

CONFIDENTIAL

Petro-Canada Inc.
Menkman Coal Project

1988 Mapping Program on the
Onion Syncline

A Report

PERMIT TO PRACTISE
LAS ENERGY ASSOCIATES LTD.
Signature [Signature]
2 Dec 1988
PERMIT NUMBER: P-1000
The Association of Professional Engineers
and Geophysicists of Alberta

October, 1988

Prepared for Petro-Canada Inc.
Prepared by LAS Energy Associates Ltd.

742

B.C. Government Title Page

Monkman Coal Project

Petro-Canada Inc. as Operator

ONION-FIVE CABIN BLOCK
1988 RECONNAISSANCE MAPPING PROGRAM

Property Ownership: Petro-Canada Inc.
Smoky River Holdings Ltd.
Mobil Oil Ltd.
Sumitomo Canada Ltd.

Peace River Land District
NTS 93I/15
Lat. 54 47'N
Long. 120 55'W
Coal Licences 3252, 3253, 3254,
3255, 3256, 3257, 3258, 3259, 8901

Work completed in September, 1988
Report submitted in October, 1988

Original author (1988): L. A. Smith, P. Geol.

October, 1988

Prepared for Petro-Canada Inc.
Prepared by LAS Energy Associates Ltd.

File: VX\W\ENERGY\MONKMAN\BCTITLE

MONKMAN COAL PROJECT
ONION-FIVE CABIN BLOCK
1988 RECONNAISSANCE MAPPING PROGRAM

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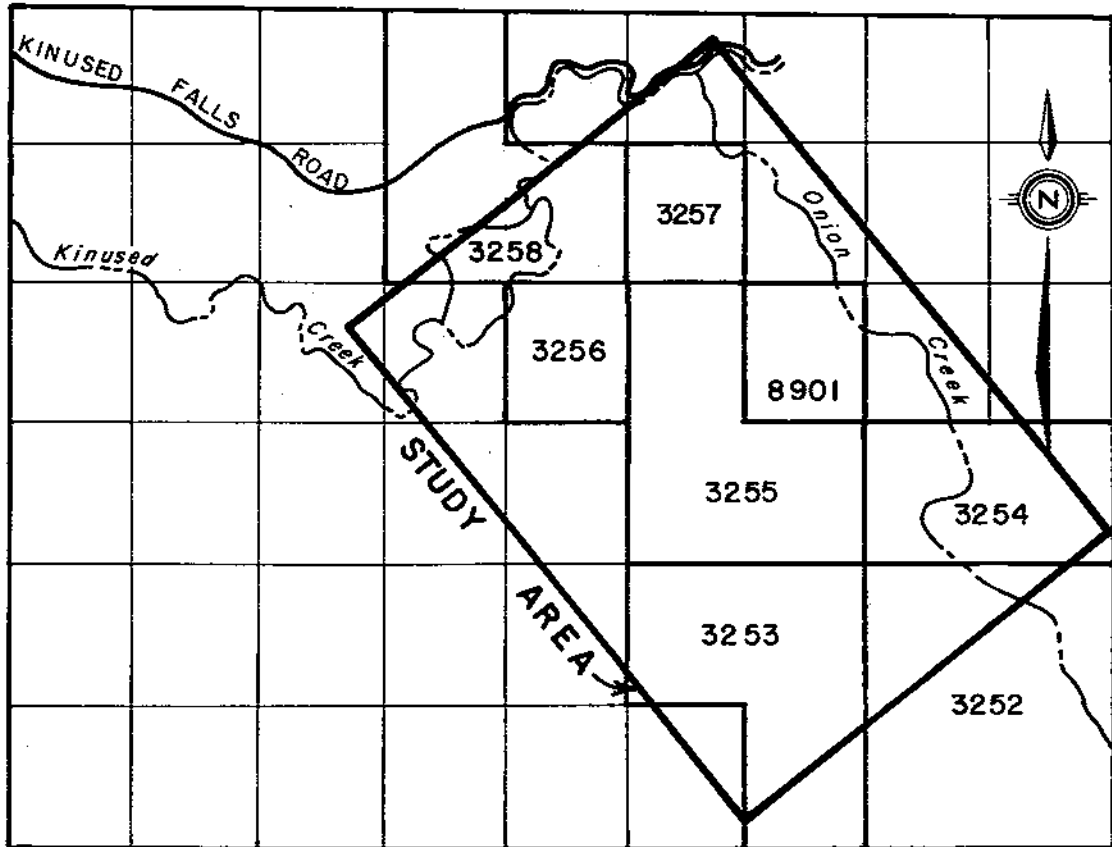
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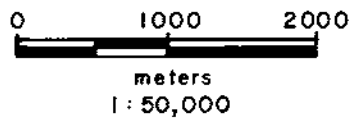
Map 1	Geology of Onion Syncline, North End	Folder
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1988 MAPPING PROGRAM

NTS 93 1/15



MONKMAN COAL PROJECT
ONION-FIVE CABIN BLOCK
1988 RECONNAISSANCE MAPPING PROGRAM

1. Introduction

The mapping program in the north end of Onion Syncline and along the south side of the Kinuseo Creek Valley was requested by the Monkman Project operator, Petro-Canada Inc., in a Geological Mapping Services Contract dated 1 September, 1988. This report provides the results of the mapping program with a measurement of the potential open pit mining potential of the Gates coal seams that occur within the study area (the north end of Onion Syncline).

2. Work Objectives

Per the contract between Petro-Canada Inc. and LAS Energy Associates Ltd., the work objectives and scope of work as set out are as follows:

Contractor shall carry out a Geological mapping program with a view to determine the mining potential of existing leases (in the Onion Syncline area) and to help make decisions in regards to dropping unproductive coal leases. This work shall comprise of, but not necessarily be limited to, the following tasks:

- a. Reconnaissance mapping of licences 3523, 3254, 3255, 3256 and 3257 in the Onion Syncline area to provide indications of mining potential for this prospect which contains coal with (up to) 30% volatile matter.
- b. Prepare and submit a detailed Report.

3. 1988 Mapping Program

This mapping project was carried out in conjunction with reconnaissance Geologic mapping in the Duchess Mountain - Dokken Ridge area reported on separately. The crew comprised of Leslie A. Smith, P. Geol. and Geology student Daniel Besserer. While mapping, a light tent camp was set up along Kinuseo Creek on the Kinuseo Falls road.

Monkman Coal Project
1988 Mapping Program on Onion Syncline

The mapping at Onion Syncline commenced on 30 August, 1988 and was completed on the morning of 3rd September, 1988. The crew returned to Calgary late on the 4th of September, 1988. A total of three full day traverses and a partial day of spot checking were completed in the low ridges southeast of Kinuseo Creek where the Onion Syncline lower Cretaceous strata outcrop. This work confirmed the location of the fold axis and the Lower Cretaceous strata outcropping in the area such that the Gates Formation coal potential can be estimated.

4. Program Costs

The program costs form a portion of the \$22,500 maximum budget set for the 1988 mapping program. As such, the costs for the Onion Syncline portion of the mapping program are estimated as a portion of the total. These costs are broken down as follows:

Consulting services (field):	\$4900.00
Rentals	\$900.00
Field Expenses	\$580.00
Structural Interpretation and Reserves Estimates (4 days)	\$1920.00
Report Preparation (2 days)	\$960.00
Drafting	\$300.00
Report materials (estimate)	\$125.00
Field trip to Property (1 day)	\$480.00
 Total	 \$10,165.00

These costs can be apportioned onto any licence grouping included in the study area.

5. North Onion Syncline Geology

5.1 Previous Interpretation

The previous (incomplete) interpretation of this area indicated that the Onion Syncline contained massive amounts of Lower Cretaceous Shaftsbury and Upper Cretaceous strata overlying the Gates Formation coal measures in the centre of the syncline. This interpretation results in fold axis plunges of 15 to 20 degrees for Onion Syncline if this fold axis is continuous with Five Cabin Syncline to the northwest (which it is). This obvious error is what spurred this mapping program.

TABLE OF FORMATIONS

PERIOD	GROUP	FORMATION OR MEMBER	LITHOLOGY
LOWER	Fort	Shaftesbury (lower unit) 250 m	Dark grey marine claystone; sideritic concretions, some sandstone grading to silty dark grey marine claystone and siltstone in lower part; minor conglomerate at base.
		Boulder Creek 125-200 m	Fine to coarse non-marine sandstone; claystone, carbonaceous claystone, and conglomerate, few thin coal seams towards base.
	St.	Hulcross 70-80 m	Dark grey marine siltstone interlayered with fine-grained sandstone and claystone; gradational change to fossiliferous sandstone and claystone in south.
CRETACEOUS	John	Gates 190-290 m	Fine to coarse non-marine sandstone; conglomerate, major coal seams, siltstone, and claystone. Torrens Member sandstone at base.
		Moosebar 80-100 m	Dark grey marine claystone with sideritic concretions in the lower portion; gradational increase in sandstone and siltstone at top.
	Bullhead	Bluesky 1 m	Glaucopitic fine-grained sandstone, varying locally to glaucopitic pebble conglomerate.
		Gething 100-150 m	Fine to coarse brown sandstone, coal, carbonaceous claystone and conglomerate.
		Cadomin 40-45 m	Massive conglomerate containing chert and quartzite pebbles interbedded with quartzose sandstone.
JURA-CRETACEOUS	Minnes + 2000 m	Conglomerate, carbonaceous claystone, thin bedded grey and brown sandstone; contains numerous thin coal seams.	

5.2 Physiography

The Physiography of the very north end of Onion Syncline is that of low hills dropping rapidly onto the Kinuseo Creek valley. The main ridges in the hills are dominated by Cadomin Formation to the outside and the Lower Gates Formation Sandstone (equivalent to the Bluesky Formation) in the central parts of the syncline. The entire area is heavily treed with spruce and, locally, elder. The thick cover and lack of outcrop probably precluded previous exploration projects from mapping this particular area.

5.3 Stratigraphy

The stratigraphy of the Lower Cretaceous rock units that outcrop in the Onion Syncline are believed to be similar to elsewhere on the Monkman Coal Property. Table 1 shows that the entire Lower Cretaceous is about 800 metres thick with the major coal bearing unit, The Gate Formation occupying the middle 300 metres of section.

Cadomin Formation (Kcd) In this area the Cadomin Formation is dominantly a chert pebble and cobble conglomerate as shown by outcrops visited during the traverses. The actual thickness is unknown but is believed to be about 65 metres. This unit outcrops on the two ridges on either side of the fold axis and provide excellent stratigraphic and structural control for the map area. The unit also has good exposures on Onion Creek at the southeast end of the map area.

Gething Formation (Kgt) The Gething is believed to be about 125 metres thick in this area. Rare Gething outcrops encountered on the map area were always sandstone and/or conglomerate. The conglomerates commonly are finer grained (pebbly) than the Cadomin and contain less chert. Although coal seams are known to occur in the Gething Formation, none were encountered on this field trip.

Moosebar Formation (Kmb) This unit is believed to be about 100 metres thick in this area. It was not viewed in outcrop, although it does outcrop at the south end of the map area in Onion Creek.

Gates Formation (Kcm(g)) The Gates Formation is a 300 odd metre thick unit that contains potentially commercial coal seams throughout the unit. This unit provides the coal at both Quintette and Bullmoose. The outcrops encountered on this map area were invariably hard sandstone, the more recessive shaley units are tree covered. The amount of coal that exists within the Gates Formation is uncertain. Up to 21 metres of mineable (+1 metre seams) occurs 12 km to the south in drill hole MOD 76-8, and an incomplete Gates section was penetrated by Drill Hole 75-3 in the Five Cabin area

about 6 Km to the northwest. This hole encountered 12 metres of coal, however the amount of Gates section penetrated is questionable. This report assumes the coal seams encountered on MOD 76-8 as being the nearest complete section available.

Hulcross Formation (KCM(h)) The Hulcross Formation is a finely laminated sandy shale unit that overlies the Gates Formation. It is commonly about 70 metres thick. This unit is not observed in outcrop within the study area.

Boulder Creek Formation (KCM(b)) The Boulder Creek Formation is the youngest member exposed on the property. It consists of up to 170 metres of sandstones, conglomerates and shales with minor coal seams. This unit was not observed in outcrop.

5.4 Structure

The structure of the study area is that of a relatively simple chevron syncline with dips of about 60 degrees on the west side and about 45 to 50 degrees on the east side. This is a major structure that extends from Section 10,000N at the south end of Onion Syncline through this study area, up into the Five Cabin Area and continues all the way northwest to the Murray River. Over much of this area, it is termed the Five cabin Syncline in the Five Cabin area and on the Quintette Property to the northwest.

In the map area, the syncline axis has a plunge of about 5.5 degrees to the southeast. With this plunge, it fits into the Five Cabin Syncline without any evidence of faulting in the Kinuseo Valley area. The Gates strata becomes completely eroded about at Section 24000N assuming there is about 30 metres of surficial cover overlying Kinuseo Creek Valley. Hulcross strata lies in the middle of the syncline axis at about Section 22000N and before Section 23000N, the Boulder Creek Formation occupies the syncline axis as outcrop.

The map data indicates a rapid shallowing of strata to the north of Section 23000N. This appears to be consistent with the small shallow anticline that exposes Cadomin Formation strata to the northeast of Five Cabin Syncline immediately north of Kinuseo Creek Valley. This structure does not, however, affect the potential open pit Geology of the Gates Formation coal seams in the syncline between Section 24000N and 22000N.

7. Coal Licence Review

Coal Licences 3253, 3254, 3255, 3256, 3257 and 3258, and the newly acquired coal licence ~~8901~~, all contain outcrop Gates Formation at surface and therefore potentially contain pit resources. These licences must be retained.

Coal licence 3259 apparently lies to the west of the Gates outcrop and does not contain Gates Formation either at surface or at depth. This licence can be released at no risk to the Monkman Coal Project.

8. Conclusions

I. Onion Syncline The recent mapping in the north end of the Onion Syncline confirms that Onion Syncline is an extension of Five Cabin Syncline. Considerable Gates Formation outcrops occur within the axis of the syncline between sections 22000N and 24000N. The Syncline was incorrectly mapped previously and the entire syncline requires reinterpretation.

II. Open Pit Mineable Coal Resources The interpretation indicates that a considerable deposit of open pit mineable coal may exist in the syncline axis between 21500N and 24000N. The reserve estimate indicates that as much as 28,000,000 tonnes of in-situ coal may occur.

III. Licence Review Licences 3253, 3254, 3255, 3256, 3257, 3258 and the newly acquired coal licence need be retained because they potentially contain open pit mineable coal deposits.

Licence 3259 can be released.

IV. Exploration The interpretation of the north end of Onion Syncline indicates major errors in the entire interpretation of Onion Syncline. A re-interpretation is required for the entire syncline. This will permit definition of the open pit resource base of the southeast end of the syncline and any other open pit prospects that may occur between the southeast end and the north-west end included in this study.

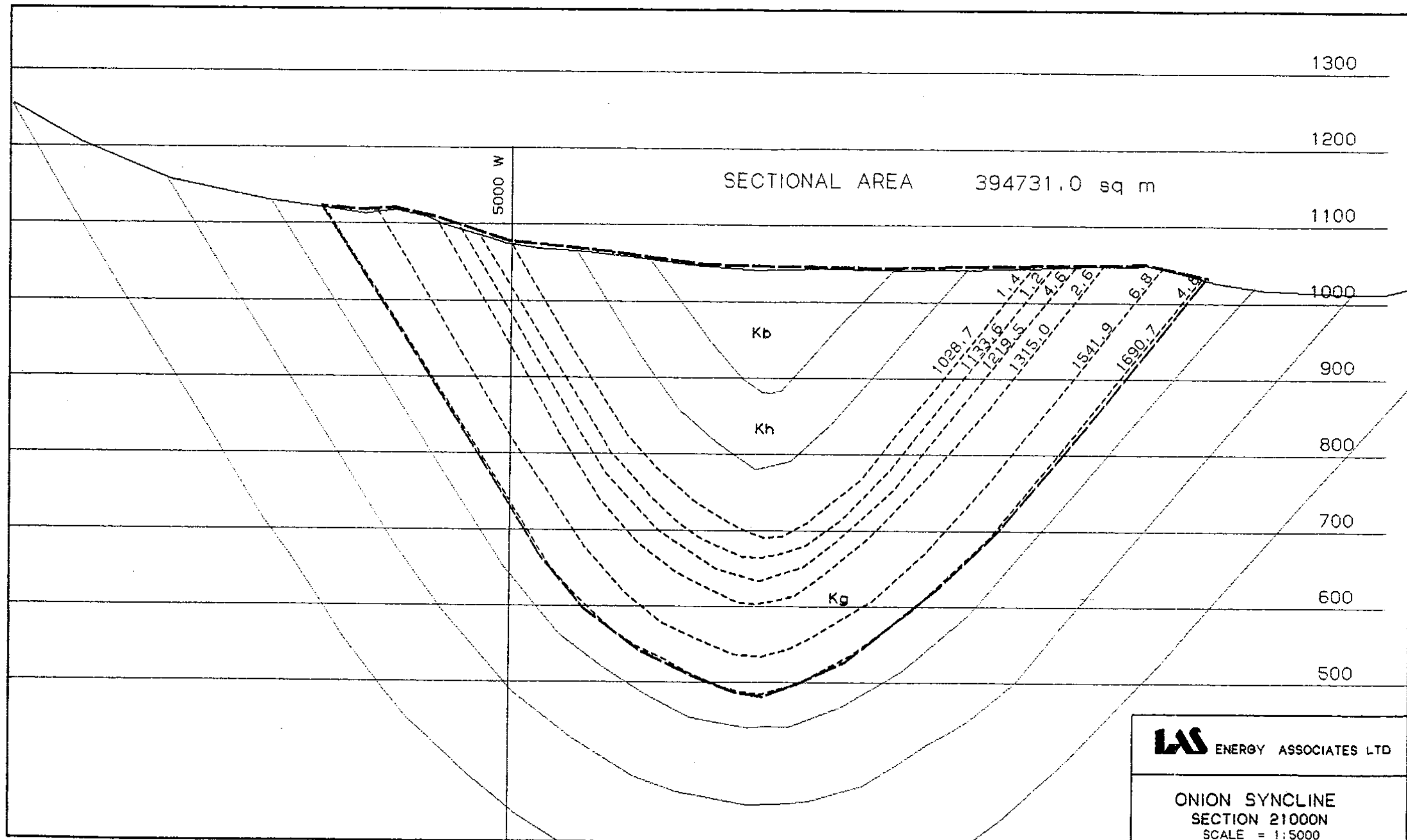
When the Monkman Coal Project is reactivated, additional exploration will be required prior to any additional engineering studies. The mapping has included practically every outcrop in the area of the potential mining deposit, therefore drilling is the next logical course of action. Because of the excellent road access to

the area, it is proposed that a low cost rotary drill program be planned with several drill holes completed along two cross section lines 22000N and 23000N. The major winter drill program could circumvent this problem.

SELECTED BIBLIOGRAPHY

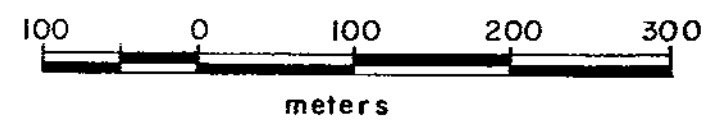
1. Pacific Petroleum Ltd., Monkman Coal Project 1976
Exploration Report, 1977
2. Pacific Petroleum Ltd., Monkman Coal Project Tech-
nical Report March, 1979.
3. Petro Canada Inc., Monkman Technical Report,
March, 1980.
4. Petro Canada Inc., Monkman Coal Project Tech-
nical Report, February, 1981.

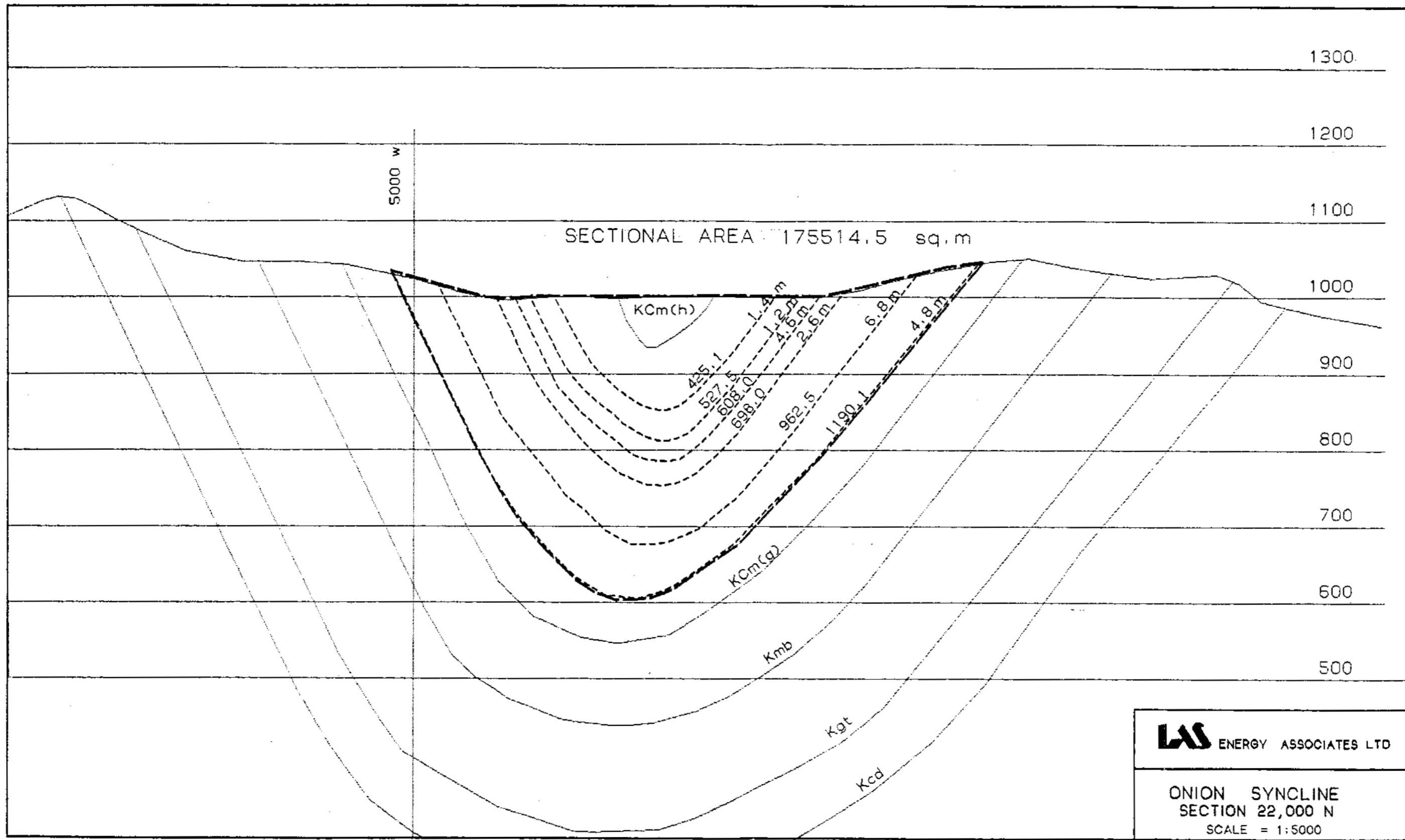
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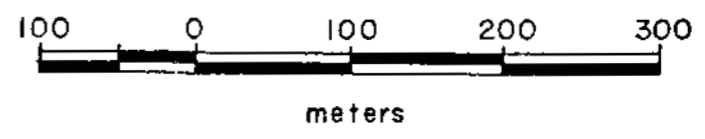
ONION SYNCLINE
SECTION 21000N
SCALE = 1:5000





LAS ENERGY ASSOCIATES LTD

ONION SYNCLINE
SECTION 22,000 N
SCALE = 1:5000



5000 W

SECTIONAL AREA 43037.0 sq. m

1300

1200

1100

1000

900

800

700

600

500

KCm(g)

Kmb

Kgt

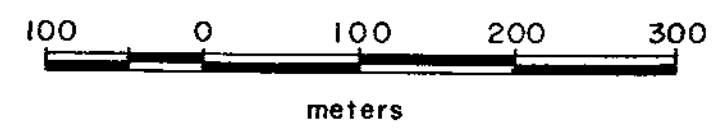
Kcd

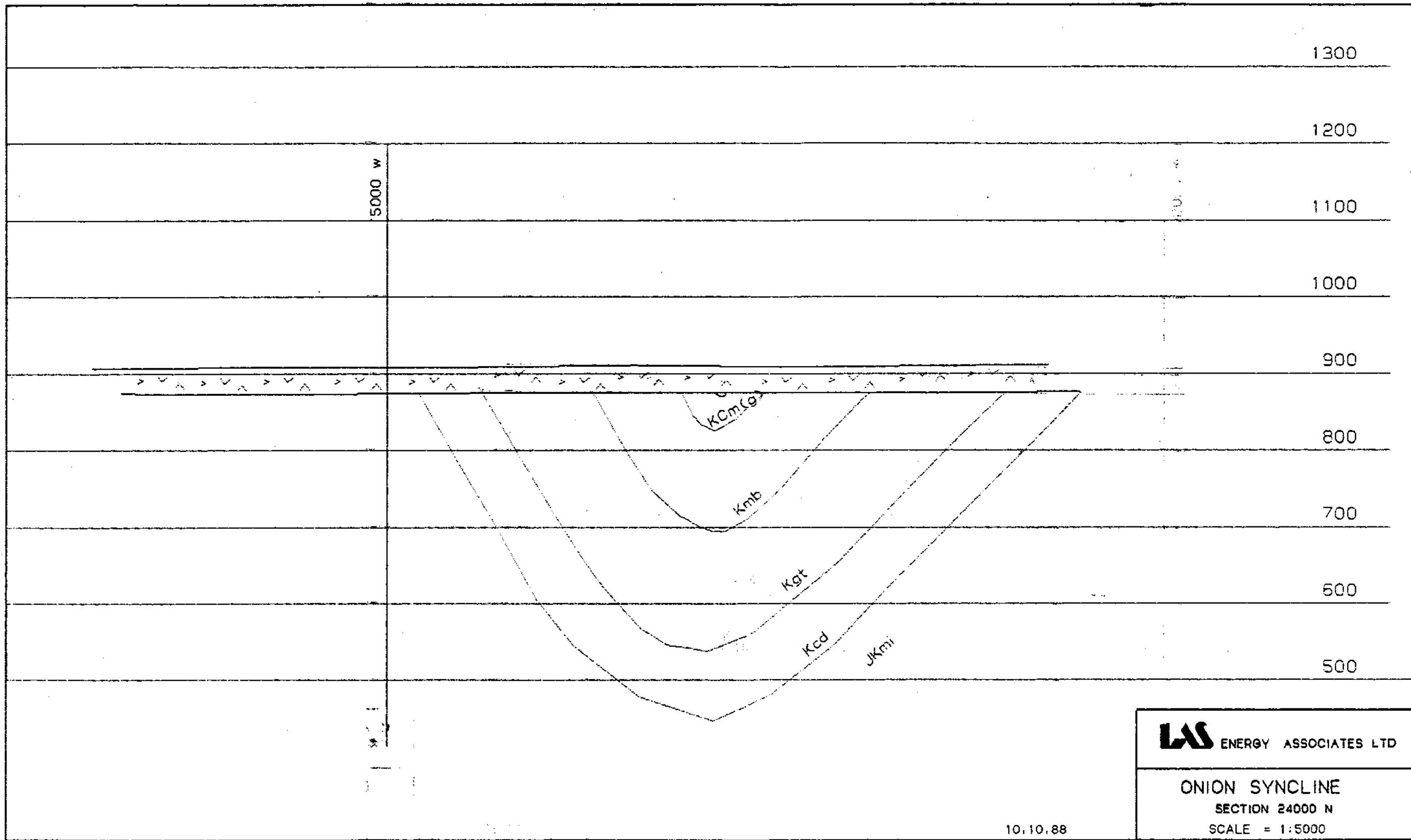
113.7
353.9
522.2
2.6
6.8
4.8

LAS ENERGY ASSOCIATES LTD

ONION SYNCLINE
SECTION 23000N
SCALE = 1:5000

10.10.88

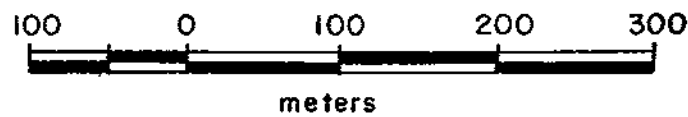


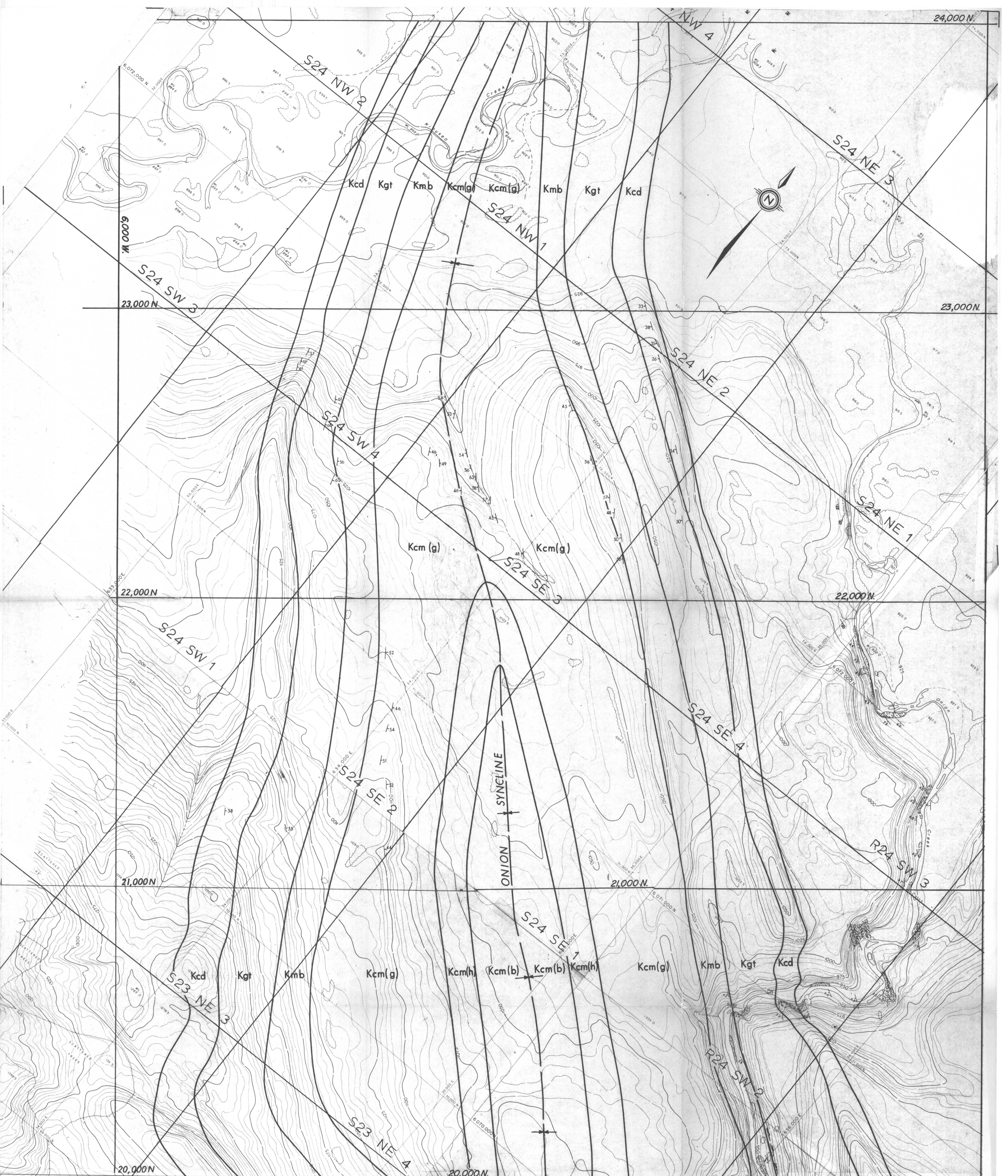


LAS ENERGY ASSOCIATES LTD

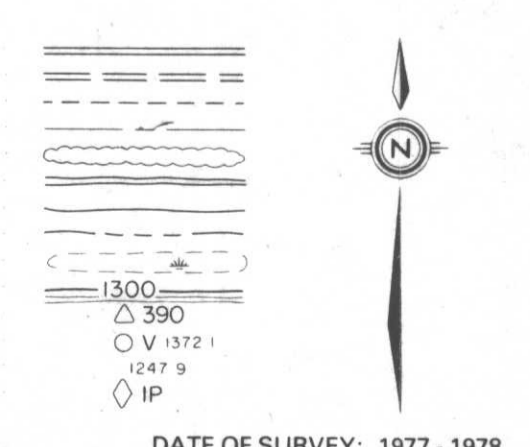
ONION SYNCLINE
SECTION 24000 N
SCALE = 1:5000

10.10.88





LEGEND
 Improved road
 Secondary road
 Track or trail
 Cut line
 Tree area
 River
 Stream
 Intermittent stream
 Swamp
 Contours
 Horizontal control
 Vertical control
 Spot elevation
 Iron Pin



CONTOUR INTERVAL: 5 METRES
 DATE OF PHOTOGRAPHY: SEPTEMBER 1975
 DATE OF SURVEY: 1977-1978
 DATE OF MAPPING: 1977-1978

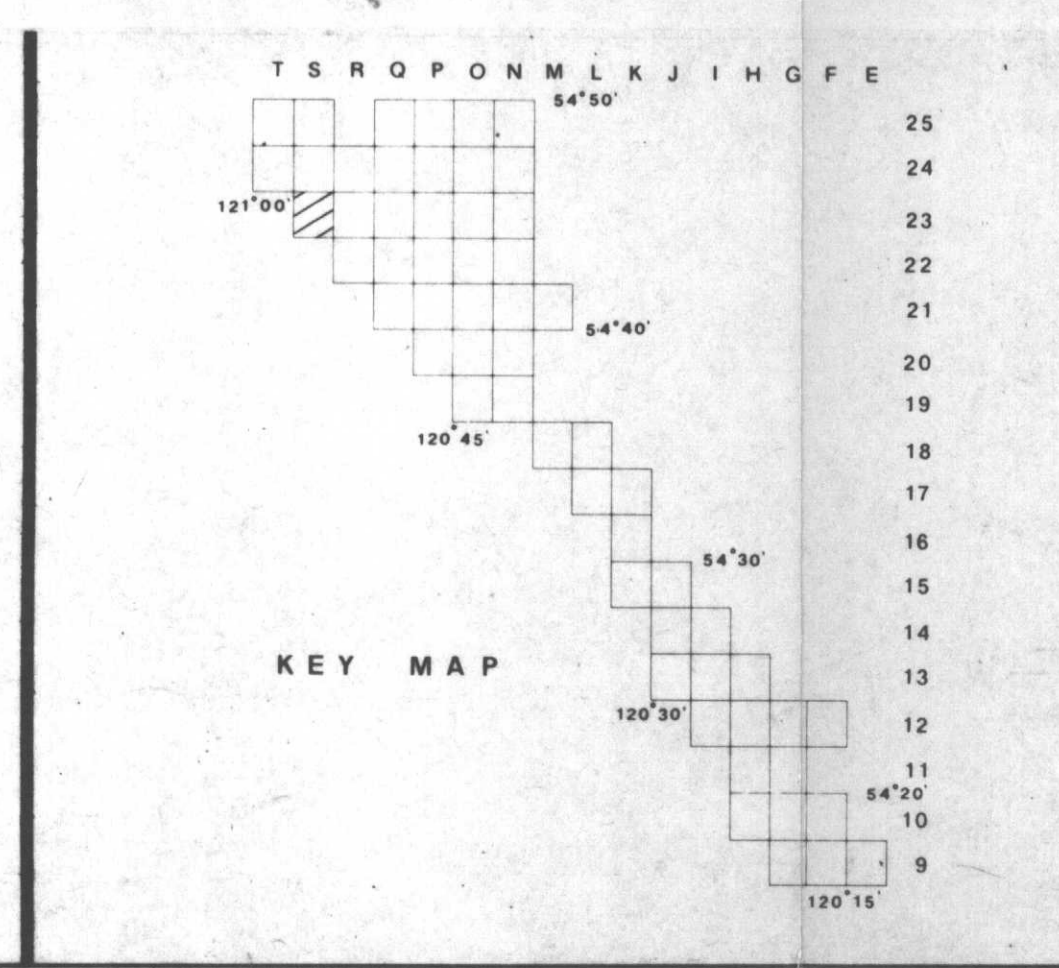
SURVEY NOTE
 The Horizontal and Vertical Coordinates were established by D. W. Watson, B.C.L.S. using conventional and EDM survey equipment. Horizontal and vertical co-ordinates and elevations are derived from Trig Stations Quarters E, Quarters S W, Main, Hawk, Marco, Kinross. All co-ordinates referred to Universal Traverse Mercator Grid Zone 10. Elevations are above Mean Sea Level were established by trig leveling, vertical angles being read at both ends of each course simultaneously.

GEOLOGICAL LEGEND

LOWER CRETACEOUS	SHAFTESBURY FM.	FORT ST JOHN GROUP
Ksh		
COMMOTION FM. (Boulder Creek Member)		
Kcm(b)		
COMMOTION FM. (Hulcross Member)		
Kcm(h)		
COMMOTION FM. (Gates Member)		
Kcm(g)		
MOOSEBAR FM. (u) upper		
Kmb		
MOOSEBAR FM. (l) lower		
Kmb		
GETHING FM.		
Kgt		
CADOMIN FM.		
Kcd		
JURASSIC - CRETACEOUS		BULLHEAD GROUP
MINNES GROUP (undivided)		
Kmi		
PALEOZOIC		MINNES GROUP
DEVONIAN, MISSISSIPPIAN		
P		

LITHOLOGIC LEGEND

COAL SEAM SUBCROP	B1
GEOLOGICAL BOUNDARY	— —
THRUST FAULT - UPPER TRACE	—▲—
THRUST FAULT - LOWER TRACE	—▼—
SYNCLINAL, ANTICLINAL AXIS	— —
DIP & STRIKE (Dipping, Vert., Horiz.)	— —
DRILL HOLE LOCATION	⊙
TRENCH LOCATION	— —
ADIT LOCATION	— —
CONGLOMERATE	⊘
SANDSTONE	⊘
SILTSTONE	⊘
MUDSTONE	⊘
COAL	— —



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PETRO - CANADA
 COAL DIVISION

MONKMAN COAL PROJECT

GEOLOGY OF ONION SYNCLINE
NORTH END

Date: OCT - 1978
Revised:
Author: L.A.S.
Drafted: A.C.
Scale: 1:5,000
Drawing: 11.4

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Monkman
Project
Resource
Calculations

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6. Mining Potential and Coal Resources

Potentially mineable coal seams will occur in the Gates Formation in the Gates subcrop zone along the Onion Syncline fold axis between 24000N and about 22000N. Given the coal seam development assumed from MOD 76-8 at the southeast end of the syncline, the following coal seams are assumed:

Table 1
Assumed Coal Development, (from MOD 76-8)

Seam	Thickness (m)
1	1.4
2	1.2
3	4.6
4	2.6
5	6.8
6	4.8
Total	

The ratio of the entire section at 21000N is over 8:1 bcm/t. This is considered to be excessive and therefore for open pit resource calculation purposes the pit end wall is assumed at 21500N. Given the assumed coal development, and assuming the mineable zone occurs between Section 22000N and 21500N, the following reserve estimates await confirmation by drilling:

Table 2
Potential Resources in the Onion Syncline (North End)-

Section	Seam	Thickness m	Length m	Width m	Resources Megatonnes
22000N	1	1.4	1000	425	2.08
	2	1.2	1000	527	0.92
	3	4.6	1000	608	4.05
	4	2.6	1000	698	2.63
	5	6.8	1000	962	9.49
	6	4.8	1000	1190	8.28
			Subtotal		27.45
23000N	1	1.4		0	
	2	1.2		0	
	3	4.6		0	
	4	2.6	1000	114	.43
	5	6.8	1000	354	3.49
	6	4.8	1000	522	3.63
			Subtotal		7.55
Total					35.00
Total, less 20%					28.00

712