REPORT
ON
FIELD AND LABORATORY INVESTIGATIONS
FOR
PACIFIC BENTONITE LTD.
CLAIMS BEN 1 & BEN 2, RECORD NO. 8939 & 8940
MINERAL TITLE REFERENCE MAP NO. 9121/13E
IN THE
KAMLOOPS MINING DIVISION
LATITUDE 50 45N , LONGITUDE 121 35W

BY

NIGEL SKERMER , P.ENG.
CONSULTING ENGINEER
AND
HERBERT HAWSON,P.ENG.
CONSULTING ENGINEER

October 1994

1. INTRODUCTION

The Ben 1 and Ben 2 claims of Pacific Bentonite (PBL) are located on the west side of Upper Hat Creek Valley. Hat Creek is 240 kilometres northeast of Vancouver, ,BC The claims are reached by 25 kilometres of paved highway from Pavilion and 2 kilometres of active logging road. The paved highway is the Cache Creek/ Lillooet highway 12. The location is shown on Figure 1.

The land slop[es gently to the northeast. It is semi-arid sage brush and cactus land and used mainly for cattle range. The vegetation is a mixture of open spaced pine and spruce with some meadows.

The property includes four post claims BEN 1 and BEN 2 with a total of 35 units Record Number 8939 and 8940 see Figure 2.

The NTS location is 92/1/13E; latitude 50 45N; longitude 121 35W.

The bentonite is a stratigraphic unit that underlies and overlies the Hat Creek coal basin which is upslope above the coal in its surface exposure. the findings of the work indicated that the bentonite was to be removed as the open pit mine was developed.

The bentonite in Hat Creek is a clay classified as an industrial mineral.

Industrial mineral, particularly clays with varied uses, are different from metal in terms of bringing a mine into operation. Clay deposits are relatively easy to delineate compared to metals. The difficulty so far as bringing a mine into production here, has been in finding appropriate uses and applications for this particular bentonite clay.As a result all Pacific Bentonite efforts in the last 2 years have been directed towards testing of the bentonite and searching for suitable markets and applications for this potentially valuable BC mineral. The need for testing and applications investigations for BC bentonite has been pointed out in a report dated,March 1994 to MEMPR by B. Ainsworth.

Them work claimed for in this report therefore is for testing of the bentonite to determine its properties for various uses.

2. LABORATORYANDFIELD WORK.

Allthe testing has been carried out on material taken from the Clay Cut on the property. The location is shown on Figure 3 and a photograph of the clay cut appears on Figure 4. Over the past 2 years up to 1000 kg clay have been sampled for various testing purposes.

The two primary objectives of the testing have been to investigate the bentonite suitability as

a) Absorbent for kitty litter or for oil and grease ,

b) Geotechnical applications for liners , slurry trench walls and drilling purposes.

Bentonite is an interesting mineral because the chemical composition can be varied. The cations can be varied depending upon how it is formed,but also the cations can be altered by processing.As found in Hat Creek, the principal cations are Calcium , magnesium and sodium (see test results by the University of Western Ontario.)

The cation can also be exchanged by the addition of Sodium carbonate,and has been done for some of the tests reported below. However for many of the modern environmental purposes,unaltered calcium/magnesium bentonite is chemically more stable than for example high swelling sodium bentonite from Wyoming.

2.1 Absorbent Testing

Bentonite is used for kitty litter and as an absorbent for oils and greases. So far testing has only been carried out for its application in kitty litter uses. In this regard its main purpose is to eliminate the ammonia smell of cat urine.

Since the market is very large in Europe, samples of the Hat Creek bentonite were sent to Redland Minerals in England. The results are presented in Appendix B.

Although probably not attractive to export markets, the results suggest that the absorbency is good and that the materials might find local application if the crushing strength and clumping properties can be improved. This will be an avenue for future testing.

Preliminary 'garage scale' testing shows that the oil absorbency is good but detailed testing has not yet been carried out.

Some of these absorbency properties are also beneficial in environmental applications such as liners discussed below.

2.2 Geotechnical Application Testing

Bentonite can be used as low permeability liners and vertical cutoff walls to contain contaminated ground. As serious problems of groundwater contamination exist in the Fraser Valley from animal wastes, farmers approached the writers to see if Hat Creek bentonite could be used to form lined ponds for winter storage of liquid manure wastes. A pond layout was discussed as shown on Figure 5. The bentonite liner was designed to be 300 mm thick.

Because a pure bentonite liner of this thickness would be expensive ,tests were conducted to determine how much Hat Creek bentonite clay to be mixed to provide low permeability liner material.

Permeability tests were performed in the soil mechanics laboratory of Nigel Skermer,consulting engineer. The apparatus and test samples are shown in Figure 6. The permeameter is 90mm diameter and the base is fitted with a wire mesh screen and a Whatmans No1 filter paper.

The first test was conducted using equal parts of pan size gravel and similar size 5 mm bentonite. The two materials were loosely mixed and placed in the permeameter and then hydrated with fresh water.Permeability tests were then conducted. However it was found that leakage occurred due to segregation of the materials.

In order to achieve a low permeable liner, it was necessary to increase the bentonite to gravel ratio to 2:1 by weight. at these proportions a permeability of 0.8 x 10-7 cm/sec was achieved with uncompacted loosely placed, material. Therefore it was concluded that a properly compacted bentonite liner could easily achieve target permeabilities of 1×10^{-7} cm/sec or less.

Because wood waste was another material that might be readily obtained and mixed with clay, further tests were carried out. A long term test was carried out using wood chips and sawdust mixed with equal volume of pea size bentonite clay. The mixture was slurried and placed loosely in the permeameter. The test was carried out from February 28 to September 5,1994. The permeability results were as follows:

Date		Days	Head (mm)	Coef. of Permeability (cm/sec)
Feb	28	0	-	
Sep	29	60	208	1.27×10^{-7}
Jul	24	147	150	1.693×10^{-7}
Sep	6	185	107	1.718×10^{-7}

Note: Sample thickness 25mm

Again these results show that a suitable low permeability liner can be achieved with a fibre and Hat Creek bentonite mixture and that the material has long term reliability under hydraulic heads in the range of 8 to 4.

The full scale tests on the Fraser Valley farm projects are yet to be performed but the constructability and economics of the bentonite lined ponds using Hat Creek material is feasible and the liners will perform as intended.

The Hat Creek clay should also perform as cut-offs and vertical seals. A test was conducted for the Ministry of Forests for a cut-off around a culvert on the Finney Creek forest road near to the claims in Hat Creek. Material from the Clay Cut was taken to the culvert site and the material; placed around the culvert pipe and backfill. The bentonite seal has performed well and a letter to this effect from the Ministry of Forests is shown in Appendix C. Similar tests are currently being conducted using Hat Creek bentonite on a forestry road culvert near to Prince George.

2.3 Drilling Fluid Testing

One of the major uses of bentonite is for a drilling fluid.The bentonite in a slurry form is used to maintain the walls of the borehole during drilling.Mud engineering has become a science in itself and many additives are now added to the bentonite drilling muds to enhance the properties of the fluid.The basic function of a drilling fluid in a borehole is to provide wall support and prevent collapse.This is primarily achieved through the hydrostatic thrust that the fluid exerts upon the walls of the borehole.When bentonite is used an additional support is achieved by the creation of a 'filtercake'ie.a thin layer of bentonite on the walls of the borehole.The creation of this 'filtercake 'is a critical feature of drilling fluids and along with the hydrostatic pressure exerted by the mud supports the walls of the borehole.The standard for drilling fluids has been established in North America by the American Petroleum Institute who have developed standard testing procedures for drilling muds (API spec 13A and API Spec 13B,Standard Procedure for Testing Drilling Fluids.)

To assess the suitability of Hat Creek bentonite for use as a drilling fluid a series of tests were initially carried out in the laboratory to check out the properties of the Hat Creek bentonite compared to standard products currently available on the market.The specifications of the two products used for comparison purposes are shown in Appendix D.The sample of Hat Creek bentonite taken from the Clay Cut was dried using blower heaters to sufficient water content to enable the material to be ground up into a powder form.The powder was sieved through a No 10 sieve to remove some of the larger remaining lumps and to remove most of the coarser fraction (see Figure 7).The prepared samples of the various clays are shown on Figure 8 along with the test equipment used to obtain measurements of viscosity (Marsh funnel) and density (mud balance).

The results of the tests are tabulated below:

	Premium Gel	Quik Gel	Hat Creek Gel		
Mixture (per100 US Gals)	50lb	50lb	50lb	100lb	150lb
Marsh Funnel (sec)	57	111	31	37	θ
Density (lbs/gal)	8.5	8.6	8.6	8.8	9.3

After completion of the laboratory tests a batch of drilling fluid was prepared and the material tested by using the material in a test drilling program. The drill rig used was a Mayhew 1000 mud rotary rig supplied by Foundex Explorations Ltd .The preparation of the material and the rig is shown on the photograph on Figure 7.The drill was advanced to some 20 to 25 m below existing ground surface .The site chosen for the drilling was such to be able to penetrate several different soil types to assess the supporting capacity of the Hat Creek bentonite mud.The drill advanced through some 12 m of soft clay followed by about 5 m of sand and finally into very dense sand and gravel till.The Hat Creek bentonite was prepared at a mixture of 120lbs/100US gallon giving a Marsh Funnel reading of about 35 secs.Observations were made during the drilling to visually assess the supporting capacity of the mud. The borehole advanced well and there were no problems of hole collapse or squeeze. The soil cuttings were adequately carried up from the boring and the operation of the drilling progressed with no apparent problems.It was apparent from the drilling test that the Hat Creek bentonite could be used for drilling muds. However,a greater weight of clay is required to provide the required mud viscosity necessary to provide the hole supporting capacity and 'filtercake'production that could be achieved from other commenrcially available products.It is probable that the clay would greatly improve with the addition of sodium carbonate or a polymer.Further tests are proposed to investigate the effect of such additives on the potential of the Hat Creek bentonite as a drilling fluid.

3. Costs Claimed

The following costs were claimed in this report of assessment credit:

a) Sample preparation and drilling costs invoiced by Foundex Explorations Ltd.

b) Engineering costs invoiced by Nigel Skermer,P.Eng. and Herbert Hawson,P.Eng. for laboratory and field testing.

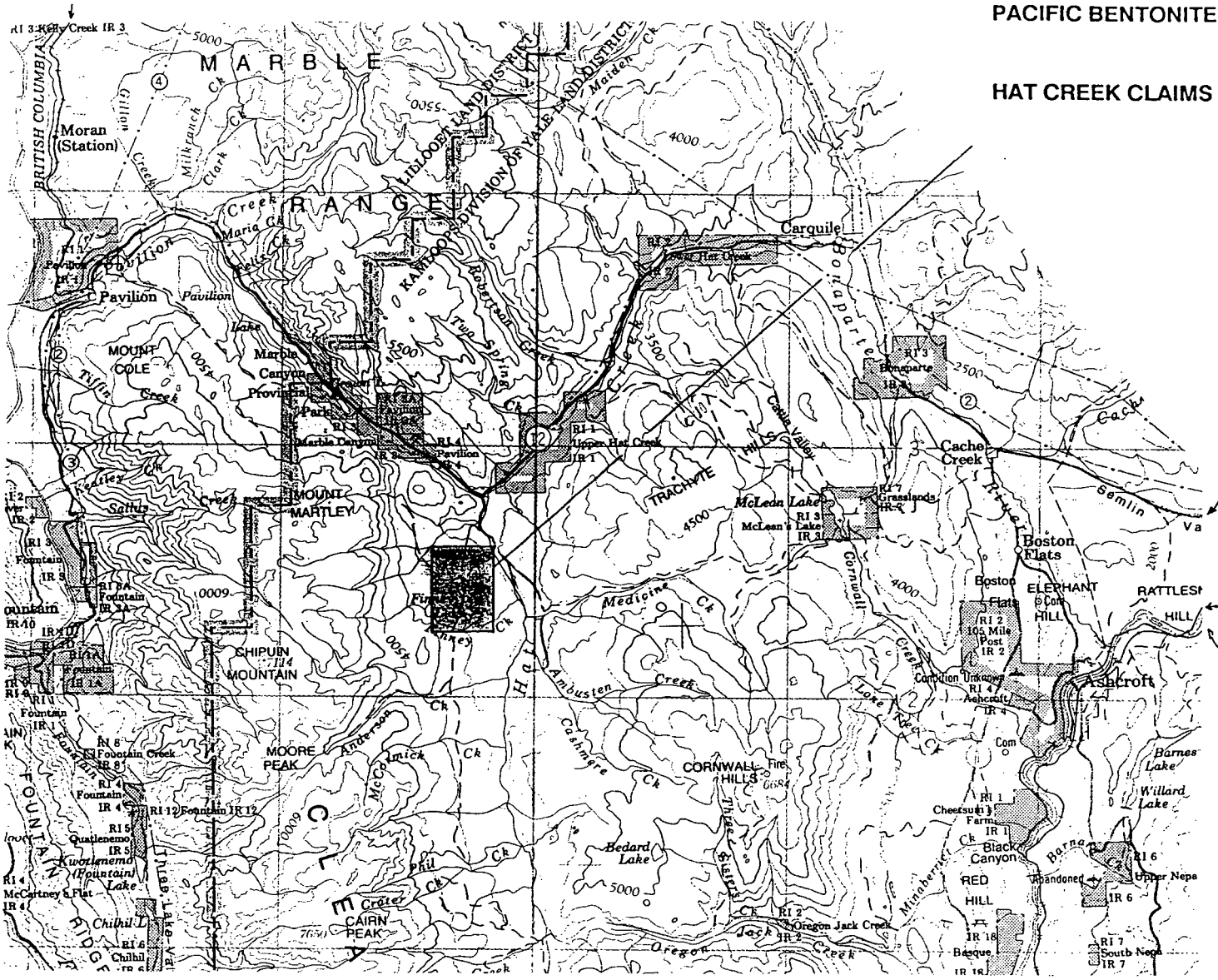
Total costs for this assessment work is $11566.70.

Nigel Skermer, P.Eng.

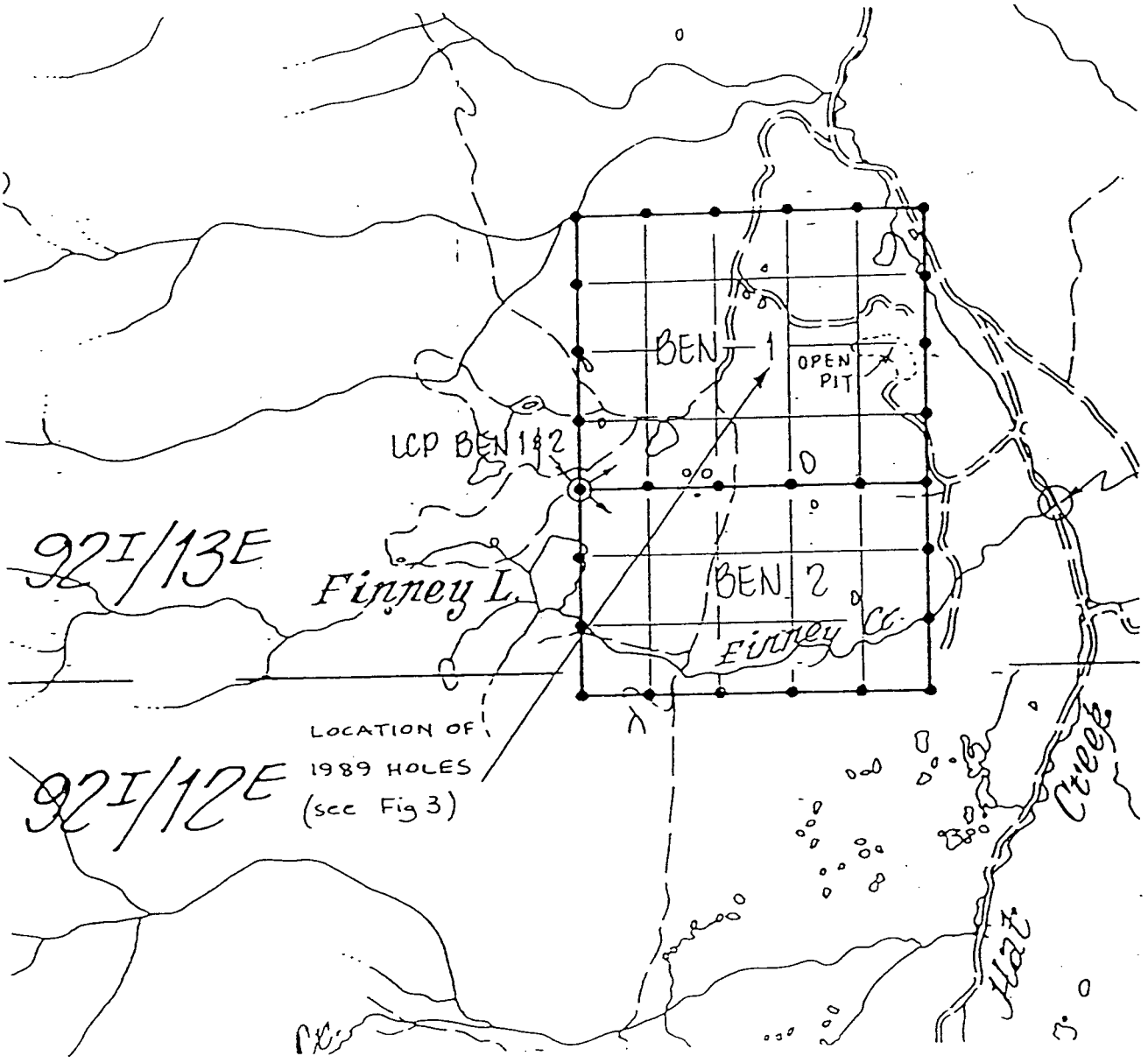
Herbert Hawson, P.Eng.

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA H. HAWSON 1044

LOCATION OF PROPERTY



PACIFIC BENTONITE LTD Fig. 1



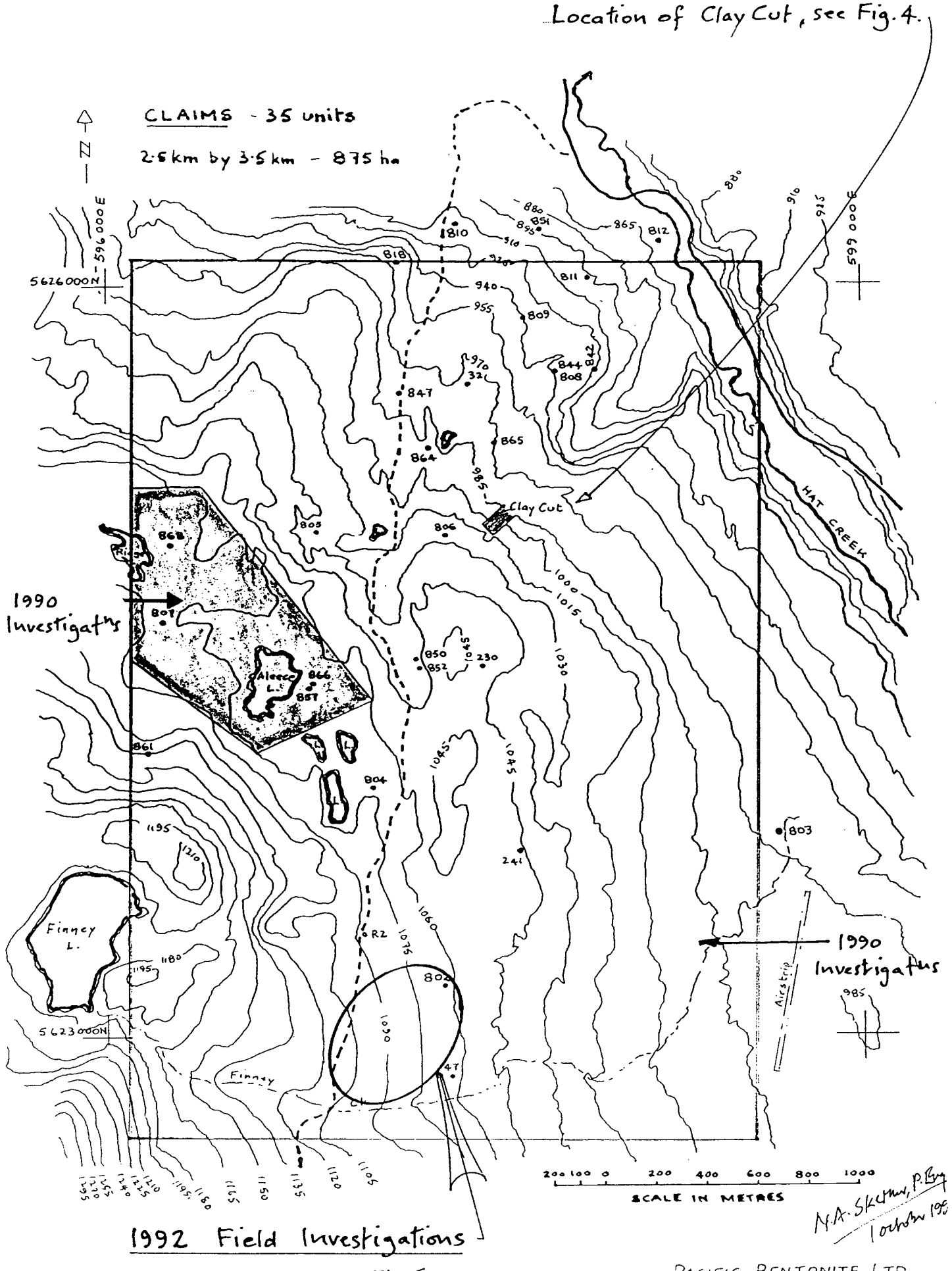
Pacific Bentonite Ltd: "Ben 1 and Ben 2" mineral claims (35 units, 875 ha)

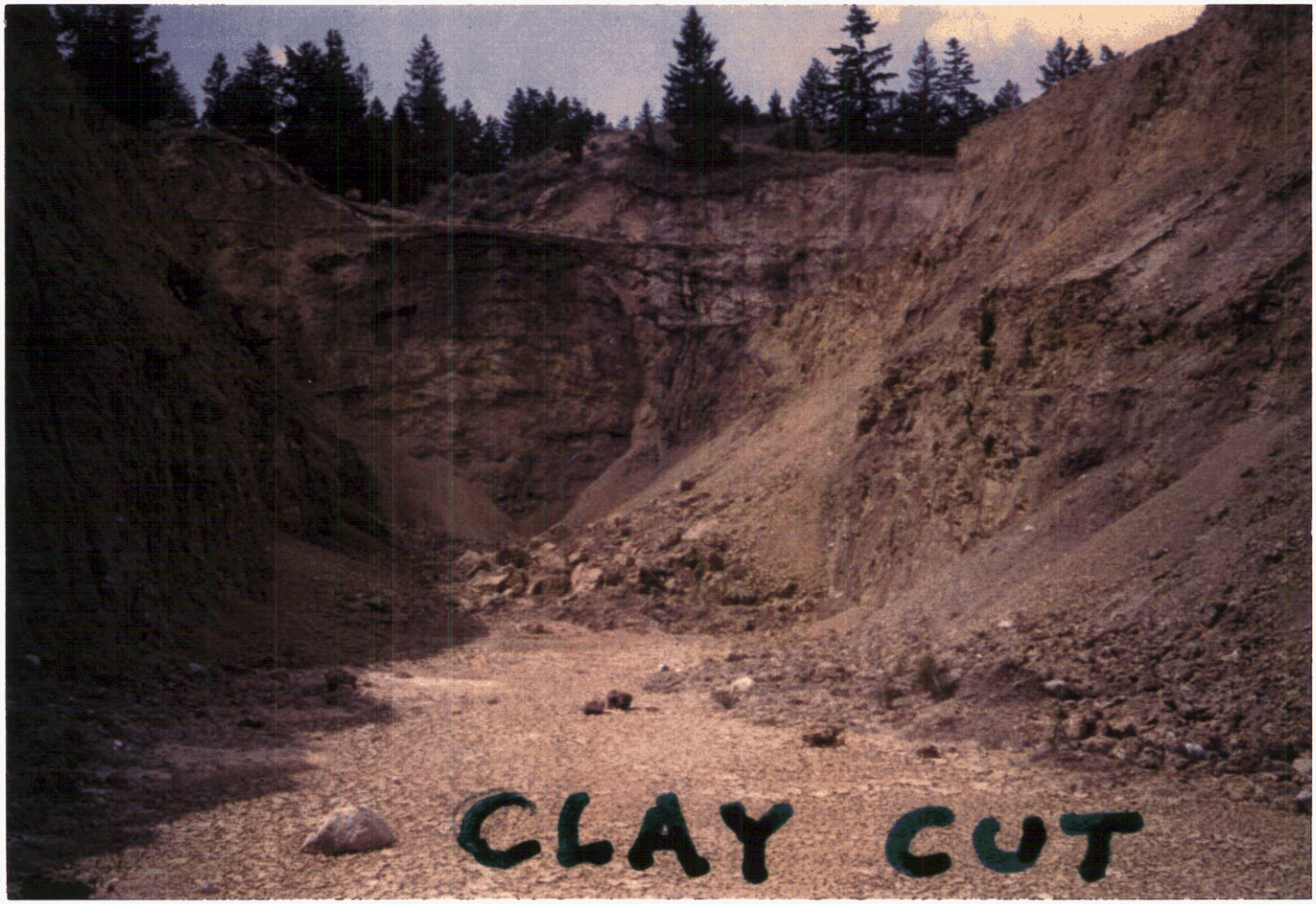
Scale 1 : 50,000

LOCATION OF CLAIMS

PACIFIC BENTONITE

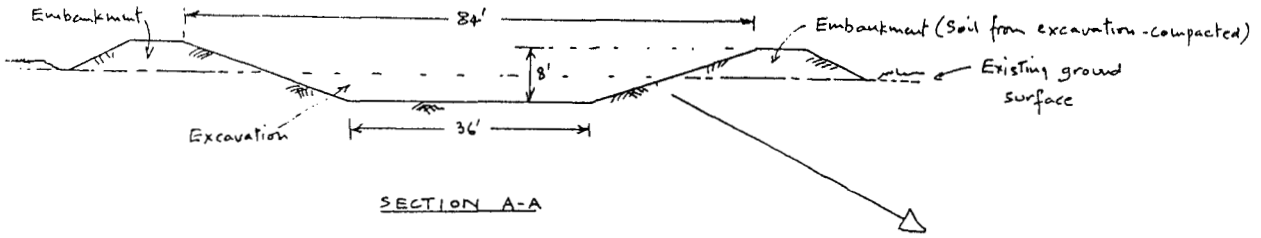
Fig. 2


Location of Clay Cut, see Fig. 4.
CLAIMS - 35 units
2.5 km by 3.5 km - 875 ha
N
596000E
599000E
5626000N
5623000N
1990 Investigations
1990 Investigations
Clay Cut
HAT CREEK
Alesco L.
Finney L.
Finney
Airstrip
1992 Field Investigations
see Fig. 5.
200 100 0 200 400 600 800 1000
SCALE IN METRES
M.A. Skermer, P.Eng
October 1992
PACIFIC BENTONITE LTD



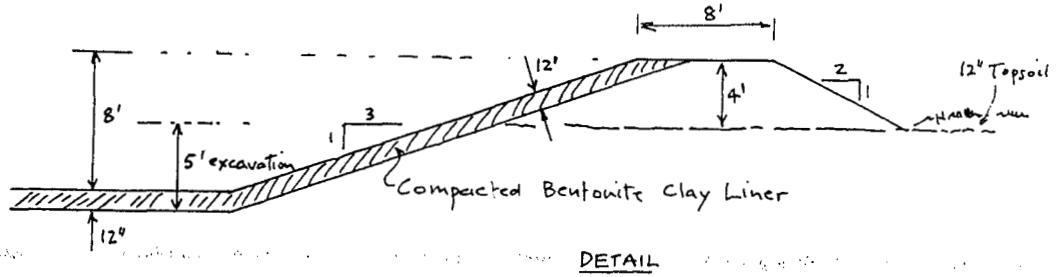
PACIFIC BENTONITE LTD

Fig 4.

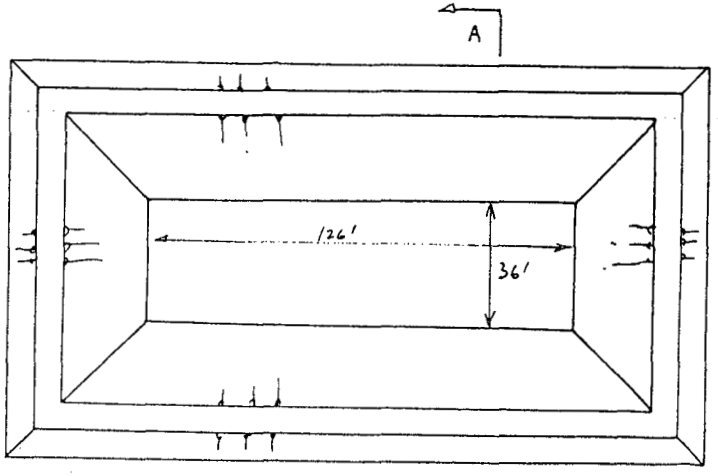


SECTION A-A

Section lengthwise similar



DETAIL



PLAN

Scale 1" = 40'-0"

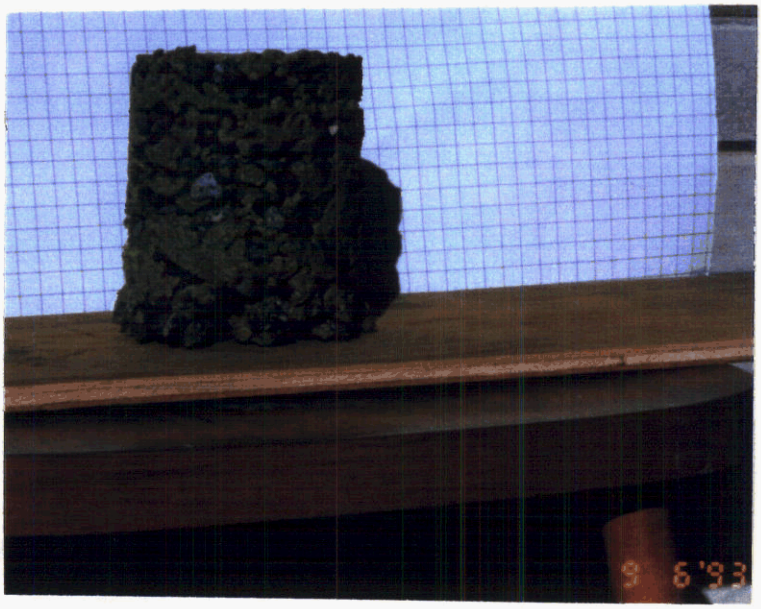
Volume of embankments = Volume of excavation
= approx 1350 cubic yards

Storage Volume of pond when full = 73,500 cuft
= 55,000 gallons

PACIFIC BENTONITE LTD Fig. 5

N.A. Skermer P.Eng.
March 1993

Permeameter with gravel and bentonite chips.



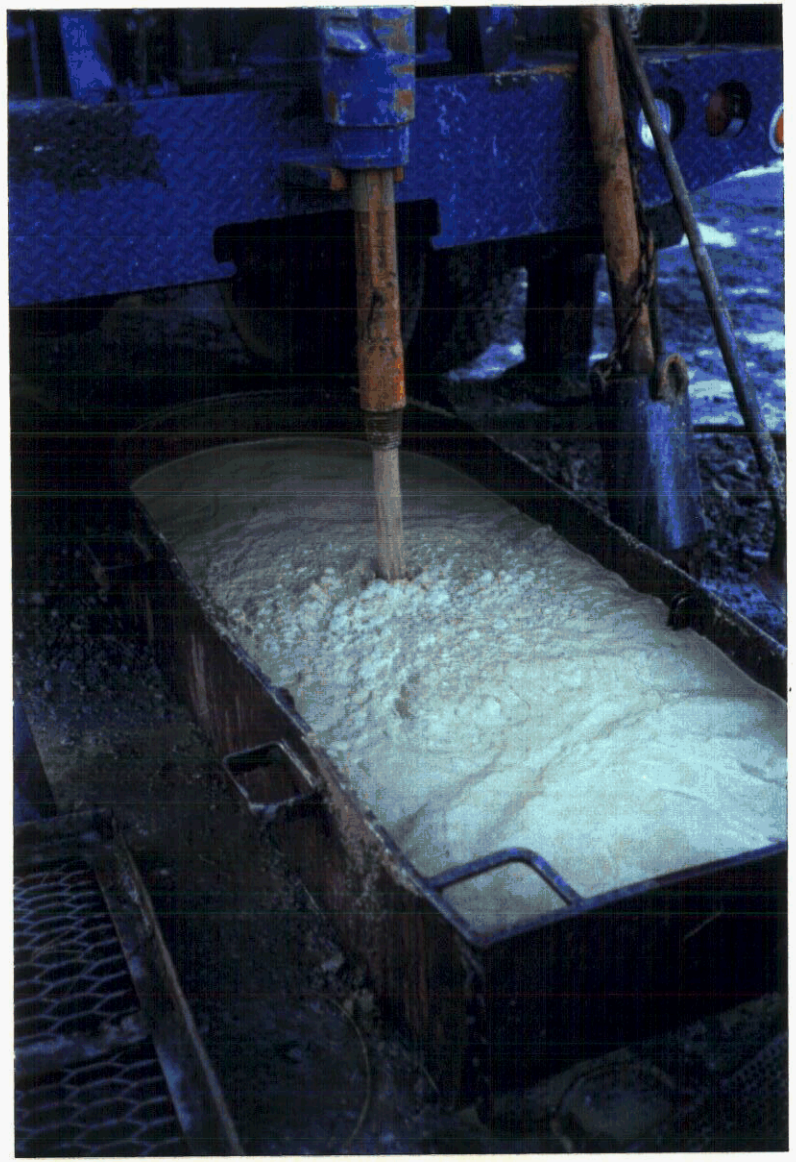
Gravel and bentonite sample after test. 50-50 gravel to bentonite. Note segregation and leakage channels.

Prototype liner sample of gravel and bentonite (1:2 ratio) under test.

PACIFIC BENTONITE LTD

Fig. 6

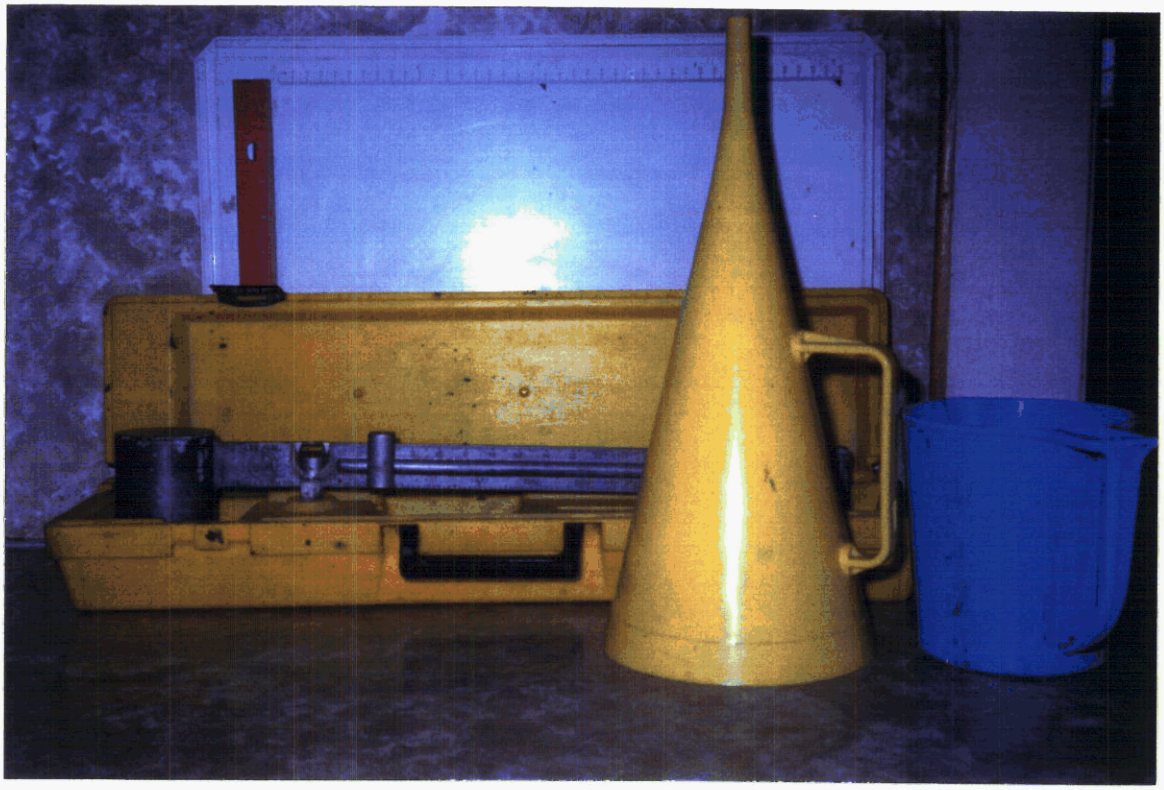
Powdered bentonite after drying and pulverizing. Material being weighed for batch of mud.



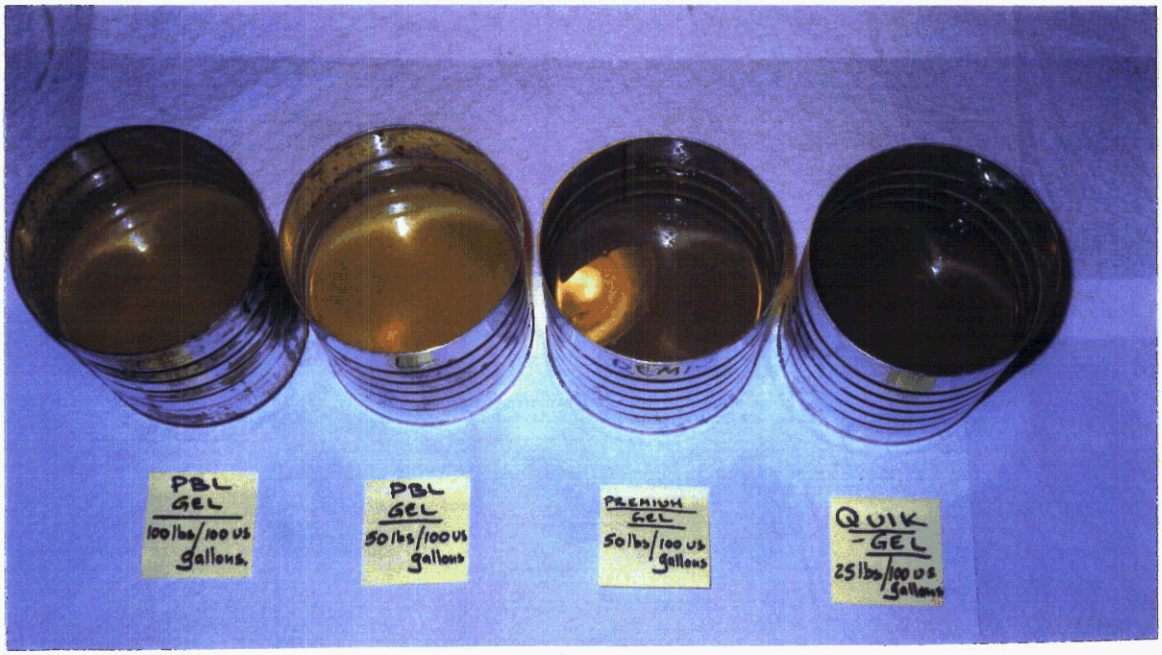
Bentonite being mixed in mud bath at drill rig.

PACIFIC BENTONITE LTD

Fig. 7.



Calibration of test equipment showing mud balance and Marsh funnel and cup.



Prepared samples of bentonite muds for viscosity and density testing

PACIFIC BENTONITE LTD Fig. 8

APPENDIX A

U. of W.O.

Test results by University of Western Ontario.

Table 1. Characterization of Hat Creek Bentonite

Test \ Sample	Sa #1 "Pure" Clay (Pour Sample)	Sa #2 "Pure" Clay	Sa #3 Mixed Clay, Tuff
Water Content, %	97	35	41
Liquid Limit %			
As received	174	190	216
(wet-sieved)(1)	213	-	-
Plastic Limit,(2) %	45	50	43
Specific Gravity	2.69	2.72	2.76
Carbonates(3)	1.2	1.1	0.9
Glycol Retention (mg/g)	131	150	131
X-ray Diffraction Powder Trace (Composition)	Abund.Smectite Minor Feldspar Minor Cristo-balite	Abund.Smectite Minor Feldspar Minor Cristo-balite	Abund.Smectite Minor Feldspar Minor Cristo-balite
Quartz, %	~ 4 ?	~ 4 ?	~ 5 ?
Porewater Cations			
Na^+ (meq/L)	10.43	11.30	21.30
K^+	0.35	0.33	0.54
Ca^{++}	2.49	3.15	4.11
Mg^{++}	1.4	1.97	2.51
Na^+ (mg/L)	240.0	260.0	490.0
K^+	13.75	13.0	21.0
Ca^{++}	50.0	63.25	82.5
Mg^{++}	17.0	24.0	30.5
SAR(3)	7.5	7.1	11.7
GRIT(5) %	0	0	-

Notes:
(1) Blended with distilled water and rubbed through No. 325 sieve (100% passing).
(2) Sample was oven dried at 105°C, pulverized and water added to bring to the plastic limit.
(3) Carbonates or gasometric method using Chittick apparatus.
(4) SAR = sodium adsorption ratio obtained on pore water squeezed from clay at saturation water content at 10 MPa.
(5) Percent passing No. 325 sieve.

APPENDIX B

Redland Minerals Limited
PO Box 2, Retford Road
Worksop
Nottinghamshire S81 7BB
Telephone: 0909 475511
Telex: 547901
Fax: 0909 486532

Redland
MINERALS

MG/PH

16th August, 1994

Fax To: Mr. Nigel Skermer
Pacific Bentonite Ltd.

Fax No.: 010 1 604 684 6241

Dear Mr. Skermer,

Following my fax of 28th June we have examined the two samples of clay from Pacific Bentonite Ltd. I attach a Table showing the results from our preliminary examination.

Our conclusion from these samples is that the bentonite is generally of low quality with a high impurity content. It would not be suitable to compete in our industrial markets as a rheological or foundry clay.

We also examined the clay for cat litter. Although the eventual absorptive capacity was good, the clump formation and mechanical strength were poor.

Overall, the properties do not offer benefits when compared to European bentonites or, I assume in the N. USA markets.

I would be happy to clarify any of these points further so please contact me if you have any queries or additional comments you would like to make.

Yours sincerely,

M. Garrett

Dr. M. Garrett
Development Manager

94/186

Table 1

Preliminary Properties

Property	Raw	Activated
Visual appraisal	Received in light brown lump form. Mills to a slightly lighter and less golden colour than Woburn.	Received in light brown lump form. Mills to a slightly lighter and less gold colour than Woburn.
XRD analysis		
Major Phase	Montmorillonite	Montmorillonite
Minor Phase	opal-CT	opal-CT
Trace Phase	Quartz, feldspar	Quartz, feldspar
CEC (meq/100 gm)	50	54
pH (10% slurry)	8.9	9.7
% alkalinity	1.3	1.8
Moisture content (wt. %)	11.7	12.5
Swelling volume (mls/2 gm)	13	15
Residue (+0.053 mm.) (wet)	4.16	4.52

APPENDIX C

Province of
British Columbia

Ministry of
Forests

Ministry of Forests
1265 Dalhousie Drive
Kamloops, British Columbia
V2C 5Z5
Tel: 371-6500 Fax: 828-4627

File: 11250-30-8536

March 18, 1994

JOHN DORMER
2235 VALLEYVIEW DRIVE
KAMLOOPS BC V2C 4C8

Dear John:

Thank you for giving us the bentonite to correct a poor culvert installation.

We removed the fill back from the culvert approximately two metres then layered bentonite and native materials along the angle of repose. The bentonite immediately became an impervious layer upon entering the water. Voids under the pipe were filled by putting bentonite only under the pipe. I believe all seepages have stopped.

Needless to say, I am very satisfied with the performance of the bentonite. The real test will be this spring. I will keep you informed of the results.

John, thanks again for showing interest in our program and we will keep your product in mind for the future.

Yours truly,

Grant Clark
Resource Officer, Engineering

cc: Nigel Skermer, E.B.A. Environmental Ltd.

PACIFIC BENTONITE LTD
SUITE 207 - 132 WEST 15th STREET, NORTH VANCOUVER, B.C., CANADA, V7M 1R5 (604) 986-6953

Appendix D

Specifications for Premium Gel and Quik-Gel drilling mud products

APPENDIX D

WESTCOAST DRILLING SUPPLIES LTD.

PRODUCT INFORMATION

PREMIUM GEL

NSF CERTIFIED

API BENTONITE

Description: PREMIUM GEL is a 200 mesh, 90 bbl. yield sodium bentonite for fresh water drilling. It complies with API drilling fluid specification 13A.

Recommended Use: May be used for all types of fresh water mud rotary drilling where higher solids are desired.

Characteristics:

- 90 bbl. yield
- Fast and easy mixing
- Stabilizes borehole
- Removes cuttings
- Cools and lubricates bit
- Reduces fluid loss into the formation

Mixing and Application: Mixing ratios are based on the use of fresh water. Water purity will affect bentonite performance. For best results, acidic and hard make up water should be pre-treated with soda ash to a pH of 8.5 - 9.0.

PREMIUM GEL mixing ratio in lbs. per 100 gallons of water:

Normal conditions	30 to 50 lbs.
Sand and gravel	50 to 70 lbs.
Fluid loss control	70 to 80 lbs.

For best results, add PREMIUM GEL slowly through a jet/hopper mixer.

Packaging: 50 lb. multi-wall paper bags, 48 bags per pallet. All pallets stretch wrapped.

NOTE: See disclaimer for supplier responsibility.

WESTCOAST DRILLING SUPPLIES LTD.
#6 - 2351 Simpson Road, Richmond, B.C. V6X 2R2
Telephone (604) 278-4954 • Fax (604) 278-4914

QUIK-GEL®

Viscosifier

QUIK-GEL® viscosifier is a finely ground, premium-grade western sodium bentonite, specially processed to promote ease of mixing and superior mud-making qualities in fresh water.

Recommended Uses

In Fresh Water or in Freshwater-based Drilling Fluids

Increasing hole-cleaning capabilities.

Forming on permeable sections of the well bore a thin filter cake that can be removed easily by backflushing.

Promoting hole stability in poorly consolidated and caving formations.

Reducing water seepage in permeable formations.

Avoiding or overcoming loss of circulation.

In Fresh Water

Making an economical, single-sack, low-solids drilling fluid.

Making gel-foam for air drilling.

Major Advantages

Effectiveness. QUIK-GEL® viscosifier makes more than twice as much mud of the same viscosity as an equal weight of API-standard bentonite.

Fast yield. QUIK-GEL reaches high viscosity quickly.

Easy mixing. QUIK-GEL viscosifier saves time and effort in making mud.

Convenience. The 50-pound (22.7 kg) bag is easy to handle.

Enviornmental acceptability. QUIK-GEL is not toxic and does not ferment.

Recommended Treatment

See table.

Approximate Amounts of QUIK-GEL® Viscosifier Added to Fresh Water or to Freshwater Drilling Fluids

	lb/100 gal	lb/bbl	kg/m³
Added to Fresh Water			
Under normal drilling conditions.	15-25	6-11	15-30
In gravel or other poorly consolidated formations.	25-40	12-18	35-50
To stop loss of circulation.	35-45	15-20	40-55
Added to Freshwater Mud			
To improve performance: for better hole cleaning, thinner filter cake, and increased hole stability.	5-10	2-5	6-14

Method of addition. Preferably, mix by adding slowly through a jet mixer or high-speed stirrer. If such mixing equipment is not available, sift QUIK-GEL slowly into the liquid close to the pump suction while circulating.

Packaging

QUIK-GEL® is packaged in multiwall, water-resistant paper bags containing 50 pounds (22.7 kg).

Availability

QUIK-GEL® viscosifier may be purchased through any NL Baroid Service Center or from the Houston plant.

DMD 34 7/80 5M GPC

Printed in U.S.A.

NL Baroid/NL Industries, Inc.
P.O. Box 1675, Houston, Texas 77001

APPENDIX E

1680

FOUNDEX
EXPLORATIONS LTD.

14613 - 64th Avenue
Surrey, B.C. V3S 1X6

Tel. (604) 594-8333
Fax. (604) 594-1815

INVOICE DATE October 24, 1994

OUR PROJECT No.

YOUR PROJECT No.

EQUIPMENT

PACIFIC BENTONITE LTD.
#207 - 132 w. 15th Street
North Vancouver, B.C.
V7M 1R5

Attention: Mr. Herb Hawson

Re: Services rendered to Pacific Bentonite Ltd.
on October 21 to 23, 1994

1) Supervision -12 hours @ $75.00 per hour		$ 900.00
2) Labour -24 hours @ $35.00 per hour		840.00
3) Drilling -10 hours @ $170.00 per hour		1,700.00
4) Trucking		100.00
5) Rentals		200.00
	SUBTOTAL:	$ 3,740.00
	GST #R101857381:	261.80
	TOTAL:	$ 4,001.80

cc: ACCOUNTS PAYABLE

NET 30 DAYS FROM DATE OF INVOICE

1.5% SERVICE CHARGE ON OVERDUE ACCOUNTS

Herbert H. Hawson
927 CANYON BOULEVARD • NORTH VANCOUVER, BRITISH COLUMBIA V7R 2J9

October 21,1994

Pacific Bentonite Ltd.

Services of H.Hawson,P.Eng.
on laboratory and drilling
testing program

----------	16 hrs @ $105.00	$1680.00
GST	7%	117.60
	Total Due	$ 1797.60

N. A. SKERMER MSc MICE PEng
consulting engineer
geotechnics

6260 Nelson Avenue
West Vancouver, British Columbia
Canada V7W 2A5
Bus: (604) ~~604-4196~~ • Res: (604) 921-6969
6850275 Fax: (604) ~~687-5690~~ 684 6241

28 September 1994

PACIFIC BENTONITE LTD.

January 1993 to September 1994

To consulting engineering services, sampling, testing and laboratory analyses of Hat Creek bentonite.

48 hours @ $105/hr	$5040
Expenses	$350
	$5390
Goods and Services Tax of 7%.	$377.30
	$5767.30

TOTAL P.01