**PITEAU ASSOCIATES**
GEOTECHNICAL AND
HYDROGEOLOGICAL CONSULTANTS

KAPILANO 100, SUITE 408
WEST VANCOUVER, B.C.
CANADA V7T 1A2
TELEPHONE (604) 926-8551
TELEX 04-352896



# CURRAGH RESOURCES CORPORATION

# ANVIL PIT

# REPORT ON

# PHASE 1

# GEOTECHNICAL AND HYDROGEOLOGICAL ASSESSMENT OF THE NORTHEAST WALL OF THE ANVIL PIT

by
Alan F. Stewart, P.Eng.
and
Andrew T. Holmes, P.Eng.

85-804

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CONTENTS

# 1. INTRODUCTION

As per your request, Piteau Associates has completed Phase 1 of the geotechnical and hydrogeological assessment of the northeast wall of the Zone 3 Anvil Pit. The approach for this phase of the assessment, which was outlined in our letter of October 17, 1985, included briefly comparing existing data and field conditions with information obtained during our previous involvement at the mine (see list of references). An appraisal of the extent and nature of potential hydrogeological and geotechnical problems, and an assessment of what level of study would be required in a detailed second phase study, was then carried out. The long term goals of the overall study include:

- Identifying potential slope stability problems in the northeast wall and developing solutions to these problems.

- Identifying the hydrogeological regime in and around the northeast pit wall (i.e. including groundwater levels, source of water, hydraulic conductivity, etc.) with the ultimate aim being the development of a method to control adverse flow and other water related problems.

Approval to proceed with the Phase 1 study was given in a letter from Curragh Resources dated October 23, 1985. Shortly thereafter a meeting was held with Mr. G. Jilson of Cyprus Anvil, at which time geological plans, cross sections, etc. were obtained and discussions were held regarding the various geological, geotechnical and hydrogeological concerns. A number of technical reports were also obtained for review. Structural geological information was obtained from Mr. R. Tolbert, geologist, who is on contract to Cyprus Anvil.

Messrs. A. Stewart and A. Holmes visited the mine between October 28 and November 1, 1985 to inspect field conditions and review relevant information in Cyprus Anvil's files. Although the presence of snow made the field inspections somewhat difficult, and a number of features were not easily observed, a general impression of overall field conditions was obtained. Following completion of the field visit, brief discussions were held with Mr. B. Fairbairn of Kilborn Engineering, at which time our preliminary findings and the proposed mining plan were outlined and discussed.

Included in the following are our preliminary findings and our proposal for Phase 2 geotechnical and hydrogeological studies.

# 2. PRELIMINARY FINDINGS

Based on the site visit and discussions with Cyprus Anvil and other personnel, a number of general observations regarding existing surface water, groundwater and geotechnical conditions can be made, as discussed in the following:

## 2.1 SURFACE WATER AND GROUNDWATER CONCERNS

In the order of one million gallons of surface flow or subsurface seepage enters the pit every day, about one-third of which appears to be seeping from the Faro Creek diversion channel. An additional one-third of the flow appears to be seeping from the Faro Valley alluvium on the north wall (a portion of this flow is being collected by drainholes), with the remaining one-third being due to precipitation and general seepage from the bedrock and overburden. At this stage, it would appear that control of these different sources of water can be achieved with varying degrees of success in the different areas of the pit.

### 2.1.1 Seepage from Faro Creek Diversion Ditch

The significant amount of seepage from the existing Faro Creek diversion ditch has a detrimental effect on both slope stability and operations. Thus, it is suggested that lining of the ditch be carried out. Towards this end, we understand that consideration has already been given to installing a sealed metal culvert in this ditch which, if installed and maintained properly, should minimize the amount of diverted water entering the pit.

### 2.1.2 Seepage from Near Overburden/Bedrock Contact

An unknown but likely significant quantity of seepage (that is part of the general seepage from the overburden and bedrock that enters the pit from all walls) appears to flow through the overburden towards the pit along the northeast wall. A major portion of this seepage probably flows along or very close to the overburden/bedrock contact, eventually either seeping out of the pit face, or into steeply dipping structures (i.e. faults, joints, contacts, etc.) associated with the Big Indian Fault Zone and its apparently numerous splays. This seepage, which is not intercepted by the Faro Creek diversion ditch, almost certainly adversely influences the overall stability of the slope, as well as causing various operational problems.

In the past, attempts at intercepting seepage at or above the bedrock/overburden contact have been made by excavating, and in some areas lining, ditches on the 4190 and 4030 benches on the pit wall. These ditches have been somewhat successful but have apparently leaked, particularly where they cross the dykes and faults on the northeast wall. At the present time, due to deterioration of the pit walls, the ditches do not extend far enough to the north to adequately intercept the seepage at or above the bedrock/overburden contact. In addition, these ditches are, for part of the wall, situated on the hanging wall side of the Big Indian Fault Zone and associated dykes and thus are not able to intercept seepage before it enters this fault zone.

Based on discussions with Mr. R. Tolbert, it is suggested that the optimum location for an interception ditch may be downslope of the Faro Valley access road on about the 4300 ft level, where it is thought that a ditch through the bedrock/overburden contact could be established at a depth of 2m to 3m. Such a ditch would probably have to be lined, at least in areas where it crosses the faults and dykes that strike approximately normal to the pit wall. In addition, to help intercept seepage that bypasses or otherwise is not intercepted by the proposed ditch, the existing ditches on the 4030 and 4190 levels should be rehabilitated and maintained. The feasibility of implementing the above ditching system and the details with regard to locating, planning, designing and constructing such a system are beyond the scope of this phase of the studies and should be investigated further. While it may be more practical to carry out some of this work in the summer, at least preliminary planning could be conducted during the winter months.

### 2.1.3 Seepage from Faro Valley Alluvium

It is uncertain at this time whether the seepage flowing from the Faro Valley alluvium will have any further impact on the overall stability of the north wall. This portion of the pit (referred to as the Zone 1 Pit) has already been excavated to its final limits and should not impact directly on the stability of the Zone 3 Pit that is considered in this report. However, if a haulroad is to be located at the toe of the north wall, some further assessment of the stability of this wall may be necessary.

The prime concern of the seepage flowing from the Faro Valley alluvial sediments would appear to be operational. That is, it may be more cost effective to intercept as much of the seepage as possible before it reaches the pit. In this regard it has been suggested that a series of wells be installed upstream of the waste dump in Faro Valley (and downstream of the creek diversion) to intercept the subsurface alluvial flow. Depending on a number of factors, including the thickness of the saturated sediments, such a dewatering scheme could be expected to intercept between 40% and 80% of the flow in the alluvium. The remainder of the flow would eventually surface in the drainholes or on the pit face and would have to be handled by an in-pit system of ditches, sumps, pumps, etc. While the exact number and configuration of wells is not known at this time, it is estimated that it would cost in the order of $12,000 to drill, develop and make operational each well, assuming power is already available in the area of the proposed wells. Ongoing power and maintenance costs would be in addition to the above cost estimate.

### 2.1.4 Recirculation of Pit Sump Water

Based on discussions with Mr. R. Tolbert, there is a distinct possibility that water pumped from the pit sumps is flowing back into the pit through the waste rock. If this situation does in fact exist, it could most easily be solved by extending the pump discharge line.

### 2.1.5 Wet Blastholes in Ore Zone

It is understood that the occurrence of wet blastholes has been of considerable concern during past operation of the pit. Based on our review of a dewatering test program conducted by mine staff in the ore zone, it would appear that the ore is relatively permeable and should be able to be drained, either by gravity or by pumping. Thus, it is suggested that, where possible, the orebody be mined in such a way that the water in the ore is able to drain into a sump. The proposed scheme of mining the pit in a series of slices from north to south should act to provide such a sump (except during Phase A of mining) and should greatly assist gravity drainage in most areas (except possibly near the pit bottom). Should it not be possible to always maintain a sump in the ore zone, it should be possible to dewater the ore zone using pumped wells. At this time it is felt that an initial pumping scheme could be designed based on existing information, and that after initial trials the pumping scheme could be optimized. It is anticipated that once the ore zone is reached, all well drilling can probably be handled by blasthole drill rigs. Re-establishment of the wells would be required as the pit is deepened in the ore zone.

### 2.1.6 Wet Blastholes in Waste Rock

The occurrence of wet blastholes in the schistose rocks of the Mt. Mye Formation is understood to be only a sporadic problem. Based on discussions with mine personnel and our brief assessment of this problem, it would appear that most of the water in the blastholes is originating as surface water in the subgrade and not as seepage from the rock mass as a whole.

Should it be required, a reduction in the number of wet blastholes in the schistose rocks of the Mt. Mye Formation could probably be accomplished by implementing a program including improved control of blastholes, grading of benches, provision of in-pit ditches and drains to promote drainage, etc.

Effective drains could possibly be established by developing a deeper subgrade along one or two rows of blastholes, and ensuring that this deeper subgrade (acting somewhat like a "french drain") is continuously developed to the crest of the working bench. If utilized, these "french drains" should be developed on benches along the eastern wall of the pit, but should not be developed on final benches. They should be located adjacent to the final benches, so that they are mined out as part of the last blast pattern which creates the bench face on the final wall.

"French drains" can be developed by increasing the subgrade depth on the previous bench along one or two rows of drainholes parallel to the east wall. If possible, the deepened subgrade should slope to the north or south so that intercepted water is easily conducted to the edges of the bench where it can be directed towards pit sumps.

### 2.1.7 Depressurization of Northeast Wall

While the possibility of depressurizing or dewatering the Mt. Mye Formation as a whole appears to be slight, the possibility of dewatering discrete fractures or faults, such as those that are associated with the

Big Indian Fault Zone and the contact with the intrusive rocks, appears to be favourable. These features are probably best dewatered by subhorizontal drainholes.

## 2.2 SLOPE STABILITY CONCERNS

The geologic interpretation of the northeast wall of the pit does not seem to have changed significantly from that discussed in our report of January, 1976. Stability of the northeast wall appears for the most part to be a function of the same parameters. That is, planar failures primarily parallel or subparallel to foliation, or wedge failures involving both foliation and other joints or faults, appear to be the prime modes of failure. High groundwater conditions continue to have a significant influence on wall stability. With increased exposure of the northeast wall it would also now seem that the Big Indian Fault Zone and associated dykes and contacts play an important role in the stability of this wall. Besides apparently acting as a back scarp for many of the failures that have occurred to date, the faults and dykes and contacts appear to contain a significant amount of water, which no doubt adversely effects the stabilty of the northeast wall.

In the past, numerous failures have occurred on the northeast wall, with most of the movement occurring in the summer months. Based on mine records, the wall was initially excavated according to design recommendations contained in our January, 1976 report for a dewatered slope where controlled blasting had been effectively utilized. However, it is evident that the northeast wall has probably always been subjected to high groundwater conditions and that controlled blasting has either not been tried to any extent or has met with little or no success to date. According to internal mine memos, consideration was given to flattening the overall slopes but it is uncertain as to whether, and at what overall slope angle, flattening was attempted. It is known, however, that the present overall slope angle along the northeast wall is about 35°. A brief review of a number of internal memos at the mine indicates that while some of the slope failures observed in the past involved a number of benches, these failures were thought to be relatively shallow and not deep seated.

At this stage it would seem that significant steepening of the wall (i.e. beyond the original slope design) in the muscovite/biotite schistose rocks may not be possible. It would also seem that continued mining of the wall at the present slope angle could be jeopardized unless such remedial measures as controlling the portion of the surface water and groundwater that is easily intercepted by ditches, drainholes and wells (e.g. such as is present along discrete faults, contacts, etc.), and implementing an effective program of controlled blasting, are undertaken. Additional safety to personnel and equipment working in the pit could also be achieved if mining adjacent to the final wall could be scheduled for winter months when slope movements have traditionally been at a minimum, or if the mining plan could be altered to include a rock waste buttress along portions of the slope where the final wall has been achieved. While measures such as these may in the end not be possible, it is suggested that they be considered in the planning that is presently being undertaken. The use of a buttress could not only assist slope stability but could also reduce waste haulage costs. Further work to assess the stability of the northeast wall of the pit is discussed below in our Phase 2 proposal in Section 3.2.

## 3. RECOMMENDATIONS AND PROPOSAL FOR PHASE 2 STUDY

Based on the preliminary findings discussed above, a proposed program of work to be carried out in Phase 2 has been developed and is outlined below. From discussions with Mr. B. Fairbairn of Kilborn Engineering, it is understood that, while consideration should be given to the whole of the northeast wall, the initial effort should be directed toward conducting sufficient work to investigate the hydrogeological and geotechnical concerns of the first phase (i.e. Phase A) of the proposed mine plan. This is understood to involve mining the northernmost 400 ft to 500 ft of the Zone 3 Pit (i.e. exposing 400 ft to 500 ft of wall in a north/south direction).

For ease of understanding, the details of the proposal are discussed under the same headings as the preliminary findings. Included under each heading are: i) the recommended work that should be completed to respond to the concerns outlined in the preliminary findings; ii) the proposed level of involvement by Piteau Associates' personnel; iii) the estimated cost for Piteau Associates' services; and iv) the suggested timing for the proposed work. It is noteworthy that for some of the tasks it is anticipated that little or no further involvement by Piteau Associates' personnel is anticipated. In these cases, all further work can probably be completed by mine staff. In addition, some of the tasks do not have to be completed immediately, or may be deemed to be unnecessary in the context of the overall engineering and mine planning. Thus, an assessment of the need for and timing of estimated expenditures should be made. A breakdown of estimated costs for all tasks in the Phase 2 study is included in Table I as well as being summarized in the following text.

## 3.1 SURFACE WATER AND GROUNDWATER CONCERNS

### 3.1.1 Seepage from Faro Creek Diversion Ditch

We feel that further studies to determine the actual amount and effects of seepage from the diversion ditch are unwarranted, and that a properly designed lined ditch or culvert should be installed as soon as possible. At this time, no further input by Piteau Associates' personnel is felt to be required.

### 3.1.2 Seepage from Near Overburden/Bedrock Contact

As discussed in Section 2.1.2, there will be some shallow groundwater flow occurring through the base of the surficial sediments and in the shallow, weathered and fractured rock. To mitigate the effects of such seepage, existing ditches constructed on the 4030 and 4190 levels should be properly rehabilitated and maintained. In this regard, it is recommended that mine personnel conduct an initial inspection of these ditches in the spring, after the snow has melted, to determine their present condition. Rehabilitation and extension of the ditches to the north can then be undertaken. However, as neither of these ditches exist north of about 8500N, and as both benches are in very poor condition north of this point, it is doubtful that these ditches could be extended much further to the north.

As discussed, it may be possible to construct a ditch near the crest of the present slope, at approximately the 4300 ft elevation. Before this construction is undertaken, it would be desirable to delineate the depth to and quality of bedrock, as well as the saturated thickness and estimated quantities of shallow groundwater flow. These data would be used to evaluate the benefits of a ditch at this elevation, as well as provide design criteria for the ditch. Costs for an investigation to determine subsurface conditions along the proposed ditch alignment and to provide design recommendations in a brief letter report are estimated to be about $3,930, of which $2,640 are fees and $1,290 are direct costs (see Table I). It is assumed that a backhoe, suitable for digging test pits to determine subsurface conditions along the ditch alignment, would be provided by the mine for a period of about two days.

The study could be carried out at any time, and could be completed within about 3 weeks of authorization to proceed. However, it is recommended that the work be delayed until after the Faro Creek diversion ditch is lined and the effect of the lined ditch can be assessed by mine personnel (probably in the spring).

### 3.1.3 Seepage From Faro Valley Alluvium

If required, and as discussed in Section 2.1.3, it should be possible to intercept 40% to 80% of the groundwater in the Faro Valley by constructing a row of wells in the valley. However, this option is only considered to be attractive if it significantly reduces pumping costs from the in-pit sump, as it does not appear to be mandatory from a stability point of view. If wells are to be installed, it would be advisable to conduct a seismic refraction survey across the valley to determine the bedrock profile and possibly the depth to the water table. The cost of the seismic refraction survey, estimated to be about $7,380, would be small in comparison to the overall cost of the wells, and would assist in locating optimum well sites and in estimating present seepage quantities. To keep costs to a minimum, it is assumed that the mine could provide a technician or labourer to assist with the field work. It is also assumed that suitable explosives for the seismic refraction survey would be available on-site and provided by the mine.

It should be noted that, due to frozen ground conditions (which can result in poor quality seismic data), it would be difficult to carry out the geophysical program before late spring. If the seismic refraction study were carried out in late spring, the mine would probably be operating and there could be problems with ground "noise". However, we feel that these problems could be overcome by scheduling data collection intervals to coincide with work breaks in the mine.

If the seismic refraction study is undertaken, it may be advantageous to seismically investigate some portions of the proposed alignment for a seepage interception ditch on the 4300 ft level (see Section 3.1.2). Consideration could be given to this additional seismic work if the initial investigation, discussed in Section 3.1.2, indicates it would be worthwhile.

If the seismic refraction survey of the Faro Valley alluvium indicates a thick saturated zone exists, wells would be capable of intercepting a large portion of the total groundwater seeapge. Wells could be installed using the air rotary drilling method. In this regard, we estimate that it would cost about $6,500 to drill, complete and develop each well, and an additional $5,000 to purchase and install a pump in each well. These estimated costs assume that a number of wells are drilled (to reduce mobilization costs per well) and that power is available close to the well sites.

If the construction of a groundwater interception well field is to be undertaken in the Faro Valley, it is recommended and proposed that a hydrogeologist be on-site for the drilling of the first two wells. Subsequent wells could be located based on the results of the geophysical survey and the data from the first two wells, and supervision could be provided by mine personnel. Following construction of the wells, initial monitoring data should be reviewed by a hydrogeologist to determine the effectiveness of the system, and the optimum pumping schedules. Our costs for this proposed involvement are estimated to be about $7,550, of which $5,720 are fees and $1,830 are direct costs (see Table I).

If the proposed seismic refraction survey is carried out, this study would not likely commence until June, 1986. We estimate it would take about two months to complete the entire program, including well construction. At the conclusion of the study, a brief report summarizing all aspects of the study would be prepared.

### 3.1.4 Possible Recirculation of Pit Sump Water

As discussed in Section 2.1.4, it would be advisable to extend the discharge line from the sump pumps to ensure that recirculation of in-pit water does not occur. The line should be extended to a point at which there is no doubt that the discharged water is moving towards the tailings pond. At this time, no further input by Piteau Associates' personnel is felt to be required.

### 3.1.5 Wet Blastholes in Ore Zone

As discussed in Section 2.1.5, it is very likely that wells and sumps can be used to dewater the ore to the extent that wet blastholes and generally wet operating conditions can be alleviated. We do not feel that any further hydrogeologic testing of the ore zone is required. Thus, it is proposed that Piteau Associates design an initial well field in the operating pit and monitor its effectiveness. In order to conduct this initial design, geological sections and mine plans would have to be reviewed so that well locations could be selected based on hydraulic considerations, surface access constraints and probable length of service of wells (before being mined out). After the wells are installed by mine personnel, the initial monitoring data would be reviewed by a hydrogeologist and design modifications would be made. Guidelines for future well installations would be developed and, after some technical transfer, the program could be supervised by mine personnel.

Once mining of Phase A is completed, it may be possible to maintain dewatered ore with gravity drainage and sumps, but this would be addressed when Phase B mining is about to commence.

The cost to review mine plans and sections, design and modify a well field, develop design guidelines, train mine personnel in design and operation of wells, and prepare a brief report summarizing our findings is estimated to be $5,710, of which $4,240 are fees and $1,470 are direct costs (see Table I). The timing of this study should coincide with the onset of mining in the ore zone when wet blastholes are first encountered.

### 3.1.6 Wet Blastholes in Waste Rock

As discussed in Section 2.1.6, if wet blastholes in waste rock are a significant operational concern, it will be necessary to reduce the quantity of water in the subgrade. As the solutions discussed in Section 2.1.6 are best designed and implemented by mine personnel, we feel that our involvement would be minimal. However, we would be interested in discussing with mine personnel any problems encountered and the results of any "french drain" trials, but do not anticipate that a budget for consulting services is required at this time.

### 3.1.7 Depressurization of Slopes

If the results of sensitivity analyses (discussed below in Section 3.2) indicate that slope depressurization of the northeast wall is desirable for slope stability purposes, a study to determine the feasibility of depressurizing the pit slopes is recommended. As discussed in Section

2.1.7, our preliminary slope depressurization strategy is to drill subhorizontal drainholes into the dykes and associated contacts and faults on the east wall. To assess the feasibility of this strategy, permeability data for the dykes and associated contacts and faults would be required. In this regard, it is proposed that this data be obtained as part of a two-stage program which would include:

i) Installing and testing piezometers
ii) Installing trial drainholes and monitoring their effect in the piezometers

Using a small airtrack drill, piezometers would be installed from final or working benches in both schistose and intrusive rocks. Falling head tests would be conducted in these piezometers to provide estimates of hydraulic conductivity which would be used as input in an initial evaluation of the feasibility of using drainholes to depressurize the slope. Assuming the hydraulic conductivity tests in the piezometers and the initial evaluation indicates indicate favourable results, trial drainholes would be installed from the existing benches. The piezometers could then be used to monitor the effect of the drainholes.

Following data collection and data reduction, a brief finite-element modelling study would be performed to predict the long term effectiveness of installing horizontal drains as a means of depressurizing the whole of the northeast wall. Finally, a brief report summarizing our findings would be prepared.

Our costs for the above studies are estimated to be $7,970, of which $5,840 are fees and $2,130 are direct costs. Considerably higher costs would be incurred, however, in contracting a drill rig that is capable of installing the trial drainholes. At this time, it is estimated that a mobilization cost of about $20,000 and a drilling cost of about $18,000 (i.e. 300m of test drainholes @ $60/m) would be expended if a contractor were hired to install the trial drainholes, complete with plastic liners.

As can be seen from the above estimate, it would be advisable to separate the study into two stages so that the drainhole drill rig would not be mobilized unless the first stage results were promising and an extensive drainhole program was likely to be undertaken.

While the timing of the study is somewhat flexible, it is suggested that the Stage 1 portion of the work (i.e. installing and testing piezometers and conducting a preliminary evaluation) be conducted contemporaneously with the slope stability study outlined below in Section 3.2. The Stage 2 portion of the work would be delayed until the results of the slope stability study and the Stage 1 portion of the work both indicated results favourable to the success of Stage 2.

## 3.2 STABILITY OF THE NORTHEAST WALL

Considering that the overall geological interpretation of the northeast wall does not seem to have changed appreciably since our previous involvement at the mine approximately ten years ago, and considering the time of year, it is proposed that an update study, primarily consisting of an office assessment of the most recent geological model, is the most practical method of assessing the stability of the northeast wall at this time. In particular, it is recommended that approximately three geologic sections be developed for the whole of the proposed wall. These sections would be selected to be typical of the various geologic conditions and proposed wall orientations and to contain as much geotechnical and hydrogeological data as possible. The relevant data would primarily be obtained from mapping and core logging data that presently exists in Cyprus Anvil's files, and would include the location of faults, dykes, etc. that could act as back scarps for failures, and/or could fill with water. It is recommended that much of the work be done by or in association with mine personnel (such as Mr. G. Jilson) who are very familiar with the geology and the geological data base. At the same time as the sections are being prepared, all relevant mapping data that is present in the Cyprus Anvil structural mapping data base would be compiled and processed. A geologic structural analysis of the foliation and the various fault and joint sets would be carried out and the results compared with our previous structural analysis.

Following the geologic structural analysis and preparation of the sections, stability analyses would be carried out for each section for both the proposed overall slopes and bench scale slopes. Initial strength values would be obtained from our previous work and from the results of back analyses of failures performed by mine personnel during operation of the mine. Sufficient analyses would be conducted such that an evaluation of the sensitivity of such parameters as strength, groundwater conditions, etc. could be evaluated. Based on the results of these analyses, and the results of a relatively brief site reconnaissance conducted following the spring thaw, the slopes would be redesigned as necessary and an evaluation of the potential benefits of dewatering, control blasting, etc. would be conducted. Where relevant, the results of the other surface water and groundwater studies discussed above would be included in the analyses and re-evaluation.

A report describing the work, engineering geology, analytical procedure results, and recommendations would be prepared. The report would also contain a summary of all of the pertinent data used in the investigation. Remedial measures for maintaining the slope in a stable condition and monitoring the slopes for instability would be discussed.

The timing of the study will determine whether the site reconnaissance should be made during or after the main portion of the structural and stability analyses. While it is felt that sufficient data is presently available to begin the study and to conduct the above discussed sensitivity analyses without conducting a detailed site reconnaissance, such a reconnaissance is felt to be necessary at some point. This field work will allow a proper assessment of actual field and geological conditions (including slope documentation) to be made before all design recommendations are finalized. Possibly the field work could be conducted in conjunction with other tasks in the overall study.

The cost for the stability assessment of the whole of the northeast wall is estimated to be $25,490. Should it be decided that only that portion of the wall to be mined during Phase A of the pit development will be assessed at this time, some cost savings could certainly be achieved. However, the cost savings would not likely be in direct proportion to the percentage of the wall investigated at the time (i.e. if only one-third of the wall were studied, it is likely that cost savings would only be about one-half, rather than two-thirds).

## 3.3 PRIORITY AND SCHEDULING

To a large extent, the priority and scheduling of the proposed studies described above in Section 3 depends on the needs and schedule of the mine re-opening. Howver, a suggested schedule, based strictly on hydrogeological and geotechnical needs, has been discussed in each of Sections 3.1.1 and 3.2.

It should be noted that some cost savings may be possible if various tasks are scheduled at the same time. For example, it should be more effecient and cost effective to conduct the field work for more than one task during the same site visit.

## 3.4 PROJECT PERSONNEL

Project personnel for the Phase 2 study would consist primarily of the same personnel that conducted the Phase 1 study. That is, geotechnical aspects would be conducted primarily by Mr. A. Stewart, with assistance from Mr. D. Martin, both of whom have carried out previous work at Anvil Mine. Mr. A. Holmes, senior hydrogeologist, would carry out most of the hydrogeological aspects. Other staff members, such as junior engineers and a geophysicist, would provide support as required.

## REFERENCES

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Piteau, D.R. & Associates Limited. August, 1977. Letter report to Cyprus Anvil Mining Corporation concerning a failure in the northeast corner of the Faro Open Pit.

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TABLE I

SUMMARY OF COST ESTIMATES

FOR PITEAU ASSOCIATES' SERVICES

| TASK | WORK ITEM | TIME (DAYS) | | | | | TOTAL FEES | DIRECT COSTS | TOTAL COSTS |
|---|---|---|---|---|---|---|---|---|---|
| | | STEWART (500/DAY) | HOLMES (420/DAY) | GEOPHYSICIST (440/DAY) | JUNIOR ENGINEER (320/DAY) | SECRETARIAL/ DRAFTING (240/DAY) | | | |
| SEEPAGE FROM FARO CREEK DIVERSION DITCH | | NO INPUT FROM PITEAU ASSOCIATES ANTICIPATED | | | | | - | - | - |
| SEEPAGE FROM NEAR OVERBURDEN/BEDROCK CONTACT | INVESTIGATE SUBSURFACE CONDITIONS ALONG PROPOSED DITCH and PREPARE BRIEF REPORT | - | 6 | - | - | ½ | 2,640 | 1,290[1] | 3,930 |
| SEEPAGE FROM FARO VALLEY ALLUVIUM | SEISMIC REFRACTION SURVEY | - | - | 6 | 6 | ½ | 4,680 | 2,700[2] | 7,380 |
| | DESIGN AND IMPLEMENTATION OF WELLS AND PREPARATION OF BRIEF REPORT | - | 12 | - | 1 | 1½ | 5,720 | 1,830[3] | 7,550 |
| | | | | | | | 10,400 | 4,530 | 14,930 |
| RECIRCULATION OF PIT SUMP WATER | | NO INPUT BY PITEAU ASSOCIATES ANTICIPATED | | | | | - | - | - |
| WET BLASTHOLES IN ORE ZONE | REVIEW MINE PLANS, DESIGN and MODIFY WELL FIELD, TRAIN MINE PERSONNEL, etc. | - | 8 | - | 2 | 1 | 4,240 | 1,470[4] | 5,710 |
| WET BLASTHOLES IN WASTE ROCK | | NO INPUT BY PITEAU ASSOCIATES ANTICIPATED | | | | | - | - | - |
| DEPRESSURIZATION OF SLOPES | INSTALLING AND TESTING PIEZOMETERS | - | 8 | - | 1 | 1 | 3,920 | 1,890[5] | 5,810 |
| | INSTALLING AND MONITORING TRIAL DRAINHOLES, EVALUATING RESULTS and PREPARATION OF BRIEF REPORT | - | 4 | - | - | 1 | 1,920 | 240[6] | 2,160 |
| | | | | | | | 5,840 | 2,130 | 7,970 |
| STABILITY OF THE NORTHEAST WALL | FIELD RECONNAISSANCE, REVIEW MINE PLAN, etc. | 7 | - | - | - | - | 3,500 | 1,830[7] | 5,330 |
| | DATA COMPILATION and PREPARATION OF DESIGN CROSS SECTIONS | 3 | - | - | 7 | 2 | 4,220 | 1,000[8] | 5,220 |
| | STRUCTURAL GEOLOGIC ANALYSIS | 2 | - | - | 3 | - | 1,960 | 300[9] | 2,260 |
| | STABILITY ANALYSIS | 2 | 1 | - | 5 | - | 3,020 | 300[10] | 3,320 |
| | REPORT PREPARATION | 8 | 1 | - | 10 | 6 | 9,060 | 300[11] | 9,360 |
| | | | | | | | 21,760 | 3,730 | 25,490 |

NOTES:
1. Includes: One (1) return airfare ($550); vehicle rental ($400); accommodation and meals ($240); miscellaneous ($100). It is assumed that a backhoe would be provided the mine for a period of two (2) days.
2. Includes: Two (2) return airfares ($1100); vehicle rental ($400); accommodation and meals ($480); equipment rental ($320); freight and miscellaneous ($400). It is assumed that the mine would provide a technician or labourer to assist with the field work and that suitable explosives for the seismic refraction survey would be available and provided by the mine.
3. Inclues: One (1) return airfare ($550); vehicle rental ($100); accommodation and meals ($480); miscellaneous ($100).
4. Includes: One (1) return airfare ($550); vehicle rental ($400); accommodation and meals ($240); computer usage ($280).
5. Includes: One (1) return airfare ($550); vehicle rental ($600); accommodation and meals ($400); computer usage and miscellaneous ($340). It is assumed that an airtrack drill would be provided by the mine for a period of three (3) days.
6. Includes: Computer usage ($240).
7. Includes: One (1) return airfare ($550); vehicle rental ($700); accommodation and meals ($480); miscellaneous ($100).
8. Includes: Computer usage ($1,000).
9. Includes: Computer usage ($300).
10. Includes: Computer usage ($300).
11. Includes: Report reproduction and miscellaneous expenses ($300).