VANCOUVER GEOTECHNICAL SYMPOSIUM

RISK AND LIABILITY IN GEOTECHNICAL ENGINEERING

MAY 27, 1988

TWO CASE STUDIES INVOLVING LITIGATION AND THE GEOTECHNICAL ENGINEER - SOME USEFUL LESSONS

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CASE STUDY NO. 1.

In the latter part of 1983, the Good Times Development Corporation ("Good Times") retained Raintree Engineering Services Ltd. ("Raintree") to study the potential development of Phase 2 of an Industrial Park being developed near Raindrop, B.C. In 1983, Raintree issued a feasibility study in which it proposed alternate plans and development costs for the expansion of the Industrial Park. Later in 1983, Good Times retained Raintree to consider the expansion of Phase 2 of the development to include the foreshore of Franklyn Bay and to develop a cost estimate for the construction of the development. In April of 1984, Raintree issued a further report including the development of the foreshore of Franklyn Bay, together with an estimate of development costs. In July of 1984, in response to a request from Good Times, Raintree issued a further report estimating costs for development on the basis of a phased construction schedule. Good Times, finding this last cost estimate economically feasible, then instructed Raintree to prepare the necessary tender documents for construction.

In order to prepare the feasibility study, Raintree requested the geotechnical engineering firm of Rocky Engineers Ltd. ("Rocky") to prepare a proposal for geotechnical services for Phase 2 of the proposed Industrial Park development. By letter dated February 19, 1983, (copy attached) Rocky submitted their proposal for preliminary geotechnical services to Raintree. On April 8, 1983, Rocky was retained by Raintree as a subconsultant to perform preliminary geophysical services at Phase 2 of the Industrial Park development. Rocky conducted an investigation of the site on April 15 - 17, 1983. During the investigation, five back-hoe test pits were excavated to bed rock where access was feasible. Peat thickness was determined at regular intervals at prescribed survey lines, using a manual peat probe. In addition, a geophysical survey was carried out over the fill area using a

signal enhancement seismograph. All field work was carried out under the full time supervision of a member of Rocky's engineering staff. Unfortunately, Rocky was unable to gain access to a large portion of the site as had been promised by Raintree, due to unfavourable terrain and site conditions. As a result, the seismographic survey results were poor and only five test pits could be excavated. The bulk of Rocky's activities centred upon determining the depth of peat covering the site.

On April 24, 1983, Rocky submitted a report (copy attached) to Raintree detailing the results of their investigation and their conclusions and recommendations for the planning and design of the proposed Phase 2 site development. At page 3 of that report, Rocky states as follows:

> "The peat deposits are underlain by a layer of till up to 0.5 meters thick containing occasional layers of loose medium to coarse sand. The till overlies the hard sedimentary bedrock of the area."

In preparing the tender documents for Good Times, Raintree relied upon the report prepared by Rocky which indicated that less than .5 meters of glacial till could be expected. As such, no cost provision for removal of glacial till was included. Apparently, Raintree also had in their possession other conflicting soils reports which pointed to the possibility of greater amounts of glacial till and other unsuitable materials being encountered. According to Good Times, these conflicting soils reports were never brought to their attention and, as such, they relied upon Raintree's tender documents which indicated a limited presence of glacial till.

Goodtimes submitted the project to tender and the lowest bid was received from Overburden Constracting Ltd. ("Overburden"). Overburden's price did not include a price for removal of glacial till or other substances not covered in the tender documents. The work to be performed by Overburden was a cut and fill balance earth moving contract to construct a dyke on the north/south foreshore, as well as to clear and grub the land. The rock for the dyke construction was to be provided from a rock quarry near the construction site. In December of 1984 and January of 1985, test drilling determined that there was overburden and glacial till on top of the quarry greatly in excess of .5 meters. As a result, Overburden could not get at the necessary rock to build the rock dyke without first handling the overburden and till materials. Overburden then made a demand for payment in excess of $700,000.00 which included equipment stand-by costs incurred because the contractor could not proceed with the work. Additional engineering costs were also incurred by Raintree. Good Times refused to pay Overburden's $700,000.00 claim, and the claim by Raintree for an additional $140,000.00 in engineering fees.

Raintree then commenced legal action against Good Times seeking recovery of its engineering fees. Good Times defended the claim by alleging that by reason of the negligence of Raintree, Phase 2 of the project was uneconomical from its inception. Good Times, therefore, claimed a set-off against Raintree's claim in an amount equal to the contracting and engineering fees paid for this Phase of the project. In its defence to the claim brought by Raintree, Goodtimes added a claim against Rocky Engineers Ltd. and its principal, Mr. Digger.

A parallel action was commenced by Overburden Contracting against Good Times, as well as Rocky Engineers. Overburden and Good Times each alleged that Rocky and its principal, Mr. Digger, negligently misstated the true condition of the site and breached their duty to warn. Overburden went further and alleged that Rocky and its principal had been guilty of fraudulent misrepresentation of the true state of the site.

We were retained to act on behalf of Rocky and Mr. Digger with respect to the allegations advanced by Overburden Contracting and Raintree Engineering.

Attached to this case study are the following documents:

1. Proposal letter dated February 19, 1983, from Rocky Engineers to Raintree.

2. Report of Rocky Engineers to Raintree on Site Investigation Industrial Park - Phase 2.

3. Sketch of proposed development area.

(1205SWF1.SPE)

E/80/227
February 19, 1983

Raintree Engineers Ltd
Vancouver, B.C.

ATTENTION: P. Eng.

Re: Site Investigation
Geophysical Investigation Services
Industrial Park - Phase II
Raindrop, B.C.

Dear Sirs:

Further to your request of February 15, 1983 we are pleased to present our proposal for provision of geotechnical services. It is understood that the purpose of the geotechnical study is to define the soil, rock and ground water conditions at the proposed site and to provide recommendations as to the required treatment of the properties for site preparation and servicing.

The proposed site is understood to be located as shown on Raindrop Franklyn Bay drawings 34176-8, 1 and 2. The site is immediately west of and south of the Phase 1 development of the industrial park. We understood that the proposed development area is approximately 650 m by 350 m in plan. The site is presently tree covered but it is understood that a clearing contract will be undertaken before this investigation proceeds.

Based on available information we believe that the site which slopes to the west at about 1 vertical to 8 horizontal is probably rock controlled at shallow depth. The bedrock, a hard sedimentary rock, is overlain by minor outwash and glacial debris, and by forest litter. Depressions in rock and soil profile are probably infilled with peat and organic matter at some locations.

PROPOSED INVESTIGATION

In order to provide the required information for planning and design of site development, we propose to undertake the field work in several stages. In this way the extent of the investigation may be limited to that required to provide the results desired.

The first stage would involve a detailed backhoe test pit investigation and overall geotechnical appraisal of the site. We anticipate that

the bedrock surface can be defined, and the overburden stratigraphy and ground water conditions identified using this technique. It is probable that about 2 days backhoe and supervising engineering time would be spent at this initial stage. We have assumed that the site will be cleared at the time of investigation and that access will be adequate. If the probable road and service corridor locations are known at this time the above data would be augmented by a second stage geophysical survey. This survey would provide additional bedrock profiles where excavation is considered, or where a balance of cuts and fills is required. Further, geophysical profiles could be determined along service alignments to define the extent of rock excavation.

A third stage investigation involving drilling to define overburden properties and bedrock would only be carried out if required. We do not envisage the necessity for such a program at this time.

GEOTECHNICAL REPORT

Based on the results of the above investigation we would provide the following information:

1. Soil stratigraphy and bedrock profiles for proposed development areas.

2. Ground water and seepage conditions.

3. Definition of construction properties of soils and rock, i.e. suitability of cuts, rippability of rock, general design parameters.

4. Design recommendations for cuts and fill materials, and slope design.

5. Site preparation for seepage control.

6. Design requirement for road pavements and service foundations.

7. Indentification of problem areas for subsequent development or structures.

ESTIMATED COST

All work would be carried out in accordance with the attached Schedule of Rates. All charges for rental of such equipment as backhoes seismic and drilling equipment would be charged at cost plus 5 per cent. All legitimate expenses for travel, communication, room and board, report preparation would be also charged at cost plus 5 per cent.

We estimate that the field investigation costs would be as follows:

Stage I	Test Pit Investigation and Geotechnical Survey	
	Estimated Cost	$ 2,000
Stage II	Seismic Survey of Cut Areas and Service Corridors	
	Estimated Mobilization Cost	$ 500
	2 Days at Estimated Cost Per Day of $500	$ 1,000
	Total Estimated Cost Stage I and II	$ 3,500
Engineering Analysis, Report Preparation and Meetings		
	Estimated Cost	$ 1,500
	TOTAL ESTIMATE	$ 5,000

If the seismic survey was considered unnecessary at the completion of Stage I, the total estimated cost would be $3,500.00.

We would be pleased to be of service on the project and would be prepared to undertake the work on your notice to proceed. We are experienced in working with design teams and would be prepared to discuss the information obtained and its significance as the project progress.

We enclose a copy of our general brochure for your information.

Yours very truly

"Rocky Engineers Ltd"

ROCKY ENGINEERS LTD.

GEOTECHNICAL ENGINEERS

April 24, 1983

Raintree Engineers Ltd.
Vancouver, B.C.

Re: Site Investigation
Industrial Park
Phase II
Raindrop, B.C.

Dear Sir:

As requested, Rocky Engineers have carried out a site investigation for the above project. The purpose of this investigation was to determine the soil, rock and ground water conditions at the site. This report presents the results of the investigation together with preliminary geotechnical recommendations for the planning and design of the proposed Phase II site development.

1.0 SITE CONDITIONS AND PROPOSED DEVELOPMENT

The proposed Phase II site is located between Bay and the Highway, immediately south of the Phase I development of the industrial park on the eastern side of Island (see Figures 1 and 2). The site is approximately 630 m by 350 m in plan with elevations ranging from 60.0 m geodetic at the western edge to sea level at the eastern edge. The site is, at present, largely tree covered and access is extremely limited. The central portion of the site has been infilled with peat and

wood debris from the Phase I development. A rock fill berm has been constructed along the eastern edge of the northern section of the infilled area to retain the fill. A large flow slide failure involving the fill material has occurred in the southern section of the fill area. Debris from the slide extends 30 m into Franklyn Bay.

The proposed site development consists of 42 serviced industrial lots with a collector road network as outlined on Raintree drawing 34176-8-2 (see Figure 2). It is understood that the proposed development shown is preliminary and may be altered to suit the site conditions.

2.0 FIELD WORK

A detailed investigation of the Phase II industrial park site was carried out April 15th to 17th, 1983.

During the investigation, 5 backhoe test pits were excavated to bedrock where access was feasible. Samples obtained from the test pits were brought back to our laboratory for classification and testing.

The peat thickness was determined at regular intervals along survey lines 1N, 3N, 5N, and 6N using a 4.5 m by 13 mm diameter manual peat probe. A geophysical survey was carried out over the fill area using a signal enhancement sesimograph. The field work was carried out under the full time supervision of a member of our engineering staff.

3.0 SOIL CONDITIONS

The locations of the test pits and the probe points are shown on the site plan, Figure 2. Cross-sections showing depths of peat encountered along survey lines 1N, 3N, and 6N are shown on Figure 3 and two interpreted

stratigraphic sections are shown on Figure 4. Detailed descriptions of the soils encountered are given in the summary of test pits, Table 1.

The results of the field investigation indicate that the site is covered by surficial peat deposits generally less than 1 m in depth, although a peat bog area was defined in the west central section of the site where peat deposits approximately 4 m deep were encountered (see Figure 2). The peat deposits are underlain by a layer of till up to 0.5 m thick containing occasional layers of loose medium to coarse sand. The till overlies the hard sedimentary bedrock of the area.

The central area of the site has been extensively infilled with peat and wood debris from the Phase I site development. The exact fill thickness has not been confirmed, but analysis of available data indicates that the fill is 6 to 8 m deep.

4.0 RECOMMENDATIONS

4.1 Development Alternatives

We understand that the industrial development being considered is as shown on the attached drawings. The area may be subdivided into the following classifications based on the site conditions and probable grades.

(a) Rock Areas - areas in which bedrock will occur naturally at surface or in which cuts will expose bedrock at final grade.

(b) Peat Areas - areas in which the natural peat deposit will be exposed at final grade.

(c) Fill Areas - areas which will require new granular fills to raise the pits to final grade.

(d) Existing Peat Soil Areas - areas which are overlain by the existing peat spoil fill.

Due to the extreme variation in the conditions as described above, each of these areas must be treated separately.

(a) Rock Areas

In areas where rock is exposed, the major difficulty will be the construction of buried services and excavation. Cuts in the rock may generally be designed at 3/4 horizontal to 1 vertical. Seepage and run-off may be controlled by surface trenches. Because of the large variation in elevation across the site and the shallow depth to bedrock, extensive drilling and blasting will be required to obtain reasonable road and lot grades.

(b) Peat Areas

In areas which are overlain by natural peat at final grade, the adverse properties of the peat must be considered. Due to the limited natural peat thickness, we suggest that the peat be removed and wasted off site where it underlies roads, buried services and structures. Parking or storage grades could be developed over the peat but these will be subject to high total and differential settlements.

A fill thickness of approximately 1.2 m would be required to adequately distribute heavy truck wheel loads to the peat without failure. Settlements of the peat under a 1.2 m fill load would be in the order of 0.3 m where 1 m of peat exists. Preloading could be used to minimize the post construction settlements. This would require a period of approximately 3 months.

All fills should consist of free draining granular materials.

(c) Fill Areas

In areas where fill will be required to achieve the final design grade, we recommend that all organic material such as peat or organic fill be removed prior to granular fill placement. The peat should be excavated to expose the underlying till or bedrock. The excavation side slopes may be cut at 2 horizontal to 1 vertical provided the site is adequately drained.

The granular fill materials may consist of sand and gravel or excavated waste rock. The fill should be compacted in lifts not exceeding 300 to 450 mm, depending upon construction equipment and procedures. The maximum particle size of the fills should not be greater than one-half of the fill lift thickness.

Provided the fills are constructed of free draining granular material as discussed above, they may be constructed with permanent side slopes of 1-1/2 horizontal to 1 vertical.

Buried services may be constructed in the fills provided they are adequately compacted. Fine grained granular bedding should be provided. All excavation side slopes should be cut to slopes as discussed above.

(d) Existing Peat Spoil Area

The existing peat spoil is an unsuitable material to act as a subbase for construction. Due to the organic content, loose density and thickness, we do not believe that preloading would be satisfactory to reduce long term settlements to acceptable values.

Therefore, we believe that the existing spoil should be removed if the area is to be developed, or the area be left undeveloped if it is too expensive to remove it. Removal would be expensive because of the large

amount of material involved and the difficulty of handling the fill which contains a large amount of wood debris.

It is possible that this area could be used for light, open storage in the long term but any increased loading will cause large and highly variable settlements extending over a long time period. We do not recommend that the area be serviced by buried services if the peat spoil is not removed.

If the existing peat spoil area is retained, care should be taken that the existing dyke is not disturbed. An additional toe berm should be provided to achieve an overall frontal slope not steeper than 1-1/2 horizontal to 1 vertical.

4.2 Preliminary Site and Foundation Design

We believe that the proposed development is more conducive to total development as opposed to individual lot development. This would allow control of surface run-off, disposal of spoil materials, and suitable excavation techniques.

Assuming that the peat is removed, all the materials encountered will provide good foundations of high bearing capacity with typical values for the overburden and rock of 290 kPa and 580 kPa, respectively. Settlements at these loadings will be negligible. Spread or strip footings should have minimum widths as described by the applicable building codes. All floor slabs may be founded at grade but should be provided with a free draining granular base course.

The peat stratum is unsuitable for structural support. Fills may be used for structural support provided they are adequately compacted.

4.3 Roads

All roads may be developed over the glacial till or bedrock, or over granular fills, provided the organic deposits are initially removed. We suggest that a minimum granular cover of 0.3 m be provided over rock provided it is adequately drained.

The surface course should consist of a minimum of 75 mm of asphaltic pavement and 150 mm of crushed sand and gravel. The sub-base should consist of sand and gravel. Where the roads are developed over coarse granular fills, the sub-base should have a minimum thickness of 150 mm of 75 mm minus material.

We trust that this report provides the information you require at this time. If you have any further questions, please do not hesitate to contact us.

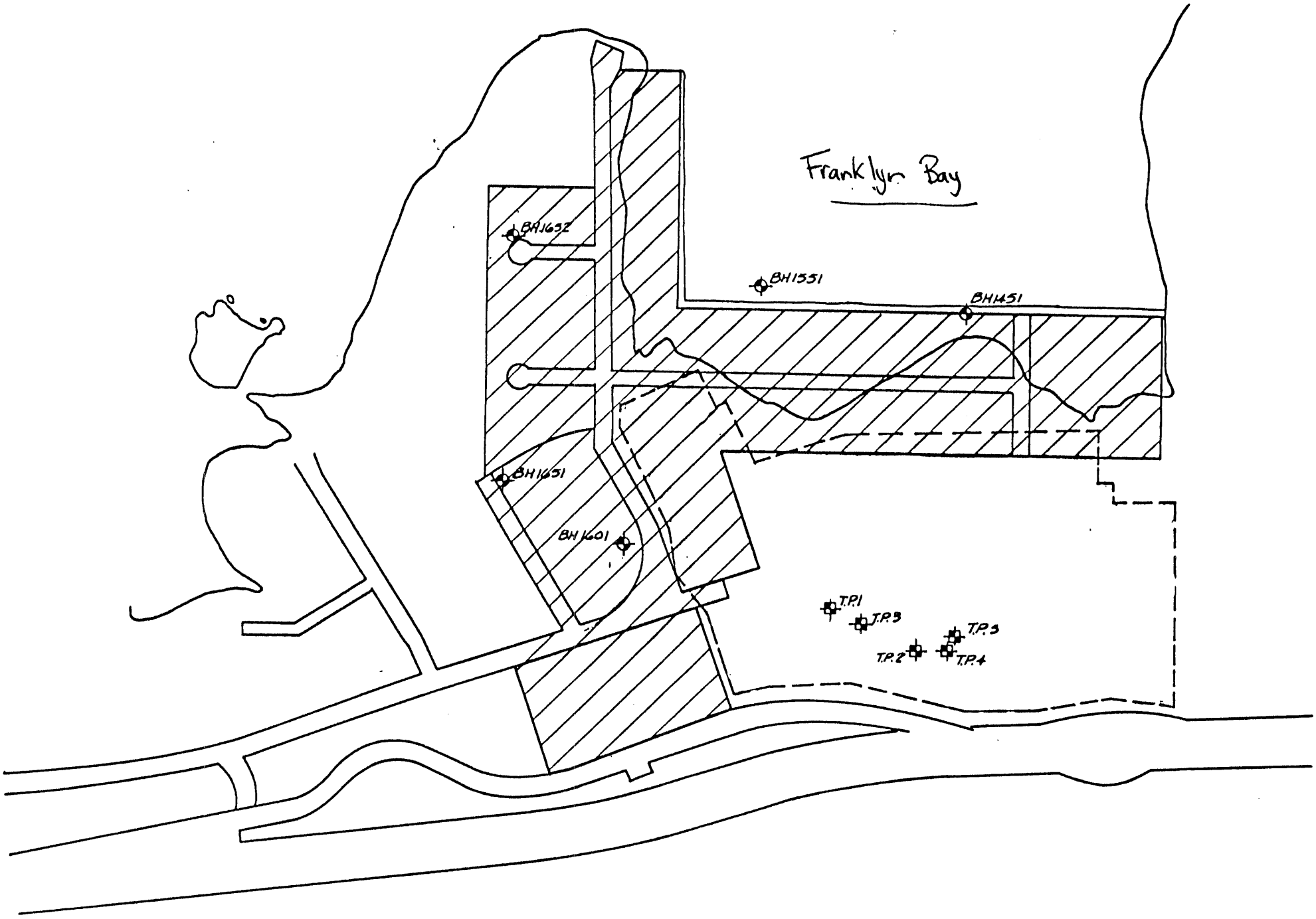
Yours very truly,

"Rocky Engineers Ltd"

TABLE 1

SUMMARY OF TEST PITS

Test Pit No.	Depth (m)	Description
1	0 - 0.79	Soft, dark brown PEAT with some sand.
	0.79 -	Bedrock.
2	0 - 1.83	Soft, dark brown PEAT with some sand.
	1.83 - 2.44	Stiff, grey fine sandy TILL with some weathered rock and some organics.
	2.44 -	Bedrock.
3	0 - 2.01	Soft, dark brown PEAT.
	2.01 - 2.24	Loose, grey-brown medium SAND with some organics.
	2.24 - 2.64	Loose, grey fine sandy SILT.
	2.64 -	Bedrock.
4	0 - 2.79	Soft, dark brown PEAT.
	2.79 - 2.87	Stiff, grey TILL with some weathered rock and some organics.
	2.87 - 3.18	Loose, brown medium-coarse SAND with some organics.
	3.18 -	Bedrock.
5	0 - 3.18	Soft, dark brown PEAT.
	3.18 - 3.48	Loose, brown medium SAND with some organics.
	3.48 - 3.66	Firm, grey fine sandy TILL with a trace of weathered rock.
	3.66 -	Bedrock.


Franklyn Bay
BH1632
BH1331
BH1451
BH1631
BH1601
T.P.1
T.P.3
T.P.5
T.P.2
T.P.4

CASE STUDY NO. 2.

McDonald Surveying & Engineering Ltd. ("McDonald Engineering") was retained by CB Coal Inc. ("CB Coal") in September of 1980 to provide engineering services on the Black Mountain Coal Project. The arrangement between the parties was formalized by contract dated April 15, 1981, effective July 17, 1980. Under the terms of the contract, McDonald Engineering's assignment included design assistance, surveys for design construction lay-out and construction supervision services. All services were performed under the direct supervision and control of the project manager, CB Coal. Scoop & Associates Geotechnical Engineers ("Scoop Engineers") were retained by CB Coal earlier in the project as geotechnical engineers and reported directly to CB Coal management. Black Mountain was being developed by CB Coal as a surface coal mining project. Although three specific areas of development were encompassed in the project, this particular claim is concerned only with that area known as the "preparation plant site". The claim against McDonald Engineers is based on soils problems which were encountered on the preparation plant site in July of 1981. During the drilling of Caissons, colluvium soils and frozen material was observed at the interface of the fill section and the original sub-grade of the site. Upon the recommendation of Scoop Engineering, the unsuitable material was removed and new fill material utilized at a total remedial cost of approximately $161,000.00. Further stand-by costs and demobilization and remobilization costs were also incurred by contractors of CB Coal in the approximate amount of $110,000.00.

In order to completely understand the problems associated with this case, it is necessary to review some background history of work at the Black Mountain project. The preparation plant site was not initially scheduled for construction in 1980. The decision to extend the 1980 work schedule to include the plant site was made by CB Coal Management in November of 1980. An

extension of the construction contract was negotiated with the general contractor, Jones International Ltd. ("Jones International") on a force account basis. McDonald Engineers was requested to increase their inspection staff to supervise the work. Grading and filling of the site was started on November 27, 1980, and completed on December 13, 1980. All work was inspected to conform with the specifications for Earth Embankment from the contract documents prepared for the Main Access Roads and Related Works for the proposed Black Mountain mine dated August 15, 1980. Geotechnical inspections and recommendations were provided by Scoop Engineers who had been retained earlier in the project directly by CB Coal. McDonald Engineers was not advised of any previous geotechnical work or reports for the site and no plans were made available which showed the proposed building locations. Both Scoop Engineers and CB Coal were fully aware that the grading and filling which took place in late November and early December, 1980, was being completed to embankment and not foundation specifications.

Due to the location of the project, weather conditions were extremely unfavourable during the time which the work took place. Weather conditions were routinely in the range of -15 to -20 degrees centigrade, and snow was falling. Conditions were so unfavourable that Jones International would only undertake the work under an express exclusion of liability entered into with CB Coal.

When the problem was discovered in July of 1981, McDonald Engineers met with CB Coal. At that time, McDonald Engineers was presented with a report dated July 31, 1981, that had been completed by Scoop Engineers detailing the geotechnical problem.

Scoop Engineers had completed 32 test bore holes and found that six of them revealed frozen ground or ice layers beneath the fill. Based upon these investigations, Scoop stated at page 2 of their report:

> "Based on records of density testing and descriptions of the work carried out, it is believed that the fill was placed on a frozen soil subgrade with snow and ice being incorporated into the fill material."

The report concludes that the following summary of its findings:

> "It is our understanding that the compacted fill for the whole of the plant site was to be completed to a specified field density of 95% of Standard Proctor maximum dry density. For general embankment purposes, this requirement would be adequate. However, for compacted fill beneath foundations, the requirement contained in our report dated September 5, 1980, should have been met in our opinion. Since compaction of the fill was done during the first two weeks in December, 1980, under freezing conditions, moisture control for placing fill would be meaningless. Based on our assessment of compaction control, and because compaction took place around the clock, it is our estimation that the compacted embankment was generally well placed. It should be emphasized, though, that the original sub-grade was frozen prior to the placement of fill, and it appears from records of observations kept by our inspectors, that some snow and ice at the interface between the fill and natural sub-grade was not completely cleared off prior to placing fill."

During the meeting between McDonald Engineers and CB Coal, CB Coal produced a number of reports prepared by Scoop Engineers during September and October, 1980, describing potential soil problems on the site and recommended specifications for construction. These reports noted the presence of soft pressable clay colluvium soil and classified this as an unsuitable foundation material. The reports further recommended that specifications for the plant site were for fill material to be on-site cut material of glacial till or alluvial fan compacted to 95% Standard Proctor maximum dry density for the general site area, and 100% Standard Proctor maximum dry density for fill directly below building foundations. McDonald Engineers had no knowledge of these reports, nor were they advised in anyway of the specification requirements for building foundations. Preparation of the plant site was done to the specifications for Earth Embankments which required a compaction of on-site materials to 95% Standard Proctor maximum dry density. All compaction tests were taken and reported by Scoop Engineers on the basis of the 95% density specification while the work was completed at the end of November and start of December, 1980.

CB Coal alleged that McDonald Engineers was charged with the overall responsibility of supervising the job and, therefore, were responsible for ensuring that the fill material met the standards required for the placing of foundations and did not contain colluvium soils and frozen materials. In defence, McDonald Engineers states that all parties were fully aware of the risk involved in proceeding with the earth works necessary for the plant site during adverse sub-zero winter conditions. The cost and scheduling advantages of preparing the site at this

time, as opposed to the spring of 1981, were considered by CB Coal management to override the risk of remedial work. Scoop Engineers had an inspector on site at all times checking compaction and material selection and CB Coal provided continous project management. The only geotechnical data which had been received by McDonald Engineers was the soil density test taken during the filling operation, all of which met the compaction standards for earth embankments.

Despite numerous attempts to resolve the problem, CB Coal refused to pay the fee accounts of McDonald Engineers totalling approximately $440,000.00. As a result, McDonald Engineers commenced action against CB Coal seeking recovery of their fees. CB Coal counterclaimed against McDonald alleging a breach of contract or, alternatively, negligence on the part of the engineer and claimed that the amount of approximately $300,000.00 should be set-off against the amount claimed owing by the Engineer. We were retained to act on behalf of McDonald Engineers in defending the allegations of professional negligence advanced in the counterclaim of CB Coal.

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