or being serviced.

The equipment fleet above proved adequate for most of the work. However, the absence of the Cat 235 backhoe from the site between June 13 and July 6, 1981 restricted work progress.

Supplementary equipment for special projects included:

(i) International 3820 rubber tired backhoe for rock trench cleanup.

(ii) Highway Trucks (up to 6) for fish gravel and Intermediate Dam drain installation.

(iii) Jaw crusher and screen.

3.4 Contractor Working Hours

Normally the Contractor worked two shifts. The day shift began at 7:00 a.m. and ended at 5:30 p.m. Included in the shift were a half hour lunch break, two coffee breaks and the travel time required to travel to and from the minesite camp (typically 10 to 15 minutes each way).

The night shift began at 8:00 p.m. and ended at 5:30 a.m. (the crew was paid one hour shift differential) with breaks and travel time similiar to the day shift.

During canal construction, work continued normally on a six day work week basis. During dam construction, the work cycle normally consisted of 12 consecutive working days followed by a two day weekend.

The Contractor was shut down over the Christmas period in 1980 between about December 12 and January 5, 1981.

3.5 Construction Weather

The project was constructed over a full year weather cycle. The work was organized to take advantage of winter freezeup for excavation and thermal lining of the canal. With the exceptions of dam foundation subexcavation and thermal lining of the south abutment of the Intermediate Dam, dam construction was performed in thawing conditions.

Maximum and minimum temperatures were observed on a daily basis at a location on the valley bottom gravel terrace near the site offices and maintenance compound. A summary of these temperatures is provided on Figure 3-1. Temperatures were also recorded at about Sta. 1+110 on the canal reference line during canal construction; these observations are on file in Golder Associates Calgary office.

Periods of significant precipitation are also noted on Figure 3-1 for reference purposes only. Winter precipitation tended to compound the normally difficult task of winter construction inspection by masking the construction activity; it also introduced some traction difficulties for scrapers. Significant snowfalls had to be cleaned up before fill placement (snow thicknesses in excess of about 8 cm were assessed to be significant).

Summer precipitation generally impeded the placement of the Class VI till cores and blankets in two ways:

(i) the material became too wet to compact,
(ii) the haul roads to the borrow area were too slippery.

Salient features of the weather over the construction period are:

(i) October and November; slightly warmer than normal,
(ii) December; colder than normal,
(iii) January, beginning February, much warmer than normal,
(iv) February 7 to 20; colder than normal,
(v) February 20 to April 3; slightly warmer than normal,
(vi) April 3 to April 19; colder than normal,
(vii) April 19 through May; slightly warmer than normal,
(viii) June, early July; much wetter than normal,
(estimated June precipitation >100 mm, normal approximately 58 mm)
(ix) September 3 to September 11; very wet.

3.6 Construction Schedule

The actual construction schedule followed by the Contractor is presented of Figure 3-2. This schedule summarizes most of the significant site activities.

The Diversion Canal was started on October 17, 1980 and the bulk of the work involved was completed by May 27, 1981. Work subsequent to May 27 in late August, September and October, 1981 pertained to the completion of the canal dyke to its final elevation. Critical canal construction elements included the production of Class IV riprap, the installation of seepage control liner (weather dependent), and the rock trench cutoff preparation.

Subexcavation of both the Cross Valley and Intermediate Dams was undertaken in January, February and March, 1981. This work was contingent on the progress of the Drainage Ditch. Material placement on the Intermediate Dam began about May 10; at the Cross Valley Dam it was started about May 29. Initial placement for both dams was concentrated in the areas north of the Drainage Ditch so that maximum amounts of fill could be placed without closing the dams and having to pump the sizeable flows contained in the Drainage Ditch.

The dams were essentially completed by October 1, 1981, before significant freezeup had occurred. However, the pumping of the Drainage Ditch flow was continued until November 30, 1981 when permission was granted by the regulatory authorities to pond water behind the dams.

The three segments of the North Valley Wall Interceptor Ditch were constructed at three distinct times to interlock with other proximate construction activity or to take advantage of ground trafficability. The mine leg (see Figure 2-2) was excavated in late February/early March, (1981) to take advantage of frozen ground access. The segment at the north abutment of the Cross Valley Dam was constructed in July and early August (1981) to provide north wall drainage and prevent ponding in the Cross Valley Dam upstream blanket area. And the Borrow Area "F" leg was undertaken in late September/early October (1981) after till borrow for the dams had been completed.

The Access Road, which was not required for substantial completion of the project, was undertaken after the dams had been completed.

The Contractor earned the full early completion bonus by substantially completing the dams on September 11, 1981. Final completion of the Contract was declared on October 14, 1981 in recognition of the fact that the major proportion of the work being conducted at that time was outside the scope of the Contract.

With exception of the two Morris pumps and a D9 dozer performing cleanup work, all of the Contractor's major equipment had been demobilized by October 30, 1981.

3.7 Exploration During Construction

3.7.1 January/February 1981

Between January 22 and February 6 (1981), a major drillng exploration program was undertaken using Midnight Sun Drilling's CME750 rig to locate more precisely the limits of an unfrozen till deposit which had been previously identified by Borehole No. 79-24 of the original Down Valley Project exploration program by Golder Associates. The need for this program related to the need for increased volumes of seepage control liner resulting from the modification to the canal dyke design (see Section 4.1.9).

A borehole schedule listing the depths and locations of the boreholes is provided on Table 3-1. These boreholes are also plotted on Figure 3-3.

Three primary areas were investigated. Borrow Areas "H" and "I", which were ultimately exploited as the source of seepage liner, were immediately adjacent to the canal between reference line chainages 1+200 and 1+500 (see Figure 2-2). The second area included on the canal backslope in the vicinity of reference line Sta. 2+000 where appreciable

volumes of unfrozen, good quality till had been encountered during canal excavation in January. The third area was located on the north valley wall almost directly across the valley from Borrow areas "H" and "I".

Detailed logs of these boreholes are being retained on file at Golder Associates' Calgary office.

3.7.2 August, 1981

Borehole Numbers 81-98 to 81-124 inclusive, were drilled in the upstream blanket area of the Cross Valley Dam to assist in the assessment of the foundation materials beneath the blanket with respect to seepage. The Midnight Sun Drilling CME750 rig was also used for this work. A listing of these boreholes is provided on Table 3-1. Detailed logs of the boreholes are provided in Appendix IV. The locations of the boreholes are shown in plan on Figure 3-3.

3.8 Instrumentation

The overall instrumentation program for the Down Valley Tailings project is summarized on Figure 3-3.

3.8.1 Preconstruction Instrumentation

Some instrumented boreholes which had been established during the 1979 exploration program were preserved during construction. In particular the standpipe piezometer and thermistors in Borehole No. 79-20 remain functional; the pneumatic piezometer in Borehole No. 79-23 also remains intact. The location of these boreholes is tabulated on Table 3-2 and plotted on Figure 3-3.

3.8.2 Construction Instrumentation

During construction of the Intermediate and Cross Valley Dams pneumatic piezometers and settlement plates were installed within the fill. A tabulation of these installations is provided on Table 3-3.

Pneumatic piezometers were generally installed in the fill by placing the leads in a backfilled notch through the intial fill lifts, its orientation being approximately perpendicular to the dam centrelines. The leads extended from the piezometer tip location to the downstream toe in the case of the Cross Valley Dam, or to the upstream toe in the case of the Intermediate Dam. At the Cross Valley Dam three or four piezometers were distributed on a section line with one of these being installed in the drainage zone just downstream of the core and the remainder being installed upstream of the core; three section lines were so instrumented at the Cross Valley Dam.

At the Intermediate Dam, a total of four piezometers were installed. Two of these were located on centreline in the silt stratum beneath the cutoff trench (one of which was destroyed during construction). The remaining two were installed upstream and downstream of the core using the notching technique described for the Cross Valley Dam. The piezometer leads for these installations were uncoiled up the upstream face to the crest of the Intermediate Dam for monitoring when the tailings pond is operational.

A typical settlement plate installation is photographically documented on Figure III-48 of Appendix III. Four settlement plates were installed on the Cross Valley Dam at the upstream boundary of the core. Three settlement plates were installed at the Intermediate Dam in the vicinity of the old Rose Channel, two being located just downstream of the core and the third near the centre of the berm area.

In addition to the above, iron bars were installed on the Cross Valley Dam centreline after the dam was completed as additional monitors of settlement.

3.8.3 Instrumentation from Other Projects

Golder Associates installed a system of nine standpipe piezometers on the existing dam in late April 1981 to monitor pore pressure in the existing dam. This borehole schedule is shown in Table 3-4.

In mid-March, 1981, Klohn Leonoff Ltd. established a network of water sampling piezometers as a part of their Faro Mine Tailings Abandonment Plan studies on behalf of Cyprus Anvil. These installations are also detailed on Table 3-4.

The installations of both of the above projects have been plotted in Figure 3-3.

3.8.4 Post Construction Instrumentation

During the dam construction thermistor strings were installed in the canal dyke at each of Borehole No.s 81-96 and 81-125 as shown in Figure 3-3 and as documented on Table 3-5.

A pneumatic piezometer was also installed in the downstream area of the south abutment of the Cross Valley Dam in Borehole 81-126 (also documented on Table 3-5).

These installations were completed in August using Midnight Sun Drilling's CME750 rig.

Comprehensive instrumentation of the project was begun when construction of the canal dyke and both dams was essentially complete. Details of this program will be documented in a subsequent report. Movement monitors, inclinometers, thermistors and piezometers were installed according to the instrumentation plan. Its objectives were both to observe geotechnical performance in areas of potential concern, and to develop a data book concerning long term performance.

A summary of the installations is provided on Table 3-5 and they are plotted in plan on Figure 3-3.

3.9 Project Quantities Summary

The tendered and final as-constructed quantities for the Contract are summarized on Table 3-6. This table also includes several Change Order and Work Order items which are explained in Appendices V and VI respectively. Payment for work conducted under a Change Order or a Work Order situation was often based on the number of hours required to complete the work as provided for by Article 24 of the Contract.

3.10 Design Changes

Major design changes to the canal dyke were made in January 1981. These changes are summarized or Change Order No.s 1, 2 and 3, which are presented in Appendix V. Discussions of the changes are provided in sections 4.1.6 (Change Order No. 3), 4.1.8 (Change Order No. 1) and 4.1.9 (Change Order No. 2).

Golder Associates consider that these changes improved the quality of canal dyke construction with respect to that which was originally planned by the Tender Documents (presented in Appendix IX).

Other changes included the provision of "Fish Gravel" in the canal outfall, the extension of rock aprons beyond the final weir in a senes of drop weirs and the provision of relief drains for the Intermediate Dam (see Change Order No. 5, Appendix V). These changes and other minor modifications are discussed in Section 4.

3.11 Site Visitors

A listing of visitors to the site during construction is provided on Table 3-7. The contributions of these individuals to the successful completion of the project is gratefully acknowledged.

TABLE 3-1

SITE INVESTIGATION
1981 BOREHOLE SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	ELEVATION	DEPTH OF BOREHOLE (m)	REMARKS
81-53	1083.50	1236.36	1096.52	9.98	Borrow Area 'H' Investigation
81-54	1017.14	1269.26	1100.56	7.01	
81-55	1180.75	1098.53	1087.88	6.10	
81-56	1121.24	1117.57	1095.26	2.44	
81-57	1122.39	1178.87	1088.51	3.05	
81-58	1129.72	1148.20	1087.52	5.18	
81-59	1220.62	1054.41	1087.18	5.03	Borrow Area 'I' Investigation
81-60	1187.80	1153.43	1083.98	5.18	
81-61	1198.87	1222.33	1085.27	12.95	
81-62	1255.97	1231.80	1076.91	7.31	
81-63	1134.16	1298.39	1085.36	2.44	
81-64	1315.94	1018.97	1080.13	1.68	
81-65	1240.37	1159.03	1080.08	1.83	
81-66	1267.75	1118.65	1082.80	0.61	
81-67	1155.87	1222.33	1084.76	11.66	
81-68	1044.39	1319.14	1098.05	9.60	
81-69	955.96	1376.81	1107.28	2.74	Borrow Area 'H' Investigation
81-70	906.76	1362.65	1111.31	4.57	
81-71	890.28	1425.80	1109.06	3.05	
81-72	997.77	1336.35	1100.31	11.96	
81-73	1082.67	1193.32	1095.28	5.21	
81-74	1027.34	1221.99	1102.53	7.98	
81-75	1844.37	1724.23	1110.70	3.20	Borrow Area 'J' Investigation
81-76	1778.29	1748.24	1103.49	4.27	
81-77	1850.46	1671.30	1105.30	4.57	

TABLE 3-1 (CONT'D)

SITE INVESTIGATION
1981 BOREHOLE SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	ELEVATION	DEPTH OF BOREHOLE (m)	REMARKS
81-78	1873.73	1620.23	1105.16	6.10	Borrow Area 'J' Investigation
81-79	1931.62	1660.94	1113.66	5.18	
81-80	1985.77	1682.58	1120.81	5.85	
81-81	1837.03	1546.51	1101.90	2.13	
81-82	1893.92	1487.84	1103.59	7.31	
81-83	1965.45	1541.02	1114.32	8.84	
81-84	1956.93	1590.72	1112.97	2.74	
81-85	2015.79	1611.70	1119.12	5.03	
81-86	2046.56	1669.92	1121.22	4.42	
81-87	1903.94	1541.60	1107.17	5.94	
81-88	1920.01	1440.00	1104.48	6.55	
81-89	1964.64	1491.43	1112.81	7.01	
81-90	2043.37	1141.20	1106.08	4.57	Investigation Borehole, Access Road, Stn 0+847 m O/S 34 mR
81-91	1932.04	1785.30	1125.25	4.11	
81-92	1777.89	1831.79	1109.79	3.76	Borrow Area 'J' Investigation
81-93	1342.75	486.04	1109.22	4.57	Investigation Borehole, Canal Backslope, Stn 2+078m, O/S 46.5m
81-94	1266.13	646.18	1106.32	2.74	Investigation Borehole, Canal Backslope, Stn 1+988m, O/S 87.5m
81-95	1256.08	679.24	1102.72	4.11	Investigation Borehole, Canal Backslope, Stn 1+866m, O/S 37.0m
81-96-T**	1847.5	-161.0	1080.6	9.60	See Canal Instrumentation Borehole Schedules
81-97**	1457.0	520.5	1085.0	6.40	Hole abandoned, see 81-125
81-98	2087.20	4.70	1050.94	6.40	Cross Valley Dam Upstream Blanket Investigation
81-99	2111.82	16.89	1050.97	5.18	
81-100	2131.93	18.13	1051.09	6.71	
81-101	2145.49	34.72	1050.94	6.71	
81-102	2170.64	47.51	1050.99	6.10	

** Location and elevations approximate

TABLE 3-1 (CONT'D)

SITE INVESTIGATION
1981 BOREHOLE SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	ELEVATION	DEPTH OF BOREHOLE (m)	REMARKS
81-103	2197.03	60.79	1050.95	6.71	Cross Valley Dam Upstream Blanket Investigation
81-104	2222.11	81.48	1048.62	5.03	
81-105	2248.83	96.63	1048.60	4.60	
81-106	2275.27	111.62	1048.29	5.03	
81-107	2299.74	128.51	1048.38	4.57	
81-108	2276.47	138.62	1048.93	5.03	
81-109	1937.40	-20.75	1051.39	2.29	
81-110	1966.49	-8.70	1049.88	3.05	
81-111	1993.47	6.98	1049.37	2.13	
81-112	2017.85	19.91	1049.15	4.27	
81-113	2038.67	29.92	1049.20	3.05	
81-114	2063.41	1.20	1050.05	3.51	
81-115	1972.84	-31.10	1049.18	3.05	
81-116	2218.64	119.94	1048.80	6.10	
81-117	2196.25	103.06	1050.30	6.10	
81-118	2168.47	91.02	1050.81	3.35	
81-119	2143.94	74.47	1051.46	6.55	
81-120	2113.00	62.71	1051.59	4.88	
81-121	2087.17	50.12	1052.46	4.57	
81-122	2061.35	41.11	1051.57	6.10	
81-123	2291.87	146.37	1049.79	6.10	
81-124	2137.12	25.55	1051.04	5.03	
81-125-T	1457.0	520.5	1085.00	9.45	See Canal Instrumentation Borehole Schedule
81-126-PP	1953.09	-163.82	1058.86	9.60	See Cross Valley Dam Post Construction Instrumentation Borehole Schedule

TABLE 3-2

PRECONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION		GROUND ELEVATION	DEPTH OF BOREHOLE	INSTRUMENTATION		REMARKS
	NORTH(m)	EAST(m)	(m)	(m)	ABBREV. *	DETAILS	
79-20	2,447.49	114.36	1076.80	37.9	HP	Tip Elev. 1039.80	North Abutment C.V.D.
					T	Thermistors at 1, 2, 3.5 7, 12, 17, 22, 29 and 37 m	
79-23	1,910.41	-387.7	1083.17	12.3	PP	Tip Elev. 1071.17 m	Location and elevations approx. (Sta. 3+120 on Backslope of canal)

*HP: Hydraulic Piezometer (Standpipe)
PP: Pneumatic Piezometer
T: Thermistor String

TABLE 3-3

DAM CONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV. *	INSTRUMENTATION DETAILS	REMARKS**
				INTERMEDIATE DAM			
IDP-1	1781.70	320.72	n/a	n/a	PP	Tip#1299, Elev.1047.00 m	Sta.0+593.7m,o/s 3.5 m L
IDP-2	1762.00	300.60			PP	Tip#1301, Elev.1048.30 m	Sta.0+621.7m,o/s 0.5 m L (destroyed)
IDP-3	1719.49	260.06			PP	Tip#3581, Elev.1053.03 m	Sta.0+680.3m,o/s 3.8 m L
IDP-4	1713.83	267.24			PP	Tip#3582, Elev.1052.46 m	Sta.0+680.1m,o/s 5.4 m L
IDS-1	1784.50	314.00			St	Init.Plate Elev.1050.87m	Crest,Sta.0+593.5 m
IDS-2	1761.00	294.50			St	Init.Plate Elev.1050.37m	Crest,Sta.0+626.6 m
IDS-3	1737.00	248.49			St	Init.Plate Elev.1051.46m	Sta.0+674.1m,o/s 23.8 m R
				CROSS VALLEY DAM			
CVDP-1	2072.58	-27.59	n/a	n/a	PP	Tip#2549,Elev.1046.81m	Sta.0+454.4m,o/s 20.3m L
CVDP-2	2079.63	-41.51			PP	Tip#2548,Elev.1046.84m	Sta.0+454.5m,o/s 4.7m L
CVDP-3	2084.80	-51.79			PP	Tip#unknown,Elev.1047.01m	Sta.0+454.6m,o/s 6.8m R
CVDP-4	2284.16	94.25			PP	Tip#3528,Elev.1046.76m	Sta.0+210.5m,o/s 31.8m L
CVDP-5	2294.41	74.13			PP	Tip#3529,Elev.1046.58m	Sta.0+210.6m,o/s 9.3m L
CVDP-6	2301.24	61.27			PP	Tip#3530,Elev.1046.67m	Sta.0+210.4m,o/s 5.3m R
CVDP-7	1932.31	-52.89			PP	Tip#3578,Elev.1047.53m	Sta.0+590.7m,o/s 62.0m L
CVDP-8	1970.25	-80.94			PP	Tip#3580,Elev.1047.93m	Sta.0+569.8m,o/s 19.7m L
CVDP-9	1976.45	-93.43			PP	Tip#3579,Elev.1048.18m	Sta.0+570.0m,o/s 5.7m L
CVDP-10	1981.21	-102.67			PP	Tip#3584,Elev.1049.10m	Sta.0+570.0m,o/s 4.7m R
CVDS-1	2302.23	71.51			St	Init.Plate Elev.1046.01m	Crest, Sta.0+204.9 m
CVDS-2	2181.10	9.35			St	Init.Plate Elev.1045.92m	Crest, Sta.0+341.0 m
CVDS-3	2076.18	-44.64			St	Init.Plate Elev.1046.75m	Crest, Sta.0+459.0 m
CVDS-4	1980.39	-94.76			St	Init.Plate Elev.1047.43m	Crest, Sta.0+567.1 m

** o/s: Off set relative to Dam centre line

* PP: Pneumatic Piezometer
St: Settlement Plate

TABLE 3-4

INSTRUMENTATION FROM OTHER PROJECTS SCHEDULE

BOREHOLE	LOCATION** NORTH(m)	LOCATION** EAST(m)	GROUND** ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV.*	INSTRUMENTATION DETAILS**	REMARKS
				1980 TAILINGS DAM			
P81-01	1329.50	1824.00	1092.98	10.82	2 HP	Tip Elev.1086.88 m Tip Elev.1082.31 m	Crest,Sta.19+00 feet West
P81-02	1209.00	1837.00	1093.10	27.74	2 HP	Tip Elev.1082.13 m Tip Elev.1065.67 m	Crest,Sta.15+00 feet West
P81-03	1068.00	1830.00	1067.41	9.45	HP	Tip Elev.1058.27 m	Downstream Toe,Sta.11+00 Feet West
P81-04	1098.00	1883.00	1092.98	27.43	2 HP	Tip Elev.1082.01 m Tip Elev.1065.55 m	Crest,Sta.11+00 feet West
P81-05	955.50	2001.00	1092.95	12.19	HP	Tip Elev.1080.76 m	Crest,Sta.5+00 feet, West
P81-06	624.00	2592.50	1093.04	6.40	HP	Tip Elev.1086.94 m	Crest,Sta.17+50 feet,East
P81-07	355.00	3019.00	1094.84	6.40	HP	Tip Elev.1088.74 m	Crest,Sta.34+00 feet,East
P81-08	359.50	3139.50	1095.66	7.62	HP	Tip Elev.1088.35 m	Crest,Sta.38+00 feet,East
P81-09	350.50	3329.90	1094.80	6.0	HP	Tip Elev.1089 m (approx)	Near "pump house', no tip depth given on borehole log
				KLOHN LEONOFF BOREHOLES			
81-K1	2626.75	-638.52	1048.21	54.3	2 HP	Tip Elev.1041.71 m Tip Elev.1017.71 m	Diversion Canal Outfall Right Bank
81-K2	2429.06	-330.18	1046.60	25.0	2 HP	Tip Elev.1040.60 m Tip Elev.1022.60 m	Drainage Ditch,Sta.0+430, o/s 64.0 m R
81-K3	2493.63	-98.96	1051.27	22.9	2 HP	Tip Elev.1040.27 m Tip Elev.1029.27 m	Approx.100m North of Cross Valley Dam Spillway Outfall
81-K4	2229.12	-154.15	1052.74	39.5	2 HP	Tip Elev.1040.74 m Tip Elev.1025.74 m	Drainage Ditch,Sta.0+705, o/s 33 m R
81-K5	2220.68	-613.27	1060.68	42.7	HP	Tip Elev.1038.68 m	Canal Backslope,Sta.3+535 o/s 77 m L
81-K6	1418.64	1790.20	1076.92	39.6	3 HP	Tip Elev.1063.92 m Tip Elev.1049.42 m Tip Elev.1037.92 m	Downstream Toe,1980 Tailings Dam
81-K7	1252.56	1752.18	1068.22	23.8	2 HP	Tip Elev.1062.22 m Tip Elev.1046.22 m	
81-K8			1130.13	17.8	HP	Tip Elev.1129.13 m	Fresh Water Supply Resevoir(not indicated on plans)

** Locations and elevations approximate for Instruments P81-01 to P81-09
HP: Hydraulic Piezometer (Standpipe)

TABLE 3-5

POST CONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV.*	INSTRUMENTATION DETAILS	REMARKS
			INTERMEDIATE DAM (ID)				
ID1-0+240	2061.2	511.5	1064.13	1.5	V,H		
ID2-0+250	2066.5	514.4	1064.1	10.67	2HP	Tip Elev.1059.60 m Tip Elev.1054.10 m	Location approximate
ID3-0+450	1894.2	391.9	1064.06	1.5	V,H		
ID4-0+460	1895.7	392.5	1065.3	20.12	2HP	Tip Elev.1060.80 m Tip Elev.1045.50 m	
ID5-0+627	1769.5	286.1	1064.90	1.5	V,H		
ID6-0+627	1767.8	284.7	1064.9	30.48	2HP	Tip Elev.1060.40 m Tip Elev.1034.70 m	
ID7-0+740	1668.8	234.4	1068.9	15.20	T,PP	Thermistor#11 10 x 1.0 m Tip#3821,Elev.1054.00 m	Thermal Liner, South Abutment
ID8-0+745	1679.3	212.9	1069.1	15.50	PP	Tip#333, Elev.1054.20 m	Thermal liner, South Abutment
ID9-0+750	1704.5	171.9	1066.3	9.80	PP	Tip#390, Elev.1057.30 m	Thermal liner, South Abutment
			CROSS VALLEY DAM (CVD)				
81-126-PP	1953.09	-163.82	1058.86	9.3	PP	Tip#3527, Elev. 1050.1 m	Downstream South Abutment
CVDB-0+370	2139.4	36.2	1052.1	9.10	T,PP	Thermistors, 10 x 1.0 m Tip#3475, Elev. 1043.0 m	Upstream Toe Blanket
CVDB-0+370	2138.3	34.8	1052.1	5.20	PP	Tip#3576, Elev. 1047.2 m	Upstream Toe Blanket
CVDC1-0+050	2394.8	126.6	1064.8	15.54	T,PP	Thermistors 8 x 2.0 m Tip#3822, Elev. 1049.6 m	NVWID Dyke Location and ground elevation approx.
CVDC2-0+150	2390.8	78.1	1062.3	14.93	PP	Tip#344, Elev. 1048.0 m	Spillway Location and elevations approximate
CVDC3-0+204	2304.0	68.6	1065.72	1.5	V,H		
CVDC4-0+215	2295.1	63.1	1065.5	34.14	2HP	Tip Elev. 1040.2 m Tip Elev. 1032.0 m	
CVDC5-0+338	2183.0	6.8	1066.82	1.5	V,H		
CVDC6-0+340	2182.1	4.7	1065.8	34.14	T,PP	Thermistors 8 x 2.0 m Tip #3526, Elev. 1032.3 m	Thermistors from 15.0-31.0m depth
CVDC7-0+450	2086.5	-44.9	1065.7	31.09	2HP	Tip Elev. 1040.1 m Tip Elev. 1035.2 m	

*SI: Slope Indicator S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor String PP: Pneumatic Piezometer HP: Hydraulic Piezometer (Standpipe)

(Cont'd)

TABLE 3-5 (CONT'D)

POST CONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV. *	INSTRUMENTATION DETAILS	REMARKS
				CROSS VALLEY DAM (CVD) (CONT'D)			
CVDC8-0+460	2076.6	-48.2	1065.69	1.5	V,H		
CVDC9-0+565	1984.1	-97.4	1065.6	33.83	2HP	Tip Elev. 1040.0 m Tip Elev. 1033.0 m	
CVDC10-0+568	1981.1	-97.4	1065.74	1.5	V,H		
CVDC11-0+645	1913.4	-133.5	1065.7	15.24	T,PP	Thermistors 8 x 2.0 m Tip#3820, Elev. 1050.8 m	South Abutment
CVDT1-0+210	2317.4	17.6	1050.0	10.06	HP	Tip Elev. 1040.2 m	Downstream Toe
CVDT2-0+450	2111.6	-102.3	1051.8	13.71	HP	Tip Elev. 1038.5 m	Downstream Toe
CVDT3-0+570	2009.1	-154.5	1053.10	13.71	HP	Tip Elev. 1040.1 m	
CVDT4-0+630	1953.4	-164.0	1058.90	15.50	T	Thermistors 8 x 2.0 m	Downstream South Abutment Location and elev. approx.
				CANAL DYKE (CD)			
CD1-0+020	701.5	2,377.4	1090.7	12.2	2PP	Piez. #368 (Elev. 1085.5?) Piez. #384 Elev. 1080.0 m	Diversion Dam, see bore-hole log for more detail.
CD2-0+150	693.5	2,294.9	1090.37	1.5	V		
CD3-0+300	732.7	2,143.6	1089.64	1.5	V		
CD4-0+400	748.6	2,053.2	1089.7	10.4	S	Settlement rings 10 X 1.0 m	
	747.2	2,057.0	1089.7	11.6	T,PP	Thermistor #12, 10 X 1.0 m Piez. #365 Elev. 1078.4	
	757.2	2,050.7	1089.7	9.8	PP	Piez. #341 Elev. 1082.7 m	
	748.3	2,054.5	1089.73	1.5	V,H		

* SI: Slope Indicator S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor String PP: Pneumatic Piezometer HP: Hydraulic Piezometer (Standpipe)

(Cont'd)

TABLE 3-5 (CONT'D)

POST CONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV. *	INSTRUMENTATION DETAILS	REMARKS
				CANAL DYKE (CD) (CONT'D)			
CD5-0+510	785.4	1,955.3	1089.8	10.1	T	Thermistor #27, 10 X 1.0 m	
	786.1	1,954.1	1089.67	1.5	V		
CD6-0+610	829.1	1,868.8	1089.69	1.5	V		
CD7-0+710	872.9	1,788.3	1089.48	1.5	V		
	879.6	1,793.3	1089.4	10.7	PP	Piez. #391 Elev. 1081.8	
CD8-0+840	947.2	1,670.5	1088.86	1.5	V		
CD9-0+960	989.7	1,553.3	1088.44	1.5	V		
	990.2	1,552.2	1088.6	6.9	PP	Piez. #346 Elev. 1083.6	
CD10-0+990	1,006.6	1,522.8	1088.52	1.5	V,H		
	1,006.2	1,523.9	1088.3	12.2	SI,S	Slope Indicator to 10.5 m Settlement Rings 10 X 1.0 m	
	1,008.7	1,519.7	1088.3	11.3	T,PP	Thermistor #23, 10 X 1.0 m Piez. #367 Elev. 1077.6 m	
CD11-1+110	1,065.2	1,427.1	1088.13	1.5	V		
CD12-1+230	1,117.4	1,307.1	1088.08	1.5	V		
CD13-1+350	1,140.6	1,185.5	1087.56	1.5	V,H		
	1,139.5	1,187.5	1087.1	10.4	2PP	Piez.#350 Elev.1081.0 Piez.#381 Elev.1077.0	Approx. Co-ordinates
CD14-1+440	1,193.8	1,112.5	1087.39	1.5	V		
CD15-1+530	1,232.9	1,031.0	1087.17	1.5	V,H		
	1,232.0	1,033.7	1087.0	11.0	SI,S	Slope Indicator to 9.8 m Settlement rings 10 x 1.0 m	
	1,233.7	1,028.7	1087.0	11.9	T,2PP	Thermistor #26 10 x 1.0 m Piez.#353 Elev. 1080.4 Piez.#362 Elev. 1075.6	

* SI: Slope Indicator S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor String PP: Pneumatic Piezometer HP: Hydraulic Piezometer (Standpipe)

(Cont'd)

TABLE 3-5 (CONT'D)

POST CONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV. *	INSTRUMENTATION DETAILS	REMARKS
			CANAL DYKE (CD) (CONT'D)				
CD16-1+160	1,257.4	954.1	1087.07	1.5	V		
CD17-1+705	1,278.9	861.0	1086.88	1.5	V		
	1,278.6	862.7	1086.9	9.6	T	Thermistor #28 10 x 1.0 m	
CD18-1+800	1,306.0	775.4	1087.10	1.5	V		
CD19-1+900	1,356.8	689.8	1086.45	1.5	V,H		
	1,355.6	691.8	1086.3	11.3	SI,S	Slope Indicator to 10.4 m Settlement rings 10 x 1.0 m	
	1,357.8	687.9	1086.3	11.6	T,2PP	Thermistor "A" 10 x 1.0 m Piez.#365 Elev. 1081.0 Piez.#382 Elev. 1077.3	"old" type-no protective PVC sheath
CD20-2+000	1,401.7	603.9	1086.4	1.5	V		
	1,403.0	601.9	1086.5	11.0	T	Thermistor #20 10 x 1.0 m	
CD21-2+100	1,455.0	511.7	1086.04	1.5	V,H		
	1,454.0	513.7	1085.9	13.7	SI,S	Slope Indicator to 10.5 m Settlement rings 10 x 1.0 m	
	1,455.9	509.5	1085.9	13.7	T,2PP	Thermistor #12 @ 3.0,5.0, 8.0, 11.0 & 13.0 m Piez.#345 Elev. 1079.8 Piez.#366 Elev. 1074.3	'old type'-no protective PVC sheath
81-125	1,442.5	515.0	1085.9	9.5	T	Thermistor #T2, 10 x 1.0 m	'old type'-no protective PVC sheath (installed Aug.13) (Sta. 2+100)
CD22-2+200	1,480.8	421.0	1085.95	1.5	V,H		
CD23-2+260	1,509.0	365.7	1085.90	1.5	V		
CD24-2+365	1,570.9	283.3	1085.89	1.5	V,H		
	1,572.1	281.8	1085.8	11.3	T	Thermistor #22 10 x 1.0 m	
CD25-2+460	1,621.0	205.5	1085.46	1.5	V		
	1,614.8	204.2	1085.5	9.8	T	Thermistor #19 10 x 1.0 m	

*SI: Slope Indicator. S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor String PP: Pneumatic Piezometer HP: Hydraulic Piezometer(Standpipe)

(Cont'd)

TABLE 3-5 (CONT'D)

POST CONSTRUCION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV.*	INSTRUMENTATION DETAILS	REMARKS
				CANAL DYKE (CD) (CONT'D)			
CD26-2+600	1,673.8	73.7	1085.42	1.5	V		
	1,674.7	71.7	1085.5	11.6	T,2PP	Thermistor #17 10 x 1.0 m Piez. #349 Elev. 1080.5 Piez. #356 Elev. 1074.3	
CD27-2+765	1,748.4	-66.6	1085.17	1.5	V		
	1,749.7	-68.4	1085.1	11.3	S	Settlement rings 10 x 1.0 m	
	1,747.2	-64.6	1085.1	12.2	T	Thermistor #18 10 x 1.0 m	
CD28-2+900	1,852.4	-160.9	1080.46	1.5	V,H		
	1,856.4	-164.9	1080.3	12.2	SI,S	Slope Indicator to 10.5 m Settlement rings 10 x 1.0 m	
	1,848.5	-157.5	1080.3	12.2	T,2PP	Thermistor #13 10 x 1.0 m Piez. #348 Elev. 1074.2 m Piez. #361 Elev. 1069.3 m	
81-96	1847.5	-161.0	1080.3	9.6	T	Thermistor#T1,@ 1.0,2.0,3.0 3.5,3.9,4.5,4.9,5.6,6.5 & 9.5 m	Installed 3/4 Aug. Co-ordinates approx. (Sta. 2+900)
CD29-3+000	1,915.3	-240.5	1075.26	1.5	V,H		
	1,916.5	-242.7	1075.0	10.7	SI,S	Slope indicator to 10.4 m Settlement rings 10 x 1.0 m	
	1,913.9	-238.0	1075.0	11.3	T,2PP	Thermistor #16 10 x 1.0 m Piez. #360 Elev. 1069.8 Piez. #351 Elev. 1064.0	
CD30-3+130	1,928.9	-391.9	1068.66	1.5	V		
	1,980.5	-357.5	1068.6	10.1	T	Thermistor #15 10 x 1.0 m	
CD31-3+360	2,110.2	-398.1	1060.28	1.5	V,H		
CD32-3+550	2,311.2	-505.7	1056.72	1.5	V,H		

* SI: Slope Indicator S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor Strina PP: Pneumatic Piezometer HP: Hydraulic Piezometer (Standpipe)

(Cont'd)

TABLE 3-5 (CONT'D)

POST CONSTRUCION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV. *	INSTRUMENTATION DETAILS	REMARKS
			CANAL BACKSLOPE (BS)				
BS1-0+150	562.5	2,207.9	1095.64	1.5	V		
BS2-0+400	707.9	2,043.6	1093.83	1.5	V,H		
	712.4	2,029.4	1094.0	9.1	SI,S	Slope Indicator to 7.5 m Settlement Rings at 2 & 5 m	
	710.4	2,037.3	1094.0	9.6	T,PP	Thermistor #1 10 x 1.0 m Piez.#354 Elev. 1085.8 m	
BS3-0+610	771.1	1,841.7	1104.25	1.5	V		
BS4-0+710	825.5	1,757.1	1096.7	11.6	T,PP	Thermistor #2 10 x 1.0 m Piez. #358 Elev. 1085.7	
BS5-0+960	951.8	1,536.8	1092.48	1.5	V,H		
	950.9	1,538.5	1092.5	12.2	SI,S	Slope Indicator to 10.5 m Settlement Rings at 2 & 5 m	
	953.2	1,534.6	1092.5	9.6	T,PP	Thermistor #3 10 x 1.0 m Piez.#369 Elev. 1085.3 m	
BS6-1+110	1,035.1	1,408.8	1088.92	1.5	V		
BS7-1+200	1,019.1	1,305.6	1098.81	1.5	V		
BS8-1+300	1,063.8	1,214.2	1096.59	1.5	V		
BS9-1+530	1,199.5	1,022.0	1088.31	1.5	V,H		Co-ordinates Approx.
	1,199.0	1,023.6	1088.3	10.8	SI,S	Slope Indicator to 10.5 m Settlement Rings at 2 & 5 m	
	1,200.0	1,018.4	1088.3	11.3	T,PP	Thermistor #4 10 x 1.0 m Piez.#355 Elev. 1077.3	
BS10-1+900	1,309.3	659.9	1098.22	1.5	V,H		
	1,308.0	662.3	1098.2	10.7	SI,S	Slope Indicator to 10.5 m Settlement ring at 2 & 4.5 m	
	1,310.5	657.3	1098.2	11.3	T,PP	Thermistor #5 10 x 1.0 m Piez. #359 Elev. 1087.2	
BS11-2+100	1,411.6	482.4	(1094.985)	1.5	V,H		Elevation needs checking
	1,410.6	484.3	(1093.8)	11.6	SI,S	Slope Indicator to 9.8 m Settlement rings at 1 & 4.5 m	Elevation needs checking
	1,413.2	480.1	(1093.5)	11.6	T,PP	Thermistor #6 10 x 1.0 m Piez. #347 Elev. 1082.5 m	Elevation needs checking

* SI: Slope Indicator S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor String PP: Pneumatic Piezometer HP: Hydraulic Piezometer(Standpipe)

(Cont'd)

TABLE 3-5 (CONT'D)

POST CONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV. *	INSTRUMENTATION DETAILS	REMARKS
			CANAL BACKSLOPE (BS) (CONT'D)				
BS12-2+260	1,462.6	344.7	1094.29	1.5	V		
	1,463.6	343.1	1094.6	10.7	T	Thermistor #10 10 x 1.0 m	
BS13-2+460	1,572.1	179.1	1085.47	1.5	V		
BS14-2+560	1,621.6	95.2	1091.34	1.5	V		
BS15-2+760	1,714.0	-93.3	1090.5	10.7	T	Thermistor #9 10 x 1.0 m	
	1,713.1	-92.5	1090.24	1.5	V		
BS16-2+900	1,816.9	-200.8	1087.69	1.5	V,H		(Lower)
	1,815.1	-198.2	1087.8	15.9	SI	Slope Indicator to 14.5 m	(Lower)
	1,819.0	-202.4	1087.1	14.3	T,PP	Thermistor #7 10 x 1.0 m Tip #357, Elev. 1072.9 m	(Lower)
BS17-2+900	1,796.0	-214.3	1092.36	1.5	V,H		(Upper)
	1,796.4	-216.4	1092.4	10.5	SI,S	Slope Indicator to 10.5 m Settlement rings at 2 and 5 m.	(Upper)
BS17-2+900	1795.2	-212.3	1092.4	9.6	T	Thermistor #14 10 x 1.0 m	(Upper)
BS18-3+000	1879.3	-284.3	1082.81	1.5	V,H		
	1880.7	-286.3	1083.2	11.3	SI,S	Slope Indicator to 1.4 m Settlement rings at 2, 3.5, 5 and 6.5 m	
	1,877.9	-282.5	1083.2	11.6	T,PP	Thermistor #8 10 x 1.0 m Tip #352, Elev. 1072.2 m	
	1,881.9	-288.4	1083.0	11.9	HP	Tip Elev. 1074.9	
79-23	1,910.41	-387.7	1083.17	12.3	PP	Tip Elev. 1071.17 m	Location and elevations approximate (Sta.3+120)
BS19-3+130	1,928.9	-391.9	1081.45	1.5	V		
BS20-3+300	2,050.8	-444.3	1065.32	1.5	V,H		
BS21-3+550	2,286.6	-539.3	1057.61	1.5	V,H		

* SI: Slope Indicator S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor String PP: Pneumatic Piezometer HP: Hydraulic Piezometer (Standpipe)

(Cont'd)

TABLE 3-5 (CONT'D)

POST CONSTRUCTION INSTRUMENTATION SCHEDULE

BOREHOLE	LOCATION NORTH(m)	LOCATION EAST(m)	GROUND ELEVATION (m)	DEPTH OF BOREHOLE (m)	INSTRUMENTATION ABBREV.*	INSTRUMENTATION DETAILS	REMARKS
				CANAL SPOIL PILES (SP)			
SP1-0+990	1,045.5	1,504.5	1088.59	1.5	V,H		
SP2-1+530	1,274.1	1,055.7	1093.1	11.58	T	Thermistors 10 x 1.0 m	
	1,269.6	1,054.6	1093.1	10.67	SI,S	Slope Indicator to 10.7 m Settlement rings @ 1,3,5,7, 8 and 10 m	
	1,271.9	1,055.1	1092.9	1.5	V,H		
SP3-1+900	1,394.4	704.5	1083.5	11.58	T	Thermistors 10 x 1.0 m	
	1,396.8	700.1	1083.5	10.97	SI,S	Slope Indicator to 10.2 m Settlement rings @ 1,3,4,5 6,7 and 9 m	
	1,395.6	702.1	1083.05	1.5	V,H		
SP4-2+040	1,456.0	591.6	1083.77	1.5	V,H		
SP5-2+950	1,899.6	-177.5	1079.2	10.97	SI,S	Slope indicator to 10.3 m Settlement rings @ 1, 3.5, 5 7, 8 and 10 m	
	1,898.2	-183.1	1079.2	10.97	T	Thermistors 10 x 1.0 m	
	1,898.8	-180.2	1079.22	1.5	V,H		

* SI: Slope Indicator S: Incremental Settlement V: Vertical Settlement H: Horizontal Settlement
T: Thermistor String PP: Pneumatic Piezometer HP: Hydraulic Piezometer (Standpipe)

TABLE 3-6

TENDER AND FINAL PROJECT QUANTITIES

Item No.	Description	Tender Quantity	Final Quantity	Unit
1(a)	Mobilization	400,000.00	400,000.00	L.S.
1(b)	Demobilization	80,000.00	80,000.00	L.S.
2(a)	Slashing in Tailings Impoundment Area	30	31.90	Ha
2(b)	Clearing and Grubbing	54	60.58	Ha
2(c)	Burning of Clearing and Grubbing Debris	26.5	32.16	Ha
2(d)	Stripping and Removal of Waste Materials	144,000	224,485	m^3
3(a)	Clearing of Canal Area	52	42.13	Ha
	Canal Dyke Foundation and Excavation Area	222,000	221,718	m^3
3(c)	Common Excavation	521,000	464,928	m^3
3(d)	Upstream Blanket - Cross Valley Dam	63,000	81,728	m^3
3(e) (i)	Canal Rock Excavation	44,300	54,390	m^3
3(e)(ii)	Controlled Blasting	5,000	201	m^3
3(f)	Thermal Liner and Canal Dyke Class I Zones	249,000	126,092	m^3
3(g)	Seepage Control Liner Class II	33,000	55,289	m^3
3(h)	Filter Gravel Class I	24,000	23,562	m^3
3(i)	Rock Riprap and Filter Rock Class IV	43,500	45,020	m^3
3(j)	Canal Dyke Fill Class III	98,000	1,000	m^3
3(k)	Canal Outfall Erosion Control Class V	34,000	39,244	m^3
3(l) (i)	Filter Rock and Erosion Control Rock Stockpile - Class IV	1,000	1,000	m^3
3(l)(ii)	Filter Rock and Erosion Control Rock Stockpile - Class V	2,000	2,000	m^3
4(a)	*			
4(b)	Dam Foundation Subexcavation	(142,000)	166,166*	m^3
4(c) (i)	Excavation, Hauling, Placement and Compaction of Class VI Material for CVD Construction	86,000	84,396	m^3
4(c)(ii)	Excavation, Hauling, Placement and Compaction of Class VI Material for ID Construction	56,000	40,067	m^3

* Included on original Tender Document as a provisional item.

Cont'd

TABLE 3-6 (CONT'D)

TENDER AND FINAL PROJECT QUANTITIES

Item No.	Description	Tender Quantity	Final Quantity	Unit
4(d) (i)	Excavation, Hauling, Placement and Compaction of Class VII Material for CVD Construction	75,000	95,286	m^3
4(d)(ii)	Excavation, Hauling, Placement and Compaction of Class VII Material for ID Construction	34,000	39,171	m^3
4(e) (i)	Excavation, Hauling, Placement and Compaction of Class VIII Material for CVD Construction	97,000	93,297	m^3
4(e)(ii)	Excavation, Hauling, Placement and Compaction of Class VIII Material for ID Construction	207,000	210,578	m^3
4(f) (i)	Excavation, Hauling, Placement and Compaction of Class IX Material for CVD Construction	40,000	39,976	m^3
4(f)(ii)	Excavation, Hauling, Placement and Compaction of Class IX Material for ID Construction	11,000	10,377	m^3
4(g) (i)	Excavation, Hauling, Placement and Compaction of Class X Material for CVD Construction	80,000	79,031	m^3
4(g)(ii)	Excavation, Hauling, Placement and Compaction of Class X Material for ID Construction	30,000	37,742	m^3
4(h) (i)	Class VIII Abutment Fills for Emergency Spillways and Decant Channels - CVD	10,000	14,878	m^3
4(h)(ii)	Class VIII Abutment Fills for Emergency Spillways and Decant Channels - ID	2,200	3,491	m^3
4(i)(i)	Class IV Filter Rock for Emergency Spillways and Decant Channels - CVD	1,800	2,651	m^3
4(i)(ii)	Class IV Filter Rock for Emergency Spillways and Decant Channels - ID	1,000	1,548	m^3
4(j) (i)	Class V Erosion Control Rock for Emergency Spillways and Decant Channels - CVD	4,600	3,627	m^3
4(j)(ii)	Class V Erosion Control Rock for Emergency Spillways and Decant Channels - ID	2,800	1,986	m^3

Cont'd

TABLE 3-6 (CONT'D)

TENDER AND FINAL PROJECT QUANTITIES

Item No.	Description	Tender Quantity	Final Quantity	Unit
4(k)	Excavation, Hauling, Placement and Compaction of Class I Material for Diversion Dam Construction	12,000	11,064	m^3
4(l)	Excavation, Hauling, Placement and Compaction of Class II Material for Diversion Dam Construction	6,000	5,571	m^3
5(a)	Clearing, Grubbing and Stripping of Spoil Retainer Dyke Foundation Area	12,000	-	$
5(b)	Excavation, Hauling, Placement and Compaction of Fill for Spoil Retainer Dyke	13,000	-	m^3
6(a)	Excavation of North Valley Wall Interceptor Ditch	60,000	47,580	m^3
6(b)	Class I Thermal Lining of Channel at North Abutment of the Cross Valley Dam	20,000	5,175	m^3
6(c)	Dyke Fills for North Valley Wall Interceptor	2,000	16,369	m^3
7(a)	Fill Replacement for Access Road	60,000	60,962	m^3
7(b)	Access Road Culvert Installation	80	92	m
	Drain Ditch Excavation	-	53,986	m^3
Work Order #1	Clear Lines for Surveyors	NIL	2,406.33	$
Work Order #2	Remove Knoll at Sedimentation Pond	NIL	2,095.80	
Work Order #3	Sedimentation Pond Access Road, Supply, Haul and place riprap	NIL	4,629.80	
Work Order #4	Clean out Swamp Material from CVD Upstream Blanket Area	NIL	3,628.60	
Work Order #5	Borrow Pit "C" Stripping	NIL	687.05	
Work Order #6	Borrow Pit "C" Extra Stripping	NIL	12,525.38	

Cont'd

TABLE 3-6 (CONT'D)

TENDER AND FINAL PROJECT QUANTITIES

Item No.	Description	Tender Quantity	Final Quantity	Unit
Work Order #7	Removal of Uncompacted Class III Dyke	NIL	440.77	$
Work Order #8	Make Access Road for Drill	NIL	381.12	
Work Order #9	Access Ripping and Dozing for Samples	NIL	579.88	
Work Order #10	Creek Interception at Sta. 0+710	NIL	9,046.20	
Work Order #11	Remove Ice from Abandoned Rose Creek	NIL	9,206.47	
Work Order #12	Excavation of Canal Extension at Outfall of Rose Creek	NIL	10,819.32	
Work Order #13	Cornish Creek Interception at Outfall of Rose Creek	NIL	2,452.88	
Work Order #14	Place Additional Filter Rock on Downhill Slope of Canal, 2+820 to 3+000	Unnecessary		
Work Order #15	Mobilization/Demobilization of Fourth Vibratory Compactor	NIL	4,320.00	
Work Order #16	Correction of Stripping at Sta. 2+160	NIL	8,965.28	
Work Order #17	Removal of Excavation Step In at 1+890, 1+860	NIL	405.93	
Work Order #18	Test Trench and Core Trench Intermediate Dam	NIL	34,697.27*	
Work Order #19	Removal of Thermal Liner at 2+010	NIL	6,053.68	
Work Order #20	Dozer to Remove Thermal Liner at 3+420	NIL	1,458.67	
Work Order #21	Thermal Liner South Abutment Intermediate Dam	NIL	24,000.00	
Work Order #22	Silt Excavation Borrow Pit "A" Seepage Liner Placement	NIL	8,305.65	
Work Order #23	Diversion Dam Foundation Preparation	NIL	22,492.14*	
Work Order #24	Maintenance of Haul Roads and Placement of Fish Gravel	NIL	34.245.54	
Work Order #25	Remedial Stripping Sta. 2+700	NIL	1,359.48	
Work Order #26	Diversion of Creek into Canal and Diversion Dam Construction	NIL	13,716.81	
Work Order #27	Rock Removal in NVWID	NIL	15,938.13	
Work Order #28	Drainage Blanket 1+290 to 1+350	NIL	730.47	

* Included on original Tender Document as a provisional item.

Cont'd

TABLE 3-6 (CONT'D)

TENDER AND FINAL PROJECT QUANTITIES

Item No.	Description	Tender Quantity	Final Quantity	Unit
Work Order #29	Borrow Area Investigation	NIL	759.41	$
Work Order #30	Installation of Instrumentation	NIL	8,168.65	
Work Order #31	Reduce Weir No. 60 Install Weir No. 61	NIL	1,584.54	
Work Order #32	Cross Valley Dam Core Trench Excavation	NIL	18,177.21*	
Work Order #33	Cross Valley Dam Base Preparation	NIL	7,028.26*	
Work Order #34	Cross Valley Dam Upstream Blanket Reworking	NIL	155,480.40*	
Work Order #35	Bypass Ditch Excavation	NIL	34,242.00	
Work Order #36	Borrow Pit "H" Stripping	NIL	44,177.25	
Work Order #37	Borrow Pit "I" Stripping	NIL	43,276.50	
Work Order #38	Test Pits on Access Road	NIL	2,341.67	
Work Order #39	Removal of Till Mounds in Canal	NIL	2,140.85	
Work Order #40	Pumping of Rose Creek Drainage Ditch	NIL	199,050.66	
Work Order #41	Drain Rock Intermediate Dam South Abutment	NIL	46,829.01	
Work Order #42	Cross Valley Dam Spillway Preparation	NIL	10,972.71	
Work Order #43	Intermediate Dam Removal of Coarse Material Upstream Face	NIL	7,201.79	
Work Order #44	Instrumentation Repair	NIL	115.38	
Work Order #45	Borrow Pit "G" Stripping	NIL	3,473.03	
Work Order #46	Access Road Stripping	NIL	8,330.02	
Work Order #47	Borrow Pit "F" Remedial Stripping	NIL	4,096.74	
Work Order #48	Capping Canal Dyke with Sand and Gravel	NIL	23,455.43	
Work Order #49	CVD Upstream Blanket Silty Sand Cap	NIL	4,072.71	

* Included on original Tender Document as a provisional item.

Cont'd

TABLE 3-6 (CONT'D)

TENDER AND FINAL PROJECT QUANTITIES

Item No.	Description	Tender Quantity	Final Quantity	Unit
Work Order #50	CVD Downstream Toe Access Road	NIL	7,508.61	
Work Order #51	NVWID Base Preparation Through Borrow Pit "F"	NIL	9,202.58	
Work Order #52	Placement of Riprap Upstream Face CVD	NIL	3,502.23	
Work Order #53	Thermal Blanket Intermediate Dam	NIL	78,351.84	
Work Order #54	NVWID Riprapping at North Abutment of Cross Valley Dam	NIL	9,568.20	
Work Order #55	Stripping in Borrow Pit "M" for NVWID	NIL	2,267.26	
Work Order #56	Raising of Intermediate Dam Berm to 1068.8	NIL	11,386.21	
Change Order #1	Class I Canal Dyke	NIl	659,648.00	
Change Order #2	Placement of Seepage Liner in Rock Cutoff Trench	NIL	9,602.19	
Change Order #3	Rock Cutoff Trench	NIL	321,120.27	

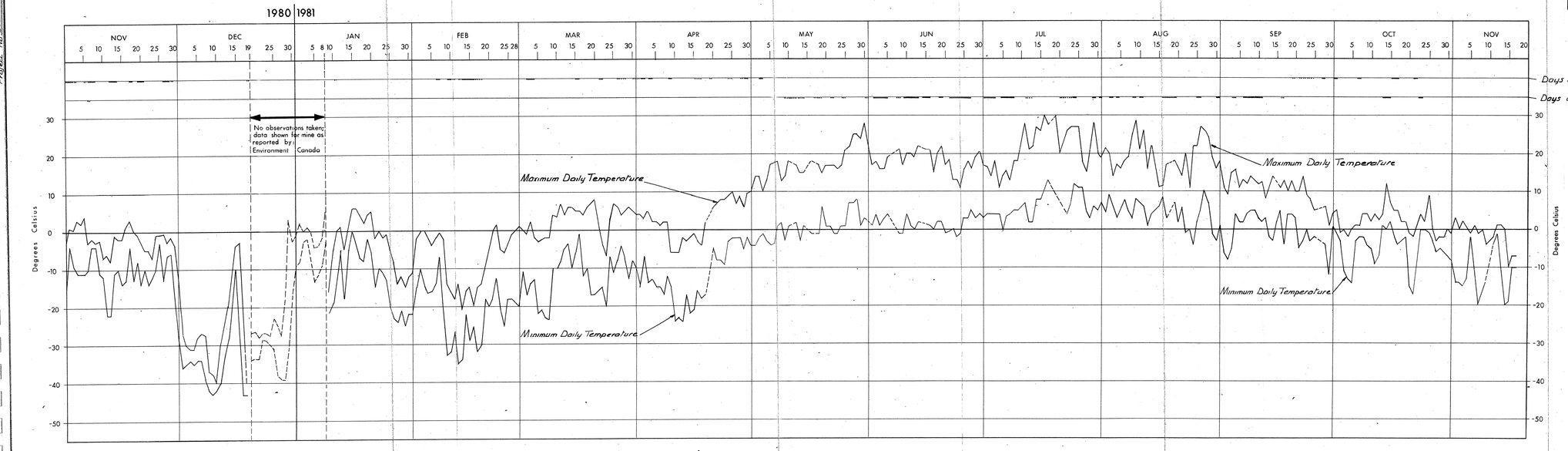
TABLE 3-7

SITE VISITORS

	1980	1981									
	Nov.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
G. Bethel, Environmental Protection Serv.			6								
W.J. Burwash, Golder Associates											13,14
J.I. Clark, Golder Associates									25,26		
R. Cooper, Yukon Territory Water Board, Technical Review Committee		30			28						
H.G. Gilchrist, Golder Associates	28			9 12,24 to 26	to7,8, 9	3,21, 22	18, 19	20	25 to 27		13,14
W.E. Hodge, Golder Associates								3			
B. McAlpine, Yukon Territory Water Board, Technical Review Committee	28	23,30	6, 25		7,16, 22, 23,28	3,4,8, 9,10, 11,28	17	23	1,13		
R. McCandless, Environmental Protection Serv.											28
J.M. Nickel, Water Resources			23, 24								
T. Polyck, Yukon Territory Water Board		8									
S. Roxborough, Department of Fisheries						1,4,8 to 11					26
Dr. Russell (UBC) Consultant to Yukon Territory Water Board									1		
M. Stepanek, Yukon Territory Water Board, Technical Review Committee		30	24		28		4				
V.M. Veldman, Hydrocon Engineering Ltd.			24		7,8			16,17			
K. Weagle, Ken Weagle Environmental Consultants						4 to 12,14		13 to 15	25,28		
D. Wiley, Golder Associates			10								
S. Withers, Water Resources			23, 24								
Group of 7 Engineers from the Yukon Pipeline Group							18				

DAILY TEMPERATURES OBSERVED AT SITE OFFICE

FIGURE 3 - 1



LEGEND

— Rain or Snow

... Light rain / Light snow, or Occasional showers / Snow Flurries

NOTE: Max - Min thermometer located on North side of a tree at the North periphery of the site office and maintenance compound. (See Fig. 2-2 for location of compound.)

Dave Sproule February 19, 1982

Drawn CP
Revd DJS
Date Feb 82

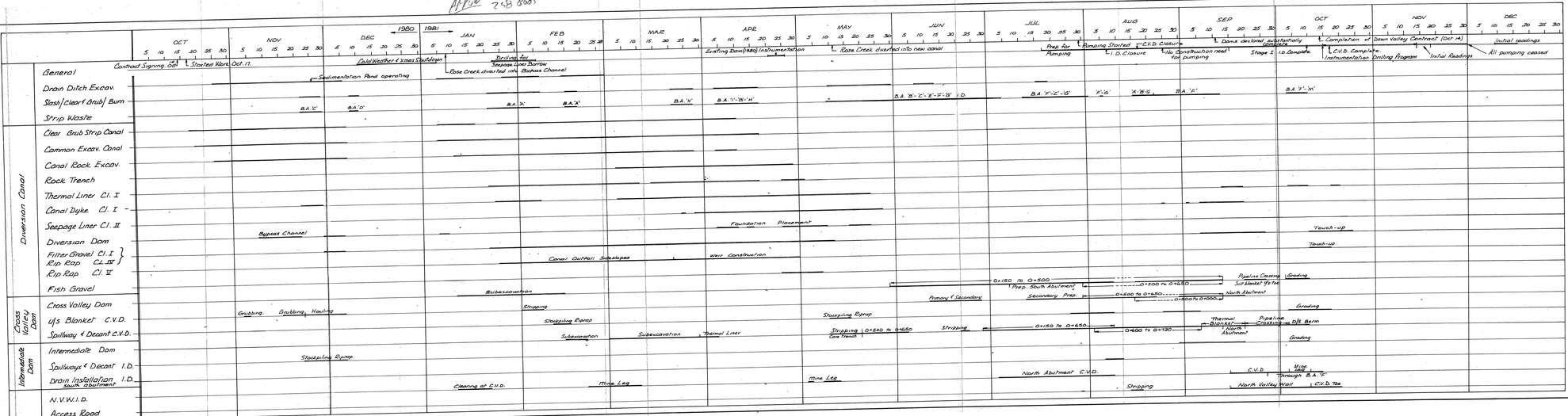
Golder Associates

Project: 862-2038

Appx 2-53 8685

CONSTRUCTION SCHEDULE

Figure. 3-2



LEGEND

I.D.	Intermediate Dam
C.V.D.	Cross Valley Dam
B.A.	Borrow Area
N.V.W.I.D.	North Valley Wall Interceptor Ditch
U/S	Upstream
D/S	Downstream

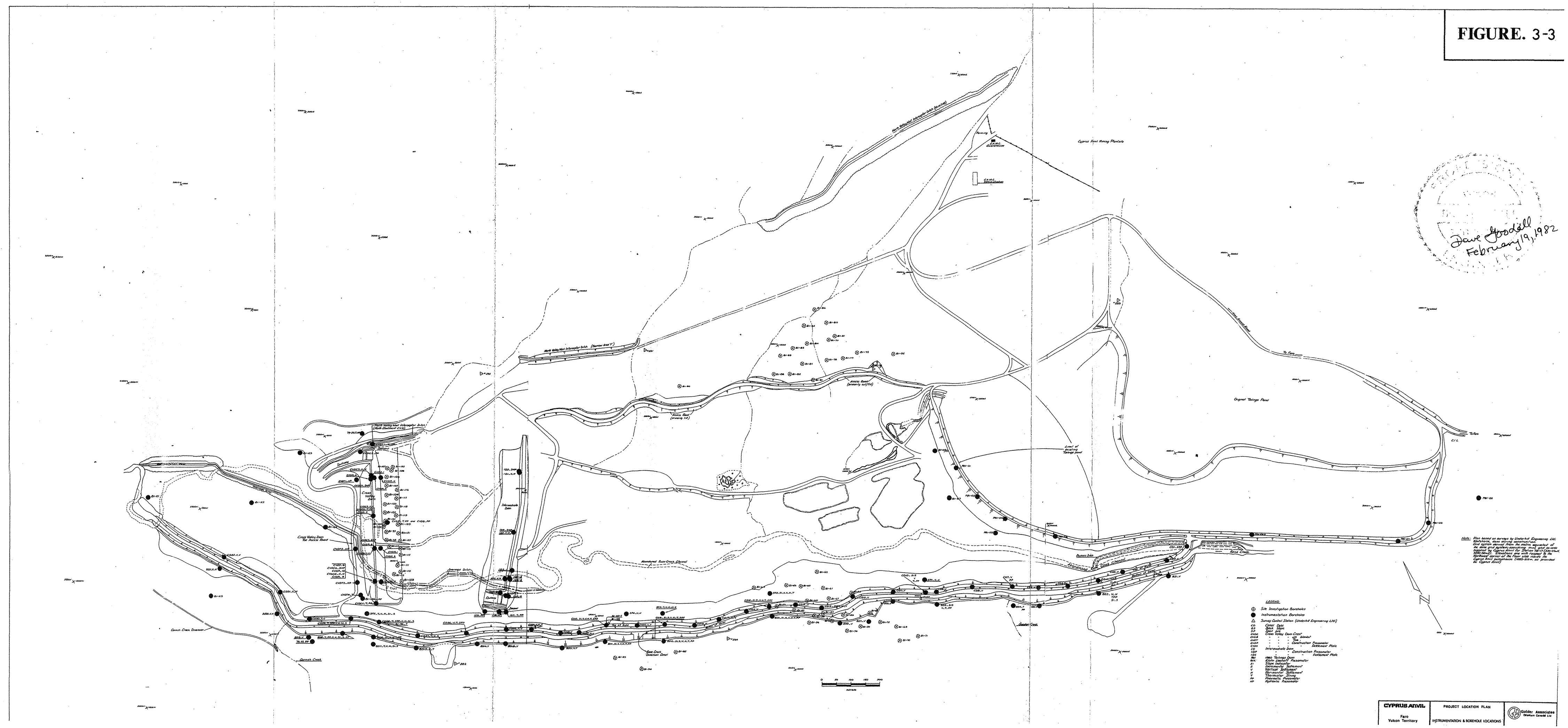
Period of activity

Start End

Drawn GF
Revd JSC
Date Feb '80

Golder Associates

FIGURE. 3-3


Dave Goodall
February 19, 1982
Note: Plan based on survey by Underhill Engineering Ltd. Instruments, dams and roads constructed subsequent to this survey are shown as at end of October, and may not be exact. Location of Tailings Access Rd. Section 98-21 (Sta 0+00 to Sta 3+00) is approximate. Co-ordinates of the Northeast corner of the Box are based on Cyprus Anvil co-ordinates (1000-200-m. as provided by Cyprus Anvil)
LEGEND
Site Investigation Boreholes
Instrumentation Boreholes
Survey Control Station (Underhill Engineering Ltd.)
Creek Gage
Weir Gage
Creek Valley Dam Crest
" " Toe Control
" " Construction Piezometer
" " Settlement Plate
Intermediate Dam
" " Construction Piezometer
" " Settlement Plate
1980 Tailings Dam
Glötzl Inclinometer
Slope Indicator
Inclinometer Settlement
Vertical Settlement
Horizontal Settlement
Electrolytic Tilting
Pneumatic Piezometer
Hydraulic Piezometer
CYPRUS ANVIL
Faro
Yukon Territory
PROJECT LOCATION PLAN
INSTRUMENTATION & BOREHOLE LOCATIONS
Golder Associates
Western Canada Ltd

4.0 CONSTRUCTION DETAILS AND DISCUSSION

DIKE CONSTRUCTION DETAILS

4.1 Canal

The normal sequence of canal construction was generally as follows:

(i) staking or flagging of clearing limits,

(ii) clearing and grubbing using dozers,

(iii) staking of the dyke toe location assuming 0.8 m of stripping,

(iv) Stripping of the excavation and dyke foundation areas using dozers (scrapers were also sometimes used over flat terrain),

(v) survey of the stripped surface and staking of the canal dyke location,

(vi) initial common excavation to level a working area for the scrapers,

(vii) common excavation using scrapers,

(viii) where rock was encountered, the rock surface was cleaned with dozers,

(ix) the excavation was staked as a rock cut,

(x) the thermal liner was installed on the backslope,

(xi) the Class I canal dyke was initiated,

(xii) the rock was drilled and blasted using relatively wide patterns,

(xiii) the shot rock was mucked and possibly stockpiled for use as rip rap,

(xiv) the rock trench was constructed using preshear techniques and closely spaced boreholes,

(xv) the rock trench was mucked and cleaned,

(xvi) seepage control liner was placed in the rock trench and on the dyke side of the canal,

(xvii) the dyke and seepage control liner were completed to a minimum elevation corresponding to a 10 year flood,

(xviii) Class I filter gravel was placed over the canal bottom and over all exposed seepage control liner in the walls of the canal

(xix) Class IV riprap was placed over the filter gravel,

(xx) in the outfall, Class V riprap was placed over the Class IV riprap and weirs were formed,

(xxi) fish gravel was placed in the weir segments of the outfall.

The Contractor organized his activity such that all of the above work was complete at the time that Rose Creek was diverted (May 11, 1981). The only post diversion work which was necessary was the completion of the canal dyke to its final elevation.

The Contractor initiated construction between reference line chainages 0+450 and 1+170 in October, 1980. Appreciable quantities of rock were encountered in this area and therefore he soon shifted his clearing, stripping, and common excavation forces to the area between 2+820 and 3+800. Once established in this area the work advanced eastward from Sta. 2+820 to about reference line Sta. 1+800 which was reached by shutdown for Christmas, 1980. In spite of this apparent progress however, the Contractor had completed very few final excavation cross-sections by the time of Christmas shutdown, perhaps due in part to the premature shutdown of operations by cold weather in December. Furthermore, the occurrence of irregular bedrock between Sta. 2+600 and 2+200 precluded uninterrupted scraper operations in this area (see Figure III-8, Appendix III).

In January 1981 the Contractor resumed his excavation activities and soon had cleared and stripped the canal area back to reference line Sta. 1+500.

The bypass ditch, which had been excavated in November, 1980 was put into service in January. This permitted work to proceed during February in the inlet section of the canal between Sta. 0+000 and 0+450 (see Figure 4-1).

The final segment of the canal, located between Sta. 1+200 and 1+500, was started in March. This area had been left basically undisturbed until this time to ensure that the potentially available seepage control liner borrow in this area (including Borrow Areas H and I) was preserved as much as possible in an unfrozen state.

During March and April all stages of construction were in progress over the full length of the canal. The Rock Trench was started in March to complete the rock excavation segments of the canal. At the end of March the Contractor began to complete the canal cross-section particularly in the canal outfall (although fish gravel was not placed until late April/early May). Placement of seepage control liner started at the end of March.

By May 1, the Rock Trench work was essentially complete and the final stages of seepage control liner placement were underway. The canal outfall was complete except for the placement of fish gravel which was completed by May 8. However, much of the production and placement of Class IV rip rap in the balance of the canal was outstanding. This resulted in part because the Contractor insisted on completing the rip-rap placement on the backslope to the full design elevation rather than the minimum 10 year elevation required for diversion. Furthermore, the filling of the Diversion Dam area and the canal dyke opposite the quarry (Sta. 2+700) had barely been started.

On May 11, Rose Creek was diverted into the new Diversion Canal with all aspects of the canal being complete as a minimum to the 10 year flood elevation. Following diversion, work continued to focus on completion of the canal dyke to final grade except that no Class IV rip rap and filter gravel was placed until September. Consequently no work was conducted on the canal between the end of May and September.

4.1.1 Survey Control

The preconstruction survey, which was conducted by Underhill Engineering, was tied to a reference line which was located about 45 m upslope to avoid construction activity and parallelled the canal investigation baseline which approximated the canal centreline. The chainages on the baseline and reference line were deliberately made to differ by about 100 m (Sta. 0+000 on the baseline corresponded to Sta. 0+100 on the reference line) to avoid possible confusion.

A summary of corresponding chainages on the reference line and the baseline is provided on Table 4-1. The difference between these chainages must be remembered when considering the design and tender information (which was tied to the baseline) and the construction and post construction information (which is and will be tied to the reference line).

Iron bars were driven into the ground at 30 m intervals on the reference line (except between Sta. 1+200 and 1+500 where the reference line stations correspond to 30 m intervals along canal centreline) and these were the reference points for cross-sections of the canal for original ground stripped surface, common excavation (including progress surveys), rock excavation, thermal liner, final as built and numerous fill check surveys which were conducted as necessary. Where rock was encountered supplementary cross-sections were taken at 10 m intervals to more accurately assess the rock surface. Supplementary cross-sections perpendicular to the canal centreline were also obtained locally where the alignment of the canal and the reference line deviated significantly.

For locally irregular work which was not easily defined by cross-sections, topographic surveys were conducted (e.g. Rock Trench, Diversion Dam).

Final surveys of the canal were conducted in early May at about the time of diversion. A traverse of the canal dyke was performed in October (1981) to measure and record the dyke work which was completed after diversion. Nearly all surveys were conducted using electronic distance measuring equipment.

4.1.2 Contractor Surveying

The Contractor was responsible for the layout of the work. Generally centreline offset information was provided to the Contractor by the Engineer.

The Contractor survey staff during construction ranged from about two to four. Considerable time was expended maintaining permanent stakes as a result of the difficulty in implanting stakes into frozen ground and

the need to replace stakes knocked down by equipment operations (particulary night shift).

The first step in layout was to flag the limits of clearing. The upslope limit was located approximately from original ground cross-sections. The downslope limit was located at the intended toe of the waste pile as agreed upon by the Engineer and the Contractor.

Following clearing and grubbing the stripping limits were defined by slope staking the upslope cut limit and the downslope dyke toe location (a stripping depth of about 0.8 m was assumed for this purpose). The type of staking at a given station was determined by the Engineer based on knowledge of preconstruction subsurface conditions and on the type of cross-section to be built. In general it was assumed that a 2 horizontal to 1 vertical thermally lined slope would be required and this was the basis of initial staking irrespective of whether bedrock was

expected or not. However, below the hydraulic level (i.e. the top of the dyke) the excavation boundaries were dependant on whether seepage control liner protection was required or not; installation of seepage control liner required a wider excavation to provide for the placement of a filter gravel between the liner and Class IV riprap.

The excavation was staked as follows:

0+000 to 0+900	Seepage Control Liner
0+930 to 0+990	Thermal Liner
1+020 to 1+110	Seepage Control Liner
1+140 to 1+150	Thermal Left Bank/Seepage Right Bank
1+500 to 2+010	Thermal Liner
2+040 to 2+100	Seepage Control Liner
2+130 to 2+280	Thermal Liner
2+310 to 2+520	Seepage Control Liner
2+550 to 2+820	Thermal Liner
2+825 to 3+420	Outfall Drop Weirs
3+420 to 3+660	Thermal Liner (no pilot channel)
3+660 to 3+830	Outfall Drop Weirs
Beyond 3+830	Hydraulic Section (no pilot channel)

Following the initial stripping, the cut to fill stake was located at the boundary between the dyke foundation area and the canal excavation. The establishment of this stake was important with respect to control of common excavation.

The Engineer insisted that the Contractor properly control his excavation slopes because the fills which were to be placed as liners were of minimum practical placement dimensions and were in a sense automatically controlled by the excavation walls. It was also found that slopes which were under-excavated were expensive to correct because much more ripping effort had to be expended to excavate a cooled permafrost face which had been exposed over a period of a day or more.

Fills wre controlled in several ways. Fills which were unrestricted by the excavation walls were staked in the normal fashion. Scraper-width fills were placed and staked afterwards for trimming. Relatively thin filter or riprap fills were controlled by thickness stakes placed perpendicular to the slope (see Figure III-22, Appendix III).

Rock trench layout was provided by the Engineer in the field because it was necessary to react to actual field conditions with respect to rock type and unearthed subcrop geometry.

4.1.3 Clearing and Grubbing

Clearing and grubbing was achieved by dozers pushing downhill to the downslope toe of the waste pile.

4.1.4 Stripping

Stripping of the canal excavations and dyke foundation areas was performed using ripping and dozing techniques (see Figure III-3 in Appendix III). Scrapers were also used to haul stripping waste from the canal area between Sta. 1+200 and 1+500 because the area normally used for the waste deposition was required as a source of seepage control liner material.

Most of the stripped material was quite hard and contained significant amounts of ice. The stripping depth appeared to be irregular and not well defined in many instances. Irregularity was due to variability in ice content. Local pockets of organic materials several metres thick were encountered at Stations 1+140, 1+410, 1+530 and 2+670. Often the common excavation exposed thin organic layers buried at depths well below what would practically be considered as stripping. These organic layers were not removed; the purpose of the stripping was to remove the near surface ice rich materials and the dominantly organic mantle over the mineral soil.

The fact of winter construction introduced several difficulties with respect to inspection and approval of stripping by the Engineer. The frozen character of the grade gives the impression of strength. A frozen brown organic silt does not contrast much in appearance from the inorganic subgrade. And snowfall, albeit light, often masked the work. In view of this the person most qualified to approve the stripping was the dozer operator because he could continuously probe the ground (particularly on night shift). The Engineer could compare the stripped surface with original ground surface at a given cross-section but this provided little assurance that the stripping was properly done between the cross-section lines and the time required to do this type of checking was incompatible with practical construction progress. The Contractor was generally impatient to start common excavation because the stripping activity was usually completed immediately in advance of common excavation so that frost penetration was minimized.

A common concern attendent to the stripped surface beneath the dyke was the deposition of common excavation waste in the dyke foundation area. Dozers naturally deposit such material if they are pushing over the area, particularly if the stripped surface was irregular (as it often was when stripped under frozen conditions). This waste material would be expected to have a very low density.

4.1.5 Common Excavation

Upon completion of stripping the dozers would begin excavation at the top of the cut to obtain a flat area for scraper access. Once this was established the dozers would rip the cut and the scraper excavation would begin. This process continued until bedrock was encountered or until the base of the excavation was acheived.

Common excavation materials varied considerably. A summary of test results is provided on Table 4-2. A sand and gravel till was generally encounterd although the observations regarding winter inspection referred to above for stripping, apply. Significant volumes of unfrozen materials were encountered at depth; a real assessment of the amount of permafrost is not possible because the excavation often advanced sufficiently slowly that freezing occured ahead of the excavation face.

At the inlet of the canal, common excavation materials tended to be coarser and schisty although they are believed to have till origins.

Beyond the location of Cornish Creek (Sta. 3+200) the excavation materials were alluvial in origin and highly variable. Local deposits of silty gravel, sand, organics, organic silts and even volcanic ash were discovered.

Seepage into the canal was observed at the following locations:

0+360	
o+690	(associated with Goodall Creek)
2+010	
2+670	(Quarry)
2+900	
3+760	(seepage into base of excavation)

These seepages proved to be problematic to winter construction because the resulting glaciation had to be removed prior to placement of any liners or to continued excavation (see Figure III-5, Appendix III).

The canal also intersected two main south valley wall creeks (Goodall Creek Sta. 0+711, Cornish Creek Sta. 3+200) which appear to flow year round. The Contractor chose initially to leave these creeks flowing within their channels or modified versions thereof and to excavate fully on both sides of each creek. This procedure, although possibly the only practical approach, resulted in the icing of the canal excavation at

both locations. At Goodall Creek, the rock excavation drilling and blasting in the backslope resulted in the rerouting of the stream and icing of the adjacent canal. At Cornish Creek the freezing flow first choked its channel with ice and entered the adjacent excavation. The Contractor recognized the potential difficulties of this eventuality before Christmas and excavated a Cornish Creek diversion channel across the alluvial fan (see Figure 2-2) some distance upstream before shutting down for Christmas 1980. Unfortunately this diversion channel also iced up, forcing the creek back into its original channel with the result that the almost complete canal excavation was flooded between the Creek and Sta. 3+420 approximately (see Figure III-6, Appendix III). When work resumed in January some additional diversion work was successfully performed; however the presence of water and ice in that portion of the canal precluded additional work there for over a month. The area was drained by excavating a small channel along the base of the excavation downstream of Sta. 3+420.

Over-excavation during common excavation was a difficult problem to assess and to protect against, particularly during winter work. In Summer work over-excavation and loose backfill are relatively easy to assess. In Winter work backfills are not so readily apparent because they are rigid, give full support and may be lost under new snowfalls. A few examples of such over-excavations and backfills were noted by the inspectors. One case occurred where a natural canal dyke was removed, only to be backfilled with common waste; loss of slope stakes was the cause. All known occurrences of this undesirable condition were re-excavated and backfilled with suitable granular fill.

4.1.6 Rock Excavation

Where bedrock was encountered, common excavation with scrapers stopped naturally at the high points of the rock surface. This meant that a considerable amount of dozer cleanup was necessary to expose the full bedrock surface for sectioning and staking. This cleanup was not always

successful because the remaining till froze and became chilled to the extent that it was almost impossible to rip with a D9 dozer. As a result some rock could not be properly cleaned and drilling and blasting had to be performed to remove these "till knobs" (see Figure III-9 in Appendix III).

Bedrock was encountered in the following canal intervals as measured along the reference line:

Reference Line Stations		Rock Volume Removed (m^3)
0+045 to 0+110	65	210
0+130 to 0+140	10	62
0+160 to 0+240	80	3673
0+270 to 0+320	50	1810
0+450 to 0+900	450	19069
1+040 to 1+115	75	(Hourly)
1+610 to 1+790	180	4772
2+170 to 2+360	190	2887
2+400 to 2+580	180	9370
	1280	
Total		51880 m^3

Rock was exposed very early in the construction between Sta. 0+450 and 0+900. At that time very little was known about the rock quality so it was decided to conduct the excavation initially between Sta. 0+450 and 0+900 assuming that a full seepage control liner installation would be required. The procedure which was initially followed therefore was to excavate a routine rock cut down to the hydraulic section (top of the dyke) at a 0.5 horizontal to 1 vertical slope and then to excavate a 2 horizontal to 1 vertical slope allowing for the installation of seepage control liner on both sides and the bottom of the canal. The cut was taken out in two benches, the first being to the top of the hydraulic section and the second being to the base of the seepage control liner subexcavation.

This procedure was followed between Sta. 0+480 and 0+750 for the first bench excavation and between Sta. 0+480 and 0+690 for the full two bench excavation (see Figure III-11, Appendix III). From inspection of the exposed rock faces it appeared that the intact rock had a relatively low permeability (less than 10^{-4} cm/sec.) and that the rock dipped south-westerly into the backslope. These observations prompted the Engineer to decide that a full seepage control liner was unnecessary and that the intact rock section cited in the Tender Documents would be adequate with one modification - that a seepage control liner be installed on the canal side of the dyke and that this liner should be keyed into intact rock.

To simplify construction, the procedure which was followed in subsequent areas where bedrock was encountered was as follows:

(i) stake rock surface for construction of intact rock section allowing for seepage control liner installation on the dyke side of the canal,
(ii) drill and blast to the neat excavation lines,
(iii) Muck out shot rock down to the neat excavation lines,
(iv) expose intact rock in the seepage control liner key area as required by the Engineer,
(v) drill and blast the Rock Trench using closely spaced production holes and preshear techniques as required by the Engineer;
(vi) muck out Rock Trench,
(vii) clean all loose and disturbed rock from the periphery of the Rock Trench.

Step (ii) of the above procedure was performed by Yukon Drilling and Blasting, the rock excavation sub-contractor. Drillholes, generally of 7.6 cm (3 in.) diameter were used in patterns varying between 2.4 m by 3.0 m (burden by spacing) and 3.0 X 3.6 m depending on depth of cut. At

the face of the cut the final line holes were drilled at one half the pattern spacing. The drillholes were loaded with Anfo supplemented with a 5 cm (2 in.) diameter forcite booster at the bottom of the drillhole. Powder factors were approximately 0.48 kg/m^3(0.8 lb/yd^3).

Typically a 0.9 m subgrade was used except on the dyke face where none was used. This procedure was generally unsuitable for the subgrade and wall control required for the seepage liner cutoff key (Rock Trench). Unfortunately the procedure could not be modified practically considering the equipment which was available on site. As a consequence separate equipment was mobilized to conduct the Rock Trench work and the sub-contractor performed only the neat line excavation.

Mucking of the rock from the excavation was generally achieved using a dozer, a front end loader and the off highway 35 ton rock trucks. The mucked rock was usually stockpiled at two central locations (primarily at Sta. 0+600 and at Sta. 2+650) for future processing.

The 4.5 m wide seepage cutoff Rock Trench was drilled and blasted using 63.5 mm drillholes. The preshear holes were spaced at 0.6 m intervals and loaded with 19 mm diameter Exacter. Production holes were loaded with 38 mm diameter forcite sticks separated by spacers. The powder factor which was generally used was 0.42 kg/cu.m (0.7 lb/cu.yd). The generally required 1 m depth of drilling was adjusted by the site Engineer with respect to rock quality. A summary of the procedure generally followed is provided in Change Order No. 3, Appendix V.

The Rock Trench was usually mucked initially with a Cat 235 backhoe. Subsequent cleanup was conducted with a small rubber tired backhoe working in coordination with a hand labour crew equipped with a 600 cfm nozzled air hose and hand shovels (See Appendix III, Figure III-16 and III-17).

Two area of rock excavation required special attention. In the vicin-ity of Sta. 0+810 some ice was noted in rock cavities in the base of the Rock Trench (see Figure III-15 in Appendix III); this area was further subexcavated by about 1 m to seek out better bedrock conditions to reduce the amount of seepage which might occur. The other area was located between Sta. 2+460 and 2+490. The rock in this area, although relatively hard, was more heavily fractured and there were indications of a shear zone (See Appendix III Figures III-12 and III-13). Here it was decided that the Rock Trench would be extended across the bottom of the canal to reduce the risk of seepage in this area (see also Figure 4-19).

At locations where bedrock disappeared from the excavtion the Rock Trench was generally shifted along the periphery of the rock into the backslope (see Figure III-18, Appendix III).

In the vicinity of Goodall Creek it was decided that the rock in the backslope should be fractured to induce flow of the creek underground in the backslope (see Appendix II, Figure III-32). This was achieved by drilling and blasting from the bedrock surface at the top of the cut and from the bench located at the elevation of the top of the dyke. The drill holes were drilled to slightly lower than the local pilot channel invert as is generally shown on Figure 4-12.

4.1.7 Thermal Liner

Thermal liner was installed on the backslope of the canal to the base of the excavation where no rock was encountered and otherwise to the bedrock surface. The material was Class I sand and gravel from Borrow Areas "D" and "A". Test results for this material are shown on Table 4-3.

The 3.8 m wide thermal liner (minimum practical placement width) was placed using scrapers. It was nominally compacted (4 passes of a Dynapac CA25D vibratory roller per 0.3 m thick lift) and placed during a

variety of temperature conditions ranging from about -30°C to +10°C (January through April, 1981). Significant accumulations of snow and/or ice were removed prior to placement.

As discussed previously there were some areas where the rock surface was not adequately cleaned before drilling and blasting because the overlying frozen till material could not be ripped. The work schedule was such that, in some areas, the thermal liner was placed over unconsolidated till material. The reach between Sta. 2+160 and 2+500 was an area of particular concern. This area had been excavated to the rock surface high points using scrapers and left over the Christmas 1980 shutdown. When the Contractor returned in January the poor definition between rock and frozen till became apparent because the till materials appeared to be almost as hard as rock and the bedrock surface was quite irregular (See Appendix III, Figures III-7 and III-8).

Investigations of the till in the 2+160 to 2+500 area by the Engineer indicated that the till material had a low water content (about 8% except for some ice laminated pockets at 16%). Such material was not considered to require a full 3.8 m width thermal liner. It was concluded that all till areas which had been drilled and blasted as rock (referred to as "Till Mounds") were trimmed back to a 2 horizontal to 1 vertical slope such that a 0.3 m thick filter layer and 0.5 m thick Class IV layer could be placed over the exposed till to provide the design hydraulic section.

A full thermal liner was not installed between Sta. 1+140 and 1+320 because very little permafrost was present in this area. Instead of 0.3 m thick layer of filler gravel was placed (see Figure 4-15).

4.1.8 Class I Dyke

In January, 1981 it was decided to modify the original canal dyke design concept. The details of these section modifications are discussed in

Appendix V, Change Order No. 1. In essence this meant that the Class III dyke shown in the Tender Documents was replaced by Class I dyke. The advantage of this change was that construction of the dyke could proceed under winter conditions.

A procedural specification was adopted for winter construction of the Class I portion of the dyke section. The Contractor was required to compact the fill in 0.15 m lifts using 8 to 12 passes of the standard vibratory packer (CA25PD Dynapac) for each lift. As well it was required that certain zones of the Class I dyke be placed at temperatures warmer than -10°C.

Placement of Class I dyke sand and gravel fill began in January, 1981 and was not finally completed until October, 1981. Materials were taken from Borrow Areas "A" and "D" between January and May and from Borrow Areas "A" and "K" in October. Typical gradations are summarized on Table 4-3.

Class I dyke was placed directly over the stripped dyke foundation area although it was impracticable to prepare the foundation to the extent normal for summer construction. The presence of minor amounts of ice and snow or common excavation debris must be acknowledged in spite of efforts to remove it. This is particularly pertinent to those areas where cold weather construction was started in January and February (Sta. 1+600 to Sta. 2+540). The acceptance of this dyke foundation condition is not expected to be a significant problem particularly because of the good quality of the Class I fill material. Nevertheless any performance evaluation of the dyke should consider the fact of imperfect foundation preparation.

The degree of compaction achieved for the dyke appeared to vary with temperature. The overall average degree of compaction was 94 percent of maximum standard Proctor density on the basis of some 615 tests. Considerable variability in the results was observed. The approach

taken by the Engineer was to ensure that the specified compaction effort was delivered rather than to accept or reject finished fill with reference to density test data.

4.1.9 Seepage Control Liner

The Tender Documents (see Appendix IX, section 3.11 of Detailed Specification) had provided for the installation of glacial till seepage control liner (Class II) at selected locations along the canal. The design modification of the canal dyke (Class I instead of Class III) and the adoption of the Rock Trench concept in part defined the need for a seepage control liner. The variability of the natural soils in which the canal was cut, the absence of 50 year flood containment in natural ground at many locations in the 0.19 percent grade construction to Sta. 2+820, and the general nature of winter construction affirmed need for a continuous seepage control liner on the dyke side of the canal. This was the subject of Change Order No. 2 presented in Appendix V.

When the Common Excavation was completed to the subexcavation grade or the Rock Trench had been completed, the placement of seepage control liner could begin. However it was required by the Engineer that this material be placed under thawing conditions to ensure that this important element of the design would be properly compacted. Furthermore, absolutely no frozen fill was permitted. This meant that seepage control liner could only be placed after late March and initially only on the day shift.

Borrow Areas "H" and "I" (for location see Figure 2-2) were delineated by test drilling conducted during February, 1981. These borrow areas together with the canal excavation between Sta. 1+200 and 1+500 (which had deliberately been saved) were intended to provide sufficient material to complete the seepage liner to at least the 10 year flood elevation. Borrow Area "H" on the upslope side of the canal was to be excavated to about the top of the hydraulic section. Borrow Area "I" was situated on the downslope side of the canal and it was started from the north side of the area to ensure that the canal dyke was not undercut.

Typical gradations and other information obtained for samples from Borrow Areas "H" and "I" are given on Table 4-4. Borrow Area "H" material was first to be used and the deposit was found to be quite bouldery (see Figure III-10, Appendix III) and generally difficult to use. Some bedrock was encountered in the backslope around Sta. 1+290. In contrast, Borrow Area "I", was more consistent and fine-grained.

The natural occurence of seepage control liner between Sta. 1+200 and 1+500 prompted the Engineer to eliminate the installation of seepage control liner in this area. Practically this meant that seepage control liner was installed only between the stripped surface and the top of the dyke. However, the occurrence of a deep organic deposit at Sta. 1+410 and at Sta. 1+390 resulted in a significant liner installation at these locations.

At the base of the canal excavation between Sta. 1+320 and 1+530 a sand and gravel stratum was encountered. This material was tested and found to contain 10.8 percent passing the No. 200 sieve. This material was considered to be marginally adequate but the extreme stratigraphic variation in this area prompted the Engineer to require subexcavation of the material to the seepage control liner subexcavation to ensure that no coarse zones were present close to the base of the canal. It is noted that a coarse nesting of the cobbles was found in the excavation wall on the dyke side of the canal at 1+530; this zone was subexcavated before placing seepage control liner.

The subexcavation between Sta. 1+320 and 1+530 did not encounter any coarse zones and it was backfilled with waste excavation from the area between Sta. 1+170 and 1+300. The material was classified as Class III material on the cross-section shown for Sta.1+350, Figure 4-16 because it was not good quality seepage control liner (Class III contains greater than 10 percent passing the No. 200 sieve).

Seepage control liner was also installed across the bottom of the canal between Sta. 0+360 and 0+400 where an extremely schisty till and weathered bedrock was encountered, and between Sta. 2+460 and 2+490 (previously discussed under section 4.1.6, Rock Excavation). The crosssection shown on Figure 4-21 at Cornish Creek also shows the seepage control liner which was installed at that location to reduce seepage from the canal into the abandoned creek bed.

The Contractor continued to use Borrow Area "I" as a source of Class II material for canal dyke and Diversion Dam completion even after Rose Creek was diverted on May 11, 1981. However, soon after diversion, seepage was noted in the Class II borrow which had been stripped near the canal dyke at Sta. 1+290. As a result additional borrow exploitation of Borrow Area "I" was not permitted. The Contractor was advised to use some suitable substitute material from the waste piles situated between 1+200 and 1+500 (material had been rejected because it was frozen). He chose to complete the seepage control liner to final grade using material from Borrow Area "E" across the valley.

The average degree of compaction observed for the seepage liner was 96 percent of maximum Standard Proctor dry density (see Table 4-4 for Proctor Test results).

4.1.10 Class I Filter Gravel

Filter gravel was required as a transition filter between the natural ground and Class IV filter rock in the outfall and also on the bottom of the canal between the seepage control liner and Class IV riprap.

Most of the filter gravel was taken from Borrow Area "A" or "B". In some cases the material was placed by pushing a 0.3 m thickness of sand and gravel up the 2 horizontal to 1 vertical slope using a dozer; in others a backhoe was used to spread dumped or stockpiled material as required. Bottom placement was achieved using scrapers (refer to Figure III-21 in Appendix III).

4.1.11 Class IV Riprap

Class IV material was specified by the Contract for two different functions. The first was to armour the 0.19 percent segments of the canal. The second was to serve as a transition material between Class I filter gravel and the heavy Class V riprap in the canal outfall. The first required a very uniformly sized gradation whereas the second was better achieved using a broadly graded material of comparable D_{50}. (see Figures III-22 and III-23 in Appendix III).

The waste rock from canal rock excavation tended to be broadly graded with signficant proportions of fine-grained material. A sample of such material (which the Contractor intended to use as Class IV riprap) was comprehensively analyzed in November 1980. The results of this analysis are presented on Figure 4-24 (typical blast rock). The material was not considered acceptable for use as armouring and the Contractor was advised of this in writing on January 22, 1981. However, the Engineer also advised the Contractor that such material could be used as a Class IV transition filter between the Class V and Class I in the outfall section.

The Contractor used selected waste rock excavation from the rock cuts in the vicinity of Sta. 0+600 and Sta. 1+700 as Class IV filter rock in the outfall. A photograph of this aspect of construction is shown on Figure III-24 of Appendix III.

The Contractor mobilized a jaw crusher and screen to the site in early March and set it up in the vicinity of Sta. 0+680 to process the stockpile of waste rock excavation which had accumulated there. Production of acceptable Class IV was extremely slow as a result of the amount of fine rock in the stockpile; it was initially estimated to be about 300 cu.m. per day (one shift basis in March).

However, the quality of the riprap was far superior to any riprap which had been produced prior to that time (see Figure 4-24).

About mid-March the Contractor decided to move the crusher to the quarry site in the hope that better production would be obtained there. He continued the operation on a single shift basis but it was found that production was not enhanced as expected. Again this was probably due in part to the random stockpiling of rock and because considerable amounts of till were known to be contained within the stockpile.

Although the Contractor started to operate a double shift of crusher production by the beginning of April, production still remained at between 200 and 300 cu.m per shift. The stockpile became depleted by mid-April and the Contractor then began to feed the crusher directly from the quarry without separating Class V material from the feed. Production remained low due to poor quality rock in the quarry at that time.

With the time to diversion rapidly diminishing the Contractor began to investigate alternative sources of riprap. The old 1974 quarry (see Figure 2-2) was drilled and blasted and further stripped. The drilling and blasting at this location generally produced acceptable quality Class IV riprap. However, the additional stripping of the area proved fruitless. Drilling in the rock backslope at Sta. 0+800 also produced marginally acceptable Class IV riprap without processing (the resulting section is shown on Figure 4-14).

At this stage the riprap requirements were reviewed by the Engineer. The conclusions of this review were as follows:

(i) Excellent quality riprap was required to armour the seepage control liner on the dyke face and on the bottom of the canal. The only material which satisfied this need was the screen processed riprap.

(ii) Quarry run riprap would be suitable as armour for the thermal liner segments of the canal on the backslope and on the bottom. It was recommended that the Contractor minimize the handling of this rock to reduce its mechanical breakdown.

(iii) The Contractor would be held responsible for inadequate quality control of the unprocessed riprap.

Subject to these rules the Contractor proceeded to produce acceptable quality riprap from the quarry by adjusting his patterns and selecting good quality rock in the quarry. Sufficient processed Class IV was available to complete the coverage of the seepage control liner to the 10 year flood elevation.

A few loads of inferior quality Class IV were noted. (see Hydrocon review of as built canal in Appendix VII). This was subsequently upgraded in September (1981).

After diversion of Rose Creek on May 11 no further riprap was produced or placed until September. The Contractor experimented unsuccessfully over this time with several methods of riprap production, including segregation of alluvial terrace material. In the end the riprap was obtained from two sources:

(i) An old coarse rejects pile from a crushing operation which had been set up to generate drain material for the existing dam construction.

(ii) Excess rock which had been stockpiled at the Intermediate Dam for spillway construction. The rock was sorted by backhoe during truck loading.

It is also noted that excess Class IV riprap had been placed on the canal slopes during the initial placement between approximately 0+100 and 0+600. This material was pulled up the slope and placed as riprap.

4.1.12 Class V Riprap

Class V riprap was required for weir construction and outfall channel lining as shown on Figure III-25 and III-26 of Appendix III. Most of this Class V was obtained by drilling and blasting in the quarry. Supplementary sources included the boulders which had been encountered during common excavation and the sorted rock excavation waste.

A rock rake blade with teeth spaced at 0.4 m was used to separate the acceptable Class V size material (D_{50} approximately 0.8 m) from the finer fractions. This method proved to be generally successful but it was extremely slow. Additional sorting was provided by the loader operator as he loaded the 35 ton rock trucks.

Figure 4-25 provides example gradations of Class V. Also shown is a gradation of a quarry run material before raking. This material was generated using a blast pattern of about 4.3 by 4.9 m.

Placement of Class V material in the outfall is illustrated on Figures III-25 and III-26 in Appendix III. Placement of the materials in areas of high backslope was achieved by using a front end loader. Where the rock trucks could gain direct access they dumped directly over the advancing face; only minor repositioning was required by a dozer in such cases.

Generally the Contractor completed one side of the canal first and then completed the other side simultaneously with the placement of the weirs on the bottom. Concern about subsurface flow in the Class V rock prompted the design modification shown in profile on Figure 4-23. This modification proved to be of practical benefit also in that this finer, more trafficable rock served as a ramp from which the weir could be placed using a dozer. It is emphasized that the profile shown in Figure 4-23 is somewhat schematic in that the actual completed surface of the Class V rock is highly irregular (see Figure III-26, Appendix III).

4.1.13 Fish Gravel

"Fish Gravel" is a term which refers to sand and gravel which was deposited between the weirs of the outfall to fill the voids of the Class V erosion control rock with the intent that the creek flow would be generally over the top of the rock rather than through the voids below grade. The material was generally a minus 100 mm sand and gravel from the southwestern corner of Borrow Area "A". Highway trucks and a front end loader were used to haul the material. Placement was achieved by spreading the gravel between the weirs with a D6 or D8 Cat dozer; a backhoe was also used as shown on Figure III-26, Appendix III but this method was not practical.

A total of about 12,900 cu.m. of "Fish Gravel" was distributed amongst the weirs.

4.1.14 Completed Canal

A plan summary of the completed canal is presented on Figures 4-1 to 4-6. These plans are available at a scale of 1:500. Selected cross-sections in order of increasing chainage are presented on Figures 4-7 to 4-22. Creek interception details for Cornish Creek and Goodall Creek are shown on Figures 4-21 and 4-12 respectively. These cross-sections show the final surveyed section of the canal and the theoretical design elements which constitute the construction.

Final elevations along the canal alignment may be determined as follows:

Pilot channel invert at Sta. 0+100 : 1085.8

Inlet to Sta. 2+824.776 (Weir No.0)

Pilot channel, invert (where it exists) at any other station = 1085.8 - (0.0019)(station distance) e.g. at Sta. 0+900

pilot channel invert is at 1085.99 - (0.0019)(900) = 1084.28.
The design of the hydraulic section at Sta. 0+900 is
1084.28 + 4.0 = 1088.28

From Weir No.0 to Weir No.47

Grades are based on 5 percent subexcavation and centreline distance.
At Weir No.0 subexcavation elevation is 1078.64
At Weir No. 32 subexcavation elevation is 1078.64 - (0.05)(32)(12) = 1059.44. (Weirs are at 12 m spacing)
The design top of the hydraulic section at Weir No.32 is 1059.44 + 5.5 = 1064.94
The design top elevation of Weir No. 32 is 1059.44 + 3.06 = 1062.5

From Weir No.47 (Sta.3+414.659) to Weir No.48 (Sta.3+663.731)

Invert grade = 1052.4 = .0019 (Chainage = 3+414.659)
Top of hydraulic section = Invert grade + 3.4

From Weir No. 48 to Weir No. 60

Grades are based on 5 percent excavation and centreline distance.
At Weir No. 48 subexcavation elevation is 1049.846
At Weir No. 60 subexcavation elevation is 1049.846 - (12)(12)(.05) = 1042.646.
The design top of the hydraulic section at weir no. 60 is 1042.646 + 5.5 =1048.146.
The design top elevation of Weir No. 60 is 1042.646 +3.06 = 1045.706.
Tailwater invert = 1045.706 - 1.1 = 1044.6 (Actual observed tailwater elev. 1044.33; this explains the need for Weir 61).

A summary of surveyed canal grades is provided on Table 4-5.

4.2 Diversion Dam

The Diversion Dam (see Figure 4-1) was constructed in April/May, 1981, simultaneous with the completion of the dyke area.

Figure 4-7 shows a cross-section of the Diversion Dam in the vicinity of the abandoned Rose Creek diversion channel. The various stages of construction in this area are shown photographically on Figures III-28, III-29, III-30 and III-31 in Appendix III.

The construction of the bypass ditch in this area (see Figure 4-1) in November 1980 enabled foundation preparation in the old channel bed area to be made in relatively dry conditions. However, some ice was present and the old channel weirs had to be drilled and blasted to be removed. The initial element of filling was to place a 1 m thick Class II seepage liner blanket over the dam foundation area. This could only be achieved by first placing a thin fine waste rock pad in a locally wet area; seepage through this rockfill was reduced by constructing a key trench through the rockfill after seepage liner placement was underway (see Figure 4-7).

A Class II seepage control liner blanket (from Borrow Area "I") was placed against the wedge of sand and gravel which divided the old diversion channel and the bypass ditch in order to reduce seepage into the bypass ditch area when the Diversion Dam was being completed. It also provided access to the area upstream of the Diversion Dam for construction of a temporary diversion structure. The continuous lining of the rib also simplified the completion of the central core across the bypass ditch because precise location of the seepage control liner was unnecessary.

The temporary diversion structure was constructed across the bypass ditch upsteam and outside the foundation area of the final diversion dam. It was constructed from coarse waste rock initially and then blan-

keted upstream with alluvium to reduce leakage through the structure (see Figure III-29, Appendix III).

The Diversion Dam was completed across the bypass ditch shortly after diversion was made. The sand and gravel rib between the bypass ditch and the old diversion channel was excavated locally and the seepage control liner previously placed against the rib was exposed. A shallow key trench was cut across the bypass ditch channel and into the existing dam structure which forms the North abutment of the Diversion Dam; seepage was encountered in the trench which extended into the existing tailings dam. The trench and adjacent area in the bottom of the bypass ditch was backfilled with Class II seepage control liner material. The 4 m wide core of the Diversion Dam was then staked and placed to final hydraulic grade (El. 1090) simultaneously with the completion of the adjacent seepage control liner in the canal dyke. Shells of Class I material were placed either side of the core and these zones were raised simultaneously. The area between the temporary and final diversion dams was completely filled up to the bench level which is normally apparent upstream of the main dam. A berm was placed beyond the actual downstream toe of the dam to ensure that the seepage control liner placed in the bottom of the old (abandoned) diversion channel would be adequately filtered (see Figure 4-7).

After the dyke hydraulic grade had been achieved in this area the top of the Diversion Dam was ramped using Class I material to make access onto the existing tailings dam (which is at Elev. 1093).

Although compaction was difficult in the confined cutoff trench across the bypass ditch area all materials placed in the Diversion Dam were adequately compacted.

4.3 Cross Valley Dam

The Cross Valley Dam is located on Figure 2-2. The plan is shown on Figure 4-31. Cross-sections are presented on Figures 4-32, 4-33, 4-34 and 4-35. The centreline profile is shown on Figure 4-36. The various phases of its construction included:

(i) the excavation of the Drainage Ditch.
(ii) the stockpiling of sand and gravel till taken from the canal excavation (between Sta. 2+400 and 2+820) in the upstream blanket area (between Sta. 0+330 and 0+450 approx.).
(iii) the subexcavation of the dam foundation area.
(iv) the filling of the dam.
(v) the completion of the upsteam blanket.
(vi) the construction of the spillway and decant.

4.3.1 Survey Control

A control reference line was set up during construction. It was located parallel to and 90 m downstream of the dam centreline. This reference line consisted of a series of iron bars at 30 m intervals from which the dam cross-sections could be taken.

4.3.2 Drainage Ditch Excavation

The purpose of the Drainage Ditch was to dewater the foundations of the Cross Valley and Intermediate Dams. Therefore this work had to precede the subexcavation of the dams.

The Drainage Ditch was designed to lower the water level by about 3 m at the location of the Cross Valley Dam. The ditch excavation was not fully achieved as designed; the effective drainage lowering was approximately 2.4 m. The Contractor was therefore held responsible for any additional dewatering which was required to achieve subexcavation to the design level.

4.3.3 Stockpiling of Upstream Blanket Till

Good quality (Class II) sand and gravel till was hauled from between Sta. 2+400 and 2+820 of the canal excavation in November 1980. This material was usually in an unfrozen condition when excavated. It was deposited in the upstream blanket area between Sta. 0+300 and 0+450 at the Cross Valley Dam. Although this area had been crudely stripped prior to placement of the blanket stockpile, the ground in the vicinity of Sta. 0+330 was very soft and could not be stripped. Some ice was also present in this area because the Drainage Ditch was not operational prior to freeze-up. However, much of the soft material and ice was displaced by the advancing fill and it was periodically removed using a backhoe. The cutoff trench in the upstream blanket area (described subsequently) revealed some buried ice in this area.

4.3.4 Foundation Subexcavation

Initial foundation subexcavation of the Cross Valley Dam was undertaken in January and February, 1981. Photographs of the work in progress are shown on Figure III-46, Appendix III.

The depth of subexcavation normally ranged between 1 and 1.5 m. The material generally consisted of fine organic sands and recent alluvium. In the vicinity of the abandoned creek and the Drainage Ditch the subexcavation exposed a firm stratum of coarse sand and gravel (sometimes containing up to 10 percent passing the No. 200 sieve). North of Sta. 0+360 to about Sta. 0+180 a fine grained sandy silt was encountered. This material typically had a moisture content of about 20 percent. The area north of Sta. 0+180 was relatively granular.

At the south abutment the upstream blanket area and the abutment of the dam were simultaneously stripped. This procedure exposed a relatively dry till which appeared to be discontinuously frozen but thaw stable and therefore no temporarily protective thermal liner was installed over this abutment.

The north abutment area stripping exposed a sand and gravel material which was of no concern with respect to stability.

Additional subexcavation work was performed at the south abutment at the time of fill construction in July (1981). This work was associated with removal of the haul road which traversed the south abutment area up to the canal. Much of the work had to be done using a backhole due to the wet nature of the area (some frozen ground, some seepage).

During the filling of the dam the common practice which was adopted was to excavate a 2 to 3 m depth trench below the subexcavation grade along the centreline of the dam to permit the keying of the central dam core into the natural ground (see Figure III-47, Appendix III). At the abutment this was practically achieved in steps by using a backhoe or a front end loader and dozer. Where permafrost was encountered (e.g. at the south abutment) the permafrost was cleaned and exposed such as to permit the flaring of core at the abutment.

4.3.5 Dam Construction

Dam filling was initiated at the end of May 1981. Photographs describing the construction progress are presented on Figures III-47 to III-53 in Appendix III. The dam was first filled in the area north of the Drainage Ditch.

The first step of construction related to the excavation and backfilling of the core cutoff trench. This work was performed in segments to decrease required pumping capacity. Furthermore, this allowed the Contractor to continue working in areas where the trench excavation and backfill were not in progress. The trench backfilling was achieved by ramping into the trench with a dozer which placed the fill in lifts for compaction (See Figure III-47, Appendix III). In this way the trench was backfilled to the subexcavation grade; the fill zones were then staked and construction could begin.

In the silt subgrade area between Sta. 0+180 and 0+360 a sand and gravel pad was required preparatory to any filling or core cutoff trench work. This pad ranged in thickness from about 0.6 to 0.8 m and was extended into the upstream blanket area. All mud and silt displaced at the advancing pad face was removed using a backhoe. Once the pad was in place the core cutoff trench was excavated and backfilled and the normal zoned construction was commenced.

Class VII till was placed in the upstream area over the subexcavation or over the sand and gravel as discussed above (See cross-section shown on Figure 4-32, 4-33 and 4-34 which cover the area north of the Drainage Ditch). The Class VII material was used to bring the upstream blanket subgrade generally to elevation 1048.5 in the area north of the Drainage Ditch. According to design the top of the upstream blanket was thus assigned to be elevation 1050 except immediately adjacent to the core where a 4 m width of blanket was thickened by 1 m (i.e. top of blanket elevation 1051).

The initial upstream blanket was placed from the dam core upstream to beyond the upstream toe of the dam (approximately to a 45 m offset) using Class VI material from Borrow Area "F". This meant that an extension of the upstream blanket protruded from the toe of the dam (in the area north of the Drainage Ditch); this protrusion proved invaluable as an access to the toe of the dam and as a tangible element of the blanket to which further blanket construction could be attached. The top elevation of this initial blanket protrusion was 1051 m to ensure extra thickness of this transition between primary and secondary upstream blanket.

During placement of the upstream blanket construction of the downstream Class X drainage blanket was also in progress. The top of the Class X zone was assigned to be at elevation 1050 except at the dam face where bony, clean Class VIII was placed to protect the downstream face of the dam against erosion.

Above Elevation 1050 clean Class VIII material of good quality (normally less than 5 percent passing the No. 200 sieve) was used for the downstream shell of the dam.

When the upstream blanket was completed, the upstream toe of the dam was staked and the embankment configuration began to take shape. A 1 m thickness of Class IX silty sand was placed over the upstream blanket area. The central core and adjacent filters were then staked and routine zoned fill placement was initiated.

Most of the dam north of the Drainage Ditch had been completed by August (1981). The pipeline had been installed across the dam as shown in plan on Figure 4-31 in preparation for pumping from the drainage ditch as required to achieve closure. Before making closure the Contractor placed fill to an elevation of about 1054 on the south side of the Drainage Ditch by installing an access culvert across the Drainage Ditch at about the centreline. The procedure followed in this south side area was basically similar to that described for the east side of the Drainage Ditch except that the entire secondary upstream blanket was placed simultaneously with the primary blanket. (See Figure III-50 in Appendix III).

4.3.6 Pumping from Drainage Ditch and Closure

To effect closure of the dam at the Drainage Ditch it was necessary to stop water from entering the area. The construction of the Intermediate Dam eliminated most of the flow in the Drainage Ditch downstream of the Intermediate Dam. However a flow of about 0.83 cu.m per sec (1000 I.g.p.m.) was still observed at the Cross Valley Dam as a consequence of seepage collection between the Cross Valley and Intermediate Dams. Therefore an additional pump was established in conjunction with a small

cofferdam at the upstream limit of the upstream blanket. This pump was required to operate continuously after closure was made to prevent flooding of the upstream blanket areas which had not been completed at this time (generally north of the haul access ramp at Sta. 0+43). This need for pumping and the fact of the 200 mm discharge pipeline at the south abutment resulted in the progressive filling of the dam from the Drainage Ditch to the south abutment with the south abutment area being maintained at elevation 1054 until the dam was nearly complete.

Closure of the Drainage Ditch was achieved in the area upstream of the core cutoff trench by cleaning the sludge from the ditch and then shaving its walls and compacting the material resulting from this operation in the bottom of the ditch. In the area downstream of the core cutoff trench, the ditch was backfilled with compacted Class X coarse sand.

The various zones within the dam were exposed on both sides of the closure section and constructed continuous across the closure area.

4.3.7 Secondary Upstream Blanket Completion

The secondary upstream blanket was not specified to full detail in the Contract Documents. Although it was originally intended that most of the material would be obtained from the canal waste excavation to conserve till in the Borrow Areas, canal excavation was insufficiently routine to achieve this and it was concluded that the material should be taken from the till borrow areas. The Contract required reworking and compaction of the material which had been placed in the winter (0+330 to 0+450).

The Engineer assigned priorities to the various segments of the upstream blanket based on a review of site soil conditions and on the results of a drilling program which was conducted in August, 1981 (the borehole logs are contained in Appendix IV; locations are shown on Figure 3-3). The conclusions of this review were:

(i) that a good quality 1.5 m thick secondary upstream blanket should be installed between Sta. 0+450 and 0+630 in the vicinity of the abandoned creek bed and in the vicinity of Borrow Area 'C';

(ii) that the winter placement made between Sta. 0+450 and 0+330 be reworked and joined to the initially placed blanket;

(iii) that a cutoff trench keyed into original ground should be constructed between Sta. 0+330 and 0+180;

(iv) that a good quality 1.5 m thick secondary upstream blanket should be constructed north of Sta. 0+180;

(v) that the blankets should be extended up the abutments to key into continuous relatively impermeable material.

As mentioned previously the blanket south of the Drainage Ditch (Sta. 0+570 to 0+630) was completed simultaneously with the primary blanket using Class IV material from Borrow Area 'F'. In the vicinity of Borrow Area 'C' the blanket was installed after this area had been subexcavated such that an upstream blanket could be constructed which was comparable in elevation to the adjacent blanket construction (top of blanket, elevation 1050.8) (refer to Figure III-50 in Appendix III). This blanket segment was constructed using a mixture of Class VI and Class VII materials (Class VII was required to have a minimum of 15 percent passing the No. 200 sieve in this case) and it was connected to the initial portion of the blanket previously constructed in this area. When closure was acheived the segments north and south of the Drainage Ditch were joined using good quality Class VI material in the primary blanket area and a mixture of Class VI and Class VIII materials in the remaining blanket area. In general, the blanket area between Sta. 0+450 and 0+630 was compacted to the same standards used for the main dam.

In the area between Sta. 0+450 and 0+330 (See Figure 4-31), the notch between the initially placed blanket and the winter placed blanket (which had resulted from excavation of the winter placed material to

allow installation of the initially placed blanket) was backfilled with compacted till shaved from the surface of the adjacent winter stockpile. The surface of the winter stockpile was then compacted using a heavy vibratory compactor (Dynapac CA51B) and then used as a route for construction traffic. The ramp onto the dam between 0+420 and 0+450 was constructed of silty sand and sandy silt from Borrow Area "C". Compacted silty sand berms were placed adjacent to this ramp to ensure that the blanket areas adjacent to the ram were continuously tied. This silty sand berm (approx. 1 m thick) on the north side of the ramp was continued for a 20 m width along the toe of the dam to Sta. 0+360 as added protection against settlements which are expected in this area as a result of permafrost thaw.

The blanket cutoff trench between Sta. 0+330 and 0+180 was constructed at the toe of the initially placed blanket between Sta. 0+330 and 0+210 and continued from there to the upstream blanket limit at Sta. 0+180 (See Figure 4-31, 4-32 and in Appendix III Figure No. III-51).

Between Sta. 0+330 and 0+210 the trench was keyed into dark grey to black organic silts, silts and silty sands which also included layers of coarse grey sand. From Sta. 0+210 to 0+180 the natural materials became progressively coarser confirming the need for full blanket construction in this area. The trench was backfilled with compacted Class VI material, most of which was taken from the Borrow Area "F" extension (some of the waste excavation and adjacent blanket material was also used).

The upstream blanket area between 0+330 and 0+180 and upstream of the cutoff trench was backfilled with stockpiled till from the winter haul and with material from a natural silty gravel ridge which extended into the blanket area at about Sta. 0+150. The silty gravel typically contained about 10 percent passing the No. 200 sieve and it was dozed into place in thin lifts. The area was subsequently trafficked with tracked construction equipment.

North of the cutoff trench a continuous blanket of a mixture of Class VI and Class VII material was placed to and up the north abutment to about elevation 1065.

The blanket was also continued up the south abutment using scraper placement of Class VI material. The blanket was placed to about elevation 1064 to a 30 m offset from centreline and then ramped down to the limit of the blanket at the 90 m offset. The natural abutment materials in this area typically contained 12 percent passing the No. 200 sieve.

4.3.8 Borrow Materials

A summary of test results for the various material classes is provided on Tables 4-6, 4-7, 4-8, 4-9 and 4-10. It should be noted that these test results are not necessarily typical of the fills placed; rather they often represent materials which were marginal and testing was performed to confirm visual judgements.

Material gradations were generally very good. Class VI till from Borrow Area "F" sometimes contained schisty pockets as a result of the shallow schist bedrock in this area. The Engineer rejected such material as Class VI core but allowed its use as Class VII in the upstream shell of the dam. Variable sandy silt or silty sand from Borrow Area "C" and silty gravel from Borrow Area "G" was also used as Class VII material above elevation 1054. Class VIII material from Borrow Areas "G", "C" and "B" was used as downstream shell material; these materials tended to contain less than 10 percent passing the No. 200 sieve and should provide excellent backup for the downstream drainage system. Class IX silty sand or sandy silt was obtained from Borrow Area "C". Class X fine gravelly sand was obtained from Borrow Areas "A", "B" and "C" but consistency of this material was sometimes a problem due to the presence of silt pockets and stringers in the pits.

Towards the end of construction no suitable coarse cobbly gravels could be found in the operating borrow pits to provide an armouring of the upstream face of the dam in the vicinity of operating water level. As a consequence supplementary rip rap was placed on the dam face to alleviate this concern (See Figure 4-31).

4.3.9 Spillway Construction

The spillway and decant channel were constructed according to the profile and cross-sections shown on Figures 4-37, 4-38 and 4-39 except that the decant channel was shifted into the spillway area downstream of the spillway apron (See plan shown on Figure 4-31).

Photographs of the construction are provided on Figures III-53 of Appendix III. Class IV and Class V rip rap for this construction generally originated from the canal rock excavation in the vicinity of Sta. 0+600 or from the old 1974 quarry.
In the horizontal portion of the spillway, the zones of the dam were terminated at elevation 1063.2 and were capped with 0.3 m of coarse cobbly gravel from Borrow Area "G". At the decant the zoning was stopped at elevation 1062.9 and capped with 0.3 m Class IV material (filter rock).

4.3.10 Dam Compaction

Compaction generally exceeded the requirement of the Contract although some short term difficulties developed due to equipment breakdowns. A summary of the compaction recorded by the Engineer for the various classes of material is as follows:

	Number of Tests	Average Degree of Compaction %	Average Moisture Content
Class VI	305	98	8.4
Class VII	220	100	7.1
Class VIII*	156	103	5.2
Class IX	98	103	6.2
Class X*	185	102	5.2

* Materials generally wetted by watering equipment.

4.3.11 Dam Completion

Although state of construction would have permitted pumping to stop at the end of August, due to the requirement that pumping be continued beyond that which was necessary for construction the fill construction was completed adjacent to the pipeline crossing of the dam (See Figures 4-31 and 2-2) and was left low at the crossing. When it became evident that pumping would be required for an indefinite period it was decided to remove the pipeline temporarily, complete the dam to final grade, replace the pipeline over the completed dam and then resume pumping. The filling of this area was difficult and awkward since the various zones had to be continued to their final elevation within a very small working area.

4.4 Intermediate Dam

The Intermediate Dam is located as shown on Figure 2-2. The plan is shown on Figure 4-26. Cross sections are presented on Figures 4-27, 4-28 and 4-29. The centreline profile is shown on Figure 4-30.

Important phases of the construction were as follows:

(i) the excavation of the Drainage Ditch;

(ii) the subexcavation of the dam foundation area in the vicinity of the creek and the excavation of the upstream face of the dam in the terrace area;

(iii) the installation of foundation drains south of the Drainage Ditch;

(iv) the filling of the dam

(v) the construction of the spillway and decant.

The construction that has been completed in accordance with the plan provides for the future raising of the dam because a foundation area has been constructed to above the retention pond elevation downstream of the dam.

4.4.1 Survey Control

Because construction equipment was active upsteam and downstream of the dam it was impossible to maintain a reference line. Instead, reference points were established on each of the abutments and at selected points in the terrace area of the dam. These points were used to lay out and station the centreline of the dam when cross section information was required.

4.4.2 Drainage Ditch Excavation

The Drainage Ditch became fully operational at the end of February, 1981. The success of the Drainage Ditch in lowering the areal water level at the Intermediate Dam is dramatically documented on Figure III-34 of Appendix III.

The Drainage Ditch was designed to lower the water level at the Intermediate Dam by about 3.5 m. However, as for the Cross Valley Dam, this was not fully achieved due to incompleted excavation. The effective lowering was approximately 3.0 m.

The excavation for the Drainage Ditch revealed a permafrost silt layer (natural moisture content 34%) just upstream of the Intermediate Dam at a depth of about 3 m. This silt layer was extremely susceptible to erosion (the 3 percent grade in this area being the major cause) and the

banks of the ditch became undercut. A minor amount of undercutting of the banks also occurred in the dam area (where the ditch grade was shallower). The banks of the Drainage Ditch were therefore cut back with a backhoe as part of the foundation subexcavation work.

4.4.3 Foundation Subexcavation

The bulk of subexcavation for the Intermediate Dam in the old Rose Creek area was undertaken in February and March (1981) (See Figure III-34, Appendix III). Typically the subexcavation was between 1 to 1.5 m except at the south abutment where a vertical depth of at least 5 m of permafrost was removed. Several organic layers were encountered in the subexcavation at the south abutment and it was considered prudent to subexcavate this material. In fact the excavation encountered some bedrock downstream of the centreline (See Figure III-43, Appendix III).

Due to anticipated thaw instability at the south abutment, a thermal liner was placed over the abutment face. This thermal liner was subsequently worked into the shell zones during the filling of the dam.

The silt stratum which had been encountered in the Drainage Ditch was encountered in the core cutoff trench north of the ditch and it extended to approximately the edge of the terrace (See Figures III-35 and III-36, Appendix III). The silt typically had a moisture content between 20 and 30 percent and it became quite spongy when disturbed; fortunately a sand and gravel layer naturally blanketed the silt.

The borehole logs obtained during the 1979 exploration drilling in the Intermediate Dam area suggest that the silt stratum is up to 10 m thick and that it gradually disappears downstream of the dam centreline. It was also found that there was a dip in the surface of the stratum at about the location of the Drainage Ditch (possibly an old erosion surface). At the south abutment, the silt transitioned to a silt till.

The core cutoff trench construction proceeded in a manner similar to that of the Cross Valley Dam although two basically different zone configurations were utilized at the Intermediate Dam. The first was used in the terrace area of the dam (See Figures 4-27 and 4-28) where an upstream facing of till was used to reduce seepage through and beneath the dam. Figure 4-29 shows the zone configuration constructed in the vicinity of Rose Creek. Figure 4-26 shows the location of the core cutoff trench in the transition interval between the two typical cross-sections. This transition is also shown photographically on Figure III-36 and III-37, Appendix III.

The cutoff trench in the terrace area was excavated to approximately the local water table. The materials encountered at the base of the trench included fine silty sand (at the southern limit of the terrace), relatively clean sand (in the middle), and silty gravel at the north abutment.

4.4.4 Dam Construction

Filling of the Intermediate Dam was started in May after the Diversion of Rose Creek had been made.

As for the Cross Valley Dam, filling of the area north of the Drainage Ditch was first completed (to an elevation of about 1064) to minimize the amount of pumping which would be required while making closure. The Engineer insisted that the fill adjacent to the Drainage Ditch not be constructed steeper than 4 horizontal to 1 vertical so that closure would be more easily achieved and so the fills would be better mated.

Initially in May the filling between the Drainage Ditch and the terrace was completed to about elevation 1057. Very little additional fill was placed in June because work was then concentrating on Cross Valley Dam construction. This pause in the filling of the Intermediate Dam was timely because it permitted consolidation of the silt stratum in the foundation and it reduced the risk of possible embankment spreading.

In July the filling of the area north of the Drainage Ditch was resumed. The terrace area Class VI cut-off was extended up to the north abutment and the placement of Class VI on the exposed face of the terrace was undertaken. The exposed face of the terrace included some gravel pockets which appeared to be very permeable (See Figure III-38, Appendix III); these pockets were subexcavated and covered with sand before backfilling with Class VI material.

By the beginning of August the pumping system upstream of the Intermediate Dam was operating. The system included a Morris pump at the middle crossing pumping up to the canal at a rate of approx. 340 litres per sec. (4500 i.g.p.m.) and a Paco pump situated just upstream of the Intermediate Dam, which pumped across both the Intermediate and the Cross Valley Dam at a rate of about 326 litres per sec. (4300 i.g.p.m.). With this system in place, steps were taken to initiate closure of the Intermediate Dam. A cofferdam was first constructed across the Drainage Ditch to eliminate flow down the Drainage Ditch and then the Contractor began to work on the south side of the Drainage Ditch by installing a small culvert in the downstream toe area of the Intermediate Dam.

Before routine filling could begin in the area south of the Drainage Ditch it was necessary to install relief drains to permit free escape of the seepages which had developed at the south abutment area. The maximum flows which had been observed were 26 litres per sec. (340 i.g.p.m.) at the west (main) seep and 7.6 litres per sec. (100 i.g.p.m.) at the east seep. Cobble drains were designed as shown in Change Order No. 5, Appendix V, to carry these flows at the dam foundation level. Photographs of the drain installations are shown on Figure III-41 of Appendix III. The plan location is shown on Figure 4-26.

Class X material was placed over the foundation area downstream of the core cutoff trench to filter any possible new seepages which might de-

velop. It was found that the major zone of seepage shifted to the southwest corner of the dam toe area as filling progressed. This seepage was contained to reduce exit velocities by constructing a small berm which spanned from the toe of the dam to the subexcavation sideslope. The seepage continued to flow at about 23 litres per sec. (300 i.g.p.m.) but gradually decreased to only 2.3 litres per sec. (30 i.g.p.m.) by October 9, 1982.

After removing all loose debris and cobbles from the base of the Drainage Ditch, closure of the Intermediate Dam was achieved by shaving back the fill (beginning from the upstream side) which had been placed north of the Drainage Ditch (see Figure III-40, Appendix III.) and excavating the core cutoff trench across the Drainage Ditch to expose the core previously placed on the north side of the ditch. The area was then staked for the standard material zones and routine filling was initiated.

The thermal liner at the south abutment was undermined to expose the natural abutment material as the fill was raised. This meant that only a minor thickness of natural soil was unfrozen at the time of filling. Keying into the abutment with a core trench was not considered practical nor advisable. Instead, the core was flared for 4 m upstream and 4 m downstream to create an effective core width at the abutment of 12 m.

4.4.5 Construction Materials

Testing results for the various classes of materials are summarized on Tables 4-6, 4-7, 4-8, 4-9 and 4-10.

At the Intermediate Dam, Class VI materials were taken from Borrow Areas "E", "F" and the "F" extension. These materials were usually of good quality but sometimes were schisty due to bedrock shallowness in the borrow pits. Class VII upstream shell material was taken from schisty areas of Borrow Areas "E" and "F" initially; when the dam was above about Elev. 1054 Class VII was taken from the western and northeastern corners of Borrow Area "C", from the northern area of Borrow Area "B", and from silty areas of Borrow Area "A".

Class VIII materials were obtained from Borrow Areas "A", "B", "C" and "G". A minor amount of Class VIII material was also taken from Borrow Area "K". Class IX silty sand materials were taken from Borrow Area "A" and "C". Class X material was selected from Borrow Areas "A", "B" and "C".

4.4.6 Dam Compaction

Compaction generally met the requirements of the Contract although some short term difficulties resulted from equipment breakdowns. A summary of the compaction recorded by the Engineer for the various classes of material is as follows:

	Number of Tests	Average Degree of Compaction %	Average Moisture Content %
Class VI	110	97	7.8
Class VII	48	98	6.6
Class VIII*	347	101	6.2
Class IX	26	102	7.6
Class X*	45	103	4.3

* Materials generally wetted by grade spraying.

4.4.7 Spillway Construction

The Intermediate Dam Spillway was constructed according to the profile shown on Figure 4-37. Design cross-sections on the dam centreline and in the 5 percent spillway area are provided on Figures 4-38 and 4-39 respectively. The location of the decant/spillway system is shown on Figure 4-26.

Class IV and Class V rock from the stockpiles in the Intermediate Dam area were used to construct the spillway and decant. It was originally obtained from the canal rock excavation in the vicinity of Sta. 0+600.

At the intersection of the dam and spillway centrelines the top of the core was brought to Elev. 1066.2. The area was then blanketed with 0.3 m of Class IV filter rock. In the decant area the zones were stopped at Elev. 1065.9 and 0.3 m of Class IV filter rock was placed above this elevation as nominal protection against erosion.

4.4.8 Dam Completion

As for the Cross Valley Dam, the Intermediate Dam could not be completed in the vicinity of the pipeline crossing until the pipeline was removed. Pumping was therefore halted for about 2 days during which the pipeline was removed, the locally low area backfilled to grade in accordance with zoning requirements, and the pipeline was replaced and pumping was resumed.

4.5 North Valley Wall Inperceptor Ditch

The North Valley Wall Interceptor Ditch is composed of three segments referred to as the mine leg, the Borrow Area "F" leg, and the Cross Valley Dam north abutment leg as shown on Figure 2-2. Each of these segments are joined by natural creek beds.

4.5.1 Mine Leg

Figure 2-2 shows the various parts of the ditch where bedrock was encountered during the excavation. The balance of the materials encountered ranged from silty sand and gravel till to coarse sand and gravel alluvium.

The channel was excavated primarily using dozers and scrapers in March, 1981. Some drilling and blasting was also required to maintain the channel grades.

The ditch was constructed to contain the 50 year design flood of 8.9 cu. m. per sec. as recommended by Hydrocon Engineering Ltd. in their May 8, 1980 report. This flow was designed to be contained within the stripped natural ground (assuming a stripping depth of 1 m) at a freeboard of 0.5 m. With the exception of a relatively steep grade of 2.5 percent at the inlet (where the bottom is completely in rock) the design grades are less than 1.25 percent.

This segment of the ditch has not yet been commissioned because it is pending regulatory approval of the Down Valley Project. (See Figure III-56, Appendix III for photograph.)

4.5.2 Borrow Area "F" Segment

Figure 2-2 shows the general location of this ditch segment. In this area the ditch is formed by a constructed dyke and the prepared, excavated surface of Borrow Area "F".

This element of the interceptor ditch was completed in early October after all construction activity had ceased in Borrow Area "F". Because poor quality bedrock was exposed in Borrow Area "F" a fill blanket 0.3 m thick was placed over the general alignment area in advance of constructing the dyke. The dyke was constructed of compacted Class VI/Class VII material from Borrow Areas "F" and "M". (See Figure III-57 in Appendix III.)

The average grade of the channel formed by the dyke and the blanketed slope is about 1.5 percent. The channel is capable of carrying in excess of 12.4 cu. m. per second with a freeboard of 0.5 m with respect to the top of the dyke.

Riprap was placed on the dyke face and across the bottom at the outlet of this segment of ditch; the right bank was cut into bedrock. This additional work was performed to prevent undermining of the dyke resulting from the acceleration of the flow velocity as it passes over the steep rock cliff. (See Figure III-58, Appendix III.)

This segment of the Interceptor ditch should be inspected for erosion periodically since the grade is relatively steep. If a problem develops use of riprapping is recommended.

4.5.3 North Abutment Cross Valley Dam

should be designed for 17.7 m³/s.

Figure 2-2 shows the general location of this ditch segment. The ditch was constructed by excavating into the north abutment of the Cross Valley Dam. A typical cross-section is shown on Figure 4-38.

The excavation was initially staked to allow for the installation of a thermal liner because it was known that permafrost was present in this area. Although the Contract specified that the construction of this cut would be performed during freezing conditions, the Contractor chose to perform the work in July. Fortunately the permafrost which was encountered was not ice rich and only very minor sloughing occurred. The thermal liner was therefore only required to the top of the hydraulic section as shown on Figure 4-38 (1.8 m above invert grade).

When the subexcavation for the thermal liner was complete a considerable amount of seepage (7.6 litres per sec/100 i.g.p.m) entered the excavation at its upstream end. It was noted that all of this flow seeped into the bottom of the subexcavation before it could reach the centreline of the Cross Valley Dam. It was therefore decided to install a seepage blanket across the base of the excavation as is shown on Figure 4-38.

Class IV riprap was used in this dare because the channel grade varies between 4.5 and 5 percent. (See Figure III-59, Appendix III.)

4.6 Access Road

The location of the Access Road is shown on Figure 2-2. The road traverses the north valley wall from the chemical storage area just above the existing dam decant to the north abutment of the Intermediate Dam. The road is approximately 10 m wide and it drops at a constant grade of 0.8 percent from the chemical storage area to the Intermediate Dam. It is intended as a route for the tailings pipeline as well as for use by maintenance traffic.

The western half of the Access Road is constructed primarily from valley bottom Class I fill because permafrost occurs in this area. In the eastern area considerable cut/fill construction was possible because very little permafrost was present there although the area adjacent to

TABLE 4-1

CORRELATION BETWEEN CANAL 'REFERENCE LINE' USED DURING CONSTRUCTION AND 'BASELINE CHAINAGES' REFERRED TO IN TENDER DOCUMENTS AND FINAL DESIGN REPORT

Reference L.	Baseline	Reference L.	Baseline	Reference L.	Baseline	Old CentreLine
0+000	---	1+290	1+180	2+580	2+468	
+030	---	+320	+217	+610	+498	
+060	---	+350	+247	+640	+528	
+090	---	+380	+277	+670	+558	
+120	0+020	+410	+307	+700	+588	
+150	+050	+440	+337	+730	+618	
+180	+080	+470	+367	+760	+647	
+210	+110	+500	+397	+790	+677	
+240	+140	+530	+427	+820	+702	2+700
+270	+170	+560	+457	+850	+732	+730
+300	+200	+590	+487	+880	+763	+761
+330	+230	+620	+517	+910	+793	+791
+360	+260	+650	+547	+940	+824	+822
+390		+680	+577	+970	+854	+852
+420	+310	+710	+607	3+000	+884	+892
+450	+340	+740	+637	+030	+914	+916
+480	+370	+770	+667	+060	+944	+944
+510	+400	+800		+090	+974	+975
+540	+430	+830	+720	+120	3+004	3+005
+570	+460	+860	+750	+150	034	+035
+600	+490	+890	+780	+180	064	+066
+630	+520	+920	+810	+210	094	+100
+660	+550	+950	+840	+240		+050
+690	+580	+980	+870	+270	Note: After	+090
+720	+610	2+010	+900	+300	Ref: Line Sta.	+118
+750	+640	+040	+930	+330	3+216.79 the	+147
+780	+670	+070	+960	+360	Ref. Line	+175
+810	+700	+100	+990	+390	diverges	+228
+840	+730	+130	2+020	+420	sharply from	+258
+870	+760	+160	+050	+450	"Canal Base-	+228
+900	+794	+190	+080	+480	line" as per	+318
+930	+824	+220	+110	+510	Contract	+348
+960	+854	+250	+140	+540	Documents	+378
+990	+884	+280	+170	+570		+408
1+020	+908	+310	+198	+600		+438
+050	+938	+340	+228	+630		+468
+080	+968	+370	+258	+660		+498
+110	+998	+400	+288	+690		+528
+140	1+028	+430	+318	+720		+558
+170	+058	+460	+348	+750		+588
+200	+090	+490	+378	+780		+618
+230	+120	+520	+408	3+810		+648
+260	+150	+550	+438			

TABLE 4-2

COMMON EXCAVATION TEST RESULTS

Station (m)	% Moisture	Sieve Analysis % Passing 4.75 mm	Sieve Analysis % Passing 75 um	Seepage Detected	Remarks (all materials generally a sand and gravel till)
0+100	7.2	67	15		Canal bottom, inlet area.
0+120	5.3	57	14		Hinge elevation.
0+250	6.1	54	14		
0+330		Schisty Till		X	
0+350	8.4	43	10		2.85 m above grade.
0+360	(12.4	32	7		1.5 m above grade.
0+360	(9.0	47	14		Dyke side of excavation.
0+370	10.4	61	16		Pilot channel, 1.0 m above grade.
0+430	18.8	36	8		1.0 m above grade.
0+450		Schist			
0+480	4.3	43	6	X	1.6 m above grade.
0+660				X	
0+690				X	
0+710				X	
0+840				X	
0+960	10.6	48	15		Downslope cut near grade.
0+990				X	
1+000	12.8	52	15		1.5 m below lower cut bank.
1+010	29.4*	49	17		Main channel at grade (*snow).
1+020	14.2	50	14		Main channel at grade.
1+580	76.3	Clay till with organics			0.6 m below stripping limit.
1+600	18.1	56	16		
1+870	17.4	75	38		2.0 m above grade.
1+930	11.9	75	32		At hinge level.
2+010	13.6			X	1.0 m below hinge.
2+050	14.8	73	38		2.5 m below hinge.
2+040	15.3	68	33		From stockpile 10 m N of dyke toe.
2+070	(17.8				1.0 m below hinge (upper).
2+070	(12.9	70	34		1.0 m below hinge.
2+100	15.1				1.0 m below top hinge.
2+120	18.0	73	38		1.0 m below hinge.
2+148	14.3	70	38		Near to grade.
2+150	14.5	72	33		At grade.
2+220				X	
2+500	13.5	64	18		
2+670				X	
2+680	(14.2	49	15		Top of downside cut.
2+680	(12.7	60	28		Bottom of downside cut.
2+700				X	
2+710	12.5	81	35		Downslope face.
2+730	9.3	75	20		1.0 m above grade.
2+900				X	
2+990				X	

TABLE 4-3 MATERIAL TESTING (FIELD)
CLASS I THERMAL LINER AND CANAL DYKE

Date	Remarks	W%	Sieve Analysis			Proctor Test	
			Max. Size (mm)	% Passing 4.75mm	% Passing 0.075mm	Optimum M/C %	Max. kg/m^3
Jan.22/81	B/A "D" - Canal 3+690	5.9	-	-	-	-	-
Jan.23/81	B/A "D" - Canal 3+710	4.7	150	34	3	(8.0)	(2165)
						(7.3)	(2185)
Jan.24/81	B/A "A" - Canal 2+400 to 2+600	4.7	150	40	2	(8.8)	(2070)
						(11.1)	(2061)
Jan.28/81	B/A "A" - Canal 1+700 to 1+900	3.1	19	93	2	(8.4)	(1736)
Feb.09/81	B/A "A" - Canal 2+100	3.9	150	50	2	(9.2)	(2138)
						(8.8)	(2113)
Feb.10/81	B/A "A" - Canal 2+130	5.3	37.5	88	5	-	-
Feb.16/81	B/A "A" - Canal 1+650 to 2+700	3.7	75	59	3	(9.2)	(2092)
Feb.18/81	B/A "A" - Canal 0+270	2.9	150	38	2	-	-
Mar.03/81	B/A "A" - Canal 0+360	5.1	75	60	5	-	-
Mar.03/81	B/A "A" - Canal 0+420 (Not typical)	15.0	150	41	6	-	-
Mar.17/81	B/A "A" - Canal 0+370	3.5	150	44	2	-	-
Mar.29/81	B/A "A" - Canal 0+330 & 1+400	3.4	37.5	83	4	-	-
Apr.15/81	B/A "B" - Canal 1+200 to 1+500	3.4	150	47	4	-	-
May 03/81	B/A "B" - Canal 0+080	2.5	75	41	2	-	-
May 24/81	B/A "B" - ID 0+600 (1052m)	-	150	67	6	9.0	2095
	Mean	4.8	100	56	3	8.9	2073
	Range	2.5-15	19-150	34-93	2-6	7.3-11.1	(1736-2185)

B/A = Borrow Area
ID = Intermediate Dam

0+100 = Chainage (m)
(1000.0m) = Elevation

TABLE 4-4 MATERIAL TESTING (FIELD)

CLASS II SEEPAGE CONTROL LINER

Date	Remarks		W%	Sieve Analysis			Proctor Test	
				Max. Size (mm)	% Passing 4.75mm	% Passing 0.075mm	Optimum M/C %	Max. kg/m^3
Mar.24/81	B/A "H" - Canal 1+500		8.8	50	79	41	-	-
Mar.24/81	B/A "H" - Canal 1+920		16.1	75	77	34	10.8	2005
Mar.25/81	B/A "H" - Canal 1+990		18.2	37.5	87	46	-	-
Mar.28/81	B/A "H" - Canal 2+070		9.1	75	67	28	6.6	2164
Apr.02/81	B/A "H" - Canal 2+100		9.8	75	60	24	7.0	2199
Apr.03/81	B/A "H" - Canal 2+040		9.1	75	65	30	7.5	2149
Apr.07/81	B/A "H" - Canal 3+200		17.2	37.5	87	41	10.0	2062
Apr.07/81	B/A "H" - Canal		7.6	37.5	77	30	-	-
Apr.07/81	B/A "H" - Canal		8.4	37.5	79	34	-	-
Apr.17/81	B/A "H" - Canal 2+250		6.1	-	-	-	-	-
Apr.17/81	B/A "H" - Canal 2+260		6.5	-	-	-	-	-
Apr.17/81	B/A "H" - Canal 2+250		6.6	75	77	28	-	-
Apr.18/81	B/A "H" - Canal		7.2	-	-	-	-	-
Apr.18/81	B/A "H" - Canal 2+460		9.6	37.5	83	41	-	-
Apr.21/81	B/A "I" - Canal		6.7	75	71	32	-	-
Apr.21/81	B/A "I" - Canal		8.6	37.5	82	42	-	-
Apr.23/81	B/A "I" - Canal 1+080		8.4	75	80	45	-	-
Apr.24/81	B/A "I" - Canal 0+930		9.1	75	76	37	8.3	2140
May 03/81	B/A "I" - Canal 0+080		9.4	37.5	83	36	-	-
		Mean	9.6	57	77	36	8.4	2120
		Range	6.1-18.2	37.5-75	60-87	24-45	6.6-10.8	2005-2199

B/A = Borrow Area

0+100 = Chainage (m)

TABLE 4-5

SURVEYED CANAL INVERT AND DYKE GRADES

Ref. Line Sta.(m)	Pilot Channel Invert Level (m)	Main Channel Invert Level (m)	Dyke Centreline Elevation (m)
0+008.79		1084.73	
@ 50° 20'00"			
0+045.29		1086.06	
@ 63° 33'20"			
0+065			1090.70
0+120			1090.67
0+150			1090.65
0+180			1090.64
0+210	1085.54	1086.13	1090.41
0+240	1085.41	1085.80	1090.26
0+270	1085.23	1085.95	1090.15
0+300	1085.15	1085.85	1090.01
0+330	1085.20	1086.00	1089.92
0+360	1085.23	1085.96	1089.83
0+390	1085.24	1085.80	
0+403			1089.87
0+420	1085.19	1085.92	
0+433			1089.93
0+450	1085.30	1085.80	
0+464			1089.98
0+480	1085.37	1085.94	
0+494	n		1089.93
0+510	o	1085.12	
0+524	p		1089.69
0+540	i	1084.73	
0+570	l	1085.00	
0+585	o		1089.68
0+600	t	1084.85	
0+616	c		1089.89
0+630	h	1084.90	
0+646	a		1090.07
0+660	n	1084.61	
0+676	n		1089.62
0+690	e	1084.47	
0+706	l		1089.42
0+736			1089.23
0+737.55			
@ 114°16'04"	1085.03	1085.54	
0+750	1084.91	1085.46	
0+766			1089.22
0+780	1084.31	1084.98	
0+796			1089.04
0+810	1084.39	1084.91	
0+826			1088.94
0+840	1084.18	1084.93	
0+856			1089.06
0+870	1084.90	1085.14	

SURVEYED CANAL INVERT AND DYKE GRADES

Ref. Line Sta.(m)	Pilot Channel Invert Level (m)	Main Channel Invert Level (m)	Dyke Centreline Elevation (m)
0+886			1088.87
0+900		1084.64	
0+911			1088.72
0+930	1084.64	1084.82	
0+960	1084.49	1084.89	
0+972			1088.70
0+990	1084.55	1084.81	
1+002			1088.63
1+020	1084.64	1084.97	
1+039			1088.42
1+050	1084.50	1085.10	
1+069			1088.38
1+080	1084.27	1085.08	
1+099			1088.27
1+110	1084.21	1084.79	
1+129			1088.29
1+140	1084.13	1084.66	
1+160			1088.23
1+170	1084.20	1084.66	
1+190			1088.27
1+200*	1083.98	1084.58	1088.27
1+230*	1083.94	1084.47	1088.24
1+260*	1083.96	1084.31	1088.72
1+290*	1083.78	1084.20	1087.79
1+320*	1083.75	1084.26	
1+330*			1087.52
1+350*	1083.55	1084.05	
1+362*			1087.52
1+380*	1083.46	1083.87	
1+391*			1087.36
1+410*	1083.49	1083.92	
1+420*			1087.47
1+440*	1083.46	1083.63	
1+449*			1087.60
1+470*	1083.40	1083.84	
1+479*			1087.63
1+500	1083.20	1083.67	
1+510			1087.73
1+530	1083.15	1083.62	1087.68
1+560	1083.03	1083.36	1087.46
1+590	1083.06	1083.36	
1+600			1087.30
1+620	1083.27	1083.58	
1+630			1087.22
1+650	1083.26	1083.89	
1+659			1087.08
1+680	1083.16	1083.73	
1+684			1087.06
1+710	1082.70	1083.45	

* Revised Reference Line Stations, See Figures 4-2 and 4-3 for details.

SURVEYED CANAL INVERT AND DYKE GRADES

Ref. Line Sta.(m)	Pilot Channel Invert Level (m)	Main Channel Invert Level (m)	Dyke Centreline Elevation (m)
1+714			1087.22
1+740	1082.57	1083.41	
1+750			1087.32
1+770	1082.85	1083.26	
1+782			1087.32
1+800	1082.87	1083.21	
1+822			1087.22
1+830	1082.70	1083.26	
1+853			1086.83
1+868.08 @ 100°26'50"	1082.83	1083.27	
1+880			1086.66
1+890	1082.81	1083.02	
1+905			1086.67
1+920	1082.73	1082.97	
1+940			1086.72
1+950	1082.50	1082.98	
1+969			1086.67
1+980	1082.26	1082.77	
1+999			1086.51
2+010	1082.31	1082.84	
2+230			1086.22
2+040	1082.41	1082.80	
2+063			1086.29
2+070	1082.24	1082.64	
2+090			1086.33
2+100	1081.97	1082.39	
2+119			1086.07
2+130	1082.22	1082.56	
2+149			1086.24
2+160	1082.13	1082.49	
2+178			1086.29
2+190	1082.15	1082.62	
2+204			1086.25
2+220	1081.97	1082.31	
2+243			1086.18
2+250	1081.93	1082.43	
2+270			1086.34
2+280	1081.83	1082.18	
2+303			1086.40
2+332.8	1081.82	1082.14	
2+333			1086.36
2+367			1086.50
2+370	1081.94	1082.12	
2+393			1086.10
2+400		1082.18	

SURVEYED CANAL INVERT AND DYKE GRADES

Ref. Line Sta.(m)	Pilot Channel Invert Level (m)	Main Channel Invert Level (m)	Dyke Centreline Elevation (m)
2+422			1085.69
2+430	1081.68	1082.39	
2+452			1085.74
2+460	1081.67	1082.21	
2+482			1086.00
2+490	1081.66	1082.37	
2+512			1085.99
2+520	1081.55	1082.05	
2+542			1085.64
2+542.54 @ 81°19'00"	1081.16	1081.61	
2+565.4 @ 70°00'00"	1081.59	1081.91	
2+571			1085.47
2+601			1085.40
2+610		1081.42	
2+640	1081.35	1081.74	
2+670		1081.30	
2+692			1085.32
2+700		1081.18	
2+730	1081.24	1081.41	
2+733			1085.25
2+760	1081.20	1081.30	
2+764			1085.28
2+790	1081.73	1081.22	
2+794			1085.20
2+824			1084.51
2+828.67 @ 99° 27' 00"		1081.29	
2+853			1082.93
2+882			1081.52
2+886.17 @ 99°27'45"		1077.63	
2+940			1078.80
2+947.83 @ 99°27'45"		1075.60	
2+968			1077.19
2+989			1075.68
3+000		1071.72	
3+017			1074.28
3+045			1072.99
3+060		1068.36	
3+074			1071.81
3+104			1070.19
3+134			1068.69
3+150		1064.20	
3+160			1066.85

SURVEYED CANAL INVERT AND DYKE GRADES

Ref. Line Sta.(m)	Pilot Channel Invert Level (m)	Main Channel Invert Level (m)	Dyke Centreline Elevation (m)
3+261.77 @ 79°48'25"		1061.31	
3+287			1064.26
3+314			1062.50
3+330		1058.42	
3+341			1060.89
3+371			1059.42
3+380			1057.92
3+412			1056.61
3+446			1056.01
3+450		1052.73	
3+476			1055.99
3+510		1052.42	1055.73
3+544			1056.70
3+570		1052.18	
3+579			1057.11
3+613			1057.14
3+630		1052.04	
3+653			1055.72
3+691			1054.33
3+717			1053.14
3+746			1051.65
3+775			1050.35
3+799			1048.17

TABLE 4-6 MATERIAL TESTING (FIELD)
CLASS VI DAM CORE

Date	Remarks	W%	Sieve Analysis			Proctor Test	
			Max. Size (mm)	% Passing 4.75mm	% Passing 0.075mm	Optimum M/C %	Max. kg/m^3
May 21/81	B/A "E" - Sampled after initial stripping	-	50	75	26	-	-
May 23/81	B/A "E" - ID	-	75	65	19	7	2234
Jun.07/81	B/A "E" - CVD 0+420 (1049m)	-	75	63	25	-	-
Jul.01/81	B/A "F" - ID	-	75	84	17	-	-
Jul.24/81	B/A "F" - ID 0+540 to 0+620	-	75	67	12	-	-
Aug.03/81	B/A "F" - ID 0+000 to 0+690	-	-	-	34	-	-
Aug.14/81	B/A "F" - CVD	-	-	-	15	-	-
Sept.04/81	B/A "F" - CVD 0+420 to 0+600	-	75	53	21	-	-
	Mean		75	68	21	7	2234
	Range		50-75	58-84	12-34	only one test	

B/A = Borrow Area
ID = Intermediate Dam
CVD = Cross Valley Dam

0+100 = Chainage (m)
(1000.0m) = Elevation

TABLE 4-7 MATERIAL TESTING (FIELD)
CLASS VII UPSTREAM SHELL

Date	Remarks	W%	Sieve Analysis: Max. Size (mm)	Sieve Analysis: % Passing 4.75mm	Sieve Analysis: % Passing 0.075mm	Proctor Test: Optimum M/C %	Proctor Test: Max. kg/m^3
May 21/81	B/A"E"] Samples taken after area initially	-	50	76	28	-	-
May 21/81	B/A"E"] stripped	-	75	74	23	-	-
Jun.26/81	B/A "G" - CVD 0+150 to 0+500	-	75	81	32	-	-
Jul.01/81	B/A "F" - CVD	-	75	84	17	-	-
Jul.01/81	B/A "G" - CVD 0+210 (1055.5m)	-		58	6	-	-
Jul.09/81	B/A "G" - Granular (Possible Cl. VII or Cl. VIII)	-	75	42	4	-	-
Jul.15/81	B/A "C" - 0+620	12.2	75	50	12	-	-
	Mean	12.2	75	66	17		2150
	Range		50-75	42-84	4-32		(assumed)

B/A = Borrow Material
ID = Intermediate Dam
CVD = Cross Valley Dam

0+100 = Chainage (m)
(1000.0 m) = Elevation

TABLE 4-8 MATERIAL TESTING (FIELD)
CLASS VIII DOWNSTREAM SHELL

Date	Remarks	W%	Sieve Analysis: Max. Size (mm)	Sieve Analysis: % Passing 4.75mm	Sieve Analysis: % Passing 0.075mm	Proctor Test: Optimum M/C %	Proctor Test: γ_d Max. kg/m^3
May 24/81	B/A "B" - ID 0+600 (1052m)	-	150	67	6	9.0	2095
May 26/81	B/A "B" - ID 0+600 (1053m)	-	75	49	3	8.6	2153
Jun.13/81	B/A "C" - CVD 0+220 to 0+300	-	75	66	7	-	-
Jun.23/81	B/A "C" - CVD 0+360 (1052m)	-	150	39	4	-	-
Jul.01/81	- CVD 0+240 (1053m)	-	50	75	19	-	-
Jul.25/81	B/A "C" - ID 0+570 (1066m)	-	50	81	10	-	-
Jul.26/81	B/A "G" - CVD (1068m)	-	150	32	5	-	-
Aug.07/81	B/A "G" - ID 0+280 (1068m)	-	100	51	6	-	-
Aug.09/81	B/A "C" - ID 0+630 to 0+720	-	150	59	2	-	-
Aug.23/81	B/A "A" - ID 0+660	-	75	49	3	-	-
Aug.23/81	B/A "C" - ID 0+550 to 0+750	-	75	58	4	-	-
Aug.26/81	B/A "A" - ID 0+600 to 0+750	-	150	42	2	-	-
Aug.26/81	B/A "B" - ID 0+600 to 0+750 (1066m)	-	75	58	9	-	-
	Mean		100	56	7	9	2120
	Range		100-150	32-81	2-19		

B/A = Borrow Material
ID = Intermediate Dam
CVD = Cross Valley Dam

0+100 = Chainage (m)
(1000.0 m) = Elevation

TABLE 4-9 MATERIAL TESTING (FIELD)
CLASS IX UPSTREAM FILTER

Date	Remarks		W%	Sieve Analysis: Max. Size (mm)	Sieve Analysis: % Passing 4.75mm	Sieve Analysis: % Passing 0.075mm	Proctor Test: Optimum M/C %	Proctor Test: γ_d Max. kg/m^3
May 26/81	B/A "A" - ID 0+570 to 0+630		-	50	75	8	-	-
Jun.24/81	B/A "C" - CVD 0+360 (1051m)		-	50	94	13	-	-
Jun.24/81	B/A "C" - CVD 0+420		-	75	77	22	9.8	1985
Jun.26/81	B/A "B" - CVD 0420 (1052m)		-	75	70	6	-	-
		Mean	-	75	79	12	9.8	1985
		Range	-	50-75	70-94	6-22	-	-

B/A = Borrow Area
ID = Intermediate Dam
C.V.D. = Cross Valley Dam

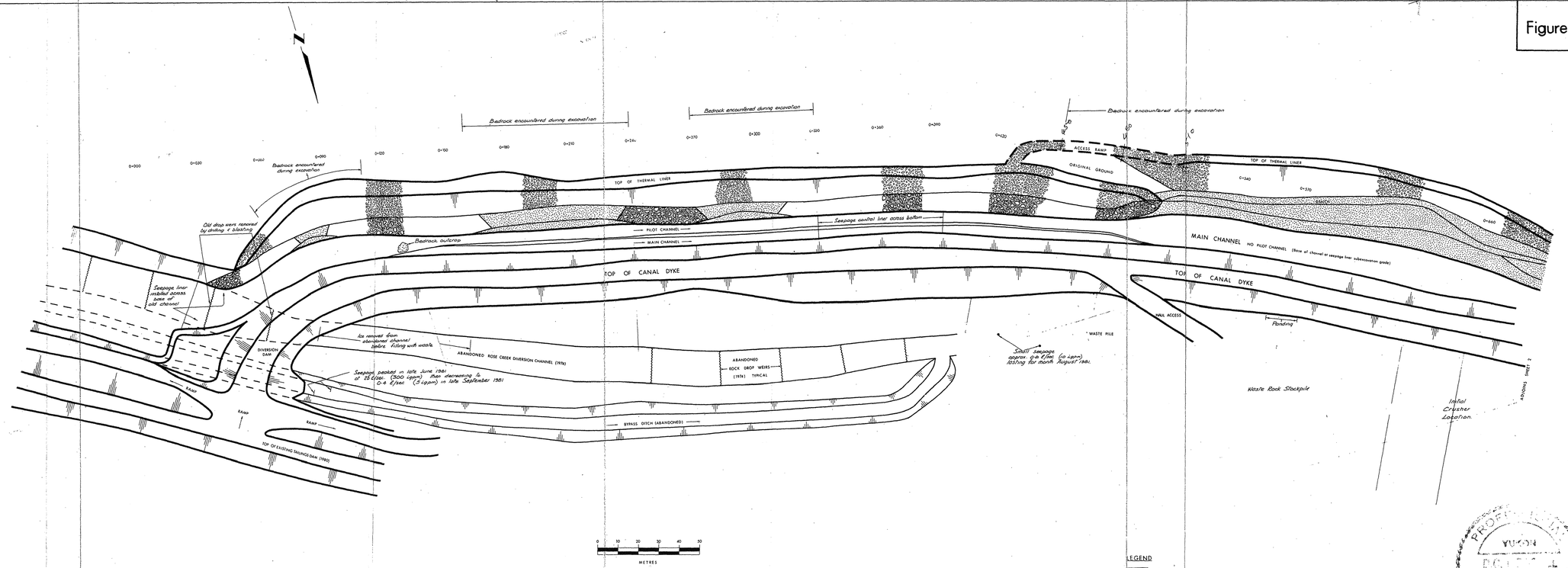
0+100 = Chainage (m)
(1000.0m) = Elevation

TABLE 4-10 MATERIAL TESTING (FIELD)
CLASS X DOWNSTREAM FILTER

Date	Remarks	W%	Sieve Analysis			Proctor Test	
			Max. Size (mm)	% Passing 4.75 mm	% Passing 0.075 mm	Optimum M/C %	Max. kg/m^3
May 26/81	B/A "A" - ID 0+615 (1053m)	-	37.5	82	5		
Jun.04/81	- CVD 0+420 (1048m)	-	75	75	1	10.1	2024
Jun.05/81	B/A "A" - CVD 0+390 (1049m)	-	75	63	3	-	-
Jun.10/81	B/A "A" - CVD 0+300 to 0+450	-	75	83	1	-	-
Jun.11/81	Material moved from ID - CVD 0+180 to 0+450	-	75	64	3	-	-
Jun.16/81	B/A "B" - ID 0+330 (1067.3m)	-	75	74	6	-	-
Jun.17/81	B/A "B" - ID	-	75	65	1	-	-
Jun.26/81	B/A "B" - CVD 0+200	-	75	74	1	-	-
Jun.27/81	B/A "B" - CVD 0+150 to 0+500	-	75	84	1	-	-
Jun.28/81	B/A "B" - CVD 0+150 to 0+500	-	75	55	3	-	-
Jun.28/81	B/A "B" - CVD 0+150 to 0+500	-	75	63	1	-	-
Jul.07/81	B/A "B" - ID 0+310	-	75	47	2	-	-
Jul.07/81	B/A "B" - ID 0+360	-	75	58	2	-	-
Jul.14/81	B/A "C" - 0+120 to 0+450	-	75	69	2	-	-
Jul.16/81	- CVD 0+450 (1054.5m)	-	75	64	5	-	-
Jul.28/81	B/A "B" - CVD	-	75	63	5	-	-
Jul.30/81	B/A "B" - ID 0+250	-	37.5	72	3	-	-
Jul.30/81	B/A "B" - CVD 0+570	-	50	76	6	-	-
Jul.30/81	B/A "B" - Possible Cl. X (not used)	-	75	69	6	-	-
Jul.31/81	B/A "B" - ID 0+180 to 0+520 (low proctor)	-	50	67	3	(6.0)	(1874)
Aug.07/81	B/A "B" - CVD 0+560	-	50	69	4	-	-
Aug.23/81	B/A "C" - CVD 0+480 to 0+600	-	75	58	4	-	-
	Mean		75	67	3	10.1	2024
	Range		37.5-150	47-84	1-6		

B/A = Borrow Area
ID = Intermediate Dam
CVD = Cross Valley Dam
0+100 = Chainage (m)
(1000.0m) = Elevation

Figure. 4-1



Notes:

1. Plan based on surveys by Underhill Engineering Ltd, Whitehorse during construction. Supplementary information has been used from photographs and topographic mapping.
2. For typical cross-sections see Figures: 4-7, 4-8, 4-9, 4-10, 4-11.

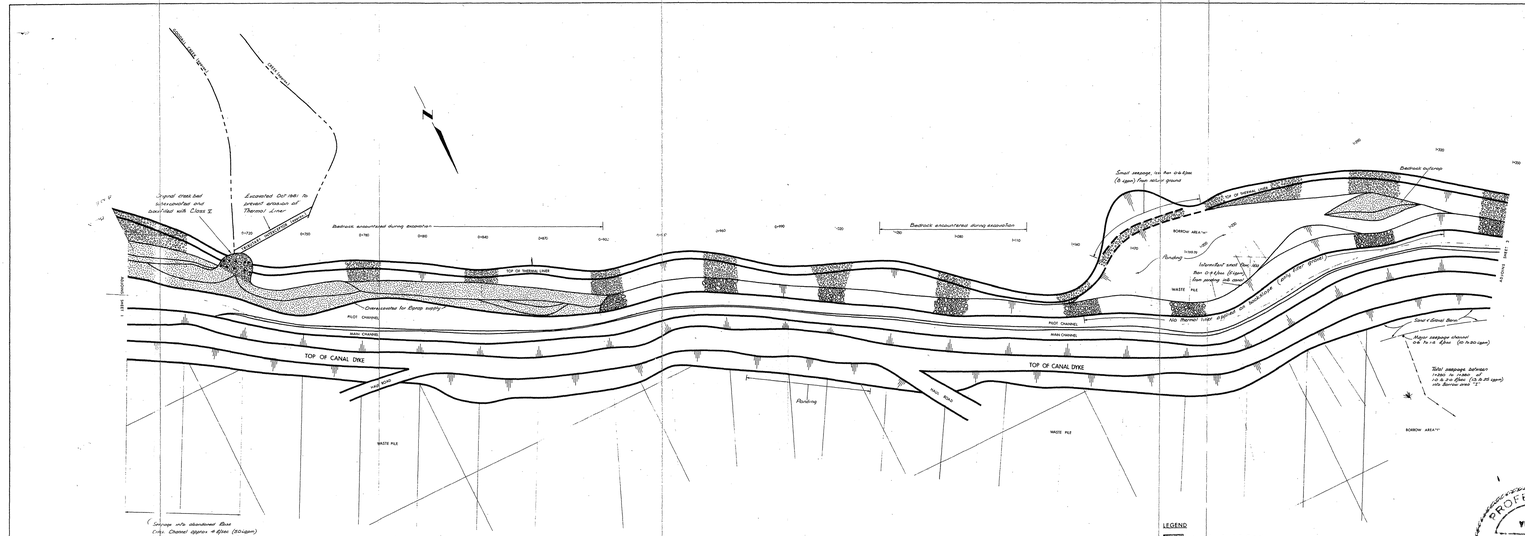
LEGEND

- Class I Sand & Gravel
- Class IV or V Riprap
- Waste pile from excavation
- Slope indicator (points downslope)
- 0+000 Reference Line chainage
- Bedrock

PROFESSIONAL ENGINEER YUKON TERRITORY Dave Goodall February 18, 1982

CYPRUS ANVIL Faro Yukon Territory Cyprus Anvil Mining Corporation	PLAN OF DIVERSION CANAL REFERENCE LINE Sta. 0+000 to Sta. 0+660 1980-81 CONSTRUCTION DOWN VALLEY TAILINGS PROJECT	Golder Associates (Western Canada) Ltd. Sheet 1 of 6

Figure. 4-2



Notes:

1. Plan based on surveys by Underhill Engineering Ltd, Whitehorse during construction. Supplementary information has been used from photographic and topographic mapping.
2. For typical cross-sections see Figures: - 3, 4-9, 4-11, 4-12, 4-13, 4-14, 4-15, 4-16, 4-17.

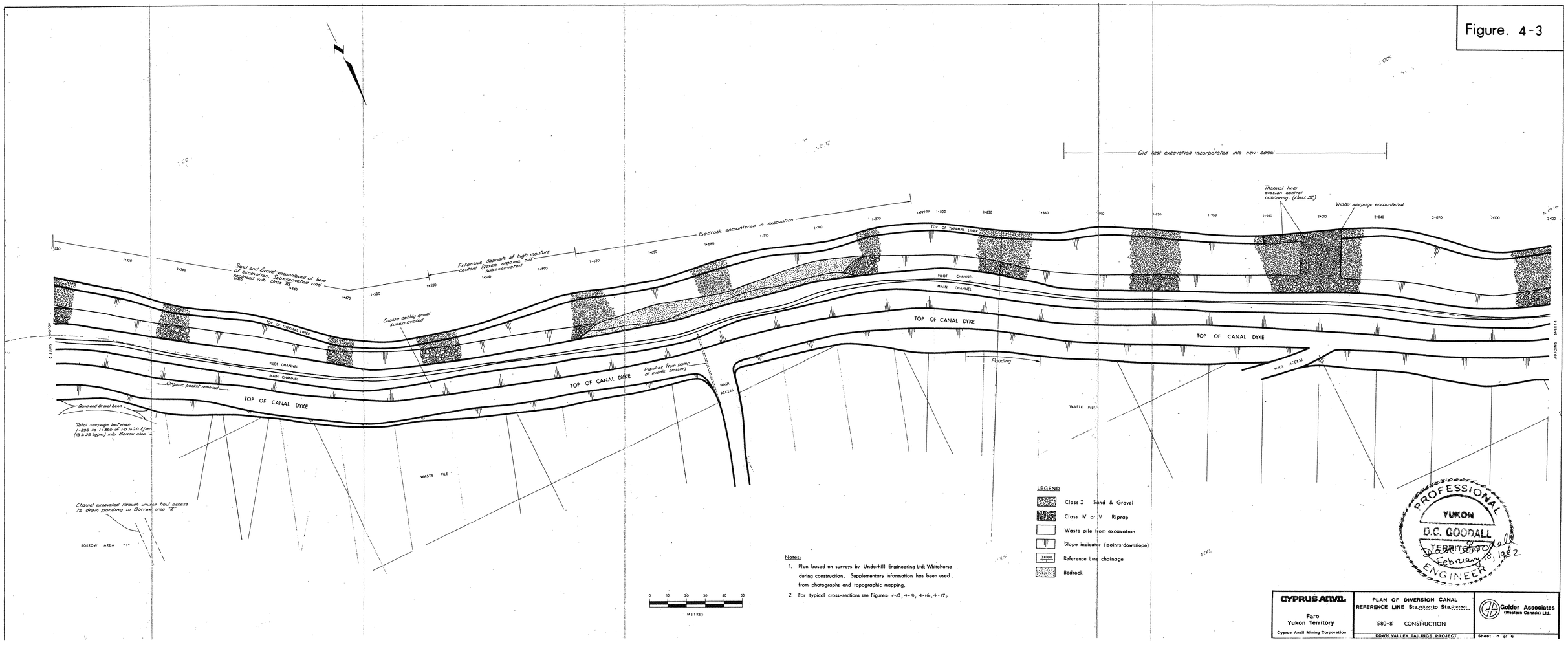
LEGEND

- Class I Sand & Gravel
- Class IV or V Riprap
- Waste pile from excavation
- Slope indicator (points downslope)
- Reference Line chainage
- Bedrock

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CYPRUS ANVIL Faro Yukon Territory	PLAN OF DIVERSION CANAL REFERENCE LINE Sta 0+000 to Sta 17+000 1980-81 CONSTRUCTION	Golder Associates Western Canada Ltd.

Figure. 4-3



LEGEND

- Class I Sand & Gravel
- Class IV or V Riprap
- Waste pile from excavation
- Slope indicator (points downslope)
- 3+000 Reference Line chainage
- Bedrock

Notes:

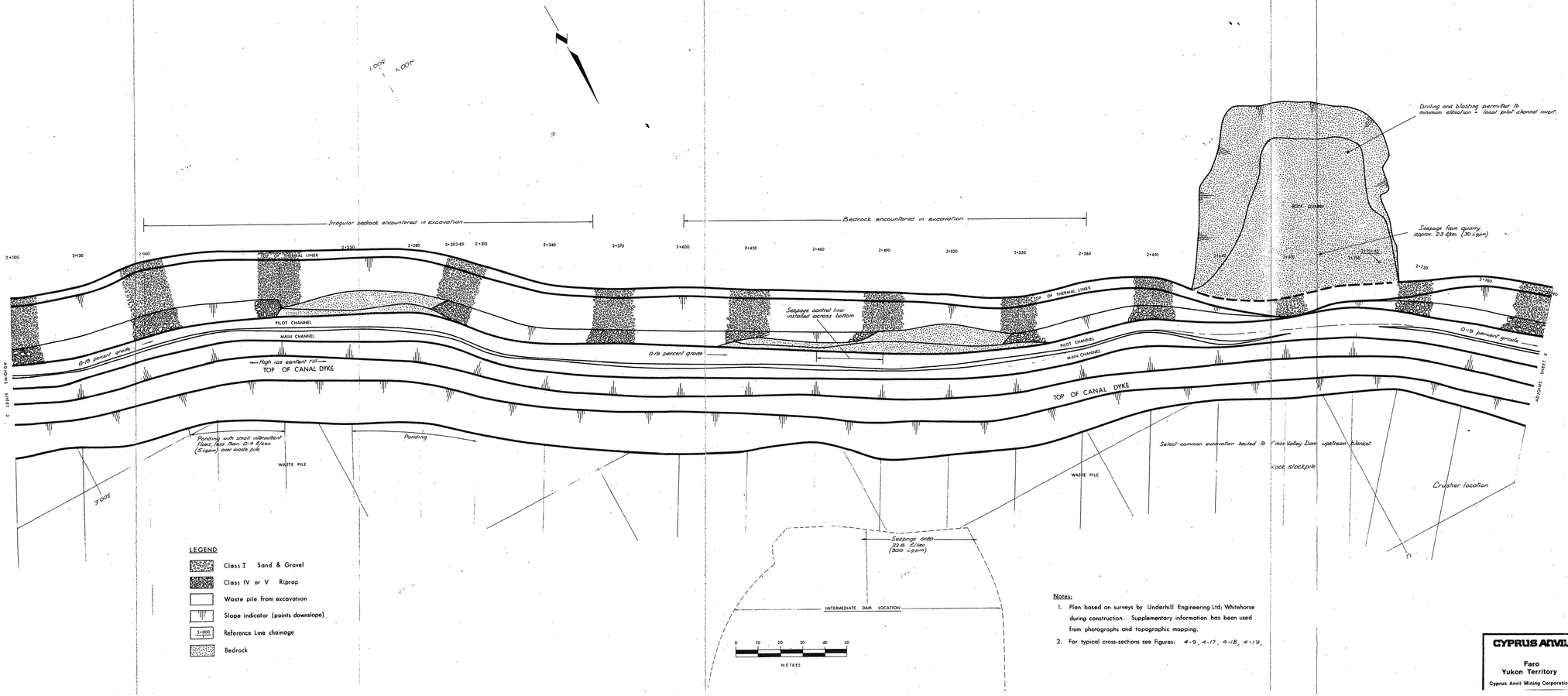
1. Plan based on surveys by Underhill Engineering Ltd; Whitehorse during construction. Supplementary information has been used from photographs and topographic mapping.
2. For typical cross-sections see Figures: 4-8, 4-9, 4-16, 4-17,

0 10 20 30 40 50
METRES

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CYPRUS ANVIL Faro Yukon Territory Cyprus Anvil Mining Corporation	PLAN OF DIVERSION CANAL REFERENCE LINE Sta 1+320 to Sta 2+120 1980-81 CONSTRUCTION DOWN VALLEY TAILINGS PROJECT	Golder Associates (Western Canada) Ltd. Sheet 3 of 6

Figure. 4-4



LEGEND

- Class I Sand & Gravel
- Class IV or V Riprap
- Waste pile from excavation
- Slope indicator (points downslope)
- 3+000 Reference Line chainage
- Bedrock

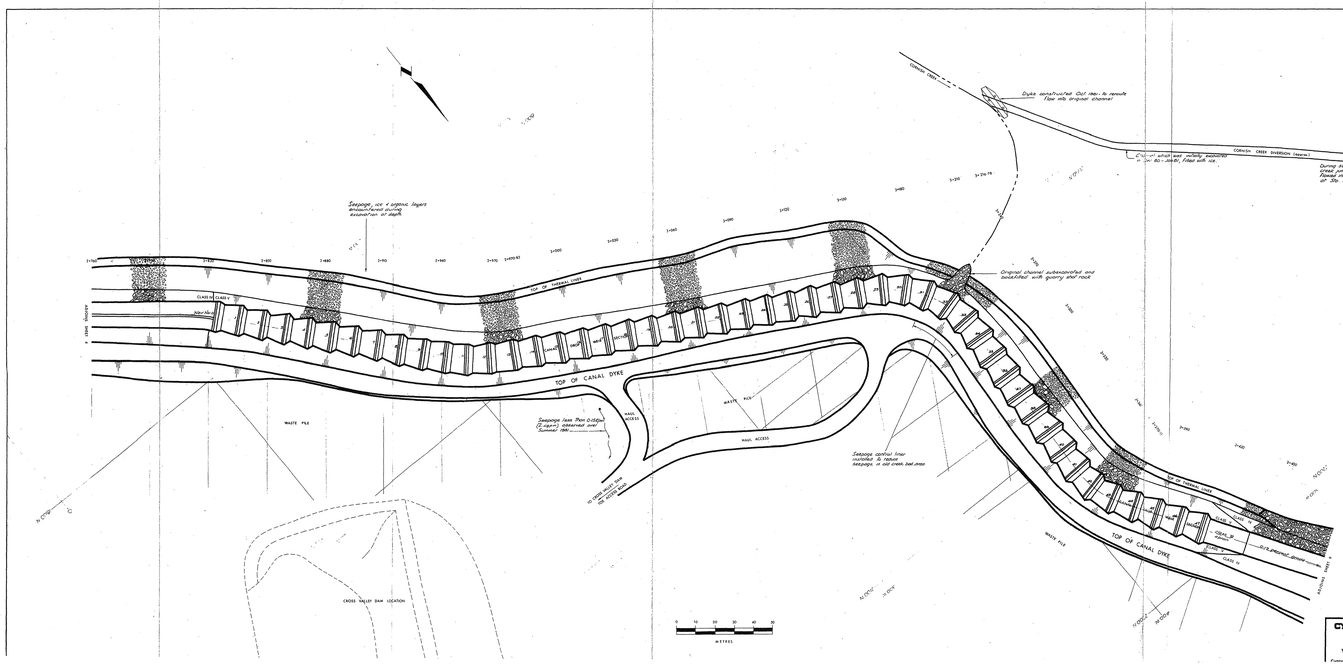
Notes:

1. Plan based on surveys by Underhill Engineering Ltd; Whitehorse during construction. Supplementary information has been used from photographs and topographic mapping.
2. For typical cross-sections see Figures: 4-9, 4-17, 4-18, 4-19,

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CYPRUS ANVIL Faro Yukon Territory Cyprus Anvil Mining Corporation	PLAN OF DIVERSION CANAL REFERENCE LINE Sta. 2+100 to Sta. 2+780 1980-81 CONSTRUCTION DOWN VALLEY TAILINGS PROJECT	Golder Associates (Western Canada) Ltd. Sheet 4 of 6

Figure. 4-5



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Diane Goodall
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LEGEND

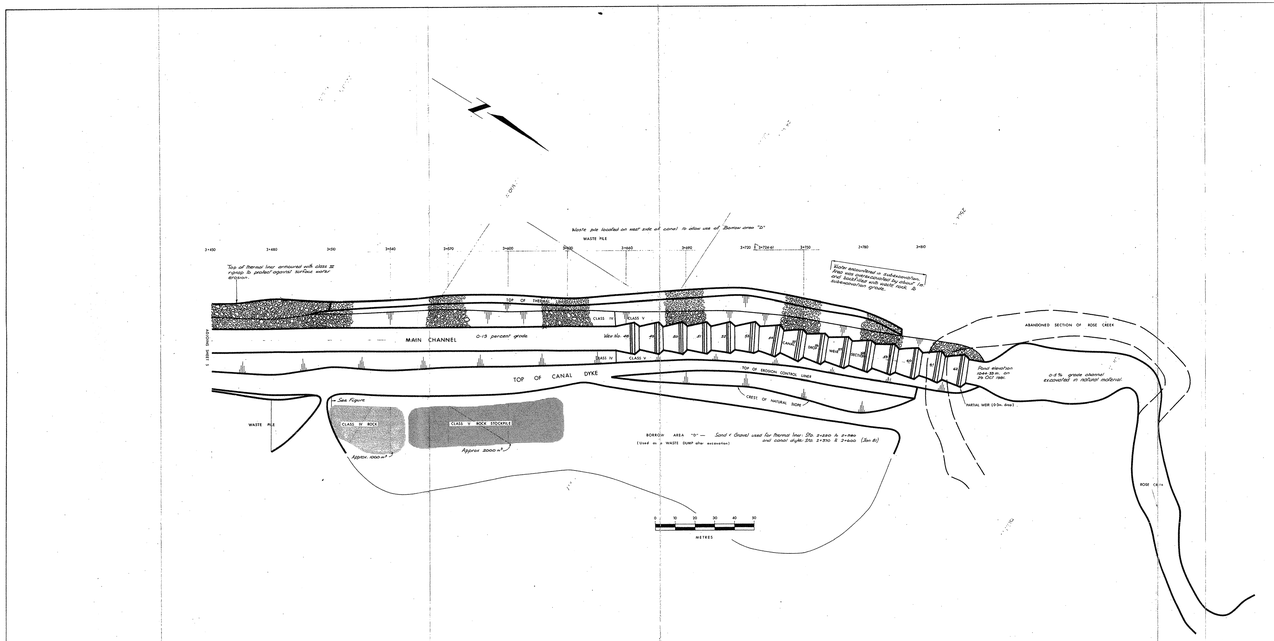
- Class I Sand & Gravel
- Class IV or V Riprap
- Waste pile from excavation
- Slope indicator (points downslope)
- Reference Line chainage

Notes:

1. Plan based on surveys by Underhill Engineering Ltd. Where shown during construction. Supplementary information has been used from photographs and topographic mapping.
2. Drop weirs are shown schematically. Actual configurations are irregular. See photographs.
3. For typical cross-sections see Figure 4-6 (Drop weir sections) and Figure 4-7a (0.5% grade).
4. Typical drop weir profile shown on Figure 4-23
5. Cornish Creek interception details shown on Figure 4-21

CYPRUS ANVIL Faro Yukon Territory Cyprus Anvil Mining Corporation	PLAN OF DIVERSION CANAL REFERENCE LINE Sta.2+760 TO Sta.3+980 1980 - 81 CONSTRUCTION	Golder Associates Geotechnical Consultants Ltd.

Figure 4-6



LEGEND

- Class I: Sand & Gravel
- Class IV or V Riprap
- Waste pile from excavation
- Slope indicator (points downslope)
- 2+000 : Reference Line chainage

Notes:

1. Plan based on surveys by Underhill engineering Ltd; Whitehorse during construction. Supplementary information has been used from photographs and topographic mapping.
2. Drop weirs are shown schematically. Actual configurations are irregular. See photographs.
3. For typical cross-sections see Figure 7 (Drop weir section) and Figure 8 (0.19% grade)
4. Typical drop weir profile shown on Figure 4-23

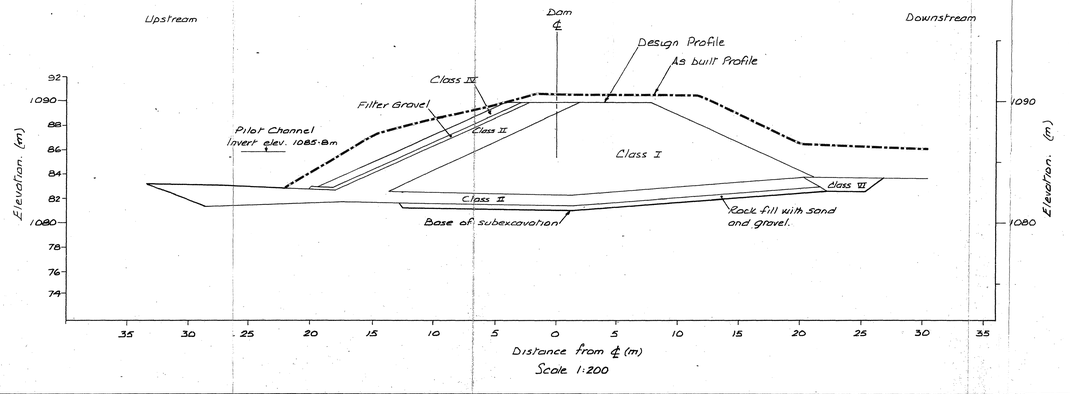
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D.C. GOODALL
TERRITORIAL
ENGINEER
July 18, 1982

CYPRUS ANVIL Faro Yukon Territory Cyprus Anvil Mining Corporation	PLAN OF DIVERSION CANAL REFERENCE LINE Sta. 2+100 TO Sta. 3+060 1980-81 CONSTRUCTION	Golder Associates Golder Consultants Ltd.

Project No. 852-2036

TYPICAL DIVERSION DAM CROSS SECTION AT ABANDONED ROSE CREEK CHANNEL

FIGURE 4 - 7



NOTES:

1. See text for explanation of material classes.
2. Information is based on survey by Underhill Engineering Ltd.

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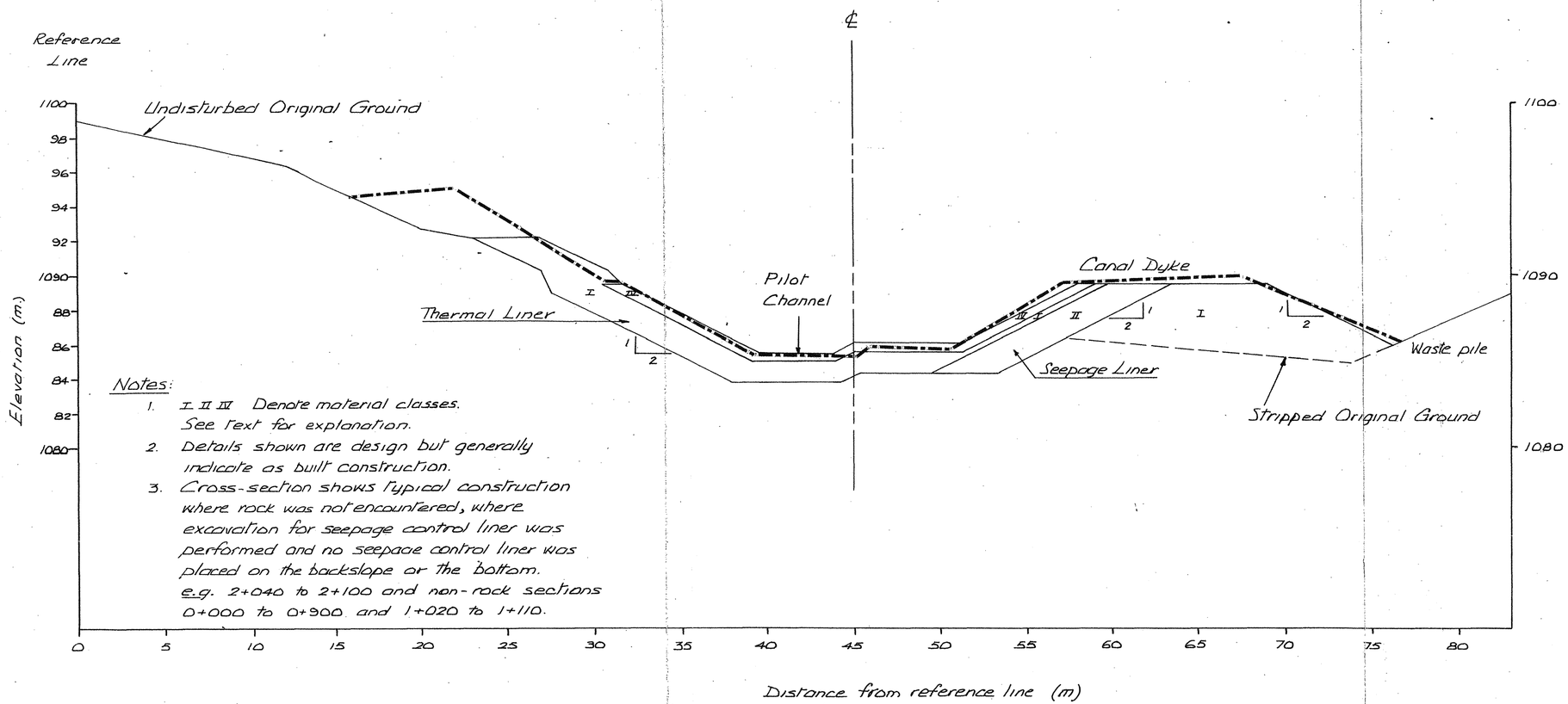
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Date Feb 82

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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 0+240

FIGURE. 4 - 8



Notes:

1. I II III Denote material classes. See text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction where rock was not encountered, where excavation for seepage control liner was performed and no seepage control liner was placed on the backslope or the bottom. e.g. 2+040 to 2+100 and non-rock sections 0+000 to 0+900 and 1+020 to 1+110.

Scale 1:200

Design Cross-section
As built profile

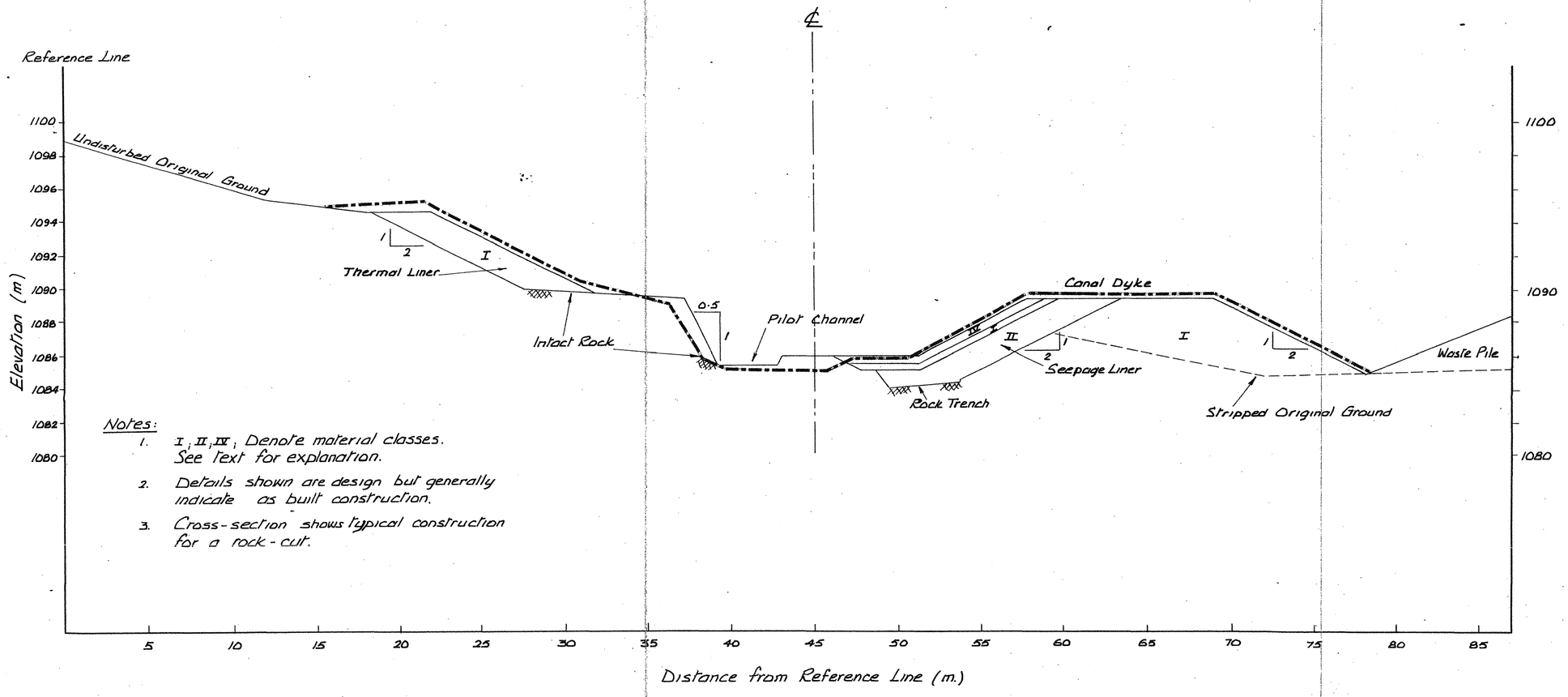
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February 19, 1982

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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 0+300

FIGURE. 4 - 9



Notes:

1. I, II, IV, Denote material classes. See text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction for a rock-cut.

Scale 1:200

Design Cross-section
As built profile

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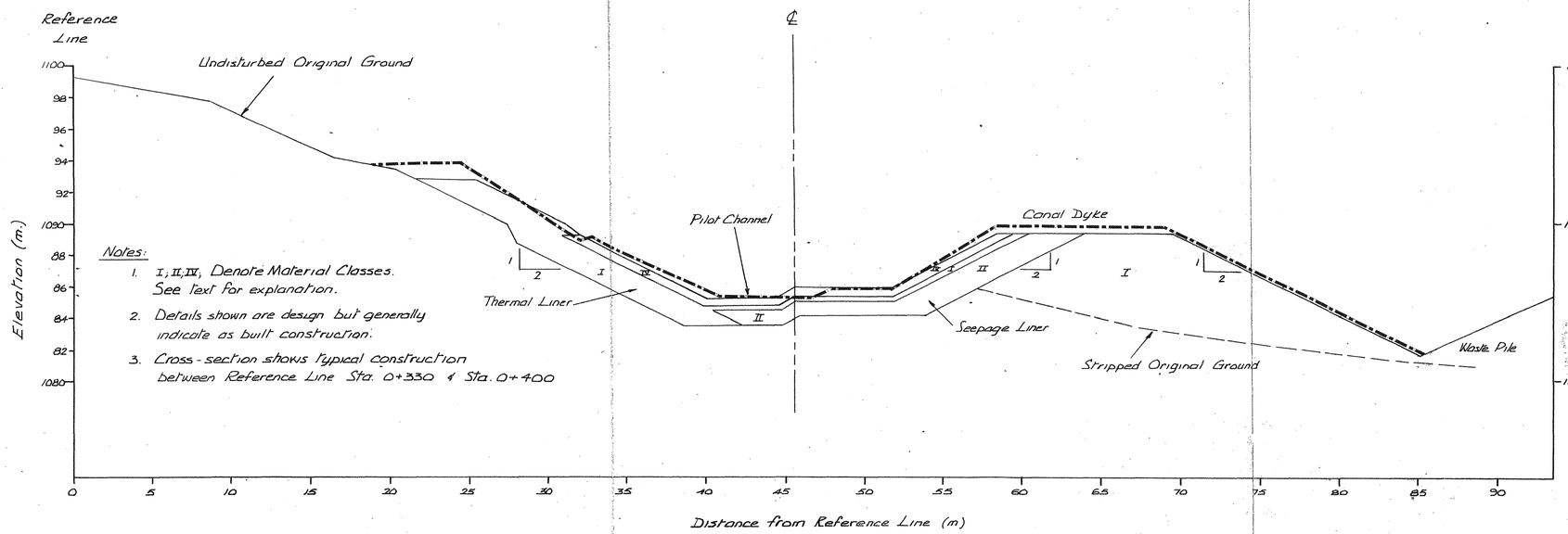
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Date Feb. '82

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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 0+390

FIGURE. 4 - 10



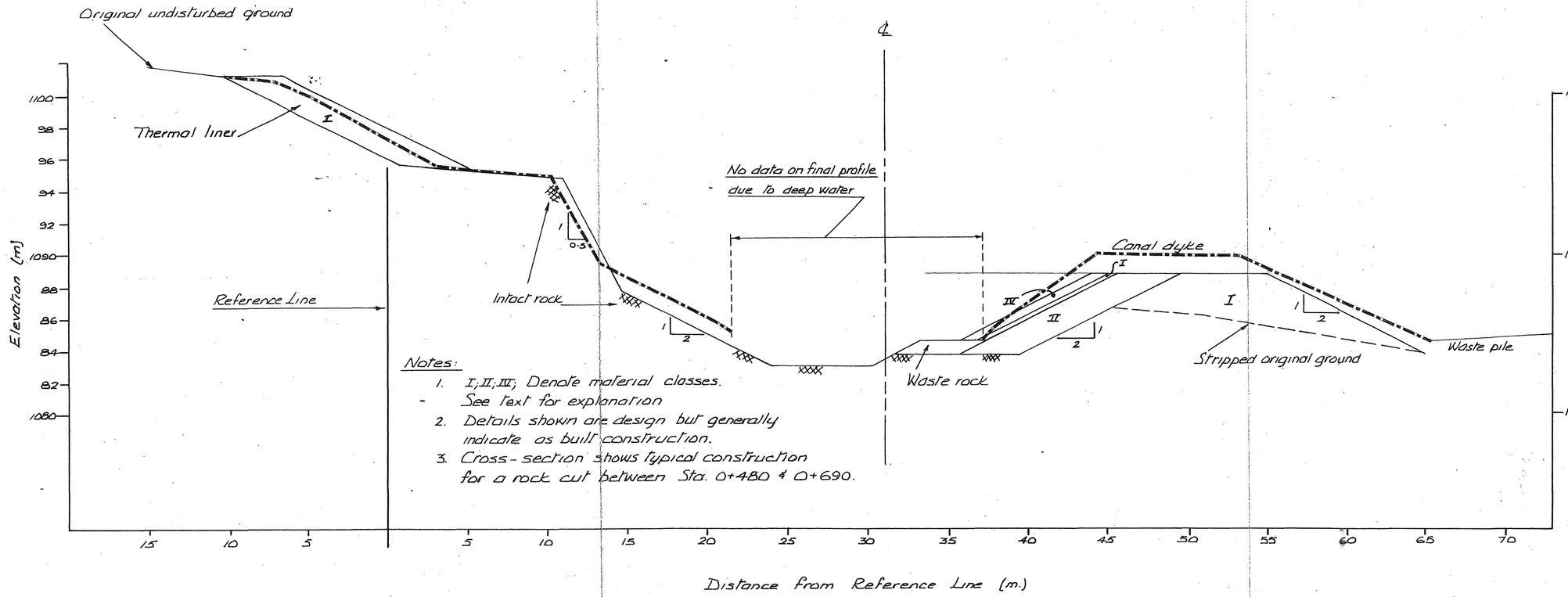
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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 0+660

FIGURE. 4 - 11



Notes:

1. I, II, III; Denote material classes. See text for explanation
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction for a rock cut between Sta. 0+480 & 0+690.

Scale 1:200

Design Cross-Section
As built profile

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TERRITORY
Dwight Goodall
February 19, 1982

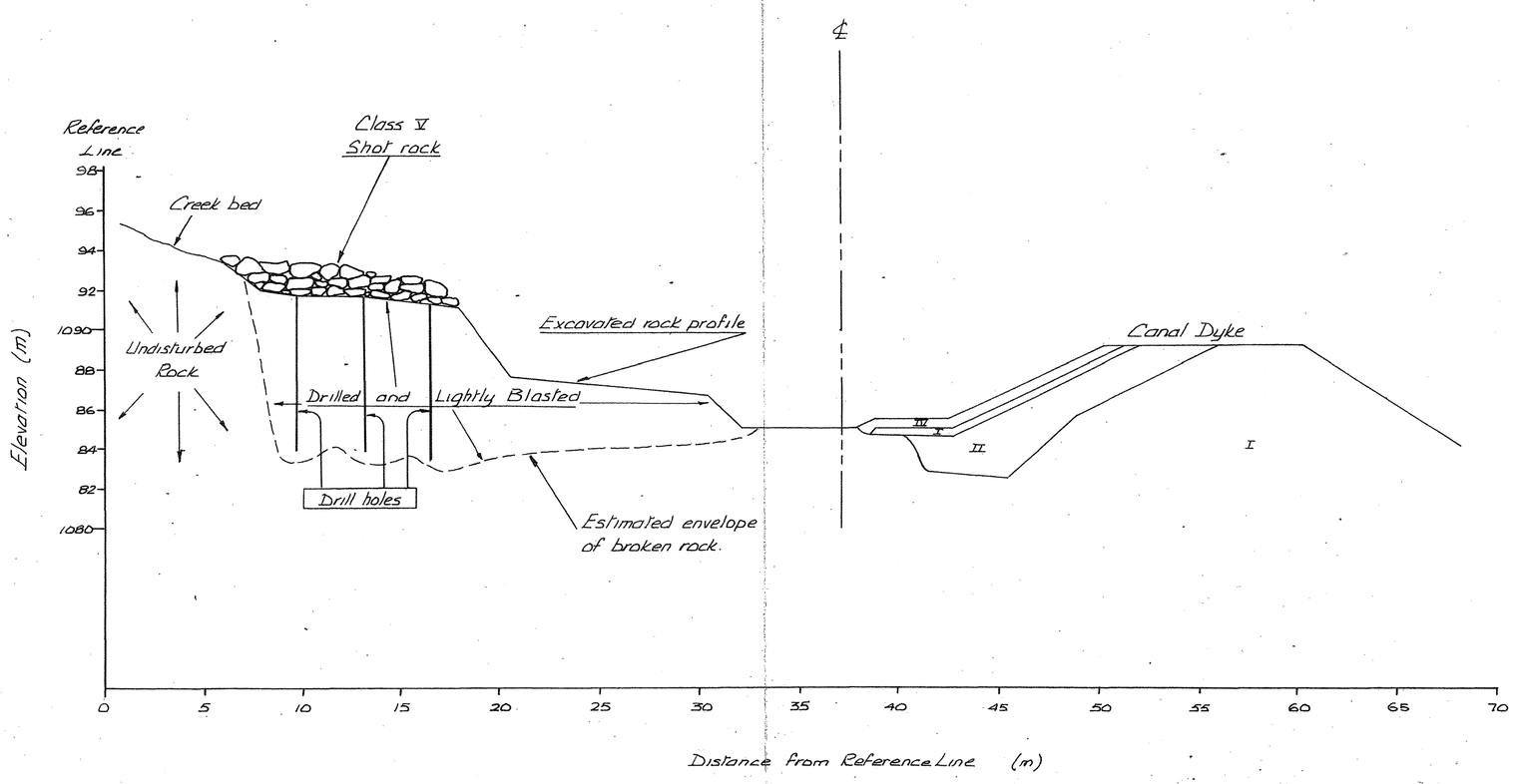
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GOODALL CREEK INTERCEPTION
REFERENCE LINE STA. 0+711

FIGURE. 4 - 12



Scale 1:200

Notes:

1. I; II; III; Denote material classes. See text for explanation.
2. Section shown is applicable for approx. 15m. along the axis of the canal centred at Sta. 0+711

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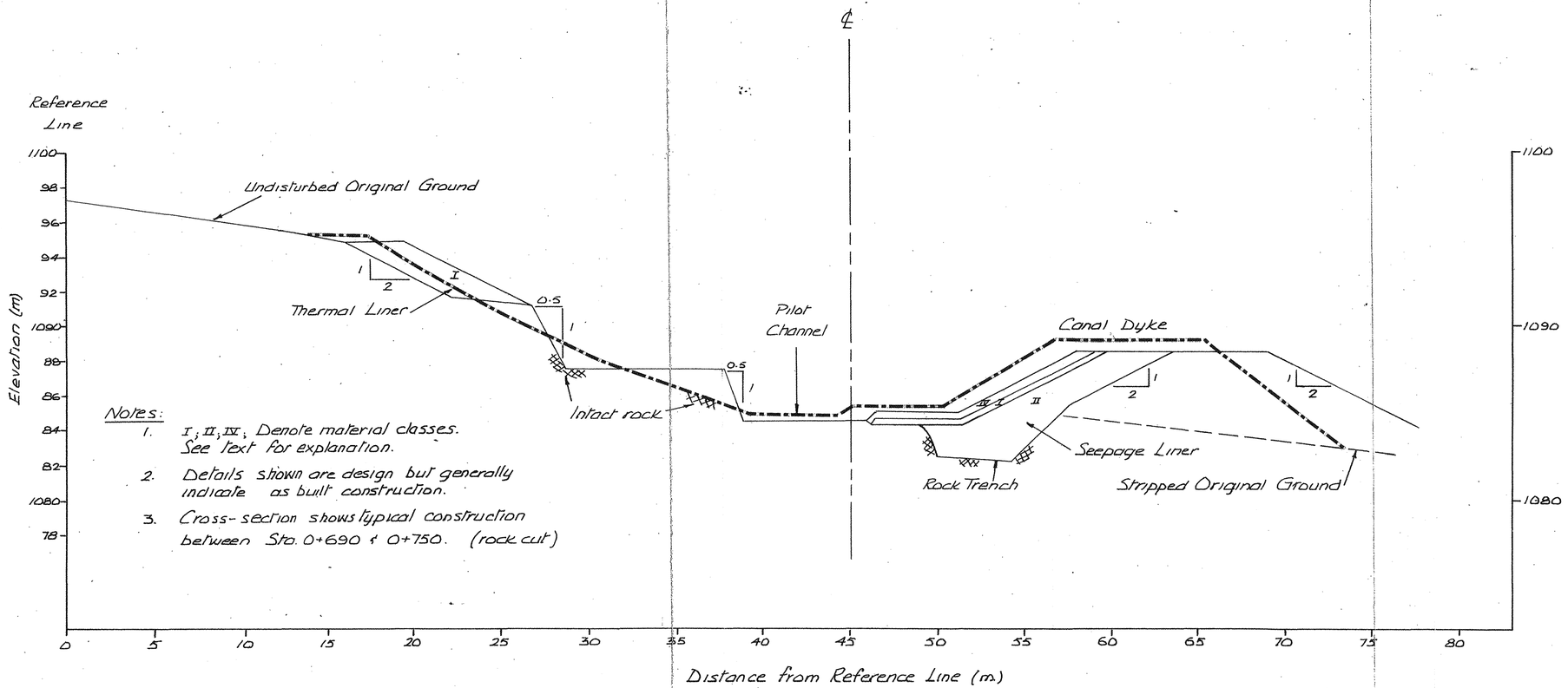
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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 0+750

FIGURE. 4 - 13



Notes:

1. I; II; IV; Denote material classes. See text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction between Sta. 0+690 & 0+750. (rock cut)

Scale 1:200

——— Design Cross-section
— — — As built profile

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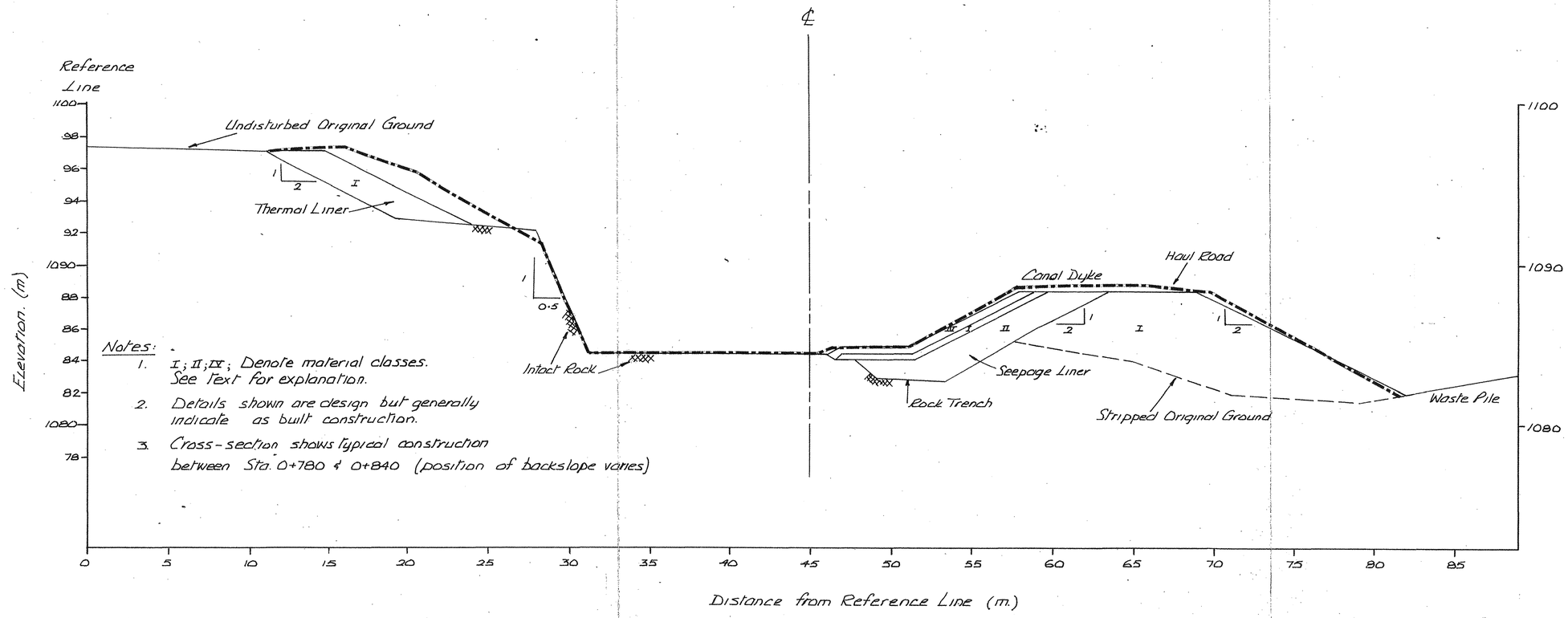
Drawn GP
Rev'd DG
Date Feb. '82

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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 0+810

FIGURE. 4 - 14



Notes:

1. I; II; IV; Denote material classes. See Text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction between Sta. 0+780 & 0+840 (position of backslope varies)

Scale 1:200

Design Cross-section
As built profile

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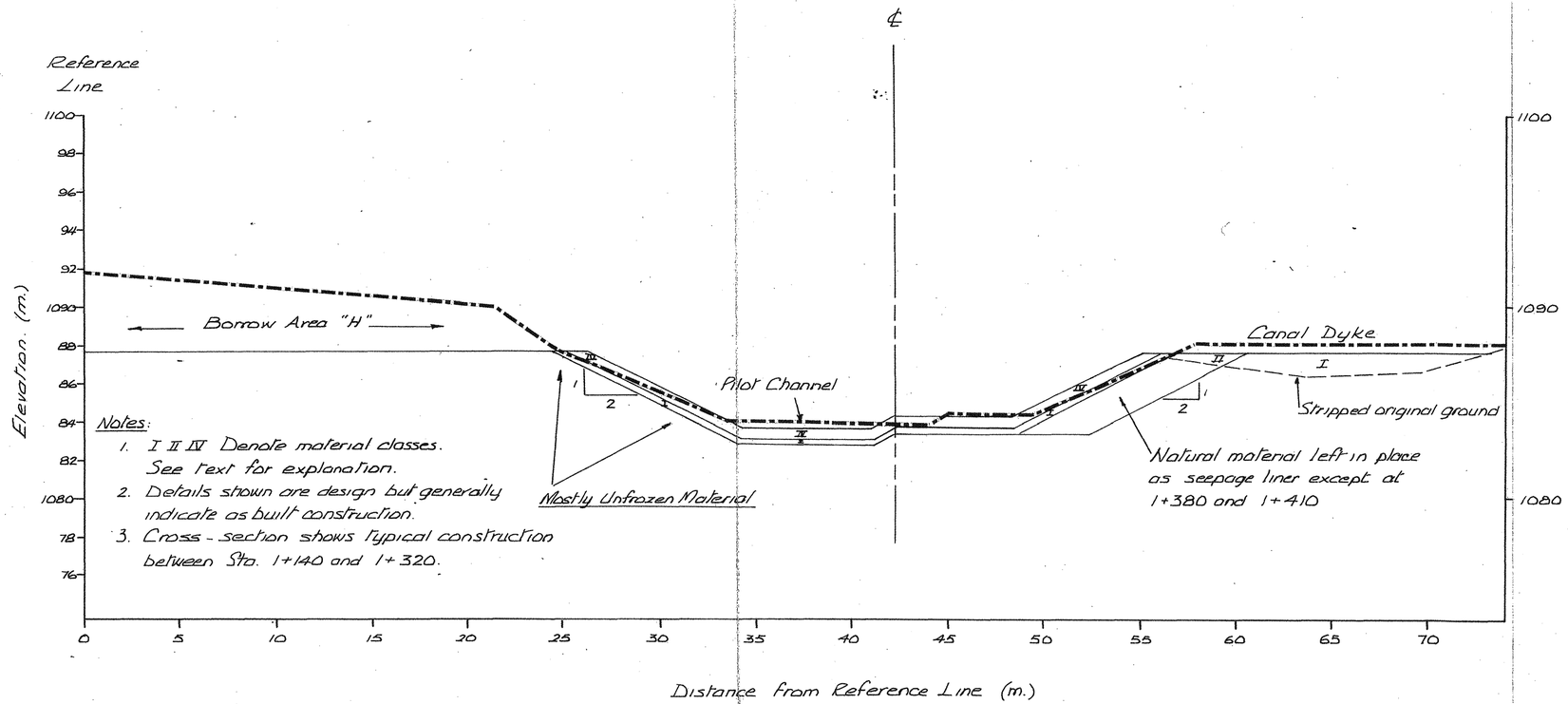
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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 1+230

FIGURE. 4 - 15



Notes:
1. I II III Denote material classes. See text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction between Sta. 1+140 and 1+320.

Scale - 1:200

Design cross-section
As built profile

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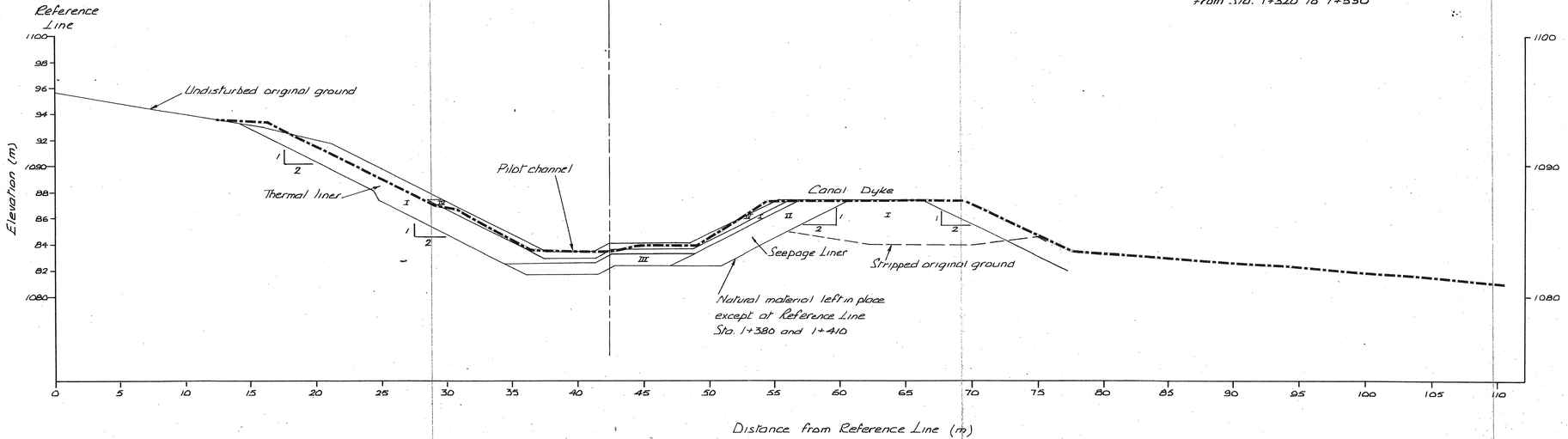
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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 1+350

FIGURE. 4 - 16



Notes:

1. I, II, III, IV, Denote material classes. See text for explanation
2. Details shown are design but generally indicate as built construction
3. Cross section shows typical construction from Sta. 1+320 to 1+530

Scale 1:200

Design Cross-section
As built profile

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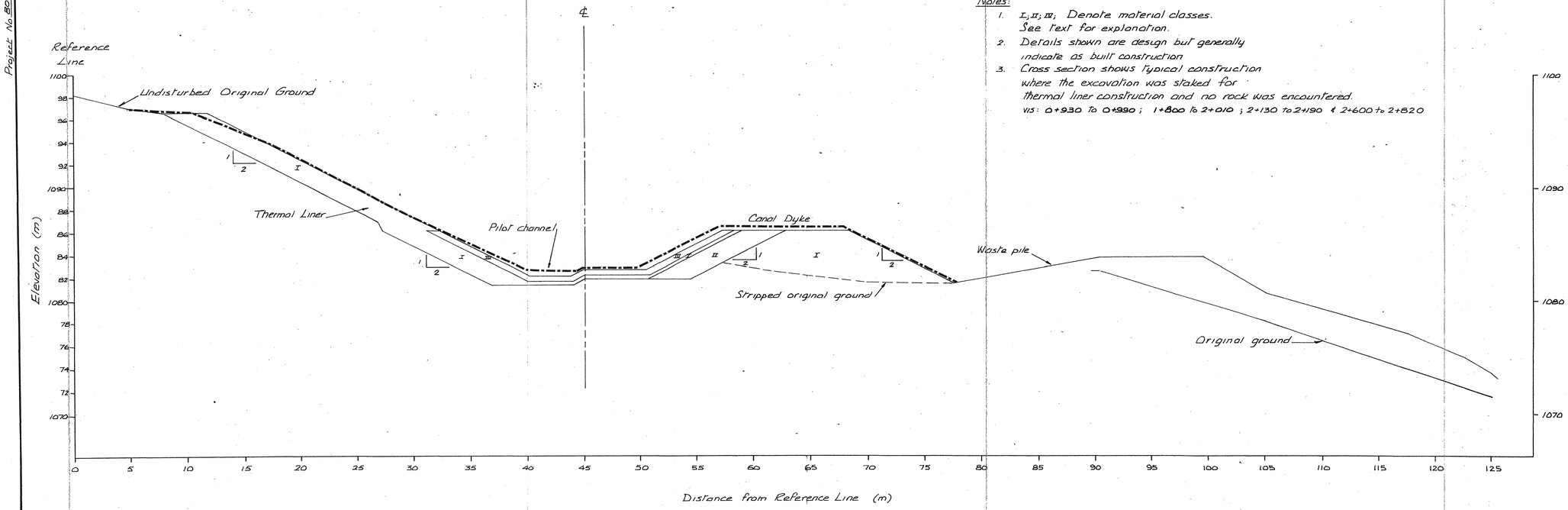
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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 1+920

FIGURE. 4 - 17



Notes:

1. I, II, III; Denote material classes. See text for explanation.
2. Details shown are design but generally indicate as built construction
3. Cross section shows typical construction where the excavation was staked for thermal liner construction and no rock was encountered. viz: 0+930 to 0+990 ; 1+800 to 2+010 ; 2+130 to 2+190 & 2+600 to 2+820

Scale 1:200

Design Cross-section

As built profile

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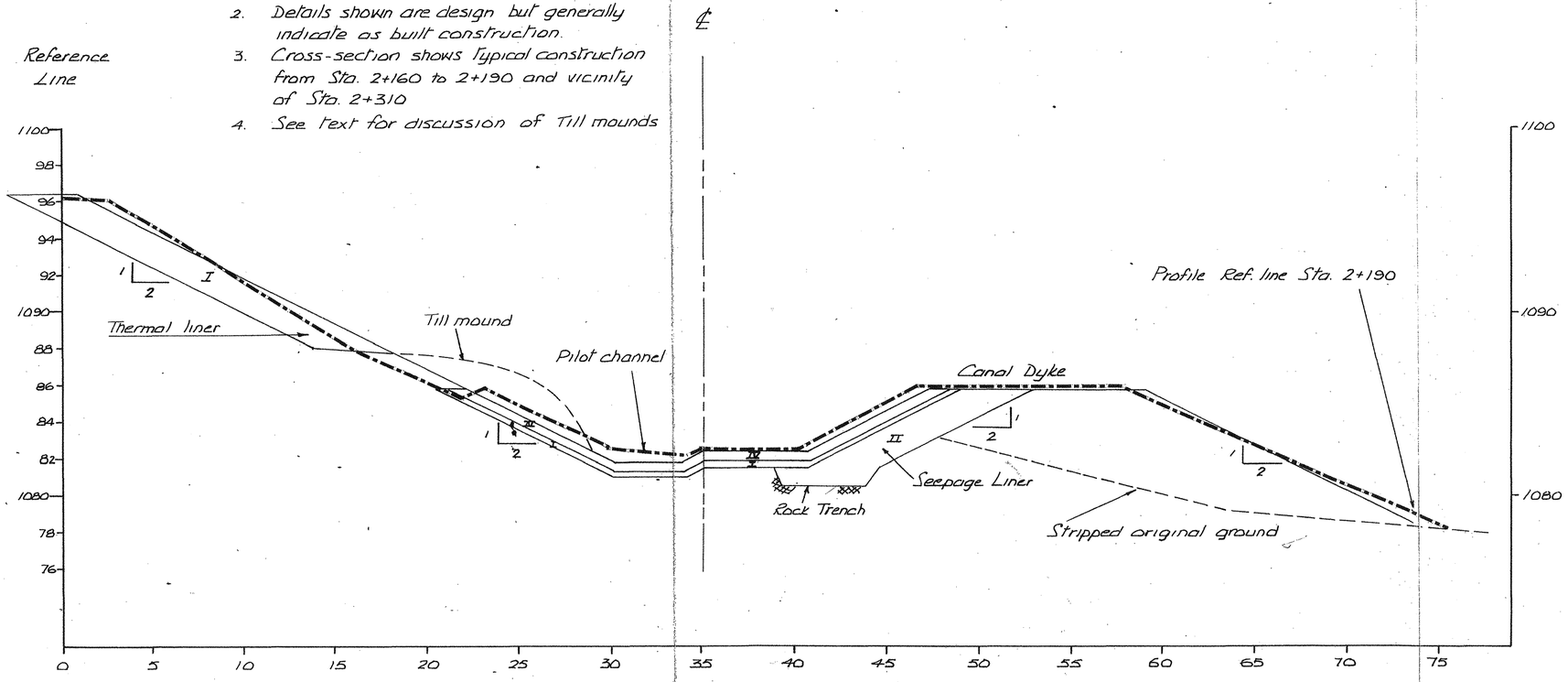
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TYPICAL CANAL CROSS-SECTION
AT TILL MOUNDS

FIGURE. 4 - 18

Notes:

1. I, II, III; Denote material classes.
   " See text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows Typical construction from Sta. 2+160 to 2+190 and vicinity of Sta. 2+310
4. See text for discussion of Till mounds



Scale 1:200

Design cross-section
As built profile

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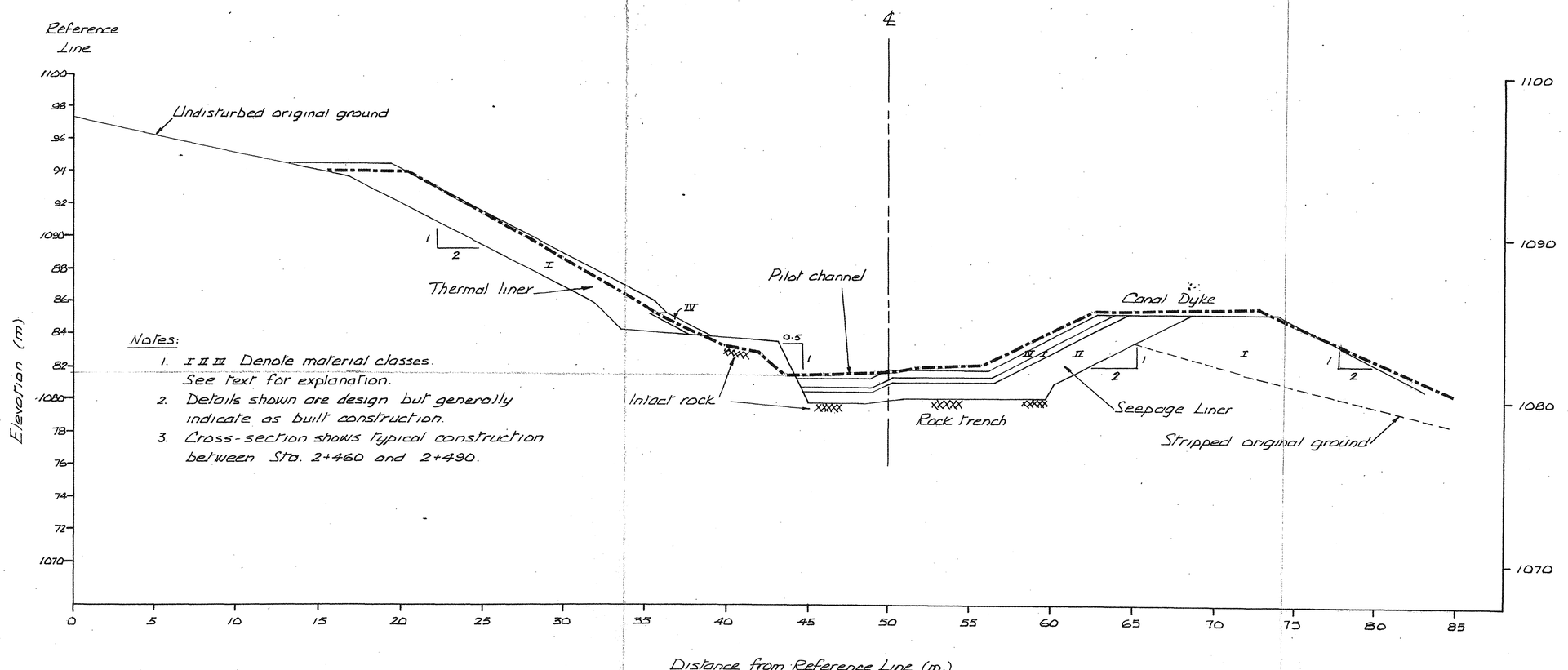
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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 2+460

FIGURE. 4-19



Notes:

1. I II III Denote material classes. See text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction between Sta. 2+460 and 2+490.

Scale 1:200

Design Cross-section

As built profile.

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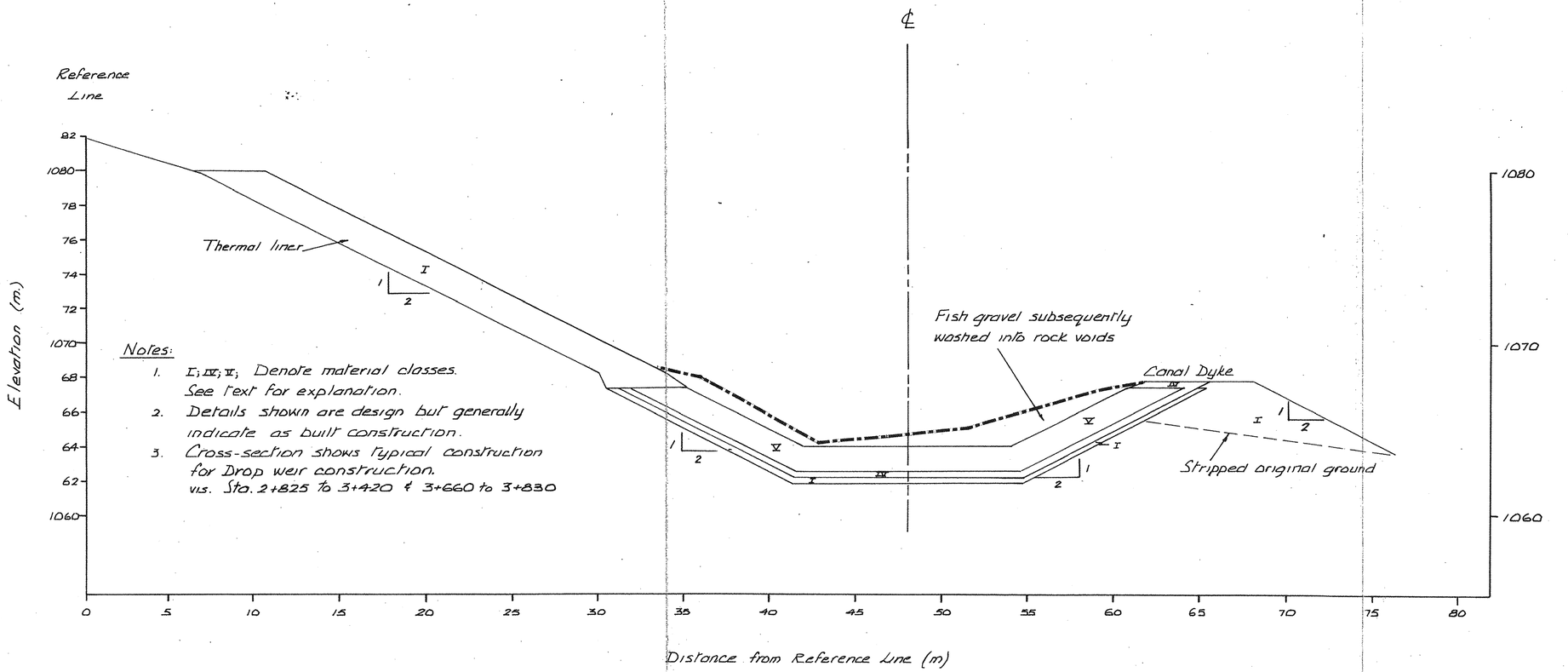
Drawn SP
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Date Feb'82

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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 3+150

FIGURE. 4 - 20



Notes:

1. I; II; V; Denote material classes. See text for explanation.
2. Details shown are design but generally indicate as built construction.
3. Cross-section shows typical construction for Drop weir construction. viz. Sta. 2+825 to 3+420 & 3+660 to 3+830

Scale 1:200

Design Cross-section
As built profile

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Dave Goodall
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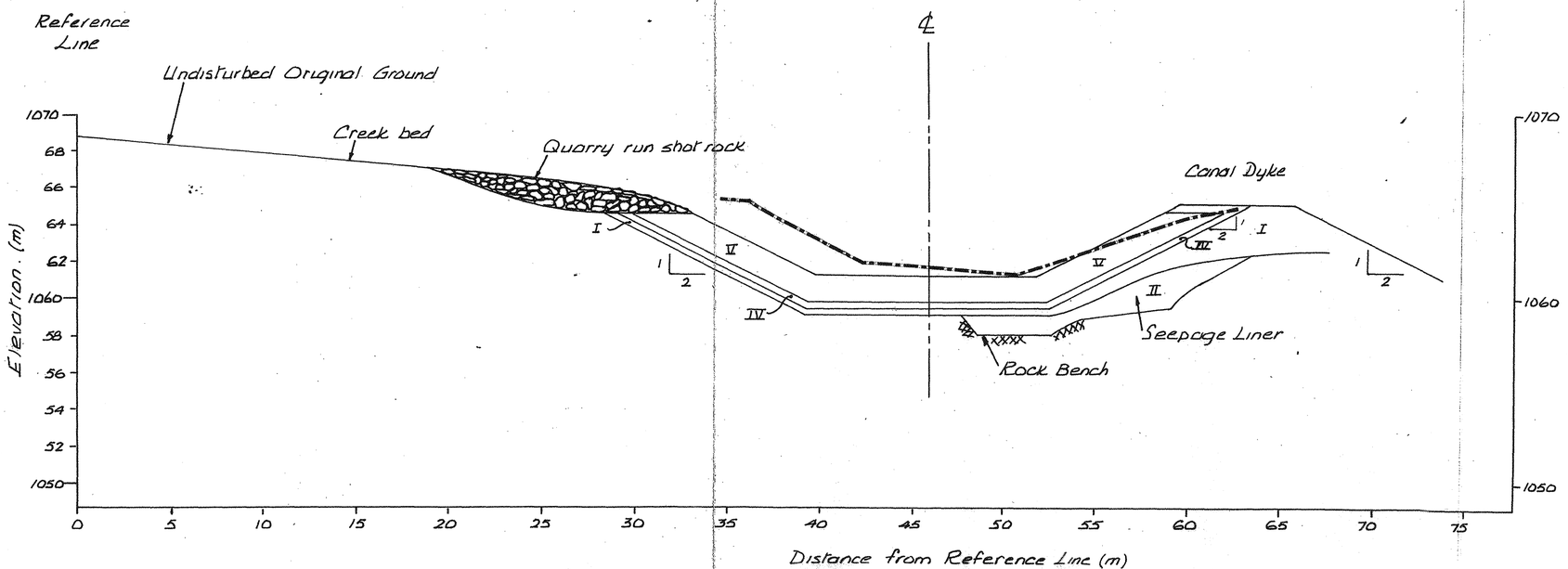
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CORNISH CREEK INTERCEPTION
REFERENCE LINE STA. 3+262

FIGURE 4 - 21

Note:
I; II; III; IV; V; Denote material classes
See text for explanation.



Scale 1:200

Design Cross-section

As built profile

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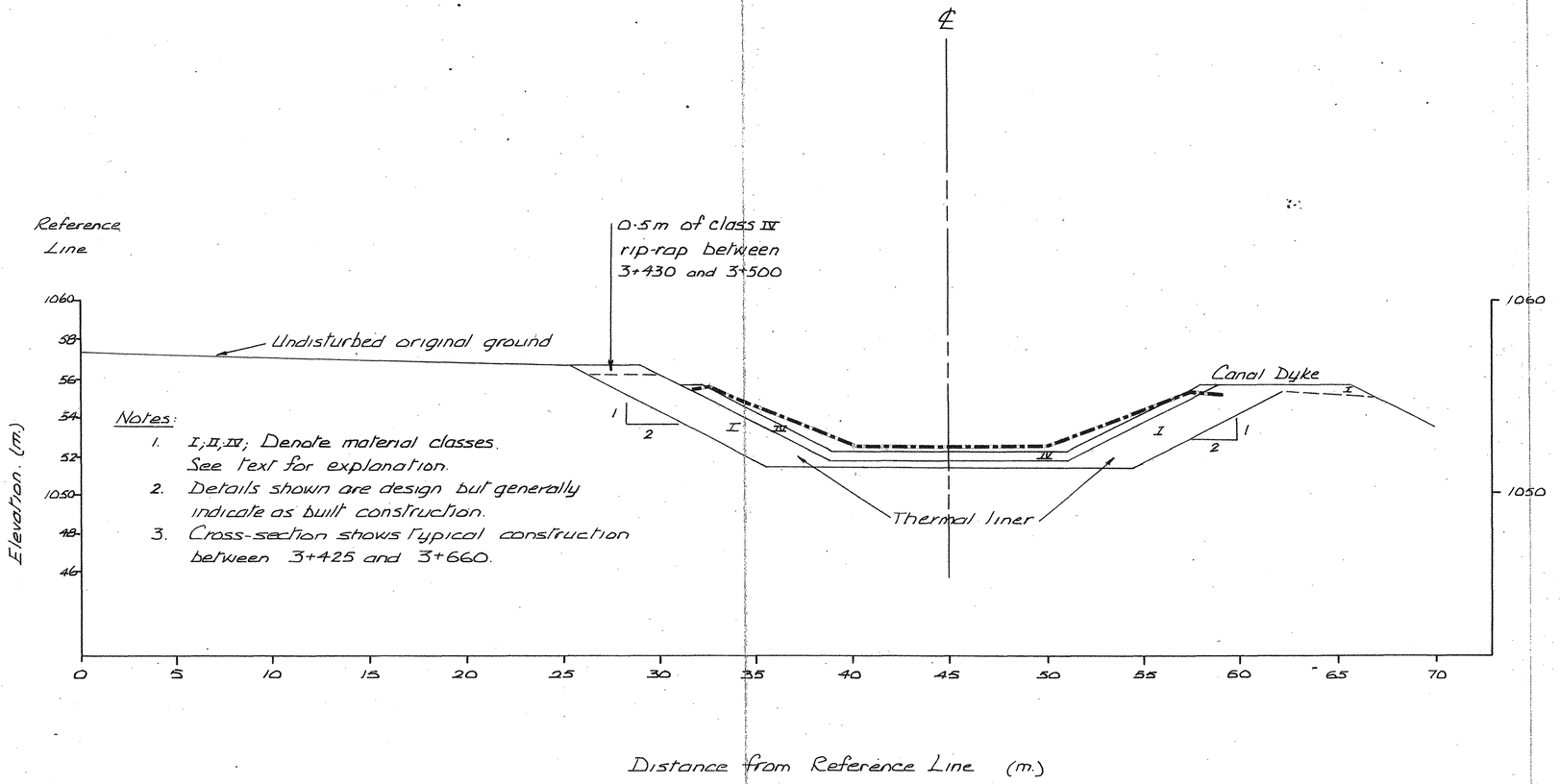
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TYPICAL CANAL CROSS-SECTION
REFERENCE LINE STA. 3+510

FIGURE. 4 - 22



Scale 1:200

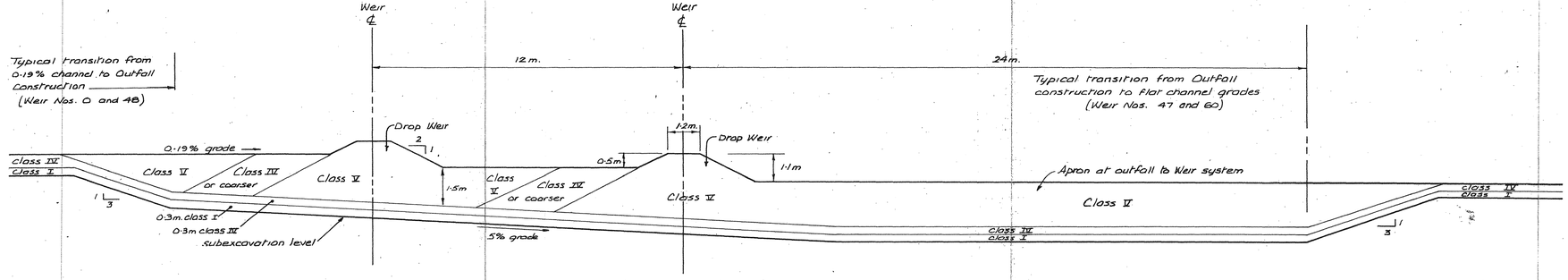
Design Cross-section
As built profile

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Dave Goodall
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Date Feb'82

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Project No. 802-2036



Scale 1:100

TYPICAL DIVERSION CANAL OUTFALL PROFILE | FIGURE 4 - 23

NOTES.

1. The actual configuration constructed is considerably more irregular than that shown due to the large size of class V riprap. See appendix III for photographs of the actual construction.
2. See text for explanation of material classes.
3. Zone labelled class III or coarser is a design change to reduce flow through the class V subgrade.
4. Sand and gravel was deposited between the weirs in the outfall section. This gravel referred to as "Fish Gravel" was redistributed by the creek in the voids of the class V rock. See appendix III for photographs

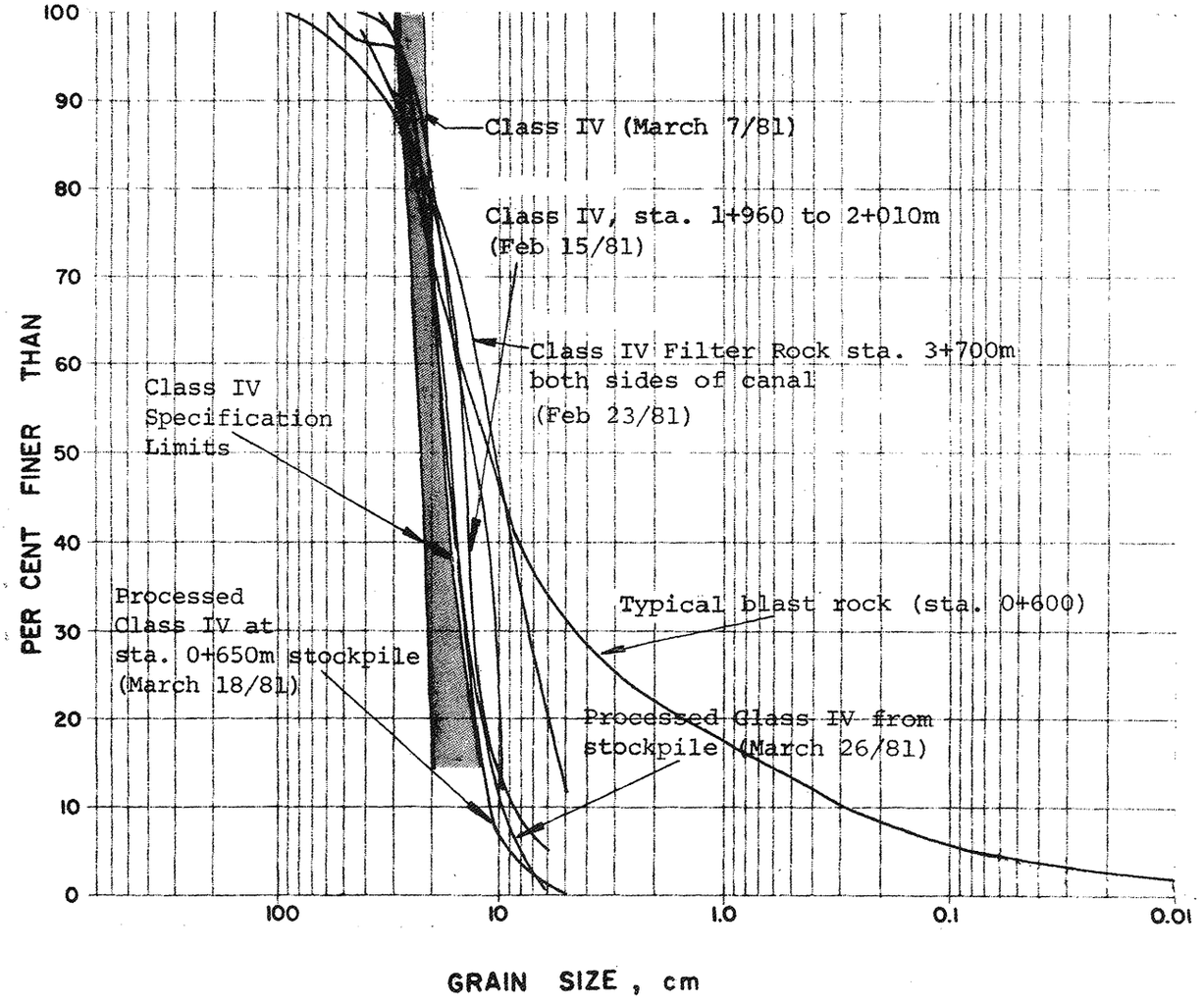
PROFESSIONAL ENGINEER
R. B. BOOSALL
TERRITORIES
Date February 19, 1982

Drawn RK/9
Rev'd DG
Date Feb '82

Golder Associates

CLASS IV RIPRAP GRADATIONS

Figure 4-24

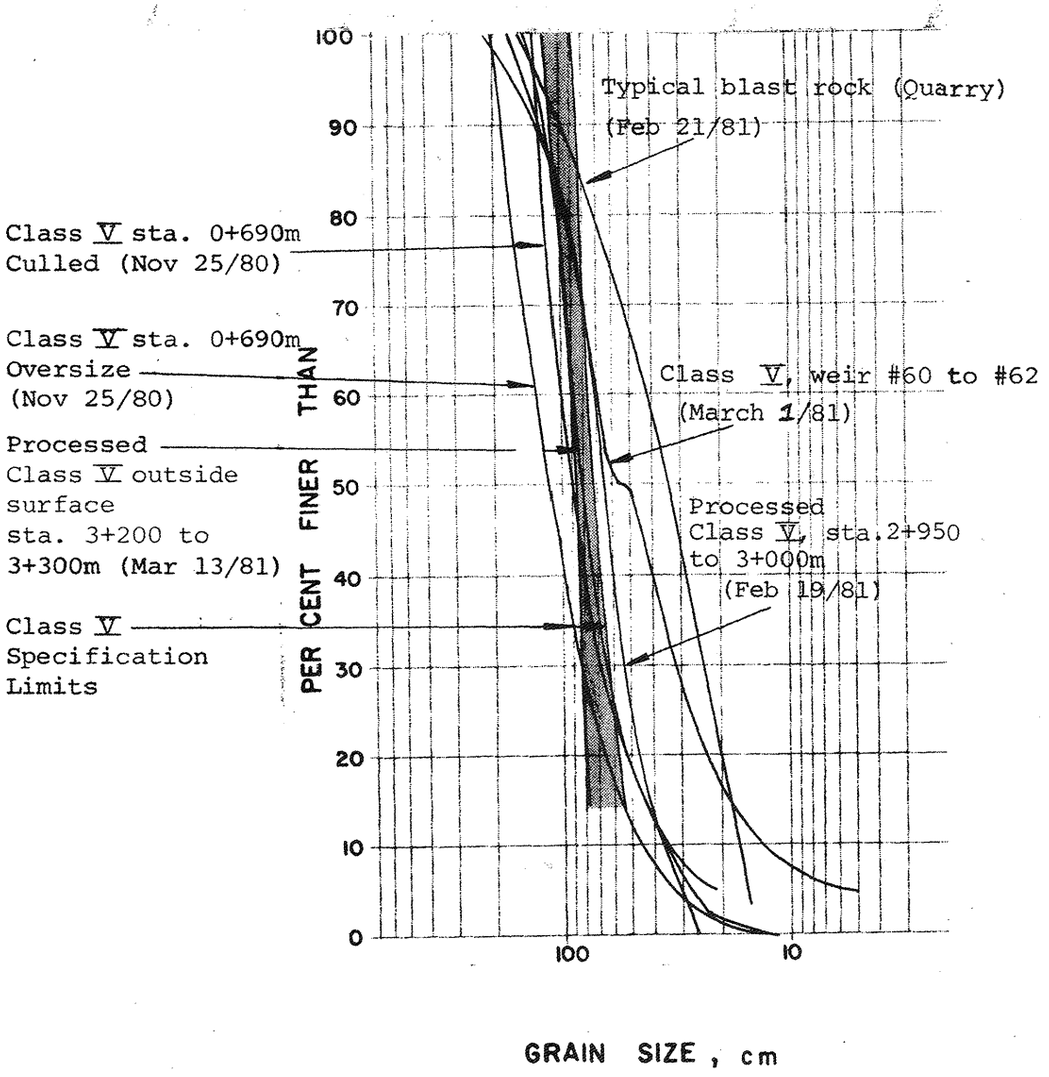


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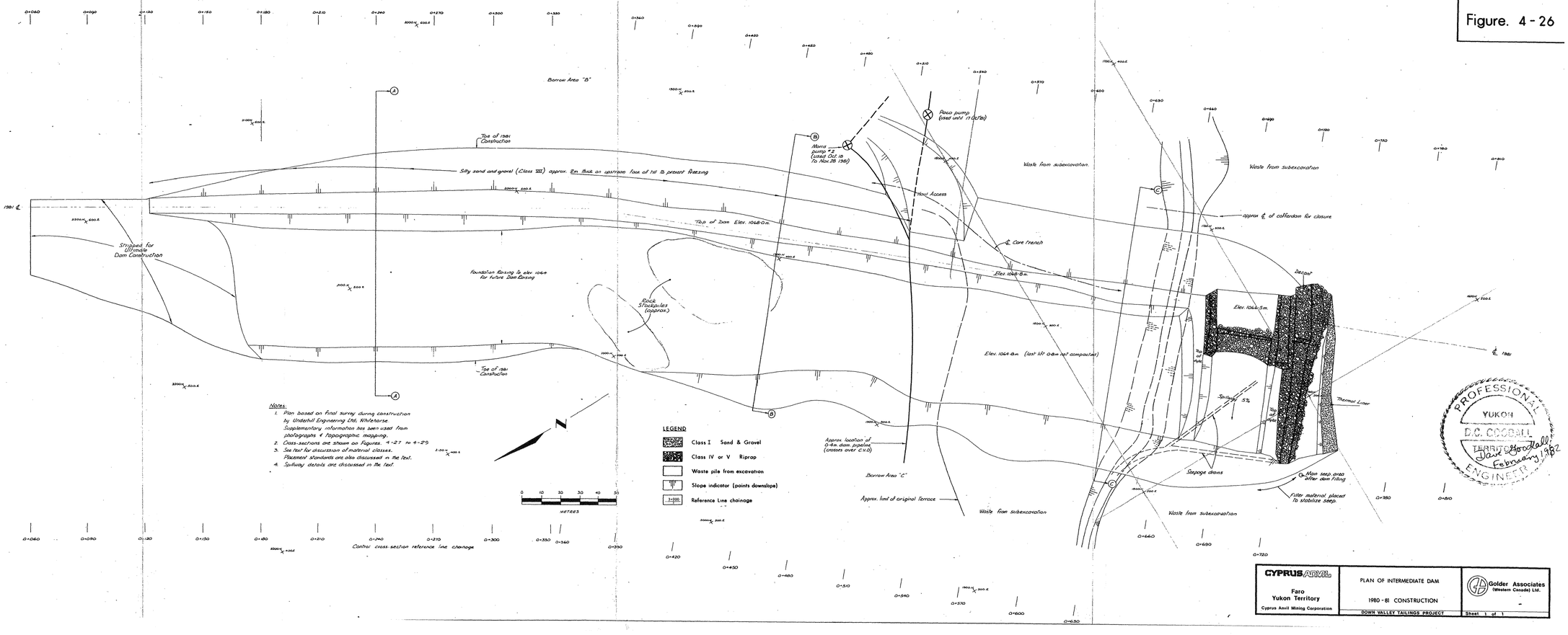
CLASS V RIPRAP GRADATIONS

Figure 4-25



Project No. 802-2038 Drawn G.B. Reviewed [illegible] Date Feb/82

Figure. 4 - 26



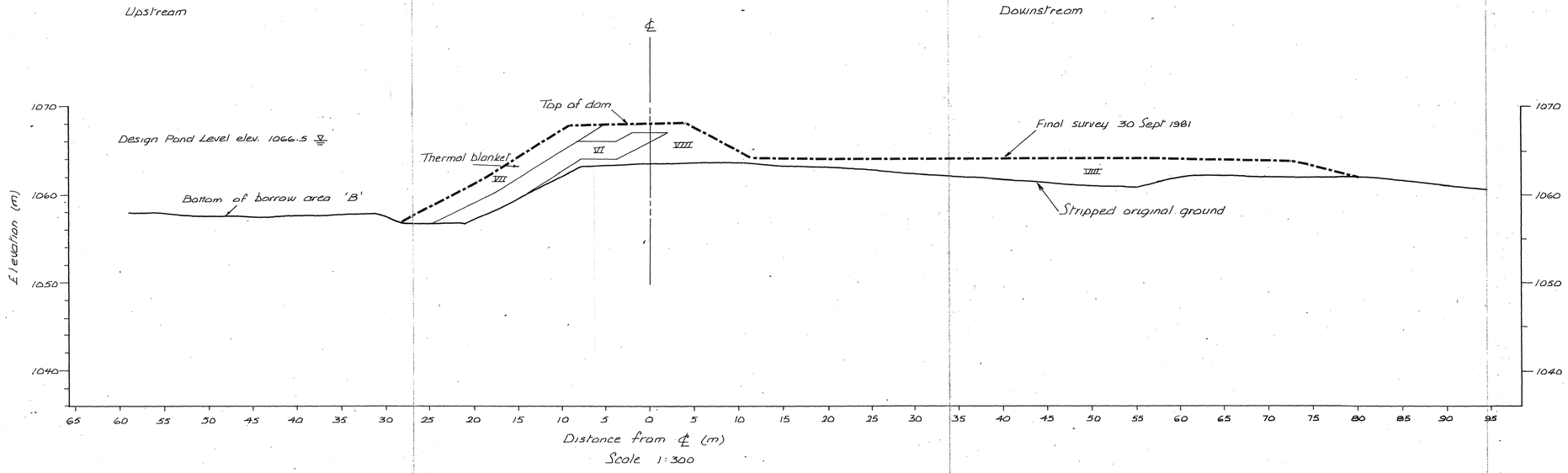
PROFESSIONAL ENGINEER YUKON D.C. COGBILL TERRITORIAL Jan Goodall February 1982

CYPRUS ANVIL Faro Yukon Territory Cyprus Anvil Mining Corporation	PLAN OF INTERMEDIATE DAM 1980 - 81 CONSTRUCTION DOWN VALLEY TAILINGS PROJECT	Golder Associates (Western Canada) Ltd. Sheet 1 of 1

Project No 802-2038

TYPICAL INTERMEDIATE DAM CROSS SECTION A-A
STAGE I CONSTRUCTION (TERRACE AREA)

FIGURE 4 - 27



NOTES.

1. See text for explanation of material classes.
2. For location of section see Figure 4-26

PROFESSIONAL ENGINEER
Steve Goodall
February 19, 1982

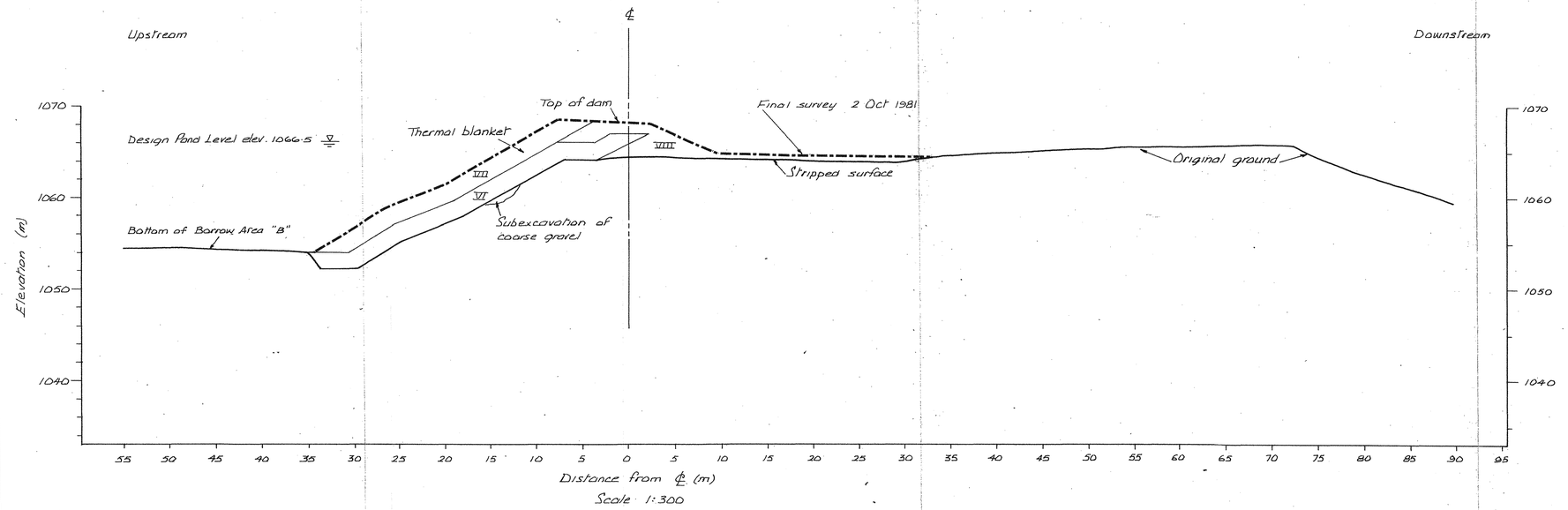
Drawn RK/G
Revd DG
Date Feb '82

Golder Associates

Project No. 802-2038

TYPICAL INTERMEDIATE DAM CROSS SECTION B-B
STAGE I CONSTRUCTION (TERRACE AREA)

FIGURE 4-28



NOTES

1. See text for explanation of material classes.
2. For location of section see Figure 4-26

PROFESSIONAL ENGINEERS YUKON D.J. GRAHAM
Dave Graham February 19, 1982

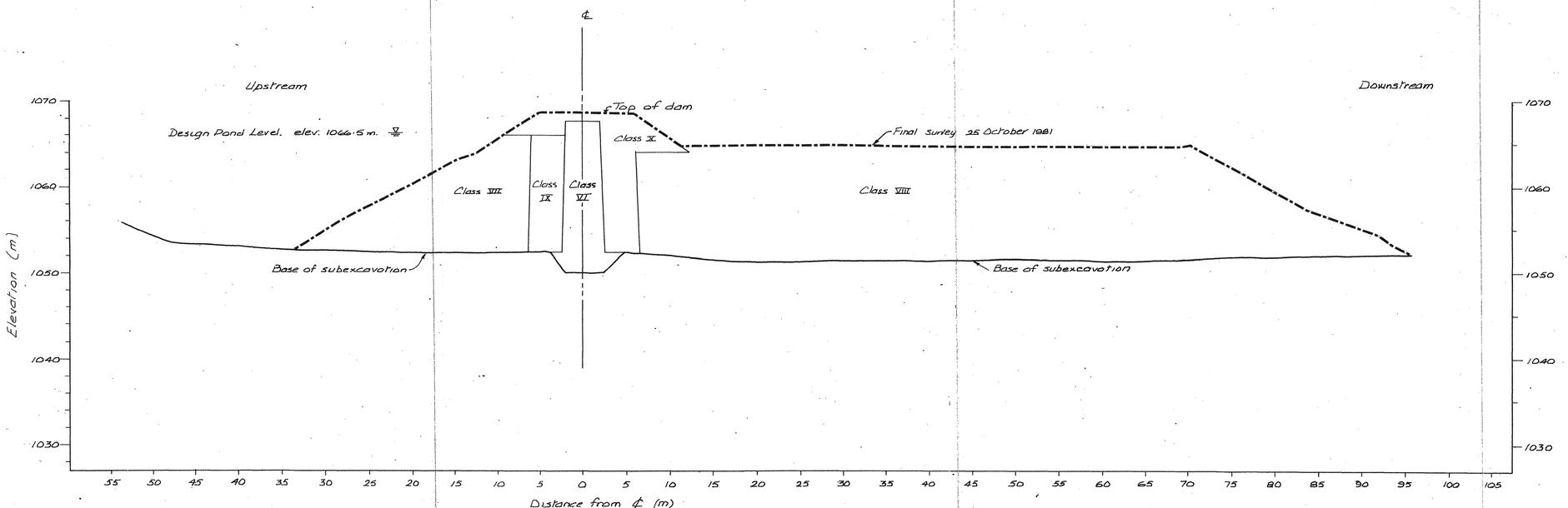
Drawn RK/GP
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Date Feb'82

Golder Associates

Project No. 802-2038

TYPICAL INTERMEDIATE DAM CROSS SECTION C–C
STAGE I CONSTRUCTION (ROSE CREEK AREA)

FIGURE 4 - 29



NOTES.

1. See text for explanation of material classes
2. For location of section see Figure 4-26

PROFESSIONAL ENGINEER
Steve Stoddell
February 19, 1982

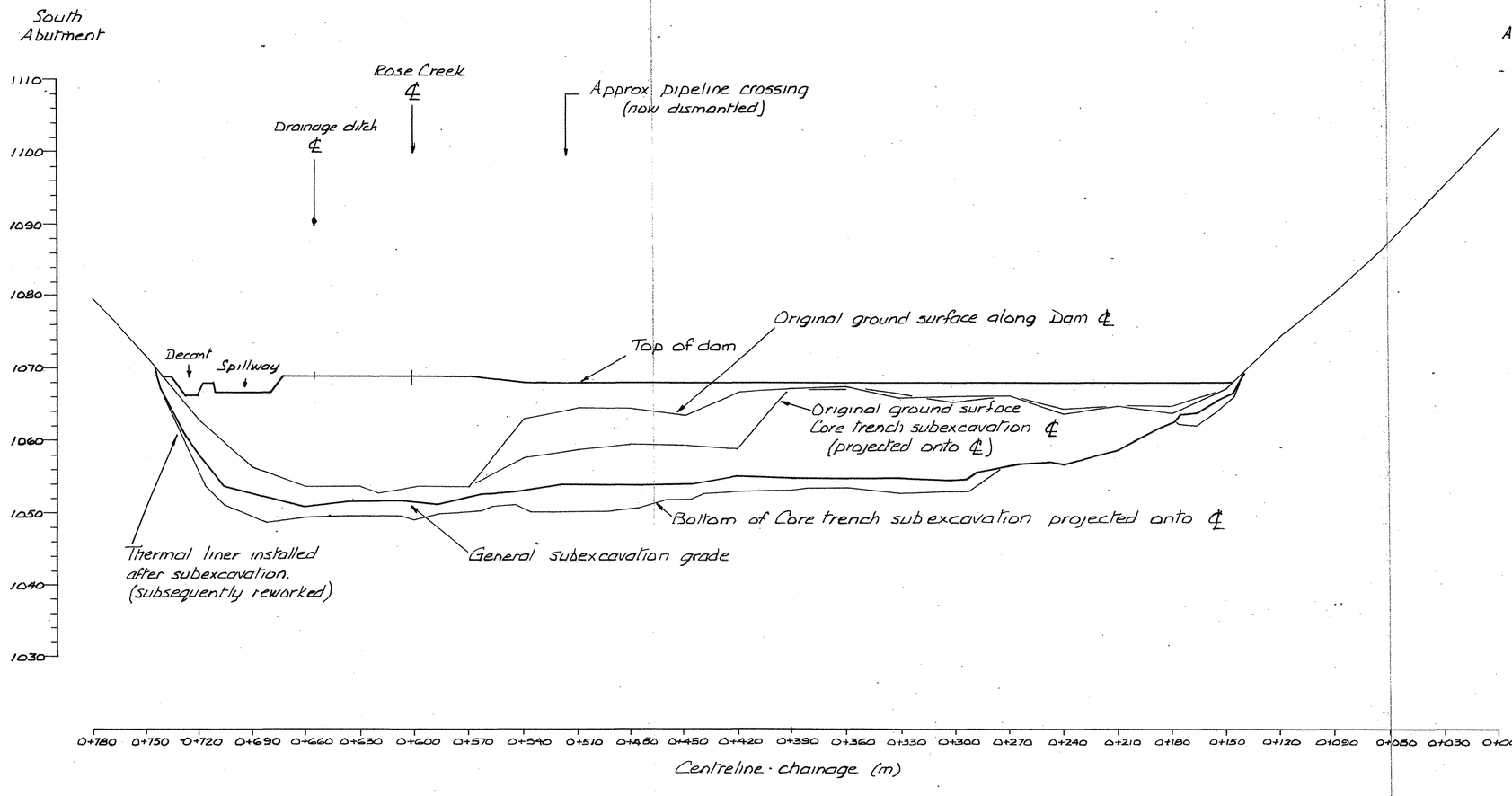
Drawn RK/CP
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Date Feb '82

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Project No. 802-2038

INTERMEDIATE DAM CENTRELINE PROFILE
STAGE I CONSTRUCTION

FIGURE 4 - 30



NOTES.

1. Cross sections shown on Figures 4-26 to 4-29
2. Plan location shown on Figure
3. Information is based on surveys by: Underhill Engineering Ltd.

SCALES.

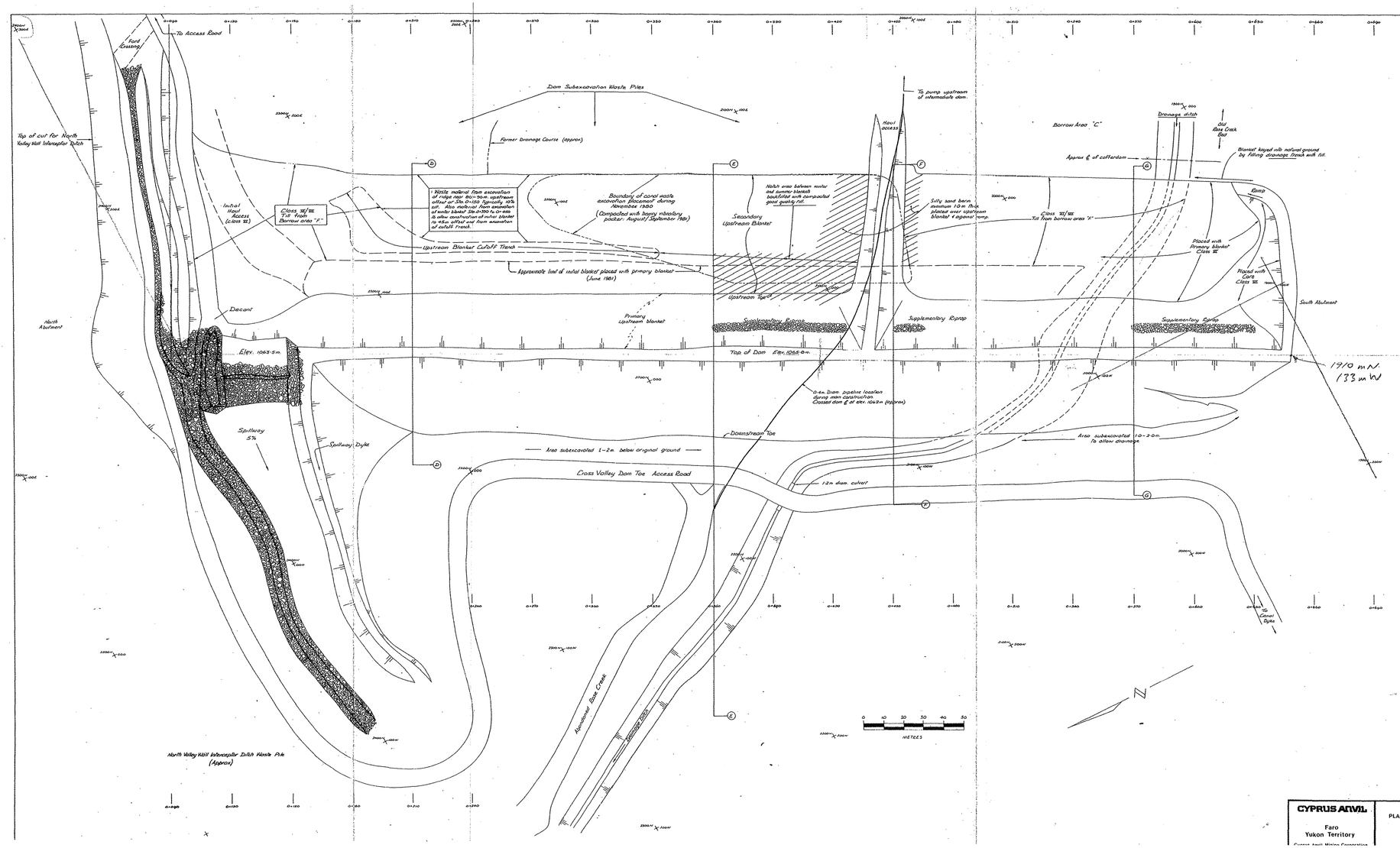
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1:500 Vertical

PROFESSIONAL ENGINEER
Dave Goodall
February 19, 1982

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Date Feb '82

Golder Associates

Figure. 4-31



LEGEND

- Class I Sand & Gravel
- Class IV or V Riprap
- Waste pile from excavation
- Slope indicator (points downslope)
- 1+000 Reference Line chainage

Notes:

1. Plan based on surveys by Underhill Engineering Ltd; Whitehorse during construction. Supplementary information has been used from photographs and topographic mapping.
2. Cross-sections are shown on Figures. 4-32 to 4-35
3. See text for explanation of material classes. Placement standards are also discussed in the text.
4. Spillway details discussed in the text.

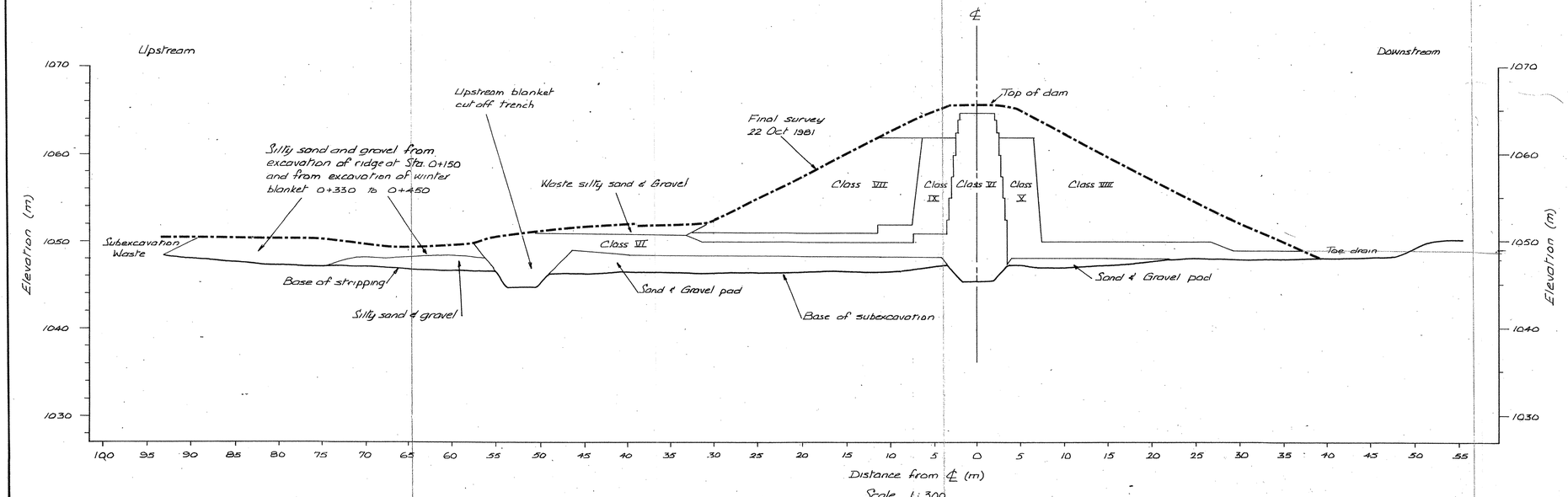
PROFESSIONAL ENGINEER YUKON E.P. BEWLAY February 19, 1982

CYPRUS ANVIL Faro Yukon Territory	PLAN OF CROSS VALLEY DAM 1980 - 81 CONSTRUCTION	Golder Associates (Western Canada) Ltd

Project No. 802-2038

TYPICAL CROSS VALLEY DAM CROSS SECTION
D–D

FIGURE 4-32



NOTES.

1. See text for explanation of material classes.
2. For location of section see Figure 4-31

PROFESSIONAL ENGINEER
YUKON
D.C. GUDMALL
Dated at Whitehorse
February 19, 1982

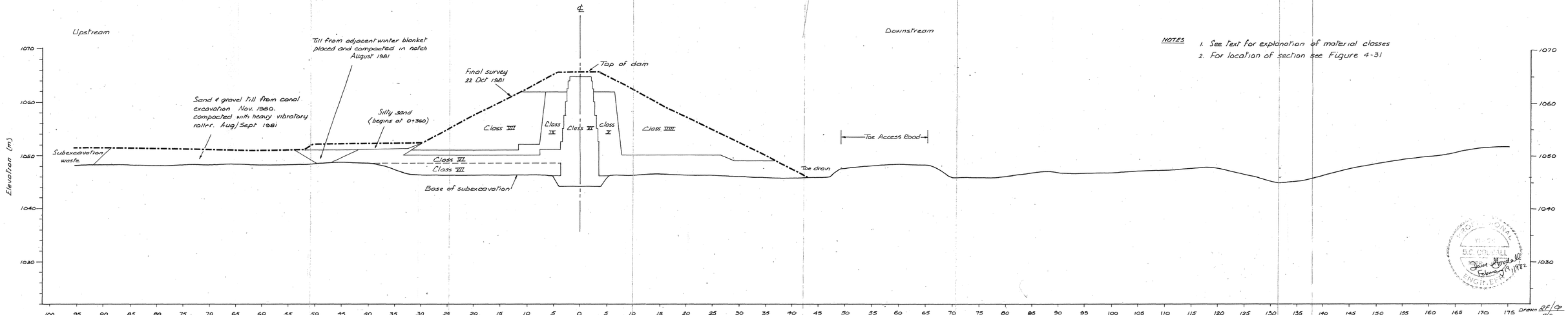
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Project No. 802-2038

TYPICAL CROSS VALLEY DAM CROSS SECTION
E - E

FIGURE 4-33



Scale 1:300

NOTES
1. See text for explanation of material classes
2. For location of section see Figure 4-31

PROFESSIONAL ENGINEER
B.C. COUNCIL
Blaine Stroshein
February 19, 1982
ENGINEER

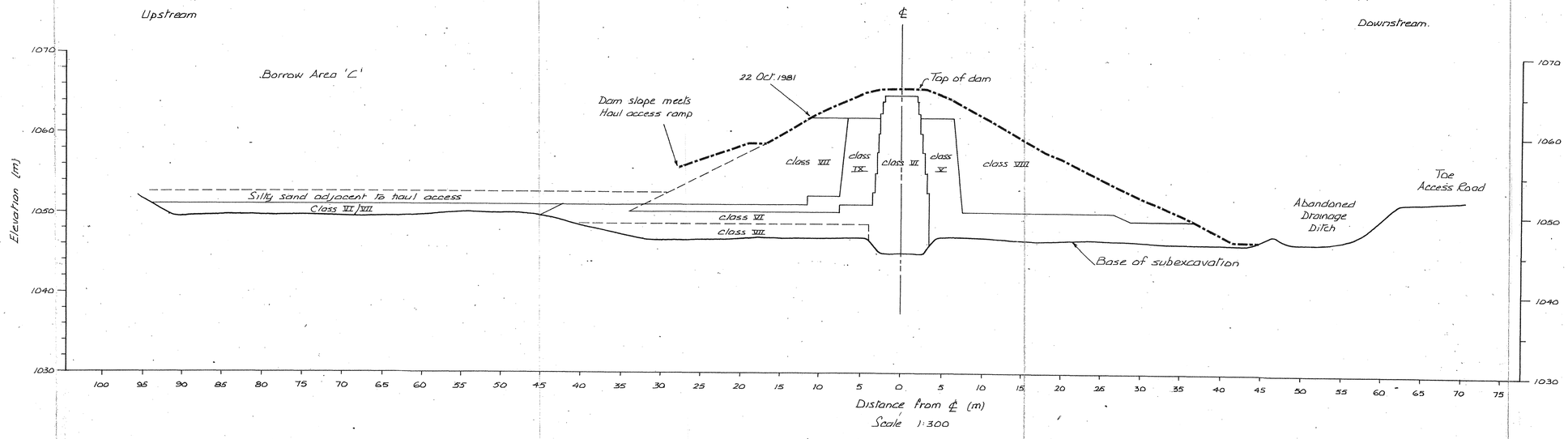
Drawn RF/Gp
Revd JG
Date Feb 82

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Project No. 802-2038

TYPICAL CROSS VALLEY DAM CROSS SECTION
F – F

FIGURE 4 - 34



NOTES.

1. See text for explanation of material classes.
2. For location of section see Figure 4-31

PROFESSIONAL ENGINEER YUKON
Dave Goodall
February 19, 1982

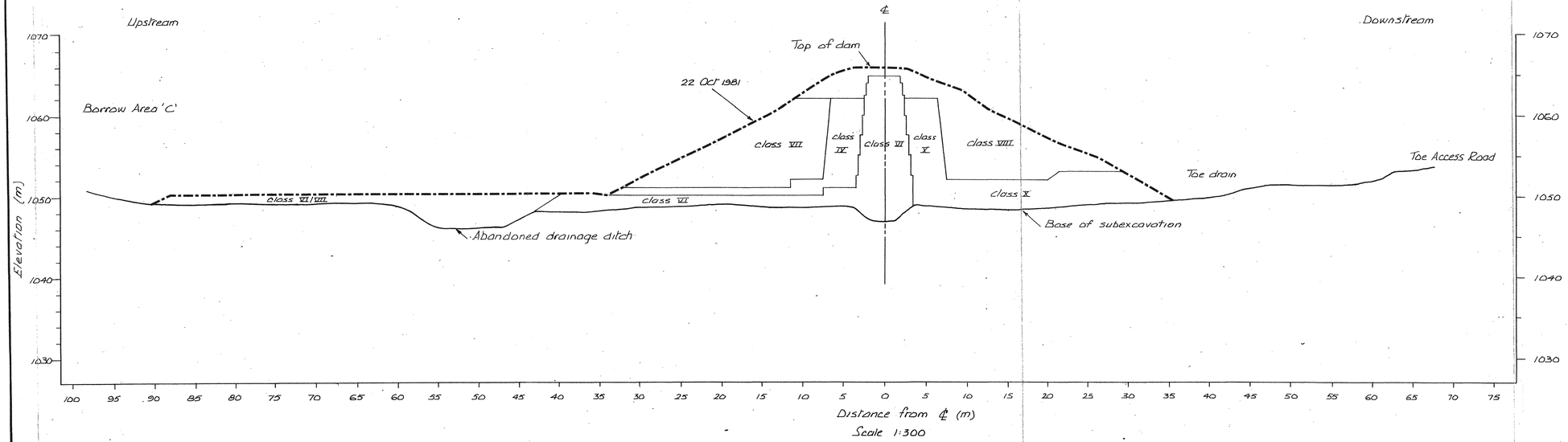
Drawn RF/GP
Revd DG
Date Feb. '82

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Project No. 802-2038

TYPICAL CROSS VALLEY DAM CROSS SECTION
G-G

FIGURE 4 - 35



NOTES.

1. See text for explanation of material classes
2. For location of section see Figure 4-31

PROFESSIONAL ENGINEER YUKON
Dave Goodall
February 19, 1982

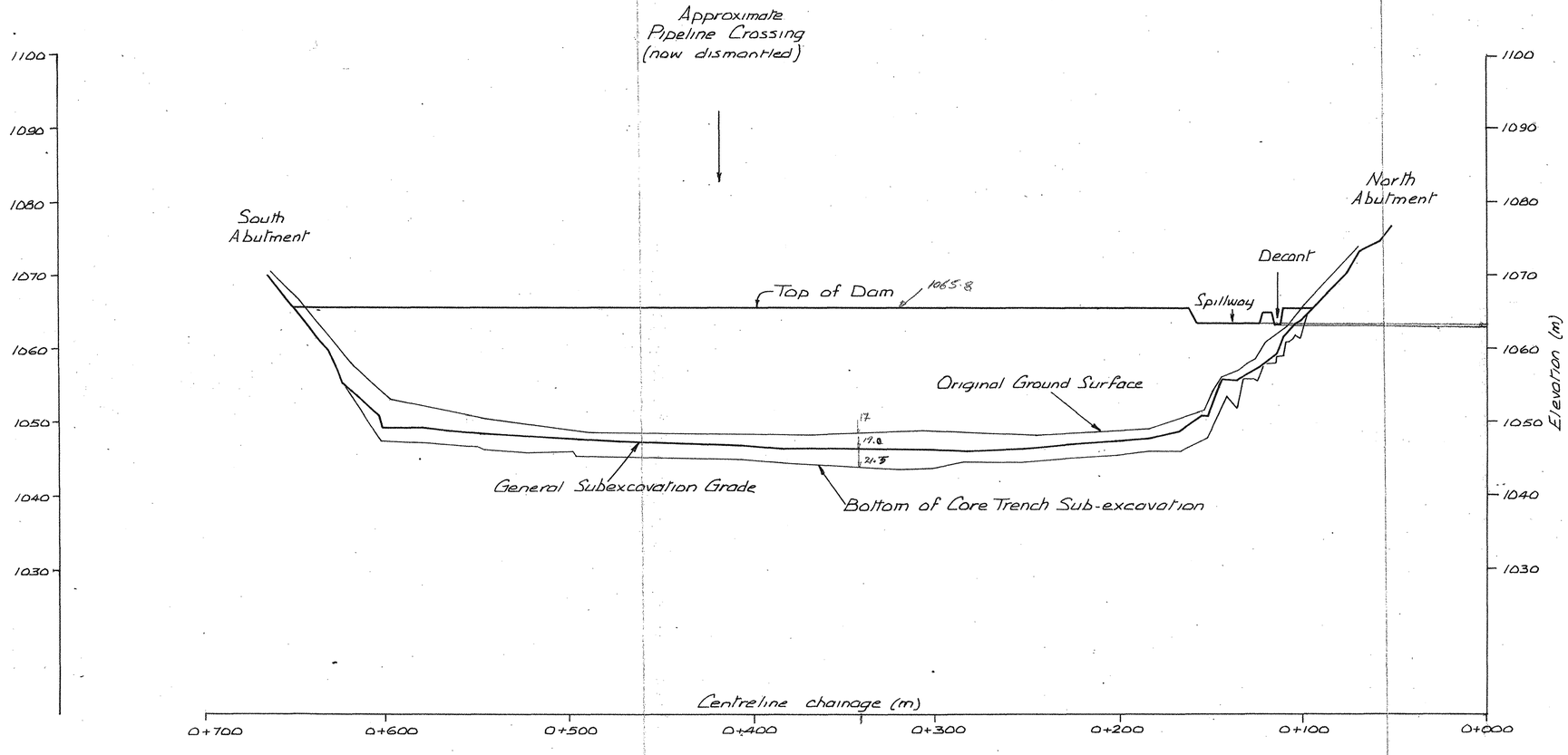
Drawn RK/GP
Rev'd DG
Date Feb '82

Golder Associates

Project No. 802-2038

CROSS VALLEY DAM CENTRELINE PROFILE

FIGURE 4 - 36



NOTES:

1. Cross-sections shown on Figures, 4-32 to 4-35
2. Plan location shown on Fig: 4-31
3. Information based on surveys by Underhill Engineering Ltd.

Scales

1:2000 Horizontal

1:500 Vertical

PROFESSIONAL ENGINEER YUKON David Goodall February 19, 1982

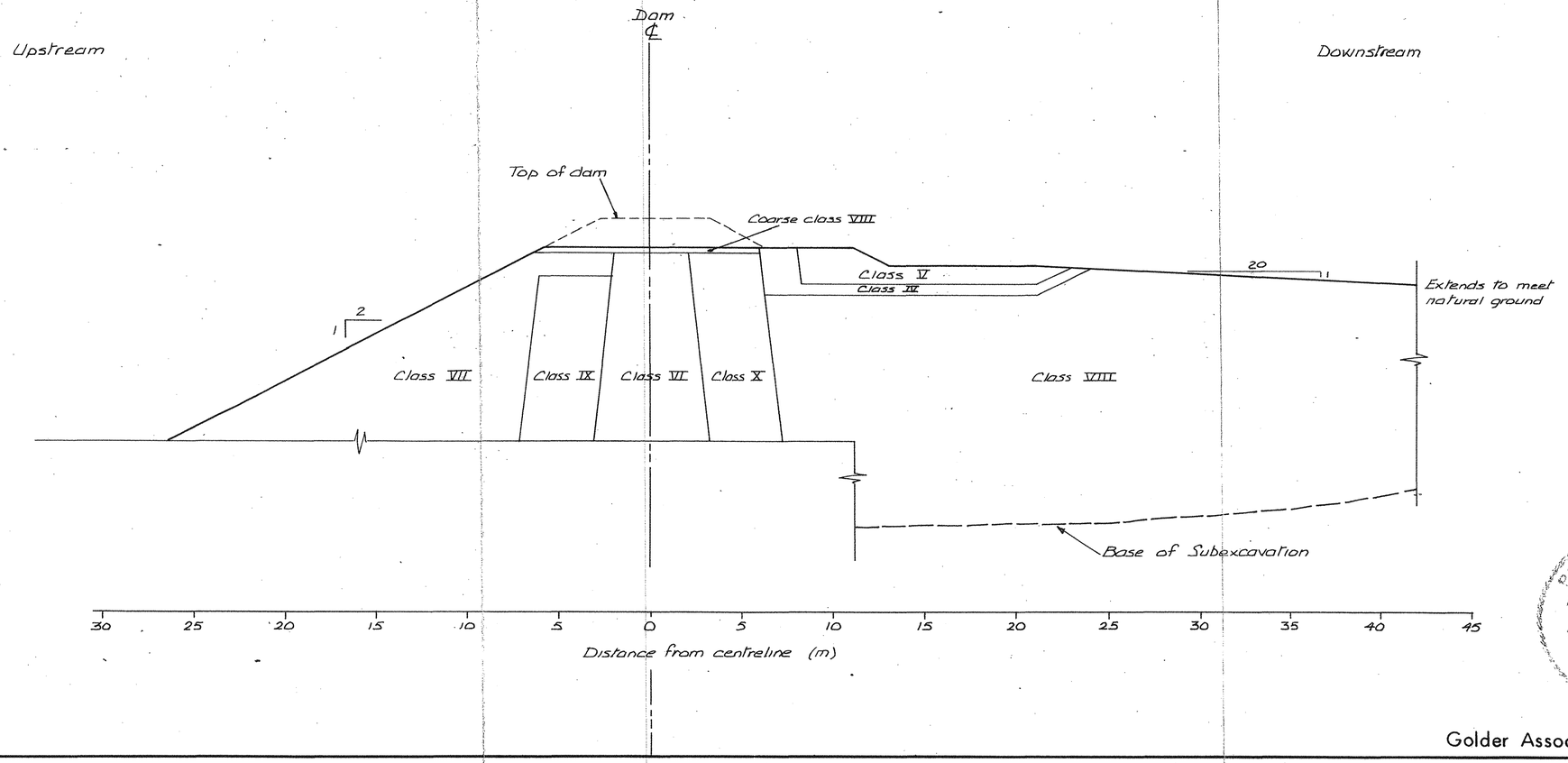
Drawn RK/GP
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Date Feb '82

Golder Associates

Project No 802-2038

TYPICAL CENTRELINE PROFILE THROUGH SPILLWAY | FIGURE 4 - 37

NOTE: See text for explanation of material Classes.



Scale 1:200

PROFESSIONAL ENGINEER YUKON Dave Goodall February 19, 1982

Drawn RK/GF
Rev'd DG
Date Feb'82

Golder Associates

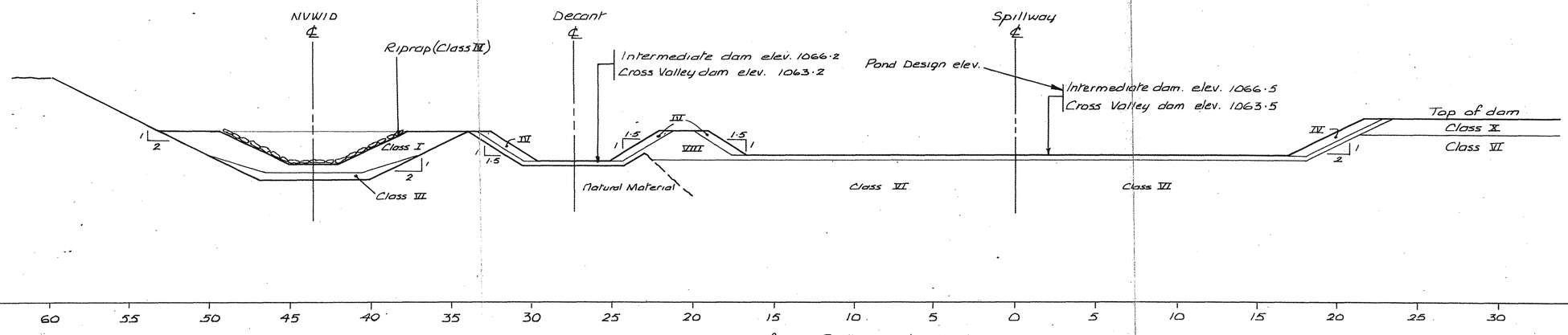
Project No. 802-2038

TYPICAL CROSS SECTION ON DAM CENTRELINE THROUGH SPILLWAY AND DECANT CHANNEL

FIGURE 4 - 38

NOTES.

1. See text for explanation of material classes.
2. Details of the North Valley Wall Interceptor Ditch (N.V.W.I.D) apply to Cross Valley Dam Only. No interceptor ditch exists at the intermediate dam. The thermal liner forms the decant wall directly
3. For location of spillways see Figures 4-26 & 4-31



Distance from Spillway ℄ (m)

Scale 1:200

PROFESSIONAL ENGINEER YUKON Dave Goodall February 19, 1982

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Date Feb' 82

Golder Associates

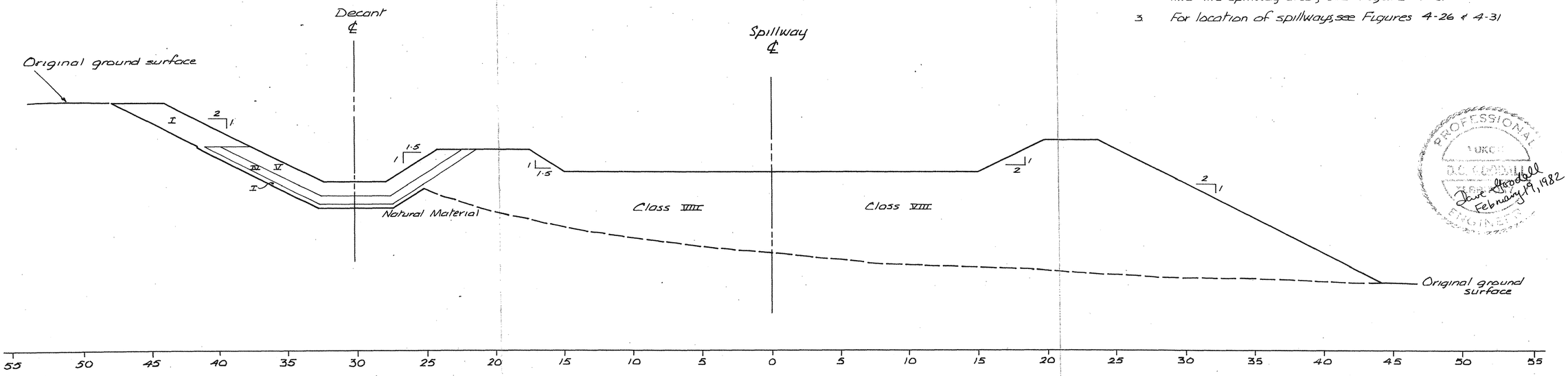
Project No 802-2038

TYPICAL CROSS SECTION THROUGH SPILLWAY AND DECANT IN 5 PERCENT GRADIENT AREA

FIGURE 4 - 39

NOTES.

1. See text for explanation of material classes.
2. In the 5 percent gradient area of the Cross Valley Dam, the dyke between the decant and spillway terminates and the decant merges into the spillway area; see Figure 4-31
3. For location of spillways, see Figures 4-26 & 4-31



Scale 1:200

PROFESSIONAL ENGINEERS
David Stoddart
February 19, 1982

Drawn RK/9
Rev'd DG
Date Feb '82

Golder Associates

5.0 CONSTRUCTION PERFORMANCE, REMEDIAL WORK AND RECOMMENDATIONS FOR FURTHER WORK

5.1 Construction Performance

Visual inspections were completed on a routine basis by Golder Associates' site personnel for the canal in particular. Additional inspections were made by Golder Associates' personnel from Calgary and Vancouver, by Mr. Wim Weldman of Hydrocon Engineering Ltd., by representatives of the Yukon Territory Water Board, and the Federal Department of the Environment.

Instrumentation installed during construction was also monitored on a regular basis. This included thermistors on the canal dyke and piezometers and settlement plates in the dams. Observations were also made of other piezometers installed by Klohn Leonoff Consultants and by Golder Associates.

5.1.1 Diversion Canal

Following the diversion of Rose Creek, Golder Associates made regular inspections of canal performance. In particular, any occurrences of seepage and evidence of cracking or subsidence were noted. A summary of these observations is provided on Table 5-1. Detailed instrumentation of the canal immediately after diversion was not possible because the canal dyke was not complete to its final elevation.

Mr. Wim Veldman of Hydrocon Engineering visited the site on July 17, 18, 1981 (after diversion) and prepared a report entitled "Hydraulic Review of As-Built Conditions - Rose Creek Diversion". This report is reproduced in Appendix VII. It is noted that the canal dyke was not complete at the time of Mr. Veldman's visit.

Dr. J.I. Clark and Mr. H.G. Gilchrist of Golder Associates visited the site on August 25, 26, 1981 to review the performance of the canal and the ongoing construction. A follow up letter was prepared by Golder Associates which reviewed the canal dyke performance in general and presented documentation of both prior and subsequent crack movement monitoring for the canal dyke. Based on these results and on knowledge of site conditions, it was concluded that cracking of the dyke was probably related to thaw settlement of the dyke foundation.

Mr. McAlpine, representing the Yukon Territory Water Board and Mr. Roxborough of the Department of Fisheries were present for the diversion of Rose Creek on May 11, 1981. Subsequent site visits were made by Mr. McAlpine on May 28, June 17, July 23, August 1 and August 13. Mr. Roxborough visited the site at the end of May and again on October 26. A number of deficiencies were noted during these site visits particularly with respect to fish passage over the weirs.

On June 4, 1981 a post diversion site visit was also made by Mr. Milos Stepanek of Hardy Associates (1978) Ltd. in connection with his responsibilities as a member of the Yukon Territory Water Board Technical Review Committee. Mr. Stepanek inspected both the seepage occurring in the south wall of the Rose Creek valley adjacent to the diversion canal and other ongoing construction work on the dams.

In keeping with the program of field monitoring, two thermistors were installed in the diversion canal dyke in August at Sta. 2+100 and at Sta. 2+900. Observations for these thermistors are presented in Appendix VIII, Tables VIII-1 and VIII-2. At Sta. 2+100, where the thermistor is located on the right side of the dyke the maximum depth of thaw recorded on October 26, 1981 was 6 m. As approximately 6 m of fill was placed at this location this indicates that no thawing beneath the stripped surface has taken place. At Sta. 2+900, where the thermistor is located on the left side of the dyke and approximately 2 m of fill was placed, thawing extended to a depth of 3 to 4 m on October 26, 1981, indicating that there has been some thawing beneath the stripped surface.

Observations for the pneumatic piezometer in Borehole No. 79-23 whose location is documented on Table 3-2 are reported on Table VIII-5, Appendix III.

A study of the seepages at the south abutment of the Intermediate Dam was undertaken to assess their source. Chemical analyses of water samples collected by Golder Associates were performed by Cyprus Anvil. The results are tabulated on Table 5-2 and are particularly useful after July 29 due to the change in canal chemistry which resulted from the startup pumping.

5.1.2 Intermediate Dam

The Intermediate Dam was completed at the end of the project construction period and significant ponding of water behind the dam was not allowed until the beginning of December (1981). As a consequence there was no period of post construction observation related to reservoir filling. However, during construction, settlement plates were installed in the vicinity of Rose Creek at the base of the dam as the first lifts of fill were placed. Three settlement plates were installed and the locations are as documented on Table 3-3 and as shown shown in plan on Figure 3-3. The record of data for the settlement plates is provided on Table VIII-9 in Appendix VIII.

The settlements appear to be proportional to load with relatively little post-loading evidence of consolidation. The largest settlement, 0.405 m was observed in the 55 m wide area between the old Rose Creek bed and the more southerly Drainage Ditch. The second largest settlement, 0.261 m, was observed in the vicinity of the old creek bed. The smallest settlement, 0.133 m was observed in the area south of the Drainage Ditch in the bench area of the dam where the height of fill is 74 percent (approx.) of that at the other locations.

Water levels recorded in the settlement plate risers are shown on Table VIII-8 on Appendix VIII.

Pneumatic piezometers were installed in the base of the dam in the silt stratum beneath the core cutoff trench. The details of these piezometers are tabulated on Table 3-3. The observations during construction are shown on Tables VIII-6 and VIII-7 on Appendix III.

5.1.3 Cross Valley Dam

Four settlement plates were installed at regular intervals near the dam centreline during placement of the first lifts of fill. The locations of the settlement plates are documented on Table 3-3 and shown in plan on Figure 3-3. The record of data for the settlement plates is provided on Table VIII-17 of Appendix VIII.

The settlements appear to be proportional to load with relatively little post-loading evidence of consolidation. The largest settlement, 0.519 m was observed at Sta. 0+341 in the area where silt was encountered during dam subexcavation. The second and third largest settlements, both approximately 0.26 m, occurred at Sta. 0+205 and at Sta. 0+570 where silty layers are known to exist. The lowest settlement, 0.109 m, was observed at Sta. 0+454 in the vicinity of the old Rose Creek channel where the subexcavation encountered sand and gravel but no evidence of a silty layer at depth.

Before dam construction began some seepage was observed in the subexcavation area south of the Drainage Ditch. Most of this seepage originated at the western fringe of the dam subexcavation and a trench was excavated along the downstream toe to capture this seepage (approx. 15.2 litres per sec, 200 i.g.p.m.).

About 7.6 litres per sec.(100 i.g.p.m.) seepage was noted at the intersection of the toe of the spillway and the downstream toe of the Cross Valley Dam in early October. This seepage was flowing for the most part from the west side of the toe drain and was believed to be related to the disappearance of the North Valley Wall Interceptor Ditch flow about 100 m downstream of the Cross Valley dam centreline. Piezometric water levels confirmed that the water table was rising in this area. Water samples taken from the North Valley Wall Interceptor Ditch, the pond upstream of the Cross Valley Dam, and the seepage at the toe drain were chemically analyzed by Cyprus Anvil and the results are as follows:

Location	Pb	Zn	Fe	Cu	Mn	Mg	Ca	Na	pH
Seep	N.D.	0.02	0.02	N.D.	0.01	19	54	3	7.8
NVWID	0.01	0.03	0.01	N.D	N.D.	16	68	4	7.3
CVD Pond	0.05	0.03	0.01	N.D.	0.36	25	60	22	7.5

Since sodium (Na) is considered diagnostic it was concluded that most of this seepage was probably related to the North Valley Wall Interceptor Ditch.

A tabulation of the observed piezometric pressures for the pneumatic piezometers installed during construction is provided in Appendix VIII, Table VIII-10 to VIII-15 inclusive. The locations of these piezometers are documented on Table 3-3 and are shown in plan on Figure 3-3. Water levels observed in the settlement plate risers are reported on Table VIII-16 in Appendix VIII.

The observations for the thermistors and the piezometer in borehole No. 79-20 at the north abutment of the Cross Valley Dam (for location, see Figure 3-3) are presented in Appendix VIII, Tables VIII-3 and VIII-4.

5.1.4 Other Instrumentation Records

Observations were obtained during the construction period for piezometers installed by Klohn Leonoff Consultants for the mine tailings abandonment plan and for piezometers installed by Golder Associates for monitoring the existing dam. The locations of these installations are tabulated on Table 3-4 and are shown in plan on Figure 3-3. The observations are shown on Tables VIII-18 to VIII-32 of Appendix VIII.

5.2 Remedial Work

A number of items of remedial work were suggested by a variety of observers. Although several of these were undertaken at the end of construction, the onset of winter precluded completion of the work and therefore some 1982 work remains. None of this work is considered to be in any way critical to the operational safety of the facilities.

5.2.1 Canal Dyke Completion

Hydrocon Engineering, in their review of as built conditions (See Appendix III), recommended that the canal dyke be raised above the design elevation of the dyke in specific areas to ensure that as-built canal would meet the design hydraulic capacity. In particular, it was suggested that dyke raising be undertaken between Sta. 0+400 and 0+950 and between Sta. 2+250 and 2+500.

The dyke was raised in the areas suggested during final completion in October (1981). The dyke was staked to the grades indicated on Hydrocon Engineering's Drawing No. 47-7.3 for the computed 500 year flood level. The dyke surveyed final grades are tabulated on Table 4-5.

5.2.2 Class IV Riprap Upgrading

Riprap was upgraded at the time that riprapping above the 10 year flood evaluation was completed. In the area on the left bank at about Sta. 0+120 the riprap was completely removed and replaced by material

consistent with design gradation. The necessary volume was sorted from the rock stockpiles at the Intermediate Dam.

In the vicinity of Goodall Creek the rip rap on the right bank was pulled to the top of the slope (this area was low) and spread over the slope face. Coarser riprap was spread over this layer.

5.2.3 Weir Modifications

On October 28, 1981, Mr. S. Roxborough of the Department of Fisheries and Oceans reviewed the performance of the drop weirs in the canal outfall with Mr. D. Goodall of Golder Associates.

Based on this verbal review a number of weirs were modified on October 29, 1981 by moving boulders laterally along the crest of the weir or by dispersing the crest of the weir longitudinally along the canal axis. The weirs so modified were Nos. 1, 2, 10, 12, 30, 31, 33, 34, 35, 36, 40, 43, 44, 49, 51, 52, 53, 54, 57, 60, and 61. Furthermore, the height of weir No. 61 was reduced by increasing the drop at weir No. 59 and by constructing a half-height weir at the theoretical location of weir No. 62.

5.2.4 Channel Enlargement

The thermal liner on the canal backslope was trimmed to locally increase the hydraulic capacity. This was achieved by cleaning the rip rap from the slope face, trimming the thermal liner and then replacing the rip-rap. It was necessary because the liner had been over built to provide construction access with the result that the channel was narrower than design width.

This work was undertaken at two locations in October, 1981. The first area treated was adjacent to the rock section at Sta. 0+480 where the

construction ramp onto the thermal liner had not been properly removed prior to placement of riprap and diversion. (This area is photographically shown in Hydrocon Engineering's report, Appendix III, Photo 5). A horizontal width of about 1 m was removed from the thermal liner. This work resulted in a small decrease of the flow velocity in the pilot channel.

The second location was at the eastern side of the rock quarry. This area had also been a ramp during placement of the thermal liner and visual inspection indicated that the canal was locally narrow. As at the other location, the Class IV rip rap was removed and about 2 m maximum (at the most narrow point) was trimmed from the thermal liner. The Class IV riprap was then replaced.

5.2.5 Thermal Liner Grading

Erosion of the thermal liner by concentrated flows down the backslope is undesirable. These flows originate from the collection of sheet flows in a trough which has resulted from settlement of the thermal liner at its contact with the natural slope. The problem of concentrated flows can be solved by grading the top of the liner so that sheet flows will pass directly over it (perpendicular to the canal centreline).

Grading of the thermal liner was attempted in the vicinity of Sta. 2+900 in October, 1981. Sand and gravel was trimmed from the thermal liner face and deposited on top of the liner at the interface with the natural ground. This work had to be abandoned because the face of the thermal liner was frozen, making the gathering of material with the backhoe difficult. Furthermore, the material placed at the top of the liner was chunky and would not form a continuous compact mass and therefore it would not be effective in restricting flow along the top of the thermal liner. This work should be undertaken when the face of the thermal liner is thawed to a depth of at least 0.3 m.

5.2.6 Control of Surface Flows Above Canal

As noted above, slope drainage flowing over the thermal liner tends to cause erosion channels to form. While most of the drainage is natural, some is concentrated by earthworks activity which has gone on above the canal, some of which had nothing to do with the project. Any work which can be done to direct these concentrated flows to armoured areas or redistribute them to prevent erosion of the thermal liner would be desirable. One such example of concentration caused significant erosion of the thermal liner at Sta. 3+140 during spring breakup. This is believed to have resulted in part from the collection of runoff in an old exploration test pit just above the canal cut. The test pit filled with water and the concentrated overflow eroded a channel down the face of the thermal liner. To prevent this from occurring in future the test pit was backfilled with its own waste excavation.

Another area of significant thermal liner erosion was in the vicinity of Sta. 0+750, just downstream of Goodall Creek (See Figure III-33, Appendix III). It appears that there is a Goodall Creek flood channel in this area which carries flow during high runoff periods. This is thought to be the main cause of thermal liner erosion in this area. Remedial work involved excavating a channel from the troublesome flood channel to the main Goodall creek channel. It is now expected that any flow in the flood channel will flow back into the main Goodall Creek channel and that no further thermal liner erosion will occur.

A dyke was also constructed across the inlet of the temporary Cornish Creek diversion channel which had been constructed by the Contractor in December, 1980/January, 1981 (See Figures 2-2 and 4-5 and Figure III-2 of Appendix III). Cornish Creek was thus rerouted back into its original channel. This work had been recommended by Hydrocon Engineering in their report which is presented in Appendix VII.

5.2.7 Drainage of Borrow Area "I"

Water ponded in Borrow Area "I" over the summer of 1981. To improve stability of the backslope of Borrow Area "I" and to promote drainage of this area. A trench was excavated across the old haul road.

5.2.8 Berm Placement at Seepage Sta. 1+320

Shortly after diversion, seepage was observed in the area between Sta. 1+290 and 1+350 at the downslope toe of the dyke. This seepage was noted in May, 1981 when the area at the downstream toe of the dyke was being stripped to develop an extension of Borrow Area "I".

A sand and gravel filter berm approximately 8 m wide and 1 m thick was placed along the toe of the dyke in this area to reduce the possibility of piping. Periodic inspections should be made to assess the need for additional filtering.

5.3 Recommendations for Additional Work

In addition to the instrumentation monitoring program, a number of items require periodic inspection and review to assess the need for maintenance work. It is expected that thermal liner erosion along the canal will continue during spring runoffs but that the number of new locations which appear each year will be few. It is recommended, therefore, that these erosion gulleys should be filled with riprap although they are already somewhat armoured by natural sorting. The most appropriate method of control may vary from place to place and will become apparent with careful observation.

The canal should regularly be inspected for evidence of erosion or damage to riprap by passage of ice chunks. Upgrading of rip rap may be required from time to time. Seepages should also be inspected to monitor the possible development of piping. New seepage occurrences should be recorded. The occurrence of cracks and subsidence in the canal dyke should also be noted.

In the canal outfall the rock forming the weirs is expected to adjust somewhat during the next several floods and it may be necessary to do some maintenance to ensure that fish passage and erosion control are maintained.

The performance of the Goodall and Cornish Creek interceptors should be inspected in summer and winter to assess the success of this construction with respect to control of erosion and icing of the canal.

The seepage at the downstream toe of the Cross Valley Dam should be monitored for quantity as well as point origin. Any evidence of the developement of a surface of seepage on the the downstream face of the dam must be reported promptly so that it may be assessed.

Erosion of the upstream face of both the Cross Valley Dam and the Intermediate Dam should be checked by placement of supplementary rip rap. The performance of the decant/spillway system at each dam should be inspected to check that the relative elevations of the decant and spillway are as designed. In the event that these spillways carry major flows, some post-flow maintenance work will need to be undertaken, particularly in the outfall channel area of the Cross Valley Dam spillway.

The rate of pond rise and corresponding piezometric response at each dam location should prove to be invaluable in the assessment of the performance of the dams. The piezometers should also be monitored during pond filling to confirm that the piezometric levels are as anticipated by the design.

Other possible maintenance items which can be identified by inspection include the erosion of the North Valley Wall Interceptor Ditch which car be treated with riprap, and the consequences of seepage from the

ditch. Some remedial work may be necessary to ensure that seepage damage does not occur and that the losses are not intolerable.

5.3.1 Thermal Liner Grading

It is recommended that the canal thermal liner be graded as discussed above in early May, 1982. At that time the thaw should have penetrated sufficiently to allow the gathering of sand and gravel material from the thermal liner slope face. Furthermore the runoff patterns and need for thermal grading will be apparent at that time.

5.3.2 Removal of Pipeline

The pumping pipeline extending from the middle crossing of the abandoned Rose Creek was buried in the canal dyke in the vicinity of Sta. 1+660 (See Figure 4-3). This pipeline should be removed as soon as the quality of the backfill construction can be assured.

5.3.3 Provision of Dyke Overflow Structure

The provision of a canal dyke overflow structure to ensure that the dyke is not overtopped at undesirable locations has been recommended by various observers. No such structure was provided during this construction; however, it may be advisable to do so for long term operations. Its location should be at a location within about 200 m of the west end of the Diversion Dam.

5.3.4 Completion of the North Valley Wall Interceptor Ditch

At the request of the Yukon Territory Water Board the mine leg of the North Valley Wall Interceptor Ditch system has not been commissioned. The mine leg may be put into service by excavating the plug at the inlet to the ditch and by raising and armouring a small dyke across the natural channel just below the inlet to the ditch (see Figure 2-2).

5.3.5 Intermediate Dam Rock Stockpiles

Before construction of Stage II of the Intermediate Dam the rock stockpiles now existing on the dam (as shown on Figure III-45) will need to be relocated. When that is done the foundation area beneath these piles should be inspected to determine if additional stripping is required.

5.3.6 Spigotting Practice

It is recommended that a plan be established for spigotting practice which is compatible with future construction needs. Should areas of instability develope along the canal dyke consideration should be given to the spigotting of tailings in these areas to develop support for the tope of the slope.

TABLE 5-1
CANAL OBSERVATIONS

MAY TO SEPTEMBER, 1981

(For detail of canal dyke cracking, See Golder Associates January 29, 1982 report Inspection - Canal Dyke at Cyprus Anvil Mine)

Station	Remarks	Seepage
Diversion Dam 0+020	Seepage after diversion in mid-May peaked in late June, then decreasing to very little in late September.	June 9 - 15 l per sec June 23 - 23 l per sec July 9 - 19 l per sec Aug. 4 - 15 l per sec Sept. 16 - (approx.) 0.4 l per sec (peak 300 i.g.p.m.)
0+435 and 0+460	Small seepage lasting for month of August and early September on right hand side (R.H.S.) of dyke waste-pile. Cracking on top right hand side of dyke between 0+430 to 0+460.	Aug. 4 - 0.8 l per sec (10 i.g.p.m.)
0+560 to 0+580	Ponding on right hand side (R.H.S.) of dyke, drying up when last checked September 16.	
0+700	Seepage into abandoned Rose Creek Channel from toe of wastepile approximately between 0+660 to 0+720.	4 l per sec (50 i.g.p.m.)
0+940	Cracking L.H.S. top of dyke between 0+920 to 0+960.	
0+970 to 1+040	Long ponding R.H.S. of dyke, drying up when last checked September 16 (pond depth approx. 10 to 40 cm), no visible seepage.	
1+150 to 1+210	Small seepage (less than 8 i.g.p.m) from natural ground into abandoned Borrow Area "H" on L.H.S. of canal. An intermittent small flow (less than 5 i.g.p.m.) from Borrow Area "H" ponding into canal over L.H.S. rip rap at 1+205.	Intermittent flow into canal, less than 0.4 l per sec (5 i.g.p.m.)

MAY TO SEPTEMBER, 1981

Station	Remarks	Seepage
1+290 to 1+380	Seepage R.H.S. of canal dyke into abandoned Borrow Area "I". Placement of sand and gravel berm at toe of dyke to reduce seepage. Pond in Borrow Area "I" drained by excavating a channel through an old haul road. Some sluffing of waste on face of excavated borrow. Some cracking on top of dyke at Stations 1+240, 1+330, 1+450, 1+620. July - severe cracking and collapse of side haul access up to canal dyke at Sta. 1+800.	May 27 - 1.0 l per sec June 4 - 0.8 l per sec June 23 - 1.1 l per sec July 19 - 1.5 l per sec (10 - 20 i.g.p.m.)
1+820 to 1+860	Ponding on R.H. S. of dyke (pond depth approx. 60 cm) no visible seepage. Cracking L.H.S. top of dyke at Sta. 1+800, 1+860 to 1+920, 1+970 to 2+050, 2+100 to 2+200. Cracking R.H.S. top of dyke at 2+040 to 2+120.	
2+180 to 2+230	Ponding R.H.S. of dyke (dond depth approx. 50 cm). Small flow (approx. 5 i.g.p.m.) over haul access and down valley wall in early August, stopped in mid-August, then started up again in mid-September.	Approx. 0.4 l per sec (5 i.g.p.m.)
2+250 to 2+310	Ponding R.H.S. of dyke. No visible seepage.	
2+400	Small pond on R.H.S. of dyke, dried up by late June 1981. Some cracking L.H.S. and R.H.S. top of dyke 2+360 to 2+520.	

MAY TO SEPTEMBER, 1981

Station	Remarks	Seepage
2+500	Location of Intermediate Dam South Abutment from 2+440 to 2+530	
	Significant seepage was first formally noted at the Intermediate Dam south abutment subexcavation on May 18, 1981, subsequent flow measurements were as follows: May 27 West Seep 26 l per sec (340 i.g.p.m.) June 9 West Seep 12 l per sec (160 i.g.p.m.) East Seep 6 l per sec (80 i.g.p.m.) June 19 West seep 8 l per sec (100 i.g.p.m.) July 3 West Seep 11 l per sec (150 i.g.p.m.) East Seep 5 l per sec (60 i.g.p.m.) July 9 West Seep 11 l per sec (140 i.g.p.m.) East Seep 8 l per sec (100 i.g.p.m.)	
	ID closure - August 6	
2+670	Seepage from Rock Quarry into canal.	Into canal approx 2.3 l per sec (30 i.g.p.m)
	Crack on L.H.S. top of dyke 2+640 to 2+660.	
	Cracking on L.H.S. and R.H.S. top of dyke 2+760 to 2+820.	
2+900	Location of Cross Valley Dam South Abutment from 2+850 to 2+920.	
	Seepage at south abutment subexcavation flowing into downstream toe area of Cross Valley Dam	July - approx. 10 l per sec (150 i.g.p.m.)

MAY TO SEPTEMBER, 1981

Station	Remarks	Seepage
3+000	Small flow (less than 0.15 l per sec, 2 i.g.p.m.) trickling down R.H.S. toe of dyke from weir 14 into ponding at weir 16 (pond depth approx. 10 cm). In mid-August a visible trickle (less than 0.15 l per sec, 2 i.g.p.m.) out of ponding at weir 16 down the valley wall.	
3+270	Two small ponds on R.H.S. toe of dyke at weir 33, dried up by mid-June, 1981	

TABLE 5-2

Chemical Analyses of Seepage at Intermediate Dam South Abutment

Location	Cation Conentration (ppm)								pH
	Pb	Zn	Fe	Cu	Mn	Mg	Ca	Na	
May 22, 1981									
Int. Dam Seep	0.08	0.15	2.80	0.02	0.09	13.0	28	3	
Canal	0.08	0.17	0.29	0.01	0.03	2.4	8	2	
May 26, 1981									
Int. Dam Seep	0.07	0.09	2.01	0.02	0.11	13.1	26	1	
Canal	0.09	0.15	0.24	0.01	0.03	3.5	9	1	
Quarry Seep	0.65	0.16	0.11	0.01	0.02	38.9	51	2	
June 11, 1981									
Int. Dam West	0.03	0.38	0.23	0.03	0.05	13	32	1	7.2
Int. Dam East	0.12	0.75	2.31	0.04	0.28	22	38	1	7.3
Canal	0.08	0.44	0.18	0.02	0.10	4	21	1	7.1
Quarry Seep	0.08	0.15	0.26	0.02	0.04	140	60	2	7.4
July 21, 1981									
Int. Dam Seep	0.06	0.30	0.10	0.03	0.02	18	38	Tr.	7.6
CVD Seep S. Abut	0.08	0.18	0.09	0.02	0.01	27	63	1	7.4
Canal	0.05	0.17	0.21	0.02	0.09	8	28	1	7.0
Quarry Seep	0.10	0.10	0.10	0.02	0.03	60	80	3	7.9
Pumping into Diversion Channel Started July, 29, 1981									
July 29, 1981 (approx. 5 hrs. after pumping started)									
Int. Dam Seep	0.06	0.41	0.04	0.02	0.03	13.0	37	6	7.6
Canal	0.03	0.51	0.12	0.03	1.33	7.19	34	28	7.7
August 3, 1981									
Int. Dam Seep	0.05	0.02	0.05	0.01	0.02	15.0	42	19	7.7
Canal	0.07	0.16	0.22	0.02	1.08	7.85	32	28	7.5
August 7, 1981									
Int. Dam (floor Seep)	0.13	0.16	0.16	0.02	0.04	14.9	50	23	7.5
Int. Dam (wall Seep)	0.07	0.08	0.08	0.01	0.04	14.6	45	19	7.7
Canal	0.06	0.09	0.10	Tr.	1.53	9.64	46	38	7.8

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

A REPORT TO
CYPRUS ANVIL MINING
summarizing the

DOWN VALLEY TAILINGS CONTAINMENT PROJECT 1980-81 CONSTRUCTION

Faro Yukon

Volume II of III

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APPENDIX I

Sept. 8/80
No. 189

Attn: Mr. G. Whitley
Yukon Territory Water Board

Re: Cyprus Anvil Down Valley Tailings Containment

Following is a reply by Golder Associates to the concerns raised by Hardy Associates in their review of the above project. Several of these concerns have been addressed by the tender documents which were tabled at the public hearing on September 3, 1980 and which are referenced in the following.

Significant differences between the final design report and the tender documents are as follows:

1. The alignment of the canal has been shifted into the slope to ensure the 50 year flood in cut criteria at more locations.

2. The canal dyke has been widened from 7.8 m to 11 m to allow future raising of the canal dyke to increase the capacity of the canal or of the tailings pond. The increased width will permit a raising of about 4 m above the presently proposed construction elevation. (The present dyke crest is 4 m above the canal invert.) See Tender Drawing No. 7922025-7.

3. The canal waste pile will be constructed independent of the canal dyke to allow placement of much of the canal dyke under summer conditions. See Tender Drawing No. 7922025-7.

4. The width of the gravel lining or the seepage control lining has been increased to 3.8 m on the walls of the canal to permit practical placement. See Tender Drawing No. 7922025-7.

5. The rock erosion control lining of the outfall has been increased in thickness and the material between the weirs is exclusively coarse rock permitting easier placement and thus providing better long term stability. See Tender Drawing No. 7922025-7.

6. The thickness of the downstream drain of the Cross Valley Dam has been increased in thickness from 2 m to 4 m to ensure that about half of the drain will be placed in the dry.

7. A spoil retainer dyke is to be constructed downstream of the Cross Valley Dam to retain waste materials resulting from dam foundation preparations. See Tender Drawing No's 7922025-2 and 12.

8. An access road is to be constructed along the North Valley wall for tailings pipeline and general access. See Tender Drawing No's 7922025-2 and 12.

The first six items represent modifications which will improve the stability of the canal or the Cross Valley Dam both in the near and in the long term.

Following are specific replies to the concerns raised by Hardy Associates:

2.1 Geotechnical aspects

2.1.1 The secondary blanket of the Cross Valley Dam will be placed in general under winter conditions but will be reworked and compacted as much as possible in a thawed condition. See detailed specifications Section 4.6.1.1 on P. G-34 (Last sentence). Furthermore, remedial work on the upstream blanket can be undertaken after the dam is in service by emptying the retention pond.

2.1.2 The thickness of the toe drain has been increased as noted in item (6). This in itself does not preclude freezing. However, our experience with the existing dam suggests that seepage

through the free draining gravels and sands does not freeze to such an extent as to prevent drainage. It appears that seepage will find an exit in relatively coarse zones. The new facility will involve a greater body of water which should retain more heat and therefore result in warmer seepage flows than the existing facility (this will become even more significant if recirculation is achieved).

If pore pressures should build up they can be detected by piezometers within the dam section or by the absence of seepage at the dam toe. Remedial action for such a situation could be pumping of monitor wells downstream of the dam or provision of a very coarse drain at the dam toe.

2.1.3 At the junction of the upstream blanket and the core of the Cross Valley Dam significant settlements due to permafrost are not anticipated. Ice rich permafrost occurrences are expected only in the vicinity of the upstream toe of the dam. Therefore abrupt differential settlements at the junction of the blanket and core are not anticipated. Furthermore, the design of the dam is such that appreciable cracking can be tolerated. First, the upstream filter is intended to heal any cracks which may occur. Second, the upstream shell is less permeable than the downstream shell in that the upstream shell is intended to be constructed from materials which do not strictly satisfy the core requirements and the downstream shell will be constructed of sand and gravel alluvium which is relatively permeable.

Should foundation subexcavation conditions indicate that ice rich premafrost exists near the junction of the core and the blanket, the thickness of the upstream blanket at the junctin will be increased during construction.

2.1.4 Dewatering of the core base will be attempted using a 3000 I.G.P.M. pump together with a practicl construction procedure to minimize seepage into the trench for the core. The detailed

specifications for this work are presented in the tender documents on P. G-33 in Section 4.5.1. It is noted that this work will be performed on an equipment rental (hourly) basis to maximize construction control and hence control the effectiveness of dewatering by limiting the length and width of trench requiring dewatering. Provided that very coarse materials are not encountered in the excavation, the core trench will be dewatered using the specified equipment.

In the unlikely event that dewatering cannot be achieved, the core materials will be placed in water as has been done for other dams of considerably larger scale and importance (eg. Arrow Dam: Reference: 'An Earth Dam Built By Dumping Through Water' by H.Q. Golder and D.J. Bazett. Paper presented at the 9th Congress for Large Dams, 1967.)

2.1.5 The cross-section used in the stability analysis assumed an upstream blanket thickness of 1 m and a downstream drain thickness of 2 m. For construction these thickness are respectively 1.5 m and 4 m and therefore provide more capacity than required. Pertinent discussion with respect to seepage and freezing and core cracking is also presented herein under 2.1.2 and 2.1.3.

2.1.6 Gradations for all materials are specified in Sections 3.3.2.1 and 4.3.3.1 of the tender documents. Piping of the dam core into the downstream drain has been checked by applying the standard piping criterion for the range of gradations specified. In general, the materials are compatible although avoidance of segregation is important locally as specified in the tender documents (see, for example 3.10.1, 3.14.1, 4.8.1, 4.9.1, 4.11.1).

2.1.7 The modification of the final design as stated under items (1) and (3) above will tend to alleviate this concern. The independence of the waste pile and the canal dyke means that failure of the waste pile will not interfere with the canal operation.

The potential for occurrence of seepage along thaw planes can only be assessed at construction. Ice rich materials which could be the source of such permeable thaw planes are to be removed as stripping beneath the dyke (see Section 3.6.1, P. G-15 of the detail specification). Furthermore, the canal excavation face will be blanketed with cohesionless sand and gravel which will tend to plug such planes in a manner similar to the intended behaviour of the upstream filter of the Cross Valley Dam. The excavated face could be lined with the seepage control liner if deemed necessary. (It is noted that the test excavation has held about 1 m of water since June, 1980).

2.1.8 The tender documents include provisions for installation of instrumentation in Sections 3.2.7 (P. G-10) and 4.2.5 (P. G-29). The location of the instrumentation will be determined at the time of construction so that it may be located in the most critical area. Some instrumentation will be installed following the completion of construction using Cyprus Anvil Drilling equipment or other drilling equipment.

Thermistors will be installed at selected locations along the canal similar to the monitoring provided at the test excavation. A survey control line has been established upslope of the canal to flag downslope movements. EDM survey techniques will be used for preconstruction and as constructed surveys as well as movement monitoring.

Monitoring of the Cross Valley Dam will consist of piezometers and settlement points located at critical areas. Piezometers will be installed in the downstream drain and in the foundation beneath the drain. The seepage quantity at the dam toe will be inspected on a regular basis. The settlement points will be surveyed as necessary to monitor vertical and horizontal movements.

In general instrumentation will be installed as deemed necessary by the design engineer at the time of construction. In the past,

Cyprus Anvil has acknowledged the necessity to install instrumentation to confirm design assumptions and to regularly inspect the constructed structures. Groundwater chemistry has been extensively monitored by Cyprus Anvil and has proven to be extremely useful in tracing seepage paths. The installation of chemical monitor wells downstream of the Cross Valley Dam will augment the geotechnical monitoring program as well as provided for the control of seepage pressures if necessary.

2.2 Hydrological Aspects

2.2.1 The function of the spillways is only to pass flows which cannot be passed by the diversion canal. Originally, it was intended to select the diversion dam crest elevation such that flows which could not safely be handled by the diversion canal (as determined by the continuous operation of the canal) would be passed through the tailings pond. It is considered that the 1 in 50 year design capacity (assuming a 1 m freeboard for the canal dyke) of the diversion canal together with the 1 in 50 year design of the spillways would be adequate during the operating life of the mine when modifications to the canal could be made as necessary. The capacity of the diversion canal could be actually as high as the 1 in 500 year flood if such a flood were short lived. The design capacity of the diversion canal may also be increased by raising the canal dyke crest elevation at abandonment or sooner if considered necessary (see item (2) above).

2.2.2 It is noted that 'Dam's Crest' in this context actually refers to the spillway crest. The spillway is designed to pass the 1 in 50 year flood without the main dam being overtopped.

2.2.3 An as-constructed survey will be conducted at the completion of the canal construction. Monitoring of the geometrical changes of the canal can be performed as warranted.

2.2.4 The diversion dam will be constructed at a section of the existing diversion where the excavated channel bottom is sloped at a grade of 2 percent. This means that the base of the diversion

dam will be about 3.6 m lower than necessary if grades were consistent upstream and downstream of the diversion dam. The volume storage of this 'sediment trap' is about 5000 cu.m.

Observation of the tributary streams will dictate need for sediment traps on such tributaries. We expect small streams to locally erode the gravel lining of the canal and repair will be required at such locations (cleaning and backfill with rock riprap). The major stream at Sta. 0+600 is incised in rock and only minor amounts of sediment are anticipated. The other major stream at Sta. 3+200 may require a sediment trap although the high velocity of the flow in the canal outfall should preclude significant sedimentation.

2.2.5 The canal outfall is designated to dissipate gravitational energy throughout its length and step by step. It is not a chute-stilling pond design. However, riprapping of the channel bottom beyond the limit of riprapping presently intended (about 6 m beyond the final weir) is being considered.

2.3 Environmental aspects

Golder Associates terms of reference did not include formulation of an abandonment or rehabilitation plan nor the chemical impact of the tailings project on the environment. At this stage the following comments are considered appropriate with respect to abandonment:

1. The critical stability period for the canal will occur within the first 5 years of operation.

2. The long term performance of the canal is best assessed by observation.

3. At abandonment, some enhancement of the rock riprapping could be undertaken.

4. At abandonment or earlier the canal dyke could be raised by up to 4 m to provide additional flow capacity.

5. The canal has deliberately been constructed in cut to enhance its stability.

6. Some portions of the canal are cut in rock and are very stable in the long term.

Fisheries has raised the issue of 47 drop weirs in succession possibly being too demanding of the fish. The horizontal pool portions adjacent to each drop weir are stilling basins in which the mean velocity is comparable to the main channel velocity. This statement will be checked by hydrocon engineering.

In conclusion, it is hoped that the above will assist you in your assessment of the down valley project. If the information offered is inadequate to yourselves or to your consultants, please advise us further. The hydraulic and hydrologic aspects herein have been based on discussions with Mr. Wim Veldman of Hydrocon Engineering (presently in Alaska) and his more direct input may be submitted if required.

Regards

D.C. Goodall
Golder Associates
Calgary, Alberta

APPENDIX II

October 8, 1980
File No. 802-2038

Mr. G. Whitley
Yukon Territory Water Board
Whitehorse, Yukon Territory

Dear Sir:

Re: Cyprus Anvil Down Valley Tailings Containment

Further to our discussions of October 2, 1980 we hereby submit our proposal for dewatering the foundation areas of the Cross Valley and Intermediate Dams. Briefly, the method involves the excavation of a channel adjacent to the existing creek bed. The channel would be excavated at a grade flatter than the existing Rose Creek bed and, if this channel is initiated from a point downstream of the Cross Valley Dam, the net effect is to lower the drainage invert at the Cross Valley Dam and Intermediate Dam.

The proposed scheme has several advanatges both from a construction and from an end product quality point of view. The removal of surface water and the lowering of the groundwater table in the Cross Valley Dam area will greatly improve the possibilities for foundation preparation in the dry. Removal of permafrost would be possible completely in the dry. The proposed method would also permit preparation of the Cross Valley Dam foundation area during the winter season. It would also virtually eliminate the need for clarification of pumping water from the excavation area and hence the need for the Spoil Retainer Dyke.

The location of the proposed channel is shown on Figure 1. The channel would be excavated adjacent to the existing Rose Creek bed such that interference with the creek would be minimized. The outlet for the proposed channel would be located at point 0 downstream of the originally proposed Spoil Retainer Dyke location. The inlet would be located about 100 m upstream of the Intermediate Dam.

The profile of the existing Rose Creek bed and of the proposed ditch invert is shown on Figure 2. The cross-section of the proposed channel, which is adequate to carry winter flows at a 0.2 percent grade, is shown on Figure 3. Clearly the proposed construction would lower the creek invert in the Cross Valley Dam area by about 4 m which is approximately the maximum depth of foundation subexcavation required.

To be most effective this work should be performed as soon as possible so that it may be completed prior to complete freeze-up. Creek crossings would be required at points A, C and D shown on the Figures. Excavation would progress from point 0 and when point B was reached the creek would be routed through the overflow channel (see Figure 1) by deepening it by about 1 m and/or dyking at point C; this would reduce construction interference with the creek between points B and C and the drainage channel would ultimately be used as the downstream seepage collector for the Cross Valley Dam.

Auxiliary drainage ditches are also anticipated in the vicinity of the Cross Valley Dam foundation area to accelerate the surface drainage and the lowering of the water table.

With the above works in place, foundation subexcavation of the Cross Valley Dam and the Intermediate Dam would be undertaken during the winter months and thus reduce the critical nature of this work with respect to the completion of the Down Valley Project on schedule.

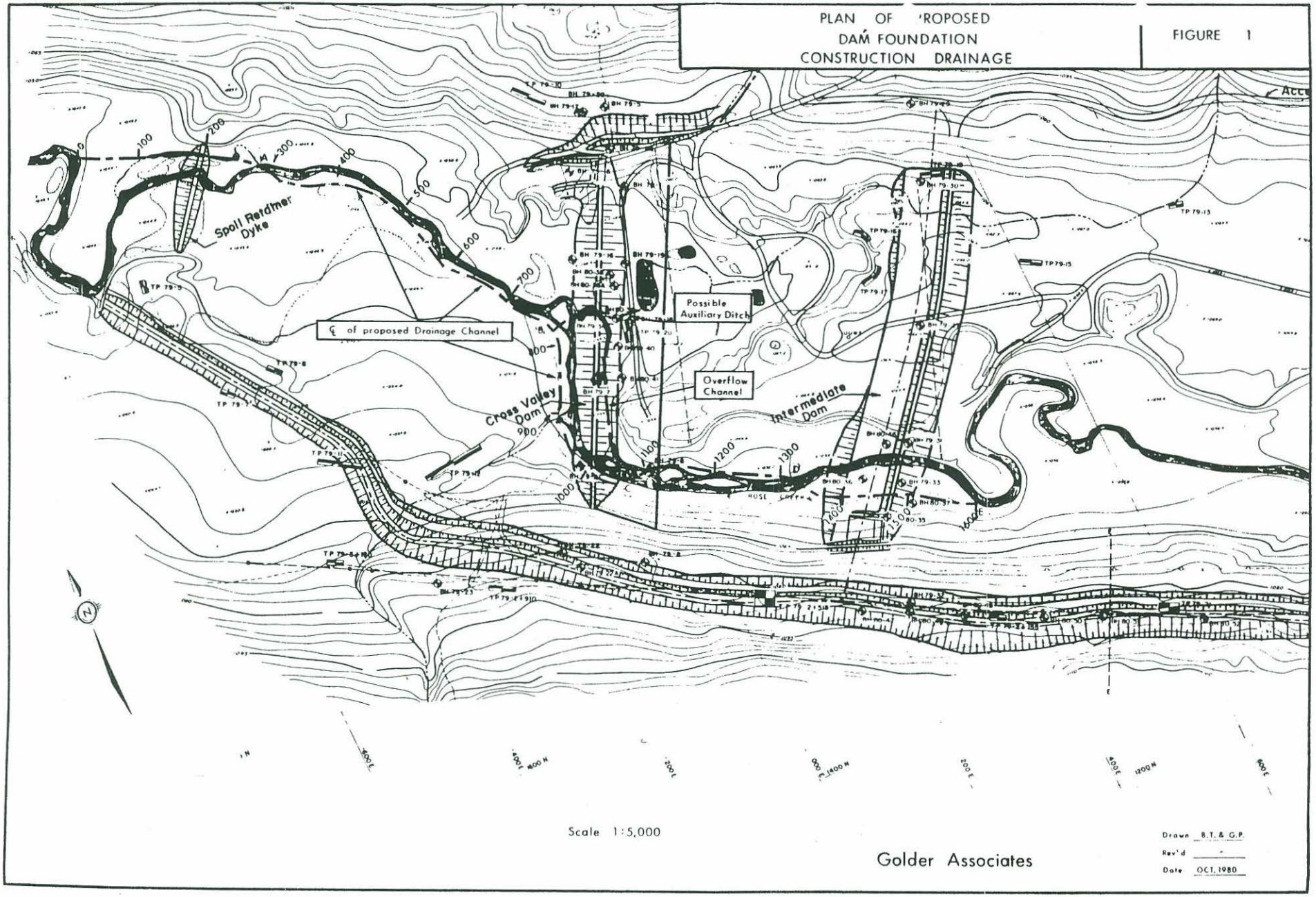
We would appreciate your prompt consideration of this matter.

Yours very truly,

GOLDER ASSOCIATES

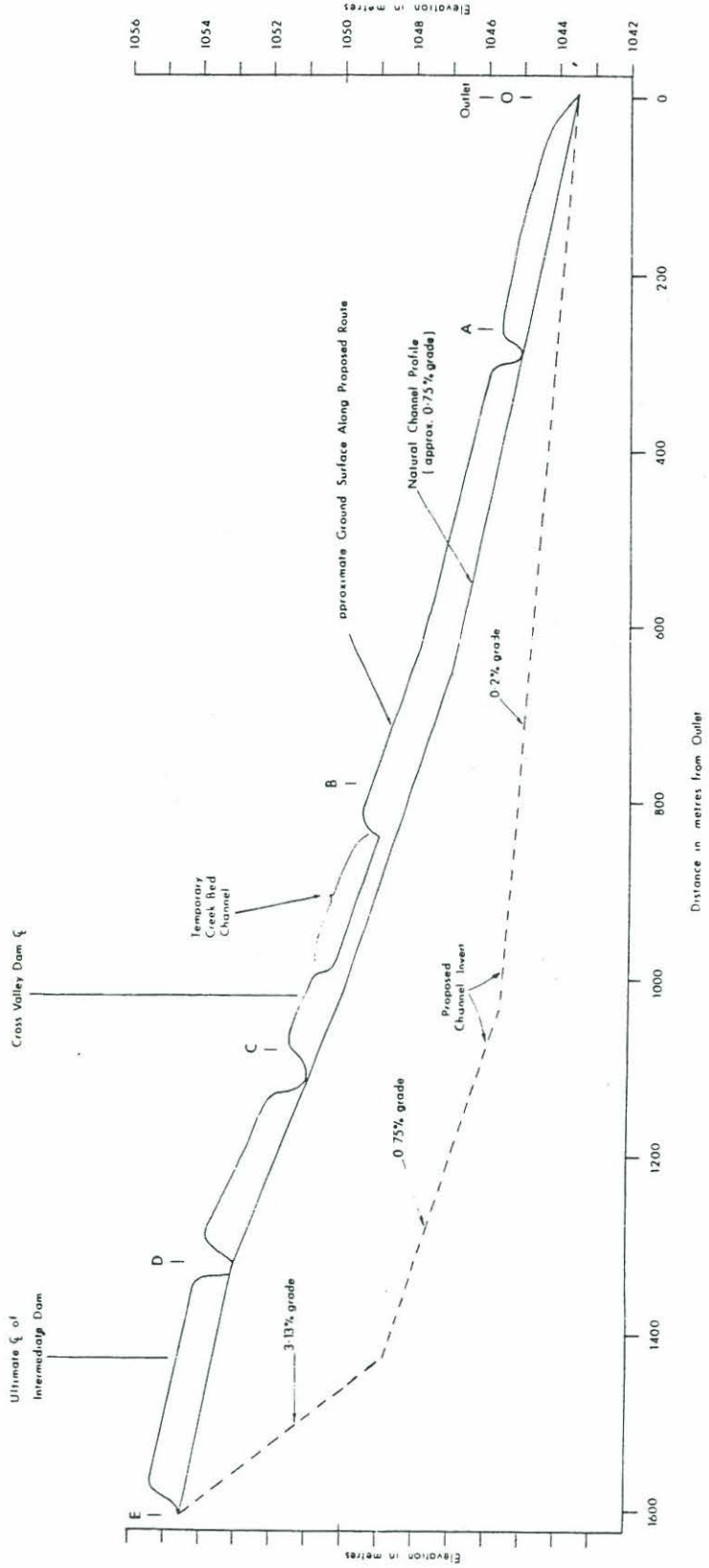
Dave Goodall

D.C. Goodall, P.Eng.
DCG/kk
Encl.
cc: N.G. Cornish, Superintendent Environmental Control
Cyprus Anvil Mining Corporation


PLAN OF PROPOSED
DAM FOUNDATION
CONSTRUCTION DRAINAGE
FIGURE 1
Spoil Retainer Dyke
℄ of proposed Drainage Channel
Possible Auxiliary Ditch
Overflow Channel
Cross Valley Dam
Intermediate Dam
Scale 1:5,000
Golder Associates
Drawn B.T. & G.P.
Rev'd
Date OCT. 1980

PROFILE OF PROPOSED
DAM FOUNDATION
CONSTRUCTION DRAINAGE

Figure 2

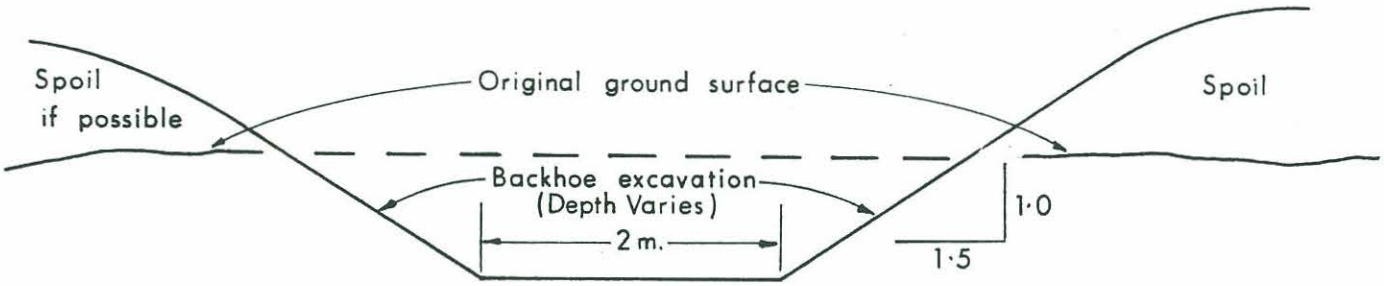


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CROSS-SECTION OF PROPOSED DAM FOUNDATION CONSTRUCTION DRAINAGE DITCH

Figure 3



Note: At some locations spoil could be placed only on one side of the excavation

Scale 1:50

Project No. 802-2038 Drawn GP Reviewed DG Date OCT. 1980

PROJECT PHOTOGRAPHS

	Figure
Overall Site Photographs	III-1
Canal	
Cornish Creek Diversion	III-2
Common Excavation	III-3 to 10
Rock Excavation/Rock Trench	III-11 to 18
Canal Dyke Placement (Class I)	III-19 to 20
Filter Gravel Placement	III-21
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- Outfall	III-24
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North Valley Wall Interceptor Ditch (N.V.W.I.D.)	
Mine Leg	III-56
Borrow Area "F"	III-57 to 58
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Access Road	III-60

OVERALL SITE PHOTOGRAPHS

Figure III-1



VIEW EAST



VIEW N.W.

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Golder Associates

CORNISH CREEK DIVERSION

Figure III-2



Aerial view of Cornish Creek diversion undertaken by the Contractor in December and January 1980/81 to maintain a dry canal excavation. Note escape of stream from intended channel (lower right half). Water ended up entering the canal at station 3+480. In October 1981 a dyke was constructed across this diversion to route the flow through its original channel.

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COMMON EXCAVATION

Figure III-3



Clearing, stripping and initial common excavation was usually performed using dozers. The major problem with this method is that waste common excavation tends to be deposited over the stripped dyke foundation area (view S.E. , station 1+900)



Common excavation using motor scrapers, pushcats and ripper cats. (station 3+000, view N.W.)

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COMMON EXCAVATION

Figure III-4



Motor scraper in process of common excavation. Note ripped up frozen ground in foreground.



Northwest view of nearly complete excavation from station 2+800 (outfall area). Note "hinge" on backslope and wet frozen windrows at sides of bottom.

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COMMON EXCAVATION

Figure III-5



Seepage icing in excavations caused winter construction difficulties (progress and control). This westerly view shows seepage from rock bluff (quarry site) at about station 2+700



Seepage from the backslope of the excavation at station 2+900

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COMMON EXCAVATION

Figure III-6



View S.W. showing Cornish Creek path across canal with excavation in progress on both sides. Icing of this channel caused the creek to jump its channel and fill the excavation downstream of this area with water and ice.

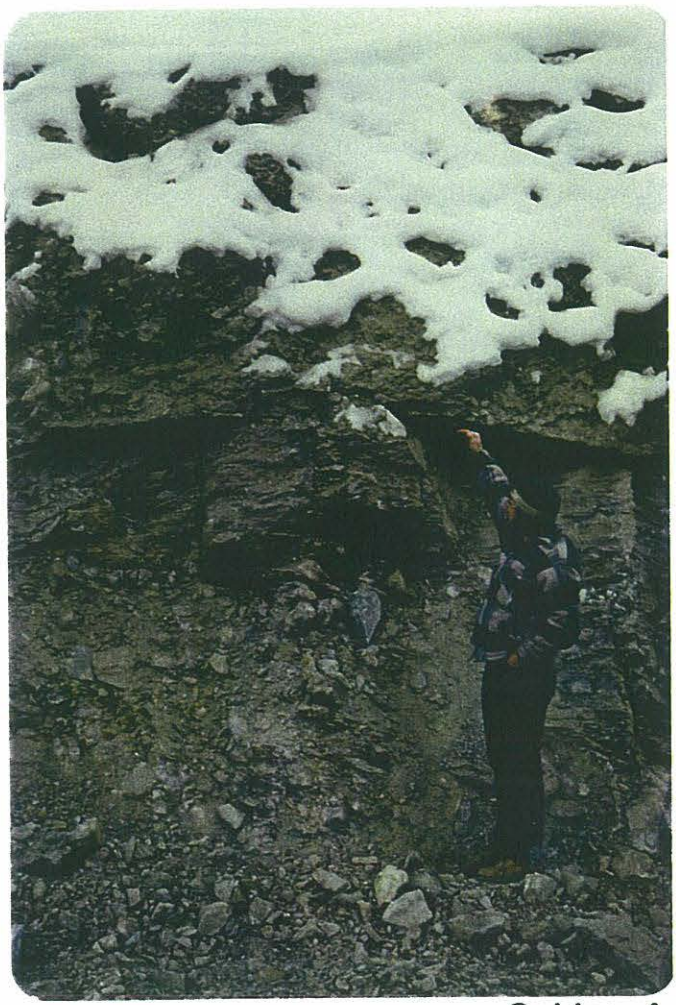


View S.E. from station 3+500, excavation filled with ice and water from Cornish Creek during December/January 1980/81. (Cornish Creek located at sharp left bend in upper half of photo.)

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Irregular bedrock surface in the vicinity of station 0+100, (view S.W.)



Irregular bedrock and winter temperatures resulted in till being considered as bedrock, photo indicates actual bedrock surface vicinity 2+500. Till above rock was subsequently removed.

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COMMON EXCAVATION

Figure III-8



View east of "bedrock surface" exposed by Common Excavation (station 2+300)



View southeast of irregular "bedrock surface" exposed by Common Excavation. The irregularity of the surface resulted in frozen till being considered as bedrock. (station 2+300)

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COMMON EXCAVATION

Figure III-9



Cleaning of bedrock surface vicinity station 2+300. Mound on which group of people are standing was maintained to be rock.



Subsequent drilling and blasting of above "rock" revealed that it was very hard frozen till (with some boulders).

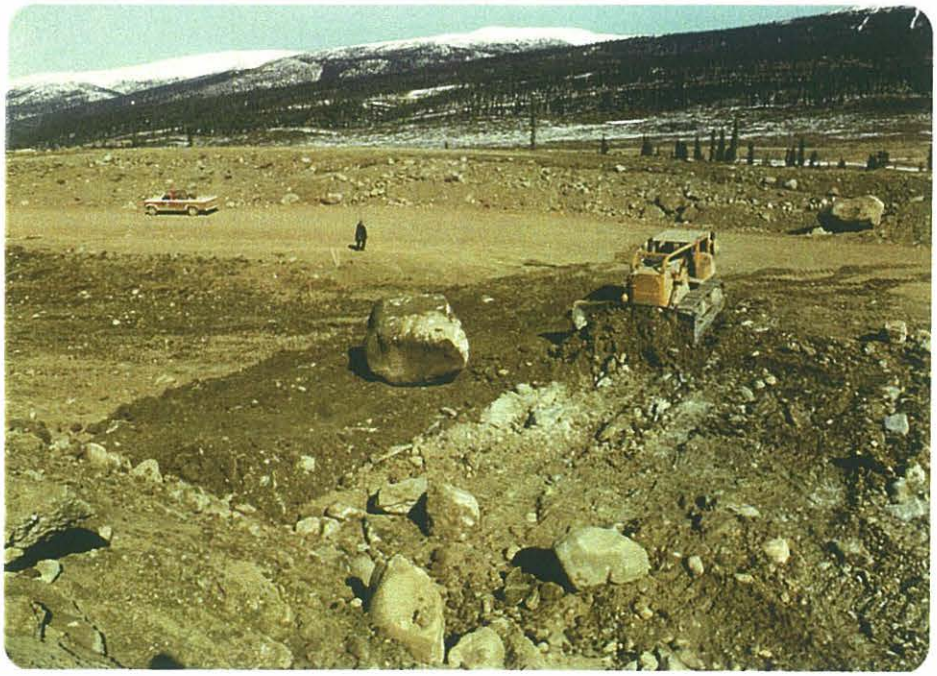
Project No. 802-2038 Drawn G.L.B. Reviewed _____ Date Feb/82

COMMON EXCAVATION

Figure III-10



View S.E. showing Common Excavation underway in unfrozen ground in vicinity of station 1+400. Such material was used where possible as seepage control liner.

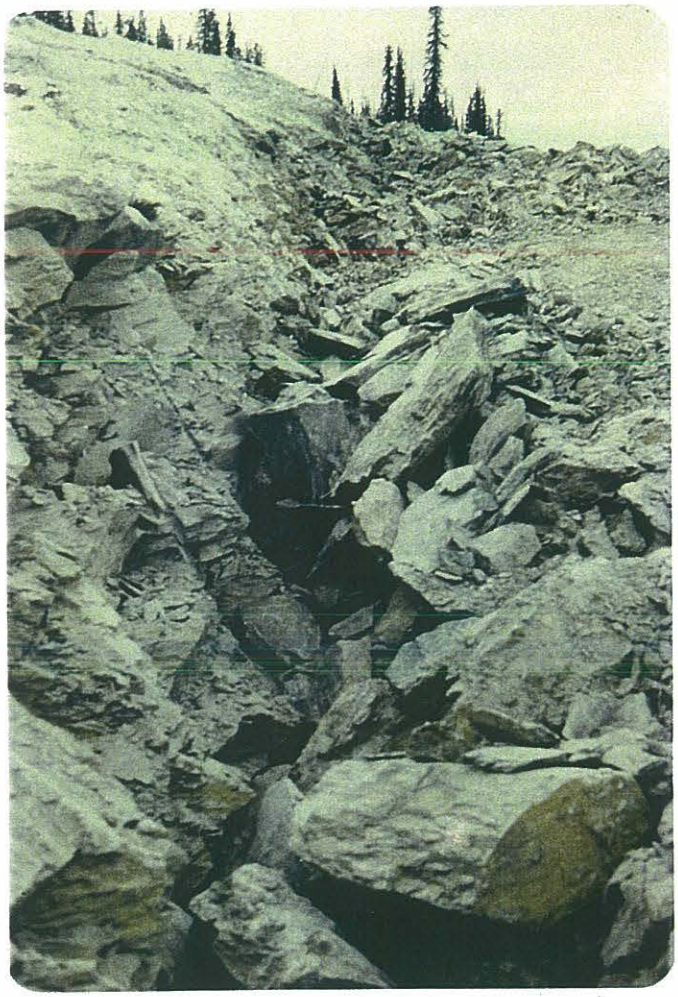


Some large boulders were encountered during excavation. Photo shows boulders in 1+400 area which were particularly troublesome when material used for seepage control liner.

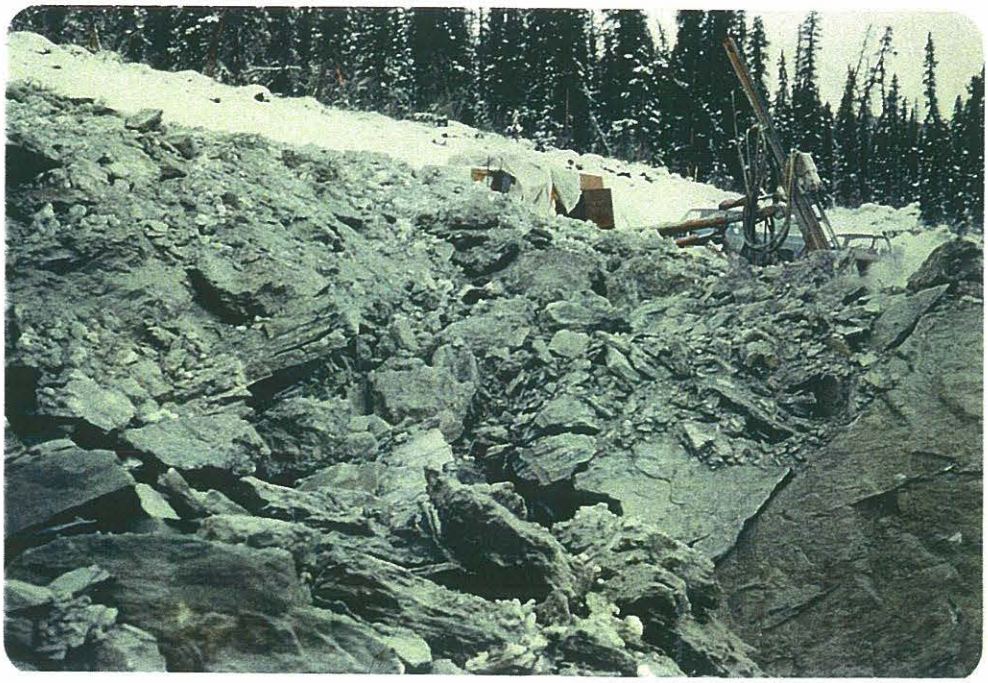
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ROCK EXCAVATION

Figure III-11



View west of the backwall after blasting to the first bench level (approx. a 6m cut) in the vicinity of station 0+600.



Drilling in the backslope near station 0+700. Compressor and drill are sitting on bedrock surface exposed by Common Excavation.

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ROCK EXCAVATION

Figure III-12



Highly weathered bedrock in wall of rock trench near station 0+360 (typical of 0+360 to 0+400 area). Seepage control liner was placed across the bottom of the canal excavation in this area.

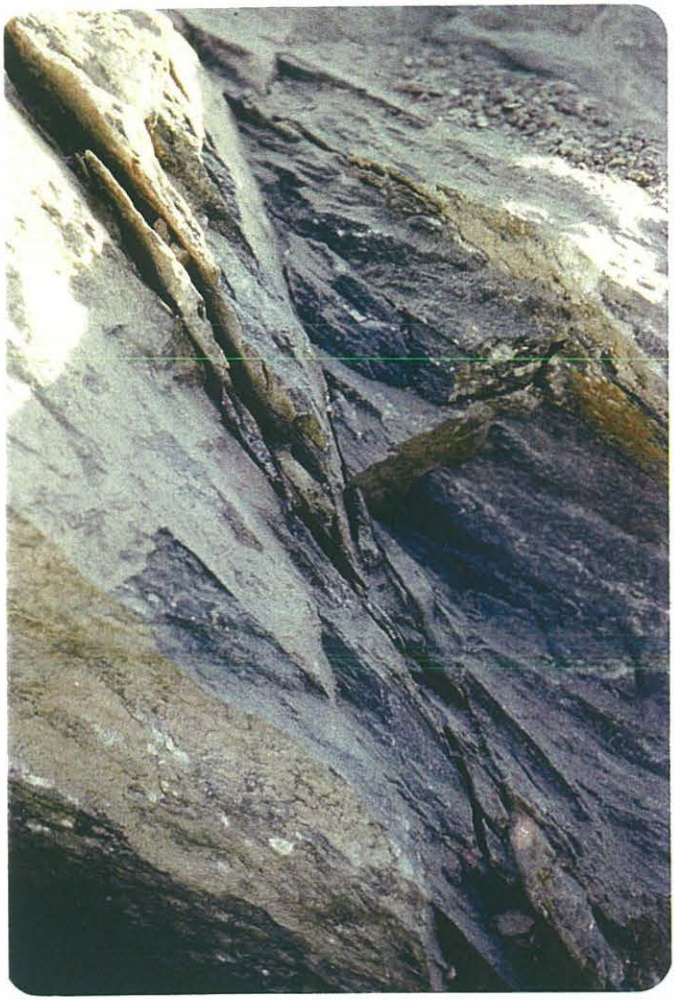


Fractured rock on wall of rock trench near station 2+460. Note secondary calcite and possibly gypsum. Seepage control liner was placed across the bottom of the canal excavation in this area.

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ROCK EXCAVATION

Figure III-13



Shear zone in wall of rock trench near station 2+475.

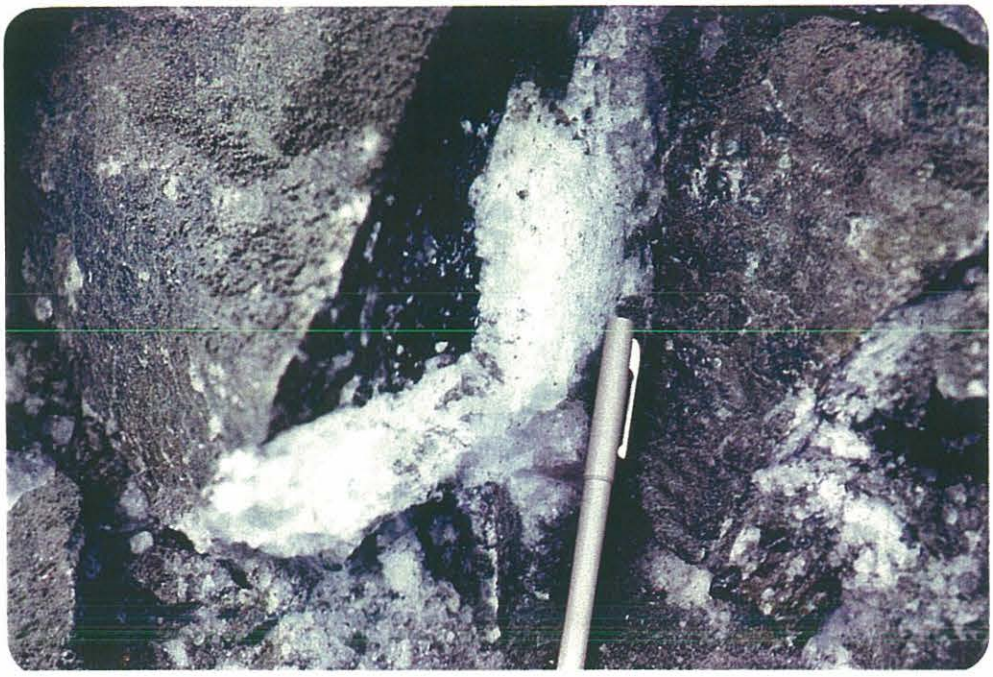


Shear zone in wall of rock trench near station 2+475 (seepage liner was placed across the bottom of the canal excavation in this area).

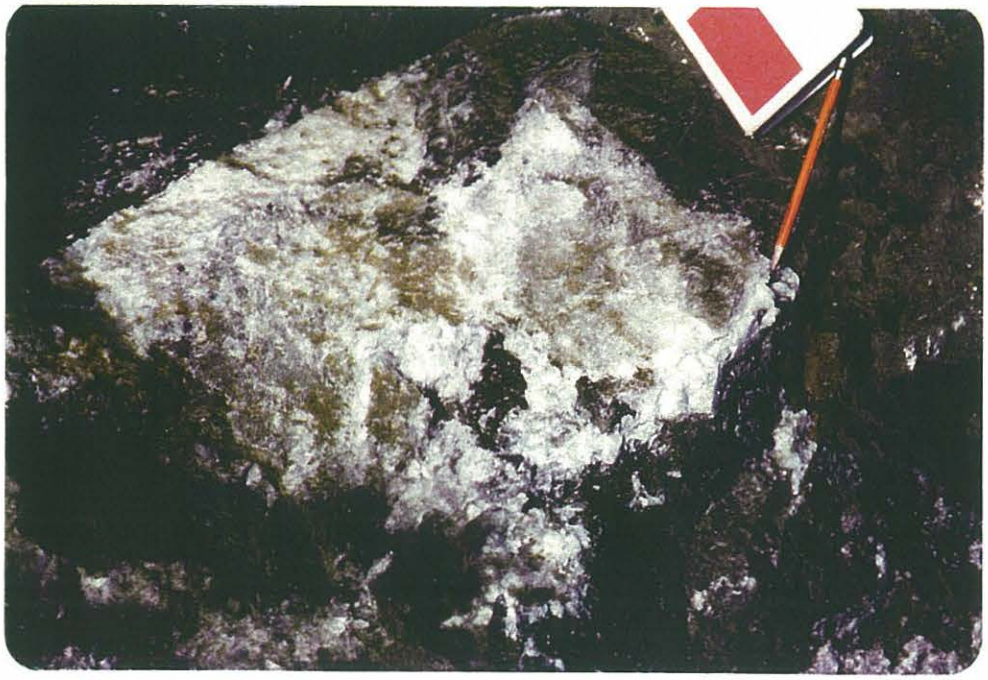
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ROCK EXCAVATION

Figure III-14



Ice in rock joint exposed by rock trench station 2+500

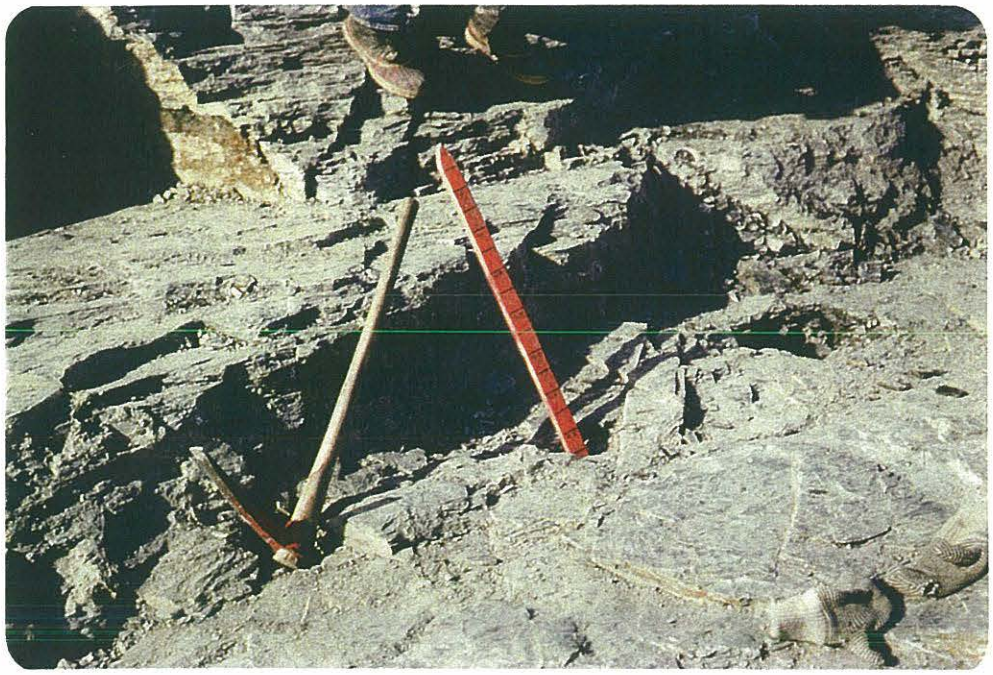


Ice in rock joint station 2+500

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ROCK EXCAVATION

Figure III-15



Rock cavities in base of rock trench near station 0+750 resulting from melting of ice. Pick and stake indicate example cavities. Rock trench was deepened locally to combat condition.



Irregular bedrock in rock trench near station 2+220 (view S.W.)

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ROCK TRENCH

Figure III-16



Cleaning of rock trench in vicinity of station 0+300. Note small piles of loose rock to left of trench gathered by small backhoe.



Hand shovel cleaning of the trench was also used when necessary.

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ROCK TRENCH

Figure III-17



Cleaning of the Rock Trench between station 2+460 and 2+490 (rock trench extended across bottom of canal due to poor quality rock) View S.W.



S.E. view of above. Note rock irregularity.

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SEEPAGE LINER PLACEMENT - ROCK TRENCH

Figure III-18



View S.E. from station 2+450 area. End dozing was required due to irregularity of trench and the need to maintain the integrity of the trench rock.



View S.W. at station 1+770 area. Note curving of rock trench to chase subcrop into backslope.

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CANAL DYKE PLACEMENT (CLASS I)

Figure III-19

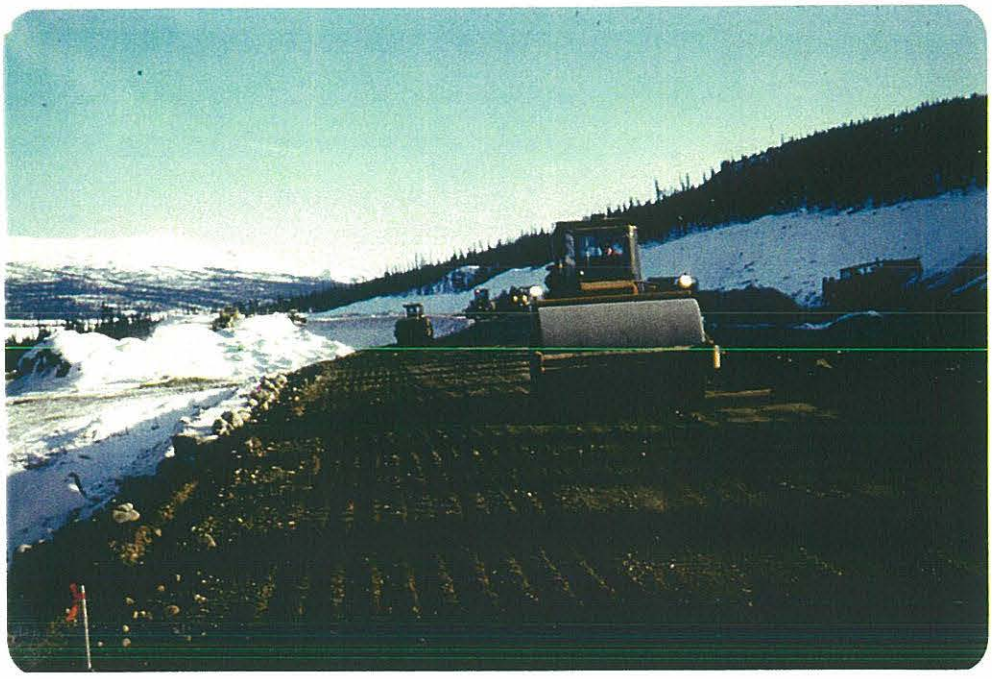


View east from station 2+700. Note initial stages of class I dyke placement (March 1981). Material was borrowed from sand and gravel terraces situated on the north side of the valley bottom (the borrow areas are not shown on these photos; the Intermediate Dam subexcavation shows at left)

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CANAL DYKE PLACEMENT

Figure III-20



Winter compaction of Class I sand and gravel dyke. Material compacted using 8 to 12 passes per 0.15 m lift. Material typically had moisture content of 4 percent. (view east from station 2+600).



Placement of seepage control liner adjacent to Class I dyke. Canal excavation at left. (station 1+900 approx.)

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FILTER GRAVEL PLACEMENT

Figure III-21



Backhoe placement of 0.3 m thickness of filter gravel (class I) being placed over seepage liner. View S.W. from station 0+400.



Dozer placement of filter gravel in outfall area. Appreciable accumulations of snow were removed prior to placement

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CLASS IV RIPRAP - 0.19 PERCENT GRADE

Figure III-22



Placement of class IV riprap over filter gravel on right bank. Note stakes for thickness control. View S.W. from station 2+000.



Class IV placement atop bedrock to provide erosion protection to the top of the hydraulic section.

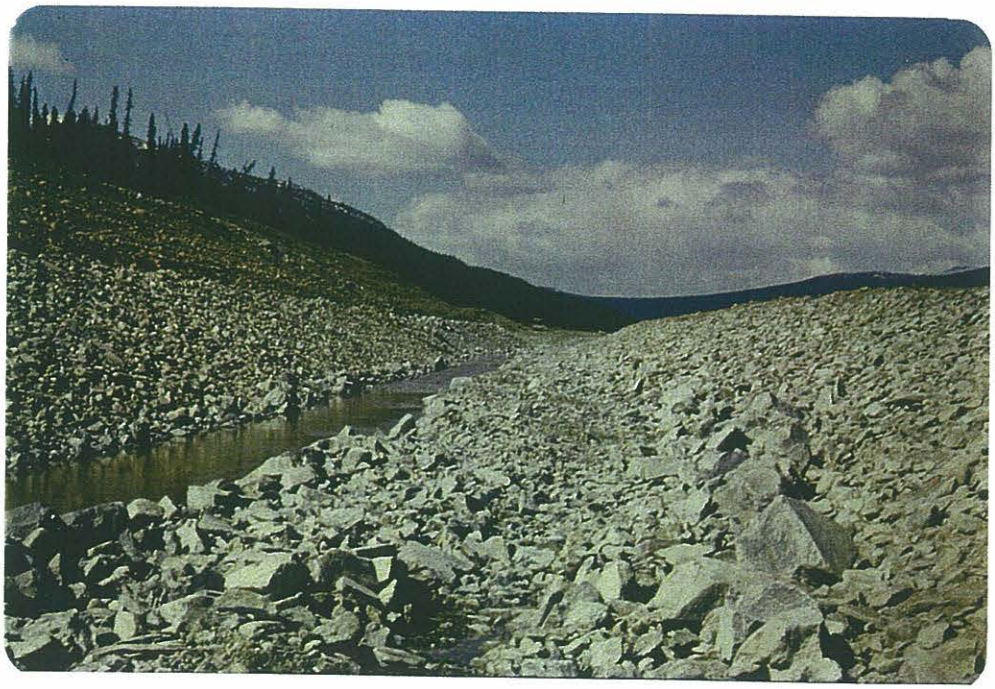
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CLASS IV RIPRAP - 0.19 PERCENT GRADE

Figure III-23



View S.E. showing riprap placed over thermal liner on backslope (None had been placed on bottom). (station 1+950).



View S.W. from 1+950 showing all class IV riprap in place and pilot channel before diversion.

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CLASS IV RIPRAP - OUTFALL

Figure III-24



View N.W. of class IV riprap (filter rock) on walls near outlet of canal to Rose Creek.



Beginning placement of class V riprap over class IV filter rock. View S.W. at station 3+000.

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CLASS V - OUTFALL

Figure III-25

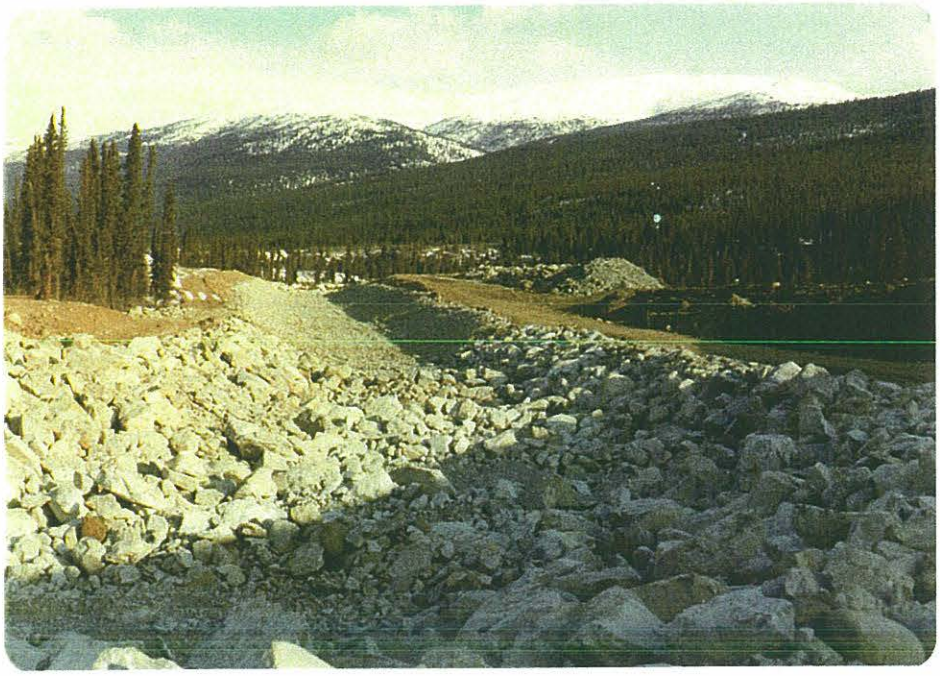


View S.W. from station 2+850. Placement of class V on backslope.



View W from 3+300. Class V rock being placed on bottom (forming weirs). Note also 0.19 percent class IV section in upper third of photograph.

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View N.W. from 3+300 (approx) showing completed rock weirs.



View S.E. from 3+300 showing placement of fish gravel in progress.

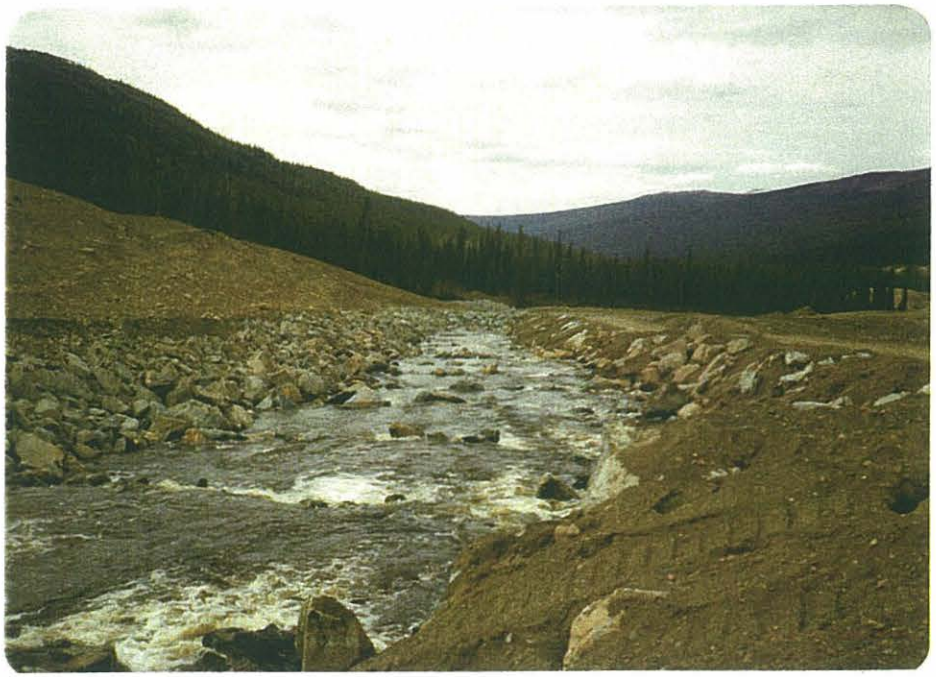
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FISH GRAVEL

Figure III-27



Looking downstream (W) from station 2+850. Note "fish" gravel placed over erosion control rock.

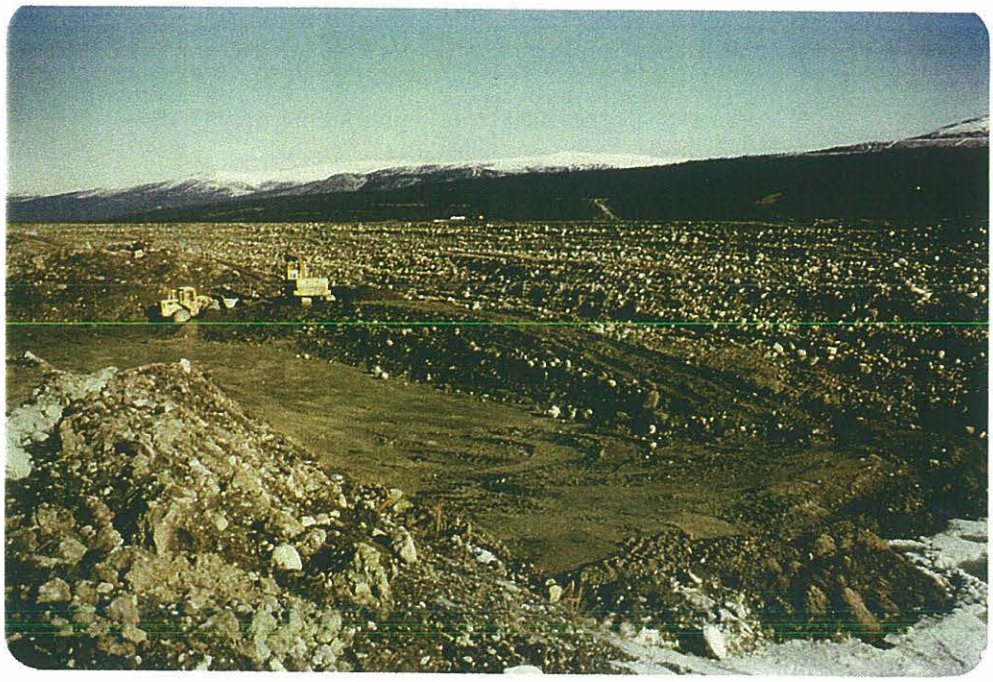


As above after diversion. Fish gravel appears to have successfully plugged voids in erosion control rock.

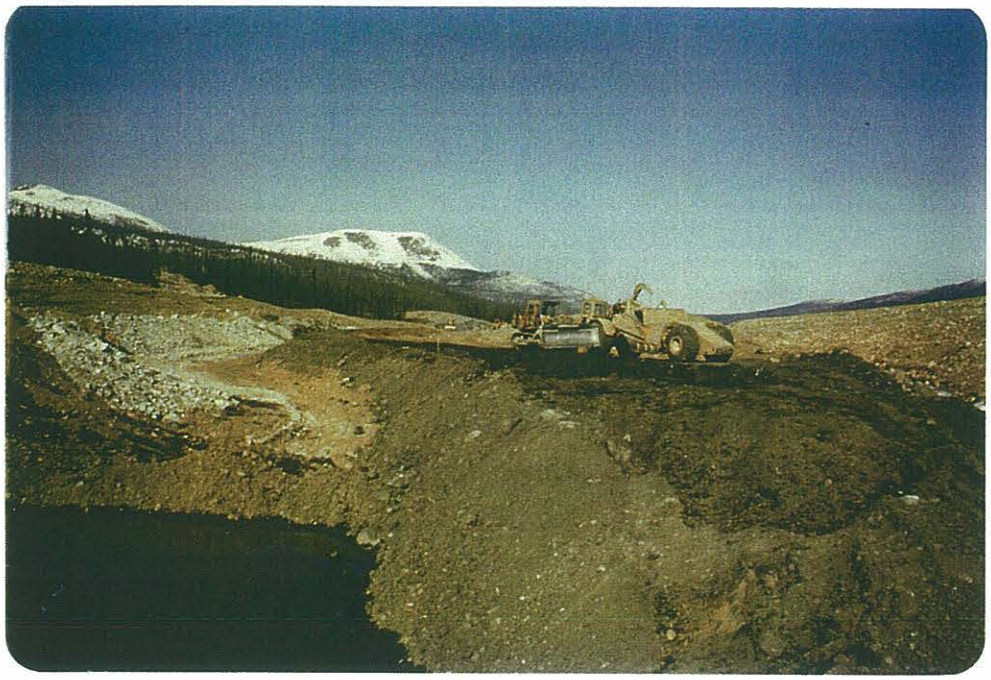
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DIVERSION DAM

Figure III-28



Initial stages of construction. Old diversion channel in foreground, existing dam at right. Seepage liner (dark silty material) was placed in bottom of old Rose Creek channel and adjacent to rib between bypass ditch and old channel (view N.W.)

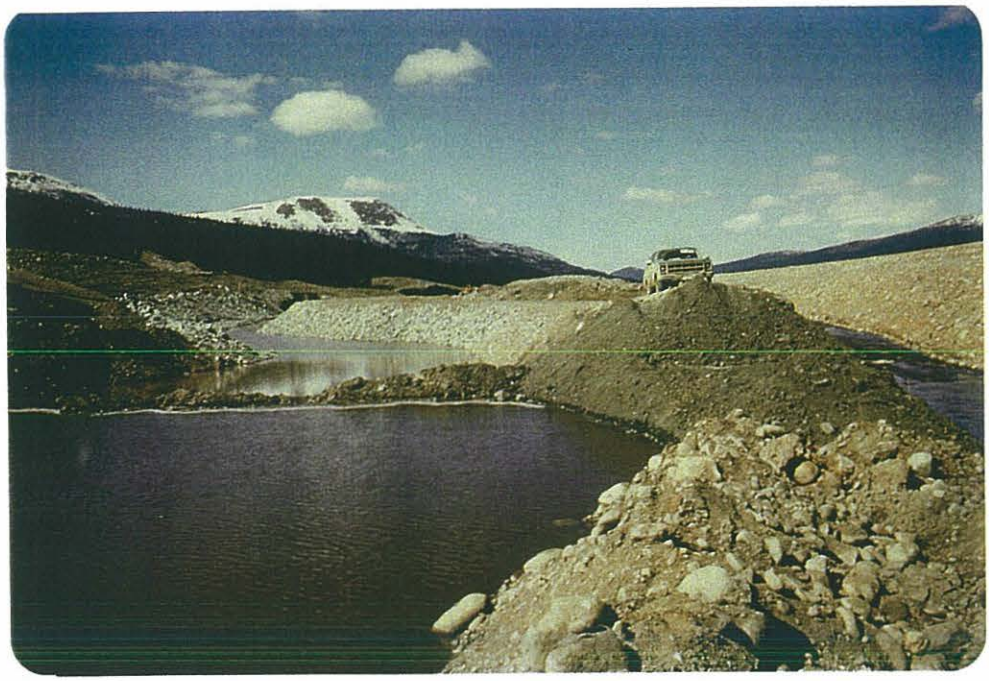


Similar to above. Bypass ditch is between equipment and existing dam on right. Cofferdam in foreground to keep canal area dry.

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DIVERSION DAM

Figure III-29



View N.W. just prior to diversion. Truck sitting on rib blanketed with seepage control liner (till) between old Rose Creek channel (at entrance to new canal) and bypass ditch at right. Truck situated at approximate location of temporary diversion dam.



View east of bypass ditch with temporary diversion dam under construction. Rock was dozed into channel initially and followed by sand and gravel to reduce seepage.

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DIVERSION DAM

Figure III-30



View west from top of temporary diversion dam showing final Diversion Dam construction. Diversion Dam core (till) is being placed across bypass ditch tying into seepage liner along rib (left) and keying into existing dam on right. Area between temporary dam and Diversion Dam was filled with sand and gravel (see below).



View southwest similar to above, core of Diversion Dam is being raised.

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DIVERSION DAM

Figure III-31



View S.E. of completed Diversion Dam. Existing Dam on left. Seepage emerging in bypass ditch (foreground) initially increased to about 300 i.g.p.m. and later decreased to less than 10 i.g.p.m. by August 1981.

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CREEK INTERCEPTIONS

Figure III-32



View of backslope at Goodall Creek (station 0+711). Rock in backslope on both bench levels was blasted to fracture down to the elevation of the pilot channel. Note also riprap in creek vicinity.



View of backslope at Cornish Creek (3+180). Flow passes through erosion control rock rather than over surface. Also note rock apron at creek mouth.

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THERMAL LINER EROSION

Figure III-33



Washout in vicinity of station 0+750 due to natural overflow channel at Goodall Creek. A trench was dug in October 1981 from this overflow channel to the main Goodall Creek channel to prevent similar future occurrences.

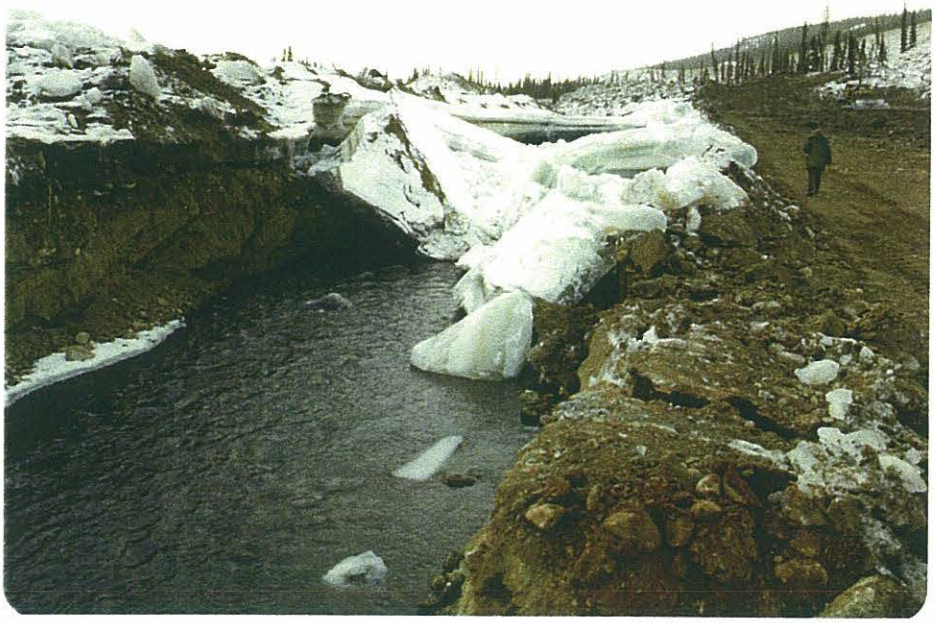


Backslope erosion in vicinity of station 2+000. Note riprapping of thermal liner at top and downslope. Seepage was emerging at slope mid-height and slope riprap was intended to prevent erosion from such seepage. It was also intended that surface water flow along the tip of the thermal liner and downslope where the slope was riprapped. The latter objective was not achieved.

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Subexcavation of south abutment (view west, March 1981).



View east of drainage ditch in Intermediate Dam area. Note collapse of ice when drainage ditch became operational enabling subexcavation to be conducted in dry.

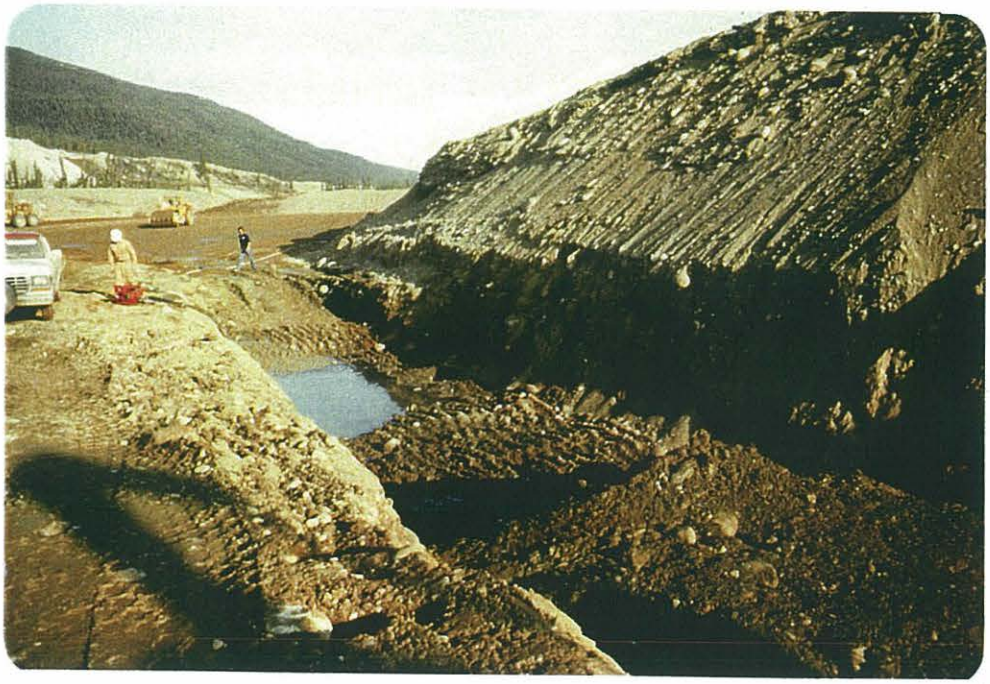
Project No. 802-2038 Drawn G.B. Reviewed ..... Date Feb/82

INTERMEDIATE DAM CONSTRUCTION

Figure III-35



View N.N.E. showing backfilling of cutoff trench. Note silt stratum into which the trench is keyed.



View S.W. showing cutoff trench adjacent to terrace. Trench was excavated to water level before backfilling with till.

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INTERMEDIATE DAM CONSTRUCTION

Figure III-36



View north showing initial stages of filling. Note the curving of the cutoff trench from the 1981 centreline to the upstream face of the dam(yet to be excavated completely) and the evidence of the silty stratum into which the trench is cut.



View similar to above showing completion of cutoff trench north of the drainage ditch to the terrace and the commencement of filling in the downstream berm area.

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INTERMEDIATE DAM CONSTRUCTION

Figure III-37



View north showing construction sequence. Note the filling of the area between the drainage ditch and the terrace. Placement of the upstream till facing is in progress.



Subsequent view to above. Note that upstream till facing has been shifted to a central position. The area between the drainage ditch and the terrace has been brought to Elev. 1064 approx. Note also pump and pipeline setup in preparation for closure of the drainage ditch. No filling had been undertaken at this stage south of the drainage ditch.

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INTERMEDIATE DAM CONSTRUCTION

Figure III-38



View S.W. in vicinity of station 0+400 showing coarse zone in upstream excavated face of Intermediate Dam.



Closeup of the above, Such pockets were subexcavated and covered with a sand filter (material adjacent to these coarse zones) before placing upstream till facing.

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View south showing seepage from south abutment area to Drainage Ditch (in foreground). Note thermal liner.



Closeup of thermal liner between two seepage channels above. Although most seepage flowed from the base area, some flowed from thermal liner particularly after filling in this area. (bedrock underlies the thermal liner in this area).



View south showing the subexcavated dam foundation south of the drainage ditch. Note the cofferdam across the drainage ditch (at left) in preparation for closure. Note also thermal liner at south abutment and core cutoff trench south of drainage ditch (lower right corner).



View S.S.W. showing preparation of base south of drainage ditch downstream of centreline. Backhoe excavation east drain. Note removal of thermal liner to key in core.

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INTERMEDIATE DAM CONSTRUCTION

Figure III-41



View S.S.W. showing installation of west drain at south abutment area. Note crushed rock filter and placement of cobble drain. East drain is already in place ready to be joined up with west drain.



Cobble drain was covered with naturally occurring coarse gravel

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INTERMEDIATE DAM CONSTRUCTION

Figure III-42



View south showing closure of the dam at the drainage ditch upstream of centreline.



View N.N.E. showing completion of core closure and the beginning of zoning in area south of former drainage ditch.

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View south as area south of former drainage is raised. Note undermining of thermal liner at south abutment and bedrock exposed at base of thermal liner.



Closeup of south abutment at base of thermal liner shown in perspective above. In general bedrock was encountered downstream of the 1981 centreline.

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INTERMEDIATE DAM CONSTRUCTION

Figure III-44

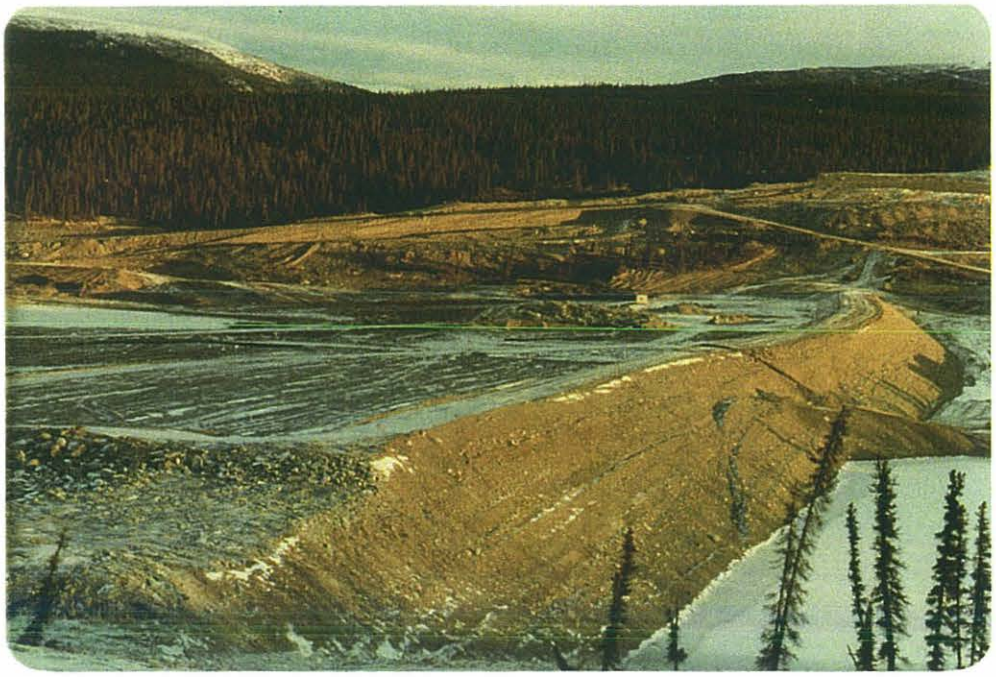


View north showing nearly completed dam with spillway dyke and apron construction in progress.

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INTERMEDIATE DAM

Figure III-45



View north showing completed Intermediate Dam. Note spillway in left foreground.

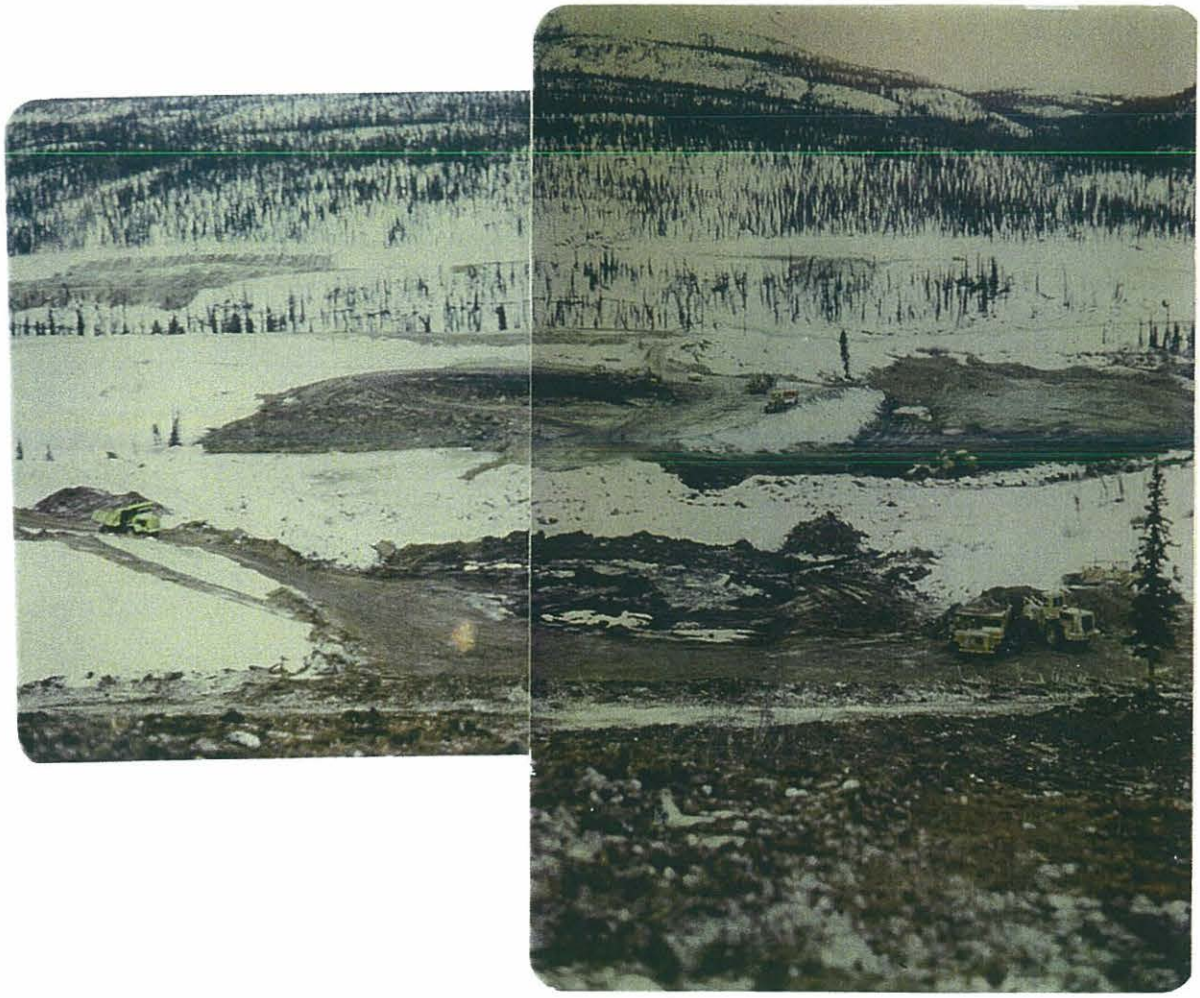


View S.S.W. showing completed Intermediate Dam. Note pump and pipeline. Rock stockpiles on berm area will require removal before future construction.

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CROSS VALLEY DAM CONSTRUCTION

Figure III-46



Subexcavation of Cross Valley Dam, January 1981, Note location of upstream blanket and waste piles. Note also ponding of water near solitary tree, upper part of photograph (area of permafrost, station 0+360)

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CROSS VALLEY DAM CONSTRUCTION

Figure III-47



View north showing first stages of dam filling. As for the Intermediate Dam the area to the Drainage Ditch was filled first. Note advancement of core trench and pad construction on the vicinity of the backhoe. Also note Borrow Area "C" in upstream blanket area before excavation (south of solitary tree middle right).

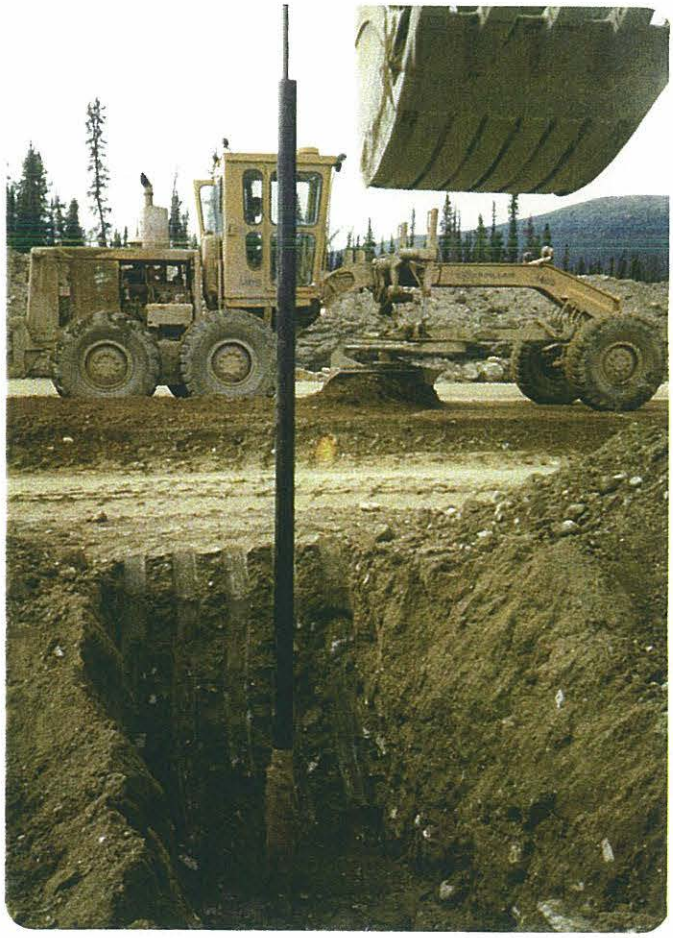


View south of core cutoff trench. Trench was constructed in segments allowing better dewatering control.

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CROSS VALLEY DAM

Figure III-48



Typical settlement plate installation. Note 2.5 cm pipe riser welded to 0.6 m by 0.6 m plate at bottom. A 7.5 cm plastic ABS pipe surrounds the 2.5 cm pipe to prevent friction. Installation was slotted near bottom (burlap covered interval) for measuring water pressures.

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CROSS VALLEY DAM CONSTRUCTION

Figure III-49



View northeast showing upstream blanket construction to 45m offset. Note surface runoff and seepage south of Drainage Ditch.



View north showing dam construction north of Drainage Ditch. Note zoning and blanket to 45m offset at upstream toe area. Note also excavation Borrow Area "C" in upstream blanket area. Dam zoning also evident. Work on south side of Drainage Ditch just starting.

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CROSS VALLEY DAM CONSTRUCTION

Figure III-50



View S.W. showing upstream blanket construction to 90^{+}m offset and initial dam construction south of Drainage Ditch.



View south showing upstream blanket construction from 45 m offset to 90 m offset in Borrow Area "C" vicinity. Note 20 cm pipeline across upstream blanket at south abutment in preparation for closure at Drainage Ditch (just beyond ramp).

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CROSS VALLEY DAM CONSTRUCTION

Figure III-51



View north showing closure complete, upstream blanket complete from south abument to ramp. Note 41 cm pipeline in place across dam (buried in ramp and damp, exits left centre). Note excavation of blanket cutoff trench north of ramp; also dozer excavation of ridge in blanket area near north abutment.



Upstream blanket trench cutoff station 0+270 (approx.). Trench is being simultaneously excavated into natural ground and backfilled. Note trench turns out to 90 m limit at station 0+210.

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CROSS VALLEY DAM CONSTRUCTION

Figure III-52



View west from Intermediate Dam showing: Drainage Ditch in foreground, cofferdam across Drainage Ditch at upstream limit of upstream blanket, and the placement of upstream blanket up the face of the CVD south abutment.

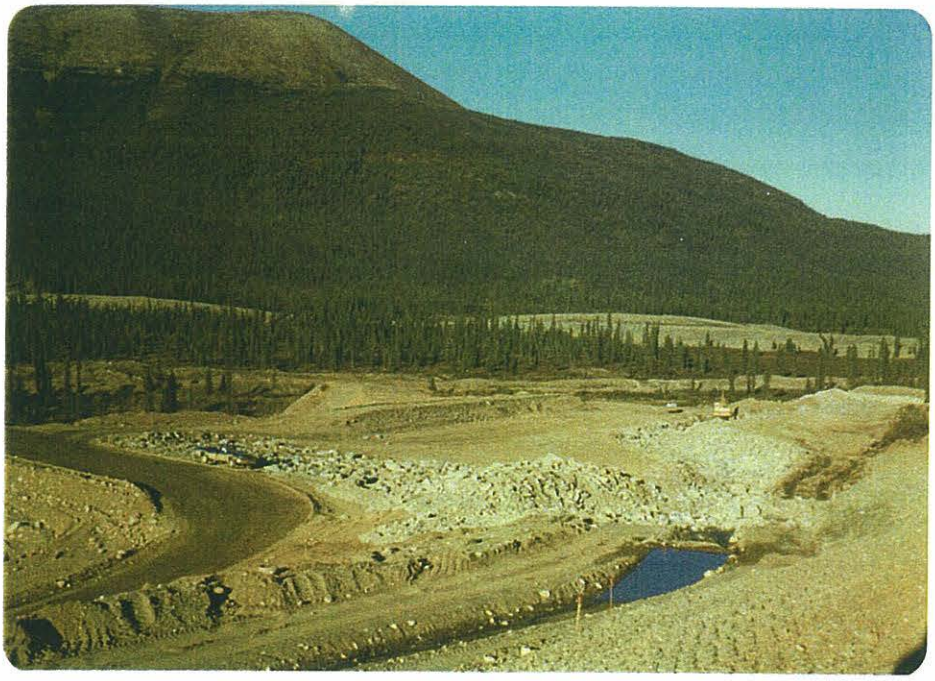
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CROSS VALLEY DAM CONSTRUCTION

Figure III-53



View S.W. showing initial spillway construction. North Valley Wall Interceptor Ditch in foreground. Rock apron under construction.



View similar to above showing decant and spillway under construction.

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CROSS VALLEY DAM

Figure III-54



View S.S.W. showing completed dam with spillway in foreground



View W.S.W. showing completed spillway with North Valley Wall Interceptor Ditch in foreground.

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CROSS VALLEY DAM

Figure III-55



View N.N.E. showing downstream side of completed dam. Note toe drain, pipeline and toe access road.

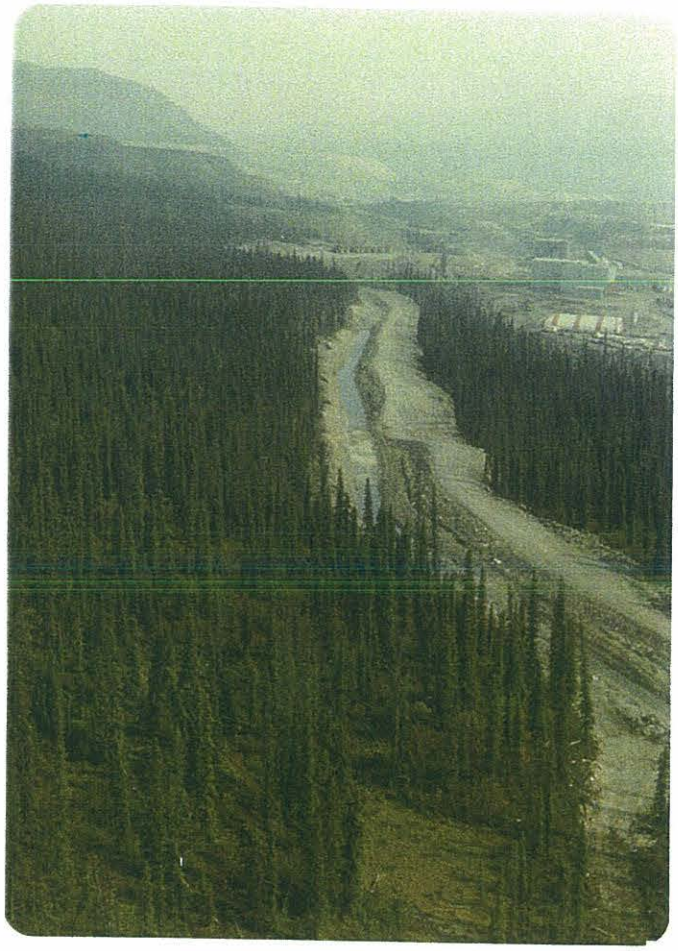


View north showing upstream face of completed dam. Note supplementary riprap.

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NORTH VALLEY WALL INTERCEPTOR DITCH

Figure III-56



View northeast showing mine leg segment of ditch. Rock excavation in base of channel was completed sugsequent to photograph. Inlet to this segment has not been excavated as of time of writing (February 1982).

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NORTH VALLEY WALL INTERCEPTOR DITCH - BORROW AREA "F"

Figure III-57



Looking west from old valley wall road, note beginning of dyke at valley wall creek. Dyke constructed from local till materials. Borrow Area "F" in this area was initially exploited into schisty bedrock. Therefore the base of the channel and dyke was blanketed with till to reduce seepage.



Looking east along dyke to inlet shown above

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NORTH VALLEY WALL INTERCEPTOR DITCH - BORROW AREA "F"

Figure III-58



Looking northwest near outlet of this ditch segment. Water from snow melt or from natural seeps in this area



Closeup of outlet shown above. Note riprap on dyke bank. Channel was incised into rock on right bank

Project No. ..... Drawn ..... Reviewed ..... Date .....

NORTH VALLEY WALL INTERCEPTOR DITCH NORTH ABUTMENT CVD

Figure III-59



Looking west, note riprap in channel against thermal liner which also serves as access. The base of the channel was lined with seepage control liner (till) and class I sand and gravel



Looking east from decant in CVD spillway area. Note junction of NVWID and decant as well as cut backslope and access road.

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Typical cut/fill construction used where natural materials were not useable. Note sidehill drainage ditch upslope of road (at toe of cut). (Station 0+500 view N.W.)



Typical fill construction used where good materials (dry till) were found. Rudimentary cleaning only was conducted in advance of filling (station 0+690 view W)

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RECORD OF BOREHOLE 81-98

LOCATION (See Figure. .) 2087.20 N 4.70 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1050.94	Ground Surface							
0.0	FILL, brown silty SAND and GRAVEL TILL							
1048.35								
2.59	Dark grey-brown SAND and GRAVEL with organic silt and fine sand seams, Oxides (Frozen @ 1047.89 m)		1	AS			M+C= 31.8 %	
1046.06								
4.88	Red-brown GRAVEL with coarse sand and silt (saturated)		2	AS				
1045.15								
5.79	Silty TILL		3	DO	21			
1044.23								
6.71	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-98
SHEET 1 OF 1

Project No. 802-2038 Drawn GPB Reviewed DH Date Feb '82

RECORD OF BOREHOLE 81-99

LOCATION (See Figure. .) 2111.82 N 16.89 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1050.97	Ground Surface							
0.0	Brown SAND and GRAVEL TILL, Oxides							
1048.68								
2.29	GRAVEL with medium coarse sand and silt							
1047.69								
3.28	Grey-brown silty GRAVEL and fine to medium SAND, Oxides (Frozen @ 1046.09 m)							
1045.79			1	AS			M+C= 37.2 %	
5.18	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-99
SHEET 1 OF 1

Project No. 102-2038 Drawn G.P.B. Reviewed DM Date Feb'82

RECORD OF BOREHOLE 81-100

LOCATION (See Figure. .) 2131.93 N 18.13 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1051.09	Ground Surface							
0.0	Brown silty SAND and GRAVEL TILL, Oxides							
1048.96								
2.13	Brown GRAVEL with medium fine sand							
1048.35								
2.74	Dark brown silty GRAVEL, Oxides							
1045.76								
5.33	Dark brown GRAVEL with medium-coarse sand and some silt (wet) (Frozen below 1045.4 m)		1	AS			M+C= 11.3%	
1044.69			2	DO	72			
6.40	Layered grey brown silty GRAVEL, medium coarse sand and grey SILT with fine sand (Frozen)							
1044.38								
6.71	End of Borehole							

Project No. 802-2038 Drawn G.P.B. Reviewed DH Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-100
SHEET 1 OF 1

RECORD OF BOREHOLE 81-101

LOCATION (See Figure. .) 2145.49 N 34.72 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1050.94	Ground Surface							
0.0	FILL, brown silty SAND and GRAVEL, Oxides							
1048.65								
2.29	Brown silty SAND and GRAVEL (Frozen @ 1047.28 m)							
1046.82								
4.12	Dark grey-brown silty GRAVEL with fine coarse sand and seams of silt (Frozen)		1	AS			M+C = 34.4 %	
			2	DO	70			
1044.36								
6.58	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-101
SHEET 1 OF 1

Project No. 802-2036 Drawn G.P.B. Reviewed DM Date Feb '82

RECORD OF BOREHOLE 81-102

LOCATION (See Figure. .) 2170.64 N 47.51 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1050.99	Ground Surface							
0.0	FILL, brown silty SAND and GRAVEL							
1046.72								
4.27	Grey-brown silty fine to coarse SAND, little gravel (very wet, no DO sample taken due to sloughing)		1	AS			M+C=10.5 %	
1044.89								
6.10	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-102
SHEET 1 OF 1

Project No. 802-2038 Drawn S.P.S. Reviewed DM Date Feb 82

RECORD OF BOREHOLE 81-103

LOCATION (See Figure. .) 2197.03 N 60.79 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1050.95	Ground Surface							
0.0	FILL, brown silty SAND and GRAVEL							
1047.6								
3.35	FILL, brown silty fine-medium SAND and GRAVEL							
1046.29	← very wet →							
4.66	Black organic SILT with rootlets and fine sand seams		1	AS				
1044.40			2	DO	10			
6.55	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-103
SHEET 1 OF 1

Project No. 802-2038 Drawn G.L.B. Reviewed D.A. Date Feb '82

RECORD OF BOREHOLE 81-104

LOCATION (See Figure. .) 2222.11 N 81.42 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1048.62	Ground Surface							
0.0	FILL, red-brown SAND and GRAVEL							
1047.40								
1.22	Brown silty SAND and GRAVEL TILL, becomming dark brown		1	AS			M+C=32.9%	
			2	AS			M+C=28.1%	
			3	DO	13			
1043.59								
5.03	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-104
SHEET 1 OF 1

Project No. 802-2038 Drawn G.P.B. Reviewed DA Date Feb 82

RECORD OF BOREHOLE 81-105

LOCATION (See Figure. .) 2248.83 N 96.63 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L		ADDITIONAL LAB. TESTING
1048.60	Ground Surface								
0.0	FILL, brown GRAVEL with fine-medium sand								
1047.53									
1.07	Dark brown silty SAND and GRAVEL TILL		1	AS			M+C=11.8%		
1046.01									
2.59	Grey brown to brown silty GRAVEL TILL with fine-coarse sand (very wet, sloughing, frozen at 1044.18 m)		2	AS					
1044.03									
4.57	End of Borehole								

Project No. 802-2038 Drawn G.P.B. Reviewed [illegible] Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-105
SHEET 1 OF 1

RECORD OF BOREHOLE 81-106

LOCATION (See Figure. .) 2275.27 N 111.62 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1048.29	Ground Surface							
0.0 / 1047.22	FILL, brown GRAVEL and fine-medium SAND							▽ Water level @ 1047.38 m before back-filling hole
1.07 / 1046.37	Dark brown silty SAND and GRAVEL TILL							
1.92 / 1045.55	Dark brown silty GRAVEL							
2.74 / 1044.94	Grey-brown GRAVEL and medium-coarse SAND with some silt (wet)		1	AS			M+C= 18.9%	
3.35 / 1043.26	Dark, becomming light brown silty GRAVEL and fine-coarse SAND (saturated)		2	AS				
			3	DO	23			
5.03	End of Borehole							

Project No. 802-2038 Drawn G.P.S. Reviewed DA Date Feb 82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-106
SHEET 1 OF 1

RECORD OF BOREHOLE 81-107

LOCATION (See Figure. .) 2299.74 N 128.01 E
BOREHOLE TYPE Solid Stem Auger
SAMPLE HAMMER WEIGHT 63.5 kg DROP 762 mm

BORING DATE August 11, 1981
BOREHOLE DIAMETER 150 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1048.38	Ground Surface							
0.0	Brown GRAVEL and fine-medium SAND (very wet @ 1046.86 and saturated @ 1045.64 m)		1	AS				▽ Water level @ 1047.77 m prior to backfilling hole
1044.26								
4.12	Brown GRAVEL and medium to coarse SAND (saturated)		2	AS				
1043.81								
4.57	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-107
SHEET 1 OF 1

Project No. 802-2038 Drawn G.P.B. Reviewed [illegible] Date Feb '82

RECORD OF BOREHOLE 81-108

LOCATION (See Figure. .) 2276.47 N 138.62 E
BORING DATE August 11, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1048.93	Ground Surface							
0.0	FILL, brown silty SAND and GRAVEL TILL							
1048.02								
0.91	Black organic SILT with some gravel and rootlets							
1046.80								
2.13	Dark brown silty SAND and GRAVEL TILL, Oxides (very wet)		1	AS			M+C= 20%	
1045.65								
3.28	Light brown fine-medium SAND some gravelly layers		2	AS				
			3	DO	10			
1043.90								
5.03	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-108
SHEET 1 OF 1

Project No. 802-2038 Drawn G.P.B. Reviewed DM Date Feb'82

RECORD OF BOREHOLE 81-109

LOCATION (See Figure. .) 1937.40 N -20.75 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L		ADDITIONAL LAB. TESTING
1051.39	Ground Surface								
0.0	Silty GRAVEL TILL with rounded and irregular rocks, hole terminated on rock		1	AS			M+C = 28.4 %		
1049.10			2	DO					
2.29	End of Borehole								

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-109
SHEET 1 OF 1

Project No. 802-2038 Drawn G.P.S. Reviewed GDP Date Feb '82

RECORD OF BOREHOLE 81-110

LOCATION (See Figure. .) 1966.49 N -8.70E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_p W W_l		ADDITIONAL LAB. TESTING
1049.88	Ground Surface								
0.0	Olive brown sandy SILT with some gravel becomming grey, (wet @ 1047.44 m then frozen at bottom of borehole)		1	AS					▽ Water level @ 1048.76 m
1046.83			2	AS					
3.05	End of Borehole								

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-110
SHEET 1 OF 1

Project No. 802-2038 Drawn G.P.B Reviewed DP Date Feb 82

RECORD OF BOREHOLE 81-111

LOCATION (See Figure. .) 1993.47 N 6.98 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L		ADDITIONAL LAB. TESTING
1049.37	Ground Surface								
0.0	Brown fine-medium SAND becomming coarser with depth (saturated). Possibly frozen at bottom of borehole		1	AS					
1047.24									
2.13	End of Borehole								

Project No. 802-2238 Drawn G.P.B. Reviewed [illegible] Date Feb 82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-111
SHEET 1 OF 1

RECORD OF BOREHOLE 81-112

LOCATION (See Figure. .) 2017.85 N 19.91 E BORING DATE August 12, 1981

BOREHOLE TYPE Solid Stem Auger BOREHOLE DIAMETER 150 mm

SAMPLE HAMMER WEIGHT 63.5 kg DROP 762 mm DATUM Project

SOIL PROFILE								PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	ADDITIONAL LAB. TESTING
1049.15	Ground Surface							
0.0	Olive brown silty fine SAND to fine sandy SILT, becomming gravelly @ 1047.02 m and 1045.19 m (saturated)		1	AS				
1044.88			2	AS				
4.27	End of Borehole							

Project No. 802-2038 Drawn C.P.B. Reviewed DH Date Feb'82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-112

SHEET 1 OF 1

RECORD OF BOREHOLE 81-113

LOCATION (See Figure. .) 2038.67 N 29.92 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L		ADDITIONAL LAB. TESTING
1049.20	Ground Surface								
0.0	Light brown silty fine SAND with some gravel becomming brown GRAVEL and medium coarse SAND (saturated @ 1047.98 m)		1	AS					
1046.15			2	AS					
3.05	End of Borehole								

Project No. 802-2038 Drawn S.P.B. Reviewed DH Date Feb 82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-113
SHEET 1 OF 1

RECORD OF BOREHOLE 81-114

LOCATION (See Figure. .) 2063.41 N 1.20 E BORING DATE August 12, 1981

BOREHOLE TYPE Solid Stem Auger BOREHOLE DIAMETER 150 mm

SAMPLE HAMMER WEIGHT 63.5 kg DROP 762 mm DATUM Project

SOIL PROFILE									WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE				
1050.05	Ground Surface									
0.0	Brown SAND and GRAVEL TILL, becomming grey brown SILT TILL with fine sand and trace of gravel (moist)		1	AS						
			2	AS						
1046.54			3	DO	18					
3.35 1046.70	Grey-brown sandy SILT with organics becomming red-brown to black GRAVEL and fine-medium SAND									
3.51	End of Borehole									

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-114
SHEET 1 OF 1

Project No. 802-2038 Drawn S.P.B. Reviewed Date Feb 82

RECORD OF BOREHOLE 81-115

LOCATION (See Figure. .) 1972.84 N -31.10 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1049.18	Ground Surface							
0.0	Light brown SILT TILL with fine-coarse sand, gravel and occasional boulders and cobbles		1	AS			M+C=37%	
1047.43								
1.75	Light brown SILT and fine GRAVEL TILL with coarse sand and occasional cobbles (saturated)		2	AS				
1046.13								
3.05	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-115
SHEET 1 OF 1

Project No. 802-2038 Drawn G.P.S Reviewed Date Feb 82

RECORD OF BOREHOLE 81-116

LOCATION (See Figure. .) 2218.64 N 119.94 E
BOREHOLE TYPE Solid Stem Auger
SAMPLE HAMMER WEIGHT 63.5 kg DROP 762 mm

BORING DATE August 12, 1981
BOREHOLE DIAMETER 150 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P — W — W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1048.80	Ground Surface							
0.0	Black organic SILT with rootlets and sulphates (Frozen between 1047.73 and 1046.36 m)		1	AS				
1046.36								
2.44	Black organic SILT with fine sand and occasional gravel, sulphates (saturated)		2	AS				
1043.62								
5.18	Dark grey-brown silty GRAVEL (saturated)		3	AS				
1042.70								
6.10	End of Borehole							

Project No. 802-2038 Drawn G.P.S. Reviewed DH Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-116
SHEET 1 OF 1

RECORD OF BOREHOLE 81-117

LOCATION (See Figure. .) 2196.25 N 103.06 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L		ADDITIONAL LAB. TESTING
1050.30	Ground Surface								
0.0	FILL, yellow-brown silty SAND and GRAVEL TILL with cobbles, Oxides (very wet @ 1048.78 then frozen @ 1048.0 approx.) becomming light brown below 1047.56 m		1	AS					
1045.42 4.88	Grey-brown silty GRAVEL with coarse sand		2	AS					
1044.20 6.10	End of Borehole								

Project No. 802-2038 Drawn G.P.B. Reviewed DM Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-117
SHEET 1 OF 1

RECORD OF BOREHOLE 81-118

LOCATION (See Figure. .) 2168.47 N 91.02E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1050.81	Ground Surface							
0.0	FILL, brown silty SAND and GRAVEL TILL with organics and oxides (Frozen below 1049.90 m)		1	AS				
1047.64 3.17	GRAVEL (frozen and impenetrable)							
1047.30 3.51	End of Borehole							

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-118
SHEET 1 OF 1

Project No. 802-2038 Drawn G.A.S. Reviewed [illegible] Date Feb 82

RECORD OF BOREHOLE 81-119

LOCATION (See Figure. .) 2143.94 N 74.47 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L		ADDITIONAL LAB. TESTING
1051.46	Ground Surface								
0.0	FILL, brown silty SAND and GRAVEL TILL with organics and oxides, trace of sulphates below 1048.72 m (frozen between 1049.33 and 1046.00 m)		1	AS					
			2	AS					
1046.00 5.46	Black organic SILT with fine sand								
1045.36 6.10	Grey medium-coarse SAND with gravel		3	AS	14				200 mm recovery
1044.91 6.55	End of Borehole								

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-119
SHEET 1 OF 1

Project No. 802-2038 Drawn GAB Reviewed DJP Date Feb '82

RECORD OF BOREHOLE 81-120

LOCATION (See Figure. .) 2113.00 N 62.71 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE								PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	ADDITIONAL LAB. TESTING
1051.59	Ground Surface							
0.0	Organic SILT							
1050.98								
0.61	Brown-grey brown silty SAND and GRAVEL TILL Oxides (frozen @ 1049.15m)							
1047.63								
3.96	Grey brown organic SILT (frozen)		1	AS				
1046.71								
4.88	End of Borehole (terminated due to frozen silt plugging auger)							

Project No. 802-2038 Drawn GPS Reviewed WA Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-120
SHEET 1 OF 1

RECORD OF BOREHOLE 81-121

LOCATION (See Figure. .) 2087.17 N 50.12 E BORING DATE August 12, 1981

BOREHOLE TYPE Solid Stem Auger BOREHOLE DIAMETER 150 mm

SAMPLE HAMMER WEIGHT 63.5 kg DROP 762 mm DATUM Project

SOIL PROFILE									PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L		
1052.40	Ground Surface								
0.0	FILL, brown-grey brown silty SAND and GRAVEL TILL with some fine-medium sand, Oxides (frozen below 1049.53 m)		1	AS					
1048.19 4.27	Black organic SILT (frozen)		2	AS					
1047.88 4.63	End of Borehole (terminated due to organics plugging auger)								

Project No. 802-2038 Drawn G.P.B Reviewed DM Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-121

SHEET 1 OF 1

RECORD OF BOREHOLE 81-122

LOCATION (See Figure. .) 2061.35 N 41.11 E BORING DATE August 12, 1981

BOREHOLE TYPE Solid Stem Auger BOREHOLE DIAMETER 150 mm

SAMPLE HAMMER WEIGHT 63.5 kg DROP 762 mm DATUM Project

SOIL PROFILE ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
1051.57	Ground Surface							
0.0	FILL, brown GRAVEL and medium SAND							
1049.74								
1.83	FILL, silty SAND and GRAVEL TILL, Oxides (possibly frozen between 1049.0 to 1048.0 m)							
1048.06								
3.51	Black organic SILT with rootlets and sulphates (saturated)		1	AS				
1046.69								
4.88	Grey-brown silty GRAVEL and coarse SAND(saturated)		2	AS				
1045.47								
6.10	End of Borehole							

Project No. 802-2038 Drawn G.P.B. Reviewed DP Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-122

SHEET 1 OF 1

RECORD OF BOREHOLE 81-123

LOCATION (See Figure. .) 2291.87 N 146.37 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE								PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS /	ELEVATION SCALE	WATER CONTENT PERCENT W_P W W_L	ADDITIONAL LAB. TESTING
1049.79	Ground Surface							
0.0	Yellow-brown sandy SILT TILL with gravel and some organics and rootlets		1	AS				
1047.50								
2.29	Brown medium-coarse silty SAND with some gravel		2	AS				
1045.52								
4.27	Brown fine SAND with some silt and occasional gravel		3	AS				
1043.69								
6.10	End of Borehole							

Project No. 802-2038 Drawn G.P.S. Reviewed [signature] Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-123
SHEET 1 OF 1

RECORD OF BOREHOLE 81-124

LOCATION (See Figure. .) 2137.12 N 25.55 E
BORING DATE August 12, 1981
BOREHOLE TYPE Solid Stem Auger
BOREHOLE DIAMETER 150 mm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 762 mm
DATUM Project

SOIL PROFILE													PIEZOMETER OR STANDPIPE INSTALLATION / ADDITIONAL LAB. TESTING
ELEV. / DEPTH. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS/ 305 mm	ELEVATION SCALE	WATER CONTENT PERCENT W_p W W_L						
1051.04	Ground Surface												
0.0	FILL, brown silty SAND and GRAVEL TILL												
1049.36													
1.68	FILL, brown silty GRAVEL and fine-coarse SAND (frozen below 1047.69 m)												
1048.30													
2.74	Grey-brown SILT TILL with fine sand, occasional gravel and organics		1	AS									
			2	DO	52								
1045.98													
5.06	End of Borehole												

Project No. 802-2038 Drawn G.P.B. Reviewed [illegible] Date Feb '82

VERTICAL SCALE 1:50

Golder Associates

BORE HOLE No. 81-124
SHEET 1 OF 1

APPENDIX NO. V

List of Change Orders

Change Order No. 1	Canal Dyke
Change Order No. 2	Seepage Liner Control
Change Order No. 3	Rock Trench Cut-off
Change Order No. 4	North Valley Wall Interceptor
Change Order No. 5	Intermediate Dam Foundation Seepage Control Measures Required At The South Abutment

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

CHANGE ORDER NO. 1

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Subject of Change: CANAL DYKE

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following: Formalization of memo to General Enterprises dated January 22, 1981, in reference to canal dyke. The specifications in this memo remain in full force.

A more accurate estimate of the impact of the change on quantities is as follows:

CANAL DYKE ITEM	TENDER QUANTITY (m^3)	REVISED ESTIMATE (m^3)
Class III	98,000	0
Class I	59,400*	157,000

Changes in Class I quantities due to change in quantity of seepage control liner are documented in Change Order No. 2 and due to rock trench cut off in Change Order No. 3.

*Estimate portion of 249,000 m^3 showing on Schedule A.

Golder Associates	Subject: Change Order N° 1 — Canal Dyke	Made by: DG	Job No. 802 2038
		Checked by:	Date: Jan 22/81
		Approved by:	Sheet No. 1/2

To: R. K. Byram, General Enterprise
From: D. C. Goodall, Golder Associates

This is to confirm and explicitly document our recent discussions concerning the canal dyke modification. Please refer to the attached Drawing issued for construction.

The main change is a substitution of Class I material for Class III material and the compaction requirements for the fill. The new configuration will not include any Class III material. The Class I dyke shall be compacted as shown on the Drawing whereas the Class III material was to be compacted to 100 percent standard Proctor density under continuous thawing conditions. The terms "compaction to the discretion of the Engineer" shall mean compaction using the compactor specified in the contract (smooth drum acceptable) to the extent of 8 to 12

Golder Associates	Subject: Canal Dyke	Made by	Job No.
		Checked by	Date
		Approved by	Sheet No. 2/2

passes per 0.15 m lift as required by the Engineer.

Additional modifications not shown on the attached Drawing pertain to the seepage liner required on the upslope side of the dyke. Details of this liner will be given on a station by station basis. A drilling program is presently underway to ensure that adequate material can be found to permit installation of the seepage liner.

An estimate of the impact of the ~~quantities~~ change on quantities is as follows:

Canal Dyke

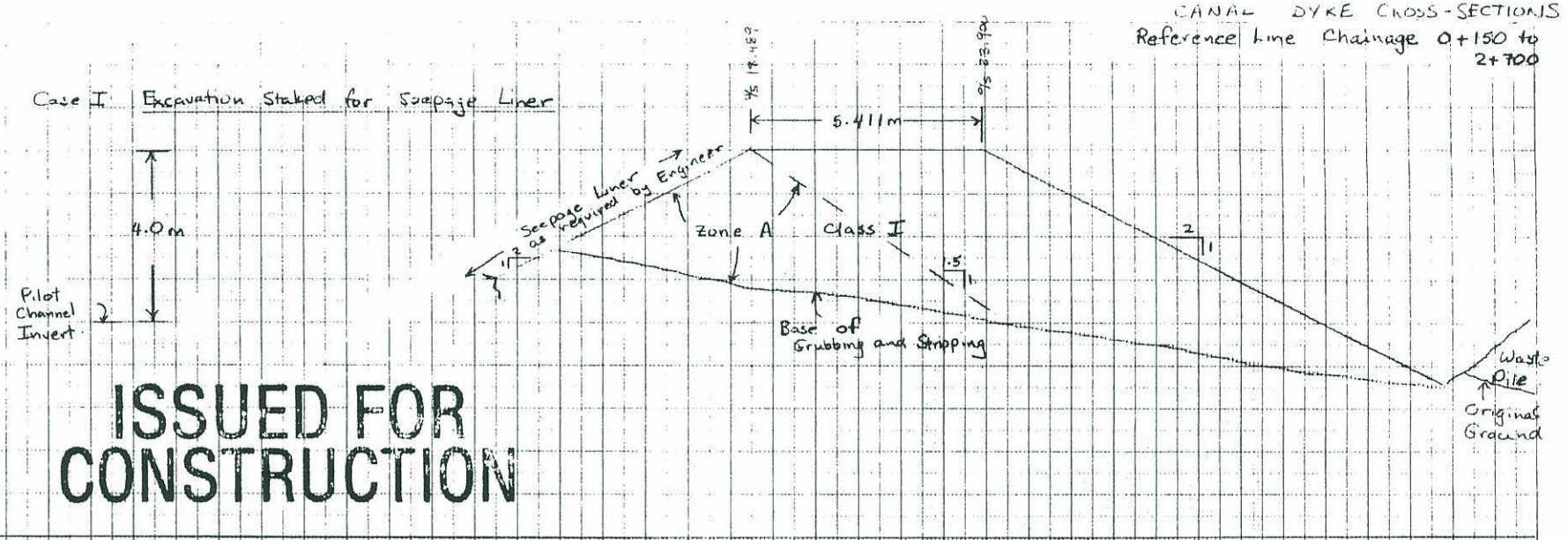
Item	Tender Quantity (m^3)	Revised Estimate m^3
Class III	98,000	0
Class I	249,000	+98,000 − *38570 ≈ 308,000 m
Class II	33,000	+ 50,000 = 83,000 m^3

* decrease due to increased use of seepage liner

Dave Woodall

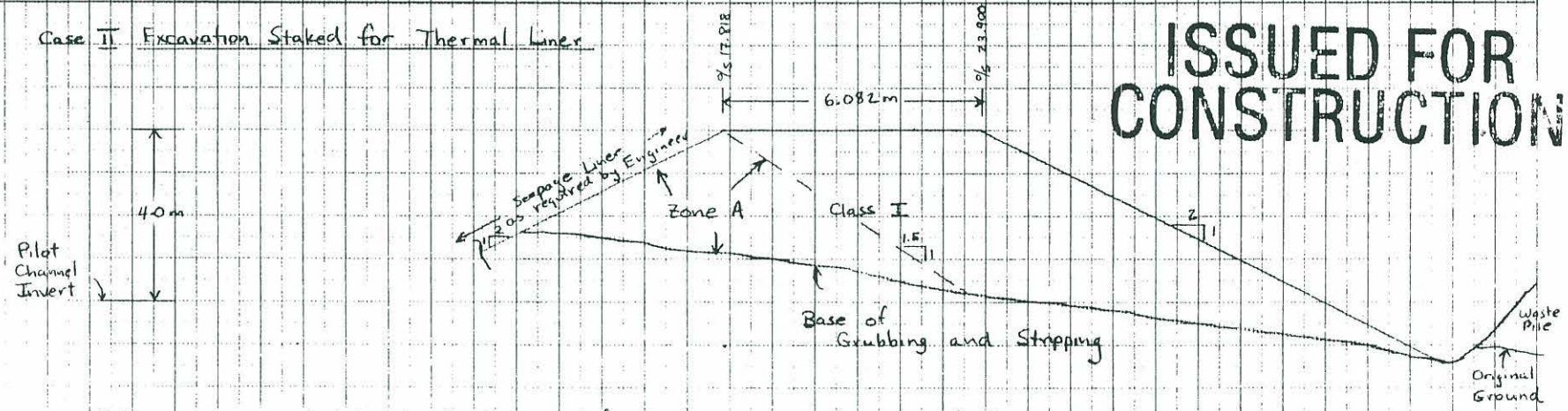
CANAL DYKE CROSS-SECTIONS
Reference line Chainage 0+150 to 2+700

Case I Excavation Staked for Seepage Liner



ISSUED FOR CONSTRUCTION

Case II Excavation Staked for Thermal Liner



ISSUED FOR CONSTRUCTION

Note: Class I material shall be as defined in the Detailed Specifications of the Down Valley Tailings Containment Contract Documents. Class I material within Zone A as shown above shall be compacted when temperatures are greater than -10 °C as determined by the Engineer. All materials shall be placed and compacted in accordance with the Detailed Specifications of the Down Valley Tailings Containment Contract Documents except that zone A shall be compacted to 95 percent of the standard Proctor maximum dry density and the remainder of the Class I dyke shall be compacted to the discretion of the Engineer.

47 1510
K+E

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

CHANGE ORDER NO. 2

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Subject of Change: SEEPAGE LINER CONTROL

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following:

(a) The volume of seepage control liner Class II material is increased from 33,000 m^3 as shown on Schedule "A" of the Contract to an estimated quantity of 65,000 m^3. This quantity increase will provide for a continuous seepage control liner on the downslope cut face of the canal (or equivalently the upslope side of the dyke) and for intermittent seepage control liner on the bottom of the canal as required by the Engineer between reference line chainages 0 + 100 and 2 + 820 (beginning of the canal outfall). No upslope cut face seepage control liner is presently contemplated although this may change, depending on the results of final excavation.

The increased quantity of seepage control liner will replace Class I thermal liner and therefore reduce the quantity of Class I thermal liner by 32,000 m^3.

The volume of filter gravel remains approximately the same as that shown on Schedule A, namely 24,000 m^3.

(b) The borrow source of the increased volume of Class II materials shall be canal waste excavation materials as specified in section 3.4 of the Contract. If

(b) substantial completion of the canal is to be achieved before May 1, 1981, Class II materials must be borrowed from additional borrow areas as well as from suitable unfrozen common excavation materials between chainages 1 + 200 and 1 + 500 on the reference line. Areas of potential borrow are shown on the Drawing attached. Approximate available quantities are as follows:

(i) Canal excavation - 23,000 m^3

(ii) Borrow Area "H" - 28,000 m^3

(iii) Borrow Area "I" - 80,000 m^3

(iv) Borrow Area "J" - 60,000 m^3 (not shown on Drawing; quantity is approximate and is located on the North Valley Wall).

It is expected that a significant amount of wastage will be unavoidable in these areas due to freezing of the borrow pits, variable materials and/or local pockets of permafrost.

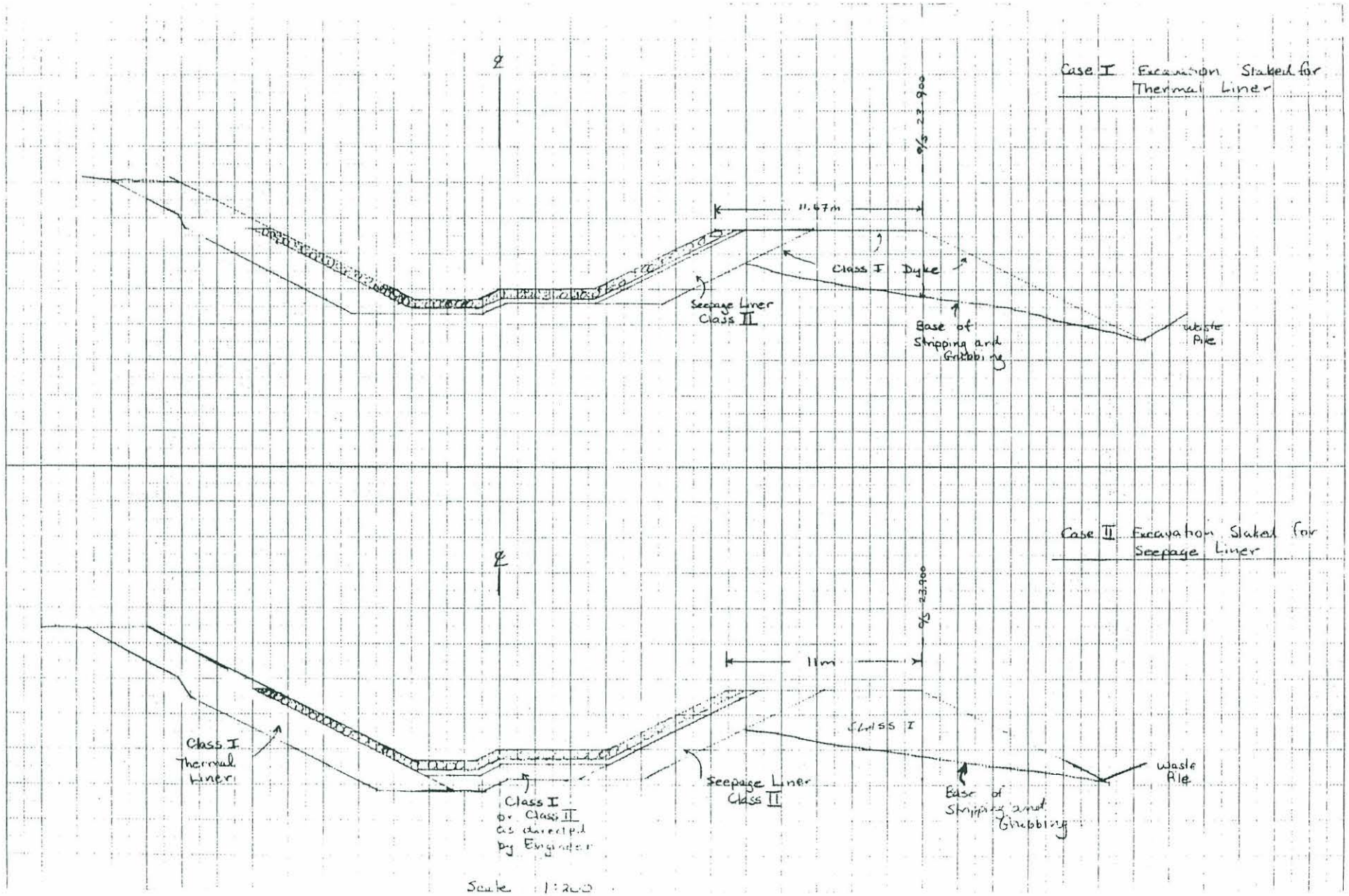
(c) Example cross-sections showing the use of the seepage control liner are shown on the attached Drawings. Estimates of the use frequency of the 4 cases illustrated on the Drawings are as follows:

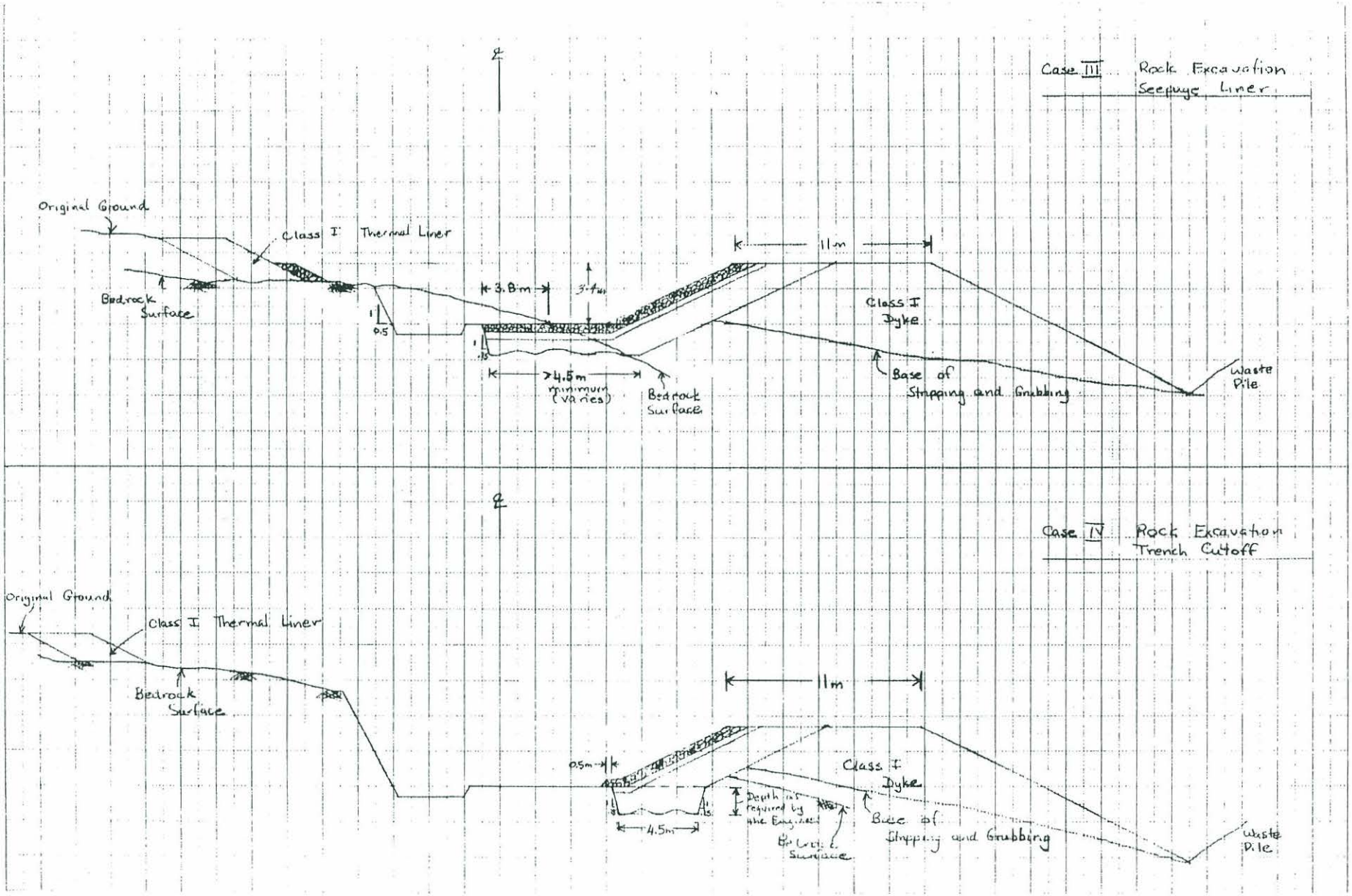
ref. Line Sta.	0 + 100 to 0 + 700	Case II
	0 + 700 to 0 + 900	Case IV
	0 + 900 to 1 + 050	Case II
	0 + 050 to 1 + 110	Case III
	1 + 110 to 1 + 600	Case II
	1 + 600 to 1 + 810	Case IV
	1 + 810 to 2 + 160	Case I
	2 + 160 to 2 + 580	30% Case IV 70% Case II
	2 + 580 to 2 + 820	Case I

Decisions regarding the particular cross-sections to be used at a given station will be made by the Engineer. Modifications to the cross-sections may also be necessary on a local scale.

(d) The seepage control liner shall be completed to a minimum elevation of the 10 year flood (2.3 m above pilot channel invert grade) before May 1, 1981, provided that weather conditions permit construction acceptable to the

(d) Engineer. A detailed schedule to be followed for the completion of the canal shall be calculated by the Contractor and the Engineer and shall be strictly followed by the Contractor. The substantial completion of the canal will be the objective of this schedule but it shall be sufficiently flexible as to provide for the minimum completion to the elevation of the 10 year flood.


Case I Excavation Staked for Thermal Liner
11.67m
Class I Dyke
Seepage Liner Class II
Base of Stripping and Grubbing
Waste Pile
Case II Excavation Staked for Seepage Liner
11m
Class I
Class I Thermal Liner
Class I or Class II as directed by Engineer
Seepage Liner Class II
Base of Stripping and Grubbing
Waste Pile
Scale 1:200


Case III Rock Excavation Seepage Liner
Original Ground
Class I Thermal Liner
Bedrock Surface
3.8m
3.4m
11m
Class I Dyke
>4.5m minimum (varies)
Bedrock Surface
Base of Stripping and Grubbing
Waste Pile
Case IV Rock Excavation Trench Cutoff
Original Ground
Class I Thermal Liner
Bedrock Surface
11m
0.5m
Class I Dyke
Depth as required by the Engineer
4.5m
Bedrock Surface
Base of Stripping and Grubbing
Waste Pile

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

CHANGE ORDER NO. 3

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Subject of Change: ROCK TRENCH CUT-OFF

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following: The drilling, blasting, excavation and clean-up of rock trench in the base of the canal as is generally shown for Case III and Case IV of the attached Drawing. The depth and width of this trench will vary depending on rock quality and configuration and will be determined as the work progresses by the Engineer.

The procedure to be followed is as follows:

(i) Excavate the canal such that the Engineer can determine the configuration of the undisturbed bedrock. Where glacial till is encountered the excavation shall be completed to provide for the installation of the seepage control liner cross-section. Specifically, this shall apply but not to be restricted to the following chainage intervals of the canal reference line:

0 + 160 to 0 + 240

0 + 270 to 0 + 330

0 + 450 to 0 + 900

1 + 040 to 1 + 115

1 + 610 to 1 + 790

(i) 2 + 160 to 2 + 360

2 + 400 to 2 + 580

In addition, sub-excavation to provide for the installation of a seepage control liner at the boundaries of the rock may be required.

(ii) The Engineer will determine and lay out the configuration of preshear line drilling of the rock cut-off trench. The Contractor shall drill, load and blast these holes as directed by the Engineer.. Depths of drilling will be about 1.7 m, hole diameters may range between 51 and 64 mm, hole inclinations shall be 0.25 horizontal to 1 vertical and hole spacing may vary between 0.6 m and 0.8 m. Production holes shall be similar to the holes drilled for preshear except that a square pattern ranging between 1.2 m and 1.5 m will be used. An example drilling and blasting pattern is shown on the attached.

(iii) The Contractor shall excavate, haul and waste the blasted rock.

(iv) The Contractor shall clean the periphery of the cut-off trench to the satisfaction of the Engineer using suitable procedures such as backhoe clean-up and compressed air.

Estimated quanitities (upper limit) are as follows:

(i) line drilling 3630 holes @ 1.7 m → 6172 m
(ii) production holes 3588 holes @ 1.7 m → 6100 m
(iii) excavation volume (rock) 12000 m^3
(iv) the use of the attached cross-sections will result in a reduction in Class IV rip rap quantities by 7000 m^3.
(v) the use of the attached cross-sections will result in a reduction in Class I thermal lining by 70,600 m^3. In summary of Change Orders Nos. 1, 2 and 3, the use of Class I thermal liner which initially included the canal dyke in the Tender Document is as follows:

	TENDER	REVISED
Class I Canal Dyke	59,400	157,000
Class I Thermal Liner	189,600	119,000
Class I Total (viz. Item 3 (f)	249,000	276,000

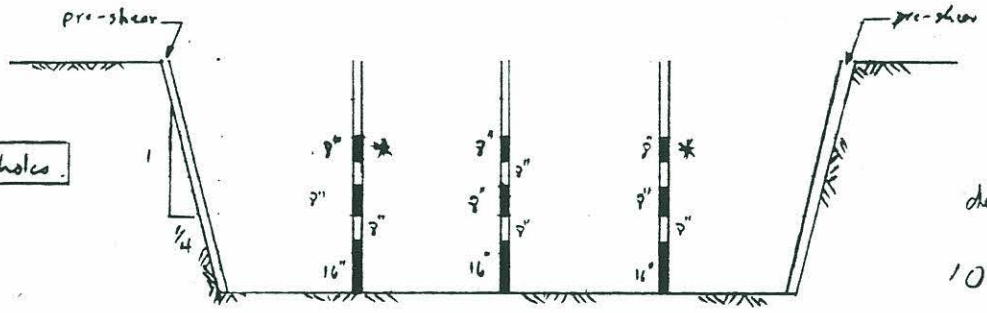
Golder Associates	Subject: Cyprus Anvil Cut-off Trench Blasting pattern	Made by: D. Wyllie Checked by: Approved by:	Job No. 8022037 Date: Feb. 11, 1991. Sheet No. 1

PATTERN *1

	Pre-shear	Main pattern
Hole diameter	2 in	2 in.
Hole spacing	2 ft. – 2½ for ⅜ "Xactex"	4 ft. × 4 ft.
Hole depth	3-6 ft.	3-6 ft.
Explosive diameter	400 grain Primaflex. or ⅝ in. Exactex	1½ in. Forcite or equivalent.
Explosive load	0.85 lb	2.5 lb.
Explosive column length	72 in	32 in *
Equivalent load	0.07 lb/ft³ or 0.18 lb/ft.	0.7 lb/cu.yd. or 1 lb/ft.
Hole inclination	¼:1 into cut.	¼:1 parallel to ditch ℄.

8 in. of 2 in powder
36 in of 1 in powder.

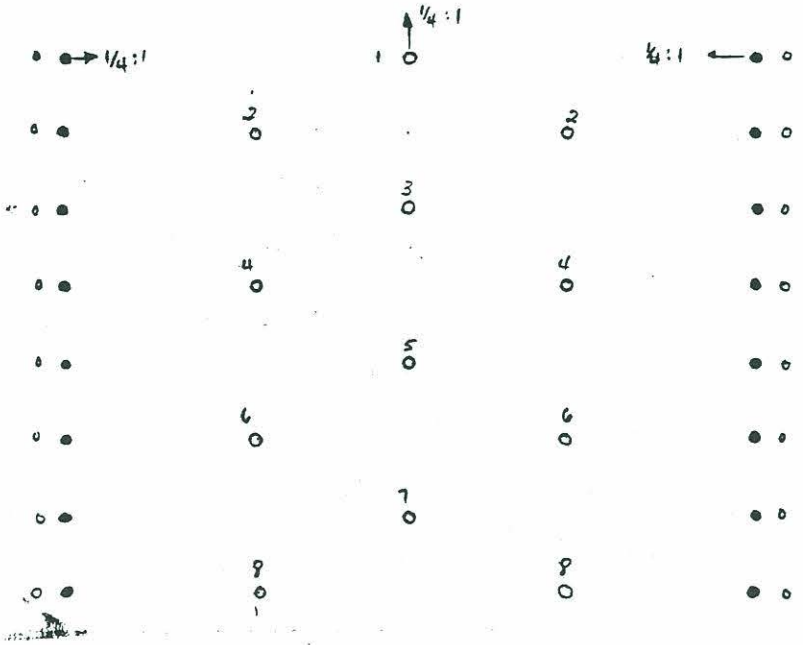
* reduce load in side holes if blast is damaging walls.

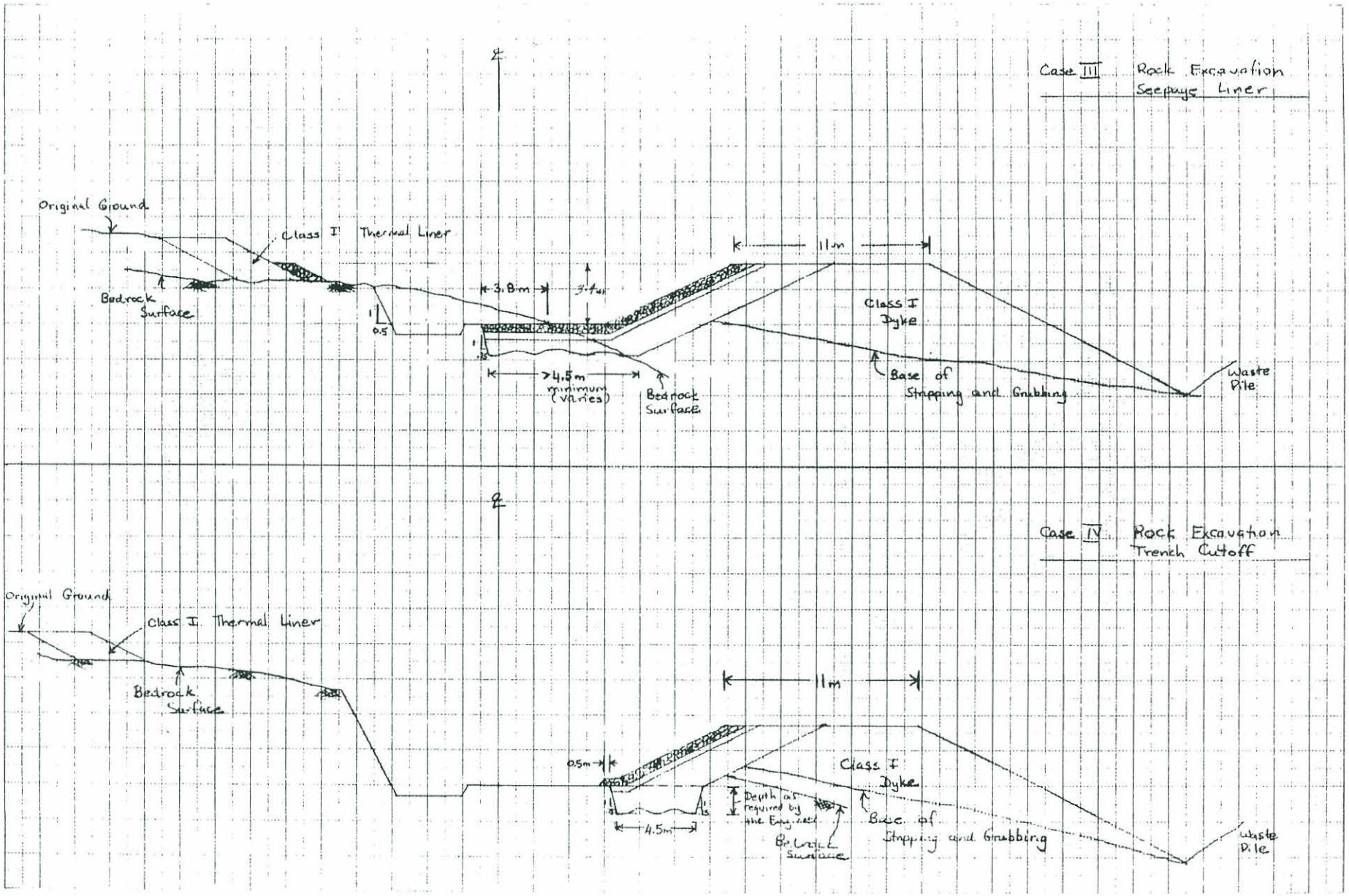


Stem all holes.

delay 10 ms ≡ 2 ms/ft

10 rows/blast.




Case III Rock Excavation Seepage Liner
Original Ground
Class I Thermal Liner
Bedrock Surface
0.5
1
.5
3.8m
3.1m
11m
Class I Dyke
>4.5m minimum (varies)
Bedrock Surface
Base of Stripping and Grubbing
Waste Pile
Case IV Rock Excavation Trench Cutoff
Original Ground
Class I Thermal Liner
Bedrock Surface
11m
0.5m
Class I Dyke
Depth as required by the Engineer
4.5m
Bedrock Surface
Base of Stripping and Grubbing
Waste Pile

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

CHANGE ORDER NO. 4

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Subject of Change: NORTH VALLEY WALL INTERCEPTOR

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following:

(a) The bottom width of the North Valley Wall Interceptor at the North Abutment of the Cross Valley Dam is reduced from 6.1 m to 3 m. This width reduction has resulted in a volume of excavation reduction at the North Abutment of 13,000 m^3.

(b) The volume of excavation in other segments of the North Valley Wall Interceptor Ditch is increased from 20,000 m^3 to 35,000 m^3.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

CHANGE ORDER NO. 5

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

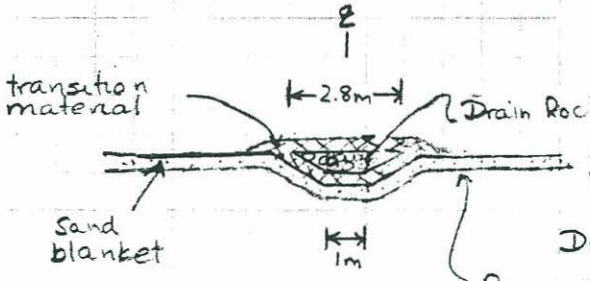
Subject of Change: INTERMEDIATE DAM FOUNDATION SEEPAGE CONTROL MEASURES REQUIRED AT THE SOUTH ABUTMENT.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following: The excavation and back-filling of drainage trenches at the south abutment of the Intermediate Dam as shown on the attached plan and cross-sections. Drain rock shall be obtained from the cobble rejects pile, east of the pumphouse. Transition zone material shall be taken from the crushed rock stock-pile adjacent to the Cyprus Anvil Administration Building. Class X blanket will be borrowed from an appropriate borrow pit. Filter fabric, acceptable to the Engineer, shall be supplied and installed by the Contractor. Location and grades of the trenches will be provided by the Engineer.

Golder Associates	SUBJECT Drain Cross-Sections.		
	Job No. Ref.	Made by DG. Checked Reviewed	Date July 6/81 Sheet of

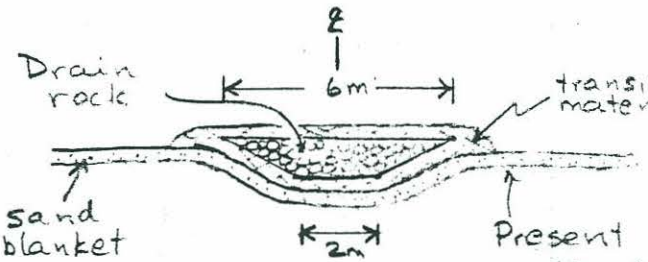
Section A-A East Trench.

Materials
Drain rock - 0.5 to 15 inch dia gravel, cobbles
Transition - 2 inch crush or chemically stable fabric $k = 1$ cm/sec
Sand - Class X



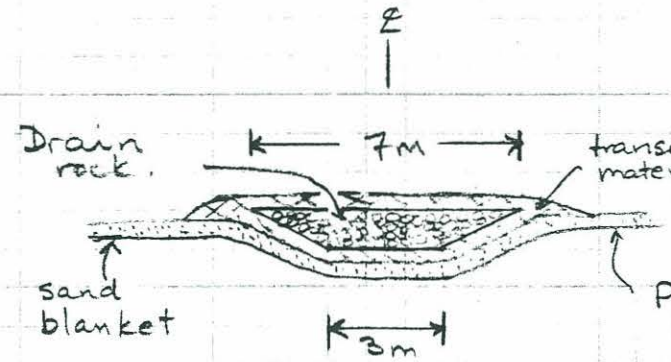
Drain thickness 0.6 m
Present Ground Surface (Proof Rolled)

Section B-B West Trench



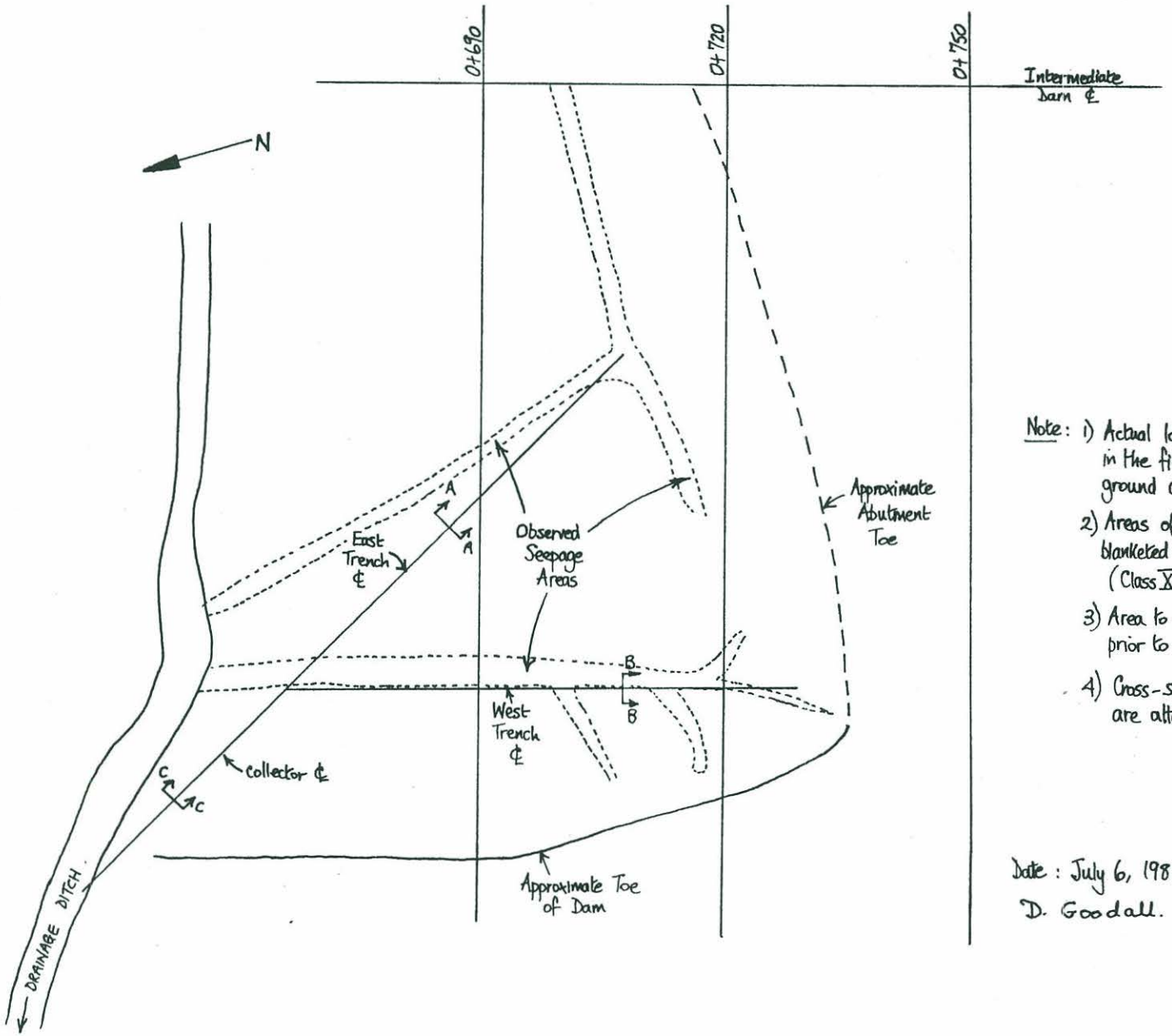
Drain thickness 1m.
Present Ground Surface. (Proof Rolled)

Section C-C Collector Trench



Drain thickness 1m.
Present Ground Surface (Proof Rolled)

Note: All trench materials to be compacted with backhoe compaction.



Note: 1) Actual locations will be determined in the field according to ground conditions

2) Areas of seepage to be blanketed with clean sand (Class $\overline{X}$ material).

3) Area to be proof rolled prior to fill placement

4) Cross-sections A, B & C are attached.

Date : July 6, 1981

D. Goodall.

LIST OF WORK ORDERS

Work Order	#1	Clear Lines for Surveyors Control
	#2	Drainage Ditch - Remove Part of Knoll on Line of Pond
	#3	Sedimentation Pond - Make Access Road for Hauling Rip Rap. To Outfall Area Supply and Place Rip Rap
	#4	Clean out Swamp Material from CVD Upstream Blanket
	#5	Strip a Section of Borrow Pit "C"
	#6	Extra Stripping of Borrow Pit "C"
	#7	Removal of Uncompacted Class III Dykes
	#8	Make Access Road for Drill
	#9	Access, Ripping and Dozing for Samples in Canal Bottom
	#10	Creek Interception at Sta. 0+710
	#11	Remove Ice from Abandoned Rose Creek
	#12	Excavation of Creek Extension at Outfall of Rose Creek
	#13	Cornish Creek Interception at 3+200
	#14	Place Additional Filter Rock on Downhill Slope of Canal, 2+820 to 3+000
	#15	Mobilization/Demobilization for Fourth Vibratory Packer
	#16	Correction of Stripping 2+160
	#17	Removal of Excavation Step In
	#18	Test Trench Intermediate Dam
	#19	Removal of Thermal Liner at Sta. 2+010
	#20	Removal of Canal Thermal Liner at Sta. 3+420 for Rock Apron
	#21	Thermal Liner for the South Abutment of the Intermediate Dam
	#22	Silt Excavation in Borrow Area "A" for Canal Rock Trench Backfill
	#23	Diversion Dam Foundation Preparation
	#24	Maintaining Haul Roads for Tandem Trucks and Hauling of Fish Gravel
	#25	Remedial Stripping Canal 2+700
	#26	Diversion of Water from Bypass Ditch to new Diversion Canal and Construction of Diversion Dam
	#27	Rock Removal for North Valley Wall Interceptor
	#28	Drainage Blanket Adjacent to Canal Dyke Sta. 1+290
	#29	Borrow Area A and B Test Pits for Borrow Material Quantities

(Cont'd)

LIST OF WORK ORDERS (CONT'D)

Work Order	#30	Installation of Instrumentation at Cross Valley and Intermediate Dams
	#31	Reduce Weir No. 60, Install Weir No. 61
	#32	Cross Valley Dam Core Trench Excavation
	#33	Cross Valley Dam Base Preparation
	#34	Upstream Blanket Reworking
	#35	Bypass Ditch Excavation
	#36	Borrow Pit "H" Stripping
	#37	Borrow Pit "I" Stripping
	#38	Test Pits Access Road
	#39	Removal of Till Mounds in Canal
	#40	Pumping of Rose Creek Drainage Ditch
	#41	Drain Rock Intermediate Dam South Abutment
	#42	Spillway Preparation - Cross Valley Dam
	#43	Removal of Coarse Material, Intermediate Dam Upstream Face
	#44	Instrumentation Repair
	#45	Borrow Area "G" Stripping
	#46	Access Road
	#47	Borrow Area "F" Remedial Stripping
	#48	Capping Canal Dyke with Sand and Gravel
	#49	Upstream Blanket Silty Sand Cap Cross Valley Dam
	#50	Cross Valley Dam Toe Access Road
	#51	North Valley Wall Interceptor Pit "F"
	#52	Placement of Boulders on Face of Cross Valley Dam
	#53	Thermal Blanket Intermediate Dam
	#54	North Valley Wall Interceptor Ditch Rip Rapping at North Abutment Cross Valley Dam
	#55	Stripping Borrow Pit "M"
	#56	Raising of Intermediatae Dam Berm to 1068.8 m

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 1

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: CLEAR LINES FOR SURVEYORS' CONTROL

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Clear trees along designated lines as required for surveyors' control lines.

Work was performed on Nov. 3 and Nov. 29, 1980 and payment was included in November progress estimate.

December work this W.O. was included in December progress estimate.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 2

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: DRAINAGE DITCH - REMOVE PART OF KNOLL ON LINE OF POND

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

On a section of the drainage ditch alignment working area for excavation equipment and area for disposal is restricted by a knoll.

Removal of part of this knoll is necessary.

The work was performed and completed in November and payment was included in November, 1980 progress estimate.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 3

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: SEDIMINEATION POND - MAKE ACCESS ROAD FOR HAULING RIPRAP TO OUTFALL AREA. SUPPLY AND PLACE RIPRAP.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Armouring of the sedimentation pond outfall is required to control water flowing from the sedimentation pond. An access road is required to allow haul units to get the riprap to the pond outfall.

The work was performed and completed on November 19, 1980 and payment was included in the November, 1980 progress estimate.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 4

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: CLEAN OUT SWAMP MATERIAL FROM C.V.D. UPSTREAM BLANKET

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Payment for dam foundation subsexcavation has been included in Addendum #4 at the unit price of $\$5.60/m^3$ as offered in G.E.'s Tender for Subexcavation. The final clean out of swamp areas cannot be measured as a unit and a backhoe is being used for excavation and a dozer for pushing this wet material to disposal.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 5

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: STRIP A SECTION OF BORROW PIT "C"

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

It was not possible to measure all of the stripping required to be done in Borrow Pit "C" by cross-sectioning and obtaining the volume for payment under the contract unit price.

The work was performed to completion on November 28, 1980, and this section of the pit was paid for in the November progress estimate.

Another section will later be similarly stripped under another extra work order.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 6

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: EXTRA STRIPPING OF BORROW PIT "C"

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

It is required to strip another section of Borrow Pit "C" (See W.O. #5). It was not possible to measure this stripping by taking cross-sections.

The total of Work Order #6 shall not ~~shall not~~ exceed the cost of stripping and clearing the stripped area on a unit price basis assuming that 30 percent of the work had already been completed on areas previously cleared and stripped. That is maximum payment for areas where clearing and stripping had already been performed (prior to commencement of the contract) will be made at a rate of 70 percent of the appropriate stripping and clearing to allow for the removal and disposal of such materials.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 7

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: REMOVAL OF UNCOMPACTED CLASS III DYKES

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

It is required to remove previously placed uncompacted Class III Dykes. Class III dyke was placed on November 28, 1980 between reference line chainages 2+600 and 2+800. Initially compaction was acceptable but the compactor broke down (engine blew) and Class III fill placement was continued, the Contractor attempting to use scrapers to compact the lifts. The resulting compaction was approximately 80 percent of standard Proctor density. In the November progress estimate payment was made for 1000 m^3 as an assessment of the work, although about 1500 m^3 were placed as the adjacent excavation progressed.

The amount of this work order shall not exceed (1000)($3.25) = $3,250 in payment for removal of the defective work.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 8

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: MAKE ACCESS ROAD FOR DRILL

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

It is required to drill and sample the potential borrow area for seepage liner material. It is necessary to construct an access to the area (south of Canal Sta. 12-15) so that the drillers and their equipment can get to the area.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 9

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: ACCESS, RIPPING AND DOZING FOR SAMPLES IN CANAL BOTTOM

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Provide access for drill rig to get to borrow area. Also rip for samples canal bottom, as directed, Sta. 2+700 - 2+160.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO.10

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: CREEK INTERCEPTION AT STA. 0+710

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The creek at Sta. 0+710 is to be intercepted before entering the canal. The work consists of backfilling a notch in the hill at the top of the cut with broken rock; finer rock is to be placed on the bottom of the trench.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 11

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: REMOVE ICE FROM ABANDONED ROSE CREEK

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The abandoned section of Rose Creek at the bypass is the designated spoil area coming from canal excavation in the nearby area. Ice is to be cleaned out of the abandoned creek section.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 12

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: EXCAVATION OF CREEK EXTENSION AT OUTFALL OF ROSE CREEK

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The outfall excavation is to be extended across the Rose Creek meander. A rock apron will be extended beyond the final weir and the diversion canal flow will pass over it to enter Rose Creek.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 13

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: CORNISH CREEK INTERCEPTION AT 3+200

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Cleaning of ice and snow at Cornish Creek followed by ten loads of class V rock on the upslope side of the canal.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 14

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: PLACE ADDITIONAL FILTER ROCK ON DOWNHILL SLOPE OF CANAL, 2+820 to 3+000.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

No additional work was required because contractor had already placed more class IV than required.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 15

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: MOBILIZATION/DEMOBILIZATION FOR 4th VIBRATORY PACKER

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The quantity of Class I material to be used in canal dyke construction has been substantially increased from the Tender amount(see Change Order No. 1). This requires an increase in compactor capacity to obtain the specified compaction. The tendered bid allowed for 3 vibratory compactors only. Another vibratory is required for compaction of the increase in Class I quantity. Letter from G.E. to Golder Associates confirms agreement for payment of $4,320.00 ($3,160 for mobilization/ $2,160 for demobilization)

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 16

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: CORRECTION OF STRIPPING 2+160

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

A stripping correction was required between stations 2+070 and 2+130 due to X-sections indicating little if any stripping was done in the dyke area. Work undertaken was removal and backfill of the class I dyke. The problem originated from the deposition of fill and debris for an old exploration cut line which ascends the valley wall and crosses the canal.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 17

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: REMOVAL OF EXCAVATION STEP IN AT 1+890 and 1+860

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

In January good seepage liner material was encountered at Sta 1+860 during excavation, in an effort to avoid placement of seepage liner the cut stakes were moved in 3.8 metres on the downhill side at 1+860. Unfortunately, the existing surface was not suitable to work on for placement of seepage liner and the excavation had to be completed to grade between 1+830 and 1+890.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 18

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: TEST TRENCH INTERMEDIATE DAM

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Excavation and backfill of a test trench down the centre-line of the intermediate dam south side. This work was necessary to investigate the sub-surface materials beneath the sub-excavation for the intermediate dam. Further trenching on the north side of the drainage ditch will be undertaken in a similar fashion in the near future (similar work will also be undertaken for the Cross-Valley Dam)

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 19

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: REMOVAL OF THERMAL LINER AT STA. 2+010

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Removal of thermal liner and replacing with rip-rap, also excavation of an interceptor ditch at Sta 2+010. This is to protect against surface water flowing over the thermal liner on the backslope, which is known to occur in this area. Also a seep exists in the slope about one-third upright at 2+010 which has heaved the thermal liner in this area - rip-rapping should alleviate this problem.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 20

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: REMOVAL OF CANAL THERMAL LINER AT STA. 3+420 FOR ROCK APRON

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work included removal of thermal liner from the walls of the canal at Sta. 3 + 420 (Weir No. 47) to allow for a rock apron downstream of weir No. 47.

This work order includes only this work. Additional bottom excavation and rock placement are recorded in the appropriate unit price items.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 21

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: THERMAL LINER FOR THE SOUTH ABUTMENT OF THE INTERMEDIATE DAM

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Thermal lining of the south abutment of the Intermediate Dam was required to protect against permafrost degradation and sloughing of the canal waste pile.

Payment was to be according to the thermal liner unit price with no compaction being provided. This thermal liner was to be reworked when dam construction was underway at the expense of the Contractor. (See memo #194).

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 22

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: SILT EXCAVATION IN BORROW AREA "A" FOR CANAL ROCK TRENCH BACKFILL.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work included backhoe and scraper excavation to borrow silt from Borrow Pit "A" and placement of the silt in the rock trench in the canal near Sta. 1 + 700 using the 966C frond end loader. The silt was preferred initially because it would mould into the voids of the prepared rock surface better than the bouldery till which was being encountered in Borrow Pit "H". However, the quality of the till improved, the silt became wet and the use of the silt for the initial backfill of the rock trench was stopped.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 23

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: DIVERSION DAM FOUNDATION PREPARATION

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work included the dozer removal of snow and ice and other loose debris, the drilling and blasting of the abandoned weirs and their removal using trucks and 988 B loader, and the subsequent backfill of the dam sub-excavation. Backfill materials are included in the appropriate items of the schedule of quantities and prices (Schedule A). The Cat 235 backhoe was also used for this work.

CYPRUS ANVIL MINING CORPORATION

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EXTRA WORK ORDER NO. 24

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: MAINTAINING HAUL ROADS FOR TANDEM TRUCKS AND HAULING OF FISH GRAVEL.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Gravel required to fill in the voids of the outfall erosion control rock was hauled using highway tandem trucks loaded by a 980C or 988 loader. The gravel was taken from Borrow Pit "A" and hauled to the outfall either via the lower creek crossing or via the middle creek crossing when the lower crossing had washed out. At the time of construction haul roads were generally thawing out and maintenance particularly for the tandem trucks, was required. Because the lower haul road was not being used by any other equipment the roads had to be maintained at the expense of this Work Order. Some dozer, scraper and grader time was involved. After the washout of the lower crossing, some sharing of maintenance costs for the middle haul road was considered appropriate.

Travel time for truck drivers from downtown is inlcuded.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 25

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: REMEDIAL STRIPPING CANAL 2 + 700

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work is basically an extension of Work Order No. 7, removal of uncompacted Class III dyke. Because the area at 2 + 700 had been generally used as a marshalling area for the crusher and quarry activity, it was difficult to define what clean-up work belonged to the Contractor and what was required to remove previously placed Class III.

The inspector and foreman agreed on an equipment split for this work.

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EXTRA WORK ORDER NO. 26

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M. Kelly

Extra Work Order Title: DIVERSION OF WATER FROM BYPASS DITCH TO NEW DIVERSION CANAL AND CONSTRUCTION OF DIVERSION DAM.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes payment for construction of the temporary diversion dam and for extra equipment required to complete the final diversion dam across the bypass ditch. For the temporary dam payment was made for Class V rock and for the equipment not included in the haul of the Class V rock (e.g. dozer to doze in gravel upstream of the rock).

The second part extra equipment required to complete the dam including a dozer, backhoe and in some cases a packer, was paid for. Material required for construction was measured on a load count and surveyed quantity basis and included in the quantities for the Diversion Dam.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 27

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: ROCK REMOVAL FOR NORTH VALLEY WALL INTERCEPTOR

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes the drilling and blasting necessary to remove the high spots along the mine leg of the Interceptor Ditch. Some dozing of the blasted rock is required. In addition, some ripping and dozing of poor quality rock is necessary to complete the interceptor ditch (mine leg only).

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 28

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: DRAINAGE BLANKET ADJACENT TO CANAL/DYKE STA. 1 + 290 TO 1 + 350.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

When Borrow Pit I was stripped for canal seepage liner (after the creek had been diverted) a seepage zone was revealed. This seepage zone was blanketed with clean sand and gravel to protect against piping.

The sand and gravel was hauled from Borrow Area "A" using a pushcat, scrapers, and a dozer to place the material.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 29

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: BORROW AREA A & B TEST PITS FOR BORROW MATERIAL QUANTITIES

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Some concern has been expressed about available alluvium borrow remaining for construction of the dams. Three test pits were excavated in Borrow Area "A" and one in Borrow Area "B". Density tests were performed in these pits as the excavation advanced (to augment our borrow pit in situ density information) and the test pits were logged. The information obtained was used to estimate the reserve volume of alluvium in Borrow Areas "A" and "B".

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 30

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: INSTALLATION OF INSTRUMENTATION AT CROSS VALLEY AND INTERMEDIATE DAMS

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Piezometers and settlement plates were installed at both the Cross Valley and Intermediate Dams. The Cat 235 backhoe was used for much of this work. The JCB backhoe has been used. Some welding and pumping is also included.

Materials supplied by General Enterprises namely 1" pipe, 2' x 2' ½" plates, 3" ABS sleeves will also be charged to this Work Order.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 31

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: REDUCE WEIR NO. 60, INSTALL WEIR NO. 61

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The tailwater at the outfall of the canal was too low (actually lower than the original creek bed) and the head drop across Weir No. 60 exceeded 2 ft. Weir No. 60 was reduced because it was too high. An additional weir, Weir No. 61 was constructed using the excess rock from Weir No. 60 and rock hauled from stockpile. The Cat 235 backhoe was used to place rock, 988B loader was used to bring rock and sand and gravel.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 32

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: CROSS VALLEY DAM CORE TRENCH EXCAVATION

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

A trench 2 to 3 m deep below the foundation sub-excavation level was excavated using the 235 backhoe. The trench was about 7 m wide at the level of the sub-excavation and 5 m wide at the bottom of the trench. This trench was inspected and logged.

This work should not be considered as extra work but rather as a part of Item 4 (a) (iii).

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 33

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES N Kelly

Extra Work Order Title: CROSS VALLEY DAM BASE PREPARATION

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

This work includes the clean-up of soft material displaced by the working pad preparation required at the Cross Valley Dam. The backhoe was used for this work.

This work should not be considered as extra work but rather as part of sub-excavation backfill. (Item 4 (b) (i) of Addendum No. 4).

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 34

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: UPSTREAM BLANKET REWORKING

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes the hauling of stockpiled upstream blanket materials in the vicinity of the upstream toe of the Cross Valley Dam and placement and compaction of this material in the upstream blanket area.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 35

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: BYPASS DITCH EXCAVATION M Kelly

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work included the excavation of a ditch parallel to the existing canal in the vicinity of the Diversion Dam and for the first 400 m of the canal. Payment for the work was made at the unit price bid for canal excavation.

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 36

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES M Kelly

Extra Work Order Title: BORROW PIT H STRIPPING

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Borrow Pit H (seepage liner borrow pit) is located on the left bank (upslope) side of the canal between Sta. 1 + 200 and 1 + 300 (approx.). Because the stripping material in this area had to be hauled with scrapers to avoid burying Borrow Pit I, payment was made at the unit price bid for canal excavation.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 37

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: BORROW PIT I STRIPPING

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Borrow Pit I (seepage liner borrow pit) is located on the right bank of the canal between Sta. 1 + 250 and 1 + 420 (Approx.). Payment for this work was made at the unit price bid for canal stripping.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 38

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: TEST PITS ACCESS ROAD

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Test Pits were excavated along the approximate alignment of the Access Road to assess the availability of borrow materials from the cuts which will be required for the road.

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 39

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: REMOVAL OF TILL MOUNDS IN CANAL

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Exposure of till material to cold weather resulted in chilling of permafrost materials to the point that ripping of this material became virtually impossible and it therefore became difficult to discern the material from rock based on rippability. This resulted in some till mounds being mistakenly considered as bedrock and the rock cross-section was constructed.

The till mounds in the backslope (2 + 380 area) required drilling and blasting. It was agreed that the costs of drilling and blasting would be shared on a 50/50 percent basis between the Owner and the Contractor. In addition, General Enterprise were paid for common excavation required to remove the material.

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 40

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: PUMPING OF ROSE CREEK DRAINAGE DITCH

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The costs of pumping the flow in the Rose Creek Drainage Ditch will be shared on a 50/50 percent basis between the Owner and the Contractor.

Should pumping across the closed dams be required beyond that which would be required for construction, the full costs of pumping will be borne by the Owner.

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EXTRA WORK ORDER NO. 41 / CHANGE ORDER NO. 5

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES 177 Kitty

Extra Work Order Title: DRAIN ROCK INTERMEDIATE DAM SOUTH ABUTMENT

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes the supply of drain rock, crushed filter rock and the construction of the drainage system as detailed by Change Order No. 5.

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 42

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: SPILLWAY PREPARATION - CROSS VALLEY DAM

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes dozer and compactor activity required to level the area downstream of the Cross Valley Dam in preparation for placement of Class VIII material using scrapers.

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 43

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: REMOVAL OF COARSE MATERIAL, INTERMEDIATE DAM UPSTREAM FACE

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

In the upstream terrace cut of the Intermediate Dam a few small lenses of medium to coarse openwork gravel were exposed. These were subexcavated at least 0.3 m into the face of the cut and backfilled with sand filter using a grader.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO.44

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: INSTRUMENTATION REPAIR

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Although the Contractor is responsible for damage which he may cause to instrumentation, some instances of settlement plate repair have been required through no obvious action of the Contractor. The settlement plate riser pipes have been broken on some occasions in spite of normal filling operations due to pipe weakness. In the latter cases, as judged by the Engineer, the costs of repair are charged to this Work Order.

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 45

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES DV Valley

Extra Work Order Title: BORROW AREA 'G' STRIPPING

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Additional stripping required to develop Borrow Area "G" subsequent to the initial stripping are included in this Work Order. Material removed was a wet organic to inorganic silt.

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 46

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: ACCESS ROAD

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes all stripping required for the cut/fill portion of the Access Road (east of Station 0 + 600). Sub-excavation for the section of road adjacent to the chemical storage pad is included.

In addition to stripping, this Work Order includes all work associated with the cut/fill construction (except gravel capping) of the Access Road between 0 + 000 and 0 + 600.

Ditch excavation was also allotted to this Work Order.

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EXTRA WORK ORDER NO. 47

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: BORROW AREA "F" REMEDIAL STRIPPING

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Some parts of Borrow Area "F" (particularly the east extension of Borrow Area "F") have required removal of organic debris, schisty material or silty gravel which was not removed during the initial stripping. Removal of such material was required on a discontinuous basis and hence the need for payment on an hourly basis.

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EXTRA WORK ORDER NO. 48

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: Capping Canal Dyke with Sand and Gravel

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The canal dyke was completed within the contract tolerances with respect to top elevation on the basis of the contract unit price. However, it became evident that there was a need to cap the dyke with additional sand and gravel for the following reasons:

(1). The seepage liner element of the dyke tended to rut with traffic. Precipitation tended to aggravate the situation and cause it to become muddy.

(2). Hydrocon Engineering recommended that certain sections of the dyke be raised to maintain design hydraulic capacity which was reduced locally due to the varying cross-section of the canal (which was adopted for construction convenience or expedience), to overfilling of the canal walls, and to the design change in the canal dyke.

(3). Trimmings of the seepage liner for completion of the top part of the dyke were spread over the top of the dyke. While this material increased the grade of the dyke, it required capping to prevent it from turning to mud and to maintain

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EXTRA WORK ORDER NO. 48 - cont'd.

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: Capping Canal Dyke with Sand and Gravel

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

(3). good access along the top of the dyke.

Sand and gravel was hauled from Borrow Area "K" (coarse cobbly material) and from Borrow Area "A" (sand and gravel).

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EXTRA WORK ORDER NO. 49

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: Upstream Blanket Silty Sand Cap Cross Valley Dam

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

A silty sand cap from Borrow Area "C" was placed between Station 0 + 360 and 0 + 420 in the upstream toe area of the Cross Valley Dam. The cap was about 1 m thick and extended from the upstream toe of the dam to a width over the upstream blanket of about 15 m. The purpose of the cap was to provide healing material to seal cracks in the underlieing upstream blanket which may develop due to thaw of permafrost and ice.

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EXTRA WORK ORDER NO. 50

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: CROSS VALLEY DAM TOE ACCESS ROAD

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work consists of the construction of an access road about 10 m wide across the valley near the downstream toe of the Cross Valley Dam. Materials will be borrowed from nearby natural deposits and any other waste piles of granular materials. A 48 in. diameter culvert is to be installed to cross the drainage ditch.

In general, the road will be field engineered with the intent of providing year round access across the valley and to the toe of the dam.

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EXTRA WORK ORDER NO. 51

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: NORTH VALLEY WALL INTERCEPTOR PIT "F"

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes non-routine construction for the North Valley Wall Interceptor through Borrow Area "F". This includes the initial levelling of the dyke area, dyke construction and excavation at the west end outfall (including rip rapping), and excavation of the culvert and back-filling at the east end.

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EXTRA WORK ORDER NO. 52

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: PLACEMENT OF BOULDERS ON FACE OF CROSS VALLEY DAM

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Boulders were placed on the upstream face of the Cross Valley Dam between elevations 1,062.5 and 1,064.5 m between stations 0 + 360 and 0 + 465 and between 0 + 570 and 0 + 630. This work was required to augment the generally cobble deficient material which was placed in this area; suitable materials were not available at the time of fill placement.

CYPRUS ANVIL MINING CORPORATION

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 53

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: THERMAL BLANKET INTERMEDIATE DAM

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

The work includes the preparation for and placement of a scraper width of Class VII type material from Borrow Area "B" on the upstream side of the upstream core of the Intermediate Dam. The material was to be compacted to a minimum of 95 percent of maximum standard Proctor dry density. The volume of material to be paid for was the actual volume placed with scrapers. Approximate Volume 18,000 m^3.

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EXTRA WORK ORDER NO. 54

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: NORTH VALLEY WALL INTERCEPTOR DITCH RIP RAPPING AT NORTH ABUTMENT CROSS VALLEY DAM.

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

At the north abutment of the Cross Valley Dam, the North Valley Wall Interceptor Ditch has a relatively steep grade of 5 percent. The necessary armouring of the channel was not obtained by windrowing cobbles. Therefore, a 0.3 m thickness of Class IV rip rap from the Intermediate Dam rock stockpile was placed to a height of approximately 1 m above the rip rap invert.

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GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 55

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: STRIPPING BORROW PIT "M"

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Borrow Area "M" was opened up to provide silty till for the construction of the North Valley Wall Interceptor Ditch dyke through Borrow Area "F". This new Borrow Area "M" is located east of Borrow Area "F" in the vicinity of the old Access Road.

802-2038

CYPRUS ANVIL MINING CORPORATION

by

GOLDER ASSOCIATES

EXTRA WORK ORDER NO. 56

Contract Title: DOWN VALLEY TAILINGS CONTAINMENT

Contractor: GENERAL ENTERPRISES

Extra Work Order Title: Raising of Int. Dam Berm to 1068.8

Pursuant to provisions of Article 24 of the general conditions, EXTRA WORK and PAYMENT FOR PROVISIONAL ITEMS, the Contract for DOWN VALLEY TAILINGS CONTAINMENT is hereby amended to incorporate the following EXTRA WORK:

Between the terrace foundation area of the Intermediate Dam and the Intermediate Dam (approx Sta of 520 and of 670) the berm area of the dam was raised to El 1068.8 from 1068 (a calculated volume of 5291 m^3) using Class VIII material from Borrow Area "C". This material was not compacted due to equipment breakdown and therefore payment will be made based on the equipment operation hours.

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

A REPORT TO
CYPRUS ANVIL MINING
summarizing the

DOWN VALLEY TAILINGS CONTAINMENT PROJECT 1980-81 CONSTRUCTION

Faro Yukon

Volume III of III

Distribution: 20 copies: Cyprus Anvil Mining Corporation
Faro, Yukon Territory
3 copies: Golder Associates
Calgary, Alberta

802-2038

February, 1982

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HYDRAULIC REVIEW OF AS-BUILT CONDITIONS
ROSE CREEK DIVERSION
DOWN VALLEY TAILINGS DISPOSAL PROJECT
CYPRUS ANVIL MINING CORPORATION
FARO, Y.T.

Prepared for:
GOLDER ASSOCIATES
Calgary, Alberta.

Prepared by:
HYDROCON ENGINEERING (Continental) LTD.
Calgary, Alberta.

AUGUST 21, 1981
FILE: 47-7.3

HYDROCON ENGINEERING (Continental) LTD.
ENGINEERING CONSULTANTS IN WATER RESOURCES

August 21, 1981 File No. 47-7.3

Mr. Glen Gilchrist, P.Eng.,
Golder Associates,
5915 - 3rd Street S.E.,
CALGARY, Alberta.
T2H 1K3

SUBJECT: Rose Creek Diversion - Down Valley Tailings Proposal Project
Hydraulic Review of As-Built Conditions

Dear Mr. Gilchrist:

Our review of the hydraulic aspects of the as-built conditions for Rose Creek versus design is contained herein. The review is based on our field and office assessments, field data collected by your staff and various discussions with you and your personnel and Mr. N. Cornish of Cyprus Anvil during construction and preparation of this report.

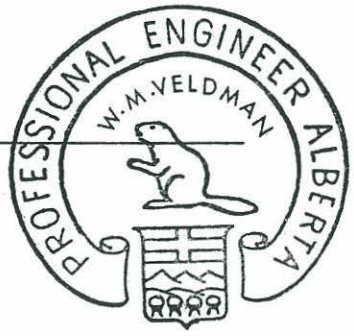
Provided the modifications recommended herein are undertaken, we believe the diversion channel will satisfy the initial hydraulic design objectives as outlined in our May 1980 report. Hydraulic monitoring is also recommended.

Please advise if you have any comments or question.

Yours truly,
HYDROCON ENGINEERING (Continental) LTD.

W.M. Veldman

W.M. Veldman, P.Eng.



ASSOCIATION OF
PROFESSIONAL ENGINEERS
OF ALBERTA
PERMIT NUMBER
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HYDROCON ENGINEERING
(CONTINENTAL) LTD.

cc: Mr. N. Cornish, Cyprus Anvil, Faro.
Mr. D. Goodall, Golder Associates, Faro.
Mr. B. McAlpine, Indian and Northern Affairs, Whitehorse.
Mr. R.H. Cooper, Northwest Hydraulic Consultants Ltd, Edmonton.
Mr. M. Stepanek, Hardy Associates, Edmonton.

WMV:tc

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INTRODUCTION

Flow diversion of Rose Creek around the Down Valley Tailings Disposal Project commenced in May 1981. Some work remains to be done.

Hydrocon Engineering (Continental) Ltd., responsible for the hydrology and hydraulic design of the channel for Golder Associates[1], was asked to review the hydraulic aspects of the present as-built conditions and to recommend additional measures if necessary to ensure the channel will satisfy the design intent. Wim M. Veldman, P.Eng. of Hydrocon, in addition to pre-design trips, visited the site during construction (February 24-25, 1981 and April 7-8, 1981) and after diversion (July 17-18, 1981).

Consultants to the Yukon Water Board have previously reviewed the design.[2] A response to these comments was prepared by Hydrocon on April 24, 1981.[3] The Board's consultants also prepared additional comments following a pre-diversion site visit on April 28, 1981.[4]

Whereas the previous design reports and governmental reviews covered the hydraulic and hydrologic aspects of the North Valley Interceptor Ditch the Intermediate and Cross-Valley dams as well as the Rose Creek Diversion this review is limited to the latter and addresses:

---

1. "Hydrologic and Hydraulic Design of Down Valley Tailings Disposal Project, Cyprus Anvil Mining Corporation, Faro, Y.T." Hydrocon Engineering (Continental) Ltd., May 8, 1980.

2. "Review of Hydraulic and Hydrologic Aspects of the Cyprus-Anvil Down Valley Tailings Containment Project." Northwest Hydraulic Consultants Ltd., February, 1981.

3. "Response to Review Comments on Hydrologic and Hydraulic Design of Down Valley Tailings Disposal Project, Cyprus Anvil Mining Corporation, Faro, Y.T." Hydrocon Engineering (Continental) Ltd. April 24, 1981.

4. Letter from R.H. Cooper, P.Eng., Northwest Hydraulic Consultants Ltd. to B. McAlpine, Indian and Northern Affairs, May 14, 1981.

1) The expected hydraulic performance of the as-built channel,
2) Additional works if necessary, and
3) Expanding on previous review comments in light of limited operating experience to date for the diversion.

The review was based on:

1) Previous reports for the channel by Golder Associates and Hydrocon.
2) Twenty as-built representative cross-sections of the channel upstream of the upper 5% drop weir section (as prepared and submitted by Golder Associates). As-built water levels were determined by the Corps of Engineers' HEC-2 computer program.
3) Detailed cross-sections and velocity measurements obtained by Golder Associates at a "metering reach" in the channel. Manning's roughness values were determined from this data.
4) Riprap sizes measured by Golder Associates during construction and by Hydrocon during the July 17-18, 1981 site visit.
5) Site visits and discussions with Golder Associates personnel and Mr. N. Cornish of Cyprus Anvil.

Site photographs are appended to this report as well as a comparison of water levels and grades and computer printouts of the HEC-2 backwater studies.

HYDRAULIC REVIEW OF AS-BUILT CONDITIONS

General

The chief areas of concern related to the as-built conditions of the channel are:

1) A somewhat narrower-than-design section in some locations,
2) Steeper-than-design side slopes in some reaches particularly on the right (downhill) bank of the channel,
3) Anticipated performance of the riprap armouring particularly on some areas of the right (downhill) slope.

It is understood that as a consequence of some surveying and construction complications and procedures[5], the channel in some locations is somewhat narrower than design. End dumping of the Class IV armouring over the side slopes, rather than placing it from the bottom probably was a factor contributing to the as-built slopes being somewhat steeper than design in some locations. Difficulties in obtaining and manufacturing riprap combined with a tight diversion schedule resulted in placement of some armour material not wholly satisfying the Class IV armor specifications particularly in the latter stages of construction.

Other as-built conditions and/or design refinements, of less concern than the above that were reviewed are:

1) Expected performance of the somewhat irregular pilot channel,
2) Need for additional drop structures,
3) Need for riprap on the upstream diversion dam,
4) Final alignment of Cornish Creek into the Rose Creek,
5) Repairs or modifications of the inlet of Goodall Creek into Rose Creek,
6) Field designed solutions, if necessary, for the various tributaries which generally flow only during spring breakup.

---

5. From personal communication with Golder personnel.

A concern previously raised by the Board's consultants[2] was the hydraulic capacity of the channel in the event Manning's roughness is greater-than-anticipated in design. Limited operating data to date was reviewed to expand on a previous response.[3]

Channel Cross Section

Using twenty representative as-built cross-sections of the channel (as surveyed and plotted by Golder Associates), water levels for the 1:500 year design discharge of 160 m^3/sec and Manning's 'n' value of 0.030 were computed using the U.S. Corps of Engineers' HEC-2 backwater program. These are compared to design levels on Drawing 47-7.3-1. The drawing also illustrates design and as-built thalweg elevations of the main channel. As-built channel widths are also compared to their design values. Since the sections were selected to be representative of every part of the channel, simple straight line interpolation was assumed between the sections in both the HEC-2 work and on the drawing.

Due to cross-section variations which create head losses, the computed water levels for the as-built dimensions can be expected to be somewhat higher than those computed for the uniform design sections. This is apparent in the 0+700 - 0+900 and 2+300 - 2+500 reaches. Generally except for the areas from approximately Station 1+000 - 1+300, 1+500 - 1+900 and 2+450 - 2+700 area, the as-built grades for the main channel invert satisfy design requirements.

To satisfy the initial design requirements, ie: that the diversion channel is capable of carrying the 1:500 year contingency flood, the crest elevation of the right (downhill) dyke should be equal to or greater than the computed elevations shown on Drawing 47-7.3-1. The amount the existing dyke has to be raised is not known since the surveyed cross sections used in this study do not reflect the present dyke height. It appears that raising may be required from approximately Station 0+400 - 0+950 and from about 2+250 - 2+500.

The crest elevation of the left (uphill) slope riprap is considered to be adequate as is because:

1) Differences between initial design and computed elevations are small, and,
2) Areas where the greatest differences occur are low velocity and/or rock areas.

Riprap

Class 1V Armouring - Riprap sizes during early phases of construction were measured at the processing site and in place by Golder Associates. These sizes, reviewed by Hydrocon, met design requirements. To meet the very rigid diversion date, it was necessary to place some armour material directly from the quarry rather than first processing it. This resulted in a wide range of sizes as illustrated on Photo 4.

During the July 17-18 field evaluation, Hydrocon randomly measured Class 1V armour sizes in place on the downhill slope near the upstream end of the channel. Every piece falling under the 3 foot mark of a stretched out tape was measured and the average size of 66 measurements computed to be 150mm. compared to a design range of 180 to 210mm. Such a measurement technique was not possible for the reaches containing fine grained material interspersed with the larger sizes as shown on Photo 4.

For a given design velocity, riprap stability is dependent on material size, flow depth and side slope. Drawing 47-7.3-2 illustrates the relationship between allowable velocity and side slopes for the 50 and 500 year design floods. It illustrates that for design-sized armour material, the riprap is stable for the as-built side slopes and the design assumptions shown. Using the same type of analysis, in place armour material having a D_{50} of 150mm. at a side slope of 1.5H to 1V was found to be marginally stable for design flood conditions.

The fact that less-than design-sized material at a steeper slope still satisfies design objectives is not an indication of over-conservatism in the initial design but due to the use of a higher safety factor to allow for some breakage during handling and placement.

In areas such as shown on Photo 4 where armour was placed directly from the quarry without processing, namely:

1) The right (downhill) bank for about 200-300 metres upstream and 100 metres downstream of Goodall Creek, and
2) The left (uphill) slope from the bedrock control in the upstream end of the channel to approximately Station 0+160 (the rock outcropping on the left bank),

removal of the undersized material and replacement with material sizes consistent with the rest of the channel armouring is recommended. The precise extents of this rework should be field determined.

Class V Drop Weir Riprap - Except for perhaps four or five drop weirs which from a hydraulic viewpoint may require some additional riprap in the future, the Class V riprap and drops meet design objectives. Size measurements by Golder Associates in early 1981 indicated the material meeting design requirements.

With higher flows no doubt there will be some movement of some of the smaller rock sizes in the weirs resulting in perhaps some gaps. These gaps, if small, are not a concern from a hydraulic viewpoint and are apparently desirable from a fisheries viewpoint.

There may be some steeper-than-design side slopes in the right (downhill) slope of the channel armoured with Class V riprap (see Photo 12). Until the "fish" gravel is transported and/or settles further into the voids, the exact as-built slope is difficult to assess. The April 7-8, 1981 site visit by Hydrocon prior to placement of the "fish" gravel indicated no concern with the slopes. Some additional side slope riprap may be required at the most upstream weir in the future.

Additional riprap placement is not considered necessary at this time. Close monitoring of the structures is recommended and maintenance and/or upgrading of the potential areas of concern noted undertaken if greater-than-anticipated movement of the weir riprap occurs which could affect the hydraulic performance of the channel. It should be noted that adequate weirs from a fisheries viewpoint may not be totally adequate from a hydraulic viewpoint and vice versa and thus some compromising may be required.

Pilot Channel

The pilot or low-flow channel on the uphill side was intended primarily to reduce potential icings in the channel and to a lesser degree, concentrate the zone of highest velocity along the uphill slope. The as-built pilot channel is somewhat irregular as shown in a comparison of Photos 8 and 10 which illustrate a well defined and non-existent pilot channel respectively. Generally the pilot channel is non-existent only in the over-wide or over-deep areas where the need for it, from the viewpoint of the second intent, is less.

Historically icing problems have occurred as a result of fluctuating flows caused by a plant power outage which requires increased spillage into Rose Creek. Since power problems now are less frequent and of short duration (15-20 minutes)[6] future icing problems are expected to be relatively minor in the Rose Creek Diversion. If unusual or unexpected events caused icings which could affect the hydraulic capacity of the channel during breakup, ice would have to be removed prior to breakup as was done in 1976 and 1977. It should be noted that the old diversion channel had no pilot channel. Based on the above discussion, the as-built pilot channel meets the design intent.

---

6. From personal communication with N. Cornish of Cyprus Anvil.

Additional Drop Structures

The fisheries related need for additional drop structures in the 0.19 percent slope section has been reviewed by Mr. B. McAlpine of Indian and Northern Affairs with Mr. N. Cornish of Cyprus Anvil and it has been tentatively agreed that an additional structure will probably be constructed at the location shown on Photo 5 - a 15 metre long, narrow high velocity reach. If constructed at the downstream end of the fast reach with a crest elevation equal to the water level at the upstream end, the weir will have no significant impact on the hydraulic performance of the diversion channel during design conditions. Local widening of the pilot channel may, by reducing average velocities, also be effective. If done in a series of small steps (in the longtitudinal direction), it would probably satisfy fish passage requirements.

An additional weir will probably be required at the outlet of the channel into Rose Creek. The need for the weir is due to the lower-than-anticipated tailwater level in the natural channel caused probably by channel straightening and bed degradation. This additional weir has been recommended by Cyprus Anvil's fishery consultant.[7] With or without this weir, the channel will meet the hydraulic design intent during design flood conditions.

Riprap on Upstream Diversion Dam

The upstream face of the dam is shown on Photo 1. During normal flows, a low berm protects the dam from waves which could be generated in the relatively wide channel upstream of the dam (Photo 2). Peak flows and stages on Rose Creek, because of its small drainage area, are of short duration. Thus the probability of high flows coinciding with high winds from the right direction (parallel to the channel) is low. Since the dam cross-section is quite massive and the material contains numerous large boulders, wave induced erosion will be relatively minor and is not expected to affect the integrity of the dam. Thus additional rock to protect the face of the dam is not considered necessary at this time. The structure should be monitored.

---

7. According to N. Cornish of Cyprus Anvil

Alignment of Cornish Creek

During the 1980-1981 winter, Cornish Creek was temporarily diverted parallel to Rose Creek to prevent icings in the channel under construction. Significant ice formed along the temporary diversion (Photo 15). Presently the flow is along part of the winter diversion channel (Photo 16), and then breaches this diversion (Photo 18) to enter the main diversion channel (Photo 14).

Options considered for Cornish Creek were:

1) Divert flow back into its natural channel,
2) Maintain the winter diversion with Cornish Creek entering Rose Creek downstream of the diversion channel or,
3) Maintain present flow alignment.

Options 2 or 3 would both require extensive excavation, grading and armouring. Beyond the limits of the alluvial fan developed by Cornish Creek where the material is very fine grained and susceptible to erosion, an armour layer underlain by a filter layer would be required to stabilize the channel.

Cornish Creek can be readily diverted back into its natural channel (Option[1]), and into the Rose Creek diversion channel via the rock inlet section (Photo 13) with the following work:

1) Cleanup vegetation and trees pushed into the lower part of the creek during construction of the temporary diversion channel,
2) Clear to the start of the winter diversion area,
3) Clean-out bottom of natural creek at start of the winter diversion channel,
4) Construct a boulder core diversion dam across the present temporary diversion downstream of the natural channel. Use locally available material (Photo 17),
5) Complete dam by adding fine grained impervious material to its upstream face and armour with gravel boulders. Field engineering of the structure is recommended.

If future operation of Rose Creek diversion indicates an icing problem as a result of inflow from Cornish Creek, the rock inlet section into Rose Creek may have to be revised or a structure constructed upstream which permits diversion of winter flows along the 1980-1981 temporary diversion route while summer flows continue along the natural Cornish Creek into Rose Creek diversion.

Goodall Creek

Goodall Creek has deposited significant quantities of gravel from the thermal liner placed on the slope into the Rose Creek diversion (see Photos 6 and 7). Construction activity may have contributed to Goodall Creek "jumping" its natural banks and entering Rose Creek diversion downstream from its designed inlet area.

Measures may be necessary to ensure future "jumping" of Goodall Creek is prevented and that it enters Rose Creek at its designed area. These are best field engineered. Some additional rock and/or breaking of the bedrock is also recommended in the lower portion of the designed inlet (Photo 6) where the flow presently surfaces. This could, if left as is, result in icing problems in winter. Gravel deposited by Goodall Creek in Rose Creek should be cleaned out.

Other Tributaries

Provided that the rilling caused by the other snow-melt runoff create no thermal or geotechnical concerns[8], no action is considered necessary at this time. It may take several more years to firmly establish the prime location of the overflow areas. At the present, one source of water may create up to three overflow areas into the diversion channel often as a result of temporary construction disturbances.

---

8. Golder Associates believe that the very local nature of these overflows present no geotechnical/thermal concern. It is understood that the Board's geotechnical consultant is of the same opinion.

If in the future, some of these tributaries create problems such as excessive loss of thermal liner from the slope and/or gravel deposition in Rose Creek, a possible design solution at that time may be a riprapped inlet such as at Cornish and Goodall Creek. Half-round culverts down the side slopes could be another option provided they are well located and installed.

Manning's Roughness Values

The Board's consultants questioned the design roughness value of 0.030 and expressed concern about the capacity of the channel if the Manning's value proved to be as high as 0.04[2]. Golder Associates accurately measured 4 cross sections and surface velocities in a straight reach of the channel. By adjusting the surface to an average velocity, Hydrocon computed the average Manning's 'n' value to be about 0.024. Although this is certainly by no means an indication of the composite roughness of the channel at design flood conditions, it also does not justify a higher design value at this time particularly since the roughness decreases at increased flows. Continued monitoring and metering of the channel is recommended, particularly at higher flows, to better determine actual roughness values and thus hydraulic capacity.

CONCLUSIONS AND RECOMMENDATIONS

1. Except for three reaches, station 1+000 - 1+300, 1+500 - 1+900 and 2+450 to 2+700, the as-built grades of the main channel invert satisfy design objectives. To ensure the as-built channel meets the design hydraulic capacity, raising of the downhill (right) dyke may be required from approximately station 0+400 to 0+950 and from about 2+250 to 2+500. Drawing 47-7.3-1 illustrates the differences in computed water levels for the as-built conditions versus design. Since the present as-built elevations in these areas is not known, the magnitude of the necessary dyke raise is not known at this time.

2. Upgrading of the Class 1V channel armouring is required on the downhill (right) slope near Goodall Creek and on the uphill (left) bank at the upstream and - two areas where unprocessed armouring was placed. The remainder of the armouring is adequate.

3. The precise limits for the above recommended work should be field determined.

4. The drop weirs should be monitored and modifications and/or upgrading, whether fisheries or hydraulic related, made when and if necessary.

5. The as-built pilot channel meets design objectives.

6. If desired from a fisheries viewpoint, an additional low drop weir may be built in a narrow, high velocity reach in the diversion. As an alternative, the pilot channel could be widened here to reduce velocities and facilitate fish passage.

7. An additional weir can, if deemed necessary from a fisheries viewpoint, be constructed at the downstream end of the lower drop weir reach. The present condition will satisfy hydraulic requirements during design flood conditions.

8. The weirs should be monitored particularly following high flows and riprap added if necessary.

9. The upstream diversion dam requires no additional wave protection.

10. Cornish Creek should be diverted back into its natural channel.

11. Measures should be taken if necessary to ensure Goodall Creek stays within its banks. Some additional riprap is required and/or loosening of the bedrock where it enters Rose Creek diversion to ensure sub-surface flow occurs. Material deposited in Rose Creek by Goodall Creek should be cleaned out.

12. No action is required at this time at the other tributaries entering the diversion channel.

13. A preliminary and rough computation of Manning's 'n' value from the hydraulic characteristics of the as-built channel indicates no reason to suggest the design value of 0.030 is low.

14. A hydraulic monitoring program should be developed and implemented to better assess the hydraulic capacity and performance of the channel.

APPENDIX A
PHOTOGRAPHS



PHOTO 1

Looking downstream at channel inlet and diversion dam. Note bench upstream of dam and material sizes in fill.

July 17, 1981



PHOTO 2

Looking upstream from diversion dam at earlier diversion channel.

July 17, 1981

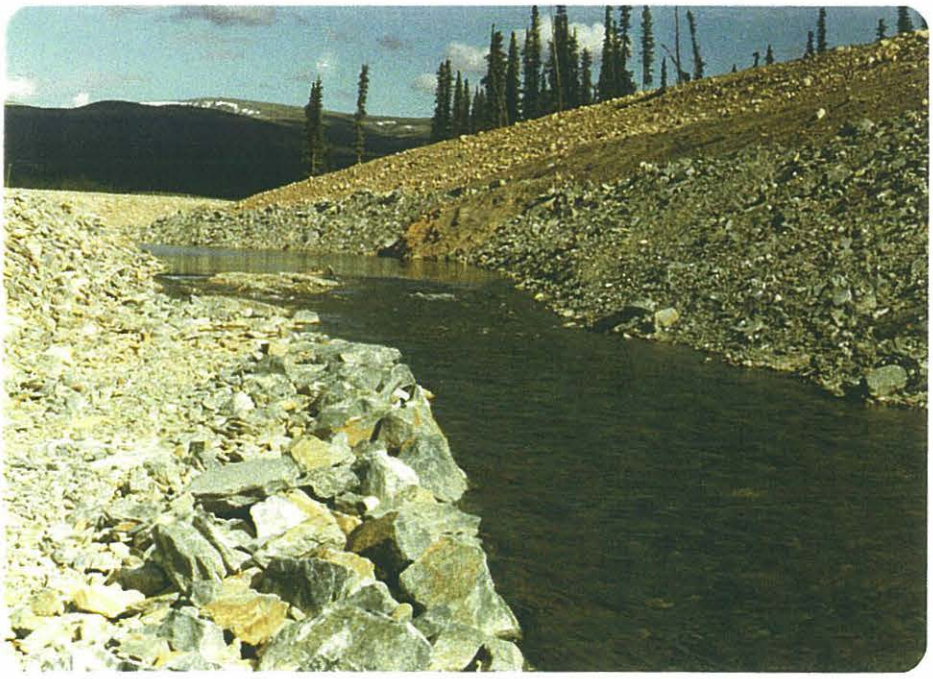


PHOTO 3

Looking upstream at rock outcropping in channel bed at upstream end of channel.

July 17, 1981



PHOTO 4

Looking downstream at left bank at Station 0+210. Highwater and present depths (and flows) are 1m (5.5 m^3/sec.) and 0.35 (1.7 m^3/sec.) respectively.

July 17, 1981

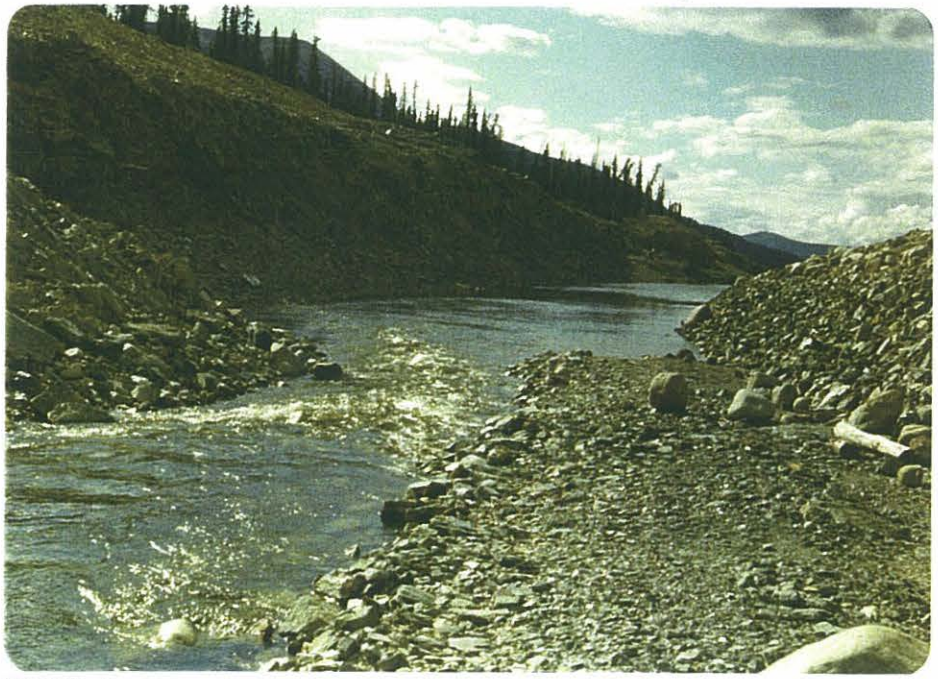


PHOTO 5

Downstream at high velocity and transition area at Station 0+570 (approx.). Weir with a crest elevation equal to the water level at the upstream end of the fast section to be constructed.

July 17, 1981

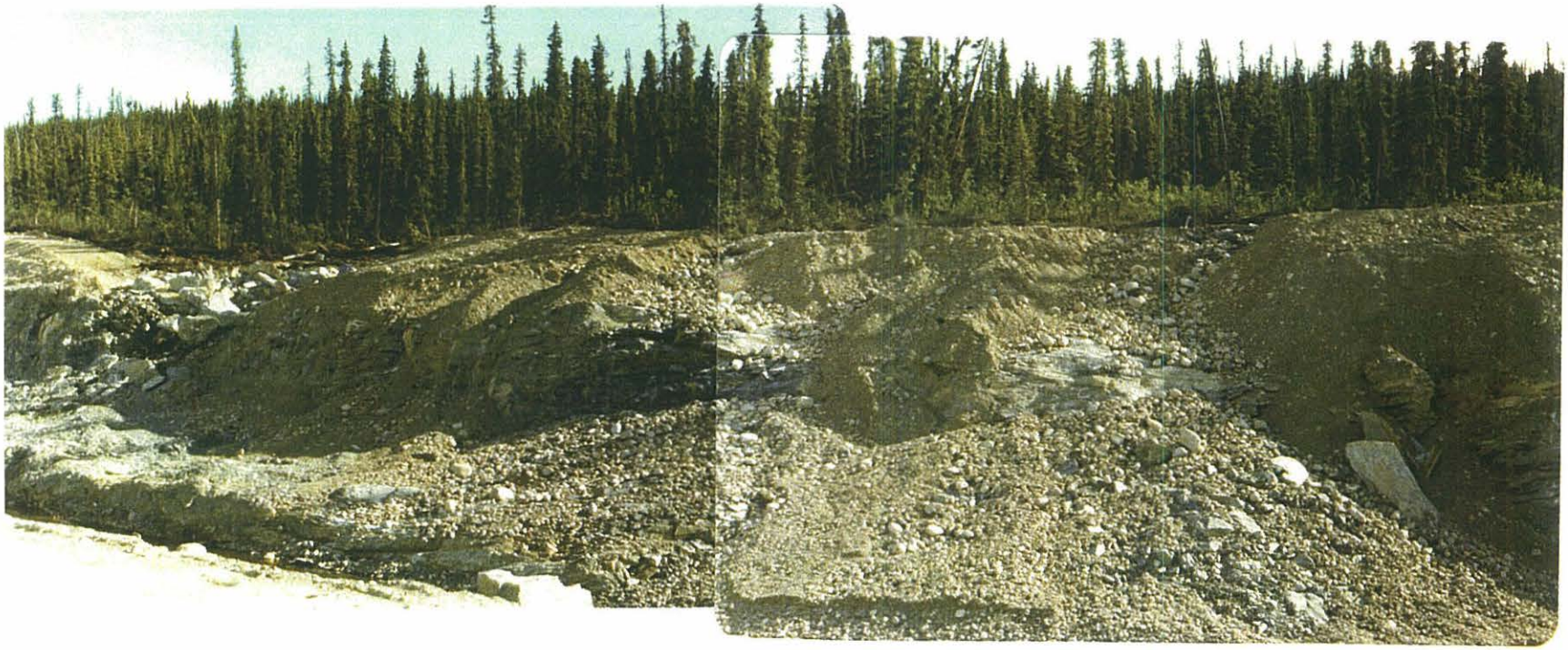


PHOTO 6

Panoramic view of Goodall Creek. Flow spilled over designed section causing gravel to be deposited at base of slope in the creek bed. See next photo as well. Deposited material to be removed.

July 17, 1981

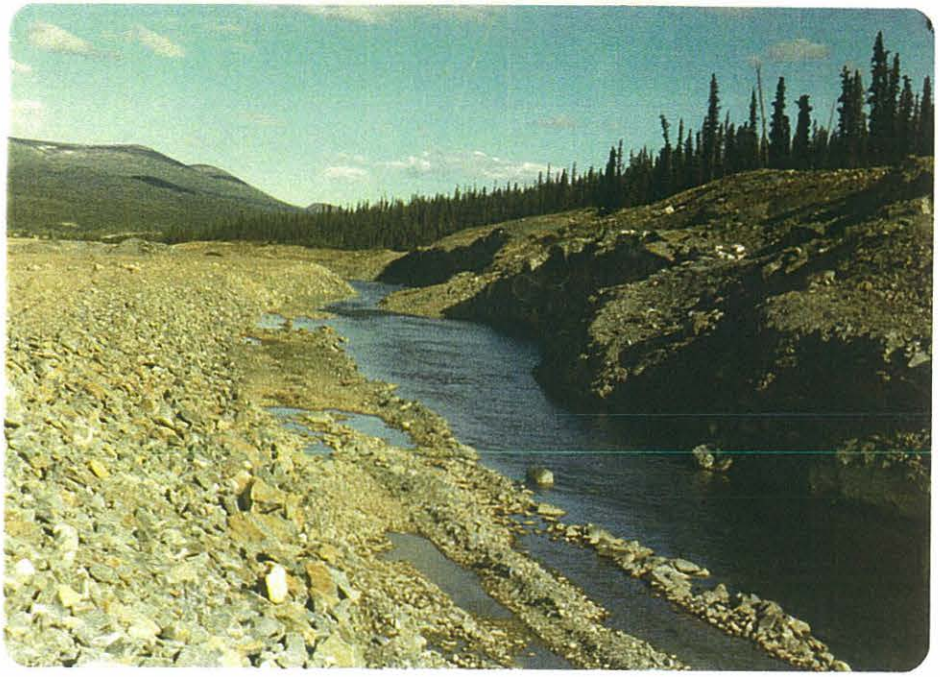


PHOTO 7

Looking upstream from Station 0+900 towards Goodall Creek. Deposition of material is obvious. Upgrading of riprap required on right (downhill) bank at Goodall Creek.

July 17, 1981

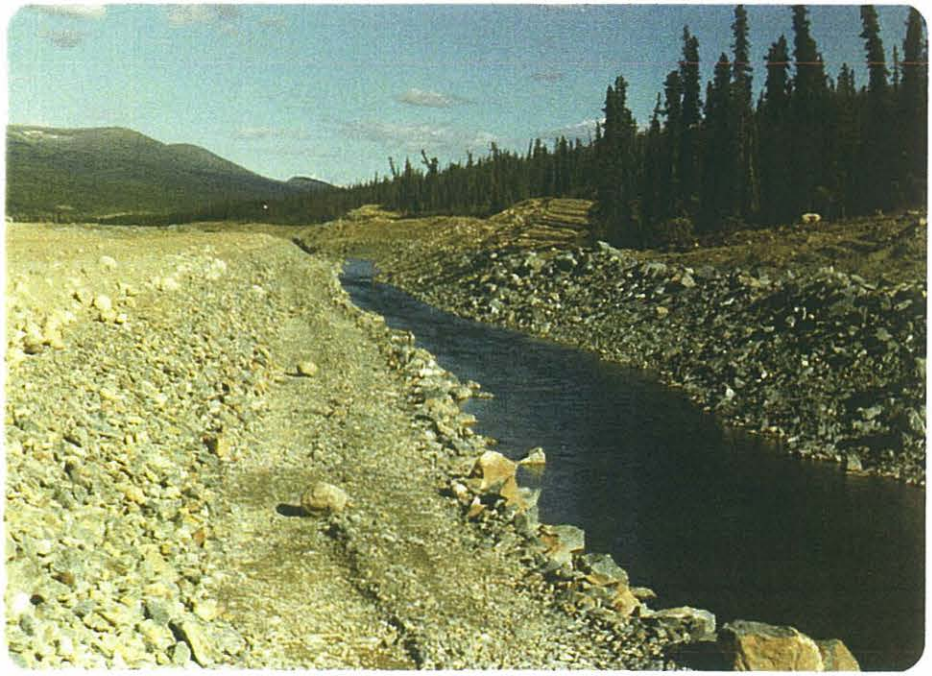


PHOTO 8

Looking upstream from Sta. 1+200 with Goodall Creek in background.

July 17, 1981

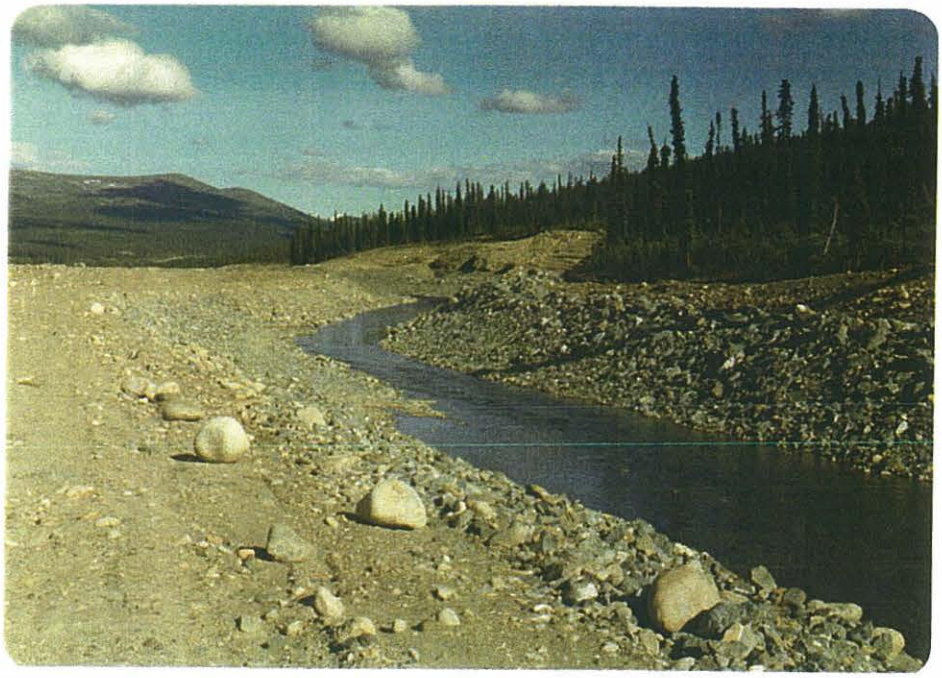


PHOTO 9

Looking upstream from Sta. 1+590 towards location of previous photo.

July 17, 1981

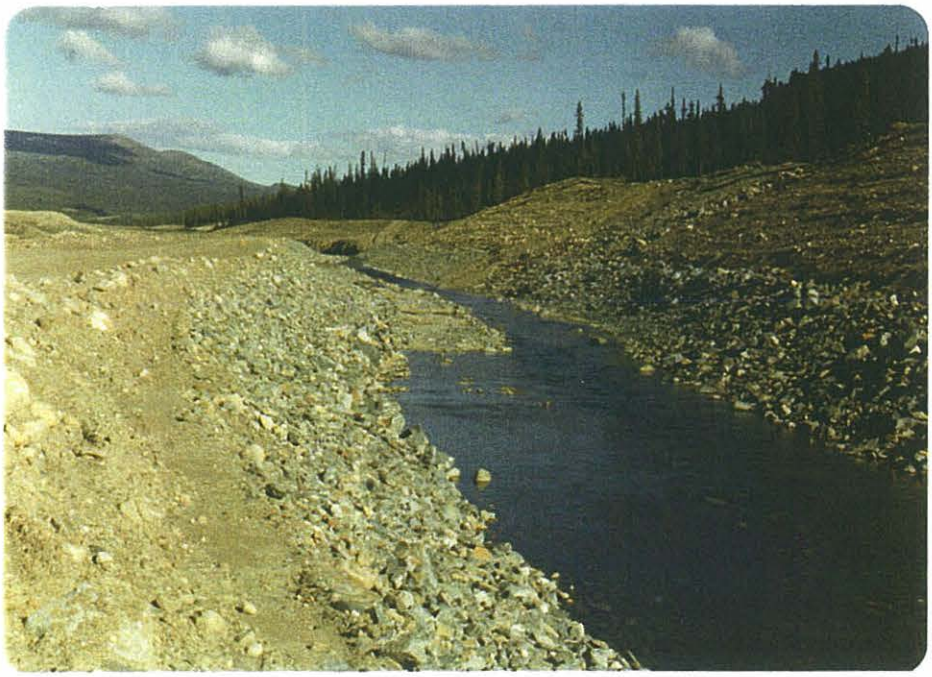


PHOTO 10

Looking upstream from Sta. 2+130.

July 17, 1981



PHOTO 11

Looking upstream from Sta. 2+820 (first drop structure).

July 17, 1981

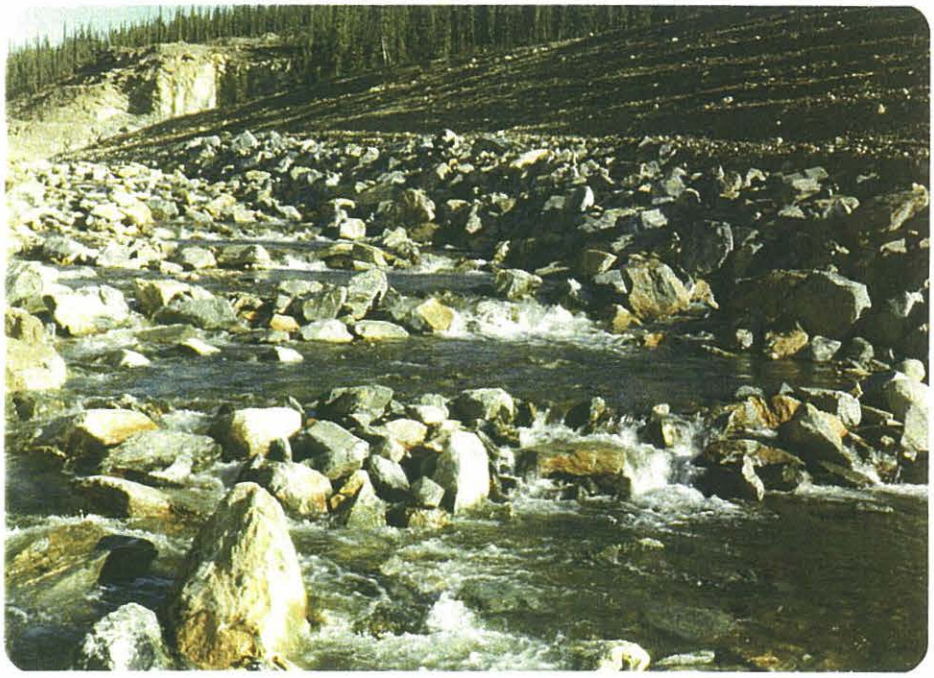


PHOTO 12

Upstream series of drop structures (1-15 approx.) Still extensive "Fish" gravel in slope riprap on right (downhill) bank.

July 17, 1981

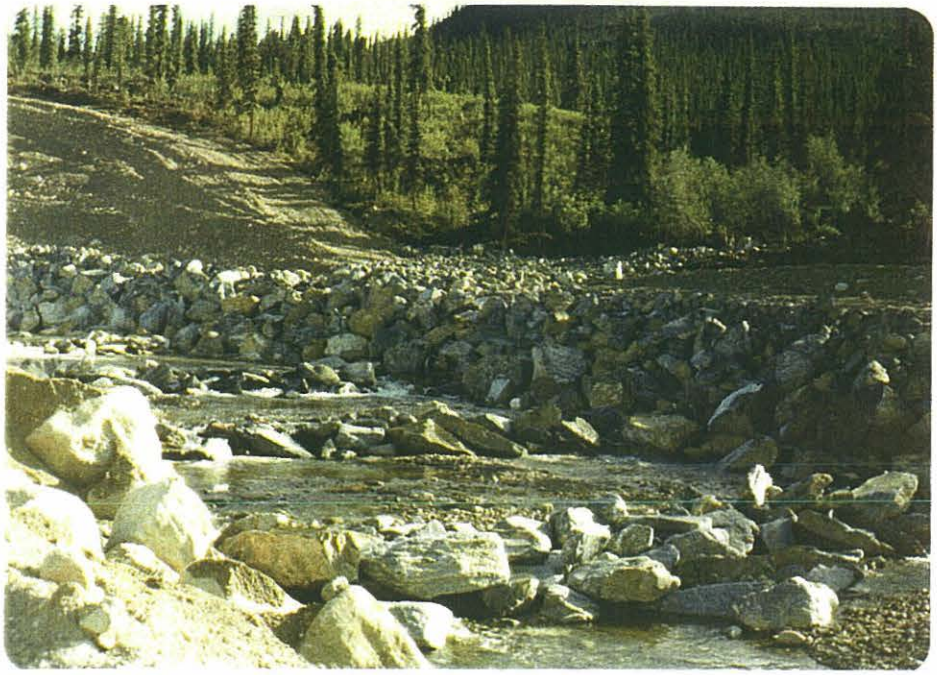


PHOTO 13

Looking upstream at entrance of Cornish Creek.

July 17, 1981.



PHOTO 14

Looking upstream between the 5% slope sections. Cornish Creek presently enters Rose Creek over the slope just upstream of the "fish" gravel bar.

July 17, 1981



PHOTO 15

Looking downstream at icings in Cornish Creek diversion channel. Diversion made during construction to prevent ice development in Rose Creek channel.

February 25, 1981



PHOTO 16

Looking downstream the diversion channel from near its upstream end.

July 18, 1981



PHOTO 17

Upstream towards start of diversion channel. Recommendation is to build a rock core diversion dam at bottom of photo and divert flow back into its natural channel which exits from the lower left of photo.

July 18, 1981



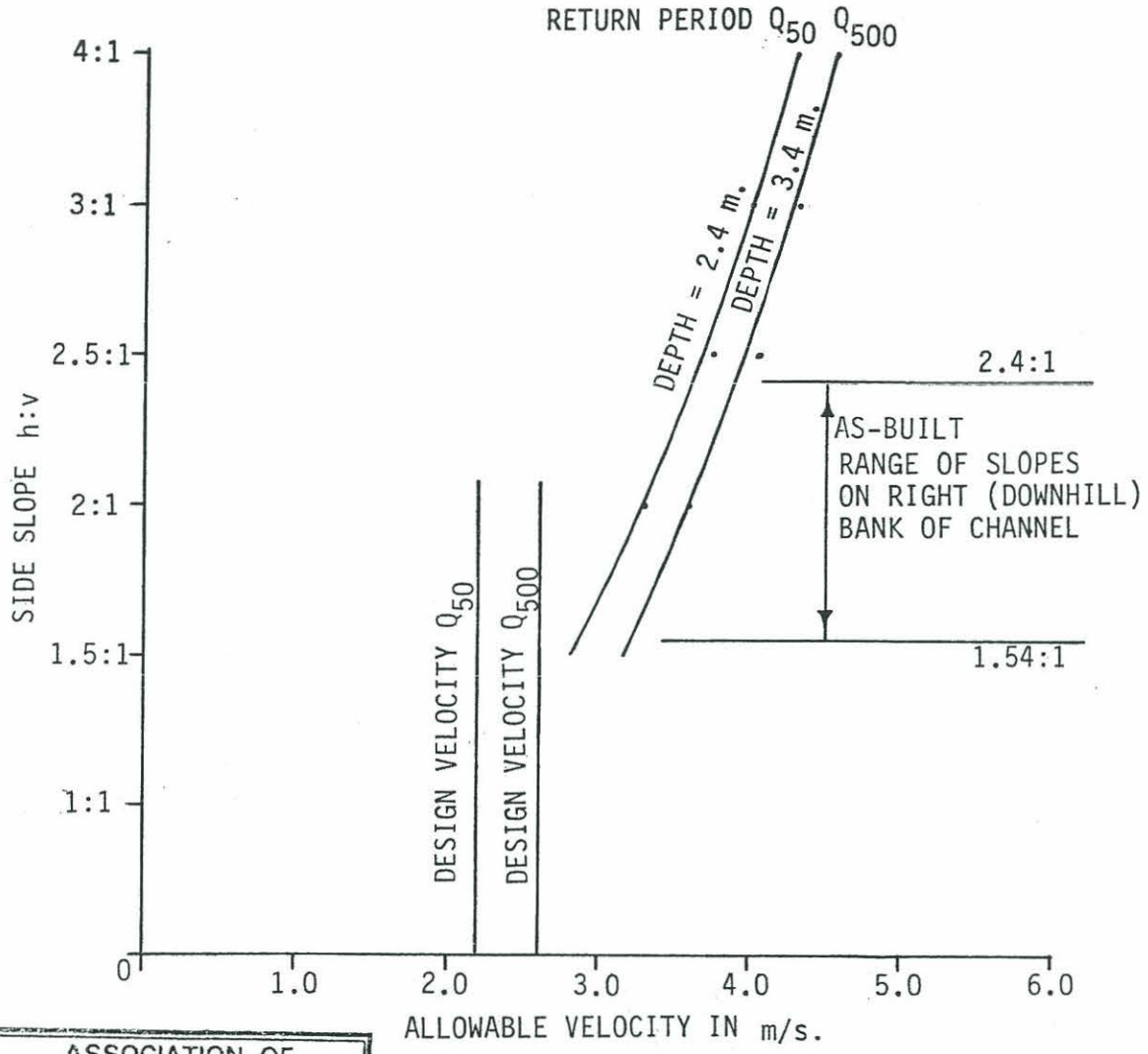
PHOTO 18

Breach and undercutting of Cornish Creek through the diversion channel spoil dike. If material is undercut further and/or melts, flow could be temporarily blocked and perhaps continue downstream along the winter diversion route.

July 18, 1981

APPENDIX B

DRAWINGS



ASSOCIATION OF PROFESSIONAL ENGINEERS OF ALBERTA
PERMIT NUMBER
P 2785
HYDROCON ENGINEERING (CONTINENTAL) LTD.

PROFESSIONAL ENGINEER ALBERTA
W.M.VELDMAN

NOTES:
1. Riprap Safety Factor = 1.15.
2. Angle of Repose = 42°
3. Reference: M.A.Stevens, D.B.Simons and G.L.Lewis "Safety Factors for Riprap Protection" July 1974 ASCE Meeting, Montreal, Canada
4. Curves shown are for class IV armouring.

GOLDER ASSOCIATES

ROSE CREEK DIVERSION

AS-BUILT DESIGN CHECK
DESIGN VS. ALLOWABLE VELOCITIES

DRAWN: DLW	DESIGNED: WMV		DRAWING No.:	REV.
DATE: Aug 21,81	APPROVED: W.M.Veldman	PE	47-7.3-2	0

REV.	BY	DESCRIPTION	DATE	APPR'D

APPENDIX C

COMPUTER PRINTOUTS

Q_{500}, n=0.030

```
**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED APRI 1980
  ERROR CORR -  01,02,03,04
  MODIFICATION -  50,51,52,53,54
**************************************************

T1  GOLDER ASSOCIATES - ROSE CREEK DIVERSION
T2  11500 YEAR FLOOD  Q = 180 CUM/SEC
T3  N = 0.030

J1  ICHECK    INQ       NINV      IDIR      STAT      METRIC    HVINS     Q         WSEL      FQ
      -10.       0.        0.        0.  0.000000      1.00      0.0     180.    84.740    0.000

*PROF 1
```



```
    ICHK      LSEL      ITYP      ISEC      QSEC      TW        CB        HL        ELLOC     ELTRD
    NPROF     IPLOT     PRFS      WSEL      CRIWS     HVINS     TaskQ     KQ        LOBANK    ROBANK
    ELMIN     MSECT     PLOT      VARIOS    OPTION    ITRY      ISECT     IBRCH     XLOBR     XROBR

0
 *SECNO 2700.000
   2700.00     3.84     84.74     0.00     84.75     85.19      .32      0.01      0.06     10.76
      180.       0.      180.       0.       0.       64.       0.       0.        0.      83.26
      0.00     0.00     2.48      0.10      .100     .032      .100     0.000    81.10     82.12
   .001741       0.       0.        0        0        0         0        0.0      0.00      0.0
0
 *SECNO 2520.000
   2520.00     3.03     85.13     0.00     0.00     85.03      .40       .47       .03     11.71
      180.       0.      180.       0.       0.       27.       0.       15.       3.      82.80
       .02     0.00     2.81      0.00      .100     .036      .100      .030     81.50     18.42
   .002233     240.     240.      240.       0        0         0       0.00     21.00     38.42
0
 *SECNO 2490.000
   2490.00     3.53     85.23     0.00     0.00     85.83      .41       .07       .00     83.50
      180.       0.      180.       0.       0.       57.       0.       16.       6.      88.50
       .03     0.00     2.83      0.00      .100     .030      .100      .030     81.70     16.74
   .002366      30.      30.       30.       0        0         0       0.00     22.88     41.40
0
 *SECNO 2430.000
   2430.00     4.80     85.80     0.00     0.00     85.78      .16       .07       .05     82.80
      180.       0.      180.       0.       0.       80.       0.       21.       5.      89.10
       .04     0.00     1.78      0.30      .100     .030      .100      .030     80.70     18.48
   .000750      80.      80.       80.       2        0         0       0.00     80.11     43.53
0
 *SECNO 2340.000
   2340.00     4.44     85.84     0.00     0.00     85.87      .23       .02       .03     82.00
      180.       0.      180.       0.       0.       75.       0.       28.       10.     81.00
       .05     0.00     2.13      0.00      .100     .020      .100      .030     81.20     14.81
   .001158      80.      80.       80.       2        0         0       0.00     23.78     41.37
0
 *SECNO 2250.000
   2250.00     3.88     85.88     0.00     0.00     86.07      .38       .14       .02     82.30
      180.       0.      180.       0.       0.       56.       0.       24.       13.     80.80
       .06     0.00     2.72      0.00      .100     .030      .100      .020     81.80     14.28
   .002278      80.      80.       80.       2        0         0       0.00     23.51     38.01
0
```

SECNO / Q / TIME / SLOPE	DEPTH / GLOB / VLOB / XLOBL	CWSEL / QCH / VCH / XLOCH	CRIWS / QROB / VROB / XLOBR	WSELK / ALOB / XNL / ITRIAL	EG / ACH / XNCH / IDC	HV / AROB / XNR / ICONT	HL / VOL / WTN / CCRAR	QLOSS / TWA / ELMIN / TOPWID	BANK ELEV LEFT/RIGHT / SSTA / ENDST
*SECNO 2130.000									
2130.00	3.89	85.89	0.00	0.00	86.32	.34	.25	.01	94.30
160.	0.	160.	0.	0.	62.	0.	41.	15.	81.00
.07	0.00	2.57	0.00	.100	.030	.100	.030	82.10	20.00
.0001852	120.	120.	120.	2	0	0	0.00	24.14	44.14
0									
*SECNO 1380.000									
1380.00	3.85	85.85	0.00	0.00	87.13	.21	.83	.01	91.80
160.	0.	160.	0.	0.	55.	0.	79.	27.	82.70
.12	0.00	2.45	0.00	.100	.030	.100	.030	82.60	11.31
.0001847	450.	450.	450.	2	0	0	0.00	27.11	35.42
CCHV= .300 CEHV= .500									
*SECNO 1050.000									
1050.00	4.10	87.40	0.00	0.00	87.64	.24	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
0									
*SECNO 1050.100									
1050.10	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
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160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
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.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
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1050.40	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
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.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1050.600									
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.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
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160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
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1050.80	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
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.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.000									
1051.00	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.100									
1051.10	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.200									
1051.20	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.300									
1051.30	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.400									
1051.40	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.500									
1051.50	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
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1051.60	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.700									
1051.70	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.800									
1051.80	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1051.900									
1051.90	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.000									
1052.00	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.100									
1052.10	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.200									
1052.20	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.300									
1052.30	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.400									
1052.40	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.500									
1052.50	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.600									
1052.60	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.700									
1052.70	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.800									
1052.80	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1052.900									
1052.90	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.000									
1053.00	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.100									
1053.10	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.200									
1053.20	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.300									
1053.30	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.400									
1053.40	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.500									
1053.50	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.600									
1053.60	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.700									
1053.70	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.800									
1053.80	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1053.900									
1053.90	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.000									
1054.00	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.100									
1054.10	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.200									
1054.20	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.300									
1054.30	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.400									
1054.40	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.500									
1054.50	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.600									
1054.60	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.700									
1054.70	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.800									
1054.80	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1054.900									
1054.90	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.000									
1055.00	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.100									
1055.10	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.200									
1055.20	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.300									
1055.30	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.400									
1055.40	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.500									
1055.50	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.600									
1055.60	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.700									
1055.70	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.800									
1055.80	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									
*SECNO 1055.900									
1055.90	3.42	87.42	0.00	0.00	87.63	.21	.15	.02	88.70
160.	0.	160.	0.	0.	72.	0.	81.	35.	82.20
.18	0.00	2.18	0.00	.100	.030	.100	.030	83.80	11.31
.0001888	300.	300.	300.	2	0	0	0.00	27.88	41.11
CCHV= .300 CEHV= .500									

*SECND 330.000

CASE DIVIDED FLOW

330.00	3.87	88.17	0.00	0.00	85.48	.82	.17	.07	93.80
180.	0.	180.	0.	0.	84.	0.	180.	82.	84.20
.27	0.00	2.51	0.00	.100	.030	.100	.030	85.80	7.25
.001753	180.	180.	180.	2	0	0	0.00	25.03	32.44

0

*SECND 300.000

300.00	4.01	88.19	0.00	0.00	88.81	.83	.12	.04	95.00
170.	0.	170.	0.	0.	83.	0.	167.	82.	84.20
.25	0.00	2.83	0.00	.100	.030	.100	.030	85.80	10.82
.001770	60.	60.	60.	2	0	0	0.00	20.81	32.55

0

*SECND 240.000

240.00	4.09	88.48	0.00	0.00	88.17	.80	.15	.05	93.81
180.	0.	180.	0.	0.	82.	0.	171.	82.	84.20
.24	0.00	2.82	0.00	.100	.030	.100	.030	85.80	9.73
.001884	60.	60.	60.	2	0	0	0.00	21.85	32.71

0

8/03/20. 05.01.43.

SIGMA	DEPTH	PAREL	DELAB	ANELK	EE	AV	AL	ELEV	DRAG BLAS
Q	SLOT	WSP	AREA	ALOB	ARC	AALL	WIL	TAW	LEFTAREA
TIME	VLOB	VOR	VROB	ANL	ANCH	AAR	ATA	ELCHA	BETA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IBO	ICONT	SGRAV	TOPWID	ENDST

*SECND 210.000

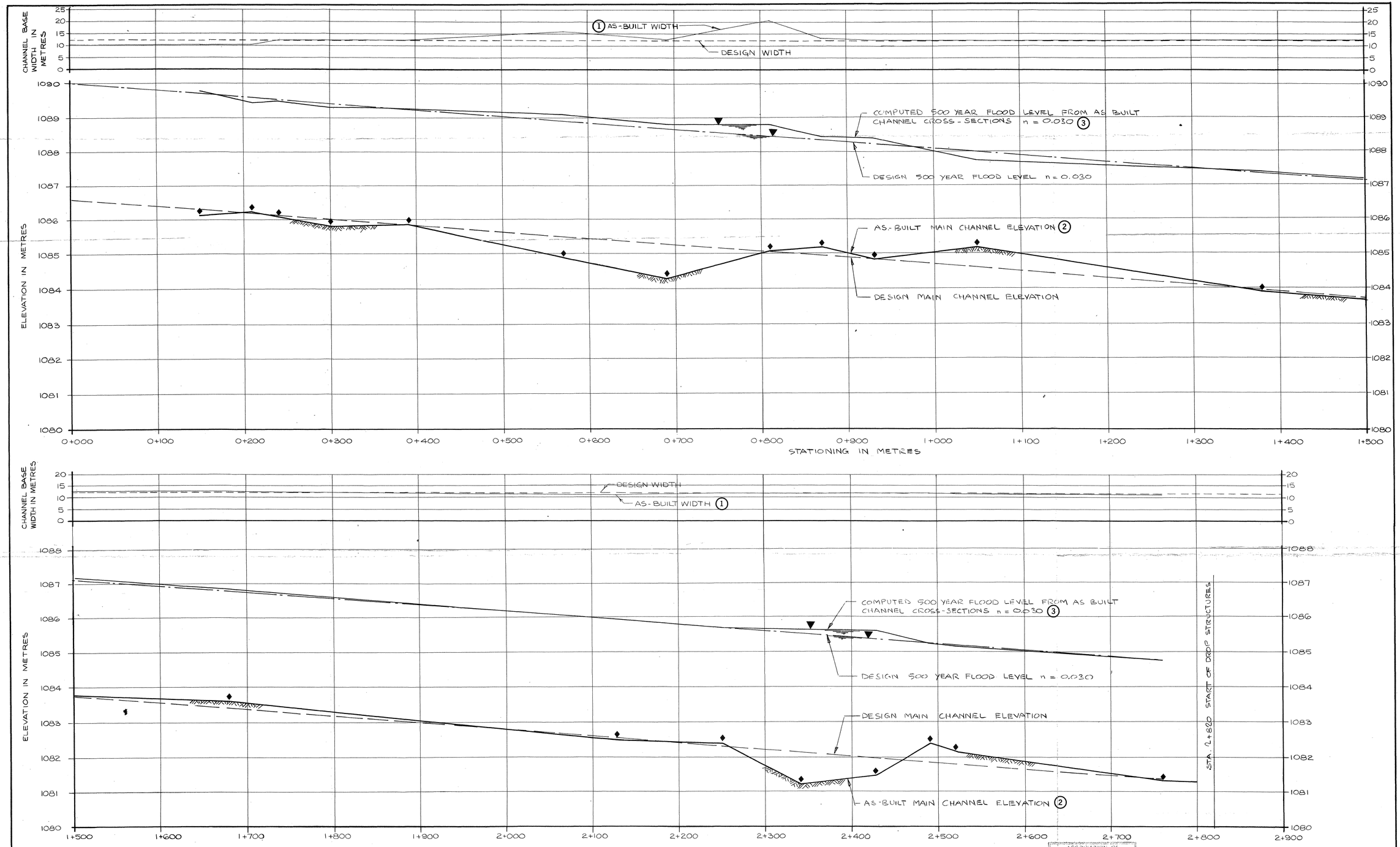
210.00	3.82	88.42	0.00	0.00	88.81	.48	.05	.08	95.00
160.	0.	160.	0.	0.	52.	0.	173.	85.	84.20
.25	0.00	3.10	0.00	.100	.030	.100	.030	85.80	14.82
.002756	30.	30.	30.	2	0	0	0.00	19.14	33.86

0

*SECND 150.000

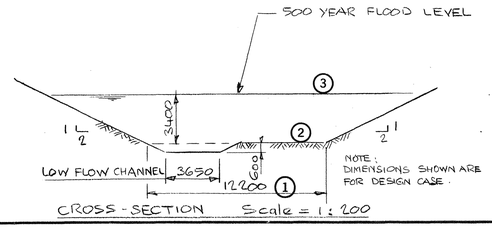
150.00	4.18	88.76	0.00	0.00	90.07	.82	.15	.02	94.40
160.	0.	160.	0.	0.	84.	0.	177.	86.	95.00
.30	0.00	2.49	0.00	.100	.030	.100	.030	85.80	3.30
.001885	60.	60.	60.	2	0	0	0.00	24.15	32.45

0



NOTES:

1. LOCATION OF CROSS SECTIONS USED SHOWN BY '◆' CROSS-SECTION INFORMATION FOR HEC-2 BACKWATER COMPUTATIONS INTERPOLATED BETWEEN SECTIONS.
2. CROSS-SECTIONAL DATA AS OBTAINED BY GOLDER ASSOCIATES. IN SEVERAL LOCATIONS, AS-BUILT THALWEG ELEVATION IS LOWER THAN INDICATED.
3. DESIGN THALWEG ELEVATIONS AS SHOWN ON GOLDER'S TENDER DOCUMENTS ARE ADJUSTED FOR REFERENCE LINE STATIONING USED DURING CONSTRUCTION. DESIGN WATER LEVELS AS COMPUTED PREVIOUSLY BY HYDROCON.
4. DESIGN WIDTH AND AS-BUILT WIDTH ARE MEASURED AT THE MAIN CHANNEL INVERT.
5. STARTING DEPTH FOR THE HEC-2 COMPUTATIONS AT DOWNSTREAM END ASSUMED EQUAL TO DESIGN DEPTH.



REV.	BY	DESCRIPTION	DATE	APPR'D

ASSOCIATION OF PROFESSIONAL ENGINEERS OF ALBERTA
PERMIT NUMBER P 2785
HYDROCON ENGINEERING (CONTINENTAL) LTD.

PROFESSIONAL ENGINEER ALBERTA W.M. WELDMAN

GOLDER ASSOCIATES

ROSE CREEK DIVERSION

AS-BUILT CHECK
WATER LEVEL PROFILES

ME HYDROCON ENGINEERING (Cont.) LTD

DRAWN	DESIGNED	CLIENT APPR	DRAWING NO.	REV.
DLW & MN	WMV		47-7.3-1	0
DATE 21 AUG, 1981	APPROVED W.M. Weldman	DATE		

TABLE VIII-17 (CONT'D)

CROSS VALLEY DAM SETTLEMENT PLATES

Date 1981	Sta. 0+459.0 m Settlement Plate CVDS-3* Plate Elev.	Settlement (m)	Fill Elev.	Sta. 0.567.1 m Settlement Plate CVDS-4* Plate Elev.	Settlemen (m)	Fill Elev.
June 5			1047.0			
8						
9	(Settlement plate broken					
11	and settlement survey re-					
17	started on June 29)					
23						
26						
28						
29	1046.77	0.00				
July 2	1046.735	0.035				
3						
6	1046.739	0.031				
9	1046.739	0.031				
13	1046.733	0.037	1055.10			
14	1046.731	0.039				
16	1046.726	0.044	1055.42			
17	1046.725	0.045	1055.59			
20	1046.716	0.054	1056.07			
23	1046.714	0.056	1056.12			
25	1046.702	0.068	1056.276			
27						
28	1046.712	0.058				
29				1047.427	0.0	1048.5
30	1046.712	0.058		1047.422	0.005	
Aug. 5	1046.709	0.061				
7				1047.424	0.003	
8	1046.710	0.060		1047.424	0.003	
13	1046.708	0.062		1047.424	0.003	
20	1046.707	0.063		1047.425	0.002	
27	1046.728	0.042	1056.383	1047.418	0.009	1051.968
Sept. 2	1046.706	0.064	1061.78	1047.371	0.056	1057.27
9	1046.678	0.092	1063.171	1047.195	0.232	1061.75
29	1046.665	0.105	1065.61	1047.158	0.269	1065.84
Oct. 8	1046.661	0.109	1065.76	1047.158	0.269	1065.74

Note: * See Table 3-3 for details on locations.

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : P81-01 1,329·5 m N 1,824·0 m E

P81-01-S (shallow)
Tip Depth : 6·1 m
Ground Elev: 1093·0 m
Tip Elev. : 1086·9 m
Top of tube above ground: 0·73 m

P81-01-D (deep)
Tip Depth : 10·7 m
Ground Elev: 1093·0 m
Tip Elev. : 1082·3 m
Top of tube above ground: 0·73 m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS		W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
April 24 81				installed					installed
28	-			dry		-			dry C.E.
29	-			dry		-			dry C E
30	-			dry		-			dry C.E.
May 1	-			dry		-			dry C E
June 17	-			dry		9·06	1084·67	8·33	C E
July 7	-			dry		8·63	1085·10	7·90	C.E.
Sept 17	6·14			}		7·61	1086·12	6·88	B.P
24	6·10			rdgs assumed		8·55	1085·18	7·82	B.P.
30	6·15			} to indicate		8·29	1085·44	7·56	B.P.
Oct 9	6·12			} dry depth		8·65	1085·08	7·92	B.P.
15	6·11			}		8·63	1085·10	7·90	B.P. Pond level 3580.75' = 1091.69 m
Nov 15	-			dry		9·81	1083·92	9·08	D K & E.P.

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : P81-02 1,209.0mN 1,837mE

P81-02-1

Tip Depth : 11.0m

Ground Elev: 1093.1m

Tip Elev. : 1082.1m

Top of tube above ground: 0.86m

P81-02-2

Tip Depth : 27.4m

Ground Elev: 1093.1m

Tip Elev. : 1065.7m

Top of tube above ground: 0.87m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS		W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
April 24/81				installed - both piezometers broken and plugged at 5.8 m due to casing recovery problems.					

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : P81-03 1068·0m N 1830·0m E

Tip Depth : 9·1m

Ground Elev: 1067·4

Tip Elev. : 1058·3

Top of tube above ground: 0·61

DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS	DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS
		ELEV. (m)	DEPTH (m)				ELEV. (m)	DEPTH (m)	
April 27'81				installed					
28				artesian condition					
29				CE "					
30				CE "					
May 1				CE "					
June 17				C.E "					
July 7				CE "					
Sept 17				B.P.					
27				B.P					
30				B.P					
Oct 9				B.P.					
15				B.P.					
Nov 15				Artesian condition. DRY AT B.P.					

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location: P81-04, 1,098m N. 1,883m E.

P81-04-2 (Shallow)

Tip Depth : 11.0m

Ground Elev: 1093.0m

Tip Elev. : 1082.0m

Top of tube above ground: 0.90m

P81-04-1 (deep)

Tip Depth : 27.4m

Ground Elev: 1093.0m

Tip Elev. : 1065.6m

Top of tube above ground: 0.89m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS		W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
April 26/81				installed	April 26/81				installed
28	—			dry C.E.	28	24.1	1069.79	23.2	CE
29	—			dry C.E.	29	24.2	1069.69	23.3	CE
30	—			dry C.E.	30	24.6	1069.29	23.7	CE
May 1	—			dry C.E.	May 1	24.2	1069.69	23.3	CE
9				—	9	23.8	1070.09	22.9	CE
14				—	14	—			—
June 17	—			dry C.E	June 17	23.7	1070.19	22.8	CE
July 7	—			dry C.E.	July 7	23.7	1070.19	22.8	CE
Sept. 17	—			dry B.P.	Sept 17	23.2	1070.69	22.3	BP
24	—			dry BP	24	23.5	1070.39	22.6	BP
30	—			dry BP	30	23.5	1070.39	22.6	BP
Oct. 9	—			dry BP	Oct. 9	23.5	1070.39	22.6	BP
15	—			dry BP	15	23.5	1070.39	22.6	BP
Nov 15	—			dry DK & BP	Nov 15	23.6	1070.29	22.7	DK & BP

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : P81-05 , 955.5mN 2,001mE

Tip Depth : 12.2 m

Ground Elev: 1093 m.

Tip Elev. : 1080.8m

Top of tube above ground: 1.11m

DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS	DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS
		ELEV. (m)	DEPTH (m)				ELEV. (m)	DEPTH (m)	
April 26/81				Installed					
28	—			dry CE					
29	—			dry CE					
30	—			dry CE					
May 1	—			dry CE					
9	—			—					
14	—			—					
June 17	—			dry CE					
July 7	—			dry CE					
Sept. 17	—			dry BP					
24	—			— BP					
30	12.6	1081.51	11.5	BP					
Oct. 9	12.6	1081.51	11.5	BP					
15	12.0	1082.11	10.9	BP					
Nov. 15	12.6	1081.51	11.5	DK & BP					

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location: P81-06, 624 m N 2592.5 m E

Tip Depth : 6.1m

Ground Elev: 1093.0m

Tip Elev. : 1086.9m

Top of tube above ground: 0.92m

DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS	DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS
		ELEV. (m)	DEPTH (m)				ELEV. (m)	DEPTH (m)	
April 26/81				Installed					
28				dry CE					
29				dry CE					
30				dry CE					
May 1				dry CE					
9				–					
14				–					
June 17				dry CE					
July 7				dry CE					
Sept. 17				dry					
24				–					
30				dry					
Oct. 9				–					
15				dry					
Nov 15				dry					

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : P81-07 , 355mN 3019mE

Tip Depth : 6.1m

Ground Elev: 1094.8m

Tip Elev. : 1088.7m.

Top of tube above ground: 0.88

DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS	DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS
		ELEV. (m)	DEPTH (m)				ELEV. (m)	DEPTH (m)	
April 27/81				Installed					
28	6.1	1089.58	5.2	CE					
29	6.2	1089.48	5.3	CE					
30	6.2	1089.48	5.3	CE					
May 1	6.1	1089.58	5.2	CE					
9	6.0	1089.68	5.1	CE					
14	6.0	1089.68	5.1	CE					
June 17	6.9	1088.78	6.0	CE					
July 7	6.9	1088.78	6.0	CE					
Sept. 17	7.0	1088.68		dry? BP					
24	—								
30	6.9	1088.78		dry BP					
Oct. 9	—								
15	7.0	1088.68		dry ? BP					
Nov. 15	6.8	1088.88		dry DK & BP					

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : P81-08 , 359.5m N 3,139.5m E

Tip Depth : 7.3m

Ground Elev: 1095.7m

Tip Elev. : 1088.4m

Top of tube above ground: 0.72m

DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS	DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS
		ELEV. (m)	DEPTH (m)				ELEV. (m)	DEPTH (m)	
April 26/81				Installed					
28	6.9	1089.52	6.2	CE					
29	6.9	1089.52	6.2	CE					
30	6.9	1089.52	6.2	CE					
May 1	6.8	1089.62	6.1	CE					
9	6.7	1089.72	6.0	CE					
14	6.7	1089.72	6.0	CE					
June 17	7.5	1088.92	6.8	CE					
July 7	8.1	1088.32	7.4	CE					
Sept. 17	8.2	1088.22		dry? BP					
24	—								
30	8.2	1088.22		dry? BP					
Oct. 9	—								
15	8.2	1088.22		dry? BP					
Nov. 15	8.1	1088.32		dry DK & BP					

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location: P81-09, 350.5 m N 3330 m E

Tip Depth: 11.8 (assumed) — needs checking in the field.

Ground Elev: 1094.8 m

Tip Elev. : 1083 m (assumed) —"—

Top of tube above ground: 0.87 m

DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS	DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS
		ELEV. (m)	DEPTH (m)				ELEV. (m)	DEPTH (m)	
April 26/81				Installed					
28									
29									
30									
May 1									
9									
14									
June 17	6.3	1089.37	5.4	CE					
July 7	6.4	1089.27	5.5	CE					
Sept 17	6.5	1089.17	5.6	BP					
24	—								
30	6.5	1089.17	5.6	BP					
Oct. 9	—								
15	6.4	1089.27	5.5	BP					
Nov. 15	6.3	1089.37	5.4	DK & BP					

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : 81-K1 2626.75 m N -638.52 m E Diversion Canal Outfall

81-K1-1 (shallow, 1½" ϕ)

Tip Depth : 6.5m
Ground Elev: 1048.2 m
Tip Elev. : 1041.7m
Top of tube above ground: 0.64m

81-K1-2 (deep, 3" ϕ)

Tip Depth : 30.5m
Ground Elev: 1048.2
Tip Elev. : 1017.7
Top of tube above ground: 1.33m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
March 16/18-81				Installed by K.L.
Unknown	5.84	1043.51	5.20	See Klohn Leonoff report no. VA2758, Sept 1/81. Appendix IV
Sept 17/81	4.80	1044.04		Golder Associates monitoring
30	4.83	1044.01		
Oct 16	4.65	1044.19		
26	4.80	1044.04		
Nov 15	4.82	1044.02		DK & BP
Dec 12	4.96	1043.88		DK & KM

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar. 16/18-81				Installed by K.L.
Unknown	5.78	1043.86	4.45	See Klohn Leonoff report no. VA 2758, Sept. 1/81 Appendix IV.
Sept. 17/81	2.18	1047.35		Golder Associates monitoring
30	2.33	1047.20		
Oct 16	3.89	1045.64		
26	4.02	1045.51		
Nov 15	4.05	1045.48		DK & BP
Dec 12	4.21	1045.32		DK & KM

81-K1

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : 81-K3 2493.63 m N -98.96 m E Near Cross Valley Dam Spillway Outfall on North Side.

81-K3-1 (deep)

Tip Depth : 22.0m
Ground Elev: 1051.3
Tip Elev. : 1029.3
Top of tube above ground: 0.45m

81-K3-2 (Shallow)

Tip Depth : 11m
Ground Elev: 1051.3
Tip Elev. : 1040.3
Top of tube above ground: 0.48m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar 12/81				Installed by KL
Unknown	7.07	1045.05	6.62	See Klohn Leonoff report no. VA2758, Sept 1/81 Appendix IV
Sept 17/81	5.57	1046.18		BP
30	5.33	1046.42		Golder Associates BP monitoring
Oct 16	5.23	1046.52		BP
27	5.03	1046.72		BP
Nov 15	5.19	1046.56		DK & BP
Dec 12	5.02	1046.73		DK & KM

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
March 12/81				Installed by KL
Unknown	6.99	1045.16	6.51	See Klohn Leonoff report no. VA 2758, Sept. 1/81 Appendix IV
Sept 17/81	5.47	1046.31		BP
30	5.47	1046.31		Golder Associates BP monitoring
Oct. 16	5.07	1046.71		BP
27	4.81	1046.97		BP
Nov 15	4.96	1046.82		DK & BP
Dec. 12	4.68	1047.10		DK & KM

81-K3

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : 81-K4 2229.12mN -154.15mE Downstream of Cross Valley Dam, Near and South of Drainage Ditch.

81-K4-1 (deep)

Tip Depth : 27m
Ground Elev: 1052.7
Tip Elev. : 1025.7
Top of tube above ground: 1.12m

81-K4-2 (Shallow)

Tip Depth : 12m
Ground Elev: 1052.7
Tip Elev. : 1040.7
Top of tube above ground: 0.98m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar 13/81				Installed by K.L.
Unknown	6.80	1045.22	7.92	See Klohn Leonoff report no. VA2758, Sept. 1/81 Appendix IV
Sept 17/81	2.22			BP
30	2.30	- blocked		Golder Associates BP
Oct 16	2.24	- blocked		Monitoring BP
27	2.14	- dry/blocked		BP
Nov 15	2.41	- frozen		Dk & BP

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar 13/81				Installed by K.L.
Unknown	6.90	1045.36	7.88	See Klohn Leonoff report no. VA2758, Sept 1/81 Appendix IV
Sept 17/81	2.11			BP
30	2.18	- blocked		Golder Associates BP
Oct. 16	2.15	- blocked		Monitoring BP
27	2.31	- dry/blocked		BP
Nov 15	2.25	- frozen		Dk & BP

81-K4

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location: 81-K6 1418.64 m N 1719.20 m E Downstream Toe of 1981 Tailings Dam (continued) (See 81-K6-2)

81-K6-1 (deep)

Tip Depth : 39m

Ground Elev: 1076.9

Tip Elev. : 1037.9

Top of tube above ground: 0.84m

81-K6-2 (intermediate)

Tip Depth : 27.5m

Ground Elev: 1076.9

Tip Elev. : 1049.4

Top of tube above ground: 0.74m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar 19/81				Installed by K.L.
Unknown	8.80	1067.78	9.64	See Klohn Leonoff report no. VA 2758, Sept 1/81 Appendix IV
Sept 17/81	9.20	1068.54		BP
24	9.20	1068.54		Golder Assocs BP
30	9.05	1068.69		Monitoring BP
Oct. 15	8.94	1068.80		BP
Nov 15	8.51	1069.23		DK & BP

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar. 19/81				Installed by K.L.
Unknown	9.01	1067.77	9.75	See Klohn Leonoff report no. VA 2758, Sept 1/81 Appendix IV
Sept 17/81	9.08	1068.56		BP
24	9.10	1068.54		Golder Assocs BP
30	8.96	1068.68		Monitoring BP
Oct. 15	8.85	1068.79		BP
Nov. 15	8.40	1069.24		DK & BP

81-K6

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : 81-K6 (Continued) 1418.64m N 1719.20m E Downstream Toe of 1981 Tailings Dam.

81-K6-3 (Shallow)

Tip Depth : 13m

Ground Elev: 1076.9

Tip Elev. : 1063.9

Top of tube above ground: 0.74m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar 19/81				Installed by K.L.
Unknown	8.66	1068.02	9.40	See Klohn Leonoff report
				no. VA2758, Sept 1/81
				Appendix IV
Sept. 17/81	5.07	1072.57		BP
24	8.68	1068.96		Golder Assoc's BP
30	8.59	1069.05		Monitoring BP
Oct. 15	8.46	1069.18		BP
Nov. 15	7.96	1069.68		Dk & BP

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS

81-K6 (contd)

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer Data Sheet

Location : 81-K7 1252.56mN 1752.18mE Downstream Toe of 1981 Tailings Dam.

81-K7-1 (deep)

Tip Depth : 22m

Ground Elev: 1068.2

Tip Elev. : 1046.2

Top of tube above ground: 0.59m

81-K7-2 (shallow)

Tip Depth : 6m

Ground Elev: 1068.2

Tip Elev. : 1062.2

Top of tube above ground: 0.91m

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar. 20/81				Installed by K.L.
Unknown	2.09	1067.12	1.50	See Klohn Leonoff report no. VA 2758, Sept. 1/81 Appendix IV
Sept 17/81	1.03	1067.76		BP
24	1.08	1067.71		Golder Assoc's Monitoring BP
30	0.97	1067.82		BP
Oct 15	0.96	1067.83		BP
Nov 15	0.72	– frozen		DK & BP

DATE	W.L. from top of tube (m)	WATER LEVEL ELEV. (m)	WATER LEVEL DEPTH (m)	REMARKS
Mar. 20/81				Installed by K.L.
Unknown	2.89	1066.94	1.98	See Klohn Leonoff report no. VA 2758, Sept 1/81 Appendix IV
Sept. 17/81	1.61	1067.50		BP
24	2.65	1066.46		Golder Assoc's Monitoring BP
30	1.55	1067.56		BP
Oct. 15	1.54	1067.57		BP
Nov. 15	1.75	1067.36		DK & BP

81-K7

DOWN VALLEY TAILINGS CONTAINMENT

CONTRACT DOCUMENTS

CYPRUS ANVIL MINING CORPORATION

Faro, Yukon Territory

C O N F O R M E D C O P Y

Cyprus Anvil Mining Corporation

DOWN VALLEY TAILINGS CONTAINMENT

Faro, Yukon Territory

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CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

SPECIFICATIONS
CONTAINING

A. INVITATION FOR TENDERS AND INSTRUCTIONS TO TENDERERS
B. FORM OF TENDER
C. SCHEDULES
D. FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR
E. GENERAL CONDITIONS
F. GENERAL CLAUSES
G. DETAILED SPECIFICATIONS

Golder Associates
Consulting Geotechnical Engineers Calgary, Alberta

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

A. INVITATION FOR TENDERS AND INSTRUCTIONS TO TENDERERS

Golder Associates
Consulting Geotechnical Engineers Calgary, Alberta

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

INVITATION FOR TENDERS

Tenders are invited for the construction of the Down Valley Tailings Project associated with the mine and mill complex located near Faro, Y.T.

Work under this contract is scheduled to commence October 15, 1980, and to be completed by October 1, 1981.

Tender Documents

The Tender Documents for this contract are being provided only to selected potential contractors on an invitation to bid basis. They have been made available for pickup at specific locations upon payment of fifty dollars ($50) for the first set and twenty-five dollars ($25) for each additional set. Payment should be made by certified cheque payable to Golder Associates and shall be refunded upon return of the Tender Documents in good condition within fourteen (14) days after the Tender closing date.

Conditions of Tendering

Tenders must be for the entire work included in the Contract. Cyprus Anvil Mining Corporation reserves the right to reject any or all tenders, and to accept any tender considered advantageous to it.

All Tenderers must attend a prebid site meeting to be held in the boardroom of the Cyprus Anvil Mining Corporation, Faro minesite administration building at 13:00 hours August 20, 1980.

Cyprus Anvil Mining Corporation will not be responsible for any costs incurred by the Tenderer in preparing his tender.

Qualifications of Tenderers

Tenders will be considered only from Tenderers whose financial resources, technical ability and experience are commensurate with the work to be performed, and who have successfully completed comparable work on other projects.

Tender Closing

Sealed tenders will be received until 13:00 hours Pacific Daylight Saving Time on Monday, September 15, 1980 at:

Cyprus Anvil Mining Corporation,
355 Burrard Street,
Vancouver, B.C.
V6C 2G8

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

INSTRUCTIONS TO TENDERERS

1.0 Submission of Tenders and Public Opening

1.1 Sealed Tenders for the construction of the Down Valley Tailings Disposal Project at Anvil Mine near Faro, Yukon Territory, as generally specified herein, will be received by Cyprus Anvil Mining Corporation until 13:00 hours Pacific Daylight Saving Time, Monday, September 15, 1980 at:

Cyprus Anvil Mining Corporation,
355 Burrard Street,
Vancouver, B.C.
V6C 2G8

1.2 There will be a public opening of the Tenders at the time and place noted in Clause 1.1 above.

1.3 Four blank copies of the Form of Tender and Schedules are annexed hereto, and Tenders shall be upon these forms. Two copies shall be enclosed in a sealed envelope, clearly marked "Tender for Cyprus Anvil Down Valley Tailings Containment, Faro, Yukon Territory" and addressed to:

Cyprus Anvil Mining Corporation,
355 Burrard Street,
Vancouver, B.C.
V6C 2G8

1.4 Tenders shall be in duplicate and any documents submitted by the Tenderer which are intended to explain or qualify his Tender shall be submitted in duplicate.

2.0 Conditions of Tendering

2.1 Tenders shall be in Canadian Dollars and shall include duties, taxes both direct and indirect, insurance premiums, costs of performance and related bonds, Workmen's Compensation assessments, Unemployment Insurance assessments, and other statutory assessments, and all the Tenderer's contributions to normal provisions commonly called "Fringe Benefits" as set out in collective labour agreements in the area of jurisdiction.

2.2 All payments by the Owner will be made in Canadian Currency only, at any branch of such chartered bank as the Owner may designate.

2.3 The Owner reserves the right to reject any or all tenders for any reason, and the lowest tender will not necessarily be accepted. The Owner will not be responsible for any costs incurred by Tenderers in making their tender.

2.4 The Tenderer shall furnish evidence satisfactory to the Owner, to demonstrate conclusively that he has the ability and experience to perform the various classes of work involved, and that he has sufficient capital and plant to enable him to prosecute the same successfully and to complete and deliver it as provided in his tender.

2.5 Tenders should not be incomplete, conditional or obscure, and should not contain additions not called for, erasures, alterations or irregularities of any kind.

3.0 Information Available

3.1 A general information package is provided with the contract documents. This package includes exploratory borehole and test pit logs, laboratory testing results, climatological data, Rose Creek flow data and Xerox reproductions of site photographs. A report entitled "A Documentation of the Cyprus Anvil Test Excavation Down Valley Tailings Project" and dated June, 1980 is also provided.

3.2 The above-mentioned information package was extracted from a three (3) volume design report prepared by Golder Associates and dated June, 1980. A limited supply of this report entitled "Final Design Recommendations for the Down Valley Tailings Disposal Project" may be inspected at the following offices of Golder Associates:

(i) 5915 - 3 Street S.E.
Calgary, Alberta
T2H 1K3
Tel. (403) 259-3413
Attn: Miss Kendall Spielman

(ii) 9854 - 42 Avenue
Edmonton, Alberta
T6E 5L6
Tel. (403) 463-2131
Attn: Mrs. Gerri Ross

(iii) 224 - West 8th Avenue
Vancouver, B.C.
V5Y 1N5
Tel. (604) 879-9266
Attn: Miss Karen McKenzie

This report will also be available in limited supply for use on site from Mr. N.G. Cornish at the minesite administration building of Cyprus Anvil Mining Corporation.

The above-mentioned report may not be reproduced in whole or in part. The designs shown in the report have been modified for construction.

3.3 Additional information may be inspected at Golder Associates' office located at 5915 - 3 Street S.E., Calgary, Alberta. Tenderers wishing to make use of this service should contact Mr. D.C. Goodall by telephone at (403) 259-3413.

3.4 All information made available to the Tenderer is to assist the Tenderer in his assessment of field conditions and, while Golder Associates believes the information to be truly representative of conditions at the site, Golder Associates shall not be held liable for the interpretations placed upon or the uses made of the data and other information provided.

4.0 Jobsite Conditions

4.1 It shall be understood that the Tenderer, in preparing his tender, has satisfied himself with conditions at the Site, with the Specifications and Drawings, with board and lodging standards, and has independently investigated and is satisfied with the conditions to be encountered, qualities and quantities of work to be performed and materials to be furnished, including the conditions imposed by reason of standing collective labour agreements, labour conditions, and labour rates. The Tenderer shall not claim at any time after the submission of his tender or subsequent execution of a contract that there was any misunderstanding in regard to the conditions imposed by the Contract Documents.

4.2 The Tenderer shall form his own opinions of materials and foundation conditions, the character of the materials to be excavated, disposed of, or used in the work and of any other conditions affecting the work from inspection of the Site, from study and inspection of available samples and records and from such other investigations as he desires to make. He shall place his own interpretation upon soundings or borings made on behalf of the Owner.

4.3 The Tenderer shall arrange at his own cost for any access to and on the Site which he may require during the period for preparation of tenders.

5.0 Clarification of Tender Documents

5.1 If any Tenderer finds an inconsistency, error or omission in the Tender Documents, or requires clarification of any provision contained therein, he shall submit his query in writing to Golder Associates, 5915 - 3rd Street S.E., Calgary, Alberta T2H 1K3.

5.2 Any revisions to the Tender Documents will be issued as written "Addenda", which will be distributed to all parties registered as having purchased copies of the Tender Documents.

6.0 Inclusion of Addenda with Tender Documents

Any Addenda to the Tender Documents which may be issued to Tenderers during the time for preparation of tenders shall be covered by the tenders, and shall become part of the Tender Documents. If any Addenda are issued, each Tenderer shall acknowledge, in the space provided therefor in the Form of Tender, that he has received them and that his tender has been prepared in accordance therewith.

7.0 Acceptance of Successful Tender

7.1 Tenders shall remain valid and be irrevocably open for acceptance by the Owner for thirty (30) calendar days after the closing time for submission of tenders.

7.2 The successful Tenderer will be notified in writing by the Owner of the acceptance of his tender. The successful Tenderer shall then execute a contract with the Owner within seven (7) calendar days of notification of acceptance of his Tender in the Form of Agreement between Owner and Contractor, forming a part of the Contract Documents. The Contract shall consist of the Contract Documents as defined by Article 1 of the General Conditions.

8.0 Bonding

8.1 Each tender shall be accompanied by a Bid Bond or a certified cheque drawn on a Canadian Bank, or an irrevocable and unconditional bank letter of credit (expiring not sooner than 45 days after the closing time for submission of tenders) in the amount equal to 10 percent (10%) of the Contract Price. The cost of obtaining same (including interest on the certified cheque) is to be borne by each Tenderer.

8.2 Within fourteen (14) days following receipt by the successful Tenderer of notice in writing from the Owner of acceptance of this tender he shall furnish the Owner with the required bonds in accordance with the requirements of Article 20 of the General Conditions hereof.

8.3 In the event the successful Tenderer fails to execute the contract as required by Clause 7.2 above, or fails to furnish the bonds as required by Clause 8.2 above, the Owner may call upon or cash the Bid Bond, letter of credit or certified cheque of that Tenderer and may retain the proceeds as liquidated damages, and all other rights and obligations of the successful Tenderer and Owner with respect to the accepted tender shall cease.

8.4 The Owner will return or release the Bid Bond, letter of credit or certified cheque of each unsuccessful Tenderer when it becomes apparent that his tender will not be accepted. The Bid Bond, letter of credit or certified cheque of the successful Tenderer will be returned when he furnishes the bonds as required by Clause 8.2 above.

9.0 Construction Schedule

The successful Tenderer shall carry out the Work in such a way that the various stages of the Work are completed not later than the times stated in the "Construction Schedule", and as covered under Clause 6 of the General Clauses.

10.0 Board and Lodging

The Tenderer shall note that board and lodging are to be be supplied in part to the Contractor's labour force in accordance with Clause 14 of the General Clauses.

11.0 Schedule A - Schedule of Quantities and Prices

11.1 The work will be paid for on the basis of tendered prices for the items included in Schedule A, the Schedule of Quantities and Prices contained in the Form of Tender. Any work not included in the said Schedule of Quantities and Prices and not susceptible to classification as an item so included and not of such a nature as is ruled by the Engineer to be part of the Contractor's normal costs will be paid for in accordance with the terms of Article 24 of the General Conditions hereof, "Extra Work and Payment for Provisional Items".

11.2 The parts of the Work for which Tenderers are to submit prices have been divided into items in order to enable Tenderers to tender for different portions of the Work in accordance with their estimate of their cost so that in the event of an increase or decrease in the quantity of any particular item of work, the actual quantities executed may be paid for at the rate stated for that particular item of work, subject to the basis of payment laid down for each item in the Specifications. It is to be clearly understood that no work will be paid for under more than one item or more than once under any item.

11.3 The quantities in Schedule A - the Schedule of Quantities and Prices contained in the Form of Tender hereof have been listed for the purpose of comparing Tenders on a uniform basis. It must be distinctly understood that any quantities shown in the Schedule of Quantities and Prices are approximate only and that the Owner expressly or by implication does not represent that the actual quantities will even approximately correspond therewith. No variation whatever therefrom in the quantities actually handled shall give rise to any claim against the Owner except as permitted under Article 3(b), Form of Agreement between Owner and Contractor.

11.4 Each item as detailed in Schedule A, the Schedule of Quantities and Prices contained in the Form of Tender hereof shall be reasonably priced for such item. Under no circumstances will a manifestly unbalanced tender be considered by the Owner. When called upon to do so by the Owner the Tenderer must submit details of how each Lump sum and Unit Price item in the Schedule of Quantities and Prices has been determined.

12.0 Tender Schedules

Tenderers shall provide with the Form of Tender annexed hereto, and on the sheets provided with the Form of Tender for that purpose, the following:

12.1 Contract Schedule A - Schedule of Quantities and Prices.

12.2 Contract Schedule B - Statement of Work in Progress and of recently completed contracts.

12.3 Contract Schedule C - Preliminary Construction Schedule (monthly basis). The Work shall be performed in accordance with Contract Schedule C until approval of the Contract Construction Schedule as provided in General Clause 6.

12.4 Contract Schedule D - List of proposed Subcontractors.

12.5 Contract Schedule E - Proposed Supervisory Personnel.

12.6 Contract Schedule F - Statement listing equipment to be provided for prosecution of the work in accordance with the schedule to be submitted for approval as outlined in Article 6 of the General Clauses.

12.7 Contract Schedule G - Manpower Forecast.

12.8 Contract Schedule H - Statement of surcharge on current B.C. highways equipment rental rates.

12.9 Contract Schedule J - Statement listing equipment to be made available for foundation subexcavation and subexcavation backfill for dams.

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

B. FORM OF TENDER

Golder Associates
Consulting Geotechnical Engineers Calgary, Alberta

FORM OF TENDER

To: Cyprus Anvil Mining Corporation,
355 Burrard Street,
Vancouver, B.C.
V6C 2G8

Tender by _____

_____

a company duly incorporated under the laws of Canada, whose place of business is: _____

_____

OR Tender by: Whose place of business is:

_____ _____

and _____ _____

and _____ _____

and _____ _____

comprising the joint venture of _____

_____

_____

and having its Head Office at _____

and hereinafter called the "Tenderer".

FORM OF TENDER

1. The Tenderer has been carrying on business as _____ _____ for _____ years.

2. The Tenderer has carefully examined all the documents listed in Article 1 of the General Conditions hereof, and the Tenderer hereby agrees that should the Owner award a Contract to the Tenderer, the said documents shall be included in the Contract Documents.

3. The Tenderer agrees that the acceptance of this tender by notice in writing given to the Tenderer by the Owner shall commit the Tenderer to the performance of the Work in accordance with the Contract. The Contact shall be and be deemed to have been dated and made as of the date of said notice in writing of acceptance of this Tender.

4. The Tenderer agrees that this Tender is to continue open to acceptance and irrevocable for thirty (30) days, and that the Owner may, at any time within thirty (30) days of closing date give notice to the Tenderer in writing of acceptance of this Tender, and whether any other Tender has previously been accepted or not, and whether notice of acceptance of another Tender has been given or not. The Tenderer acknowledges the provisions of Clause 8.3 of Instructions to Tenderers and agrees that they shall apply if this tender is accepted.

5. The Tenderer agrees that, if his Tender is accepted, he shall furnish contract bonds in conformity with the requirements of Article 20 of the General Conditions hereof.

6. The Tenderer hereby proposes

_____
(Name of surety company)

_____
(Full address of surety company)

Accompanying this tender is a Consent of Surety signed by the above named surety company which binds it to provide the required Performance Bond and the required Labour and Material Bond (in accordance with the requirements of Article 20 of the General Conditions herewith) should the tender of

_____
(Name of Tenderer)

be accepted.

7. The Tenderer hereby tenders and offers to enter into a Contract, in the form herein set forth, to supply and do all or any part of that which is set out or called for in the Specifications in accordance with the Specifications for the Contract Price stated in Schedule A, the Schedule of Quantities and Prices, and the Tenderer agrees that if this Tender is accepted by the Owner the Tenderer will carry out the Work specified herein.

8. The Tenderer agrees that, if this Tender is accepted by the Owner the Tenderer will execute any additional volume or quantity of work that may be required, over and above the quantities set forth in Schedule A, the Schedule of Quantities and Prices at the unit prices and lump sum prices tendered herein except as permitted under Article A-3(b), Form of Agreement Between Owner and Contractor and in accordance in all respects with the requirements of the Detailed Specifications.

9. The Tenderer agrees that under no circumstances shall any such alterations, additions and deductions affect the validity of the terms of the Contract or give grounds for any claim.

10. The Tenderer certifies that he will commence the Work and will complete the Work in accordance with the dates specified in Clause 5 of the General Clauses.

11. The Tenderer certifies that from his personal inspection of the site, he has satisfied himself with conditions at the Site, with the Specifications and Drawings and the conditions imposed by reason of standing collective labour agreements, board and lodging standards, and that no variation whatever in the character or quantities of the materials actually handled or other conditions affecting the Work shall give rise to any claim against the Owner other than as provided by Article 3(b) of the Agreement between Owner and Contractor.

12. The Tenderer's Bankers are _____
_____

and their full address is _____
_____

13. The Tenderer certifies that he has received the following addenda to the Specifications:

Addendum No.

_____
_____
_____
_____

DATED AT _____ this _____
day of _____.

For _____

By _____

_____ For _____
Witness

By _____

For _____

By _____

NOTE: If the tender is submitted by a Corporation, it must be properly executed and the seal of the Corporation affixed in the presence of proper officers.

The Corporation Seal of _____

as hereto affixed in the presence of:

_____
(Signature and Official Capacity)

_____
(Signature and Official Capacity)

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

C. SCHEDULES

Golder Associates
Consulting Geotechnical Engineers Calgary, Alberta

CONTRACT SCHEDULE A

SCHEDULE OF QUANTITIES AND PRICES

CONTRACTOR_____

PAYMENT ITEM NO.	DESCRIPTION	UNIT	APPROX. QUANTITY	UNIT PRICE	AMOUNT
1(a)	Mobilization	L.S.	-	_____	$_____
1(b)	Demobilization	L.S.	-	_____	_____
2(a)	Slashing in Tailings Impoundment Area	Hectares	30	_____	_____
2(b)	Clearing and Grubbing	Hectares	54	_____	_____
2(c)	Burning of Clearing and Grubbing Debris	Hectares	26.5	_____	_____
2(d)	Stripping and Removal of Waste Material	m^3	144,000	_____	_____
3(a)	Clearing of Canal Area	Hectares	52	_____	_____
3(b)	Grubbing and Stripping of Canal Dyke Foundation and Excavation Area	m^3	222,000	_____	_____
3(c)	Common Excavation	m^3	521,000	_____	_____
3(d)	Upstream Blanket (CVD)*	m^3	63,000	_____	_____
3(e)(i)	Canal Rock Excavation	m^3	44,300	_____	_____
3(e)(ii)	Controlled Blasting	m^2	5,000	_____	_____
3(f)	Thermal Liner and Canal Dyke Class I Zones	m^3	249,000	_____	_____
3(g)	Seepage Control Liner Class II	m^3	33,000	_____	_____
3(h)	Filter Gravel Class I	m^3	24,000	_____	_____
3(i)	Rock Riprap and Filter Rock Class IV	m^3	43,500	_____	_____
3(j)	Canal Dyke Fill Class III	m^3	98,000	_____	_____
3(k)	Canal Outfall Erosion Control Class V	m^3	34,000	_____	_____
3(l)(i)	Filter Rock Stockpile	m^3	1,000	_____	_____
3(l)(ii)	Erosion Control Rock Stockpile	m^3	2,000	_____	_____

*CDV denotes Cross Valley Dam

PAYMENT ITEM NO.	DESCRIPTION	UNIT	APPROX. QUANTITY	UNIT PRICE	AMOUNT
4(a)	Provisional Item Dam Foundation Subexcavation	$1,100,000 x FACTOR† =			$_____
4(b)	Provisional Item Dam Foundation Subexcavation Backfill	$1,100,000 x FACTOR† =			$_____
4(c)	Excavation, Hauling, Placement and Compaction of Class VI Material for Dam Construction				
4(c)(i)	CVD*	m^3	86,000	_____	_____
4(c)(ii)	Intermediate Dam	m^3	56,000	_____	_____
4(d)	Excavation, Hauling, Placement and Compaction of Class VII Material for Dam Construction				
4(d)(i)	CVD*	m^3	75,000	_____	_____
4(d)(ii)	Intermediate Dam	m^3	34,000	_____	_____
4(e)	Excavation, Hauling, Placement and Compaction of Class VIII Material for Dam Construction				
4(e)(i)	CVD*	m^3	97,000	_____	_____
4(e)(ii)	Intermediate Dam	m^3	207,000	_____	_____
4(f)	Excavation, Hauling, Placement and Compaction of Class IX Material for Dam Construction				
4(f)(i)	CVD*	m^3	40,000	_____	_____
4(f)(ii)	Intermediate Dam	m^3	11,000	_____	_____
4(g)	Excavation, Hauling, Placement and Compaction of Class X Material for Dam Construction				
4(g)(i)	CVD*	m^3	80,000	_____	_____
4(g)(ii)	Intermediate Dam	m^3	30,000	_____	_____
4(h)	Class VIII Abutment Fills for Emergency Spillways and Decant Channels				
4(h)(i)	CVD*	m^3	10,000	_____	_____
4(h)(ii)	Intermediate Dam	m^3	2,200	_____	_____

*CVD denotes Cross Valley Dam
†-FACTOR denotes factor explained on Schedule H

PAYMENT ITEM NO.	DESCRIPTION	UNIT	APPROX. QUANTITY	UNIT PRICE	AMOUNT
4(i)	Class IV Filter Rock for Emergency Spillways and Decant Channels				
4(i)(i)	CVD*	m^3	1,800	____	____
4(i)(ii)	Intermediate Dam	m^3	1,000	____	____
4(j)	Class V Erosion Control Rock for Emergency Spillways and Decant Channels				
4(j)(i)	CVD*	m^3	4,600	____	____
4(j)(ii)	Intermediate Dam	m^3	2,800	____	____
4(k)	Excavation, Hauling, Placement and Compaction of Class I Material for Diversion Dam Construction	m^3	12,000	____	____
4(l)	Excavation, Hauling, Placement and Compaction of Class II Material for Diversion Dam Construction	m^3	6,000	____	____
5(a)	Provisional Item Clearing Grubbing and Stripping of Spoil Retainer Dyke Foundation Area		$12,000 x FACTOR† =		$ ____
(b)	Excavation, Hauling, Placement and Compaction of Fill for Spoil Retainer Dyke	m^3	13,000	____	____
6(a)	Excavation of NVWID**	m^3	60,000	____	____
6(b)	Thermal Lining of Channel at north Abutment of CVD*	m^3	20,000	____	____
6(c)	Dyke Fills for NVWID**	m^3	2,000	____	____
7(a)	Fill Placement for Access Road	m^3	60,000	____	____
7(b)	Access Road Culvert Installation	m	80	____	____
8	Premium Cost of Bonds The following will be paid by the Owner in accordance with Clause 20 of the General Conditions	NA	NA	NA	____
			TOTAL CONTRACT PRICE		$ ____

*CVD denotes Cross Valley Dam
** denotes North Valley Wall Interceptor Dyke
†-FACTOR denotes factor explained on Schedule H

CONTRACT SCHEDULE B

STATEMENT OF WORK IN PROGRESS AND STATEMENT OF RECENTLY COMPLETED CONTRACTS

CONTRACTOR: _____

A Statement of present commitments and enumeration of contracts completed over the last 5 year period:

PRESENT COMMITMENTS: Project	Owner	Joint Venture Yes	Joint Venture No	Joint Venture Sponsor Yes	Joint Venture Sponsor No	Scheduled Completion	Percent Complete	Contract Amount ($000)

RECENTLY COMPLETED CONTRACTS: Project	Owner	Joint Venture Yes	Joint Venture No	Joint Venture Sponsor Yes	Joint Venture Sponsor No	Scheduled Completion	Percent Complete	Contract Amount ($000)

CONTRACTOR: _____

DATE PREPARED: _____

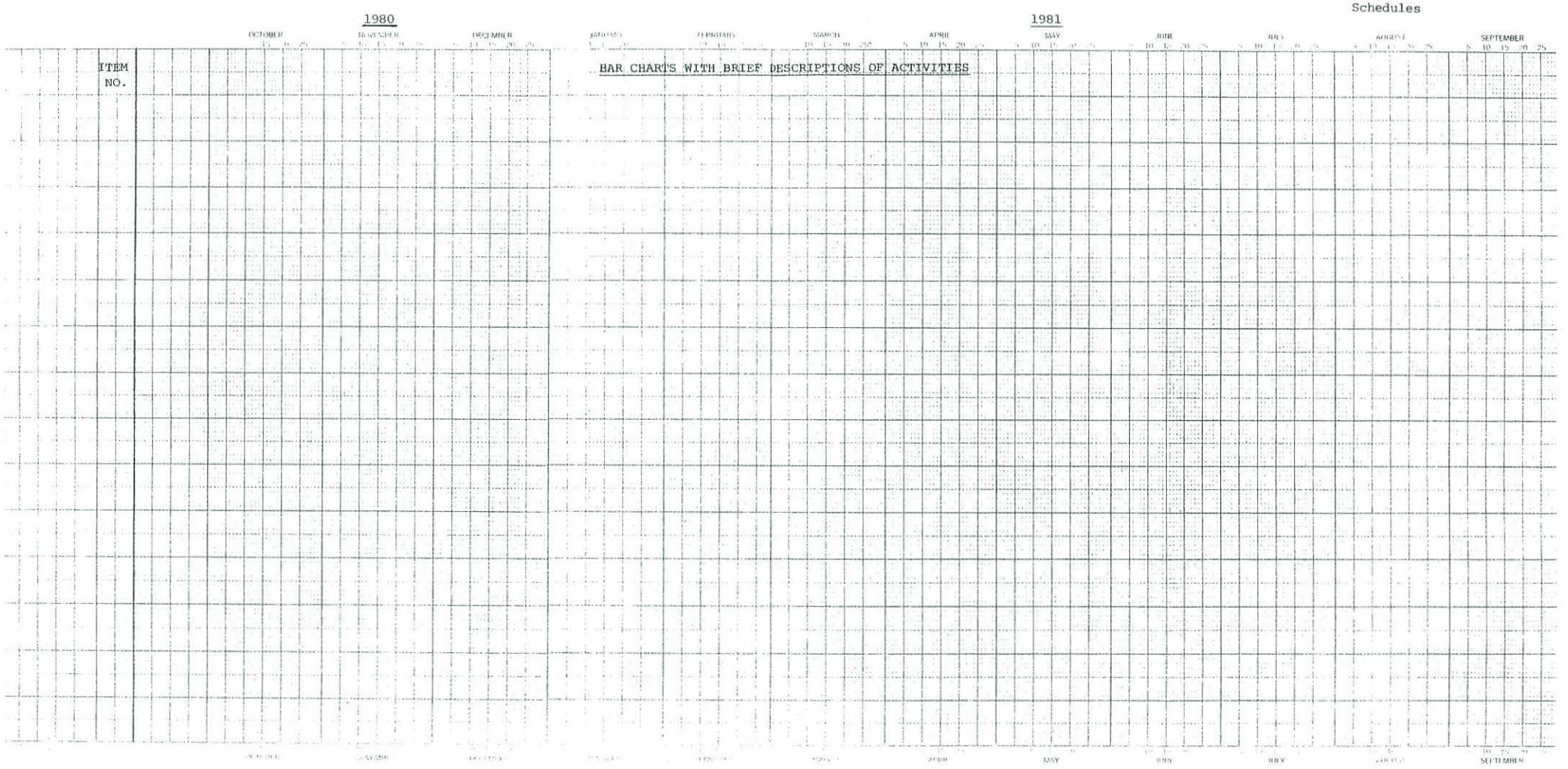
COMPLETION DATE: _____

CONTRACT SCHEDULE C

PRELIMINARY CONSTRUCTION SCHEDULE

C-5(b)
Schedules

C-5(a)
Schedules



CONTRACT SCHEDULE D

LIST OF PROPOSED SUBCONTRACTORS

CONTRACTOR: _____

NAME OF SUBCONTRACTOR	ADDRESS	ITEMS OR PORTION OF WORK SUBCONTRACTED

CONTRACT SCHEDULE E

PROPOSED SUPERVISORY PERSONNEL

CONTRACTOR: _____

NAME AND PROPOSED POSITION	EXPERIENCE AND QUALIFICATIONS	NAME OF REFERENCE CONTACT

CONTRACT SCHEDULE F

STATEMENT LISTING EQUIPMENT TO BE PROVIDED FOR PROSECUTION OF THE WORK IN ACCORDANCE WITH THE SCHEDULE TO BE SUBMITTED FOR APPROVAL AS OUTLINED IN ARTICLE 6 OF THE GENERAL CLAUSES

CONTRACTOR: _____

NO. OF UNITS	DESCRIPTION	SIZE OR CAPACITY	YEAR OF MANUFACTURE	PRESENT LOCATION

CONTRACT SCHEDULE G

MANPOWER FORECAST

CONTRACTOR: _____

	1980			1981									
PERSONNEL CLASSIFICATION	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
Manpower Shift 1													
Manpower Shift 2													
Manpower Shift 3													
Total Manpower													

CONTRACT SCHEDULE H

STATEMENT OF SURCHARGE ON CURRENT BRITISH COLUMBIA HIGHWAYS EQUIPMENT RENTAL RATES

CONTRACTOR: _____

It is understood that a significant proportion of the work will be paid for on a substantiated expenditure basis in accordance with Article 24 General Conditions.

All such work shall be charged at the current British Columbia Highways Equipment rental rates in force at the time the work is performed, surcharged by _____ percent.

The Provisional Items Sums 4(a), 4(b) and 5(a) shown on the Schedule of Quantities and Prices (Contract Schedule A) were prepared assuming a surcharge of thirty (30) percent on the British Columbia Highways Equipment Rental Rates (1980). The Tenderer shall multiply the Provisional Items Sums shown on the Schedule of Quantities and Prices (Contract Schedule A) by a Factor determined as follows:

$$\text{FACTOR} = \frac{\text{100 percent plus tenderers surcharge percent}}{\text{100 percent plus thirty (30) percent}}$$

CONTRACT SCHEDULE J

STATEMENT LISTING EQUIPMENT TO BE MADE AVAILABLE FOR FOUNDATION SUBEXCAVATION AND SUBEXCAVATION BACKFILL FOR DAMS

CONTRACTOR: _____

It is understood that the work of foundation subexcavation and subexcavation backfill for dams as defined in Sections 4.5, 4.6 and 5.1 of the Detailed Specifications for dams will be paid for on a substantiated expenditure basis.

The following equipment will be available for this work:

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

D. FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR

Golder Associates
Consulting Geotechnical Engineers Calgary, Alberta

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

AGREEMENT BETWEEN OWNER AND CONTRACTOR

THIS AGREEMENT made in duplicate this _____ day of _____

in the year Nineteen hundred and _____ by and between

CYPRUS ANVIL MINING CORPORATION

herein (and in the General Conditions) called the "Owner",
and

_____

herein (and in the General Conditions) called the "Contractor",

WITNESSETH: That the Owner and the Contractor undertake and agree as follows:

ARTICLE 1 The Contractor shall:

(a) provide all the materials and perform all the work shown on the Drawings and described in the Specifications titled

Cyprus Anvil Mining Corporation
Down Valley Tailings Containment
Faro, Yukon Territory

which have been signed in duplicate by both the parties, and which have been prepared by

Golder Associates
Consulting Geotechnical Engineers

acting as, and herein (and in the General Conditions) titled, the "Engineer", and

(b) do and fulfill everything indicated by this Agreement, and

(c) complete substantially as certified by the Engineer, all the work by October 1, 1981.

(d) Liquidated Damages and Bonus

Substantial completion of the Work shall be accomplished by the Contractor as defined by General Clause 5.3, and not later than the Substantial Completion date as set out by General Clause 5.3, or such later date as may be applicable by reason of any extension of time allowed in writing by the Engineer for Extra Work or for any other reason approved by the Owner.

Failure of the Contractor to complete the Work as aforesaid by October 1, 1981 will be of material loss and disadvantage to the Owner. It is agreed that $10,000 a day is a reasonable pre-estimate of the damages resulting from such loss and disadvantage, and the following sums shall therefore be charged to or be payable by the Contractor as liquidated damages.

> The sum of $10,000 for each calendar day by which the Substantial Completion of the Work as defined by General Clause 5.3 is delayed beyond the Substantial Completion date stated by General Clause 5.3 provided that the cumulative damages aforesaid together with any costs chargeable to the Contractor shall not exceed in total $250,000.

Provided that if the delay exceeds twenty-five (25) days and the Contractor fails to diligently prosecute the Work to completion when weather conditions permit, the Owner may, at its option, waive the payment of the liquidated damages and may claim against the Contractor for actual damages suffered by it.

If there is Substantial Completion of the Work as defined by General Clause 5.3 before October 1, 1981, all to the satisfaction of the Engineer, a bonus will be paid to the Contractor by the Owner. For this, the following sums shall be paid to the Contractor as a bonus.

> The sum of $10,000 for each calendar day by which the Substantial Completion of the Work as defined by General Clause 5.3 is accomplished before the Substantial Completion date stated by General Clause 5.3 provided that the cumulative bonus aforesaid shall not exceed $250,000.

Notwithstanding anything herein contained, in the event there are delays as defined in Article 33 of the General Conditions of the Contract (except delays due to weather conditions) the Substantial Completion date for the purposes of this clause shall be extended by a period of time equal to the time loss due to such delays. If such delays result in further delays due to weather conditions, the Substantial Completion date for the purposes of this clause shall be negotiated and agreed upon by the Contractor and the Owner before the Work resumes.

Article 2

The list of Specifications and Drawings referred to in Article 1 is as covered by Article 1 of the General Conditions hereof.

Article 3

(a) The Owner shall pay to the Contractor in lawful money of Canada for the performance of the Contract, the amounts determined for each of the items of work completed at the unit prices stated in Schedule A, the Schedule of Quantities and Prices, subject to the adjustments provided herein and in the General Conditions of the Contract. The quantities contained in this schedule are approximate only, and the final payment shall be made for the actual quantities that are incorporated in or made necessary by the work covered by the Contract.

(b) Should the quantities of completed Work of any individual item of the above Schedule vary thirty percent (30%) or more from quantities stated in such Schedule, either the Owner or the Contractor may request a revision of the unit price for the items so affected, and both parties agree that under such conditions an equitable revision of the price shall be made. If the parties fail to agree upon the revision to be made, the dispute may be determined by arbitration as provided for in Article 42 of the General Conditions of the Contract.

(c) If the Engineer orders in writing the performance of any work not covered by the Drawings or included in the Specifications that cannot be classified as coming under any of the contract units and for which no unit price, lump sum, or other basis can be agreed upon, then such Extra Work shall be performed on a Substantiated Expenditure basis as provided for in Article 24 of the General Conditions hereof.

(d) Notwithstanding the provisions contained in sub-section (a) above:

if on account of climatic or other conditions reasonably beyond the Contractor's control there are items of work that cannot readily be completed, the payment in full for the work which has been completed shall not be delayed on account thereof, but the Owner may withhold a sufficient and reasonable sum, as determined by the Engineer, until the uncompleted work is finished and such sum as will adequately protect the Owner against liens.

Article 4

The "General Conditions of the Contract" hereto annexed and the aforesaid Specifications and Drawings, are all to be read into and form part of this Agreement and the whole shall constitute the Contract between the parties and it shall enure to the benefit of and be binding upon them and their successors, executors, administrators and, subject to Article 39 of the General Conditions of the Contract, their assigns.

Article 5

All communications in writing between the parties or between them and the Engineer shall be deemed to have been received by the addressee if delivered to the individual or to a member of the firm or to an officer of the Corporation for whom they are intended or if sent by post or by telegram addressed as follows:

The Owner at Box 1000 (street and number) Faro, Y.T. Y0B 1K0 (post office)

The Contractor at _____ (street and number) _____ (post office)

The Engineer at 5915 - 3 Street S.E. (street and number) Calgary, Alberta T2H 1K3 (post office)

IN WITNESS WHEREOF the parties hereto have executed this Agreement the day and year first above written.

SIGNED, SEALED AND DELIVERED
in the presence of

(SEAL)

(SEAL)

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

E. GENERAL CONDITIONS

Golder Associates
Consulting Geotechnical Engineers Calgary, Alberta

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

GENERAL CONDITIONS

ARTICLE 1. Definitions

(a) The "Contract Documents" shall include and consist of the following:

1. Instructions to Tenderers
2. Form of Tender
3. Schedules
4. Form of Agreement between Owner and Contractor
5. General Conditions
6. General Clauses
7. Detailed Specifications
8. Drawings listed in the General Clauses
9. Addenda to the Specifications
10. Completed Form of Tender submitted by Tenderer
11. Executed Form of Contract
12. Contractor's Bonds
13. Specifications and Drawings issued after the Award or Execution of the Contract.
14. Contractor's Specifications and Drawings provided these have been approved in writing by the Engineer.

(b) The word "Specifications" and the words "Tender Documents" shall mean such of the first nine items listed in the immediately preceeding definition of the "Contract Documents" as are sent to the prospective Tenderers.

(c) The word "Drawings" shall mean all drawings, plans, sketches and maps issued with the specifications or subsequently as provided for in the Contract, and shall include any drawings submitted by the Contractor if signed and approved by the Engineer.

(d) The Owner, the Contractor and the Engineer are those named as such in the Agreement.

(e) The word "Tenderer" shall mean, as the context requires, any party or parties tendering on the work covered by these Specifications, or the successful Tenderer who later becomes the Contractor for such Work.

(f) The term "Subcontractor" includes only a person, firm or corporation having a contract for the execution of a part or parts of the work included in the Contract, and a person, firm or corpor-

ation furnishing material called for in the Contract and worked to a special design according to the Drawings or Specifications, but does not include one who merely furnishes material not so worked.

(g) The term "Work" includes all labour, materials and services required, as shown or described in the Contract Documents, supplied and installed or erected complete at the place of building.

(h) The words "Extra Work" shall mean work performed by the Contractor pursuant to a written order of the Engineer issued with respect to the work performed under Article 24 of the General Conditions hereof.

(i) The term "Other Contractor" means any person or firm or corporation employed by or having a contract directly or indirectly with the Owner otherwise than through the Contractor.

(j) The place of building is the designated site or location of the completed Work.

(k) The law of the place of building shall govern the Work.

ARTICLE 2. Contract Documents

The Contract Documents shall be signed in duplicate by the Owner and Contractor. The Contract Documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the Contract Documents is to include all labour and materials reasonably necessary for the proper execution of the work. It is not intended, however, that materials or work not covered by or properly inferable from any heading, section or trade in the Specifications shall be supplied unless shown on the Drawings. Descriptions of materials or work in words which so applied have well known technical or trade meanings shall be held to refer to such recognized standards. Should the Specifications conflict with the Drawings, the Specifications shall govern. In the case of discrepancies between Drawings, those of larger scale, or if the scales are the same, those of later date shall govern. All Drawings and Specifications shall be interpreted in conformity with the Agreement and these General Conditions which shall govern.

ARTICLE 3. Detail Drawings & Instructions.

The Engineer will furnish, as necessary for the execution of the work, additional instructions, by means of drawings or otherwise. All such additional instructions shall be consistent with the Contract Documents. The Work shall be executed in conformity therewith and the Contractor shall do no work without such additional instructions. In giving such additional instructions, the Engineer will have authority to make minor changes in the work, not inconsistent with the Contract.

If either the Contractor or the Engineer so requests, they shall jointly prepare a schedule, subject to change from time to time in accordance with the progress of the Work, fixing the dates at which the various detail drawings will be required, and the Engineer shall furnish them in accordance with this schedule; and on like request, a schedule shall be prepared, fixing the dates for the submission of shop drawings, for the beginning of manufacture and installation of materials and for the completion of the various parts of the Work.

ARTICLE 4. Copies Furnished

The Engineer shall furnish to the Contractor, without charge, as many copies of all Drawings and Specifications as are reasonably necessary for the proper execution of the Work.

ARTICLE 5. Drawings and Specifications on the Work

The Contractor shall keep one copy of all Drawings and Specifications on the work, in good order, available to the Engineer and to his representatives.

All Drawings used for construction of the Work shall be marked "Approved for Construction" and signed by the authorized representative designated by the Engineer.

ARTICLE 6. Ownership of Drawings

All Drawings, Specifications and copies thereof furnished by the Engineer are his property. They are not to be used on other work, and, with the exception of the signed contract set of Drawings and Specifications, are to be returned to him on request on the completion of the Work.

ARTICLE 7. Samples

The Contractor shall furnish to the Engineer such samples of construction materials as he may reasonably require.

ARTICLE 8. Engineer and Contractor

The Engineer is in the first instance the interpreter of the Contract and the judge of its performance; he shall use his powers under the Contract to enforce its faithful performance by both parties hereto. The Contractor shall, however, have complete control, subject to Article 10, of his organization. In case of the termination of the employment of the Engineer, the Owner shall appoint an Engineer whose status under the Contract shall be that of the former Engineer.

ARTICLE 9. The Engineer's Decisions

The Engineer shall decide on questions arising under the Contract Documents, whether as to the performance of the Work or the interpretation

of the Specifications and Drawings; but should the Contractor hold such decisions to be at variance with the Contract Documents or to involve changes in Work already built, fixed, ordered or in hand in excess of the Contract, or to be given in error, he shall notify the Engineer in writing and wait a period of up to 5 working days for a response before proceeding to carry them out. In the event of the Engineer and the Contractor failing to agree as to such excess or error and the Engineer deciding to carry out such disputed work, the Contractor shall act according to such decision. Any questions of excess of cost due to the aforesaid cause may be decided in the manner hereinafter provided in Article 42.

ARTICLE 10. Superintendence

The Contractor shall keep on the Work, during its progress, a competent project manager or superintendent and any necessary assistants, all satisfactory to the Engineer. The project manager or superintendent shall not be changed except with the consent of the Engineer, unless the project manager or superintendent proves to be unsatisfactory to the Contractor or ceases to be in his employ. The project manager or superintendent shall represent the Contractor in his absence and directions on minor matters given to him shall be held to be given to the Contractor. Important directions shall be given in writing to the Contractor. The Contractor shall give efficient supervision to the work using his best skill and attention.

ARTICLE 10A. Employees

Notwithstanding Article 10, any person employed upon the Work, who shall be deemed by the Engineer to be uncooperative, incompetent or disorderly, or one who has been discharged on such grounds by another contractor on the Site shall, upon representation by the Engineer to the Contractor, be by the latter removed from the Work, and shall not at any time thereafter be employed upon the same.

The Contractor shall not permit the use of alcoholic liquors upon or about the Work.

ARTICLE 11. Layout and Measurement

The Engineer will establish on the ground at the Site a survey control base line and one master bench mark together with such other survey marks and bench marks as he may choose to provide to enable the Work to be set out.

The Contractor shall be responsible for the true and proper layout of the Work in relation to original points, lines and levels of references set out by the Engineer and confirmed in writing (or by Drawings) and for correctness of the positions, levels, dimensions and alignment of all parts of the Work and for the provision of all necessary instruments, appliances and labour in connection therewith.

From the said bench mark and reference points the Contractor shall establish and reference further control points and complete the layout of the Work to the satisfaction of the Engineer. He shall be responsible for all measurements that may be required for the execution of the Work to the exact positions and elevations as shown on the Drawings, or as the same may be modified at the direction of the Engineer to meet changed conditions or as a result of modifications to the Work.

The Contractor shall furnish at his own expense, all the equipment, materials, tools and labour that may be required to lay out the Work from the survey reference points and bench mark established by the Engineer. The Engineer may require that construction work be suspended at any time when location and limit marks established by the Contractor are not reasonably adequate to permit checking completed work or work in progress.

If at any time during the progress of the Work any error shall become evident or arise in the position, levels, dimensions or alignment of any part of the Work, the Contractor, if and when required to do so by the Engineer, shall at his own expense rectify such error to the satisfaction of the Engineer. Provided that if such error is based on incorrect data supplied in writing by the Engineer, the Contractor shall be reimbursed for rectifying the same in accordance with Article 24 "Changes and Extra Work".

The checking of any layout or of any line or level by the Engineer shall not in any way relieve the Contractor of his responsibility for the correctness thereof, and the Contractor shall carefully protect and preserve all bench marks, batter boards, pegs and other measures used in the layout of the Work.

The Contractor shall afford all reasonable facilities and assistance to the Engineer for checking the setting-out and lines and grades established by the Contractor. The checking of any setting-out or of any line and grade by the Engineer shall not in any way relieve the Contractor of responsibility for the correctness thereof.

No payment will be made for any expense incurred by the Contractor as a result of any work performed in the establishment of control points or in the checking of these and the taking of any other measurements by the Engineer and no extension of time will be allowed for any delay occasioned thereby.

Before any work on the site is commenced, the Engineer will carry out surveys to enable the surface of the ground to be accurately recorded. During the progress of the Work, the Engineer will take further surveys to record the extent of any excavation and fill. The Engineer will give notice to the Contractor when the Engineer requires any survey to be taken and the Contractor shall forthwith send a qualified representative to attend and assist the Engineer in taking such surveys.

Should the Contractor neglect or omit to send a qualified representative, then the surveys taken by the Engineer or approved by him shall be taken to be correct.

The Engineer shall determine by measurement the quantities of Work performed on a unit price basis.

ARTICLE 12. Labour, Materials, and Equipment

Unless otherwise stipulated, the Contractor shall provide and pay for all labour, materials, and equipment, and including tools, water, light, power and all other consumable items necessary for the execution of the Work. Unless otherwise specified, all materials shall be new. The Contractor shall not employ on the Work any unfit person or anyone not skilled in the work assigned to him.

ARTICLE 13. Inspection of Work

The Owner or the Engineer on his behalf and their representative shall at all times have access to the Work wherever it is in preparation or progress and the Contractor shall provide proper facilities for such access and for inspection. If the Specifications, the Engineer's instructions, the laws, or the ordinances of any public authority require any work to be specially tested or approved, the Contractor shall give the Engineer timely notice of its readiness for inspection, and if the inspection is by an authority other than the Engineer, of the date and time fixed for such inspection. Inspections by the Engineer shall be promptly made. If any such work should be covered up without approval or consent of the Engineer it must, if required by the Engineer, be uncovered for examination and made good at the Contractor's expense.

Re-examination of questioned work may be ordered by the Engineer with the consent of the Owner. If such work be found in accordance with the Contract, the Owner shall pay the cost of re-examination and replacement. If such work be found not in accordance with the Contract, through the fault of the Contractor, the Contractor shall pay such cost.

ARTICLE 14. Rejected Work

The Contractor shall promptly remove from the premises or replace any defective work, which has been condemned by the Engineer as failing to conform to the Contract Documents, whether incorporated in the Work or not.

ARTICLE 15. Deductions for Uncorrected Work

If in the opinion of the Engineer it is not expedient to correct defective work or work not done in accordance with the Contract Documents, the Owner may deduct from the contract price the difference in value between the work as done and that called for by the Contract, the amount of which shall be determined in the first instance by the Engineer.

ARTICLE 16. Emergencies

The Engineer has authority in an emergency to stop the progress of the work whenever in his opinion such stoppage may be necessary to ensure the safety of life, or of the Work, or of neighboring property. This includes authority to make such changes and to order, assess and award the cost of such work extra to the Contract or otherwise as may in his opinion be necessary.

ARTICLE 17. Protection of Work and Property

The Contractor shall maintain continuously adequate protection of all his work from damage and shall take all reasonable precautions to protect the Owner's property from all injury arising in connection with this Contract. He shall make good any damage or injury to his work and shall make good any damage or injury to the property of the Owner resulting from the lack of reasonable protective precautions. He shall not be responsible, however, for any damage or injury to his work and to the property of the Owner which may be directly due to errors in the Contract Documents or caused by the Owner, his agents or employees, provided the Contractor has taken reasonable protective precautions. He shall adequately protect adjacent property as required by law and the Contract Documents.

ARTICLE 18. Contractor's Liability Insurance

(a) The Contractor shall protect himself and indemnify and save the Owner and Engineer harmless from any and all claims which may arise from the Contractor's operations under the Contract where bodily injury, death, or property damage is caused and for this purpose, shall without restricting the generality of the foregoing, maintain insurance as set forth in Clause (c) below.

(b) The Contractor shall furnish evidence of compliance with all requirements of the applicable workmen's compensation Act or Ordinance of the Territory of the Yukon including payments due thereunder.

(c) The Contractor shall maintain Comprehensive general liability insurance covering premises and operations liability, completed operations liability, Contractors Contractual liability, Automobile and Machinery liability insurance (covering licensed and unlicensed units) and covering owned, non-owned, or hired units. The foregoing shall include as specified perils (but without restricting the generality of the foregoing) insurance covering personal injuries (including death) and damage to or destruction of the property of others (including but without limitation standing timber both mature and immature and whether situate on or off the construction site, electric power transmission towers and lines, whether situate on or off the Construction site) by fire, subsidence or explosion, with extended coverage for fire fighting, legal liability expense resulting from actions or omissions of the Contractor (whether incurred by the Owner, the Contractor or

others, including the owners or occupiers of neighbouring lands and the Crown) in a minimum amount of $5,000,000 (five million dollars) with a Company acceptable to the Owner and showing the Owner as Co-insured and payable to the Owner and the Contractor as their respective interest may appear and protecting each in such terms as will preclude subrogation claims by the insurer against anyone insured thereunder.

The Contractor shall hold the Owner and Engineer harmless with regard to any loss or damages resulting from equipment owned or leased by the Contractor.

(d) Subcontractors shall have similar insurance coverage to that required to be in force by the Contractor or shall be covered by the Contractor's insurance.

(e) All insurance policies which the Contractor is required to obtain or to require any Subcontractor to obtain under this Article 18 and Article 19 shall provide that the insurance shall not be cancelled, reduced, restricted or changed in any way without the Insurer giving at least thirty days' notice in writing to the Owner.

(f) If the Contractor fails to do all or anything which is required of him with regard to insurance, the Owner may do all that is necessary to effect and maintain such insurance, and any monies expended by the Owner shall be repayable by and recovered from the Contractor.

(g) Neither the providing of insurance by the Owner nor the insolvency, bankruptcy, nor failure of any insurance company carrying insurance of the Contractor and/or the Owner and/or Sub-contractors, nor the failure of any insurance company to pay any claim accuring shall be held to waive any of the provisions of this Contract with respect to the liability of the Contractor or otherwise.

(h) All liability insurance policies shall be written in such terms as will fully protect the Contractor notwithstanding his assumption of liability and his indemnity covenants under the Contract.

(i) Prior to the commencement of any work hereunder, the Contractor shall file with the Owner a copy of each insurance policy and certificate required. All such insurance shall be maintained until final completion of the work.

ARTICLE 19. Fire Insurance

The Contractor shall maintain Fire Insurance acceptable to the Owner, with standard Extended Coverage Endorsement, in the joint names of the Owner and Contractor, payable to the Owner and Contractor as their respective interest may appear, and protecting each in such terms as will preclude subrogation claims by the Insurer against anyone insured thereunder.

In the event of a loss, the Contractor shall act on behalf of the Owner and himself for the purpose of adjusting the amount of such loss with the Insurer. On completion of such adjustment the Contractor shall repair the damage and complete the Work, and shall be entitled to receive from the Owner (in addition to any sum due under the Contract) the amount at which the Owner's interest has been appraised in the adjustment, to be paid as the work of restoration proceeds and in accordance with the Engineer's certificates. Damage shall not affect the rights and obligations of either party under the Contract except as aforesaid, and except that the Contractor shall be entitled to such reasonable extension of time for completion of the work as the Engineer may decide.

In the event that the Owner utilizes or occupies the Work or any part thereof prior to the date of substantial completion as certified by the Engineer, any increase in cost of insurance arising out of such use or occupancy shall be at the Owner's expense.

Prior to commencement of any work hereunder, the Contractor shall file with the Owner a copy of the insurance policy. All such insurance shall be maintained continuously until a date ten (10) days after issue by the Engineer of the Acceptance Certificate, after which date the Owner shall assume responsibility for insuring the whole Work.

ARTICLE 20. Performance and Labour and Materials Bonds

The Contractor shall provide and maintain in good standing a Performance Bond in the amount of one hundred percent (100%) of the Contract price guaranteeing the due performance of this Contract by the Contractor and a Labour and Material Payment Bond in the amount of fifty percent (50%) of the contract price binding the surety for the payment of Labour and Material used in performance of this Contract and providing that the notice stipulated thereunder may be given within Two Hundred (200) days after the last of the labour was performed and the last of the materials was furnished. The Contractor shall also cause each Subcontractor to provide and maintain a similar Labour and Material Payment Bond (with the Subcontractor as Principal and the Contractor and the Owner as Joint Obligee) and a similar Performance Bond if the same must be issued simultaneously in order to obtain the Labour and Material Payment Bond.

Such bonds shall be obtained with a duly incorporated surety company acceptable to the Owner and authorized by law to transact business in the Yukon Territory. Except as otherwise provided herein, the bonds shall be in the standard forms approved by the Canadian Construction Association.

The costs attributable to providing the bonds shall be borne by the Contractor and/or Subcontractors and shall therefore be included in the Tender price.

The Contractor shall report to and obtain the written consent of the surety for all amendments to and increases in the Contract where the increase in value of the Contract is greater thant ten (10) percent as soon as such an increase is indicated. The Contractor shall provide the Owner with a copy of the surety's consent, and shall ensure continued bonding of the Contract.

The Contractor shall obtain from the surety who issues a bond an assurance satisfactory to the Owner that the bond will not be terminated or varied unless the Owner first consents in writing.

ARTICLE 21. Fire Fighting Equipment

The Contractor shall at all times during his presence on the site provide fire fighting equipment. The minimum requirements shall be as follows:

(a) All vehicles shall be equipped in conformity with all applicable laws, statutes, ordinances and regulations.

(b) The Contractor shall supply a minimum of three (3) fire fighting pumps of a size and type acceptable to the Engineer plus 500 m of hose per pump, subject to the Engineer's approval. These pumps shall be kept in good operating condition and working order. The disposition of the pumps around the site will be as approved by the Engineer.

ARTICLE 22. Pollution of Adjacent Water Courses

The Contractor shall restrict his work in order that he initiates no pollution of creeks or adjacent water courses. He shall carry insurance sufficient to cover any monetary liability under the Northern Inland Waters Act and consequent legal costs and showing the Owner and Engineer as a Co-insured and without limitation, the Contractor further agrees to indemnify and save harmless the Owner and Engineer from any and all liability claims, damages and costs arising out of any pollution of Creeks or adjacent Water Courses.

ARTICLE 23. Subsurface Conditions

In the event that during the execution of the work subsurface conditions at the site are found to differ materially from those indicated on the Contract Documents and soils data provided, or otherwise represented by Owner or Engineer to the Contractor then the Contractor shall promptly notify the Engineer in writing of such conditions. The Engineer shall promptly investigate such conditions and if he finds that they differ materially and will result in an increase or decrease in the cost of, or time required, for performance of this Contract an equitable adjustment shall be made between the parties and the Contract modified in writing in accord-

ance with Article 24. If the parties fail to agree upon the adjustment to be made the dispute may be determined as provided for in Article 42.

ARTICLE 24. Extra Work and Payment for Provisional Items

(a) Definition of "Changes"

The term "Changes", as used herein, means a substitution for, an addition to, or a deletion of, any work or other requirement, the performance of or compliance with which is contemplated by the Contract.

(b) Definition of "Extra Work"

The term "Extra Work", as used herein, means any work or other requirement, the performance of or compliance with which is not contemplated by the Contract.

Extra Work does not include the following:

i. Work necessitated by the failure of the Contractor to perform satisfactory work or to maintain a satisfactory work schedule; and

ii. Changes in quantities of work as detailed in the Schedule of Quantities and Prices.

(c) Performance of Extra Work

The Engineer may, at any time, without invalidating the Contract or any Performance Bond given thereunder, and without notice to the sureties, make Changes in the Work, and may require the Contractor to perform Extra Work.

(d) Notification of Change

Where a Change, in the opinion of the Engineer, will result in an increase or decrease in:

i. The cost of performing the Work for which no corresponding increase or decrease in the Contract Price is provided for under the Contract, or

ii. The time required to complete the Work, or any part of the Work for which a completion date is set forth in the Contract,

The Engineer will issue the Contractor a written Notification of Change. The Contractor shall promptly perform the Work in accordance with the Notification of Change. When the increase or decrease in the Contract Price, as provided in Article 24[f], or in the time to perform the Work as provided in Article 33, has been established, the Engineer will issue a written Change Order to the Contract setting out the details of such increase or decrease.

(e) Authorization of Extra Work

In general, formal Extra Work orders will be issued in writing by the Engineer whenever Extra Work is required, and formal Change Orders will be issued whenever Changes result in Extra Work.

(f) Payment for Extra Work and Provisional Items

Extra Work for which there are, in the opinion of the Engineer, applicable unit prices in the Schedule shall be paid for at such unit prices.

Where there are no such unit prices, Extra Work may be paid for on a lump sum and/or unit price basis as agreed by the Engineer and the Contractor.

Where, in the opinion of the Engineer, there are no applicable Items in the Schedule of Quantities and Prices for the Extra Work, and the Engineer and the Contractor are unable to agree upon a lump sum or unit prices basis, Extra Work shall be paid for on a Substantiated Expenditure basis.

When payment is to be made on a Substantiated Expenditure basis, Substantiated Expenditure shall mean actual and necessary net costs as approved by the Engineer, plus percentage fees all as hereinafter described:

i. Direct Labour

The direct wages paid to direct labour employed on the Extra Work including the proper proportion of the foremen directly supervising the Extra Work, and including payroll costs such as fringe benefits and statutory assessments paid on the direct wages to labour.

The fringe benefits and statutory assessments shall include assessments under the Workmen's Compensation Act, the Unemployment Insurance Act, Statutes providing for vacations with pay, government hospitalization or any similar statutes of Canada, or payments on account of usual vacations made by the Contractor to his employees engaged on the work at the site, to the extent to which such assessments or payments for vacations with pay relate to the Work covered by this Contract, and all taxes where applicable.

ii. Materials

The actual net cost to the Contractor or to an approved Subcontractor, whichever is the less, of materials supplied by the Contractor or such approved Subcontractor which are necessary for the performance of the Extra Work, subject to a discount to the Owner to be determined by the Engineer in respect of any re-used materials and in respect of the salvage of any materials not completely consumed.

iii. Equipment

The rental charges for equipment other than small tools necessary for performance of the Extra Work by the Contractor and Subcontractors for the time directly used in the performance of the Extra Work. Equipment rental charges shall be determined in accordance with the current edition British Columbia Highways Equipment Rental Rate Schedule hereinafter referred to as the "Equipment Rental Rate Schedule", plus a surcharge on these rates bid by the Contractor in Contract Schedule H, attached hereto and by this reference incorporated herein. "Small Tools" shall include all hand tools such as picks, shovels, wheelbarrows, hoses and other single items each of a new market value of $500.00 or less.

The rental rates, terms and conditions set out in the Equipment Rental Rate Schedule shall apply to the items of equipment which the Contractor provides on the site for the execution of extra work performed on the basis of Substantiated Expenditure when such equipment is required by the Engineer for the performance of such extra work.

No extra payment other than that provided for below and in Item 1 of the Detailed Specifications will be made for the cost of mobilizing and demobilizing the equipment.

All rates include allowances for depreciation, interest, taxes, insurance, repairs, maintenance, servicing (except as otherwise specifically provided), supplies (other than fuel or lubricants), supervision, overhead and profit.

Where rates are quoted as "Bare Rental" such rates shall include all costs except wages and board cost of operators and servicing with fuel and lubricants.

Where rates are quoted "All Found less operator" such rates also include allowances for fuel and lubricants.

Where rates are quoted as "All Found" such rates also include allowance for operators' wage, board loss, fuel and lubricants.

The Owner shall pay to the Contractor an hourly rental in respect of each item of the Contractor's equipment furnished pursuant to the terms hereof at the applicable rate set forth in the Equipment Rental Rate Schedule for each hour that each item of equipment is operated as defined herein.

The rentals for the use of the Contractor's equipment shall apply whether such equipment is operated during day shifts, or night shifts, or both and no additional compensation shall be payable by the Owner to the Contractor if such equipment is operated on both shifts.

For the purpose of determining the hours of operation the Contractor's equipment shall be deemed to have been operated upon the site during the actual time:

It is used in performing work authorized by the Engineer whether or not such work is performed on the site,

or

It is being moved or transported on or about the site for work authorized by the Engineer,

or

It is held in a specific work area, with engine running and an operator on duty in readiness to commence work, provided the Engineer considers the nature of the work to be performed by such equipment necessitates such availability.

The Contractor's equipment shall not be considered to have been operated upon the site during the time:

It is being moved or transported from a location away from the site to the site and unloaded in the first instance to perform work, or it is being loaded and removed from the site when it is, in the opinion of the Engineer, no longer required.

or

It is undergoing regular daily servicing during the working shift.

or

It is being maintained or repaired.

or

It cannot be used because of inclement weather, labour disputes, fires, forest closures, or Acts of God.

or

It cannot be used because of a breakdown or a fault in the equipment.

or

It is on standby as described hereafter.

or

It is not actually in use.

Items of the Contractor's equipment shall be deemed to be on standby during the times when:

They are being modified or adapted, with the consent of the Engineer, to perform specific work, and the restoration of such equipment to its former status.

They are required to be held on the job specifically for work expected to be required in the future at the specific written request of the Engineer.

Payment to the Contractor for equipment on standby shall be negotiated to the mutual satisfaction of the Contractor and the Engineer prior to the rental of such equipment, but standby time if payable shall never exceed an amount required to bring the total of the operating hours plus the standby hours to a maximum of 8 hours in any day or 40 hours in any week. For any standby in excess of these limits only the operators' costs will be paid if incurred.

When an item of the Contractor's equipment is in a category between the increments as shown on the Equipment Rental Rate Schedule, the rental rate payable in respect thereof shall be determined by the Engineer by straight line interpolation from the schedule rounded off to the nearest five cents.

If the Contractor is unable to supply any item of equipment from his own fleet of equipment that may be required by the Engineer for short periods of time the Engineer may request the Contractor to rent such items of equipment from others, subject to the following conditions, namely:

The terms and conditions upon which such items of equipment are leased to the Contractor, including without limitation, the rentals thereby reserved, shall be subject to the prior written approval of the Engineer.

The Owner shall reimburse the Contractor for the actual amount of rent and mobilization approved by the Engineer that the Contractor pays to others for the rental and mobilization or demobilization of such items of equipment.

Notwithstanding anything herein contained the Owner reserves the right at any time and from time to time to furnish such of his own construction equipment as he may deem necessary for the work and the Contractor shall only be paid for maintaining and operating such equipment and shall not receive any rental payments in respect of the equipment.

When equipment is required but a rental rate is not listed in the rate schedule, pertinent information such as year, make, model, serial number, etc. shall be supplied to the Engineer, who will formulate a rental rate consistent with the schedule.

vii Fee

A fee of sixty-five percent (65%) on the regular time and the regular time portion of premium time (and including payroll costs in both instances) of direct labour charges for all of the actual hours worked on Item i, above. This fee shall include all charges for:

All job overhead charges such as, but not limited to, timekeeping, first aid, clerks, safety men, superintendence, wages and salaries of supervisory personnel, engineers, draftsmen, storekeepers, board and camp costs;

All general overhead such as, but not limited to, office salaries and expenses, furnishings, stationery supplies, general supervision, head office costs;

Contractor's profit.

A fee of fifteen percent (15%) on the material costs in Item (ii) above and of five percent (5%) on the Subcontract costs covered in Item (v) above to cover all overheads andprofit. profit.

No percentage fee shall be paid in respect of the rental charges for equipment, or for the costs of expendables and small tools.

(g) Daily Field Reports

The Contractor shall submit to the Engineer a daily report on all Extra Work in progress. The report shall be of a form in the number of copies required by the Engineer and shall be submitted daily on the first working day following each day on which any Extra Work is executed. For all Extra Work performed on a Substantiated Expenditures basis the report shall include the following information:

i. The names, occupations, union rates and time engaged on such Extra Work of all labour including the proper proportion of the time of foremen directly supervising such Extra Work.

ii. The description and quantity of all materials actually incorporated into such Extra Work.

iii. The description and time operated of all equipment necessarily used in the performance of such Extra Work.

iv. The daily cost of all expendable materials and supplies consumed in the performance of Extra Work.

v. The daily costs for Sub-Contractors engaged on Extra Work.

Copies of each daily field report shall be approved by the Engineer when agreed upon and returned to the Contractor who shall attach one copy of the approved report with invoices and other necessary documents to his monthly progress estimates.

(h) Revocation and Audit

The Engineer shall supply the Owner with a copy of all Extra Work Orders and Change Orders, together with cost estimates relating thereto, prior to the commencement of the relevant work and the Owner shall be entitled to revoke the same at any time prior to the commencement of the work.

The Owner shall also have the right to audit all invoices and documents relevant to claims for payment under Extra Work Orders and Change Orders.

ARTICLE 25. Alterations, Deductions and Additions

The Engineer shall have the right to make such alterations, deductions and additions as he may require in the line, grade, form, location, dimensions, quantities, or material of the Work herein contemplated or any part thereof, either before or after the commencement of construction.

Under no circumstances shall such alterations, deductions or additions affect the validity of the terms of the Contract. If, however, such alterations, deductions or additions shall make useless any work already done or material already supplied, the Engineer shall make reasonable allowance thereof.

ARTICLE 26. Acceptance Certificate.

When the entire Work has completely fulfilled the requirements of the Contract, in the opinion of the Engineer, the Engineer shall so certify in writing by means of an Acceptance Certificate to the Owner and to the Contractor, and it shall then be deemed that the Owner has taken over the Work.

ARTICLE 27. Progress Estimates and Payments

On or about the end of each month, a progress estimate, on a form approved by the Engineer shall be prepared by the Contractor showing the estimated amount of each class of work including Extra Work performed during the month, and the values thereof will be computed in accordance with the unit or lump sum prices set out in the Contract, provided that such estimate shall not include and no payment shall be made on account of the value of materials delivered to the Site which have not been incorporated in the permanent work.

The progress estimate shall be accompanied by such satisfactory evidence as the Engineer may require to establish that the costs have been properly incurred and by an appropriate certification to the effect that all wages and currently due workmen's compensation and unemployment insurance have been paid for the period covered by the said progress estimate.

The progress estimate will be submitted to the Engineer for checking and certification. When the Engineer is satisfied that the estimate is correctly made out in accordance with the provisions of the Contract, he will certify the estimate and forward it to the Owner.

The Engineer shall within ten (10) days of the receipt of the progress estimate, certify the amount for payment, or advise the Contractor promptly in writing why the account is amended or disapproved.

Eighty-five percent (85%) of the amount of each progress estimate thus prepared will be paid to the Contractor within ten (10) days after receipt of the progress estimate in the Owner's Site Operations Office at the Faro minesite duly certified by the Engineer, provided, however, that when the amount retained by the Owner equals ten percent (10%) of the Contract Price, plus two hundred and fifty thousand dollars ($250,000), the Owner shall, subject to the Contractor's satisfactory performance of the Work, pay to the Contractor the full amount of all subsequent compensation accruing to the Contractor under the terms of the Contract.

ARTICLE 27A. Final Payment

Within thirty (30) days of signing the Acceptance Certificate (as described in Article 26 hereof) for the whole Work, the Engineer will prepare a final statement of the total quantities of the various classes of work performed, based on field measurement. The statement will show the total amount due to the Contractor for all Work, including Extra Work, performed under the Contract.

Except as hereinafter provided, the amount due to the Contractor, after deducting from the total so shown the amounts of all previous monthly progress payments and the amounts of any monies due or claimed to be due to the Owner from the Contractor, will be paid by the Owner to the Contractor

within thirty (30) days after the signing by the Engineer of the final statement.

Provided, however, that before payment is made, the Contractor shall execute a release to the Engineer and the Owner from all claims or demands whatsoever arising out of or in connection with performance of the Work, and shall furnish satisfactory evidence to the Engineer and the Owner that all claims or demands against the Contractor arising out of or in connection with the performance of the Work have been satisfied.

Provided, further, that notwithstanding anything herein contained, the Owner shall be entitled to retain as a holdback under the Mechanics' Lien Ordinance, ten percent (10%) of all payments due to the Contractor under this Contract until the expiration of thirty (30) days following the date of the Acceptance Certificate (or such other percentage for such other period as may from time to time be prescribed by the Mechanics' Lien Ordinance or a successor ordinance thereto).

ARTICLE 28. Taxes

Unless otherwise provided herein, the Contractor shall pay all government sales or excise taxes in force during the continuance of this Contract.

ARTICLE 29. Permits, Notices, Laws and Rules

The Contractor shall apply and pay for all necessary permits or licences required for the execution of all the Work (but this shall not include the obtaining of permanent easements or rights of servitude). The Contractor shall give all necessary notices and pay all fees required by law and comply with all laws, ordinances, rules and regulations relating to the Work and to the preservation of the public health.

If the Contract Documents are at variance therewith, any resulting additional expense incurred by the Contractor shall constitute an addition to the Contract Price.

ARTICLE 29A. Safety

The Contractor shall be responsible for the safety of all workmen and equipment on the project in accordance with all applicable safety legislation passed by federal, territorial and local authorities governing construction safety.

The Contractor shall at all times exercise all necessary precautions for the safety of his employees and shall comply with all statutory requirements and any instructions of the Engineer or of the Safety Inspectors employed by said authorities. Safety precautions as applicable shall include but shall not be limited to adequate life protection and life-saving equipment, fire fighting tools, adequate illumination for all operations, instructions in accident prevention for all employees including, where necessary, care in the use of explosives, adequate traffic control,

and such machinery guards, walkways, scaffolds, ladders, bridges and other safety devices as are necessary to prevent accidents or injuries.

The Contractor, in addition to any other reports which may be required, shall promptly report to the Engineer all accidents involving death of or serious injury to any person.

ARTICLE 30. Patent Fees

The Contractor shall pay all royalties and licence fees and shall save the Owner and Engineer harmless from loss on account of suits or claims for infringement of patents in the doing of the Work.

ARTICLE 31. Use of Premises

The Contractor shall confine his equipment, the storage of materials and the operations of his workmen to limits indicated by laws, ordinances, permits or by direction of the Engineer and shall not unreasonably encumber the premises with his materials. The Contractor shall not load or permit to be loaded any part of the Work with a weight that will endanger its safety. The Contractor shall enforce the Engineer's instructions regarding signs, advertisements, fires and smoking.

ARTICLE 32. Cleaning Up

The Contractor shall at all times keep the site free from accumulations of waste material or rubbish caused by his employees or work, and at the completion of the Work he shall remove all his rubbish and all tools, equipment and surplus materials from and about the Work and shall leave the Work in an orderly condition. In case of dispute the Owner may remove the rubbish and charge the cost as the Engineer shall determine to be just.

ARTICLE 33. Delays and Extension of Time

If the Contractor is delayed in the completion of the Work by any act or neglect of the Owner, Engineer or any Other Contractor or any employee of any one of them or by changes ordered in the Work, then the time of completion may be extended for such reasonable time as the Engineer may decide. If the Contractor is delayed in completion of the Work by labour disputes, strikes, lock-outs (including lock-outs decreed or recommended by a recognized contractors' association for its members of which the Contractor is a member), fire, unusual delay by common carriers or unavoidable casualties or, without limit to any of the foregoing, by any cause of any kind whatsoever beyond the Contractor's reasonable control, then the time of completion shall be extended for a period of time equal to the time loss due to such delays. In addition and without limit to the foregoing the time of completion shall be extended because of any cause whatsoever within the Contractor's control which the Engineer shall decide as justifying a delay for such reasonable time as the Engineer may decide.

No such extension shall be made for delay unless written notice of claim is given to the Engineer within seven (7) days of its commencement, provided, however, that in the case of a continuing cause of delay only one claim shall be necessary.

Notwithstanding anything herein contained, if the Contractor is delayed in completion of the Work or if there are one or more suspensions of the Work by reason of labour disputes, strikes or lock-outs involving employees of the Owner, the Engineer or any other employer, the time of completion shall be extended for a period of time equal to the time loss due to such delays or suspensions but the Contractor shall have no claim against the Owner or the Engineer in respect of the delays or suspensions and the Contractor shall be obliged to complete the Work following the delays or suspensions without being entitled to receive any compensation or reimbursement for loss or extra costs and charges resulting from the delays or suspensions.

If no schedule is made under Article 3, no claim for delay shall be allowed on account of failure to furnish drawings until two weeks after demand for such drawings and not then unless such claim be reasonable.

The Engineer shall not, except by written notice to the Contractor, or as provided in Article 16, stop or delay any part of the Work pending decisions or proposed changes either by himself or by the Owner.

ARTICLE 34. Owner's Right to do Work

If the Contractor should neglect to prosecute the Work properly or fail to perform any provision of this Contract, the Owner, after ten (10) days' written notice to the Contractor may, without prejudice to any other right or remedy he may have, make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due to the Contractor; provided however, that the Engineer shall approve both such action and the amount charged to the Contractor.

ARTICLE 35. Owner's Right to Perform Work or Stop the Work or Terminate Contract

If the Contractor should be adjudged as bankrupt, or makes a general assignment for the benefit of creditors under the Bankruptcy Act (Canada) or if a receiver or receiver manager is appointed in respect of any of his property, the Owner may, without prejudice to any other right or remedy he may have, by giving the Contractor or receiver or receiver-manager or trustee in bankrupty written notice, terminate the Contract.

If the Contractor should neglect to prosecute the Work properly or otherwise fails to comply with the requirements of the Contract to a substantial degree and if the Engineer has given a written statement to the Owner and the Contractor that sufficient cause exists, the Owner may notify the Contractor in writing that he is in default of his contractual obligations and instruct him to correct the default in the ten (10) working days immediately following the receipt of such notice.

If the correction of the default cannot be completed in the ten (10) working days specified, the Contractor shall be in compliance with the Owner's instructions if he:

(a) commences the correction of the default within the specified time, and,

(b) provides the Owner with an acceptable schedule for such correction and,

(c) completes the correction in accordance with such schedule.

If the Contractor fails to correct the default in the time specified or subsequently agreed upon, the Owner, without prejudice to any other right or remedy he may have, may:

(a) correct such default and deduct the cost thereof from any payment then or thereafter due the Contractor provided the Engineer has certified such cost to the Owner and the Contractor, or,

(b) terminate the Contractor's right to continue with the Work in whole or in part or terminate the Contract.

If the Owner terminates the Contractor's right to continue with the Work under the conditions set out in this General Condition, he shall:

(a) be entitled to take possession of the Work and utilize the construction machinery and equipment subject to the rights of third parties, and finish the Work by whatever method he may consider expedient but without undue delay or expense, and

(b) withhold further payments to the Contractor until the Work is finished, and

(c) upon Total Performance of the Work, charge the Contractor the amount by which the full cost of finishing the Work as certified by the Engineer, including compensation to the Engineer for his additional services exceeds the unpaid balance of the Contract Price; however, if such cost of finishing the Work is less than the unpaid balance of the Contract Price, he shall pay the Contractor the difference.

The provisions of this General Condition shall be exercised in accordance with the conditions of the performance bond.

The Contractor's obligation under the Contract as to quality and correction of the work performed by him up to the time of termination shall continue in force after such termination.

ARTICLE 36. Contractor's Right to Suspend Work or Terminate Contract

If the Work should be stopped under an order of any court, or other public authority through no act or fault of the Contractor or of anyone employed by him (but excluding a stoppage related to a labour dispute, strike or lock-out) or if the Engineer fails to issue a certificate in accordance with Article 27, or if the Owner should fail to pay the Contractor within ten (10) days of its maturing and presentation, any sum certified by the Engineer or awarded by arbitrators, then the Contractor may upon ten (10) days written notice to the Owner and the Engineer stop work and/or terminate this Contract without prejudice to any other right or remedy he may have, and recover from the Owner payment for all work executed and any loss sustained upon the plant or material with reasonable profit and damages.

ARTICLE 37. Damages and Mutual Responsibility

If either party to this Contract should suffer damage in any manner because of any wrongful act or omission of the other party or anyone employed by him (but excluding an act or omission of an employee related to a labour dispute, strike or lock-out) then he shall be reimbursed by the other party for such damage. Claims under this paragraph shall be made in writing to the party liable within a reasonable time after the first observance of such damage and not later than the time of Acceptance Certificate, except as expressly stipulated otherwise in the case of faulty work or materials, and may be adjusted by agreement or in the manner set out in Article 42, and the party reimbursing the other party as aforesaid shall thereupon be subrogated to the rights of the other party in respect of such wrongful act or neglect if it be that of a third party. Should the Contractor cause damage to any Other Contractor on the work, the Contractor agrees upon due notice to settle with such Other Contractor by agreement or arbitration, if he will so settle. If such Other Contractor sues the Owner on account of any damage alleged to have been so sustained the Owner shall notify the Contractor who shall defend such proceedings at the Owner's expense and if any final order or judgment against the Owner arises therefrom the Contractor shall pay or satisfy it and pay all costs incurred by the Owner. Provided that if the Contractor becomes liable to pay or satisfy any final order or judgement against the Owner then the Contractor shall have the right, upon undertaking to indemnify the Owner against any and all liability for costs, to appeal in the name of the Owner such final order or judgements to any and all court of competent jurisdiction.

ARTICLE 38. Separate Contracts with Other Contractors

The Owner reserves the right to let separate contracts in connection with the undertaking of which the Work is a part and the Contractor shall connect properly and coordinate his work with that of Other Contractors. If any part of the Contractor's work depends for its proper execution or result upon the work of any Other Contactor, the Contractor shall in writing report promptly to the Engineer any defects in the work of such

Other Contractor as may interfere with the proper execution of the Contractor's work. Should the Contractor fail so to inspect and report he shall have no claim against the Owner by reason of the defective or unfinished work of any Other Contractor except as to latent defects not reasonably noticeable at the time of the commencement of the Contractor's work. In letting separate contracts the Owner shall be responsible for the coordination of fire and other insurance coverage and shall take all precautions reasonably possible to avoid possible occurrence of a labour dispute or disputes on the Work.

ARTICLE 39. Assignment

Neither party to the Contract shall assign the Contract without the written consent of the other.

ARTICLE 40. Subcontractors.

The Contractor agrees to preserve and protect the rights of the parties under the Contract with respect to work to be performed under subcontract and to:

(a) enter into contracts or written agreements with his Subcontractors to require them to perform their work in accordance with and subject to the terms and conditions of the Contract Documents, and

(b) be as fully responsible to the Owner for acts and omissions of his Subcontractors and of persons directly or indirectly employed by them as for acts and omissions of persons directly employed by him.

The Contractor therefore agrees that he will incorporate the terms and conditions of the Contract Documents into all Subcontract Agreements he enters into with his Subcontractors.

The Contractor agrees to employ those Subcontractors proposed by him in writing and accepted by the Owner at the signing of the Contract.

The Owner may, for reasonable cause, object to the use of a proposed Subcontractor and require the Contractor to employ other Subcontractors. In the event that the Owner requires a change from a proposed Subcontractor the Contract Price shall be adjusted by the difference in cost and mark-up occasioned by such required change.

The Engineer may, upon reasonable request and at his discretion, provide to a Sub-Contractor information as to the percentage or quantity of the Sub-Contractor's work which has been certified for payment.

Nothing contained in the Contract Documents shall create a contractual relationship between a Sub-Contractor and the Owner.

The Contractor shall not be obliged to employ as a Subcontractor or supplier any person or firm to whom he may reasonably object.

ARTICLE 41. Relations of Contractor and Subcontractor

The Contractor agrees to bind every Subcontractor by the terms of the Contract Documents, as far as is applicable to his work.

ARTICLE 42. Arbitration

In the case of any dispute arising between the Owner (or the Engineer acting on his behalf) and the Contractor as to their respective rights and obligations under the Contract, either party hereto shall be entitled to give to the other notice of such dispute and to request binding arbitration thereof; and the parties may, with respect to the particular matters then in dispute, agree to submit the same to binding arbitration.

Arbitration proceedings shall not take place until after the completion or alleged completion of the Work except (a) on a question of certificate for payment, or (b) in a case where either party can show that the matter in dispute is of such nature as to require immediate consideration while evidence is available.

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

1980 Embankment and Dam Raising

GENERAL DESCRIPTION OF THE PROJECT

1.0 LOCATION

The site of the Work is located in the valley of Rose Creek, downstream of the North Fork of Rose Creek at the Anvil Mine Property near Faro, Yukon Territory. The project elevation of the site is as shown on the contract drawings.

2.0 PURPOSE

The purpose of the proposed construction is to provide tailings containment. The construction program as described herein is intended to provide storage capacity for future tailings production from Cyprus Anvil Mine. The Work involves diversion of Rose Creek into a channel to be constructed along the slope of the south wall of the valley plus construction of creek diversion facilities, two embankments dams, and an interceptor ditch along part of the slope of the north wall of the valley.

3.0 SCOPE OF WORK

The work includes but shall not necessarily be limited to the following:

(a) Clearing, grubbing of natural ground surface and stripping of topsoil as required for dam foundation and dyke construction and development of borrow source areas.

(b) Excavation of all materials necessary to construct the diversion canal.

(c) Excavation and wasting of unsuitable materials present in the base areas of the new dams.

(d) Excavation and hauling of granular materials from the designated borrow areas for construction of the embankment dams and lining of the diversion channel.

(e) Excavation, hauling, placing and compaction of select canal excavation material to construct an engineered dyke section along the diversion channel.

(f) Excavating of relatively impervious material from designated borrow areas for construction of core zones of the dams.

(g) Hauling, and placing of riprap materials from an approved quarry area or from other approved sources of such material.

It is the intent that the Contractor shall supply all labour, materials, equipment and tools to carry out the required Work and that the equipment available shall be adequate to produce a balanced plant.

4.0 DIRECTION OF WORK

The Contractor shall supply all equipment and suitable experienced personnel to operate the equipment such that best usage of the equipment will be achieved. The Contractor will be responsible for providing all maintenance and repair of equipment. All work will be directed and controlled by the Engineer as the Owner's designated representative.

5.0 COMMENCEMENT, PROSECUTION AND COMPLETION OF THE WORK

5.1 Commencement

The Contractor shall commence work at the jobsite on the later of October 15, 1980, or the fourteenth (14th) day following the day on which he is notified in writing by the Owner of acceptance of his tender.

5.2 Prosecution

The sequence and progress of the Work shall be carried out in accordance with the Contract Construction Schedule covered by General Clause 6.

5.3 Substantial Completion

Substantial Completion of the Rose Creek diversion canal shall mean that all excavation, thermal lining, seepage control blanket, canal dyke fills, and erosion control lining are constructed as required by the Engineer and that the new diversion canal can carry the full flow of Rose Creek over the full length of the canal to the satisfaction of the Engineer.

Substantial Completion of the dams shall mean that the dams are constructed in all respects, and as shown on the drawings, and that no work remains, and that the tailings containment dam can begin to impound the full outflow from the mine's facilities to the satisfaction of the Engineer.

Substantial Completion of all work shall be accomplished not later than October 1, 1981.

5.4 Final Completion

The work shall be completed without restriction or risk of damage to the work including final cleanup, and the Contractor shall have all of his equipment removed from the jobsite within forty-five (45) days of the substantial completion date.

6.0 CONSTRUCTION SCHEDULE

6.1 Preliminary Schedule

Until the Contract Construction Schedule is approved as provided by Section 6.2 below, the Work shall be performed in accordance with Contract Schedule C, Preliminary Construction Schedule.

6.2 Submission And Approval

The Contractor shall within fourteen (14) days after being notified in writing by the Owner of acceptance of his tender submit to the Engineer a reproducible copy (transparency) of his proposed construction schedule covering all Contract activities. Such schedule shall include a Bar Chart Schedule and/or a Network Diagram, a list of activities and a written explanation of the proposed plan and schedule of construction of the Work, all as hereinafter set forth. The Contractor shall adequately demonstrate on his proposed construction schedule the impact of significant variables on the start and finish dates of all major activities.

The Contractor's proposed construction schedule shall be subject to approval by the Engineer to ensure that it respresents a practical and achievable plan for completion of the Work in accordance with all Contract requirements. Following approval by the Engineer, the Contractor's proposed construction schedule shall become the Contract Construction Schedule and shall take precedence over the Preliminary Construction Schedule shown as Contract Schedule C.

The Contractor shall prosecute the Work in accordance with the Contract Construction Schedule. The Contractor will be permitted reasonable variance from the sequence of activities indicated by the Contract Construction Schedule, provided such variance does not jeopardize timely completion of the Work, in accordance with all provisions of the Contract, and provided that no interference is caused to operations of others. The Contractor shall at all times keep the Engineer informed of his proposed courses of action, and his day to day schedule of operations.

If, in the opinion of the Engineer, delay to an activity or a series of activities jeopardizes timely completion of the Work or a portion thereof in accordance with requirements of the Contract, the Contractor shall take such action as necesary to improve his progress including, but not necessarily limited to, increasing any or all of his forces, construction equipment, shifts and/or hours of work. The Contractor shall submit a detailed plan showing his proposed method of acceleration of production to provide compliance with the Contract Construction Schedule and upon approval by the Engineer of an adequate plan shall immediately and effectively implement such program.

6.3 Progress Reports and Site Meetings

During the course of the Work, the Contractor shall submit to the Engineer periodic progress reports on the actual progress of the Work. Such reports shall be furnished as the Engineer may request, but will not be required more often than weekly nor less often than once monthly, and shall contain the following:

i) The list of activities scheduled to be in progress or actually in progress during the report period, together with the Contractor's estimate of progress made to the cutoff date and actual or forecast start and/or completion dates for each of these activities.

ii) A list of activities scheduled to be started within the next two reporting periods with forecast start dates.

iii) A brief narrative report presenting a general resume of Contract progress and an explanation of any actual or anticipated delays or problems affecting progress of the Work.

Such progress reports shall be presented during regular site meetings to be held on dates as agreed upon by the Engineer and Contractor.

7.0 TRANSPORTATION

The Contractor shall make his own arrangements and shall be responsible for transporting all necessary material, equipment and labour to the site and also for the removal of his unused materials and his equipment and labour upon completion of the Work.

8.0 CONSTRUCTION POWER

The Contractor shall at his own expense arrange for the generation of all electrical power necessary for performing the Work covered by this Contract.

9.0 CONSTRUCTION ROADS AND ACCESS FACILITIES

The Contractor shall, at his expense, construct and maintain throughout the duration of the Contract such haul roads and access facilities as may be necessary for the supply and placement of all earthwork materials and other items required for the construction. He shall also provide at his expense, all lighting, signs, barricades, distinctive markings, traffic control facilities, dust control, snow removal, sanding and personnel necessary for the safe movement of his own traffic as well as other traffic which may be affected by his operations.

The Contractor shall, at his expense, keep and maintain Owner's roads used by him in a condition equivalent to or better than their condition at the start of the Contract.

The location, grades, widths and dimensions of all haul roads and other access facilities to be constructed by the Contractor shall be subject to the approval of the Engineer and details of these access roads and facilities shall be submitted to the Engineer in due time prior to their construction.

Access and haul roads and all other associated facilities shall be constructed so as not to interfere with natural or directed drainage courses and shall be graded and drained properly so as not to create a hazard to property or to the Work. The quality of materials used in construction shall be such that the roads and facilities will remain in a stable and safe condition throughout the period of their use.

The Contractor shall comply with any ruling regarding traffic movement on the existing access roads which may be made by the Engineer.

10.0 FIRE PROTECTION

A fire break shall be provided around the periphery of the works and all brush shall be stockpiled inwards from the periphery of clearing, if directed by the Engineer.

11.0 ACCESS TO PRIVATE PROPERTY

The Engineer will attempt to obtain the necessary permission to enter on or use private property. The Contractor shall not enter or use or permit any of his employees to enter or use any property other than that designated as being within the project property area without the specific permission of the Engineer. If the Contractor wishes to enter or use any property for which he has not received permission, he shall make application to the Engineer. The Engineer will seek to obtain the necessary permission as rapidly as he is able, but neither the Owner nor the Engineer will be liable for any delay in obtaining the necessary permission.

12.0 PROTECTION OF PRIVATE PROPERTY

The Contractor shall be wholly responsible for any damage to private property resulting from his operations and it shall be his responsibility that all workmen and persons employed by him or his agents or under his control shall use due care that no person or property is injured or damaged and that no rights are infringed in the prosection of the Work.

13.0 PERMITS AND NOTICES

The Contractor will be responsible for obtaining all notices and permits required for completion of the Work.

14.0 ROOM AND BOARD

The Owner is presently operating a camp to construction camp standards adjacent to the minesite and beside the Cyprus Anvil Administration Building. Limited accommodation for up to 75 persons

will be available to the personnel of the prime Contractor and his subcontractors between October 15, 1980 and October 1, 1981. Where room and board is provided by the Owner the prime Contractor shall be charged a fixed daily rate equalling $45.00 for each of his or his subcontractor's employees. Additional meals for visitors will be charged for at a fixed rate of $6.50 for each extra meal. The Contractor shall ensure that his personnel and those of his subcontractor's adhere to all camp rules.

Accommodation for up to 40 persons in addition to that described above will be made available to the Contractor and his Subcontractors as follows. Between October 31, 1980 and May 31, 1981 such accommodation will be made available at the camp situated at the Faro townsite which will also be operated to construction camp standards. Such room and board will be charged to the Contractor at a fixed daily rate of $20.00 for each of the Contractor's or Subcontractor's employees. Between June 1, 1981 and October 1, 1981 such additional accommodation will be be made available at the minesite camp as specified above for the basic 75 person accommodation.

All room and board privileges described herein may cease on October 1, 1981 irrespective of any delays or extensions of the substantial completion date.

15.0 OFFICE FOR THE ENGINEER

The Contractor shall provide a site office trailer for the Engineer. It shall measure 10 ft. x 40 ft. It shall have an adequate furnace, electrical power, sufficient lighting, and be supplied with heating oil. Furnishings shall consist of two (2) desks, eight (8) chairs, two (2) tables, two (2) benches, two (2) steel filing cabinets, two (2) drafting tables and two (2) stools. It shall have a water cooler with bottle (potable water will be supplied by others). The trailer shall be located in a stable permanent position for the duration of the contract and shall be provided with a housed-in entrance porch and steps with hand rails. The trailer underside shall be sheathed down to the ground level and the sheets shall be backed with 6" fibreglass insulation.

The Owner has a 10 ft. x 40 ft. office trailer at the site. The Contractor shall move this trailer to a position adjacent to the Engineer's site office trailer. This trailer shall be supplied with electrical power, and furnace heating oil. Exterior additions shall be as described for the Engineer's site trailer office.

The Contractor shall provide an 8 ft. x 16 ft. mobile site office. The Contractor shall move this office at reasonable time intervals as the work progresses to various work site locations as requested by the Engineer. This office shall be supplied with a furnace, electrical power, lighting and heating oil. It shall be furnished

The following drawings form a part of these specifications:

DRAWING NO.	DESCRIPTION
7922025-1	Site Photomosaic, Limits of Clearing, Borrow Areas
7922025-2	Site Contour Plan
7922025-3	Canal Plan and Profile Baseline Chainage 0+000 to 1+060
7922025-4	Canal Plan and Profile Baseline Chainage 1+020 to 2+420
7922025-5	Canal Plan and Profile Baseline Chainage 1+980 to 3+280
7922025-6	Canal Plan and Profile Centreline Chainage 2+600 to 3+700
7922025-7	Canal Cross-Sections and Drop Weir Profile
7922025-8	Cross Valley Dam Plan and Profile
7922025-9	Cross Valley Dam and Spillways Cross-Sections
7922025-10	Intermediate Dam Plan and Profile
7922025-11	Intermediate Dam Cross-Sections
7922-25-12	Miscellaneous Details

with a table, four (4) chairs, a drafting table, stool and a bench. The heating and lighting facilities of the site offices described above shall be maintained in good working order by the Contractor.

16.0 SECURITY

The Contractor shall assume full responsibility for the security of the Work.
In addition, the Contractor shall provide suitable "no trespassing" signs on the access roads to the site to prohibit entry of the public.

17.0 SPECIAL PRECAUTIONS

(a) Explosives
The Contractor shall comply with all laws and regulations applicable to the use, handling and storage of explosives.

(b) Fuel Storage
Supplies of gasoline, fuel oils and other liquified petroleum or gas products shall be stored and transported in accordance with the applicable laws of the Territory of the Yukon.

18.0 MEASUREMENT AND COMPUTATION OF QUANTITIES

Measurement for payment of Contract items will be as described in the Detailed Specifications. The Engineer will make all measurements and computations for quantities in accordance with good engineering practice.

19.0 SANITATION

The Contractor shall provide and maintain, so long as any of his employees are employed on the Work, adequate sanitary conveniences for their use and their provision, maintenance and removal shall accord in every way with the requirements of the local Medical Officer of Health. The Contractor shall also provide and be responsible for the servicing of similar facilities which he shall install at the site office of the Engineer.

20.0 FAIR WAGES

The Contractor shall pay all tradesmen employed on the Work not less than the fair rate of wages for work of a similar nature prevailing in the vicinity of the Work.

21.0 DRAWINGS

The Drawings listed in the following schedule are included in and form part of this Specification. Revision of these Drawings may be made and furnished to the Contractor during the construction of the Work, and all revised Drawings shall take precedence over previous issues of such Drawings. The Contractor shall act only on written instructions or revised Drawings and not on oral instructions.

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G. DETAILED SPECIFICATIONS

Golder Associates
Consulting Geotechnical Engineers Calgary, Alberta

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DETAILED SPECIFICATIONS

ITEM 1

MOBILIZATION AND DEMOBILIZATION

1.1 PAYMENT ITEM 1(a) - MOBILIZATION

Mobilization shall mean the complete mobilization of all equipment and manpower from place of origin to the site of the project along with any support facilities required in accordance with proposed Contract Schedules C, E, F, G, H and J of the Contract Schedules detailed herein and to the approval of the Engineer.

Mobilization will be assessed by the Engineer and will be computed as the percentage with respect to weight of the Contractor's proposed equipment mobilized to the site or the percentage of completion of the Contract whichever is most.

Mobilization will be paid as a percentage of the lump sum price bid under Item 1(a) of the Schedule of Quantities and Prices.

1.2 PAYMENT ITEM 1(b) - DEMOBILIZATION

Demobilization shall mean the complete demobilization of all equipment and manpower from the site to the place of origin, or otherwise, along with any support facilities required in accordance with proposed Contract Schedules E, F and G of the Contract Schedules detailed herein and to the approval of the Engineer.

Demobilization will be assessed by the Engineer and will be computed as the percentage with respect to weight of the Contractor's equipment removed from the site or the percentage of completion of the Contract, whichever is least.

Demobilization will be paid as a percentage of the lump sum price bid under Item 1(b) of the Schedule of Quantities and Prices.

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DETAILED SPECIFICATIONS

ITEM 2

SLASHING, CLEARING, GRUBBING AND STRIPPING

2.1 SCOPE

The work shall consist of but shall not be restricted to supplying all labour, plant and small tools and performing the following:

(i) The slashing of designated areas of the tailings impoundment area generally bounded by the existing tailings faiclity, the Access Road, the Intermediate Dam and the existing Rose Creek channel as generally shown on Drawing No. 7922025-1 and excepting areas which require further work as described below.

(ii) The clearing, grubbing and stripping of Borrow Area "A", Borrow Area "B", Borrow Area "C" (if required) and Borrow Area "D". Also the clearing, grubbing and stripping of the terrace area foundation of the Intermediate Dam as shown on Drawing No. 7922025-1.

(iii) The clearing, grubbing and stripping of Borrow Area "E", Borrow Area "F" and Borrow Area "G" or any other areas which may be required to obtain the necessary borrow materials.

(iv) The clearing and grubbing of the area required to construct the North Valley Wall Interceptor Ditch as designated by the Engineer and not included in other items described herein.

(v) The clearing and grubbing and burning of the resulting debris in the area bounded by the Cross Valley Dam, the Intermediate Dam, the existing Rose Creek channel and the Access Road. This work shall exclude areas which are developed as borrow sources or are otherwise prepared as defined herein.

No payment will be made for clearing and grubbing required for haul roads and other contractor's facilities except as directed by the Engineer to be cleared. No payment will be made for areas already cleared.

Clearing, grubbing and stripping required for the Diversion Canal and other specific items is specifically defined in the specifications for these items and is not included herein.

2.2 GENERAL PROVISIONS

All borrow Areas should be stripped and operated on a schedule such that depth of frost penetration is minimized. The Contractor should submit his proposed schedule of borrow pit development to the Engineer for his approval. Stripped materials from borrow areas on the North Valley wall shall be piled in such a manner that they can be reclaimed as required by the Engineer. Reclamation of stripped areas will be paid for in accordance with the provisions of Article 24 of the General Conditions.

2.3 DISPOSAL OF WASTE MATERIAL

2.3.1 No disposal of waste material shall be necessary where slashing only is required.

2.3.2 Waste materials resulting from the clearing, grubbing and stripping of Borrow Area "A" and Borrow Area "B" shall be disposed of along the south or southwestern boundaries of these borrow areas which are generally defined by a contour line of Elevation 1065 m as shown on Drawing No. 7922025-2. Waste materials may also be disposed of in the bottom of spent borrow pits which shall be designated as such by the Engineer. Waste materials shall be deposited such that they do not interfere with the construction of the Intermediate Dam or any other activity required to complete the Work.

2.3.3 Waste materials resulting from the clearing, grubbing and stripping of the terrace area foundation of the Intermediate Dam shall be deposited in the spent borrow pits of Borrow Area "B" which shall be designated as such by the Engineer and generally east of the upstream toe of the Intermediate Dam as defined by the Engineer.

2.3.4 Waste materials resulting from the clearing, grubbing and stripping of Borrow Area "D" shall be deposited along the northeastern boundary of the Borrow Area "D" which is generally defined by a contour line of Elevation 1050 m as shown on Drawing No. 7922025-2. Waste materials may also be disposed of in the bottom of spent borrow pits which shall be designated as such by the Engineer. Waste materials shall be deposited such that they do not interfere with the construction of the Spoil Retainer Dyke or the Diversion Canal or any other activity required to complete the Work.

2.3.5 Waste materials resulting from the clearing, grubbing and stripping of Borrow Area "E" and Borrow Area "F" or any other area which may be required to obtain the necessary borrow materials shall be disposed of in the bottom of spent borrow pits which shall be designated as such by the Engineer. In the absence of spent borrow pit capacity all waste materials shall be deposited

shall be designated as such by the Engineer. In the absence of spent borrow pit capacity all waste materials shall be deposited at locations within or adjacent to the borrow areas such that they do not interfere with the optimization of recovery of materials from the borrow area and with the construction or operation of the North Valley Wall Interceptor Ditch all as determined by the Engineer.

2.3.6 Waste materials resulting from the clearing and grubbing of the area required to construct the North Valley Wall Interceptor Ditch shall be disposed of outside of the area required to excavate or place fill for the construction of the North Valley Wall Interceptor Ditch.

2.3.7 All slash, stumps, roots and other debris resulting from clearing, grubbing and danger tree removal in the area bounded by the Cross Valley Dam, the Intermediate Dam, the existing Rose Creek channel and the Access Road shall be piled and burned completely to ashes at points located well within the cleared area.

The number of fires to be started at any one time shall be limited by the Contractor's ability to control the fires. Burning shall be performed so that surrounding live trees are not damaged.

All burning shall be performed subject to the provisions of the pertinent acts of the Yukon Territory and regulations thereto and permission must be obtained from the local Forest Ranger through the Engineer before burning commences. In the event burning is prohibited by Forestry regulations at the time burning is proposed, the materials may be piled in the cleared area until such time as burning is permitted, providing that these piles do not interfere with the work schedule.

In areas in which controlled fires are burning, a watchman shall remain on the area at all times at the Contractor's expense until the fire is completely extinguished.

The Contractor shall be required to burn in accordance with the provisions herein all clearing and grubbing waste which may be gathered to the satisfaction of the Engineer from the waste disposal areas presently existing adjacent to Borrow Area "C" and which have resulted from the clearing, grubbing and stripping of Borrow Area "C" by Other Contractors.

2.3.8 All waste materials resulting from the stripping of Borrow Area "G" or Borrow Area "C" (if required) shall be deposited at the boundaries of these borrow areas or in spent borrow pits designated as such by the Engineer and such that the disposed waste materials do not interfere with the construction of the Cross Valley Dam, the upstream blanket of the Cross Valley Dam or any other activity required to complete the Work. The Contractor shall similarly remove any stripping waste materials which have

resulted from the stripping of Borrow Area "C" by Other Contractors.

2.4. PAYMENT ITEM 2(a) - SLASHING IN TAILINGS IMPOUNDMENT AREA

2.4.1 Work Description

Slashing shall mean the falling of all standing timber larger than 75 mm in diameter as measured within 20 mm of the natural ground surface. Slashing shall be performed as required by the Engineer in the general tailings impoundment area defined by the existing tailings facility, the Access Road, the Intermediate Dam and the existing Rose Creek channel as generally shown on Drawing No. 7922025-1.

2.4.2 Method of Measurement

The quantity of slashing to be paid for will be determined by measuring the areas slashed as required by the Engineer. Measurement for slashing of isolated trees will be taken over the area which was directly under the foliage of such trees. The area determined for payment will be on the basis of horizontal measure.

2.4.3 Basis of Payment

Payment for slashing will be made at the unit price bid per hectare under Item 2(a) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all labour, plant and small tools required to slash areas as directed by the Engineer. No payment will be made for slashing of haul roads, or other areas slashed by the Contractor outside the areas required by the Engineer to be slashed.

2.5 PAYMENT ITEM 2(b) - CLEARING AND GRUBBING

2.5.1 Work Description

Clearing shall mean the complete removal and disposal of all trees, shrubs, logs, loose stumps, debris and other objectionable material from areas required by the Engineer to be cleared.

Grubbing shall mean the entire removal and disposal of all stumps, roots, embedded logs and other buried debris from areas where stumps, roots and other debris would spoil the use of excavated materials for fill or the use of in situ materials as a foundation as determined by the Engineer.

Clearing and grubbing shall be performed as required by the Engineer over areas within the designated borrow areas, the terrace area foundation of the Intermediate Dam, the area required for construction of the North Valley Wall Interceptor Ditch and the area bounded by the Cross Valley Dam, the Intermediate Dam, the existing Rose Creek channel and the Access Road.

2.5.2 Method of Measurement

The quantity of clearing and grubbing to be paid for will be determined by measuring the areas cleared and grubbed as required

by the Engineer. Measurement for clearing and grubbing of isolated trees will be taken over the area which was directly under the foliage of such trees. The area determined for payment will be on the basis of horizontal measure.

No payment will be made for areas already cleared and grubbed.

2.5.3 Basis of Payment

Payment for clearing and grubbing will be made at the unit price bid per hectare under Item 2(b) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all labour, plant and small tools required to clear and grub areas as directed by the Engineer as well as the disposal of waste material exclusive of any burning which may be required. No payment will be made for clearing and grubbing of haul roads, or other areas cleared and grubbed by the Contractor outside the areas required by the Engineer to be cleared and grubbed.

2.6 PAYMENT ITEM 2(c) - BURNING OF CLEARING AND GRUBBING DEBRIS

2.6.1 Work Description

The work includes the burning of all waste materials from the clearing and grubbing of the area bounded by the Cross Valley Dam, the Intermediate Dam, the existing Rose Creek channel and the Access Road in accordance with the provisions of Section 2.3.7. The work also includes the burning in accordance with the provisions of Section 2.3.7 of all clearing and grubbing waste which may be gathered to the satisfaction of the Engineer from the waste disposal areas presently existing adjacent to Borrow Area "C" and which have resulted from the clearing, grubbing and stripping of Borrow Area "C" by Other Contractors.

2.6.2 Method of Measurement

The quantity of burning to be paid for will be determined by measuring the total area bounded by the limits of clearing and grubbing requiring disposal by burning as determined by the Engineer and generally defined by the area bounded by the Cross Valley Dam, the Intermediate Dam, the existing Rose Creek channel and the Access Road.

The area determined for payment will be on the basis of horizontal measure.

2.6.3 Basis of Payment

Payment for burning of clearing and grubbing waste as specified herein will be made at the unit price bid per hectare under Item 2(c) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all labour, plant and small tools required to burn all clearing and grubbing waste materials within the designated area. No payment will be made for burning of waste

materials resulting from clearing and grubbing of areas outside the area determined by the Engineer.

2.7 PAYMENT ITEM 2(d) - STRIPPING AND REMOVAL OF WASTE MATERIALS

2.7.1 Work Description

The work includes but shall not be limited to the excavation, removal and disposal of all topsoil, volcanic ash, mixtures of silt, topsoil, organic material, volcanic ash and cobbles or boulders both frozen and unfrozen, as will be required by the Engineer to develop all borrow areas and to prepare the terrace area foundation of the Intermediate Dam.

2.7.2 Method of Measurement

The quantity of material to be paid for will be determined as the in-place volume obtained by comparing surveys performed by the Engineer prior to and subsequent to the stripping of the area or waste removal as directed by the Engineer.

2.7.3 Basis of Payment

Payment for excavation and removal of all stripping or unsuitable materials as determined by the Engineer will be made at the unit price bid per cubic metre in place under Item 2(d) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, remove and dispose of all stripping or waste materials.

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DETAILED SPECIFICATIONS

ITEM 3

DIVERSION CANAL

3.1 SCOPE

The work includes but shall not necessarily be limited to the following:

(i) The clearing, grubbing and stripping of the canal excavation area and foundation of the canal dyke.

(ii) The excavation, hauling and disposal of all materials required to complete the canal excavation as directed by the Engineer.

(iii) The hauling and placing or the hauling and stockpiling of select waste excavation materials in the upstream blanket area of the Cross Valley Dam.

(iv) The excavation, hauling, placement and compaction of all canal liner materials including filter gravel, glacial till and rock riprap as directed by the Engineer.

(v) The excavation, hauling, placement and compaction of the canal dyke using select materials from the wasted canal excavation materials.

(vi) The excavation, hauling, placement and compaction of gravel zones within the canal dyke configuration.

(vii) The production, hauling and placement of all filter rock and rock riprap necessary for the construction of the drop weir structures and erosion protection in the canal.

(viii) The stockpiling of 1,000 m^3 of filter rock and 2,000 m^3 of canal outfall erosion control rock.

3.2 GENERAL PROVISIONS

3.2.1 The Contractor shall submit for the approval of the Engineer, details of his proposed methods of excavation and placing of materials and the sequence of operations to be followed. The Contractor will be required to arrange his construction so as to make maximum use of the borrow materials.

3.2.2 Canal excavation between canal baseline chainages 1+000 and 3+670 as generally shown on Drawing Nos. 7922025-2, 7922025-3, 7922025-4, 7922025-5 and 7922025-6 shall be completed under freezing temperature conditions unless approved otherwise by the Engineer. The lining of the same must also be completed under freezing conditions except where the exposed excavation materials are such as to require a seepage control liner as determined by the Engineer.

The balance of the canal excavation may be completed under either thawing or freezing temperatures or both. The canal lining and canal dyke filter gravel zones may be similarly completed except where a seepage control liner is required as determined by the Engineer.

3.2.3 The seepage control liner and the canal dyke (except the filter gravel zones) shall be constructed under continuous thawing temperature conditions as determined by the Engineer. Construction of the seepage control liner must also be in accordance with the following:

(i) Frozen material shall not be placed as fill.

(ii) Fill shall not be placed on frozen material unless specifically approved by the Engineer.

(iii) Fill materials shall not be placed at temperatures which, in the opinion of the Engineer, will cause freezing of the material before it is adequately compacted.

(iv) Frozen crust or any accumulated snow and ice layers on the surface of the fills shall be removed by the Contractor or allowed to melt completely as directed by the Engineer prior to placement of additional lifts.

3.2.4 Fills constituting parts of the canal other than those described in section 3.2.3 shall be constructed in accordance with the following:

(i) Fills requiring compaction as specified elsewhere and placed under freezing conditions shall be compacted without delay after placement. No fill placement shall be allowed under freezing conditions if the necessary compaction equipment is inoperative.

(ii) A vibratory pad foot compactor equivalent to or heavier than a CA 25 PD compactor of Dynapac manufacture to the satisfaction of the Engineer shall be used to achieve the required compaction. An equivalent compactor shall be similar with respect to the number and protrusion of the protruding feet on the compactor drum and shall have a weight and a flywheel horsepower exceeding that of the compactor referenced herein.

(iii) Snow and ice shall be removed from the fill surfaces and canal excavation walls to the satisfaction of the Engineer. Construction operations will be permitted if snowfall is occurring and the snowfall is deemed by the Engineer not to detract from the fill integrity.

(iv) Fill materials shall not contain snow and/or ice debris.

(v) Fill materials shall not be agglomerated as frozen chunks unless otherwise approved by the Engineer.

3.2.5 Notwithstanding provisions for topsoil removal and grubbing, all fill materials shall not contain organic contents in excess of 1 percent on an air dry weight basis when considering a representative 1 kg. sample.

3.2.6 The Contractor shall provide at his own expense all dewatering facilities required to complete the canal construction.

3.2.7 The Contractor shall make allowance for the reasonable interruption of his activities by the Engineer for purposes of installation of monitoring instrumentation as deemed necessary by the Engineer. The Engineer will notify the Contractor at least seven (7) days in advance of such activity except when an emergency occurs as described in Article 16 of the General Conditions. The Contractor shall reasonably control his equipment so that any monitoring instrumentation is not destroyed.

3.2.8 The Contractor shall organize his activities so that the Test Excavation constructed between Canal Baseline chainages 1+700 and 2+000 is properly incorporated into the canal construction as directed by the Engineer. The Contractor may reuse the thermal lining materials as Class I material provided that such materials are not contaminated by other materials and the provisions of Section 3.3 are satisfied. If the existing thermal lining is not removed the Test Excavation shall be trimmed according to the lines and grades shown on Drawing No. 7922025-7 and to the tolerances defined herein.

3.2.9 Where the term Drawings is referred to under Item 3, Drawings shall include Drawing No. 7922025-2 to 7922025-7, all inclusive.

3.3 MATERIALS

3.3.1 Excavation Materials

After stripping is completed, as determined by the Engineer, the excavation materials will be classified as Common Excavation or as Rock Excavation as defined herein.

Rock Excavation

An excavation material will be considered as Rock Excavation if the material consists of sound and solid masses, layers, or ledges of mineral matter in place and of such hardness and texture that:

(i) The material is not rippable when using a late model tractor-mounted hydraulic ripper equipped with one digging point of standard manufacturer's design adequately sized for use with, and propelled by, a crawler-type tractor with a net flywheel power rating between 210 and 240 KW, operating in low gear or;

(ii) In areas where it is impracticable to classify by use of the ripper described above, rock excavation is defined as sound material of such hardness and texture that it cannot be loosened or broken down by a 3 kg drifting pick, with handle not less than 0.9 m in length.

No allowance for Rock Excavation will be made if, in the opinion of the Engineer, the material is not rippable due to freezing from unnecessary exposure to very cold temperatures or extended exposure resulting from premature stripping or discontinuous excavation.

All boulders or detached pieces of solid rock more than 1 cu.m. in volume will be classified as Rock Excavation.

Common Excavation

Common Excavation includes all material other than Rock Excavation and stripping materials. All boulders or detached pieces of solid rock less than 1 cu.m in volume will be classified as Common Excavation.

3.3.2 Fill Materials

All materials placed shall conform to the specifications of the various material as set out herein. The descriptions of fill materials Class I, Class II, Class III, Class IV and Class V are given to allow the Contractor to determine suitable excavation, hauling, placing and compaction procedure and equipment. Class I materials shall be excavated from Borrow Areas "A", "B", "C" and "D" and used as the thermal liner or as filter. Class II and Class III materials shall be obtained from the thawed canal waste excavation materials and used as the canal seepage control liner fill and canal dyke fill respectively.

Class IV and Class V materials shall be excavated from quarries approved by the Engineer and developed by the Contractor at his expense or from any other areas which may supply any part of the necessary materials volume. Materials processing may be required to obtain the specified materials gradations and such processing shall also be at the Contractor's expense. Class IV materials will be used for the filter rock and main channel riprap rock. Class V materials will be used for the erosion control lining and rock drop weirs in the 5 percent invert grade outfall segments of the canal.

All materials placed as fill shall be placed without segregation and compacted where required in accordance with the specifications herein.

3.3.2.1 Gradations:
The following gradation limits shall apply for the fill types to be included in the construction.

Class I - Canal Thermal Liner and Filter

U.S. Standard Sieve Size	Minimum Percent by Weight Passing	Maximum Percent by Weight Passing
6 in.	70	100
1 1/2 in.	60	95
No. 4	30	70
No. 40	8	35
No. 200	0	10

Class II - Canal Seepage Control Liner
It is intended that this material shall be obtained from selected canal waste excavation materials. The material shall be broadly graded but not gap graded and contain a minimum of 15 percent passing a U.S. Standard sieve size No. 200. The material shall generally range between clay size and 100 mm diameter. Boulders and cobbles in excess of 150 mm diameter will not be permitted as fill for the seepage control liner.

Class III - Canal Dyke Fill
The material shall be obtained from selected canal waste excavation materials. The material will be broadly graded and contain a minimum of 10 percent passing a U.S. Standard sieve size No. 200. Except in the canal outfall area the material shall generally range between clay size and 100 mm diameter. Boulders in excess of 500 mm diameter shall not be permitted as fill.

Class IV - Filter Rock and Channel Riprap

Diameter in mm	Percent by Weight Passing
210 to 300	100
180 to 210	50
120 to 180	15

Class V - Outfall 5 percent grade Erosion Control Rock

Diameter in mm	Percent by Weight Passing
880 to 1250	100
730 to 880	50
520 to 730	15

It is intended that Class IV and Class V materials shall be obtained from shot rock from the same quarry by gradation processing or by controlled blasting. Other sources of Class IV or Class V materials may be used only if approved by the Engineer.

Gradation tests will be performed by the Engineer according to standard procedures. All tests will be conducted on unfrozen materials. The presence of visible ice within shot rock shall be sufficient fact for rejection of such rock unless the Contractor can demonstrate to the satisfaction of the Engineer that upon thaw such rock particles satisfy the gradation specifications.

Furthermore, all Class IV and Class V material must remain intact when handled in a thawed condition and must not be susceptible to breakdown by slaking or short term weathering as determined by the Engineer.

Notwithstanding the above, the gradation of the material in place will be the basis of the Engineer's approval.

3.4 BORROW AREAS

3.4.1 The borrow areas shown on Drawing No. 7922025-1 are approved as sources of borrow material for the work. Sources other than those specified will be permitted subject to the approval by the Engineer.

Class I Material	- Borrow Areas "A", "B", "C" and "D" and the Test Excavation (see Section 3.2.8).
Class II and III Materials	- Select canal waste excavation materials.
Class IV and V Materials	- Quarry areas, developed by the Contractor. If required, materials processing shall be performed.

3.4.2 The Contractor shall organize his activities such that the excavation of Class I material from the available sources of such material together with the excavation and borrow activities of items other than the canal, will result in the foundation preparation necessary as determined by the Engineer and the schedule to construct:

(i) the upstream blanket of the Cross Valley Dam as shown on Drawing Nos. 7922025-8 and 7922025-9.

(ii) the upstream slope core of the Intermediate Dam as shown on Drawing Nos. 7922025-11.

If materials are encountered in these areas which are unsuitable for use as fill elsewhere and the Contractor is directed by the Engineer to excavate such materials, the work shall be performed in accordance with to Article 24 of the General Conditions.

3.4.3 The Contractor shall be required to develop the borrow areas as required by the Engineer to ensure reasonable fill uniformity. If required the depth of cut shall be adjusted in various areas of the borrow pit to combine appropriate amounts of fine and coarse grained materials.

3.4.4 The Contractor shall reasonably control his activities such that survey monuments used by the Engineer within the boundaries of the borrow areas are not disturbed.

3.4.5 The Contractor shall control his activities in Borrow Area "D" so that the canal wall remains intact and is not undermined to the satisfaction of the Engineer.

3.5 PAYMENT ITEM 3 (a) - CLEARING OF CANAL AREA

3.5.1 Work Description

Clearing shall mean the complete removal and disposal of all trees, shrubs, logs, loose stumps, loose moss, snow, ice and other objectionable material within the area generally defined as canal clearing on Drawing No. 7922025-1. All trees falling outside the area required by the Engineer to be cleared shall be brought back into the cleared area and disposed of with the other clearing debris. Snow and ice removal required after the initial clearing shall be included in this item. All clearing debris shall be piled at the downhill edge of the designated limit of canal clearing. NO burning of cleared debris will be permitted nor will clearing beyond the designated limit of canal clearing be allowed unless expressly approved by the Engineer. No firebreak will be permitted outside the area requierd to be cleared by the Engineer unless expressly approved by the Engineer. Notwithstanding anything else herein contained, the Contractor will be held responsible for all damage resulting from unauthorized activity outside the designated limits of canal clearing and shall rectify such damage by placing thermal protection fills at his own expense to the satisfaction of the Engineer.

3.5.2 Method of Measurement

The quantity of clearing to be paid for will be determined by computing the area actually cleared by the Contractor as required by the Engineer. Areas already cleared will not be included in the area for payment. The area determined for payment will be made on the basis of horizontal measure.

3.5.3 Basis of Payment

Payment for clearing will be made at the unit price bid per hectare under Item 3 (a) shown on the Schedule of Quantities and

Prices. This price shall include the cost of all labour, plant and small tools required to clear the canal area as directed by the Engineer and to dispose of all waste material as specified herein.

No payment will be made for clearing haul roads or other areas cleared by the Contractor outside the areas specifically required by the Engineer to be cleared.

3.6 PAYMENT ITEM 3(b) - GRUBBING AND STRIPPING OF CANAL DYKE FOUNDATION AND EXCAVATION AREA

3.6.1 Work Description

Grubbing shall mean the entire removal and disposal of all stumps, roots, embedded logs and other buried debris from the canal excavation and dyke foundation areas as generally shown on Drawing No. 7922025-7. Stripping shall mean the excavation and removal of all organic debris, moss, organic brown silt, volcanic ash and near-surface ice rich debris to the satisfaction of the Engineer from the canal excavation and dyke foundation areas also shown on Drawing No. 7922025-7. All grubbing and stripping waste shall be removed to the downslope cleared area adjacent to the clearing debris and as such will form the toe of the canal waste excavation pile.

3.6.2 Method of Measurement

The quantity of materials to be paid for will be determined by computing the volume of in-place grubbing and stripping material based on a pre-construction survey performed in July and August, 1980 and on a survey to be conducted following stripping.

3.6.3 Basis of Payment

Payment for grubbing and stripping of the areas required by the Engineer will be made at the unit price bid per cubic metre of excavated volume under Item 3(b) of the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate and remove the grubbing and stripping materials.

3.7 PAYMENT ITEM 3 (c) - COMMON EXCAVATION

3.7.1 Work Description

The work includes but shall not necessarily be restricted to the excavation, hauling and wasting of all Common Excavation materials to the lines and grades of the Drawings (see Section 3.2.9) and as directed by the Engineer. A 0.15 m tolerance will be permitted with reference to the lines and grades shown on the Drawings. The Contractor shall be required to excavate, haul and waste all Common Excavation materials such that Class II and Class III

III materials will be accessible as borrow materials for construction of the canal seepage control liner and the canal dyke in accordance with Section 3.2.3 of the Detailed Specifications. The materials shall be disposed of in the area generally designated as Canal Waste Pile on Drawing No. 7922025-7 except as provided in Section 3.8.

The Contractor shall control the Common Excavation work such that the downslope wall of the canal excavation is not unnecessarily ripped or overexcavated beyond the specified tolerances.

3.7.2 Method of Measurement

Provided that no Rock Excavation is encountered the quantity of Common Excavation to be paid for will be determined by computing the in- place volume of excavated material between the base of the stripping and grubbing and the neat lines of the excavation as directed by the Engineer. Where Rock Excavation is required, the quantity of Common Excavation to be paid for will be determined by computing the in-place volume of excavated material between the base of the stripping grubbing, the surveyed Rock surface and the neat line boundaries of the Common Excavation materials.

3.7.3 Basis of Payment

Payment for excavation, hauling and wasting of Common Excavation materials will be made at the unit price bid per cubic metre of excavated volume as shown under Item 3 (c) of the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, haul and waste the Common Excavation materials. No payment will be made for overexcavation unless expressly approved by the Engineer.

3.8 PAYMENT ITEM 3 (d) - UPSTREAM BLANKET - CROSS VALLEY DAM

3.8.1 Work Description

The work includes but shall not necessarily be restricted to the hauling and placing of the upstream blanket for the Cross Valley Dam as generally shown on Drawing No. 7922025-8 and 7922025-9 and as required by the Engineer. Where the upstream blanket may not be installed due to Rose Creek flow, sufficient material shall be stockpiled adjacent to the area to be completed as directed by the Engineer.

The material shall be obtained from select Common Excavation materials as required by the Engineer resulting from canal excavation between baseline chainages 2+000 and 3+000 of the DiversionCanal.

All materials excepting those stockpiled shall be placed in 0.15 m maximum thickness lifts and compacted as much as possible using the hauling equipment. Fill materials shall not contain any snow or ice debris. Snow and ice must be removed from the fill surface to the satisfaction of the Engineer. Construction operations

will be permitted if snowfall is occurring and the snowfall is deemed by the engineer not to detract from the fill quality.

3.8.2 Method of Measurement

The quantity of material to be paid for under this item will be based on surveys conducted to determine the excavated in-place volume of Common Excavation materials hauled from the canal excavation to construct the Cross Valley Dam upstream blanket.

3.8.3 Basis of Payment

Payment for the hauling and placement or hauling and compaction of the Cross Valley Dam upstream blanket will be made at the unit price bid per cubic metre of in-place Common Excavation material taken from the canal for construction of the Cross Valley Dam upstream blanket as shown under Item 3 (d) of the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to haul, level and place the Cross Valley Dam upstream blanket. No payment will be made for the excavation of the required materials other than provided for under Item 3 (c). Notwithstanding anything herein contained the payment described herein is intended only to compensate the Contractor for having to dispose of canal waste excavation materials in the Cross Valley Dam upstream blanket area instead of disposal in the Canal Waste Pile as provided for in Section 3.6. No separate payment will be made for overhaul.

3.9 PAYMENT ITEM 3 (e) - CANAL ROCK EXCAVATION

3.9.1 Work Description

The work includes but shall not necessarily be restricted to the excavation, hauling and wasting in the designated canal waste pile area of all Rock Excavation within the configuration of the cross-sections and grade lines as generally shown the Drawings and as directed by the Engineer. A 0.3 m tolerance will be permitted to the lines and grades shown on the Drawings.

3.9.1.1 General

The seepage integrity of the canal excavation will depend to some degree upon the existing jointing and crack system in the rock and will be influenced greatly by the procedures of blasting used. Consequently, the Contractor shall carefully control all blasting by limiting the size and type of the charges in accordance with these specifications, varying the size and spacing of drill holes, using delays, and such other controls as may be reasonably required by the circumstances to preserve the rock beyond the neat lines and grades of the excavation in the soundest possible conditon.

Trial blasts shall be conducted as required by the Engineer at the start of the work, and at other times when the rock and/or dimensions of the blasts change, to determine the optimum drill hole

layout, explosive loads and delay sequences. The specifications below shall be used as a guideline in determining the optimum procedure.

The Contractor shall submit to the Engineer for review full details of the drilling and blasting patterns and controls he proposes to use in areas of Rock Excavation not less than three (3) days prior to commencing excavation. The Contractor shall not commence excavation until his drilling and blasting patterns and controls have been reviewed and approved in writing by the Engineer.

If, in the opinion of the Engineer, the methods of excavation adopted by the Contractor are unsatisfactory in that they result in an excessive amount of excavation and/or rock damage beyond the minimum lines and grades or that they fail to satisfy the requirements specified elsewhere in these specifications, then, notwithstanding the Engineer's prior review of such methods, the Contractor shall adopt such revised methods, techniques and procedures as are necessary to achieve the required results.

3.9.1.2 Rock Excavation Slopes

To ensure that final slopes are stable, controlled blasting shall be used to minimize the damage to the rock behind the faces. The following specifications describe the general method of blasting to be used on final slopes with heights greater than 2 m. The optimum procedure, which may vary at different locations on the site, shall be determined from trial blasts.

All rock slopes shall be cut at an overall angle of 0.5 horizontal to 1 vertical unless otherwise specified.

3.9.1.3 Controlled Blasting Terminology

These specifications, in part, provide for the use of final line holes, buffer holes, production holes, maximum charges, and blasting delays to achieve the specified blasting control for the slopes. Explanations of these terms are as follows:

(i) Final line holes - holes drilled at close spacing (10 to 15 times the hole diameter) on the final face line which, when appropriately loaded and fired, will produce a relatively smooth final wall.

(ii) Buffer holes - a line of holes of spacing intermediate between the spacing of the final and production holes, separating the final line holes from the production (main pattern) holes. Their function, when moderately loaded in relation to the production holes, is to protect the final face area by more uniformly distributing the blasting agent within the rock mass adjacent to the final face.

(iii) Production holes (main pattern holes) - these holes are drilled in the main body of rock to be blasted. Their spacing and charging is related to the quantity of explosive permitted per delay, and the degree of rock breakage desired.

(iv) Maximum charge - that amount of explosive agent which may be detonated by a single detonation impulse.

3.9.1.4 Final Line Blasting

The Contractor shall use controlled blasting on the line of the design cut slope face.

(i) Blast holes and timing in detonation sequence - "Controlled Blasting" shall mean the technique of carefully drilling the final line of holes on the plane of the final cut slope required. Each hole of the final line shall be loaded with an explosive charge "de-coupled" from the blast hole wall with a centering sleeve. The holes shall be fired simultaneously, and either first or last in the delay sequence to create a crack along the plane of the final rock surface.

(ii) Alignment and depth of holes in the final line - the final line of holes shall be on the line of the final face and the spacing shall be as uniform as possible, and the diameter of these holes shall not be greater than 65 mm (2 1/2 inches). The bottoms of final line holes shall not be positioned at a higher elevation than the bottoms of adjacent production blast holes. The depth of the final line holes shall be limited to 10 m.

(iii) Explosives - the hole spacing and amount of explosive in the final line of holes may require adjusting, depending on surface quality and integrity of the exposed rock surface and conditions encountered during the progress of the work. Water resistant explosives shall be used if required for some of the work.

3.9.1.5 Main Pattern and Buffer Blasting

(i) Buffer holes and charges - the line of buffer holes shall be parallel to the final line of holes and shall be the same diameter as in the holes of the final line. The amount of explosives per hole shall be less that the explosive used per production hole contained in the main pattern.

(ii) Main pattern holes and loading - the main production blasting shall use 38 to 75 mm (1 1/2 to 3 inch) diameter holes laid out to detonate in a delay sequence employing the criteria of loading and maximum charge per detonation given in Maximum Charges and Delays, Section 3.9.1.6, following. Detonation shall be toward a free face perpendicular to the centreline of the cut. The maximum depth of a main pattern blast hole shall be 10 m.

3.9.1.6 Maximum Charges and Delays

(i) Maximum charges - vibrations generated by detonation of charges for both the final line and main pattern blasting shall be controlled by use of delays to minimize damage to the surrounding rock. The Contractor shall advise the Engineer in sufficent time ahead of each blast to provide the Engineer with an opportunity to monitor the vibrations from the blast if requested by the Engineer.

(ii) Design of delays - delay sequencing for multiple shots shall be accomplished through the use of short period delays of the type appropriate to the method of fusing adopted.

3.9.1.7 The foreman or foremen who supervise the work described in this Item shall have a minimum of two years experience in similar work. The qualifications of the intended foreman or foremen shall be included on Contract Schedule E, Proposed Supervisory Personnel. Licensed blasters shall be employed for the setting and detonation of all charges, and for the control and carriage of all blasting agent. Appropriate Yukon Territory laws shall be followed concerning the carriage, handling and storage of all blasting materials.

3.9.2 Method of Measurement

The quantity of Rock Excavation to be paid for will be determined as the in-place volume between the surveyed rock surface and the neat lines of the Rock Excavation as directed by the Engineer. Where controlled blasting is required by the Engineer, the face area of the rock excavation sideslopes will also be measured as an additional quantity for payment.

3.9.3 Basis of Payment

Payment for excavation, hauling and wasting of all canal Rock Excavation will be made at the unit price bid per cubic metre as shown under Item 3(e)(i) as shown on the Schedule of Quantities and Prices. Additional payment for controlled blasting will be made at the unit price bid per square metre as shown under Item 3(e)(ii). These prices shall include the cost of all materials, labour, plant and small tools required to perform the work as specified herein. No payment will be made for excavation beyond the neat lines of Drawing No. 7922025-7 unless expressly directed otherwise by the Engineer. Furthermore, no payment will be made for any additional excavation beyond the neat lines of the excavation as required by the Engineer to remove dangerous loosened rock or rock which must be excavated to allow installation of a seepage control liner where blasting methods approved by the Engineer are not followed or unapproved blasting methods are used.

3.10 PAYMENT ITEM 3(f) - THERMAL LINER AND CANAL DYKE CLASS I ZONES

3.10.1 Work Description

The work includes but will not necessarily be restricted to the excavation of Class I materials from approved borrow areas according to the provisions of Section 3.4, the hauling of these

materials, and their placement and compaction to the lines and grades respecting thermal lining and canal dyke gravel zones as shown on Drawing No. 7922025-7 as directed by the Engineer. A 0.15 m tolerance will be permitted to the lines and grades shown on Drawing No. 7922025-7 except that the Contractor shall not be required to place greater thicknesses of thermal lining than those shown on Drawing No. 7922025-7. In respect of the thermal lining, excess fill beyond the specified tolerance as determined by the Engineer shall be removed to ensure that the canal provides the designed hydraulic capacity.

Placement and Compaction

The Class I fill shall be placed in continuous horizontal loose lifts having a thickness of not greater than 0.3 m and such that unnecessary segregation of coarse materials near the canal excavation face or fill foundation does not occur. The Class I fills shall be placed and compacted in accordance with the provisions of Section 3.2.4 and all other applicable provisions of Section 3.2.

The fills shall be compacted using a minimum of 4 passes of the type of compactor specified in Section 3.2.4 (ii) per 0.3 m thick loose lift.

3.10.2 Method of Measurement

The quantity of materials to be paid for in the case of the thermal liner will be determined by calculating the in-place volume bounded by the canal excavation neat line boundary, the inside neat line boundary of the thermal liner both as shown on the cross-sections or combination of cross-sections on Drawing No. 7922025-7 and the limits of application of the thermal liner as directed by the Engineer.

In the case of the canal dyke gravel zones, the quantity of materials to be paid for will be determined by calculating the in-place volume of Class I material bounded by the thermal liner, the surveyed, stripped and grubbed ground surface and the neat lines of the canal dyke gravel zone configurations as shown on Drawing No. 7922025-7. Measurements will be performed by the Engineer as soon as possible after placement and compaction.

3.10.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class I fill required under the specifications of this Item will be made at the unit price bid per cubic metre in place under Item 3 (f) of the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul. No payment will be made for removal of excess fill materials as necessary to provide the canal design hydraulic capacity.

3.11 PAYMENT ITEM 3 (g) - SEEPAGE CONTROL LINER CLASS II

3.11.1 Work Desicription.

A seepage control liner will be required by the Engineer where pervious soil materials or fractured and broken rock form the boundaries of the excavated cross-section of the canal.

The work includes but shall not necessarily be restricted to the excavation, hauling, placement and compaction of Class II materials to the lines and grades of the cross-sections shown on Drawing No. 7922025-7 and as directed by the Engineer. A seepage control liner may not be required over the full boundary of the excavation at a given chainage in which case the constructed cross-section will be a combination of the cross-sections shown on Drawing No. 7922025-7. A 0.15 m tolerance will be permitted to the lines and grades shown on Drawing No. 7922025-7 except that the Contractor shall not be required to place greater thicknesses of seepage control lining than those shown on Drawing No. 7922025-7. Excess fill beyond the specified tolerance as determined by the Engineer shall be removed to ensure that the canal provids the desired hydraulic capacity.

Placement and Compaction

The fill shall be placed in continuous horizontal loose lifts having a thickness of not greater than 0.3 m and such that unnecessary segregation of materials within the fill does not occur. The seepage control liner will be placed in accordance with the provisions of Section 3.3.2 and all other applicable provisions of Section 3.2.

The seepage control liner fill shall be compacted to 100 percent of the standard Proctor maximum dry density as measured according to the procedure outlined in ASTM D698, corrected for oversize if appropriate. The moisture content of the fill shall be controlled such that the above compaction standard may be achieved with suitable equipment.

No allowance will be made for settlement occurring within the foundation, the excavated sideslopes or other fill materials.

3.11.2 Method of Measurement

The quantity of materials to be paid for will be determined by calculating the volume bounded by the canal excavation neat line, the inside neat line boundary of the seepage control liner both as shown on the cross section or combination of cross sections on Drawing No. 7922025-7 and the limits of application of the seepage control liner as directed by the Engineer.

3.11.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class II fill required to construct the seepage control liner as specified herein will be made at the unit price bid per cubic metre in place under Item 3 (g) as shown on the Schedule of

Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul. No payment will be made for removal of excess fill materials as necessary to provide the canal design hydraulic capacity.

3.12 PAYMENT ITEM 3 (h) - FILTER GRAVEL CLASS I

3.12.1 Work Description

The work includes but shall not necessarily be restricted to the excavation of Class I materials from approved borrow areas according to the provisions of Section 3.4, the hauling of these materials, and their placement and compaction to the lines and grades shown on Drawing No. 7922025-7. A 0.15 m tolerance will be permitted to the lines shown on the Drawing excepting that a minimum thickness of 0.3 m of filter shall be provided when measured perpendicular to the filtered slope face and that the Contractor shall not be required to place greater thicknesses of filter gravel than 0.3 m.

Placement and Compaction

The fill should be placed in two (2) 0.15 m thick lifts and such that unnecessary segregation of coarse materials is prevented.

The appropriate provisions of section 3.2 shall apply to the placement and compaction of the fill excepting that compaction of the material described herein shall be performed using a crawler-type tractor. Each lift will be compacted by continuous coverage of the tracks of the equipment being used for placement.

3.12.2 Method of Measurement

The quantity of material to be paid for under this item will be determined by calculating the in-place volume of Class I material bounded by the seepage control liner or the canal excavation neat lines as appropriate and the neat line providing for the 0.3 m thickness of filter gravel. The quantity for payment will not include any excess material placed unless otherwise directed by the Engineer.

3.12.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class I material as required under the specifications of this item will be made at the unit price bid per cubic metre in place under Item 3 (h) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul.

3.13 PAYMENT ITEM 3 (i) - ROCK RIPRAP AND FILTER ROCK CLASS IV

3.13.1 Work Description

The work includes but shall not necessarily be restricted to the excavation, hauling and placement of all Class IV material required to riprap the canal and required as filter rock in the canal outfall to the lines and grades of the cross-sections shown on Drawing No.7922025-7. A tolerance of 0.15 m will be permitted to the neat lines shown on the drawing except that a minimum thickness of 0.5 m will be required and that the Contractor will not be required to place greater thicknesses than 0.5 m. In case of dispute, the surface of the riprap or filter rock will be assessed as that occurring at the base of the tracks of a crawler-type tractor with a net flywheel power rating between 210 and 240 KW or equivalent to the satisfaction of the Engineer.

Placement

The canal riprap and the canal outfall filter rock shall be placed in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the larger rock fragments to form a well keyed uniform layer of riprap of the specified thickness. Properly placed materials need not be compacted. The appropriate provisions of Section 3.2 shall apply.

3.13.2 Method of Measurement

The quantity of Class IV material to be paid for will be the in-place volume calculated between the neat lines of the canal thermal liner or filter gravel layer or the excavation boundary and the inside neat line boundary of the canal riprap or the neat line of the Class V Erosion Control Rock. The thickness measured perpendicular to the excavation face to be used for volume computation is 0.5 m.

3.13.3 Basis of Payment

Payment for excavation, hauling and placement of all Class IV materials as required in the specifications of this item will be made at the unit price bid per cubic metre in place under item 3 (i) of the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, haul, place and level the material. No separate payment will be made for overhaul. No separate payment will be made for any processing of rock materials required to obtain the specified Class IV gradation.

3.14 PAYMENT ITEM 3 (j) - CANAL DYKE FILL CLASS III

3.14.1 Work Description

The work includes but shall not necessarily be restricted to the excavation, hauling, placement and compaction of all Class III fill in accordance with the lines and grades of the cross-sections on Drawing No. 7922025-7. A 0.15 tolerance will be permitted to the lines and grades shown on the Drawing.

Placement and Compaction

The Class III fill shall be placed in continuous horizontal loose lifts having a thickness of not greater than 0.3 m and such that unnecessary segregation of coarse materials does not occur.

The fill shall be placed and compacted in accordance with the provisons of Section 3.2.3 and all other applicable provisions of Section 3.2.

The Class III canal dyke fill will be compacted to 100 percent of the Standard Proctor maximum dry density as measured according to the procedure outlined in ASTM D698, corrected for oversize if applicable. The moisture content of the fill shall be controlled such that the above compaction standard is achieved with suitable equipment.

No allowance will be made for settlement occurring within the foundation or other fill materials.

3.14.2 Method of Measurement

The quantity of Class III material to be paid for under the specifications of this item will be determined as the in-place volume bounded by the neat line cross-section configuration shown on Drawing No. 7922025-7 and the surveyed, grubbed and stripped surface of the canal dyke foundation. The survey of the grubbed and stripped foundation area will be completed when the stripping and grubbing is completed to the satisfaction of the Engineer. No allowance will be made for settlement or erosion of the dyke foundation area unless expressly approved by the Engineer.

3.14.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class III material as required in the specifications of this Item will be made that the unit price bid per cubic metre in place under Item 3 (j) as shown on the Schedule of Quantities and Prices. The price shall include the cost of all materials, labour, plant and small tools required to excavate, haul, place, level and compact the material. No separate payment will be made for overhaul.

3.15 PAYMENT ITEM 3 (k) - CANAL OUTFALL EROSION CONTROL CLASS V

3.15.1 Work Description

The Work includes but shall not necessarily be restricted to the excavation, hauling, and placement of all Class V material required to construct the erosion control lining and rock drip weirs in the canal outfall to the lines and grades of the cross-section shown on Drawing No. 7922025-7. A tolerance of 0.15 m will be

permitted to the neat lines shown on the Drawing. In case of dispute, the surface of the placed erosion control rock will be assessed as that occurring at the base of the tracks of a crawler type tractor with a net flywheel power rating between 210 and 240 KW or equivalent to the satisfaction of the Engineer.

Placement

The Class V material shall be placed in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the larger rock fragments to form a well keyed uniform layer of riprap of the specified thickness. Properly placed materials need not be compacted. The appropriate provisions of Section 3.2 shall apply.

3.15.2 Method of Measurement

The quantity of Class V material to be paid for will be the in-place volume calculated between the neat line boundary of the underlying filter rock and the inside neat line boundary of the canal channel as shown on Drawing No. 7922025-7. The quantity of Class V material required to construct the rock drop weirs will be included in the quantity for payment.

3.15.3 Basis of Payment

Payment for excavation, hauling and placement of all Class V material in accordance with the specifications herein will be made at the unit price bid per cubic metre in place under Item 3 (k) of the Schedule of Quantities and Prices. This price shall include the cost of all labour, plant and small tools required to excavate, haul, place and level the material. No separate payment will be made for overhaul. No separate payment will be made for processing rock materials to obtain the specified Class V gradation.

3.16 PAYMENT ITEM 3 (l) - FILTER ROCK AND EROSION CONTROL ROCK STOCKPILE

3.16.1 Work Description

The work includes but shall not be limited to the excavation, hauling and separate stockpiling of Class IV and Class V materials in the area designated as Emergency Rock Storage on Drawing No. 7922025-1. The materials will be piled to the satisfaction of the Engineer such that a minimal storage area is required.

The quantity of materials required is:

(i) 1000 cubic metres of Class IV material in one pile.

(ii) 2000 cubic metres of Class V material in a second pile.

3.16.2 Method of Measurement

The quantity of materials to be paid for will be determined by surveys of the stockpile foundations and the piled material.

3.16.3 Basis of Payment

Payment for excavation, hauling and stockpiling all Class IV and Class V materials to the specifications of this Item will be made at the unit price bid per cubic metre in place under Item 3 (1)(i) for Class IV materials and Item 3 (1)(ii) for Class V materials. These prices shall include the cost of all labour, plant and small tools required to produce, haul and stockpile the materials. No separate payment will be made for overhaul. No separate payment will be made for processing rock materials to obtain the specified gradations.

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

DETAILED SPECIFICATIONS

ITEM 4

DAMS

4.1 SCOPE

The work includes but shall not necessarily be limited to the following:

(i) The excavation, hauling and removal of all unsuitable organic and inorganic material from the foundation and abutment areas of the Cross Valley Dam, the Intermediate Dam and the Diversion Dam. Also the grubbing and stripping of the general foundation areas of the dams.

(ii) The excavation, hauling, placement and compaction of suitable materials to raise the foundation area of the dams to slightly above water level.

(iii) Construction above the local water table of a zoned dam herein referred to as the Cross Valley Dam.

(iv) Construction above the local water table of a zoned dam herein referred to as the Intermediate Dam.

(v) Construction of a zoned dam herein referred to as the Diversion Dam.

(vi) Construction of emergency spillways and decant channels at the North abutment of the Cross Valley Dam and at the South abutment of Intermediate Dam.

(vii) The reworking and compaction, if possible, of the Cross Valley Dam upstream blanket placed during winter.

It is intended that all work would be performed on a unit price basis excepting elements (i), (ii) and (vii) which would be paid for on an equipment rental basis.

4.2 General Provisons

4.2.1 The Contractor shall submit for the approval of the Engineer, details of his proposed methods of placing of materials and the sequence of operations to be followed. The Contractor shall be required to arrange his construction so as to make maximum use of the borrow materials. In the case of work conducted in accordance with Article 24 of the General Conditions, the Engineer and the Contractor shall agree on a procedure prior to commencement of the work and modify such procedure as necessary to expedite completion

of the work in such a manner which is compatible with the dam designs. The Contractor shall not be permitted to claim any delay resulting from the foundation prepartaion work for the Cross Valley and Intermediate Dams unless expressly approved by the Engineer.

4.2.2 All work shall be performed under continuous thawing temperature conditons unless otherwise stated herein or otherwise expressly directed by the Engineer. All construction performed under thawing temperature conditions must be in accordance with the following:

(i) Frozen material shall not be placed as fill.

(ii) Fill shall not be placed on frozen materials unless specifically approved by the Engineer.

(iii) Fill materials shall not be placed at temperatures which, in the opinion of the Engineer, will cause freezing of the material before it is adequately compacted.

(iv) Frozen crust or any accumulated snow and ice layers on the surface of the fills shall be removed by the Contractor or allowed to melt completely as directed by the Engineer prior to the placement of additional lifts.

4.2.3 Work which shall be completed during freezing conditons in whole or in part, as determined by the Engineer, includes but shall not be restricted to the following:

(i) The grubbing and partial stripping of the secondary upstream blanket foundation of the Cross Valley Dam.

(ii) Abutment preparation for the Intermediate and Cross Valley Dams.

(iii) Preliminary foundation preparation to the extent possible for the Cross Valley and Intermediate Dams.

4.2.4 Notwithstanding provisions for topsoil removal and grubbing, no fill materials shall contain organic contents in excess of 1 percent on an air dry weight basis when considering a representative 1 kg. sample.

4.2.5 The Contractor shall make allowance for the reasonable interruption of his activities by the Engineer for purposes of installation of monitoring instrumentation as deemed necessary by the Engineer. The Engineer will notify the Contractor at least seven (7) days in advance of such activity except when an emergency occurs as described in Article 16 of the General Conditions. The Contractor shall reasonably control his equipment so that any monitoring instrumentation is not destroyed.

4.3 MATERIALS

4.3.1 Placement and Compaction

Notwithstanding anything else herein contained within item 4, the fill shall be placed in continuous horizontal lifts and shall be placed and compacted to the lines and grades as shown on the drawings. A 0.15 m tolerance will be permitted, to that shown on the drawings.

All Class I, Class III, Class VI, and Class VII, Class VIII, Class IX and Class X fill shall be compacted to 100 percent of the standard Proctor maximum dry density as measured according to the procedure outlined in ASTM D698, corrected for oversize if appropriate. The Contractor shall be required to place the fill in loose lifts having a thickness of not greater than 0.3 m. The moisture content of the fill shall be controlled such that the above compaction standard may be achieved with suitable equipment.

It is intended that sections of fill will be tested to determine the number of passes of the compaction equipment, supplied by the Contractor, required to achieve the desired density. This data will be used to establish a procedural control of the compaction together with periodic in situ density tests.

No allowance will be made for settlement occuring within the foundation or fill soils.

All new fill must be blended with ground contours at the embankment abutments and adequately compacted subject to the Engineer's approval.

4.3.2 Excavation Materials

Foundation subexcavation shall be required in the immediate Rose Creek vicinity of the Intermediate Dam foundation, the bulk of the Cross Valley Dam foundation and the abutments of both of these dams. Most of these materials consist of recent alluvium ranging in gradation from cobbles and boulders in the current creek bed to fine sands and silts. Organic material is often mixed in with such material. Limited amounts of permafrost shall be removed as required by the Engineer.

Foundation subexcavation shall also be required for the Diversion Dam in the existing diversion canal area to remove the rock erosion control liner material which has a gradation similar to Class V material described in section 3.3.2. In addition, all loose recently deposited alluvium in the bottom of the canal and within the Diversion Dam foundation area must be removed. All loose debris in other areas of the Diversion Dam foundation area must similarly be removed.

4.3.3 Fill Materials

All materials placed shall conform to the specifications of the various materials as set out herein.

The descriptions of fill materials Class VI, Class VII, Class VIII, Class IX and Class X are given to allow the Contractor to determine suitable excavation, hauling, placing and compaction procedure and equipment. Class IV and Class V materials are specified in section 3.3.2 of the Detailed Specifications. Class IV and Class V materials shall be obtained from quarries developed by the Contractor and shall be used as erosion protection for the dam spillways and decant channels. Class VII materials may be excavated from Borrow Areas "E", "F", and "G" and used as upstream shell material and upstream foundation preparation. Class VIII material generally may be obtained from Borrow Areas "A", "B", "C" or "D" and used as downstream shell material. Class IX and Class X material may be obtained by selective borrow from Borrow Areas "A", "B", "C" or "D" and used as upstream and downstream core filters respectively.

All materials placed as fill shall be placed and compacted where required in accordance with the specifications herein.

4.3.3.1 Gradations

The following gradation limits apply for the fill types to be included in the construction.

Class VI Dam Core

It is intended that these materials will be obtained from Borrow Areas "E" and "F". Some selection of materials shall be required to obtain the following gradation.

U.S. Standard Sieve Size	Minimum Percent by Weight Passing	Maximum Percent by Weight Passing
2 inch	85	100
3/4 inch	80	100
No. 10	55	85
No. 60	30	60
No. 200	20	50

Boulders and cobbles in excess of 150 mm diameter shall not be permitted as Class VI fill.

Class VII Upstream Shell or Upstream Foundation Preparation

These materials may be obtained from Borrow Areas "E", "F" and "G". This material classification includes some materials of Class VI gradation. The Contractor shall conserve areas in the borrow pits where Class VI is available until such time as it is apparent that adequate Class VI material is available for the construction to the satisfaction of the Engineer.

The range of Class VII gradations is as follows:

U.S. Standard Sieve Size	Minimum Percent by Weight Passing	Maximum Percent by Weight Passing
2 inch	80	100
3/4 inch	65	100
No. 10	25	80
No. 60	15	45
No. 200	10	30

Class VIII Downstream Shell

These materials may be obtained from Borrow Areas "A", "B", "C" or "D". The specified material gradation shall be as follows:

U.S. Standard Sieve Size	Minimum Percent by Weight Passing	Maximum Percent by Weight Passing
6 inch	70	100
1 1/2 inch	40	95
No. 4	15	70
No. 40	0	35
No. 200	0	15

Class IX Upstream Filter

These materials may be obtained from select borrow of Borrow Areas "A", "B", "C" or "D". In general the materials should be sands to silty sands with less than 30 percent by weight passing the No. 200 U.S. Standard Sieve size.

Class X Downstream Filter

These materials may be obtained from select borrow of Borrow Areas "A", "B", "C" or "D" and will consist of clean sand and gravel with less than 2 percent by weight passing the No. 200 U.S. Standard Sieve size. At least 80 percent of the material by weight shall pass the 2 inch U.S. Standard Sieve size.

Gradation tests will be performed by the Engineer. The Contractor shall develop the borrow area as required by the Engineer to ensure reasonable soil uniformity. If required by the Engineer the Contractor shall adjust the depth of cut in various areas of the borrow pit to combine appropriate amounts of fine and coarse grained soils as required to produce an acceptable fill material.

4.4 BORROW AREAS

4.4.1 The borrow areas shown on Drawing No. 7922025-1 are approved as sources of borrow materials required for the work. Sources other than those specified will be permitted subject to approval by the Engineer.

Class IV and V Materials	- Quarry Areas, developed by the Contractor. Gradation processing shall be undertaken if required.
Class VI	- Borrow Areas "E", "F"
Class VII	- Borrow Areas "E", "F", "G"
Class VIII, IX, X	- Borrow Areas "A", "B", "C", "D"

4.4.2 The Contractor shall reasonably control his activities such that survey monuments used by the Engineer within the boundaries of the borrow areas are not disturbed.

4.5 PROVISONAL ITEM 4 (a) - DAM FOUNDATION SUBEXCAVATION

4.5.1 Work Description

The work includes but shall not be restricted to the excavation and removal to disposal dumps designated by the Engineer of all organic debris, ice rich soils, loose material and mixtures of such materials as occur in the vicinity of the current Rose Creek channel area of the Intermediate Dam foundation area and in the general valley bottom area of the Cross Valley Dam foundation. The limits of excavation materials by the Engineer. It is anticipated that required depths of excavation could be as much as 3 m below Rose Creek water level. It is also anticipated that about 2000 cubic metres of permafrost excavation may be required. Some above water removal of materials will be possible in certain areas.

The work also includes the abutment preparation of the Cross Valley Dam, the Intermediate Dam and the Diversion Dam, the grubbing and partial stripping for the secondary upstream blanket foundation area of the Cross Valley Dam. Snow shall be removed during the placement of the secondary blanket as directed by the Engineer.

The work also includes diversion of surface streams and possibly Rose Creek to ensure a maximum dry excavation in the required areas and continuous operation of equipment so that the foundation preparation may be completed as soon as possible.

The Contractor shall supply a minimum pumping capacity of 0.22 cubic metres per sec. (3000 igpm) for the express purpose of dewatering dam foundation subexcavations for the time in which such work is scheduled to attempt to dewater the foundation subexcavation as much as possible so that the excavation may be inspected as thoroughly as possible.

Removal of recent alluvium and erosion control rock in the foundation area of the Diversion Dam where it crosses the existing canal will be required. The erosion control rock has a gradation similar to the Class V material described in section 3.3.2.

The Contractor and the Engineer shall carefully plan the excavation methods together and formulate work schedules which are compatible with the other ongoing construction work and with the time of substantial completion. Methods of excavation and general procedure will be reviewed by the Engineer, but notwithstanding such review, the Engineer may reject parts of the work if the final product of the work is unsatisfactory to him.

4.5.2 Method of Measurement

The quantity of work to be paid for will be based on the number of hours required to complete the work as directed by the Engineer in accordance with the procedure defined in Article 24, part (f) of the General Conditions.

4.5.3 Basis of Payment

Payment will be made on a substantiated expenditure basis in accordance with the provisions of Article 24, part (f) of the General Conditions of these specifications.

4.5.4 Schedule Provisional Item 4 (a)

A provisional sum of $1,100,000 is stated on the Schedule of Quantities and Prices for Item 4 (a) to allow a more realistic appraisal of total Contract Price. This indicated sum is a preliminary estimate and does not constitute the actual amount to be paid.

4.5.5 Tenderer's Proposed Procedure

The Tenderer must submit on Schedule J a list of equipment which he plans to make available for the work herein described. The Tenderer shall submit details of his proposed procedure for performing the work as defined herein. Such procedure will not necessarily be the one adopted for performing the work.

4.6 PROVISIONAL ITEM 4 (b) - DAM FOUNDATION SUBEXCAVATION BACKFILL

4.6.1 Work Description

4.6.1.1 Intermediate Dam and Cross Valley Dam Areas

The work includes but shall not be restricted to the excavation, hauling, placement and compaction of all Class VI, Class VII, and Class X materials required to raise the foundation area of the dams from the base of excavation to an elevation such that the fill can be placed in compacted lifts in the dry. The fills shall be placed to the lines and grades of the cross-sections shown on Drawing Nos. 7922025-9 and 7922025-11. The work also includes the reworking and compaction, if possible, of the upstream blanket materials placed during winter conditions.

4.6.1.2 Diversion Dam

The work includes but is not restricted to the placement of a rockfill and development of an essentially water tight dam upstream of this rockfill using wet construction methods. The rockfill material shall be obtained from the removal of the rock erosion liner and rock weirs resulting from the foundation

preparation for the Diversion Dam. Other materials to be excavated, hauled, and placed are generally Class I and Class III materials as described under Item 3. The intended general cross-section of the Diversion Dam is shown on Drawing No. 7922025-12. The foundation preparation fill will be considered complete when the elevation of the fill is such that the fill may be placed in compacted lifts.

4.6.1.3 Placement and Compaction

The fills shall generally be placed by end dumping or side casting. The fill shall be placed so as to minimize the settlement which will occur after the fill is in place. A dozer shall be required to advance the working face of the fill by dozing materials downwards to the base of the excavation thereby displacing any loose debris or sludge as may sediment on the base of the prepared excavation. The Contractor shall remove such sludge by dredging or pumping as required by the Engineer.

The fills shall be compacted as much as possible by construction traffic and placing activities during placement of the foundation preparation fill lift which shall be up to 3 m in thickness.

4.6.2 Method of Measurement

The quantity of work to be paid for will be based on the number of hours required to complete the work as directed by the Engineer in accordance with the procedure defined in Article 24, part (f) of the General Conditons.

4.6.3 Basis of Payment

Payment will be made on a substantiated expenditure basis in accordance with the provisions of Article 24, part (f) of the General Conditions of these specifications.

4.6.4 Schedule Provisonal Item 4 (b)

A provisional sum of $1,100,00 is stated on the Schedule of Quantities and Prices for Item 4 (b) to allow a more realistic appraisal of total Contract Price. The indicated sum is a preliminary estimate and does not constitute the actual amount to be paid.

4.6.5 Tenderer's Proposed Procedure

The Tenderer shall submit with his tender on Schedule J a list of equipment which he plans to make available for the work described herein. The Tenderer shall also submit details of his proposed procedure for performing the work as described herein on Schedule J. Such procedure will not necessarily be the one adopted for performing the work.

4.7 PAYMENT ITEM 4 (c) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF CLASS VI MATERIAL FOR DAM CONSTRUCTION

4.7.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement, and compaction of all Class VI materials required to construct the cores of the Cross Valley and Intermediate Dams to the lines and grades shown on Drawing Nos. 7922925-9 and 7922025-11. A 0.15 m tolerance will be permitted to the lines of these drawings.

Placement and compaction of the materials shall be in accordance with the provisions of section 4.3.

4.7.2 Method of Measurement

The quantity of Class VI material to be paid for will be the calculated in-place volume bounded by the neat line boundaries of the fill as shown on Drawing Nos. 7922025-9 and 7922025-11 and the surveyed surface of the foundation subexcavation backfill.

No allowance will be made for settlement of the foundation subexcavation backfill, the foundation or any other fill or in situ material.

4.7.3 Basis Of Payment

Payment for excavation, hauling, placement and compaction of all Class VI material in accordance with the specifications contained herein will be made at the unit price bid per cubic metre in place made under Item 4 (c)(i) Cross Valley Dam and 4 (c)(ii) Intermediate Dam on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul.

4.8 PAYMENT ITEM 4 (d) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF CLASS VII MATERIAL FOR DAM CONSTRUCTION

4.8.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement, and compaction of all Class VII material required to construct the Cross Valley and Intermediate Dams to the lines and grades shown on the Drawing Nos. 7922025-9 and 7922025-11. A 0.15 m tolerance will be permitted to the lines and grades shown on these drawings.

Placement and compaction of the materials shall be in accordance with the provisions of section 4.3. The Contractor shall organize his placement such that the finer Class VII materials are placed adjacent to the core and upstream filter. The Contractor shall place cobble and boulder size materials at the upstream boundary of the Cross Valley Dam in the upper 3 m of the dam cross-section. The Contractor shall place the fill such that segregation of materials within the fill does not occur.

4.8.2 Method of Measurement

The quantity of Class VII material to be paid for will be the calculated in-place volume bounded by the neat line boundaries of the fill as shown on Drawing Nos. 7922025-9 and 7922025-11 and the surveyed surface of the foundation subexcavation backfill.

No allowance will be made for settlement of the foundation subexcavation backfill, the foundation or any other fill or in situ material.

4.8.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class VII material in accordance with the specifications contained herein will be made at the unit price bid per cubic metre in place under Item 4 (d)(i) Cross Valley Dam and 4 (d)(ii) Intermediate Dam as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant, and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul.

4.9 PAYMENT ITEM 4 (e) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF CLASS VIII MATERIAL FOR DAM CONSTRUCTION

4.9.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement, and compaction of all Class VIII materials required to construct the Cross Valley and Intermediate Dams to to the lines and grades shown on Drawing Nos. 7922025-9 and 7922025-11. A 0.15 m tolerance will be permitted to the lines and grades on these drawings.

Placement and compaction of the materials shall be in accordance with the provisons of section 4.3. The Contractor shall organize his placement such that the finer Class VIII materials are placed in the interior of the fill. The Contractor shall place the fill such that segregation of materials within the fill does not occur.

4.9.2 Method of Measurement

The quantity of Class VIII materials to be paid for will be the calculated in-place volume bounded by the neat lines boundaries of the fill as shown on Drawing Nos. 7922025-9 and 7922025-11 and the surveyed surface of the foundation subexcavation backfill.

No allowance will be made for settlement of the foundation sub-excavation backfill the foundation or any other fill or in situ material.

4.9.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class VIII materials in accordance with the specifications contained herein will be made at the unit price bid per cubic

metre in place under Item 4 (e)(i) Cross Valley Dam and 4 (e)(ii) Intermediate Dam as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material.

No separate payment will be made for overhaul.

4.10 PAYMENT ITEM 4 (f) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF CLASS IX MATERIAL FOR DAM CONSTRUCTION

4.10.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement, and compaction of all Class IX materials required to construct the Cross Valley and Intermediate Dams to the lines and grades shown on Drawing Nos. 7922025-9 and 7922025-11. A 0.15 m tolerance will be permitted on the lines and grades on these drawings.

Placement and compaction of the materials shall be in accordance with the provisons of section 4.3. The Contractor shall place the fill such that segregation of materials does not occur particularly at the boundaries of the fill where compatibility with adjacent materials is necessary.

4.10.2 Method of Measurement

The quantity of Class IX materials to be paid for will be the calculated in-place volume bounded by the neat line boundaries of the fill as shown on Drawing Nos. 7922025-9 and 7922025-11 and the surveyed surface of the upstream blanket of the Cross Valley Dam. No allowance will be made for settlement of the foundation excavation backfill, the foundation or any other fill or in situ material.

4.10.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class IX materials in accordance with the specifications contained herein will be made at the unit price bid per cubic metre in place under Item 4 (f)(i) Cross Valley Dam and 4 (f)(ii) Intermediate Dam as shown the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No payment will be made for overhaul.

4.11 PAYMENT ITEM 4 (g) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF CLASS X MATERIAL FOR DAM CONSTRUCTION

4.11.1 Work Description

The work includes but shall not be restricted to the excavation, hauling, placement and compaction of all Class X materials required to construct the Cross Valley and Intermediate Dams to the lines and grades shown on Drawing Nos. 79220250-9 and 79220205-11. A 0.15 m tolerance will be permitted to the lines and grades shown on these drawings.

Placement and compaction of the Class X materials shall be in accordance with the provisons of Section 4.3. The Contractor shall place the fill such that segregation of materials does not occur particularly at the boundaries of the fill where compatibility with adjacent materials is necessary.

4.11.2 Method of Measurement

The quantity of Class X materials to be paid for will be the calculated in-place volume bounded by the neat line boundaries of the fill as shown on Drawing Nos. 7922025-9 and 7922025-11 and the surveyed surface of the foundation subexcavation backfill.

No allowance will be made for settlement of the foundation subexcavation backfill, the foundation or any other fill or in situ material.

4.11.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class X material as specified herein will be made at the unit price bid per cubic metre in place under Item 4 (g)(i) Cross Valley Dam and 4 (g)(ii) Intermediate Dam as shown the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul.

4.12 PAYMENT ITEM 4 (h) - CLASS VIII ABUTMENT FILLS FOR EMERGENCY SPILLWAYS AND DECANT CHANNELS

4.12.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement and compaction of all Class VIII material required to construct the abutment fills of the emergency spillways and decant channels of the Cross Valley and Intermediate Dams to the general lines and grades shown on Drawing No. 7922025-9. A 0.15 m tolerance will be permitted to the lines and grades shown on the Drawing. Location in plan of the spillways and decant channels is shown on Drawing Nos. 79220205-8 and 7922025-10.

Placement and compaction of the materials shall be in accordance with the provisions of Section 4.3.

4.12.2 Method of Measurement

The quantity of Class VIII materials to be paid for will be the calculated in-place volume bounded by the surveyed surface of the abutment fills and the surveyed, grubbed and stripped foundation area beneath the fill.

No allowance will be made for settlement of the foundation or any other fill or in situ material.

4.12.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class VIII material in accordance with the specifications contained herein will be made at the unit price bid per cubic metre in place under Item 4 (h)(i) Cross Valley Dam and 4 (h)(ii) Intermediate Dam as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material.

No separate payment will be made for overhaul.

4.13 PAYMENT ITEM 4 (i) - CLASS IV FILTER ROCK FOR EMERGENCY SPILLWAYS AND DECANT CHANNELS

4.13.1 Work Description

The work includes but shall not be limited to the excavation, hauling, and placement of all Class IV material in accordance with the specifications of section 3.3.2 required to construct the emergency spillways and decant channels of the Cross Valley and Intermediate Dams to the lines and grades of Drawing No 7922025-9. A 0.15 m tolerance will be permitted to the lines and grades shown on the Drawing.

The filter rock shall be placed in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the large rock fragments to form a well keyed uniform layer of the specified thickness. Properly placed materials need not be compacted. The minimum rock filter thickness is 0.5 m.

4.13.2 Method of Measurement

The quantity of Class IV materials to be paid for will be the calculated in-place volume bounded by the neat lines of the fill as shown on Drawing No. 7922025-9.

No allowance will be for settlement of the foundation or any other fill or in situ material.

4.13.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class IV material as specified herein will be made at the unit price bid per cubic metre in place under Item 4 (i)(i) Cross Valley Dam and 4 (i)(ii) Intermediate Dam as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material.

No separate payment will be made for overhaul.

No separate payment will be made for any processing which may be required to obtain the specified Class IV gradation.

4.14 PAYMENT ITEM 4 (j) - CLASS V EROSION CONTROL ROCK FOR EMERGENCY SPILLWAYS AND DECANT CHANNELS

4.14.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement and compaction of all Class V material as specified in section 3.3.2 required to construct the emergency spillways and decant channels of the Cross Valley and Intermediate Dams to the lines and grades of Drawing No. 7922025-9. A 0.15 m tolerance will be permitted to the lines and grades on the Drawing.

The erosion control rock shall be placed in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the larger rock fragments to form a well keyed uniform layer of specified thickness. Properly placed materials need not be compacted.

4.14.2 Method of Measurement

The quantity of Class V materials to be paid for will be the calculated in-place volume bounded by the neat lines of the rock fill as shown on Drawing No.7922025-9.

No allowance will be made for settlement of the foundation or any other fill or in situ material.

4.14.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class V material as specified herein will be made at the unit price bid per cubic metre in place under Item 4 (j)(i) Cross Valley Dam and 4 (j) (ii) Intermediate Dam of the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material.

No separate payment will be made for overhaul.

No separate payment will be made for any processing which may be required to obtain the specified Class V gradation.

4.15 PAYMENT ITEM 4 (k) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF CLASS I MATERIAL FOR DIVERSION DAM CONSTRUCTION

4.15.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement and compaction of all Class I material as specified in Section 3.3.2 to construct the Diversion Dam to the grades and lines shown on Drawing No.7922025-12. A 0.15 m tolerance will be permitted to the lines and grades shown on the Drawing.

Placement and compaction of the Class I material shall be in accordance with the provisions of Section 4.3. The Contractor will organize the placement of Class I material such that coarse Class I materials shall border on adjacent coarse zones of the dam

and such that fine Class I materials shall border on adjacent finer materials.

4.15.2 Method of Measurement

The quantity of Class I materials to be paid for will be the calculated in-place volume bounded by the neat line boundaries of the fill as shown on Drawing No. 7922025-12 and the surveyed boundaries of the fill at the discretion of the Engineer, and the surveyed surface of the foundation preparation.

No allowance will be made for settlement of the foundation preparation, the foundation or any other fill or any in situ material.

4.15.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class I material as specified herein will be made at the unit price bid per cubic metre in place under Item 4 (k) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, and place the material.

No separate payment will be made for overhaul.

4.16 PAYMENT ITEM 4 (1) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF CLASS II MATERIAL FOR DIVERSION DAM CONSTRUCTION

4.16.1 Work Description

The work includes but shall not be limitd to the excavation, hauling, placement and compaction of all Class II material as specificied in section 3.3.2 to construct the Diversion Dam to the grades and lines of Drawing No. 7922025-12. A 0.15 m tolerance will be permitted to the lines and grades on the Drawing.

Placement and compaction of the Class II material shall be in accordance with the provisions of Section 4.3. The Contractor shall place the fill such that segregation of materials does not occur within the fill.

4.16.2 Method of Measurement

The quantity of Class II materials to be paid for will be the calculated in-place volume bounded by the neat line boundaries of the fill as shown on Drawing No. 7922025-12 or the surveyed boundaries of the fill at the discretion of the Engineer and the surveyed surface of the foundation preparation. No allowance will be made for settlement of the foundation preparation, the foundation or any other fill or in situ material.

4.16.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class II material as specified herein will be made at the unit price bid per cubic metre in place under Item 4 (l) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No payment will be made for overhaul.

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

DETAILED SPECIFICATIONS

ITEM 5

SPOIL RETAINER DYKE

5.1 PROVISIONAL ITEM 5 (a) - CLEARING, GRUBBING AND STRIPPING OF SPOIL RETAINER DYKE FOUNDATION AREA

5.1.1 Work Description

The work includes but shall not be limited to the clearing, grubbing and stripping of the foundation area of the Spoil Retainer Dyke foundation area as directed by the Engineer. The depth of stripping will be limited such that only near surface organic materials, cobbles and boulders in the recent Rose Creek channel area and loose debris will be removed. The maximum depth of stripping is expected to be about 1 m. No dewatering will be required.

5.1.2 Method of Measurement

The quantity of work to be paid for will be based on the number of hours required to complete the work as directed by the Engineer and in accordance with the procedure defined in Article 24, part (f) of the General Conditions.

5.1.3 Basis of Payment

Payment will be made on a substantiated expenditure basis in accordance with the provisions of Article 24, part (f) of the General Conditions of these specifications.

5.1.4 Schedule Provisional Item 5 (a)

A provisional sum of $12,000 is stated on the Schedule of Quantities and Prices for Item 5 (a) to allow a more realistic appraisal of total Contract Price. The indicated sum is a preliminary estimate only and does not constitute the actual amount to be paid.

5.1.5 Tenderer's Proposed Procedure

The tenderer shall submit with his tender a list of equipment which he plans to make available for this work.

5.2 PAYMENT ITEM 5 (b) - EXCAVATION, HAULING, PLACEMENT AND COMPACTION OF FILL FOR SPOIL RETAINER DYKE

5.2.1. Work Description

The work includes but shall not be limited to the excavation, hauling, placement and compaction of the fill required to construct the spoil retainer dyke to the lines and grades shown on Drawing No. 7922025-12. The final elevation of the top of the dyke will be determined in the field by the Engineer.

The materials to be used for the work will be obtained from the waste excavation piles of the canal outfall or, if inadequate, material is available from Borrow Area "D". In general, the materials shall nonagglomerated sand and gravel. The Contractor shall not undermine the wall of the canal by his activity in Borrow Area "D".

Placement and compaction of the materials shall be in accordance with the provisions of sections 4.2 and 4.3.

5.2.2 Method of Measurement

The quantity of material to be paid for will be the calculated in-place volume bounded by the surveyed bottom of foundation subexcavation and the surveyed surface of the completed fill.

No allowance will be made for settlement of the foundation or any other fill or in situ material.

5.2.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of the material in accordance with the specifications herein will be made at the unit price bid per cubic metre in place under Item 5 (b) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material.

No separate payment will be made for overhaul.

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

DETAILED SPECIFICATIONS

ITEM 6

NORTH VALLEY WALL INTERCEPTOR

6.1 PAYMENT ITEM 6 (a) - EXCAVATION OF NORTH VALLEY WALL INTERCEPTOR DITCH

6.1.1 Work Description

The work includes but shall not be limited to the excavation, hauling and wasting of all materials required to excavate the cross-section of the North Valley Wall Interceptor Ditch to the lines and grades shown on Drawing No. 7922025-12. Waste excavation materials shall be disposed of downstream of the Cross Valley Dam, adjacent to the excavation or as provided for in Section 6.3. A 0.15 m tolerance will be permitted to the lines and grades shown on the drawing. The excavation required in the vicinity of the north abutment of the Cross Valley Dam shall be completed during freezing conditions and in accordance with the provisions of section 3.2.4.

6.1.2 Method of Measurement

The quantity of materials to be paid for will be determined by calculating the in-place volume of excavated material bounded by the surveyed ground surface before excavation and the neat line boundary of the excavation as shown on Drawing No. 7922025-12.

6.1.3 Basis of Payment

Payment for excavation, hauling, and wasting of materials in accordance with the specifications contained herein will be made at the unit price bid per cubic metre in place under Item 6 (a) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate and dispose of the material.

No payment will be made for overexcavation.

6.2 PAYMENT ITEM 6 (b) - CLASS I THERMAL LINING OF CHANNEL AT NORTH ABUTMENT OF THE CROSS VALLEY DAM

6.2.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement and compaction of all Class I material to the lines and grades shown on Drawing No. 7922025-12. A 0.15 m tolerance will be permitted to the lines and grades shown on the

Drawing except that the Contractor shall not be required to place thermal lining thicknesses greater than those shown on the Drawings.

The Class VIII fill shall be placed in continuous horizontal loose lifts having a thickness of not greater than 0.3 m and such that unnecessary segregation of coarse materials near the excavated face does not occur. The Contractor shall windrow cobbles and boulders as shown on the Drawing. The fill shall be constructed under freezing conditions and shall be placed and compacted in accordance with the provisions of section 3.2.4 and all other applicable provisions of section 3.2.

6.2.2 Method of Measurement

The quantity of materials to be paid for will be determined by calculating the in-place volume bounded by the excavation neat line boundary and the outside neat line boundary of the fill.
No allowance will be made for fill required to make up for overexcavation although such fill shall be placed and compacted to the specifications contained herein.
No allowance will be made for settlement occurring within the foundation or fill soils.

6.2.3 Basis of Payment

Payment for excavation, hauling, placement and compaction of all Class VIII material in accordance with the specifications contained herein will be made at the unit price bid per cubic metre in place under Item 6 (b) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No payment will be made for overhaul.

6.3 PAYMENT ITEM 6 (c) - DYKE FILLS FOR NORTH VALLEY WALL INTERCEPTOR

6.3.1. Work Description

The work includes but shall not be limited to the excavation, hauling placement, and compaction of selected waste materials from the excavation of the North Valley Wall Interceptor Ditch to the lines and grades shown on Drawing No. 7922025-12. The locations of such dykes will be determined in the field by the Engineer.
The fill shall be placed and compacted in accordance with the specifications of sections 4.2 and 4.3. Organic debris, topsoil and coarse grained materials shall be removed from the foundation area of the dyke.

6.3.2 Method of Measurement

The quantity of material to be paid for will be the in-place volume of the specified materials calculated between the surveyed base of the foundation preparation and the surveyed final dyke

configuration. No allowance will be made for settlement occurring within the foundation of fill soils.

6.3.3 Basis of Payment

Payment will be made for excavation, hauling, placement and compaction of all suitable material, as determined by the Engineer and in accordance with the specifications contained herein, at the unit price bid per cubic metre in place under Item 6 (c) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul.

CYPRUS ANVIL MINING CORPORATION

DOWN VALLEY TAILINGS CONTAINMENT

Faro Yukon Territory

DETAILED SPECIFICATIONS

ITEM 7

GENERAL ACCESS AND PIPELINE ACCESS ROAD

7.1 PAYMENT ITEM 7 (a) - FILL PLACEMENT FOR ACCESS ROAD

7.1.1 Work Description

The work includes but shall not be limited to the excavation, hauling, placement and compaction of all Class VIII material required to construct the access road as shown on Drawing Nos. 7922025-12 in Cross-Section on Drawing No. 7922025-2 in approximate plan. A 0.15 m tolerance will be permitted to the lines and grades shown on the Drawing.

The fill shall be constructed in May 1981 or at such other time as is approved by the Engineer. The Contractor will be required to remove any snow, trees, and loose debris which may occur within the foundation area of the road before any fill is placed.

The fill shall be placed and compacted in accordance with the applicable provisions of section 3.2.

The fills shall be compacted using a minimum of 4 passes of the specified compactor in section 3.2.4 (ii) per 0.3 m thick loose lift.

7.1.2 Method of Measurement

The quantity of material to be paid for will be the calculated in place volume bounded by the surveyed, prepared surface and the surveyed surface of the compacted fill.

7.1.3 Basis of Payment

Payment will be made for excavation, hauling and placement of all Class VIII material required to construct the access road as specified at the unit price bid per cubic metre in place under Item 7 (a) of the Sechdule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to excavate, level, place and compact the material. No separate payment will be made for overhaul.

7.2 PAYMENT ITEM 7(b) ACCESS ROAD CULVERT INSTALLATION

7.2.1 Work Description

The work includes but shall not be limited to the installation and supply of 0.6 m nominal diameter culverts where the Access Road crosses North Valley Wall creeks as determined by the Engineer. The culverts shall be properly seated and fill placed around the culverts shall be compacted to the satisfaction of the Engineer.

7.2.2 Method of Measurement

The quantity of material to be paid for shall be the total length of 0.6 m nominal diameter culvert supplied and installed to the specifications herein contained.

7.2.3 Basis of Payment

Payment will be made for supply and installation of the culverts as specified herein and as required by the Engineer at the unit price bid per metre under Item 7(b) as shown on the Schedule of Quantities and Prices. This price shall include the cost of all materials, labour, plant and small tools required to supply and install the culverts.

INSTRUMENTATION READINGS

	Table
Canal Dyke	
Sta. 2+100, Thermistor	VIII-1
Sta. 2+900, Thermistor	VIII-2
Preconstruction Instrumentation	
79-20) Piezometer North Abutment CVD	VIII-3
) Thermistor North Abutment CVD	VIII-4
79-23 Piezometer Canal Backslope Sta. 3+120	VIII-5
Construction Instrumentation Intermediate Dam	
IDP-1, IDP-2, Piezometers	VIII-6
IDP-3, IDP-4, Piezometers	VIII-7
IDS-1, IDS-2) Piezometric Levels	VIII-8
IDS-3) Settlements	VIII-9
Construction Instrumentation Cross Valley Dam	
CVDP-1, CVDP-2, Piezometers	VIII-10
CVDP-3, Piezometer	VIII-11
CVDP-4, DVDP-5, Piezometers	VIII-12
CVDP-6, Piezometer	VIII-13
CVDP-7, CVDP-8, Piezometers	VIII-14
CVDP-9, CVDP-10, Piezometers	VIII-15
CVDS-1, CVDS-2,) Piezometric Levels	VIII-16
CVDS-3, DVDS-4) Settlements	VIII-17
1980 Tailings Dam	
P81-01 to P81-09, Piezometers	VIII-18 to VIII-26
Klohn Leonoff Boreholes	
81-K1, 81-K3, Piezometers	
81-K4, 81-K6, Piezometers	VIII-27 to
81-K7, Piezometer	VIII-32

THERMISTOR DATA : STATION 2+100 (VALLEY SIDE)
THERMISTOR STRING NO.2

Table VIII - 1

TIP No.	1	2	3	4	5	6	7	8	9	10
DEPTH (m)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	6.9	7.8	8.8
Calibration at 0°C Ice Bath	no ice bath calibrations available therefore use theoretical 0°C value of 16.32 kΩ for temperatures									
KOHMS										
Temp.°C										
DATE										
14 Aug '81	8.99	9.74	11.35	13.42	15.76	16.45	16.45	16.45	16.39	16.52
	+12.1	+10.5	+7.2	+3.9	+0.7	-0.2	-0.2	-0.2	-0.1	-0.3
22 Aug '81	9.29	10.21	11.41	13.33	15.39	16.46	16.46	16.96	17.09	17.23
	+11.4	+9.5	+7.1	+4.0	+1.1	-0.2	-0.2	-0.7	-0.9	-1.1
16 Sept'81	12.62	11.96	12.18	13.25	14.67	16.05	16.61	16.93	17.03	17.16
	+5.1	+6.2	+5.8	+4.1	+2.1	+0.3	-0.4	-0.7	-0.8	-1.0
24 Sept'81	13.71	12.61	12.69	13.45	14.65	15.91	16.51	16.80	16.82	16.85
	+3.4	+5.1	+5.0	+3.8	+2.1	+0.5	-0.2	-0.6	-0.6	-0.6
30 Sept'81	15.87	13.57	13.14	13.67	14.65	15.83	16.60	16.84	16.88	16.94
	+0.5	+3.6	+4.3	+3.5	+2.1	+0.6	-0.4	-0.6	-0.7	-0.7
16 Oct '81	15.73	15.13	14.55	14.41	14.86	15.86	16.53	16.79	16.88	17.01
	+0.7	+1.5	+2.2	+2.5	+1.8	+0.6	-0.3	-0.6	-0.7	-0.8
26 Oct '81	17.58	15.36	14.87	14.30	14.00	14.66	16.35	16.47	16.36	16.51
	-1.5	+1.2	+1.8	+2.6	+3.0	+2.1	0.0	-0.2	-0.1	-0.2
28 Oct '81	17.76	15.53	15.02	14.92	15.26	15.83	16.45	16.69	16.63	16.50
	-1.7	+1.0	+1.6	+1.8	+1.3	+0.6	-0.2	-0.5	-0.4	-0.2
15 Nov '81	-	16.52	16.05	15.89	15.98	16.26	16.62	16.82	16.88	17.02
		-0.3	+0.3	+0.5	+0.4	+0.1	-0.4	-0.6	-0.7	-0.8
9 Dec '81	35.7	19.85	16.47	16.35	16.33	16.41	16.58	16.78	16.84	16.96
	-14.6	-3.8	-0.2	0.0	0.0	-0.1	-0.3	-0.5	-0.6	-0.7

Project No. 812-2241 Drawn GPB Reviewed [illegible] Date Jan '82

THERMISTOR DATA : STATION 2+900 (CANAL SIDE)
THERMISTOR STRING NO.1

Table VIII - 2

TIP No.	1	2	3	4	5	6	7	8	9	10
DEPTH (m)	1.0	2.0	3.0	3.5	3.9	4.5	4.9	5.6	6.5	9.5
Calibration at 0°C Ice Bath	no ice bath calibrations available therefore use theoretical 0°C value of 16.32 KΩ for temperatures									
DATE / KOHMS / Temp.°C										
5 Aug '81	11.76	15.78	16.41	16.55	16.41	16.11	16.10	16.09	16.13	16.29
	+6.5	+0.7	-0.1	-0.3	-0.1	+0.3	+0.3	+0.3	+0.2	0.0
6 Aug '81	11.88	15.83	16.42	16.56	16.53	16.41	16.39	16.31	16.25	16.33
	+6.3	+0.6	-0.1	-0.3	-0.3	-0.1	-0.1	0.0	+0.1	0.0
7 Aug '81	11.94	15.84	16.42	16.55	16.54	16.47	16.49	16.37	16.30	16.34
	+6.2	+0.6	-0.1	-0.3	-0.3	-0.2	-0.2	-0.1	0.0	0.0
14 Aug '81	11.94	15.61	16.44	16.58	16.59	16.57	16.62	16.50	16.41	16.37
	+6.2	+0.9	-0.2	-0.3	-0.3	-0.3	-0.4	-0.2	-0.1	-0.1
22 Aug '81	12.29	15.44	16.46	16.57	16.58	16.57	16.64	16.53	16.41	16.37
	+5.6	+1.1	-0.2	-0.3	-0.3	-0.3	-0.4	-0.3	-0.1	-0.1
16 Sept'81	13.64	15.18	16.45	16.60	16.61	16.59	16.65	16.71	16.45	16.41
	+3.5	1.4	-0.2	-0.4	-0.4	-0.3	-0.4	-0.5	-0.2	-0.1
24 Sept'81	13.94	8.22	16.24	16.52	16.59	16.52	16.42	16.27	16.21	16.12
	+3.1	+14.0*	+0.1	-0.3	-0.3	-0.3	-0.1	+0.1	+0.1	+0.2
30 Sept'81	15.01	15.67	16.44	16.59	16.59	16.58	16.65	16.55	16.44	16.38
	+1.2	+0.8	-0.2	-0.3	-0.3	-0.3	-0.4	-0.3	-0.2	-0.1
15 Oct '81	8.11	8.11	16.34	16.41	16.42	16.47	16.51	16.45	16.33	16.29
	+14.3	+14.3*	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	0.0	0.0
26 Oct '81	16.19	16.10	16.35	16.40	16.33	16.40	16.49	16.46	16.29	16.32
	+0.2	+0.3	0.0	-0.1	0.0	-0.1	-0.2	-0.2	0.0	0.0
28 Oct '81	16.44	16.36	16.40	16.55	16.48	16.45	16.59	16.47	16.32	16.35
	-0.2	-0.1	-0.1	-0.3	-0.2	-0.2	-0.3	-0.2	0.0	0.0
15 Nov '81	8.28	8.28	16.44	16.61	16.63	16.61	16.65	16.56	16.46	16.42
	+13.9*	+13.9*	-0.2	-0.4	-0.4	-0.4	-0.4	-0.3	-0.2	-0.1
9 Dec '81	8.54	8.54	16.46	16.60	16.64	16.61	16.67	16.56	16.46	16.43
	+13.2*	+13.2*	-0.2	-0.4	-0.4	-0.4	-0.4	-0.3	-0.2	-0.1

* Questionable Data

Project No. 812-2041 Drawn GPB Reviewed [illegible] Date Jan '82

CYPRUS ANVIL DOWN VALLEY PROJECT

Hydraulic Piezometer (HP) Data Sheet

Location : 79-20 (North Abutment C.V.D.) 2447·49 mN 114·36 mE

Tip Depth : 37·0m

Ground Elev: 1076·8 m

Tip Elev. : 1039·8 m

Top of tube above ground: 0·25 m

DATE	W.L. from top of tube (m)	WATER LEVEL		REMARKS	
		ELEV. (m)	DEPTH (m)		
Aug 16 '79				Installed	
28	28·58	1048·47	28·33		
Sept 27	28·67	48·38	28·42		
Dec 5	28·91	48·14	28·66		
Mar 9 '80	28·83	48·22	28·58		
July 8'	28·82	48·23	28·57		
Aug 5		47·2	29·6		
18		47·75	29·05		
Sept 16	29·19	47·86	28·94		
30	28·86	48·19	28·61		
Oct 16	28·59	48·46	28·34		
27	28·22	48·83	27·97		
Nov 15	28·24	48·81	27·99	D.K & B.P.	
Dec 12	27·41	49·64	27·16	D.K & K.M.	

79-20

CYPRUS ANVIL DOWN VALLEY PROJECT

Thermistor (T) Data Sheet

LOCATION: 79-20 2447.49mN 114.36mE
North Abutment C.V.D. Ground Elev. 1076.8 m

THERMISTOR STRING No. (Thermistor type with no P.V.C. protective sheath) installed 16 Aug 1979

TIP No.	1	2	3	4	5	6	7	8	9	10	
DEPTH (m)	3.5	1.0	2.0	7.0	12.0	17.0	22.0	29.0	37.0		
Calibration at 0°C Ice Bath(1)	no ice bath calibrations avaliable therefore use theoretical 0°C value of 16.32kΩ for temperatures										
DATE / KOHMS / *Temp.°C											
21 Aug '79	16.38	13.01	15.18	16.45	16.44	16.17	15.93	15.56	—		
	-0.1	+4.5	+1.3	-0.2	-0.2	0.2	0.5	0.9			
28 Aug '79	16.24	12.88	14.84	16.44	16.36	16.26	15.98	15.42	—		
	+0.1	+5.0	+1.9	-0.2	0.0	0.0	+0.4	+1.1			
27 Sept '79	16.42	14.06	15.27	16.56	16.47	16.37	16.16	15.87	—		
	-0.15	+2.9	+1.3	-0.3	-0.2	-0.1	+0.2	+0.6			
5 Dec '79	16.45	16.88	16.45	16.59	16.53	16.40	16.18	15.92	—		
	-0.2	-0.65	-0.2	-0.3	-0.25	-0.1	+0.15	+0.5			
9 Mar '80	16.48	19.26	16.61	16.63	16.56	16.40	16.19	15.95	15.59		
	-0.2	-3.2	-0.35	-0.4	-0.3	-0.1	+0.15	+0.5	+0.9		
8 July '80	16.51	14.47	16.55	16.64	16.58	16.44	16.22	15.97	—		
	-0.20	+2.40	-0.25	-0.35	-0.30	-0.15	+0.15	+0.45			
9 Nov '80	16.52	16.61	16.31	16.67	16.59	16.46	16.29	15.98	—		
	-0.3	-0.4	0.0	-0.4	-0.3	-0.2	0.0	+0.4			
1 Mar '81	16.54	19.93	16.63	16.68	16.60	16.45	16.25	15.99	15.61		
	-0.3	-3.9	-0.4	-0.4	-0.4	-0.2	+0.1	+0.4	+0.9		
13 May '81	16.53	17.72	16.83	16.50	16.07	15.72	15.99	15.98	15.62		
	-0.3	-1.6	-0.6	-0.2	+0.3	+0.7	+0.4	+0.4	+0.9		
5 Aug '81	16.53	13.09	15.83	16.66	16.61	16.45	16.28	16.00	18 to 20?		
	-0.3	+4.4	+0.6	-0.4	-0.4	-0.2	0.0	+0.4			
18 Aug '81	16.54	12.86	15.32	16.67	16.57	16.44	16.26	15.97	18-20?		
	-0.3	+4.7	+1.2	-0.4	-0.3	-0.2	+0.1	+0.4			
16 Sept '81	16.53	13.59	15.07	16.66	16.59	16.47	16.29	15.98	—		B.P.
	-0.3	+3.6	+1.6	-0.4	-0.3	-0.2	0.0	+0.4			
30 Sept '81	16.53	14.37	15.29	16.67	16.59	16.45	16.27	15.99			B.P.
	-0.3	+2.5	+1.3	-0.4	-0.3	-0.2	+0.1	+0.4			

(1.) Readings in KOHMS. (Two sets of calibration readings were taken)

* Temperature calculated using a mean value of 16.20kΩ for 0°C, calculated using the 0°C ice bath calibration sheets supplied by "Cantech Controls Ltd." for each thermistor string.

** Indicates thermistor for which the ice bath calibration differs more than 0.2kΩ from the mean of 16.20kΩ

CYPRUS ANVIL DOWN VALLEY PROJECT

Thermistor (T) Data Sheet

LOCATION: 79-20 : contd. sheet 2
North Abutment C.V.D.

THERMISTOR STRING No.

TIP No.	1	2	3	4	5	6	7	8	9	10	
DEPTH (m)	3.3	1.0	2.0	7.0	12.0	17.0	22.0	29.0	37.0		
Calibration at 0°C Ice Bath(1)											
DATE / KOHMS / *Temp.°C											
16 Oct '81	16.55	15.58	15.75	16.67	16.62	16.48	16.29	15.99	—		B.P.
	-0.3	+0.9	+0.7	-0.4	-0.4	-0.2	0.0	+0.4			
27 Oct '81	16.54	16.06	16.03	16.67	16.60	16.46	16.30	15.98	—		B.P.
	-0.3	+0.3	+0.3	-0.4	-0.4	-0.2	0.0	+0.4			
15 Nov '81	16.53	16.67	16.33	16.66	16.61	16.47	16.30	15.98	—		D.K. B.P.
	-0.3	-0.4	0.0	-0.4	-0.4	-0.2	0.0	+0.4			
9 Dec '81	16.53	16.96	16.54	16.68	16.61	16.48	16.29	15.99	—		D.K. K.M.
	-0.3	-0.7	-0.3	-0.4	-0.4	-0.2	0.0	+0.4			

(1.) Readings in KOHMS. (Two sets of calibration readings were taken)

* Temperature calculated using a mean value of 16.20kΩ for 0°C, calculated using the 0°C ice bath calibration sheets supplied by "Cantech Controls Ltd." for each thermistor string.

** Indicates thermistor for which the ice bath calibration differs more than 0.2kΩ from the mean of 16.20kΩ

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer (PP) Data Sheet

Location : 79-23 (3+120) 1910.41mN
-387.7 mE
Tip Number:
Tip Depth : 12.0 m
Ground Elev: 1083.2 m
Tip Elev. : 1071.2 m

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS	
Aug 22'79				Installed	
28	3.2	1073.44	9.76		
Sept 27	3.5	73.65	9.55		
Mar 8'80	2.5	72.95	10.25		
July 8	3.0	73.30	9.90		
Oct 16	3.0	73.30	9.90		
26	3.0	73.30	9.90		
Nov 15	3.2	73.44	9.76	D.K & B.P.	

79-23(3+120)

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

Sheet 1 of 2

Location : IDP-1

Tip Number: #1299

Tip Depth :

Ground Elev:

Tip Elev. : 1047.0 m

IDP-2

Tip Number: #1301

Tip Depth :

Ground Elev:

Tip Elev. : 1048.3 m

Readings taken by 'bicycle pump air method'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS
22 May'81	4.0	1049.8		time 11.00 installed				
	7.0	1051.9		16.30	3.0	1050.4		installed
23 May	9.0	1053.3		10.25 Fill elevn	6.5	1052.9		
	13.0	1056.1		17.30 =1052m	8.0	1053.9		
25 May	10.0	1054.0		10.00 Fill elevn	6.0	1052.5		
	10.0	1054.0		14.30 =1053m	-	-		
26 May	7.0	1051.9		9.00	6.0	1052.5		
	11.0	1054.7		12.30	-	-		destroyed.
	10.5	1054.4		17.30				
27 May	10.5	1054.4		9.30				
	9.0	1053.3		13.00				
	10.0	1054.0		16.30				
28 May	12.5	1055.8		11.00 Fill @ 1054.5m				
29 May	11.0	1054.7		9.00 Fill elevn				
	13.0	1056.1		15.30 =1055m				
30 May	11.5	1055.1		9.30 Fill elevn				
	11.0	1054.7		15.30 =1056m				
1 June	9.5	1053.7		9.30 Fill elevn				
	9.0	1053.3		14.00 =1058.5				
2 June	9.5	1053.7		9.30				
3 June	9.0	1053.3		11.00				
	9.0	1053.3		13.30				
4 June	8.0	1052.6		8.20				
5 June	8.0	1052.6		10.30				
8 June	7.5	1052.3		11.30				
9 June	7.0	1051.9		10.30				
11 June	7.5	1052.3		9.45				
15 June	7.0	1051.9		11.00				
19 June	7.0	1051.9		15.00				

IDP-1, IDP-2

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

Sheet 2 of 2

Location : IDP-1

Tip Number: #1299

Tip Depth :

Ground Elev:

Tip Elev. : 1047.0 m

Up to 27 Oct 1981 : readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards : readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS
26 June '81	6.5	1051.6		
1 July	6.5	1051.6		(Fill
9 July	7.0	1051.9		Elevation)
15 July	8.5	1053.0		(1060.1m)
23 July	8.3	1052.8		CE (1061.5m)
27	8.5	1053.0		DK (1062.5m)
5 Aug	8.2	1052.7		DG
13	8.0	1052.6		
18	8.0	1052.6		GDR (1062.6m)
22	8.0	1052.6		GDK (1063.9m)
29	8.7	1053.1		(1065.1m)
8 Sept	8.5	1053.0		(1066.5m)
16	9.5	1053.7		BP
30	9.5	1053.7		BP
10 Oct	9.5	1053.7		DA (1068.8m)
16 Oct	10.0	1054.0		BP
27 Oct	10.0	1054.0		BP
15 Nov	10.8	1054.56		B.P & D.K.
11 Dec	13.9	1056.73		D.K & K.M.

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS

IDP-1

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

Location : IDP-3 (D/S of core) IDP-4 (U/S of core)

Tip Number: #3581 **Tip Number:** #3582

Tip Depth : **Tip Depth :**

Ground Elev: **Ground Elev:**

Tip Elev. : 1053·03 m **Tip Elev. :** 1052·46 m

Up to 27 Oct 1981 - readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards - readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS		Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS
Aug 8'81				installed					installed
13	0.0	1053.0		11.00am		0.0	1052.5		
18	0.0	1053.0		11.00am		0.0	1052.5		G.D.R.
22	0.0	1053.0		11.00		0.0	1052.5		G.D.R.
29	0.0	1053.0		17.00		0.0	1052.5		
Sept 8	0.5	1053.4		14.00		0.5	1052.8		
16	1.0	1053.7		14.00		0.5	1052.8		B.P
30	1.5	1054.1		14.15		0.5	1052.8		B.P.
Oct 10	1.8	1054.3		15.00		0.5	1052.8		D.A.
16	1.5	1054.1		11.00		0.5	1052.8		B.P.
27	1.5	1054.1		15.30		0.5	1052.8		B.P.
Nov 15	2.5	1054.78				3.4	1054.84		B.P & D.K.
Dec 11	3.4	1055.41				6.0	1056.66		D.K & K.M.

IDP-3, IDP-4

TABLE VIII-8

INTERMEDIATE DAM WATER ELEVATIONS

(Measured in Settlement Plate Risers)

Date (1981)	IDS-1 Settlement Plate #1 Water Elevation (m)	IDS-2 Settlement Plate #2 Water Elevation (m)	IDS-3 Settlement Plate #3 Water Elevation (m)
June 17	1051.96	1051.51	
July 9	1052.33	1052.00	
July 15	1052.32	1052.00	
Aug. 5	1052.17	Blocked	
Aug. 18	1052.25	"	1051.69
Aug. 22	1052.25	"	1052.02
Sept. 16	1052.54	"	Blocked
Sept. 30	1052.94	"	"
Oct. 16	1053.22	"	"
Oct. 27	1053.50	"	"
Nov. 15	1053.80	"	"
Dec. 12	1054.57	"	"

TABLE VIII-9

INTERMEDIATE DAM SETTLEMENT PLATES

Date 1981	Sta. 0+593.5m Settlement Plate IDS-1* Plate Elev.	Settlement (m)	Fill Elev.	Sta. 0+626.6 m Settlement Plate IDS-2* Plate Elev.	Settlement (m)	Fill Elev.	Sta. 0+674.1 m o/s 23.8 m R Settlement Plate IDS-3* Plate Elev.	Settlement (m)	Fill Elev.
May 27	1050.87	0.0	1051.0	1050.37	0.0	1051.5			
28	1050.87	0.0		1050.37	0.0				
29	1050.85	0.02		1050.35	0.02				
30	1050.84	0.03		1050.31	0.06				
June 4	1050.82	0.05		1050.28	0.09				
15	1050.82	0.05		1050.286	0.084				
18	1050.82	0.05		1050.289	0.081				
23	1050.82	0.05		1050.291	0.079				
July 2	1050.82	0.05		1050.285	0.085				
6	1050.814	0.056		1050.282	0.088				
13	1050.811	0.059	1058.39	1050.284	0.086	1055.57			
15	1050.771	0.099	1060.15	1050.276	0.094	1055.57			
20	1050.715	0.155	1061.49	1050.267	0.103	1055.78			
23	1050.701	0.169	1061.48	1050.264	0.106	1055.77			
27	1050.674	0.196	1062.489	1050.261	0.109	1055.79			
30	1050.685	0.185		1050.259	0.111				
Aug. 5	1050.678	0.192		1050.258	0.112				
8	1050.674	0.196		1050.242	0.128		1051.456	0.0	1051.5
10							1051.432	0.024	
13	1050.672	0.198		1050.170	0.200		1051.398	0.058	
18	1050.675	0.195	1062.55	1050.083	0.287	1061.03	1051.371	0.085	1058.47
23	1050.652	0.218	1063.90	1050.103	0.267	1063.39	1051.34	0.116	1061.59
25							1051.364	0.092	
28	1050.647	0.223	1065.11	1050.063	0.307	1065.79	1051.348	0.108	1064.41
Sept.2	1050.639	0.231	1065.48	1050.046	0.324	1065.93	1051.345	0.111	1064.42
10	1050.628	0.242	1066.55	1050.032	0.338	1066.57	1051.322	0.134	1068.017
18	1050.616	0.254	1067.90	1049.986	0.384	1068.73	1051.317	0.139	1067.79
Oct. 8	1050.609	0.261	1068.83	1049.965	0.405	1068.76	1051.323	0.133	1067.75

Note: * See Table 3-3 for details on locations.

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

STATION 0+450

Location : CVDP-1 (20m u/s of ℄) CVDP-2 (5m u/s of ℄)

Tip Number: #2549 **Tip Number:** #2548

Tip Depth : **Tip Depth :**

Ground Elev: **Ground Elev:**

Tip Elev. : 1046.81m **Tip Elev. :** 1046.84m

Up to 26 Oct 1981 - readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards - readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS (Fill Elevation)	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS
June 8 '81		1046.8		installed (1047.0)		1046.8		
9	1.0				0			
10	1.0				1.0			
11	1.5				2.0			
12	2.0				1.0			
15	1.0				1.0			
19	0.0				0.0			
26	1.0				1.0			
28	1.0				1.0			
July 1	0				0.5			
9	0.5				0.5			
15	1.5			(1055.3m)	1.5			
23	1.0			(1056.1m)	0.5			
Aug 5	0.5				0.5			
18	0.3				0.5			
29								
Sept 8	0.5			(1063m)	0.5			
16	0.5				0.5			
20	0.5				0.5			
22	0.5				0.5			
30	0.5			(1065.6)	0.5			
Oct 10	0.5				0.5			
16	0.5				0.5			
26	0.5	1047.2			0.5	1047.2		
Nov 15	2.6	1048.63			2.5	1048.59		
Dec 11	2.4	1048.49			2.48	1048.58		

C.V.D. STA. 0+450

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

STATION 0+450

Location : CVDP-3 (7m D/S of ℄)

Tip Number: no serial number given

Tip Depth :

Ground Elev:

Tip Elev. : 1047.01 m

Up to 26 Oct 1981 - readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards - readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS	
June 8 '81		1047.0		installed	
9	0				
10	0				
11	1.0				
12	1.0				
15	0				
19	-			lead leaking excessively	
26	-				
28	-				
July 1	1.0				
9	1.0				
15	1.0				
23	1.0			C.E	
Aug 5	0.5			DG & GDR	
18	0.3			G.D.R.	
29					
Sept 8	0.5			B.P.	
16	0.5			B.P.	
20	0.5			B.P.	
22	0.5			B.P.	
30	0.5			B.P.	
Oct 10	0.5			D.A.	
16	0.5			B.P.	
26	0.5	1047.4		B.P.	
Nov 15	1.7	1048.20		B.P & D.K.	
Dec 11	-			D.G & D.K. outlet iced up.	

STA 0+450

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

STATION . 0+210

Location : CVDP-4 (32m U/S of ℄) CVDP-5 (9m U/S of ℄)

Tip Number: #3528 **Tip Number:** #3529

Tip Depth : **Tip Depth :**

Ground Elev: **Ground Elev:**

Tip Elev. : 1046.76 m **Tip Elev. :** 1046.58 m

Up to 26 Oct 1981 - readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards - readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS (Fill Elevation)		Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS
June 15 '81	0	1046.76		installed (1047.5m)		1	1047.3		installed
19	0					0	1046.6		
26	1.0	1047.5				1.0	1047.3		
28	1.0					1.0			
July 1	1.0					1.0			
9	1.0					0.5	1046.9		
15	1.0			(1059.8m)		2.0	1048.0		
23	1.0			(1063.1m)		1.5	1047.6		
Aug 5	1.8	1048.0				2.0	1048.0		
18	1.5	1047.8				1.8	1047.8		
29	1.5	1047.8		(1065.3m)		1.7	1047.8		
Sept 8	1.0	1047.5				1.0	1047.3		
16	2.0	1048.2				1.5	1047.6		
20	1.5	1047.8				1.5			
22	1.5	1047.8				1.5			
30	0.5	1047.1		(1065.7m)		1.5			
Oct 10	2.5	1048.5				2.0	1048.0		
16	3.0	1048.9				2.5	1048.3		
26	3.0	1048.9				3.0	1048.7		
Nov 15	4.2	1049.70				4.2	1049.52		
Dec 11	3.55	1049.25				4.9	1050.01		

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

STATION 0+210

Location : CVDP-6 (5 m D/S of ℄)

Tip Number: #3530

Tip Depth :

Ground Elev:

Tip Elev. : 1046.67 m

Up to 26 Oct 1981 - readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards - readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS	
June 15'81	0	1046.7		installed	
19	0				
26	1.0	1047.4			
28	1.0				
July 1	1.0				
9	1.0				
15	1.5	1047.7			
23	1.0	1047.4			
Aug 5	1.5	1047.7		DG & G.D.R.	
18	1.5			G.D.R.	
29	1.5			D.G.	
Sept 8	1.0	1047.4		B.P.	
16	1.0			B.P.	
20	1.0			B.P.	
22	1.0			B.P.	
30	1.0			B.P.	
Oct 10	1.5	1047.7		D.A.	
16	1.0	1047.4		B.P	
26	2.0	1048.1		B.P.	
Nov 15	3.2	1048.91		BP & DK	
Dec 11	3.5	1049.12		DG & DK.	

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

STATION 0+570

Location : CVDP-7 (62m u/s of ℄) CVDP-8 (20m u/s of ℄)

Tip Number: *3578 **Tip Number:** *3580

Tip Depth : **Tip Depth :**

Ground Elev: **Ground Elev:**

Tip Elev. : 1047.53m **Tip Elev. :** 1047.93m

Up to 26 Oct 1981 - readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards - readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS (Fill Elevation)	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS
Aug 5 '81		1047.5		installed (1048m)		1047.9		installed
18	1.2	1048.3			0.5	1048.3		
Sept 8	3.6	1050.0		seepage of water out of tube (1061.7m)	3.3	1050.2		
16	4.0	1050.3		"	4.0	1050.7		
20	5.0	1051.0		"	4.0			
22	3.0	1049.6		"	4.0			
25	4.5	1050.7		"	4.5	1051.1		
30	7.0	1052.4		" (1065.8m)	5.5	1051.8		
Oct 6	-			frozen	5.5			
10	-			"	5.5			
16	-			"	5.5			
26	-			"	5.5			
Nov 15	7.4	1052.68			6.3	1052.34		
Dec 11	7.53	1052.77			6.4	1052.41		

C.V.D. STA 0+570

CYPRUS ANVIL DOWN VALLEY PROJECT

Pneumatic Piezometer Data Sheet

STATION 0+570

Location : CVDP-9 (6 m W/S of ℄) CVDP-10 (5 m D/S of ℄)

Tip Number: #3579 **Tip Number:** #3584

Tip Depth : **Tip Depth :**

Ground Elev: **Ground Elev:**

Tip Elev. : 1048·18 m **Tip Elev. :** 1049·10 m

Up to 26 Oct 1981 - readings taken by 'bicycle pump air method'
From 15 Nov 1981 onwards - readings taken with 'Petur Pneumatic Readout Unit'

DATE	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS	Rdg. P.S.I.	PIEZOMETRIC ELEV. (m.)	PIEZOMETRIC DEPTH (m.)	REMARKS
Aug 5 '81		1048·2		installed		1049·1		installed
" 18	0·3	1048·4			0·2	1049·2		
Sept 8	2·5	1049·9			0·3	1049·3		
16	3·0	1050·3			0·5	1049·5		B.P.
20	3·0				0·5			B.P.
22	3·0				0·5			B.P.
25	3·5	1050·6			0·5			B.P.
30	4·5	1051·3			0·5			B.P. Nth Pond 51·23 Sth Pond 53·17
Oct 6	4·0	1051·0			0·5			B.P.
10	4·5	1051·3			0·5			D.A.
16	5·0	1051·7			0·5			B.P.
26	4·0	1051·0			0·5			B.P.
Nov 15	5·8	1052·24			1·3	1050·01		B.P. & D.K.
Dec 11	5·72	1052·18			1·1	1049·87		K.M. & D.K.

STA 0+570

TABLE VIII-16

CROSS VALLEY DAM WATER ELEVATIONS

(Measured in Settlement Plate Risers)

Date (1981)	CVDS-1 Settlement Plate A Water Elevation (m)	CVDS-2 Settlement Plate B Water Elevation (m)	CVDS-3 Settlement Plate C Water Elevation (m)	CVDS-4 Settlement Plate D Water Elevation (m)
June 17	1046.91	1046.00	1046.90	
July 9	1051.00	1051.72	1047.11	
July 15	1051.27	1052.11	1047.62	
Aug. 5	1050.92	Blocked	1047.18	
Aug. 18	1050.42	"	1047.86	
Sept. 16	1050.46	"	1048.71	
Sept. 20	1050.45	"	1048.68	
Sept. 30	1050.50	"	1047.73	1050.60
Oct. 16	1050.31	"	Blocked	Dry
Oct. 27	1050.47	"	"	1052.26
Nov. 15	1050.42	"	"	Blocked

TABLE VIII-17

CROSS VALLEY DAM SETTLEMENT PLATES

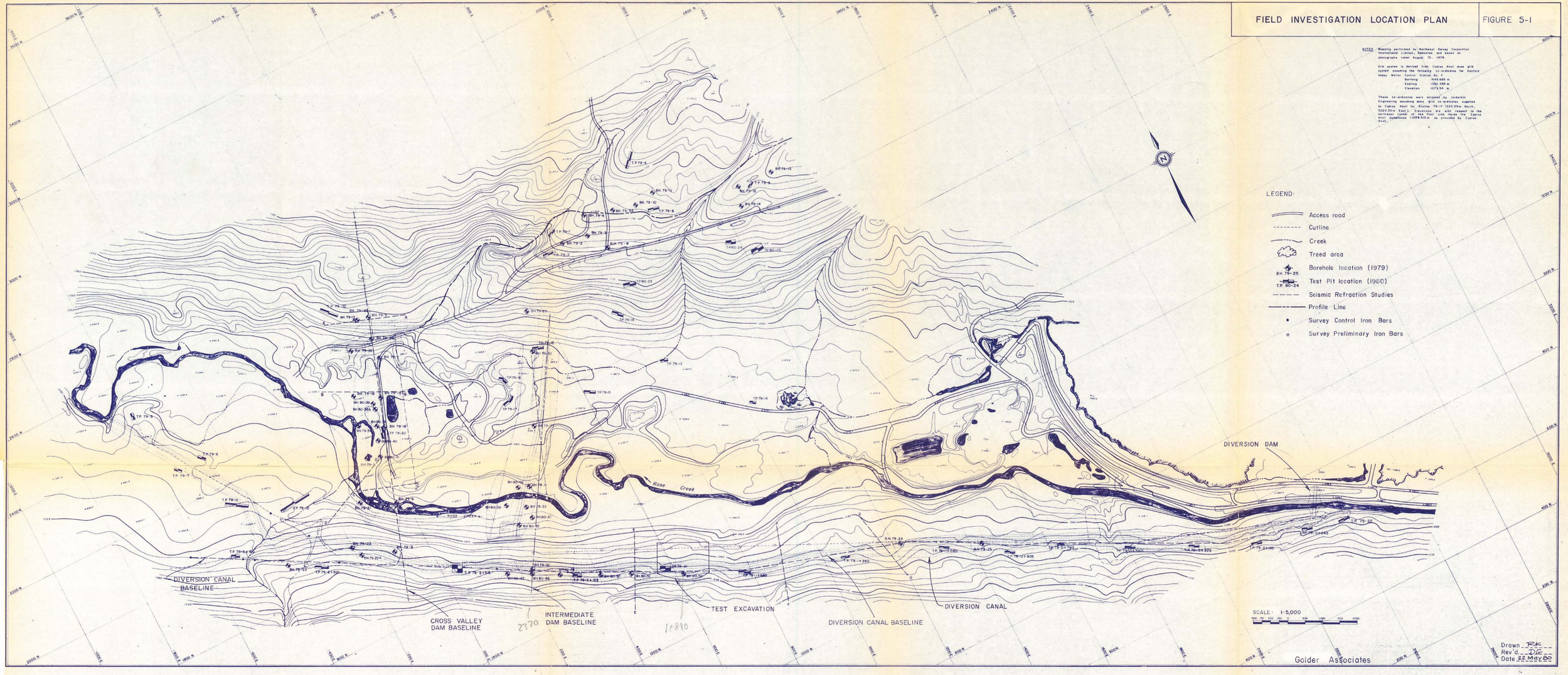
Date 1981	Sta. 0+204.9 m Settlement Plate CVDS-1* Plate Elev.	Settlement (m)	Fill Elev.	Sta. 0+341.0 m Settlement Plate CVDS-2* Plate Elev.	Settlement (m)	Fill Elev.
June 5				1045.92	0.0	1046.0
8				1045.91	0.01	
9				1045.90	0.02	
11	1046.01	0.0	1047.3	1045.87	0.05	
17	1045.944	0.066		1045.81	0.11	
23	1045.938	0.072		1045.78	0.14	
26	1045.922	0.088		1045.751	0.169	
28				1045.750	0.170	
29	1045.899	0.111				
July 2	1045.854	0.156		1045.719	0.201	
3	1045.858	0.152				
6	1045.841	0.169		1045.655	0.265	
9	1045.841	0.169		1045.612	0.308	
13	1045.812	0.198	1059.77	1045.567	0.353	1059.43
14	1045.810	0.200		1045.553	0.367	
16	1045.801	0.209	1061.02	1045.523	0.397	1060.90
17	1045.793	0.217	1061.75	1045.512	0.408	1061.515
20	1045.789	0.221	1061.904	1045.488	0.432	1061.580
23	1045.779	0.231	1063.094	1045.488	0.432	1062.77
25	1045.767	0.243	1064.432	1045.456	0.464	1064.45
27	1045.763	0.247		1045.450	0.470	
28	1045.760	0.250		1045.437	0.483	
29						
30	1045.763	0.247		1045.434	0.486	
Aug. 5	1045.756	0.254		1045.425	0.495	
7						
8	1045.751	0.259		1045.423	0.497	
13	1045.751	0.259		1045.419	0.501	
20	1045.753	0.257		1045.413	0.507	
27	1045.760	0.25	1065.27	1045.417	0.503	1064.60
Sept. 2	1045.757	0.253	1065.248	1045.415	0.505	1064.59
9	1045.746	0.264	1065.22	1045.402	0.518	1064.61
29	1045.752	0.258	1065.72	1045.404	0.516	1065.87
Oct. 8	1045.753	0.257	1065.71	1045.401	0.519	1065.85

Note: * See Table 3-3 for details on locations.

(Cont'd)

FIELD INVESTIGATION LOCATION PLAN

FIGURE 5-1



Golder Associates

Drawn RE
Rev'd DLC
Date 22 May 80