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Geol/370/5136 26th January, 1967.

D.E. Rooke, Esq.,
Director, Production & Supplies Division,
The Gas Council,
Hyde Park House,
4-5 Grosvenor Place,
London, S.W.1.

Dear Sir,

In accordance with instructions received from our London Office we are forwarding to you herewith one print of each of the following well logs:-

Cousland No's G1 to G5 inclusive.

Cousland No's 1 to 4 inclusive.

Yours faithfully,
for BP PETROLEUM DEVELOPMENT LTD.,

C.M. Adcock
Field Superintendent

c.c. Chief Geologist (Attn:- Mr. M.F. Ridd)

FB/

Miss Booth

EXP/MFR/UK/606/6
UK/604/5

PS/HB

The Gas Council,
Production and Supplies Division,
4-5 Grosvenor Place,
LONDON. S.W.1.

24th January, 1967

For the attention of Mr. P. Hinde

Dear Sirs,

We thank you for your letter dated 16th January, 1967, asking for data on the Cousland boreholes.

As an interim measure, until copies of completion reports for these wells have been prepared, we have asked Eakring to make copies of the well logs which they will forward to you in the near future.

Yours faithfully,
for BP PETROLEUM DEVELOPMENT LIMITED

(Sgd.) P. E. KENT

P.E. KENT
Chief Geologist

c.c. Mr. C.M. Adcock - Eakring - For Action!

A65
~~270~~

Geol/370/5127 29th December, 1966.

The Gas Council,
Production and Supplies Division,
4-5 Grosvenor Place,
London, S.W.1.

For the Attention of Dr. P. Stringer.

Dear Sirs,

Underground Gas Storage

In reply to your letter of 22nd December, addressed to Mr. David Wilson, regarding the core samples from the Cousland boreholes, only record pieces of cores, taken at 1 ft. intervals from Cousland No's 5 and 6 are available at Eakring. A list of the intervals from which these pieces of core were taken is enclosed.

No cores are available at Eakring from Cousland No's 1, 2, 3 and 4. A letter from our London Office to the Gas Council, Ref. EXP/RGWB/UK/602/1 of 12th May, 1966, refers to the cores from No's 1 and 2.

A print of the geological log of Ellenthorpe No.1 is enclosed for your retention.

Yours faithfully,
for BP PETROLEUM DEVELOPMENT LTD.,

C.M. Adcock
Field Superintendent

c.c. Chief Geologist (Attn:- Mr. M.F. Ridd) with copy of G.C. letter,

FB/

Intervals from which pieces of cores are available

Cousland No.5

890'	- 902'
912'	- 916'
924'	- 927'
1029'	- 1039'
1055'	- 1084'
1142'	- 1143' 6"
1144'	
1351'	- 1370'
1519'	- 1521'
1660' 6"	- 1664'
1696'	
1709'	
1714'	
1717'	
1736'	- 1740'
1858'	- 1861'
1887'	- 1900'

Cousland No.6

1179'	- 1186'
1195'	- 1203'
1206'	- 1216'
1228'	- 1260'
1365'	- 1396'
1401'	- 1419'
1422'	- 1429'
1436'	- 1446'
1455'	- 1465'
1493'	- 1509'
1513'	- 1528'
1533'	- 1545'
1552'	- 1564'
1613'	- 1624'
1629'	- 1641'
1644'	- 1646'
1650'	- 1656'
1735'	- 1764'
1769'	- 1778'
1820'	- 1822'
1825'	- 1831'
1842'	- 1844'
1849' 9"	
1855'	- 1857' 11"
1871'	- 1904'
1908'	

Reports filed with Technical Notes

V. C. ILLING & PARTNERS

V. C. ILLING, F.R.S.
G. D. HOBSON, PH.D.
C. J. MAY, PH.D.

TELEPHONE:
KNIGHTSBRIDGE 1251-3
CABLES: ILLINGMEY. LONDON S.W.7.

ALFRED HOUSE
23/4 CROMWELL PLACE
LONDON, S.W.7

310
A65

25th July 1951.

My dear Brunstrom,

I am forwarding you herewith a copy of a Report on the cores of Cousland No. 6 dealing with the petrographic character of the cores, and in particular the secondary minerals and their effects on porosity and permeability. Taylor is to carry out a similar examination of the cores of No. 5 which you kindly forwarded to me recently.

As you will see from his description of the cores of No. 6 there was a very considerable amount of slumping and cross-bedding in the formations, which is indicative of conditions of deposition liable to involve rapid lateral variations in the formations. The problem at Cousland is largely a question of the lateral continuity of the sandy formations over the structure and is affected by the original and secondary lateral variations in the porosity of the sands, as well as the possibility of structural de-formation.

As you will see from the Report which I am also enclosing on "Further Drilling at Cousland", I am assuming as a working hypothesis that the major problem with which we are concerned at the moment is the degree of continuity of permeability and porosity, and we are suggesting a location closer to Cousland No. 1 which is broadly in agreement with our verbal discussions. I have had to avoid the area of subsidence associated with the limestone mining operations and am proposing the location near the south-eastern corner of a rough square to which at the present time the limestone workings of Messrs. Bain Bros. are being limited. My thought is that if Cousland No. 7 has sufficient porosity and permeability, it certainly ought to find all the sands at a higher level than in No. 1, and would leave room for an additional location further to the north if the crest of the structure turns out to be a little further north than we had previously thought to be the case.

As you know, the Scottish Gas Board are anxious to drill No. 7 partly as a source of gas and secondly as a potential reservoir for input gas. We are interested if and when the well is drilled to get all the information necessary for the guidance of any future drilling as cheaply as possible.

In addition to the reports on Cousland, I am also enclosing copy of Progress Report No. 2 on the Midland area. As you will see, the shallow drilling combined with gamma ray interpretation of the logs, is being exceedingly helpful. The broad outline of the form of the structure at the top of the Keuper Marl is now clear, and our intention is to outline this north-eastwards to the zone where it should be intersected by the strong down-to-the-north fault which occurs just north of Chipping Norton.

It is interesting to note how greatly the structure has changed proceeding downwards from the top of the Lias to its base, a feature which is obviously governed by the conditions of deposition in this area in post-Trias times.

I am very grateful to you for yours was the original suggestion to utilise BP's shallow drilling equipment for this work. Associated with the surface mapping, this tool is giving us all the evidence we could desire for structural and stratigraphical investigations at depth, and I am hoping that further east we can explore down to the pinchout of the Trias sand so long as we do this outside the potential areas of closure and where the sand is not too deep.

Yours sincerely,

R.G.W. Brunstrom, Esq.,
P.O. Box 1,
Southwell,
Notts.

RGWB
A65

PE1664 12th June, 1961.

Dear Mr. Johnson,

Cousland

Thank you for your letter of the 8th instant. I was surprised to learn that the firm of Mining Consultants employed by the Scottish Gas Board was not qualified to express an opinion on the extent of the limestone sterilization necessary to safeguard both the mine workings and the gas well.

Surely there must be other Mining Experts in the Edinburgh district whom the Scottish Gas Board could consult? I feel that, to make use of local knowledge, a regional approach to the limestone sterilization problem is the correct one.

With regard to the site for Cousland well 7, the decision taken at our meeting in the Basil Street Hotel was that Professor Illing and Mr. Brunstrom should jointly select and approve the location. Professor Illing should therefore indicate the precise location on a reference map, and I would concur if he recommended a site 700 feet to the north east of No.1 well.

Yours sincerely,

C.M. Adcock

C. Johnson, Esq.,
The Gas Council,
Murdoch House,
1, Grosvenor Place,
London S.W.1.

cc. Mr. W.M. Watson,
Mr. R.G.W. Brunstrom ✓
Mr. A.S. Burt

CMA/BR

RJWB

COPY

THE GAS COUNCIL

Murdoch House, 1 Grosvenor Place

London, S.W.1.

8th June, 1961.

Dear Mr. Adcock,

Cousland

Thank you for your letter of the 1st May relating to the limestone compensation claim at Cousland and particularly referring to the appropriate radius of the area of sterilisation around No.1 well. I passed on your views to Mr. Ricketts of the Scottish Gas Board and he has since replied to me to say that it is doubtful whether the firm of mining consultants employed by his Board would be qualified to express an opinion on the particular point at issue. Mr. Ricketts has asked me, therefore, to enquire of you whether you can mention a suitable firm to him.

While I am writing to you I will mention that your letter referred to a provisional location for the suggested No.7 well at a distance of 600 feet north east of No.1 well. In a telephone discussion with Professor Illing this morning he mentioned a distance of 700 feet and said that the tentative site was beyond the boundary of proposed limestone quarrying. Perhaps when you reply to the first point in my letter you will refer to this matter of distance or, better still, indicate the precise location on a simple reference map.

Yours sincerely,

C. Johnson

C.M. Adcock, Esq.,
Senior Petroleum Production Engineer,
BP Exploration Company Ltd.,
PO Box No.1,
SOUTHWELL,
Notts.

BR

PGWS A.65

PE1616 1st May, 1961.

Dear Mr. Johnson,

Cousland

Thank you for your letter dated 28th April. The question of the extent of the limestone sterilization necessary to safeguard both the mine workings and the gas well at Cousland is a matter which requires the services of a Mining Consultant for its assessment.

Dr. May, I believe, is of my opinion, that in view of the shallow depth of the limestone workings, it should not be necessary for the sterilization zone to extend beyond say a radius of 100 feet from the well bore. However, since I am not conversant with mining practices, I have advised that you should consult a Mining Expert.

You will have received from Mr. Ricketts the site plan showing the Nunnery Quarry and Windmill plantation, also the underground plan indicating the area of the limestone workings. It is of interest to note that no mine workings are shown on the underground plan 600 feet to the north-east of well 1, which is the tentative site for well 7.

Whether the new well will be subject to, or free from, limestone compensation claims, should be ascertained from the Stair Estates after the location has been selected by Professor Illing in conjunction with Mr. Brunstrom, and before any site work is undertaken.

Yours sincerely,

C.M. Adcock

C. Johnson, Esq.,
The Gas Council,
Murdoch House,
1, Grosvenor Place,
London, S.W.1.

cc. Mr. W.M. Watson
Mr. R.G.W. Brunstrom ✓
Mr. A.S. Burt

CMA/BR

RGW3

THE GAS COUNCIL

MURDOCH HOUSE · 1 GROSVENOR PLACE
LONDON, S.W.1.

Belgravia 4321

28th April, 1961.

Dear Mr. Adcock,

Cousland

During the course of our meeting at the Basil Street Hotel on 22nd March to consider the prospect of utilising the reserve of natural gas and creating a storage for town gas you raised an informal discussion on the compensation claim by Messrs. Stair Estates Ltd. for sterilization of limestone in the region of No. 1 well. Two issues were raised, namely, whether the affected area should extend to a radius of 150 ft. and whether the claim should be considered afresh if the Scottish Gas Board decided to proceed with the drilling of an additional well identified as No. 7 well.

I think it was left that you and Dr. May would discuss whether there was any need to amend the stipulated radius and that Professor Illing would look at the mining diagrams to decide whether any future drilling could be so located as to minimise limestone compensation claims.

In a different context the Scottish Gas Board have asked for our views on certain aspects of the limestone claim which is being pressed and I thought that if you were now of the opinion that the affected area needed to be modified Scottish Gas Board should be advised to take this into account. There was also the matter of whether a proposed new borehole, identifiable as No. 7 well, could be so sited, in agreement with Professor Illing, as to affect favourably any further claim that might be presented on this account.

I would be glad if you could let me have the up to date position on these points.

Yours sincerely,

C. M. Adcock, Esq.,
Senior Petroleum Production Engineer,
B.P. Exploration Co. Ltd.,
P.O. Box No. 1,
SOUTHWELL,
Notts.

Cousland File RGWB

PE1583 11th April 1961

T.S. Ricketts, Esq.,
Chief Engineer,
The Scottish Gas Board,
26, Drumsheugh Gardens,
Edinburgh 3.

Dear Mr. Ricketts,

Natural gas - Cousland

Many thanks for your letter dated 29th March enclosing two copies each of the following drawings:-

(a) Site plan showing the Nunnery Quarry and Windmill Plantation, with the location of the existing limestone workings to 13th May 1958.

(b) Underground plan of the limestone mine workings showing the area which has been sterilised around Cousland well 1.

I have passed a copy of each drawing to Mr. Brunstrom, who will discuss the location of well 7 with Professor Illing. It is of interest to note that no mine workings are shown on the underground plan 600 feet to the north-east of well 1, which is the tentative site for well 7.

Thank you also for the March report for the Cousland gas production, which I note averaged 155,000 cubic feet per day during the 25 days the well was on production.

Yours sincerely,

C.M. Adcock

cc. Mr. R.G.W. Brunstrom ✓
Mr. A.S. Burt

CMA/BR

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The Gas Council,
Murdoch House,
1, Grosvenor Place, S.W.1.

COPY

3rd March, 1961.

Dear Mr. Adcock,

Cousland

Regarding our proposed meeting here with Professor Illing and Mr. Ricketts of the Scottish Gas Board to discuss Cousland gas reserve, I have offered Mr. Ricketts the choice of the morning of Friday, 17th March, or any time during Wednesday, 22nd March. Would you care to keep these two dates in mind until I hear further from Mr. Ricketts.

I mentioned in my previous letter that Mr. Brunstrom would be welcome if he wished to join us and I understand that Mr. Ricketts has since suggested that he would like him to be present.

Yours sincerely,

Sgd. C. Johnson

C. M. Adcock, Esq.,
Senior Petroleum Production Engineer,
B.P. Exploration Co.,
P.O. Box No. 1,
SOUTHWELL,
Notts.

c.c. Mr. R.G.W. Brunstrom.
Mr. W. M. Watson.

Reply
~~Dr Howitt~~
File
165

PE1558 10th March 1961

T.S. Ricketts, Esq.,
Chief Engineer,
The Scottish Gas Board,
26, Drumsheugh Gardens,
Edinburgh 3.

Dear Mr. Ricketts,

Thank you for your letter of the 8th instant confirming the meeting with Mr. Johnson at the Gas Council Office in London on 22nd March.

I am sending you herewith two copies of a "Note for Record" which I have prepared on the basis of our exploratory discussion at your Edinburgh Office on 19th January.

The objective has been to determine:-

Firstly - How quickly well 1 can be depleted so that it can be used for coal gas storage.

Secondly - How to deplete a new well, say well 7, without interfering with the gas production/gas storage project for well 1.

Thirdly - The procedure to be adopted to be able to produce the stored coal gas from well 1 to Glasgow, and natural gas from well 7 to Granton for reforming, using a common pipe line.

The attached diagram shows the indicated development sequence. If you agree that these proposals are in accord with your future programme, may I suggest that you send one copy of the "Note for Record" to Mr. Johnson for his consideration before the meeting on 22nd March.

You will note that by 1st January 1967 stored coal gas from well 1 should be delivered to Glasgow. A total of 400 million cubic feet is to be stored in the summer and delivered to Glasgow during the winter. By 1971 both wells should be on coal gas storage and production, the total quantity of gas per cycle being 800 million cubic feet.

Encl.

Yours sincerely,

C.M. Adcock

cc. Mr. M.H. Lowson, Britannic House,
Mr. W.M. Watson, Eakring
Mr. R.G.W. Brunstrom, Eakring ✓
Mr. A.S. Burt, BP House

CMA/BR

N O T E F O R R E C O R D

COUSLAND GAS PRODUCTION/GAS STORAGE PROJECT

TENTATIVE SCHEME

(Based on an exploratory discussion between Mr. T.S. Ricketts and the undersigned at the Edinburgh Office of the Scottish Gas Board on 19th Jan.1961

OUTLINE OF PROPOSALS

The gas to be stored is to be brought by pipe line from the Lurgi coal gasification plant at Westfield in Fife, at a pipe line pressure of 350 p.s.i. Reformed Refinery gases from Granton may not be suitable for underground storage, owing to the presence of unsaturated hydrocarbons having gum-forming possibilities.

The storage period will be from 1st May to 1st September each year. During the rest of the year the same pipe line will be required to take the production to Granton for reforming until the reservoir has been purged of natural gas. Thereafter the pipe line will be used for conveying stored coal gas to Glasgow.

Suppose that the pipe line to Granton and the Reforming plant are in operation by 1st January 1963. To deplete the 1582' sand in well 1 quickly, 100 million cubic feet of gas should be flowed to Musselburgh annually; and,in 1963,an additional 200 million cubic feet should be flowed to Granton.

Well 1 is scheduled to be on coal gas injection by 1st May 1964 using one compressor having a capacity of 2.5 million cubic feet per day at 750 p.s.i. The quantity of gas stored during the summer season is expected to be circa 300 million cubic feet. The same quantity of gas would be delivered to Granton for reforming during the winter months.

It is estimated that the 1582' reservoir may have been purged of natural gas by 1st September 1966. Hence, during the period 1st January to 1st May 1967, stored gas, equivalent to 400 million cubic feet, could be delivered to Glasgow. This should reduce the wellhead pressure to circa 100 p.s.i.g., the pressure in the Glasgow pipe line.

The second compressor will be required on 1st May 1967 to store 400 million cubic feet of gas in well 1, and to commence gas storage into a second well.

Well 7, the proposed well to the 1720' sand, is scheduled to come on to production on 1st January 1964. Initially, the production would be to Musselburgh at the rate of 100 million cubic feet per year. From 1st September to 31st December 1966 an additional 150 million cubic feet gas should be delivered to Granton for the maximum depletion of the reservoir.

Well 7 is expected to be on coal gas injection on 1st May 1967, with both the 2.5 million cubic feet per day compressors in operation. The quantity of gas injected into well 7 during the season would be circa 190 million cubic feet. The stored gas will be delivered during the winter months to Musselburgh and Granton until the 1720' reservoir has been purged of natural gas.

Deliveries of low calorific stored gas to Glasgow should commence about 1st September 1970. By 1st May 1971 a third compressor will be required so that 400 million cubic feet of coal gas can be stored in each well.

The year 1971 should see the commencement of the annual cycle in which 800 million cubic feet of gas are stored in the summer and are delivered to Glasgow during the winter. Any increase in these quantities is dependent on the drilling of more wells and the commissioning of additional compressors.

The attached diagram shows the indicated development sequence for wells 1 and 7 as outlined by the foregoing proposals.

P. L. Adcock
10/3/61

COUSLAND GAS PRODUCTION / GAS STORAGE PROJECT.

Diagram showing the indicated development sequence for Well No. 1 & the proposals for Well No. 7.

YEAR	COUSLAND WELL 1 (Million cubic feet) Musselburgh One Year	Granton One Year	REMARKS
1959	52·6	-	Cumulative production to 31/12/59
1960	28·8	-	Under firing of retorts from November.
1961	68·6	-	Reforming gas through coal charge in retorts from April.
1962	100	-	
1963	100	200	(a) Production before coal gas injection on 1st May 1964
1964	-	50[a]	Total production before gas storage 600 million cubic feet.

YEAR	Well 1: Gas Stored 120 days	Well 1: To Granton 120 days	COUSLAND WELL 7 (Million cubic feet) Musselburgh One Year	Well 7: Granton 120 days	REMARKS
1964	300	150	100	-	
1965	300	300[b]	100	-	(b) To Granton in 240 days.
1966	300	150	100	150	
1967	-	-	30[c]	-	(c) Production before coal gas injection on 1st May 1967.

YEAR	Well 1: Gas Stored 120 days	Well 1: To Glasgow 120 days	Well 7: Gas Stored 120 days	Well 7: To Musselburgh 120 days	Well 7: To Granton 120 days	REMARKS
1967	400[d]	400[e]	190[d]	30	150	(d) This is the combined capacity of the two 750p.s.i. compressors.
1968	400	400	190	60[f]	150	(e) The purging of the reservoir having been completed, the gas can be delivered into the Glasgow pipe line.
1968	400	400	190	60[f]	150	(f) To Musselburgh in 240 days.
1970	400	400	190	30	-	

YEAR	Well 1: Gas Stored 120 days	Well 1: To Glasgow 120 days	Well 7: Gas Stored 120 days	Well 7: To Glasgow 120 days.	REMARKS
1970	-	-	-	350[g]	(g) Production to allow for a nett withdrawal of 700 million cubic feet.
1971	400[h]	400	400[h]	400	(h) A third compressor is required to inject 800 million cubic feet into the two wells in 120 days.
1972	400	400	400	400	

APPENDIX

Contents

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APPENDIX

COUSLAND GAS PRODUCTION/GAS STORAGE PROJECT

TENTATIVE SCHEME

This is a tentative scheme based on an exploratory discussion between Mr. T.S. Ricketts and the undersigned at the Edinburgh Office of the Scottish Gas Board on 19th January, 1961.

A. Natural gas production from Cousland well 1 until coal gas injection in 1964

1. The production of natural gas from Cousland well 1 to be continued until the spring of 1964. The production rate was increased during November 1960 by the under-firing of the retorts at Musselburgh with natural gas. Reforming of the gas will take place during April 1961 when natural gas will be fed up through the coal charge in the retorts. The test will commence experimentally in four retorts. It is proposed to increase the annual delivery of natural gas to Musselburgh to 100 million cubic feet.

2. It is assumed that Reforming plant at Granton will be in operation on 1st January 1963. It is assumed that 200 million cubic feet of gas will be delivered to Granton during 1963, making the total annual production from well 1 of 300 million cubic feet, or 820,000 cubic feet per day.

3. Coal gas injection into well 1 will commence on 1st May 1964 at a rate of 2.5 million cubic feet per day, equivalent to the capacity of one of the 750 p.s.i. compressors which the Scottish Gas Board proposes to purchase for this project.

TABLE I

Natural gas production from Cousland 1 until coal gas injection in 1964

Year	Gas supply Areas Musselburgh M ft³	Granton M ft³	Production - M ft³ Annual	Cumulative	Flowing wellhead pressure (estimated) at end of year p.s.i.g.
1960	28.8[a]	-	28.8	81.4	550
1961	68.6[b]	-	68.6	150	530
1962	100	-	100	250	430
1963	100	200[c]	300	550	220
1964[d]	-[e]	50	50	600	180

Notes

(a) Under-firing of the retorts at Musselburgh commenced circa 23rd November 1960.

(b) Feeding natural gas up through the coal charge in the retorts to reform the gas scheduled to commence April 1961.

(c) Reforming plant at Granton assumed to be in operation on 1st January 1963, with available capacity for the treatment of 200 million cubic feet Cousland gas annually.

(d) The natural gas production from Cousland well 1 would cease in the Spring of 1964. Coal gas injection would commence on 1st May 1964.

(e) From 1st January 1964 the gas supply for Musselburgh will be drawn from well 7.

M Million cubic feet.

B. Coal gas storage followed by gas production from well 1.

1. The maximum quantity of gas which Granton can accept for reforming has been assessed at 300 million cubic feet during the 240 days production period per year, or an average of 1.25 million cubic feet per day. Hence the quantity of gas which may be injected into the 1582' sand during each 120 days storage period is 300 million cubic feet.

2. Musselburgh will not be able to accept any gas from Cousland well 1, since this pipe line will be in use for the depletion of well 7, the proposed new well for the drainage of the 1720' sand.

3. Suppose that the 1582' sand will be purged of natural gas after three storage cycles. The third cycle will take place from May to September 1966. Well 1 will be shut-in until 31st December 1966 since the Granton pipe line will be required to deplete well 7 during this period at a faster rate than is possible by producing it only to Musselburgh.

4. From 1st January to 1st May 1967 well 1 is to be produced into the 100 p.s.i. Glasgow pipe line at a rate of 3.4 million cubic feet per day, or 400 million cubic feet in 120 days. Since this is also the Granton pipe line, the production from well 7 will be delivered to Musselburgh only during this period. At the end of the Spring production period the compressors will be required to inject the Lurgi gas from the pipe line into wells 1 and 7 to build up the wellhead pressure from a minimum of 100 p.s.i. to a maximum of 400 p.s.i.g.

5. The cycle of storing 400 million cubic feet during the Summer and producing it to Glasgow at the beginning of the following year to be continued indefinitely. The period from 1st September to 31st December is required for delivering gas from well 7 to Granton for reforming until the 1782' sand has been purged of natural gas production.

TABLE II

Coal Gas Storage in Cousland well 1

Year	Cumulative production prior to storage M ft³	Gas injection rate M ft³ per day	Gas stored in 120 days from 1st May to 1st Sept. M ft³	Nett gas withdrawal from reservoir M ft³	Cousland Well 1 pressures - p.s.i.g. (1) Wellhead before coal gas injection	(2) B.H.D.P. for prdn. rate equivalent to injection rate	Initial injection pressure	(3) Wellhead pressure after storage S ft³ gas	Injection pressure at end of storage period
	P		S	P - S	a	b	a+b+5%	c	b+c+5%
1964	600	2.5	300	300	180	160	360	400	600
1965	600	2.5	300	300	180	160	360	400	600
1966	600	2.5	300	300	180	160	360	400	600
1967(4)	700	3.4	400	300	100	270	400	400	700
1968	700	3.4	400	300	100	270	400	400	700

These cycles to be repeated annually

Notes:

(1) Wellhead pressure read from graph showing wellhead flowing pressures plotted against cumulative production.

(2) The B.H.D.P. for a given production rate has been read from graph 3 on accompanying the report on the putting of Cousland well 1 back on production from the 1582 sand dated 1st January 1957.

(3) The wellhead pressure for the nett gas withdrawal has been read from the graph showing wellhead flowing pressures plotted against cumulative production.

(4) By 1967 it has been assumed that the 1582 sand will have been purged of natural gas. Hence during the withdrawal period, the gas will be delivered direct to Glasgow without having to go to Granton for reforming.

M Million cubic feet.

TABLE III

Gas production after gas storage in well 1

Year	Nett gas withdrawal from reservoir M ft^3	Production period days from 1st Jan.	Production period days from 1st Sept.	Million ft^3 Production To Granton during period	Million ft^3 Production Nett withdrawal from reservoir	Wellhead pressure after production p.s.i.g.	Remarks
							First storage cycle
1964	300	-	120	150	450	290	
1965	450	120	-	150	600	180	
							Second storage cycle
1965	300	-	120	150	450	290	
1966	450	120	-	150	600	180	
				To Glasgow			Third storage cycle
1966	300	-	-	-	-	400	Gas from well 7 to Granton
1967	300	120	-	400	700	100	Prdn. rate 3.4 M ft^3 day
							Fourth storage cycle
1967	300	-	-	-	-	-	Gas from well 7 to Granton
1968	300	120	-	400	700	100	

These cycles to be repeated annually

Notes:

It is assumed that after the third storage cycle the gas can be delivered to Glasgow without reforming at Granton. From 1966 onwards well 1 will be shut in each year from 1st September to 31st December, so that gas can be delivered from well 7 to Granton in order to deplete the new reservoir sufficiently quickly so that it can be used ultimately for gas storage.

C. Speculative natural gas production from well 7 until coal gas injection in May 1967

1. Well 7 is to be an exploitation well of the 1720' sand. Initially it may be drilled to the 2094' sand for its appraisal. Well 7 is to be located within 100 - 200 yards of well 1 in a north-easterly direction. A structural rise of circa 50 feet is expected, so that the 1720' sand could be used both for gas production and gas storage, its potential value being provisionally assessed as similar to that of the 1582' sand in well 1.

2. The supply of natural gas from well 7 to Musselburgh to commence on 1st January 1964, at a rate of 100 million cubic feet annually. From 1st September to 31st December 1966 an additional 150 million cubic feet gas would be supplied to Granton in order to deplete the 1720' sand sufficiently to commence coal gas injection on 1st May 1967.

3. Coal gas injection into well 7 should commence on 1st May 1967 at a rate of 1.6 million cubic feet per day. Together with the 3.4 million cubic feet per day being injected into well 1, the two compressors will be operating at their maximum capacity of 5.0 million cubic feet per day. The maximum injection pressure expected will be 700 p.s.i.g. at well 1. The rated capacity of the compressors of 750 p.s.i.g. appears to be adequate.

TABLE IV

Speculative gas production from Cousland 7 until coal gas injection in 1967

Year	Gas supply Areas Musselburgh M ft^3	Gas supply Areas Granton M ft^3	Production - M ft^3 Annual	Production - M ft^3 Cumulative	(d) Flowing wellhead pressure (estimated) at end of year p.s.i.g.
1964	100	-	100	100	540
1965	100	-	100	200	470
1966	100	150 (a)	250	450	290
1967 (b)	30	- (c)	30	480	270

Notes:

(a) This flowing period commences on 1st September 1966. Well 1 will be shut-in so that the gas from well 7 can be flowed to Granton for reforming. Average production rate 1.5 million cubic feet per day.

(b) Natural gas from well 7 could cease by 1st May 1967, and the 120 days season for coal gas injection would commence.

(c) No natural gas can be supplied to Granton from January to April inclusive since this is the period for the production of coal gas from well 1 into the trunk pipe line to Glasgow.

(d) The flowing wellhead pressures have been based on the performance of well 1, and assume that similar reserves will be proved in the new sand brought on production in well 7.

M Million cubic feet.

TABLE V

Coal gas storage in Cousland well 7

Year	Cumulative production prior to storage M ft³	Gas injection rate, M ft³ per day	Gas stored in 120 days from 1st May to 1st Sept. M ft³	Nett gas withdrawal from reservoir M ft³	Cousland Well 7 pressures - p.s.i.g.				Injection pressure at end of storage period
					(1) Wellhead before coal gas injection	(2) B.H.D.P. for prdn. rate equivalent to injection rate	Initial injection pressure	(3) Wellhead pressure after storage S ft³ gas	
	P		S	P - S	a	b	a+b+5%	c	b+c+5%
1967	480	1.6	190	290	270	70	360	410	500
1968	500	1.6	190	310	250	70	340	390	480
1969	520	1.6	190	330	240	70	330	370	460
1970	540	1.6	190	350	220	70	310	360	450
1971 (4)	700	3.4	400	300	100	270	400	400	700
1972	700	3.4	400	300	100	270	400	400	700

Notes:

(1) Wellhead pressures have been based on the performance of well 1, and have been read from the graph showing the pressures plotted against the cumulative production.

(2) The B.H.D.P. for a given production rate has also been based on well 1, and has been read from graph 3 accompanying the Cousland report dated 1st January 1957.

(3) The wellhead pressure for the nett gas withdrawal has also been based on well 1, and has been read from the graph showing the pressures plotted against cumulative production.

(4) By 1971 it has been assumed that the 1720' sand will have been purged of natural gas. Hence, during the withdrawal period, the gas will be delivered direct to Glasgow without having to go to Granton for reforming.

M Million cubic feet.

D. Speculative coal gas storage followed by gas production from well 7

1. The maximum quantity of gas which Granton can accept for reforming is assessed at 150 million cubic feet during the 120 days period from 1st September to 31st December. The quantity of gas supplied to Musselburgh over the 240 days period from 1st September to 1st May of the following year is assessed at 60 million cubic feet. No gas can be supplied to Granton during the period 1st January to 1st May since coal gas will be accepted from well 1 into the pipe line during this period for delivery to Glasgow.

2. It is supposed that the 1720' sand will be purged of natural gas after four storage cycles. The fourth cycle will take place from May to September 1970. From 1st September to 31st December 1970 well 7 is to be produced into the Glasgow pipe line at a rate of 2.9 million cubic feet per day, or 350 million cubic feet in 120 days, the wellhead pressure being reduced to circa 100 p.s.i.g.

3. A third compressor will be required for the 1971 gas storage period, since it is proposed to inject gas into well 7 at a rate of 3.4 million cubic feet per day, or 400 million cubic feet from 1st May to 1st September.

4. From 1971 wells 1 and 7 will be available for the storage of 800 million cubic feet gas in the summer season and the production of 800 million cubic feet gas to the Glasgow pipe line during the winter season.

TABLE VI

Gas production after gas storage in well 7

Year	Nett gas withdrawal from reservoir M ft³	Production period days from 1st Jan.	Production period days from 1st Sept.	Million cubic feet production: To Granton During period	To Musselburgh During period	Total During period	Nett withdrawal from reservoir	Wellhead pressure after production p.s.i.g.	Remarks
									1st storage
1967	290	-	120	150	30	180	470	270	
1968	470	120	-	-	30	30	500	250	
									2nd storage
1968	310	-	120	150	30	180	490	260	
1969	490	120	-	-	30	30	520	240	
									3rd storage
1969	330	-	120	150	30	180	510	250	
1970	510	120	-	-	30	30	540	230	
				To Glasgow					4th storage
1970	350	-	120	350			700	100	Prdn. rate 2.9 M ft³/day
1971	700	-	-	-			-	100	Gas from well 1 to Glasgow
1971	300	-	120	400			700	100	Prdn. rate 3.3 M ft³/day
1972	700	-	-	-			-	100	Gas from well 1 to Glasgow
1972	300	-	120	400			700	100	
1972	700	-	-	-			-	100	

These cycles to be repeated annually

Notes:

It is assumed that after the fourth storage cycle the gas can be delivered to Glasgow without reforming at Granton. From 1971 onwards well 7 will be shut-in each year from 1st January to 1st May, so that gas can be delivered from well 1 to Glasgow in order to deplete the 1582' sand for the next storage cycle.

Letter from Mr Adcock to Mr C. Johnson dated 28.2.61 re meeting with Prof. Illing filed Eskdale (B.10)

RGWS   A 65

PE1539

23rd February 1961

T.S. Ricketts, Esq.,
Chief Engineer,
The Scottish Gas Board,
26, Drumsheugh Gardens,
Edinburgh, 3.

Dear Mr. Ricketts,

Natural Gas - Cousland

Thank you for your letters dated 13th, 14th, and 16th February. I confirm that Mr. Brunstrom and myself will be pleased to be present at the forthcoming meeting with Professor Illing to discuss the programme for Cousland.

Thank you also for the information on the weight of the explosive charge used in the limestone workings near well 1. I have passed this information on to our London Office for their consideration.

From your January report on Cousland gas production I note that the offtake averaged 143,000 cubic feet per day during the month. Will you be cracking natural gas in the retorts in the near future?

Yours sincerely,

C.M. Adcock

CMA/BR

RGEWB A65

File, Cousland.

TELEPHONE
NATIONAL 1200

BP HOUSE,
ROPEMAKER STREET,
LONDON, E.C.2

31st March, 1960.

Dear Geoff,

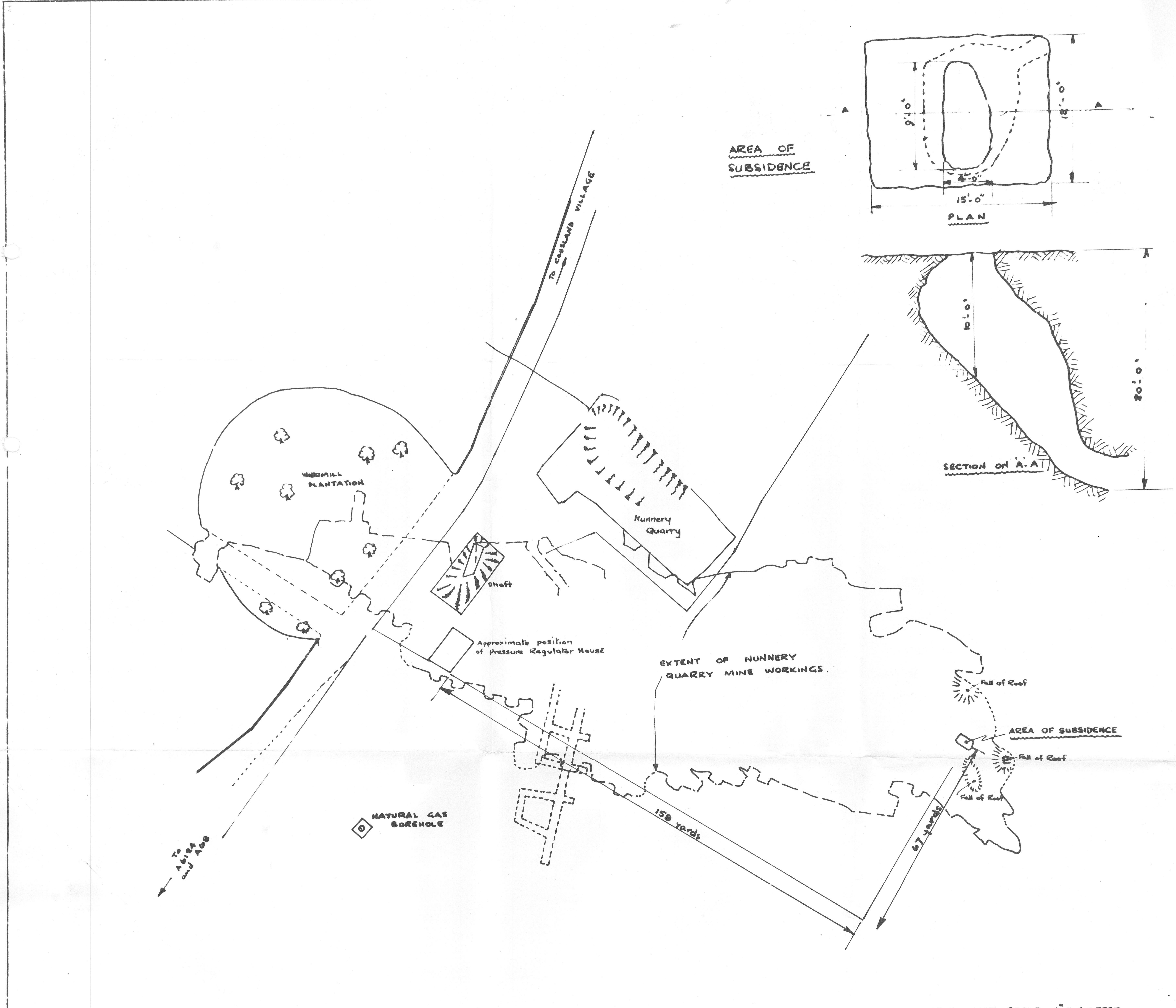
With reference to our telephone conversation yesterday, I am enclosing a copy of the Cousland map we discussed.

Yours sincerely,

(A. S. Burt)

R.G.W. Brunstrom, Esq.,
BP Exploration Co. Ltd.,
P.O. Box 1,
Southwell,
Notts.

Encl.



DRAWING NUMBER G. 34.

THE SCOTTISH GAS BOARD,
26 DRUMSHEUGH GARDENS.
EDINBURGH, 3.

APPROXIMATE LOCATION OF SUBSIDENCE NEAR COUSLAND NATURAL GAS BOREHOLE.

2nd October, 1959.

PE.276

18th February 1958

T.S. Ricketts, Esq.,
The Scottish Gas Board,
26, Drumsheugh Gardens,
Edinburgh 3.

Dear Mr. Ricketts,

Many thanks for your letters dated 6th and 11th February. In accordance with our arrangement, Mr. Kirby demonstrated to Mr. Cairns on Thursday 13th February the method of measuring wellhead gas pressures accurately by means of the deadweight tester. The wellhead pressure recorded last Thursday was 611.6 p.s.i.g.

In the Cousland report, dated 1st January 1957, it was shown that, at production rates around 100,000 cubic feet per day, there was no detectable difference between the following pressure and the closed-in pressure (See Table on page 9).

The closed-in pressure measured on 11th November 1956 was 620.4 p.s.i.g. (page7). There has been in consequence a pressure drop of 8.8 p.s.i. during the current production period. The Musselburgh meter reading on 13th February was 6,751,000 cubic feet. It will be noted that the current pressure decline rate is approximately 1.3 p.s.i. per million cubic feet of gas

It would be convenient if you would arrange to measure the wellhead pressure by deadweight tester not less than twice monthly; and if you would report these pressures, together with the dates of measurement, when you submit to us your monthly returns for the gas production. This will permit a closer study to be made of any changes which may occur in the pressure decline rate.

Mr. Kirby mentioned that you had only received one 2 p.s.i. weight for the Barnet deadweight tester. In my letter dated 31st October 1957, I stated that two 2 p.s.i. weights should be ordered. It is evident that the sum of the smallest weights must add up to 5 p.s.i., and the second 2 p.s.i. weight is definitely required.

I was pleased to learn that you have overcome the gas hydrate problem by wrapping the gas inlet pipe to the control room with an Electrothermal Armoured Heating cord, which you have lagged to conserve the heat, and to ensure its transfer to the gas stream.

Yours sincerely,

BRUNSTROM RGWS

Fileo.

Memorandum

From CHIEF GEOLOGIST **To** RESIDENT GEOLOGIST, EAKRING.

Our Ref. PRO/20 **Your Ref.** **Date** 22nd June, 1955.

Subject TECHNICAL NOTE ON COUSLAND

Thank you for your memorandum GEOL/A65/145 of 2nd June, 1955, enclosing Mr. Brunstrom's Technical Note GL-RGWB5-UK-SCOTLAND-10.5.55.

This thoughtful assembly of present geological evidence is a valuable contribution which will be of great assistance in planning future work in the area.

We agree with Mr. Brunstrom's conclusions and note that these have your support. The Cousland area will come up for consideration again in due course; for the present it suffices that Geological Division can offer two more justifiable locations for gas test wells.

N. L. Falcon

MCM

c.c. Mr.P.T.Cox.
Mr.R.K. Dickie.
D.E.C.
Mr.E.K.Steele.

C.11.46

File

Copy

R.G. EAKRING. CHIEF GEOLOGIST.

From GEOL/A65/145 **To** 2nd June, 1955.

Our Ref. TECHNICAL NOTE ON COUSLAND **Your Ref.** **Date**

Subject

In compliance with a directive from Chief Geologist Mr. Brunstrom has re-examined the evidence from past drilling at Cousland with a view to evaluating the prospects of further work in the area. The results of Mr. Brunstrom's work is set out in Technical Note GL-RGWB5-UK-SCOTLAND-10.5.55 entitled The Prospects of Finding More Gas In The Cousland Area. This report is being forwarded to Production Records for distribution in London Office.

We have little to add to Mr. Brunstrom's findings and recommendation. The main conclusions of the report are: (1) that the present known accumulation near Cousland village is probably at least twice the previous estimate; the increase being derived by drawing the structure contour map on the 1582' sand, the producing sand, and not on the No.1 limestone. The isopachyte evidence used for the 1582 sand contour is very reasonable and makes a better approach to the problem than do estimates based on the structure on the No.1 Limestone.

(2) The Carberry Hill-Falside culmination offers good prospects of a gas accumulation equal in size to the increased estimate of the Cousland culmination.

We have as a result of this re-appraisal a prospect of offering to the Gas Council a strong possibility of reserves some four times greater than those quoted in previous reports.

H. R. WARMAN

HRW/RLB

File - Cousland.
A.65

Memorandum

From MANAGER, GEOLOGICAL DIVISION **To** SENIOR GEOLOGIST U.K.

Our Ref. PRO/20. **Your Ref.** **Date** 8th March, 1955.

Subject GAS COUNCIL EXPLORATION PROJECT
COUSLAND AREA SCOTLAND.

Ref. Production Dept. Memo. PRO/60 of 9th November to D.E.C. (copied to Manager Eakring), paras.4 and 5, we have been informed by D.E.C. that the Gas Council's reaction to our completion report on Cousland No.5 (U.K.195) is to suggest that we should put up firm proposals for the next step.

The geological note by Dr.W.D.V.Jones in the U.K.195 report makes no mention of the gas possibilities of the Carberry Hill or Chalkyside crest maximum, although Mr.Cox has referred to a possible culmination on the north in para.3 of the above Memo.

A full consideration of the next step requires that we give some thought to the amount of gas which could be stored in the other two unexplored crest maxima. Without having gone into the matter in detail, it seems that there may be a geological case for drilling Carberry Hill before deciding on the possible work programme for the Cousland crest maximum.

Will you please arrange for this question to be examined on its geological merits and let us have views.

N. L. Falcon

c.c. Mr.P.T.Cox
Mr.F.R.Malden

RJ.

Cousland file A65

Note on letter - ex P.T.C. 9/11/54.

Para 4. I believe Adcock considered No 1 could drain the reservoir adequately but with any N.E. extension I do not believe it could. i.e. a N.E. well would be required.

(a). (ii) I believe this is probable.

(a)(iii) I shall have to do some more work on the northern end of the major axis.

5. Three possibilities (to be decided on the results of the economic appraisal)

(a) To abandon the Cousland project

(b) To bring No 1 into production and watch results 1 year or so.

(c) To drill a further test well and investigate productive capacity

If (a) is effected then further geological work will be rendered unnecessary. It crosses my mind however that the final decision will eventually be thrown back to Chief Geologist - who must know as far as possible what the maximum & minimum reservoir sizes can be. And here is work for 1 man for 3 months at least.

20th December 1954

Dr. Jones (Geol.)

Cousland A65

Underground storage of gas at Cousland

The possibility of storing gas in the middle Cousland dome is discussed with particular reference to the 1582'-1632' sand in well 1. The natural gas in place appears to be about 1000 million cubic feet: this is a small reservoir, which could not be used for storing large quantities of gas.

The gas/water level in the 1582'-1632' sand is placed at 1110' sub-sea; and the bottom of the sand occurs at a depth of 1067' sub-sea, or 43' above gas/water level. This should make it possible to produce the well at high production rates, after it has been charged with additional gas, without producing an undue amount of water coning.

Dr. Jones estimates that the mean diameter of the area of gas-bearing sandstones is approximately 2,500 feet. This is equivalent to 113 acres. The average sand thickness is put at 50'. Basing on 15% porosity and 40% interstial water, the quantities of gas which would be stored for given increases of reservoir pressure have been calculated. The results have been plotted on the accompanying graph, which also shows the corresponding wellhead pressures.

Suppose for instance, that 200 million cubic feet of gas have been injected into the sand; then the graph shows that the reservoir pressure may be expected to rise from the initial value of 663 p.s.i.a. to 776 p.s.i.a. This is of course a maximum pressure rise, which assumes no downward displacement of the gas/water level. From this it follows that the quantity of gas which can be stored for a given pressure rise will be substantially increased if the water level is lowered by the gas injection.

From geological considerations the closure in the middle Cousland dome appears to be rather more than 100'; and the reservoir may be nearly completely filled with gas to the"spill-point". If this is true, there would not be very much scope for further lowering of the gas water level by gas injection.

The pressure to which the storage gas has to be compressed to force it into the Cousland dome depends on the rate at which it is required to store the gas, and the quantity of gas to be stored before off-take begins. In the original formation test of the 1582'-1632' sand, a production rate of 3 million cubic feet gas per day was obtained with a bottom hole differential pressure of approximately 600 p.s.i. To attain this rate of gas input, it would be necessary to compress the storage gas to approximately 1200 p.s.i. before injection. - It would require a field test to determine the true gas input rates for a range of injection pressures.

It is not considered that there would be any danger of bringing about formation fracturing at this pressure. An injection pressure of 1200 p.s.i. is equivalent to a bottom hole pressure of 1250 p.s.i., and corresponds to a pressure gradient of 0.77 p.s.i. per foot depth. The pressure of the overburden is approximately 1 p.s.i. per foot depth; and it has been found at Eakring that a pressure equivalent to 30% above the overburden pressure is required to start formation fracturing. At Cousland, the equivalent bottom hole pressure would be 2300 p.s.i. to bring about formation fracturing. It is thought that an injection pressure of 1600 p.s.i. would be quite practicable.

It would be advisable to operate the Cousland gas storage project, at, or above, the present reservoir pressure. This is to assist the conservation of the gas, some of which would otherwise become trapped in the reservoir as a result of water encroachment, if the reservoir pressure is allowed to decline below its present value.

The supporting figures for this assessment are based on the injection of natural gas into the reservoir. This is of course mainly Methane. The assessment will be affected to the extent that compressibility factors and gas densities of the storage gas differ from natural gas. These are of course only minor points. The main factors which may extend the scope or limit the usefulness of the Cousland gas dome for gas storage depend so much on reservoir volume variations that it would only be possible to obtain more accurate data from a practical field test.

Cousland

Proposal for underground gas storage in 1582'-1632' sand

1. Gas Reservoir Space

$$V = a\,f\,h\,(1 - Sw)$$

where V = reservoir space occupied by gas - cubic feet
a = areal extent of reservoir not invaded by water - square feet
h = average pay thickness underlying reservoir area - feet
f = porosity for "ah" volume
Sw = average interstitial water content for "ah" fraction of porosity

Base on f = 15%
Sw = 40%

Then V = ah x 0.15 x 0.6 = 0.09 ah

Area of reservoir $= (2.5 \times 10^3)^2 \times 0.7854$
$= 4.9 \times 10^6$ ft^2

Base on h = 50'

Then $V = 0.09 \times 50 \times 4.9 \times 10^6$
$= \underline{22.1 \times 10^6 \text{ ft}^3}$

Notes:

(1) Gas in place 48 cubic feet per cubic foot
(2) Gas filled reservoir space 3920 cubic feet per acre-foot
(3) Areal extent of reservoir 113 acres
(4) Average thickness of reservoir 50'
(5) Gas in place $\underline{1050 \times 10^6}$ cubic feet

2. Gas injection at increasing pressures

$$S = \frac{P}{0.02827\ TZ} = \frac{P}{15Z}$$

where S = Gas saturation - cubic feet at N.T.P.
T = Reservoir Temperature - 530° FA
P = Reservoir Pressure - p.s.i.a.

Assumed R.P. p.s.i.a.	Pseudo-reduced P. & T. Temp. 530/336.8	Pseudo-reduced P. & T. Pressure P/652.4	Compressibility factor Z	Saturation P/15Z S	S_1-S	Gas Stored $V(S_1 - S)$ Million cubic ft.
663	1.58	1.003	0.920	48	-	-
700	1.58	1.07	0.915	51	3	67
800	1.58	1.23	0.900	59	11	244
900	1.58	1.38	0.892	67	19	422
1000	1.58	1.53	0.880	75	27	600
1100	1.58	1.69	0.871	84	36	800
1200	1.58	1.84	0.862	93	45	1000

3. Corresponding wellhead pressures

$$\text{Density} = \frac{1}{V} = \frac{PM}{ZRT}$$

$$D = \frac{P \times 17.85}{Z \times 10.73 \times 530} = 0.00314 \frac{P}{Z}$$

where M = Average molecular weight of gas
R = Gas Constant
T = Reservoir Temperature
Z = Compressibility factor

Assumed R.P. p.s.i.a. P	Compress. factor Z	Density lbs/ft³ $.00314\frac{P}{Z}$ D	Gas Gradient p.s.i. per ft. D/144	Pressure of 1632' gas column p.s.i.	Wellhead pressure p.s.i.a.
663	0.920	2.26	0.0157	25.6	637
700	0.915	2.40	0.0167	27.2	673
800	0.900	2.79	0.0194	31.6	768
900	0.892	3.17	0.0220	36.0	864
1000	0.880	3.57	0.0248	40.5	960
1100	0.871	3.97	0.0276	45.0	1055
1200	0.862	4.38	0.0304	49.6	1150

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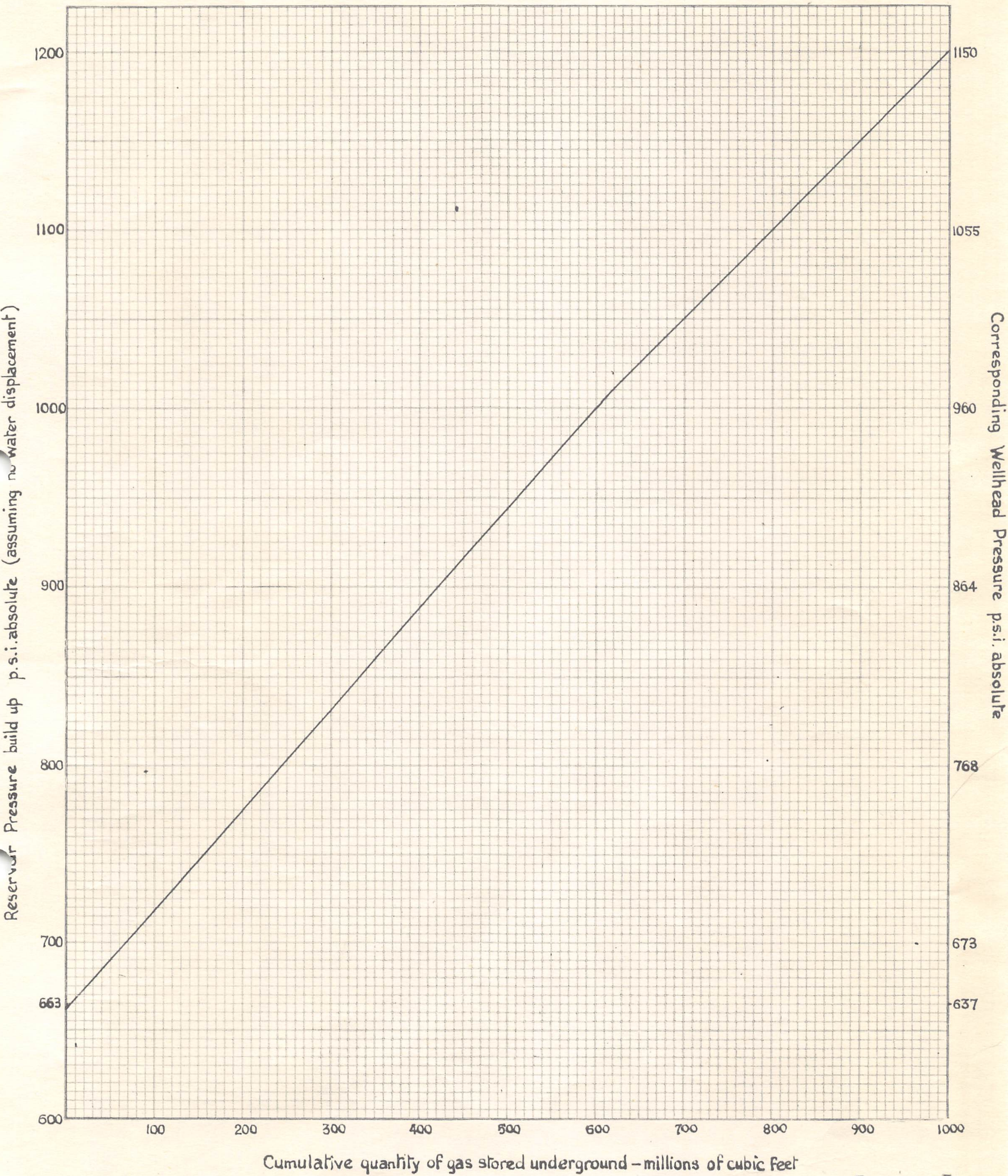
CMA/MG

Basis Average Porosity 15%
Average Water Saturation 40%
Reservoir Area 113 Acres
Average Gas Column 50'

COUSLAND
1582'-1632' Sand
Underground Storage of Gas



A.I.O.C. 1

[FIG.]

A65

8th October 1954

Dr. Jones

Cousland Gas Reserves

Cousland Gas Reserves were estimated at some 500 million cubic feet after completing a flowing production test from well 1 in 1939. The value of these reserves at £200 per million cubic feet is £100,000.

Whilst the well was closed in during the following eight years, the wellhead pressure built up very slowly, the final pressure decline being 9.1 p.s.i. as compared with 40.6 p.s.i. at the end of the 1939 production test. There is thus a small, though good, local reservoir, with restricted connection over a wider area by poor permeability conditions.

On the smaller pressure decline, and assuming no water drive, the gas reserves would be about 2,500 million cubic feet. However, in view of the poor reservoir connection beyond the local well area, it is thought that the economic production from well 1 would not be more than the 500 million cubic feet of the original estimate.

To assist the appraisal of the Cousland Area gas contents of hypothetical reservoirs, varying from 1000' to 4000' diameter, have been calculated; basing on average sand porosity 15%, and water saturation 40% of the pore space. The results have been plotted on the attached graph.

It will be seen that if the average sand thickness is 100', the reservoir area required to contain 500 million cubic feet gas reserves is represented by a circle 1200' in diameter. If the reserves are 2500 million cubic feet, then the equivalent reservoir area circle is 2700' in diameter. Similarly, reservoir areas for other sand thicknesses can be read from the graph.

A note for record is attached giving the supporting data for these figures.

C. M. Adcock

Note for record

1. Well Data

Perforations in Upper Sand	1582' - 1630'
" " Lower Sand	1720' - 1735'
Top of cement in $8\frac{3}{4}$" casing	1740'

2. Gas Recovery by gas expansion

(Park J. Jones - Oil & Gas Journal 16th July 1942)

(i) Assuming no water encroachment

(a) $B = \frac{14.7}{520} \frac{TZ}{P} = .02827 \frac{TZ}{P}$

where P = Reservoir Pressure - p.s.i.a.
T = Reservoir Temperature - 70°F - 530°R
Z = Compressibility factor = 0.920
B = Volume of reservoir space containing 1 cu.ft. gas

(b) $S = \frac{1}{B} = \frac{P}{.02827TZ}$

where S = Gas Saturation or cubic feet gas at N.T.P. in 1 cubic foot reservoir space

(c) Vol. gas originally in place = $V_1 S_1$

where V_1 = Initial Reservoir Space
S_1 = Initial Gas Saturation

(d) $C = V_1 (S_1 - S)$

where C = Cumulative gas produced
S = Gas saturation after producing C cubic feet

(e) Hence $V_1 = \frac{C}{S_1 - S}$

(ii) Calculation of Gas Reserves

$S_1 = \frac{P_1}{.02827TZ}$ $S = \frac{P}{.02827TZ}$

3rd Nov. 1939 - C.I.P. - 645.2 p.s.i.a.
Hence R.P. @ 1740' 672.1 p.s.i.a.

11th Dec. 1939 - C.I.P. - 604.6 p.s.i.a.
Hence R.P. @ 1740' - 631.5 p.s.i.a.

$\therefore S_1 = \frac{672.1}{13.78} = 48.7$

$S = \frac{631.5}{13.78} = 45.8$

Gas production during test 30.224 million cubic feet

$\therefore V = \frac{30.224 \times 10^6}{2.9} = 10.43 \times 10^6$ cubic feet

& Gas Reserves = $10.43 \times 10^6 \times 48.7$
= 508×10^6 cubic feet

By 4th June 1947 C.I.P. recovered to 636.1 p.s.i.a.
Hence R.P. @ 1740' 663.0 p.s.i.a.

$$S = \frac{663.0}{13.78} = 48.1$$

$$\text{Hence } V = \frac{30.224 \times 10^6}{0.6} = 50.4 \times 10^6 \text{ cubic feet}$$

$$\text{\& Gas Reserves} = 50.4 \times 10^6 \times 48.7$$
$$= 2450 \times 10^6 \text{ cubic feet}$$

3. Gas Reservoir Space

(i) $V = afh\,(1 - S_w)$

where V = reservoir space occupied by gas - Cubic feet
a = areal extent of reservoir not invaded by water - square ft.
h = average pay thickness underlying reservoir area - feet
f = average porosity for "ah" volume
S_w = average interstial water content for "ah" fraction of porosity

base on f = 15%
S_w = 40%

Then V = ah x .15 x 0.6 = 0.09 ah

Hence for h = 20' V = 1.8 a
h = 50' V = 4.5 a
h = 100' V = 9.0 a
h = 150' V = 13.5 a
h = 200' V = 18.0 a

Base on circular reservoir areas having the following diameters:-

Diameter feet	Area $ft^2 \times 10^6$	Values of V for the following values of h-cu.ft $\times 10^6$				
		h=20	h=50	h=100	h=150	h=200
1000	0.7854	1.41	3.49	7.06	10.6	14.13
2000	3.142	5.67	14.14	28.3	42.4	56.5
3000	7.06	12.7	31.78	63.5	95.3	127.2
4000	12.55	22.6	56.4	112.8	169.4	225.8

(ii) Gas in place

Basing on a gas saturation of 48.1 cubic feet at N.T.P. per cubic foot of reservoir space, determined from the C.I.P. recorded on 4th June 1947, the following gas reserves are calculated:-

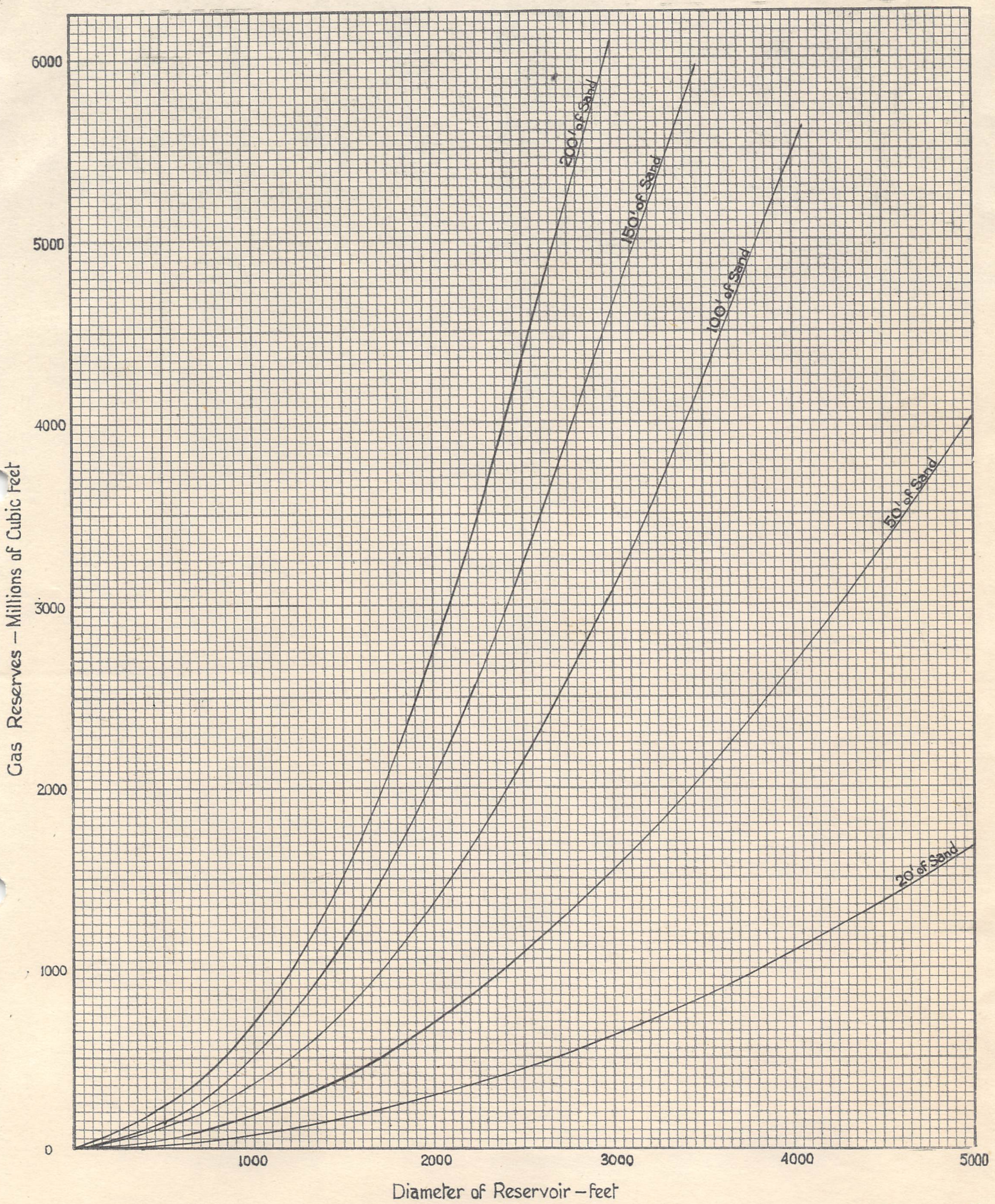
Reservoir Diameter Feet	Gas Reserves for the following values of h-cu.ft $\times 10^6$				
	h=20	h=50	h=100	h=150	h=200
1000	70	170	340	480	680
2000	270	680	1360	2040	2720
3000	610	1530	3060	4580	6100
4000	1080	2710	5420	8140	10840

Eakring
8.10.54
CMA/MG

Basis:	Average Porosity	15 %
	Average Water Saturation	40 %
	Gas Saturation	48 ft³/ft.³ reservoir space

COUSLAND

Gas Reserves estimated for Reservoirs of 1000'-4000' diameter



A.I.O.C. 1.

[FIG.]

Note on Cousland Area

by Dr. P.E. Kent.

<u>Reserves</u> Despite the limitation of the effective area of the gas-field by the failure of sands, southwards there may be an area ½ x ½ mile with good sands above gas-water level. The sands are thickening northwards at a surprisingly rapid rate, and there is no reason to suppose that the process stops suddenly at No. 1. An average sand total thickness of 50 feet may therefore be regarded as conservative.

Assuming 10 ft. porosity, with pore space 50% occupied by gas, 50% of which is recoverable (again conservative estimates) Mr. Adcock calculates a reserve figure of 400 M. cu.ft. The size of this reserve figure suggests that we are still justified in continuing exploration of the Cousland dome, irrespective of its importance in providing a lead for exploration of parallel structures.

Dl Kefge
Tuw
131

THE ASSOCIATED PORTLAND CEMENT MANUFACTURERS LTD

PORTLAND BLUE CIRCLE CEMENT

RESEARCH LABORATORIES,
STONE, GREENHITHE, KENT.

TELEPHONE: GREENHITHE 244.

CEMENT "SNOWCEM" PAINT

Cousland.
WDV.J.

OUR REF. EB/RS. YOUR REF. PEK/FEK.

21st May, 1954.

D'Arcy Exploration Co. Ltd.,
Eakring,
P.O. Box 1,
Southwell,
Notts.

Dear Sirs,

<u>Cousland Area, Edinburghshire, Scotland.</u>

I thank you for your letter dated the 20th instant regarding borehole data obtained by us in the Cousland Area in possession of the Geological Survey.

We have no objection to your inspecting these records and I have written to the Survey to this effect.

Yours faithfully,

Edmund Burke

Director of Research.

Telegram to Martin –
24/5/54

Authorization to proceed
WDV.J.

RECEIVED
EAKRING
24 MAY 1954

1. Mr Watson [illegible]
2. Dr Jones W.R.V.J.
3. File. Cousland General. W.R.V.J.

13.1

phone

20th May, 1954.

C. G. W. Robinson, Esq.,
Associated Portland Cement Manufacturers,
Research Laboratories,
Stone,
Greenhith,
Kent.

Dear Sir,

Cousland Area, Edinburghshire, Scotland

As you are probably aware, this Company (a wholly owned subsidiary of the Anglo-Iranian Oil Company) is undertaking a search for natural gas in U.K. on behalf of the Gas Council. In the course of this the potentialities of the Cousland anticline are being further explored by deep drilling, and it has become necessary to investigate the detailed structure of the northern end of the limestone inlier immediately east and southeast of Cousland village. We understand however from the Geological Survey that your Company has drilled a series of diamond core holes of 150-200 feet in this area, and wonder whether we might be permitted to see this information for the sake of its structural implications. Possibly the most convenient way would be for our geologist in Edinburgh (Mr. F.C.R. Martin) to consult the Geological Survey records, if you would give permission for this.

Any information which you can supply on these lines would be most welcome, and would of course be kept strictly confidential.

Yours faithfully,

For D'ARCY EXPLORATION COMPANY, LTD.

P.E.K.

PEK/FEK

Cousland General Files
W.D.V.J.

Memorandum

From F.C.R. MARTIN **To** GEOLOGICAL OFFICE, EAKRING.

Our Ref. **Your Ref.** **Date** 18 May 1954.

Subject COUSLAND

With reference to Dr Jones' request, over the telephone, for recent bore-hole information on the Cousland structure — Dr Mitchell of the Survey departed on leave last Friday, so I was unable to see him. Mr Tulloch, however, is the geologist in charge of that area and he produced the most recent (unpublished) Survey maps of Cousland, which I believe differ to some extent from those you have now. Enclosed is a rough tracing, which may be of some help.

The most useful recent information that exists, however, is provided by the borings put down on the eastern 'lobe' or bulge of the dome, by the Cement people. Unfortunately these B.H. logs are strictly confidential and Mr Tulloch could not show them to me without written permission from the Cement Co. concerned.

The North Greens Lst. outcrop shown

Memorandum

From **To**

Our Ref. **Your Ref.** **Date**

Subject

on the enclosed tracing has not been amended in accordance with this recent B.H. information.

If you wish to write to the Cement Co. for permission to see the B.H. logs, their address is as follows:

Mr C.G.W. ROBINSON,
Associated Portland Cement Manufacturers Ltd,
Research Laboratories,
STONE,
GREENHITHE,
Kent.

They may perhaps send copies of the logs direct to you, but if not, I could get the information from the Survey for you, once I have their letter of permission.

In any case, I will see Dr Mitchell when he returns on 2nd June, to find out if he has any information unknown to Mr Tulloch.

FCR Martin

Diagram filed with Scottish material
W.D.V. J

13.1

Copy

From	MANAGER, GEOLOGICAL DIVISION.	**To**	D.E.C., LONDON.
Our Ref.	PRO/20.	**Your Ref.**	
Date	11th May, 1954.		
Subject	C O U S L A N D.		

It is estimated by Eakring, Petroleum Engineering and Geological Staff that the assembly of data required in order to set out the case for further work at Cousland will take at least a month. As when the case has been set out it still has to be studied by Head Office, I think you should allow about two months before we will be in a position to discuss the next phase of exploration in the Cousland area with the Gas Council.

(Sgd) N. L. FALCON

c.c. to: Dr.P.E.Kent
Mr.P.T.Cox
Mr.F.R.E.Malden

RJ.

C.5.48.

Cousland file

Copy

From DR. P.E. KENT.

To CHIEF GEOLOGIST, (ATTN. MR. RICHARDSON)

Our Ref.

Your Ref.

Date 27th April 1953.

Subject EARLY STAGES OF THE U.K. GAS INVESTIGATION

The implementation of the Gas Council's request for test drilling is limited in the early stages by the state of background information.

In YORKSHIRE the two structures already well defined are ESKDALE and ROBIN HOODS BAY of which the first is now being tested, the second held by I.C.I. Other promising areas in D.E.C. licences are known from gravity and structural evidence but need definition by seismic and possibly other means. Unless it is decided to locate on the evidence of, say, a major gravity high, or to re-test the Cleveland Hills structure, we shall not be ready to recommend drilling for some months. The preferred procedure would be to do a reflection survey of both the Permian prospects and of CLEVELAND HILLS before locating.

In SUSSEX the ASHDOWN structure was investigated by A.H. Taitt and choice of a drilling location would not be difficult. As it is nearly 20 years since Taitt's work it would however be useful to have a brief re-examination carried out. The SHALFORD structure has not been examined in detail, and we should not wish to consider a location ubtil some fieldwork has been carried out.

We can offer meanwhile drilling locations in SCOTLAND and in NOTTINGHAMSHIRE where no further preliminary geological or other work is required - at COUSLAND and at WIDMERPOOL respectively.

Cousland (see map attached)

Cousland No. 1, now plugged, is a gas well, and the structure is well defined. Our suggestion would be to drill a further well (No. 5) at a point near Southfield, 1200-1300 ft. SSW of No. 1 (a location here was chosen but never drilled), and to follow this by re-opening No. 1 well (re-perforating the casing if necessary). Re-use of No. 1 would supply a second certain producer with economy in casing supply and the two wells together should permit commercial production.

At the same time two shallow structure holes (each 300 feet) should be drilled, 1000 feet due east of No. 1 and No. 5 respectively. These will permit more accurate assessment of the extent of the field, of which the uncontrolled east flank may be more gentle (and more extensive) than is at present assumed, and will facilitate choice of a further deep production hole.

__Widmerpool__ (see map attached)

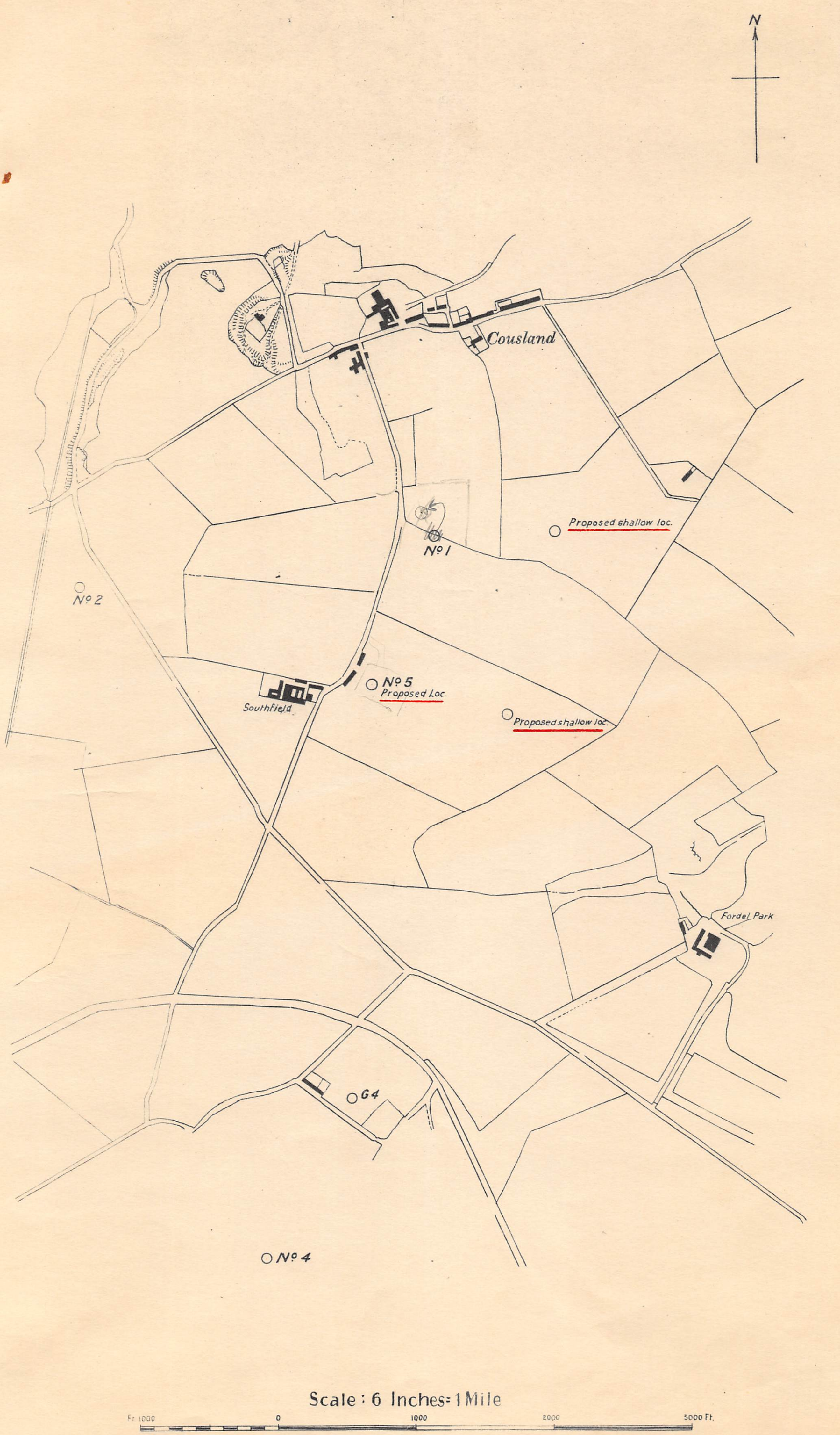
Work has been proceeding intermittently for some time on the location of wells for additional tests at Widmerpool, and either one or two locations can be recommended. Further testing would provide an opportunity for determining the potentialities not only of the known gas sand (at 4350 feet) but also of the clean Millstone Grit sands from 1950-2700 feet. Suggested locations are A. approximately 1500 feet bearing 210° from No. 1 (a location satisfactory for both reflection and refraction culminations) and B. 3100 feet bearing 260° from No. 1 (on the western end of the reflection high). The first is the more reliable structurally, the second would give the maximum amount of general geological and production information. It might also be structurally higher on Grit horizons. A total depth of 4,500 feet should be adequate in either case.

(initials)

PEK/MG

AREA: COUSLAND

O.S SHEETS EDINBURGH VIII N.E. IX N.W.



DC/893

Scottish Oils Ltd.,
Middleton Hall,
Uphall,
Broxburn,
West Lothian.

17th March, 1949.

For the attention of Mr. Crighton

Dear Sirs,

GAS AT COUSLAND

We thank you for your letter of 14th March, which is very satisfactory and we comment in detail below.

1. Sale Price of Gas Delivered Lime Kilns

We agree your calculations that the sale price of the gas, at a rate equivalent to that of coal on a Thermal basis, works out at 2.43d. per Therm at the present price of coal. We note that the Dalkeith Transport and Storage Company are prepared to pay a surcharge on this towards offsetting capital outlay by us. There can of course, be no question of recovering our total capital outlay on drilling in this area in the past and, in discussions with Mr. Pattinson and with Messrs. MacWilliam and Smith of Distribution Department, it has been agreed:

(a) That a gross price of 3d. per Therm will be acceptable to us. On this we shall have to pay 10% royalty to H.M. Government, reducing the net return to 2.7d. per Therm. The gross figure of 3d. compares with 9.5d. per Therm charged by the Musselburgh Gas Company according to the 1949 "Gas Journal" Directory.

(b) That as a provision against any substantial changes

con'd.....

in the price of coal and labour in the future, a clause should be included in the agreement by which this basic figure of 3d. per Therm is adjusted annually pro rata on a percentage basis to any change in the selling price of gas ex Musselburgh Gas Company; no adjustment being made however, unless the price of the latter is altered by 10% or more from the present figure quoted above, i.e. 9.5d. per Therm.

(c) It is left entirely to your discretion in the course of negotiations, as to whether it would be desirable to include a clause agreeing on a sliding scale of percentage adjustments in price for any substantial divergences from the present estimated requirements of 250,000 c.ft./day. The present view is that it might be inadvisable to complicate the initial agreement unduly, but that some way should perhaps be left open for increasing the price of the gas if, at the end of a year's operation it were found that the annual rate of offtake had been substantially less than estimated.requirements.

2. <u>Testing of Califoric Value of Gas.</u>

We confirm that we shall be responsible for collecting samples as and when required, but would mention that there is no point in taking another sample at the present time, as this would merely be a plain repetition of the last test, which was very carefully carried out. The calorific value of the gas may vary in the future owing to the fact that:-

(a) There are 2 sands exposed in this well and the calorific value will vary slightly with the proportion being drawn from each sand.

(b) There is a possibility that, as the reservoir pressure in the field is reduced by production, the gas may become richer, for the sand is partially saturated with oil. We would perhaps therefore, not take any further samples until the well had been on production for say 6 months, unless the Dalkeith Transport and Storage Company should dispute our present figure as a result of observations made by them on samples collected at the receiving end.

con'd.....

3. Conversion of Kilns

We are pleased that it would appear that no question arises of contingent cost of converting the kilns back to coal in the event of gas running out. We do not wish to become involved in any responsibility for the technique for the original conversion of the present kilns from coal to gas but, from the description of the kilns given on page 2 of your letter, our Engineering Department suggest that it might be as well to make sure that the Dalkeith Transport and Storage Company have fully satisfied themselves that it is possible to convert them from coal to gas firing in the first place, without structural alterations.

On this point and also on the question of delivery pressure of the gas, we agree that an approach by the Dalkeith Transport and Storage Company to the Ministry of Fuel and Power could be made. Alternatively, I.C.I. might be able to advise them, as we believe that they have had very considerable experience of lime kiln burning and it is possible, although we have no information on the point, that I.C.I. may have used coke oven gas, should any of their kilns be adjacent to a source of supply.

4. Offer of Gas to Local "Undertaker"

You will no doubt, be letting us know when the Scottish Gas Board confirm Dalkeith Gaslight Company's assurance that it is not their intention to avail themselves of their statutory right to purchase our gas.

5. Pipe Line

The estimate of £1,130 seems very reasonable. We take it that this includes wrapping. We agree that the existing 2" water line could be used as a preliminary means of supplying gas for purposes of preliminary tests with the kilns, subject to it being in good condition. It was however, laid before the war and, although we have no record, it was presumably not wrapped so it may be dangerously corroded. We would suggest therefore, that before considering using it for gas, it should be submitted to a water pressure test of say 100 to 200 lbs. per sq. inch. It may indeed be practicable to continue using this water line (even unwrapped), so long as it remains in good condition, but this point will have to be looked into further. The position is, that we shall permanently require:-

(a) an emergency source of a supply of water in large quantities, as can be delivered through the present

con'd...

water line, to kill the well either in an emergency or in order to enable any work to be carried out, such as pulling tubing or plugging off the comparatively unimportant lower sand, should it eventually go to water.

(b) a continuous very small supply of make up water for a gas fired boiler which will be required in connection with the permanent production scheme as a supply of heat to prevent hydrate trouble at the well head plant. The amount of water required would however, be trivial and could probably be met by collecting rain water to a small local tank.

Should the present water line be used for purposes of the preliminary supply of gas for testing out the operation of the kilns we consider, therefore, that it would be prudent to arrange side connections with isolating valves, so that it could still be used for water in emergency. For the permanent scheme our present view is that it would be preferable to leave the water line for water and to lay a new gas line, especially as the probability is that the water line would not stand up to gas production for very long without leakage.

6. Production Plant

We would mention that for the preliminary kiln tests we propose to install temporary plant with the minimum of equipment, leaving ordering of the final plant till later. We confirm that we will be responsible for supplying working drawings of any plant required and placing indents and so forth, but we shall be very glad to accept your offer made in conversation yesterday, to take advantage of your local workshop facilities should this be desirable.

7. Final Agreement with Dalkeith Transport and Storage Company

We confirm our arrangement during our meeting with Mr. Crichton, that whilst the heads of the agreement will be negotiated by you at your entire discretion, the draft final agreement will be sent to us for scrutiny and legal preparation.

Yours faithfully,
For D'Arcy Exploration Company, Limited.

(Sgd) D. COMINS

Encs. Copy of PRO/137 of 2.2.49 (for information only)
" " DC/858 of 2.2.49 with DC/859 of 2.2.49

c.c. Mr. Pattinson
Mr. MacWilliam
Manager, Eakring
Mr. Dickie

COPY

SCOTTISH OIL LTD.,
MIDDLETON HALL,
UPHALL,
BROXBURN,
WESTLOTHIAN.

14th March, 1949.

Your ref. DC/863

Messrs. Anglo Iranian Oil Co., Ltd.,
Britannic House,
Finsbury Circus,
London, E.C.2.

For the attention of Mr. D. Comins

Dear Sirs,

GAS AT COUSLAND

With reference to your letter of 9th February re Gas at Cousland, we have approached the Dalkeith Transport & Storage Company and find that they are using 4/6 tons of coal per day at the present time. They anticipate going as high as 8/10 tons per day to reach their maximum output. It would appear that they are quite willing to pay for gas at a rate equivalent to that of coal on a thermal basis with a surcharge to offset any capital outlay by us. The method of applying the gas to the kiln would be such as to involve no structural alterations, so that the question of cost of converting back to coal in the event of gas running out hardly arises.

The Dalkeith Gas Light Company have been asked to give us an assurance that they do not wish to buy the gas from Cousland Oil Bore and, while they have not yet had a reply from the Scottish Gas Board, they assure us that it is not their intention to avail themselves of the offer of purchasing natural gas.

An estimate for laying a 2" M.S, pipe from the Bore to the Kiln site of the Dalkeith Transport & Storage Company has been made out, from which we find that the work will cost £1,130.

Regarding gas delivery pressure, Dalkeith Transport & Storage Company are not sufficiently experienced in use of fuels of this nature to have any knowledge of the pressure required - indeed , it would appear necessary that they consult some authority on fuel for the best method of application to their somewhat unique process. An approach to the Ministry of Fuel & Power would seem to suggest itself.

The type of Kiln used by Dalkeith Transport & Storage Company consists of a high cylindrical brick structure, 8'0" dia. approx. and 42'0" long. The limestone is fed in the top and after a layer of 18" approx. has been laid on, coal is fed in, then another layer of limestone and so on. Combustion apparently takes place in the top 10' of the kiln.

An up-to-date test of the calorific value of the gas would necessitate drawing off a sample; this would either have to be done by a competent member of your staff or at least under the supervision of such a person.

con'd........

If you decide to go on with this scheme, might we suggest that the existing water pipe, which is temporarily out of commission, and passes near to the Lime Kilns, be used as a preliminary means of supplying the gas to enable a test to be carried out. Alternatively, if there is no likelihood of this pipe being required for water, we would suggest that it be now turned to this use.

We would be glad to hear from you on those latter points.

Yours faithfully,

ROBERT CRICHTON.

Assume C.V. of coal = 11,000 B.Th.U/lb.

∴ 1 ton of coal = 11,000 x 2240 = 24,640,000 B.Th.U.

Cost of Coal at say £2.10/- per ton

∴ Cost of 1,000 B.Th.U. = $\frac{2.5 \times 240}{24,640}$ = .0243 d.

∴ Cost of Gas/Therm = 2.43 d.

Taking daily consumpt. of coal at 9 tons/day

B.Th.U's/day = 24,640,000 x 9

= 221,760,000 B.Th.U.

Cost of 9 tons of Coal = £22.10.0d.

Assume C.V. (lower) for gas = 880 B.Th.U./cub.ft.

Taking daily consumpt. of gas = 250,000 cub.ft.

Total heat/day = 250,000 x 880 B.Th.U.

= 220,000,000 B.Th.U.

Daily Cost for gas at 2.43d./therm

= $\frac{220,000,000 \times 2.43}{100,000}$

= £22. 5. 6d.

COPY

Scottish Oils Ltd.,
Middleton Hall,
Uphall,
Broxburn,
West Lothian.

Your ref. DC/863

Messrs. Anglo Iranian Oil Co., Ltd.,
Britannic House,
Finsbury Circus,
London, E.C.2.

17th February, 1949.

For the attention of Mr. D. Comins

Dear Sirs,

GAS AT COUSLAND

We have to acknowledge receipt of yours of 9th February regarding gas at Cousland as a source of fuel for the Dalkeith Transport & Storage Company.

As a preliminary we are approaching the above Company regarding their views about gas charges, also whether their furnaces will be easily adaptable to use of gas and whether they will be easily reverted to coal if the occasion should arise.

We have also approached the Dalkeith Gas Light Company for a formal assurance that they do not desire to purchase this gas.

Having obtained this information, we will proceed to estimate a cost for laying the pipe and adapting the kilns to suit the gas, and also to fix gas charges that will be suitable to both parties.

Yours faithfully,

(Sgd) J.M. CALDWELL,

GENERAL MANAGER.

DC/863

Scottish Oils Ltd.,
Middleton Hall,
Uphall,
Broxburn,
West Lothian.

9th February, 1949

For the attention of Mr. Crichton

Dear Sirs,

GAS AT COUSLAND

We thank you for your letter of 19th January regarding the possibility of supplying gas to the Dalkeith Transport and Storage Company's kilns at Cousland. This should, we think be an economic proposition, at a price for the gas attractive to both parties, in view of the comparatively short pipe line involved and the order of magnitude of gas requirements. We estimate the latter at about 200,000 to 250,000 cubic feet/day dependent on the Calorific value of the coal at present being used and the relative thermal efficiency of gas as compared with coal in kiln operation on which we have no information.

As the Field is in your operating area - and you are in fact already supplying the watchmen - it occurs to us that it would be most satisfactory, if you are willing, for Scottish Oils to handle this business and assuming a satisfactory outcome to negotiations, to be responsible for laying the pipe line and operating the well when on production. It would be necessary for us to co-operate in the design and installation of wellhead plant and in the initial commissioning of the well and for our Petroleum Engineers to visit the well occasionally to observe pressure or other data bearing on depletion or re-estimation of gas reserves. (So far as the well is concerned it is already in condition to produce, the additional wellhead plant required being merely provision for water separation - as an insurance as at present there is no free water in the gas produced -; pressure reduction, with arrangements for

con'd.......

preventing formation of hydrates and metering.)

If therefore you are agreeable to this proposal, we would suggest that in the first instance you should ask the Dalkeith Transport and Storage Company to make their own estimate of gas requirements and of the price at which it would be attractive to them. There would be an advantage in fixing the price at so much per therm as this would automatically take care of any possible changes in the Calorific value of our gas in the future. The Calorific value of the gas delivered could be checked say every 6 months. The analysis of the gas when last tested in June 1943 was:-

Volumes %

O_2	nil
CO_2	0.9
N_2	7.6
CH_4	86.2
C_2H_6	4.95
C_3H_8 +	0.35

Calorific Value
(BTU's/c.ft.) at
60°F. and 30" Hg. Dry

Gross	974
Net	880

Specific Gravity (Air = 1.0)	0.623

You will note that the Calorific value is about twice that of Coal Gas.

It would also be preferable to agree on a sliding scale of percentage adjustments in price for any substantial divergences from their estimated requirements, for our outgoings would be the same whatever the throughput. Such adjustments could also be made at six monthly intervals.

The price which would be attractive to them would presumably be somewhere between the local market price per therm of coal gas and the cost of coal delivered on site also worked out per therm. An important consideration however, to be borne in

con'd.....

mind is that we are not in a position to give any guarantee as regards continuity of supply. To encourage the deal it will therefore probably be desirable:-

(a) To accept a price not far above the coal equivalent.

(b) To give an undertaking to pay the cost of converting the kilns back to coal should this prove necessary within say 5 years.

To put us in a better position to assess the cost of putting the well on production and the probable value of the gas to the consumers we should be obliged, if you are agreeable if you could:-

1. Survey the cheapest route for the pipe line and assess its cost allowing for making good in built up areas if unavoidable. We estimate that a 2" line would meet the case, wrapped and buried to 2' 6".

2. Ascertain:-

(a) Delivery pressure required at the kilns. Assuming say 5# maximum - probably more like ½# - we calculate that the inlet pressure at well site would be only about 30# at most for a throughput of say 250,000 cu.ft/day. This compares with about 600# wellhead flowing pressure available at this rate of production.

(b) The probable Calorific value (net) and probable cost per ton delivered of the coal used at the kilns.

(c) The type of kilns and the cost of converting to gas firing and of converting back to coal firing if at all appreciable.

You will appreciate that before concluding any negotiations it will be necessary to obtain formal confirmation from the local gas "undertaker", in this case presumably the Dalkeith Gas Company, that they do not wish to purchase our gas as we are under statutory obligation to give them first refusal. We understand verbally that they are not interested.

We are much obliged to you for having brought this proposal to our notice and pending hearing further from you, are looking

con'd.......

into the question of delivery dates for wellhead plant.

Yours faithfully,
For D'Arcy Exploration Company, Limited.

(Sgd) D. COMINS

Copy to:
Mr. Pattinson
Mr. MacWilliam
Manager, Eakring
Mr. Dickie

DC/SLB

COPY

From: Mr. R.E. Adlington

Our ref: PRO/137
"

To: Mr. J.F. Waters
Fields/Geological Div.

Date: 2nd February, 1949

Subject: BURNING OF GAS IN LIME KILNS

Referring to your telephonic enquiry yesterday on the above subject, we have been in touch by telephone with our friends The Callow Rock Lime Co., Ltd., of Cheddar, Somerset, and their Works Manager, Mr. Travis, has expressed the following general opinion.

He says that it is impossible to give a general statement as to the possibility of changing over from coal to gas firing and vice versa on lime kilns which vary enormously in design over the country.

Broadly speaking, kilns can be divided into two classes:

1) Those in which the solid fuel is mixed with the lime and,

2) Those in which the fuel is burned in a separate compartment.

In general, the types of kilns in (1) above are impossible to convert from coal to gas firing, but in the case of kilns described under (2) above, these can probably be converted to gas firing but the conversion depends upon the space available for flame length. Although Mr. Travis did not himself mention it, it occurs to us that kilns of type (2) could probably be converted back to coal firing with little or no alteration.

You will appreciate therefore that in the absence of detailed particulars of the kilns which you have in mind, it is not possible to express a definite opinion. Mr. Travis has, however, kindly expressed willingness to advise us on this problem if he can have access to drawings of the particular kilns.

If you will pass us the drawings, we will initiate the investigation for you.

Sgd. R.E. ADLINGTON

M E M O R A N D U M

From MR. D. COMINS. To MR. J. M. PATTINSON.

Our Ref. DC/858 Date 2nd February, 1949.

Subject COUSLAND GAS PRODUCTION

Reference Scottish Oils letter of 19th January. This is far the most interesting proposition yet considered. The pipe line would be less than a mile and it is estimated that the amount of gas required to replace the coal consumption at the kilns of 8 tons/day would be about 240,000 c.ft./day which is a reasonable maximum operating production rate for the well.

As a preliminary estimate additional capital expenditure required, including provision of the pipeline, would be about £3,000 and operating cost, exclusive of depreciation, about £1,500 a year, as compared with £500 a year at present for watchmen.

Writing off all capital expenditure over 3 years, by when on present estimates the gas reserves would be exhausted, the cost of producing the gas at this rate would be well covered at 1/- per 1000 c.ft. It is estimated however that the gas should be worth at least 2/- per 1000 c.ft. to the consumers. It is therefore recommended that a basis for negotiation would be a price between 1/- and 2/-, possibly on a sliding scale. Royalty would be payable on our gross receipts at I believe 10%.

At an average price of say 1/6d. the estimated profit on producing 300 million cubic feet over 3½ years would be between £10,000 and £15,000. Unless therefore reserves prove to be much greater than present estimates - as is indeed possible - such a profit would be modest compared with past expenditure of about £83,000 on proving and maintaining the area. In view however of the impossibility of giving consumers any guarantee as regards continuity of supply we should perhaps encourage the proposed deal by undertaking to pay the cost of converting the kilns back to coal firing should this prove necessary within say 5 years.

A "note for record" is attached roughly supporting figures arrived at in this memorandum and it is suggested that in order to permit these to be assessed more closely Scottish Oils should be asked:-

(a) If they are willing to survey the cheapest route for the pipe line and to assess its cost allowing for making good in built up areas, if unavoidable. 2" pipe wrapped and buried to say 2' 6".

(b) To ascertain delivery pressure required at the kilns. Assuming say 5#, the inlet pressure at well site would be only about 30# (gauge) for 240,000 c.ft./day throughput which compares with about 600# wellhead flowing pressure at this rate of production.

(c) To advise us as to the probable Calorific value (nett) and probable cost per ton delivered of the coal used at the kilns.

Sd/- D. COMINS.

c.c. Manager, Eakring.
Mr. Dickie.

DC/FEK

Note for Record DC/859

Cousland Gas to Cement Kilns Scheme

1. Amount of gas required

(a) On 8 tons/coal/day basis and on equivalent BTU Basis
Gas 900 BTU/nett/c.ft. approx. (for 1582 - 1630 sand)
Coal say 12000 BTU/nett/lb.

Coal BTU's/day = $8 \times 2240 \times 12000 = 2.15 \times 10^8$.

$\therefore$ C.ft. gas/day= $\frac{2.15 \times 10^8}{.9 \times 10^3}$ = 240,000 c.ft./day.

Reserves say 300 m.c.ft. (conservative estimate)

$= \frac{300}{0.24 \times 365} = 3\frac{1}{2}$ years

Coal Cost 8 tons/day and say £2.10.0/ton
delivered = £20 day.

Equivalent value of Gas = $\frac{20 \times 240^d}{240}$ = 1/8d. /1000 c.ft.

but there would also be a saving in the handling costs of coal (and possibly a higher thermol efficiency using gas) so that up to say 2/-/1000 c.ft. might be an acceptable price. Note The Dalkeith Gas Co. charges 2/- to 2/4d. per 1000 c.ft. for gas of only about half the Calorific value of the Cousland Natural Gas.

Cost of Production

1. Capital

(a) Well Head Plant

Pipe work around well and valves.
Choke assembly.
HP separator 600#.
Choke assembly.
Reducing valve from 600# to ?50#.
H.P. Displacement Gas Meter 20,000 c.ft./hr. at 50#

Preliminary estimate subject to detailed estimates say £1000.

(b) Pipe Line

Length as crow flies 3100 ft; following roads 4,100 ft. For delivery pressure say 5# inlet pressure 30# gauge for 250,000 c.ft./day through 2" lines.
Cost wrapped and buried (assuming not much making good necessary in built up areas) approx. £2000 mile based on Dalkeith Gas Co. estimates supplied R.K. Dickie in August 1948.

= approx. £1,500.

Total Capital = £2,500 say £3,000 allowing for supervision and unforeseen.

2. Depreciation

Writing off £3000 Capital in 3 years in case Reserves are exhausted by then = £1000 p.a.

3. Operating

3 men at say £5 week each =	£800 p.a.	
Office expenses and telephone = say	£200	
Supervision and Overheads = say	£500	
	£1500	£1500 p.a.
Total Cost p.a.		£2500

Bare Cost per 1000 c.ft.

$$= \frac{£2500 \times 240^{d}}{365(\text{days}) \times 240 \text{ (thousands c.ft.)}} = 7d/1000 \text{ c.ft.} + \text{Royalty.}$$

This figure does not include Depreciation on Cost of Drilling and Testing the well or on casing, tubing and present flow head.

Conclusion

As it will cost no less to produce smaller quantities than estimated, a round figure of 1/- per 1000 c.ft. for cost of production is considered reasonable and it is recommended that a basis for negotiation would be a price between 1/- and 2/- possibly on a sliding scale. In view of the impossibility of giving a guarantee as regards continuity of supply we should perhaps undertake to repay the cost of connecting the kilns back to coal should this prove necessary within 5 years.

Nett Profit on producing say 300 m.c.ft. in 3½ years

at an average price of say 1/6d./1000 c.ft.

Gross Receipts	300,000 x 1/6 =	£22500
Less Royalty at 10%		2250
Nett Receipts		£20250
Expenditure Capital	£3000	
Operating 3½ years at £1500	3750	
	6750	6750
	Estimated Profit	£13500

or say £10,000 to £15,000 which compares with past expenditure

on proving the gas in this area of	No. 1 Well	£36,000
	2 "	23,500
	3 "	11,900
	4 "	6,300
	Maintenance	5,000
	Total say	£83,000

Current expenditure on watchmen for No. 1 well is £500 p.a.

Sd/- D. COMINS.

c.c. Manager, Eakring.
Mr. Dickie
Mr. C. J. Johnson

DC/FEK

2nd February, 1949.

MIDLOTHIAN COUNTY COUNCIL

TELEPHONE No. 32526

J. W. DEIGHTON
COUNTY ROAD SURVEYOR

JWD/FMS

Road Office, 32 Palmerston Place,

Edinburgh 14th September, 1948.

Our Ref. 7.04
Your Ref. DEC/307/PE

D'Arcy Exploration Co.Ltd.,
P.O. Box 1,
Southwell,
Notts.

Mr Decker

RECEIVED
EAKRING
16 SEP 1948

Dear Sirs,

Proposed Gas Pipe Line

With reference to your letter of 24th ult. regarding the proposal to lay a pipe line from the gas well near Cousland Village to the outskirts of Dalkeith, I do not consider the County Council will raise any objections to the proposed route, provided the pipe is placed in the grass verge of the roads concerned.

I would like to point out that the portion of the road between the Curling Pond to near Ancrum Cottage is within the Burgh of Dalkeith, and the County Council have no jurisdiction over these roads. If you agree to go ahead with this scheme, I expect a more detailed plan will be sent to me or a meeting arranged for discussion on the different points which will arise.

Yours faithfully,

J. W. Deighton

County Road Surveyor.

MR. R.K. DICKIE MR. D. COMINS

25th August, 1948

COUSLAND GAS UTILISATION

I visited the Cousland area on Tuesday and Wednesday the 17th and 18th last and called on Mr. Henderson, Manager of the Dalkeith Gas Company, Mr. Webster the foreman of Newbattle Tomato Farm and Mr. Grey of Dobbies. I think we can eliminate Messrs. Dobbies from any further consideration as their use of fuel is rather intermittent, apart from the fact that supplying them entails an extra 3300 yards of line from the Newbattle Farm, or 2000 yards from the gas Works, through partly built up country.

The position regarding the Dalkeith Gas Works is that (1) the Gas Industry is to be nationalised next spring and (2) that a guarantee of some 10 years life of the gas well would be necessary to make natural gas attractive to a small works. On the other hand, owing to developments in the area in connection with increased coal production, the existing gas works of the district will soon be inadequate to deal with the demand for gas, and amalgamation and extension is inevitable. Plans are believed to be in existence for this amalgamation which, in effect, will mean that the whole district will be supplied by one large works. A supply of a relatively small volume of high C.V. gas to such a system would be much easier to arrange than to arrange it for a small works such as Dalkeith. It will be several years, however, before this system is in action. No doubt the Ministry of Fuel & Power should be approached in this connection.

I visited the Newbattle Tomato Farm and interviewed Mr. Webster, the foreman. The farm is now owned by the Scottish Wholesale Co-operative Society, having been sold to them by Mr. Bach last May after Laird saw him. This is the obvious outlet for the Cousland gas as it is the nearest possible outlet and its consumption would appear to be of the right order. In addition there would appear to be no great expense in converting the existing boiler to use gas or in converting it back to coal burning if the gas fails. I spoke to the manager, Mr. Hills, of the Fruit & Vegetable Dept. of the S.C.W.S. in Glasgow (Glasgow South 2100 ext. 27); he had heard nothing about the proposed use of gas and was not uninterested, but asked me to confirm the gist of the conversation in writing. (See attached). If his reaction is favourable I suggest we arrange a meeting.

The Newbattle Tomato Farm is heated by steam raised in a Lancashire boiler, about 30' long by 8' diameter; there is no standby. Annual consumption is now about 1400 tons of "dross" with a very varied calorific value but Mr. Webster thinks that on the average it is reasonable to take it as two thirds the value of ordinary good coal. The equivalent gas consumption would be therefore:-

$$\frac{1400 \times 2240 \times 8000}{365 \times 970} = 71{,}000 \text{ cu. ft. /day.}$$

From Cousland 1 to the tomato farm is some 4840 yards along a possible route which involves no "built up area" difficulties and is mainly along a country road and rough footpaths.

I discussed the possible route with the local assistant road surveyor, Mr. Armstrong, at his office at Bonnyrig and he advised me to write to his chief, Mr. Deighton, in Edinburgh. Mr. Deighton was not then available owing to the press of work caused by the floods. Attached is the letter to Mr. Deighton and a print of the proposed route.

Mr. Henderson very kindly gave me figures for pipe line costs from an estimate made out in 1944. He considers that if all the prices are doubled they should represent the present cost of laying a line. The prices are for 3" pipe but there would be only a small saving in using 2" pipe.

3" Stanton C.I. pipe S.G. joints in 15' lengths		5/- per yard
Track work & laying	-	6/- per yard
Cartage	-	-/6 per yard
Total	-	11/6 per yard
Add, for laying 5500 yards, £50 for special joints 10%		
Total including this additional cost		12/4 per yard
Present day cost say		24/8 per yard

Total length of line from Cousland to Tomato Farm = 4840 yards

Estimated cost of line at 24/8d. per yard = £6000

or £2180 per mile.

This seems a reasonable figure as the 1943 price of the 3" line from Kelham Hills to the siding was of the order of £1000 per mile.

RKD/REE

Enclosures

DEC/307/PE

24th August, 1948.

Mr. J.W. Deighton,
County Road Surveyor,
Palmerston Place,
Edinburgh.

Dear Sirs,

We are the owners of a gas well, Cousland No. 1, near Cousland village. With a view to utilising the gas from this well we wish to lay a 2", or possibly 3", gas line from the well to the outskirts of Kalkeith and the most convenient route would appear to be as shown in red on the enclosed print of a tracing of part of the 6" O.S. map "EDINBURGHSHIRE Sheet VIII N.E." of 1915. As shown the gas line would be buried along the western verge of the county road for a considerable proportion of its route.

The consideration of this scheme is only in the preliminary stage, but we would greatly value your advice as to whether any objections are likely to be raised to the proposed route.

Yours faithfully,

for D'ARCY EXPLORATION COMPANY LIMITED

RKD/REE

Copies to: Mr. Comins
Mr. Woodcock
File.

__Enclosure__

DEC/304/PE.

24th August, 1948.

Mr. Hills,
Manager,
Fruit & Vegetable Dept.,
S.C.W.S.,
Dalintober Street,
Glasgow, C.5.

Dear Sir,

Confirming the writer's 'phone conversation with you last week, a representative of this Company last year discussed with Mr. Bach a proposition to supply Newbattle Tomato Growers Ltd. with natural gas from our gas well at Cousland for heating purposes instead of coal. Mr. Bach was then favourably disposed to the proposal but this spring when interviewed again, he was no longer interested in proceeding with the change over from coal to gas. We have since learned that he was then negotiating the sale of Newbattle Tomato Growers to yourselves.

We should therefore like to open again the proposition to utilise the Cousland gas at the Newbattle Tomato Farm with you, and, while we are examining the costs and the availability of material to put in the necessary line, we should be glad to know if you are favourably disposed to consider it.

For the information of your Engineer, the calorific value of the gas is about 970 B.Th. U. per cubic foot and has the following approximate composition:-

Constituent	% by volume
CO_2	0.8
CH_4	87.4
C_2H_6	4.3
C_3H_8 +	0.3
N_2	7.2

The amount of gas which is available is some

p.t.o.

Memorandum

From MR. N.L. FALCON

To PETROLEUM ENGINNERING DEPT.
(Mr. R.K. Dickie to see please)

Our Ref.

Your Ref.

Date 17th March, 1948.

Subject EXAMPLE OF THE UTILISATION OF SMALL GAS RESERVES.

In a recent Swiss Publication (Erdölgeologische Untersuchungen in der Schweiz 1947) is an interesting account of the commercial utilisation of natural gas shows on the north shore of Lago Maggiore, due east of Locarno.

The gas seeps up through the water and on the shore, through alluvium. It is collected in iron or concrete constructions like inverted bells and piped away to a gasometer. It is then compressed into steel bottles at 150 Atmospheres and sold as a petrol substitute. The installations are connected to the seepage areas by over a mile of pipe line.

Monthly production was 2000 cu. metres in the summer of 1943, increasing to about 4000 cu. m. in 1945. From April 1943 to the end of 1945 total production was 110,000 cu. metres, with a sale price of Fr. 200,000 (about £2700). Compressed into steel bottles at 150 Atmospheres for use in motors it represented a substitute for 100,000 litres of petrol.

The origin of the gas is uncertain. Its composition is variable; Methane content varying from 68% to 94%, being exceptionally 98%, and as much as 20% of N or CO_2 has been recorded in it. The product as sold contains 92-95% Methane.

The enterprise was started by a garage owner in 1941 and taken over by the Swiss Jewel Co. A.G. of Locarno in 1943, so presumably it is a paying proposition. There has never, at any time, of course, been any knowledge of reserves or even of total production possibilities.

This makes our approach to the Cousland gas problem seem somewhat cautious.

c.c. Dr. Lees.

N. L. Falcon

NLF/MWS

Visits to Dalkeith & Musselborough.
30. 3. 48.

---

(1) Dalkeith Gas works.

Saw Mr Henderson.

(a) { Tully Complete Coal Gasification — 250 000 cuft/day of 320 C.V. Gross.
{ Horizontal Retorts — 120 000 cuft/day of 580 C.V. Gross.

Total Gas/day from 300 000 to 330,000 of 400 – 410 C.V. Gross

With complete shut-down of Horizontal Retorts Gas works would require 70 000 cuft/day of Coaland Gas.
This would cut out 6 stokers.

(b) Alternative scheme to (a)

Tully	—	200 000/day	of	320 C.V. Gross
Horizontal	—	80 000/day	of	580 C.V. "
Coaland		21 000/day	of	1000 C.V. "

320 000/day of 410 C.V. Gross.

This would involve shut-down of 1 bed of 5 Horizontals
2 – 3 Stokers sacked.

Coal costs 47/1 per ton.
Cost of Gas to Holder 2/- to 2/4 per 1000 cuft.

Above works a subsidiary of
British Electric Traction Coy.
86 Kingsway, London.

Man. Dir. — Mr Garske

Talked with Mr Armstrong, Deputy to Mr Deighton of County Roads Surveying Dept. (Tel. Lasswade 2268)
No difficulty about laying pipe along road.

(2) Newbattle Tomato Growers Ltd.

Talked with Mr Bach.

Not interested. Scared about a shut-down which, if even of only 1 hours duration, might lose a whole season's crop.

(3) Dobbies,

Seedsmen

Melville Nurseries

Lasswade.

Talked with Mr Grey. Interested!

They use from 600 - 800 tons of coal per year at about £2 a ton. (Pearl variety in ½" cubes)

Mechanical stoker.

Robert [illegible] Edmund Enkmann Weber

3 Boilers standby which cut one since mechanical stoker fitted.

Peak load about 20 tons / week. As low as 8 tons/week.

Costs have been as high as £3000 a year for coal depending on season. Usual about £1500.

Eight houses need gas for cooking.

(4) Stewarts of Musselborough.

(Nets, yarn etc.)

Saw Works Manager Mr Hayes.

They use 12 tons per day of poor quality coal at cost of 36/- a ton. Mechanical stokers.

If good coal used quantity would be cut to about 5 tons or 6 tons per day.

Not interested in the gas however.

(5) Bruntons Ltd.
Wire Manufacturers
Musselborough.

Talked with Mr Dunbar, Chief Engineer.
He said that scheme had been drawn up during the war with Mr Thompson at Blackie which would have involved them in capital expenditure of about £50000. Anglo-American and ourselves wanted too much for the gas — over 2/6 a 1000 cuft. Fell through.

Similar scheme now out of question. But Mr Dunbar said that if gas were laid on to their works they could use 100000 cuft/day for Galvanising and Heat Treatment etc. The cost would need to be below 1/9, say 1/6 a 1000 cuft. This would involve them in expenditure inside their works of perhaps £6000 – 7000 thus some guarantee required before they could look at it. Write, however, and ask what max. price they would be prepared to pay and for suggested conditions.

They use up to 100 tons coal per week for gas production + 25 tons of coke.

Visit of Mr Henderson of Dalkeith Gas Company to Britannic House on 8.6.48.

Local Costs of laying pipe in Built-up Areas around Dalkeith.

2" Pipe ex Stanton, Nottingham.

Total cost of pipe, delivering, wrapping, laying, screwing and testing — £2.5.0/yard.

Cost of pipe 14/1 per yard.

Thus, in worst case, cost of laying line, excluding cost of actual pipe, is almost 30/- per yard.

~~10/3~~ 40 200

(1944) 3" Stanton S.G. joint 5/- per yard in 15' lengths

Average price Trench work 5/- per yard.

~~Ground~~ Tarmac work ~~£~~ 1/yard.

Cutting 6d yd.

Add spurs £50 + 10%.

On 5000 yds ~~£3~~ 12/4/yd

This can be doubled

Double

·05 2 / 3

1·233

·10 ·033

Memorandum

From :- Mr. D. Comins. **To :-** Mr. Adcock.

Our Ref. DEC/30 **Your Ref.** **Date :-** 10th May, 1945

Subject Cousland Testing : Programme when and after reproducing water.

Reminders re action :-

(a) Collect sample of killing water.

(b) Collect samples reproduced water at appropriate intervals watching out for any change - in any case retain final sample.

(c) Measure cumulative volume of water reproduced in diary form and at any significant stages of programme.

(d) At discretion shut down reproduction for short time at appropriate intervals to determine rate of draw down by float.

(e) At any convenient time when G.W.L. still above 1500 feet shut down for 2 hours and then attempt water reproduction through tubing by natural flow without swabbing. Objective to prove whether the $\frac{1}{8}$" gas lift holes are fulfilling their purpose as without gas lift water could not be reproduced with G.W.L. at this level.

(f) After either well dry or say 25% more water reproduced than lost in present job and the last one (when loss estimated at 20,000 galls) shut in, check G.W.L by float, leave say overnight; check G.W.L.; flow out all water by natural flow in minimum time measuring water and if possible, gas.
Objective to determine how long will be required, when well is on routine production, to lower G.W.L. so many feet and the gas wastage involved.

These reminders are for guidance confirming verbal arrangements. In practice action may be varied at your discretion bearing in mind the objectives aimed at. In addition to those specifically mentioned an important objective is to arrive at some conclusion as to whether the well makes formation water in addition to reproduction of lost killing water.

D. Comins

Copies to :- Works' Manager, Eakring.
Fields Branch (Mr. C.A.P. Southwell)

DC/IBR

P.E. Testing Equipment for Cousland

1. Three 10 litres gas bottles
2. Six transit baskets containing twelve W.G. bottles
3. Four H.P. 2.5 litre gas cylinders
4. Four H.P. 5 litre gas cylinders
5. One 200 cubic feet gas meter and rubber hose
6. Half-inch H.P. Christmas tree
7. One top D.P. testing sub. 4½"
8. One 2" Audco cock with one 3" - 2" H.P. bush
9. One 50lbs gauge
10. One 100lbs gauge
11. One 300lbs gauge
12. One 1000lbs gauge
13. Two H.P. hoses and ½" connections
14. One open end orifice meter and 7 plates
15. ~~Two~~ Three small bottles mercury
16. Two glass manometers
17. Two small glass funnels
18. Assorted lengths of rubber tubing
19. One bottle shellac
20. Two thermometers and brass cases
21. One small stilsons
22. Lead acetate
23. Two ½" H.P. valves and ½" nipples
24. Sundry lengths glass tubing
25. One penknife
26. Five clips for rubber tubing
27. Eight ½" plugs
28. One ½" H.P. short nipple
29. One glass beaker
30. One gallon measure
31. One 4ft. manometer
32. One effusiometer.

C MA/CP

P.E. EQUIPMENT FOR COUSLAND

I. R.P.G.- 3 Amerada Gauge complete with 12 hours clock 2000 lbs. element and maximum thermometer.

Other equipment for gauge

1. Temperature recorder
2. 72 hours clock
3. Two spanners
4. Maximum thermometer
5. Tin of lubricant
6. Mandril for charts
7. Charts
8. Three stylus arm springs
9. Joint rings
10. Two small screw-drivers
11. Spanner for changing elements.

Other items in Amerada box

12. Bottles of ink for pressure recorder, violet and red.
13. Four experimental data note books.
14. Leather washers for H.P. hoses.
15. 4.1/2" shear pins - six.
16. Pressure recorder charts for 600 and 1200 lbs. elements.

II. N & Z pressure recorder fitted with 600 lbs. and 1200 lbs. elements, complete with copper pipe connections.

III. Dewrance dead weight tester complete with can of oil, H.P. hose and fittings and two boxes of weights.

IV. Six winchester quart bottles in transit baskets.

V. One 10 litre gas bottle.

/REE

Halliburton measuring device equipment

for Cousland

1. Halliburton measuring device complete with petrol engine.
2. Four shot sleepers
3. High pressure 2" container complete with pulley wheel and gland, matching flange and 2" H.P. nipple.
4. High pressure 2" valve ex Whitby
5. Metal float 4'-6" long x 1.3/4" dia.
6. Heavy dipper 3'-6" long x 1.1/4" dia.
7. Broomstick float 3'-6" long.
8. Eye-bolt plug, 1/2", for shackle.

\- - - -

9. Attachment to connect Amerada to D.W.T. for calibration.

\- - - -

By Mr. Dickie:-

10. Stop-watch
11. Taylor maximum thermometer.
12. Book for open-end orifice meter.

H 119–C1.39. UK/Cou/4 T.2.

Memorandum

From MR. M. W. STRONG **To** DR. G. M. LEES R/

Our Ref. **Your Ref.** **Date** 22nd July, 1947.

Subject COUSLAND GAS RESERVES.

In view of the results obtained in Cousland No.4 test, you requested a re-examination of the prospects in this area.

In going over the map we have been struck by the possibility of the flank from No.1. extending further eastwards than has previously been considered.

The 500 ft. contour surrounds a broad stretch of ground eastwards from No.1. which may be the topographical expression of the No.2. Limestone, and the strikes indicated by the survey in the coal seams north and east of this test lend support to this interpretation.

On the attached contour map we have indicated the strikes by brown lines and included the given dips for reference.

It will be noted that the strikes of the Cousland No.4. fold are strikingly at variance with those of the northern or No.1. lobe and a line of fracture between the two is strongly indicated.

In view of the poor sand developments and porosities at No.4, we have drawn an arbitrary line across the northern fold approximately half way between No.1. and No.4. and have measured up the sands in the No.1. area which may be above the oil gas levels as at present assumed.

The results are as follows:

A. Sand at 1248 - 79 in No.1.

Area approximately 20 million sq. feet.

B. Sand at 1582 - 1632 in No.1.

Area approximately 10 million sq. feet.

Continued

C. <u>Sand at 1720 - 1806 in No.1.</u>

Area approximately 6½ million sq. feet.

from which the following gas reserves are calculated:

A.	Area	20	million	sq. feet.
	Vol.	400	"	cub. "
	10% Porosity	40	"	cub. "
	Gas at 40 Atms.	1600	million	cub.feet
B.	Area	10	million	sq. feet.
	Vol.	300	"	cub. "
	10% Porosity	30	"	cub. "
	Gas at 40 Atms.	1200	million	cub.feet
C.	Area	6½	million	sq. feet
	Vol.	325	"	cub. "
	10% Porosity	32.5	"	cub. "
	Vol. at 40 Atms.	1300	million	cub.feet

Total Gas from three Sands = Say 4000 million cub. feet.

The true answer may be much less than this figure but on the other hand, it is possible to draw the contours so as to double the figure.

We, therefore, suggest that there is a case for further work in this area.

A check on the structure could most readily be carried out by two or three shallow holes with a portable outfit with the idea of checking the position of the base of No.1. Limestone, in the first place about 1000 to 1500 feet East or South-East of No.1.

At the same time, a further scrutiny of the ground might be carried out to see whether any further outcrop data is available.

<u>Continued</u>

This would include careful re-examination of the Limestone quarry sites and the mapped features. Evidence for the break indicated between the domes at No.1. and No.4. tests might also be sought.

[signature]

Encls:- 1 Structural Contour Map.
1 Section.

H. 122 C. 4.46

File

Copy

From GEOLOGICAL BRANCH,
EAKRING.

To CHIEF GEOLOGIST,
LONDON.

Our Ref.

Your Ref.

Date 17th July, 1947.

Subject SHROPSHIRE (MARKET DRAYTON) TESTS

The following names have been adopted for the projected test wells between Newport and Market Drayton:

Location A ("The Bandles"):	EDGMOND No. 1
Location B (Calvington):	STOKE-ON-TERN No. 1
Location C (on Hodnet Fault):	TERNHILL No. 1

P.E.K.

Copies to: Mr. R. Davies
Mr. J.E.R. Wood

PEK/REE

GEOLOGICAL BRANCH,
EAKRING.
COU/16.A

GEOLOGICAL BRANCH,
LONDON.

17th July, 1947.

PRODUCTION - MIDLOTHIAN OILFIELD

The A.A.O.C. has supplied the following figures for annual production from the Midlothian Field (in barrels):

Well No.	M.1	M.3	M.4	Total
1938	331	-	-	331
1939	2370	953	10	3333
1940	1788	1593	-	3381
1941	1577	753	-	2330
1942	1439	292	-	1731
1943	1376	161	-	1537
1944	1323	176	-	1499
1945	1258	83	-	1341
1946	1188	46	-	1234
				16,717 bbls

For the first six months of 1947 the figures are:

M.1 - 607; M.3 - 52; total 659 barrels.

Copies to: Mr. Comins
Mr. Adcock

PEK/REE

Crown Hotel
Tranent
East Lothian

Friday, June 27th

Dear Dr. Kent

I hope that your brief holiday passed pleasantly, though I fear the weather was poor.

Enclosed, please find my expense account for this month. The receipts in connection with my visit to London are a trifle scanty, being one of each kind, except for my café meals, where a receipt is not easily come by. The odd lunch at the Crown at Tranent was one given to ~~McLeod~~ McLeod, which, I feel, the Company should pay.

My holiday, as of course you know, begins to-morrow. For the first week (June 28 - July 5th) I shall be at:

The Palace Hotel
High Street
Fort William
Inverness-shire

Telephone - Fort W. 30

For the second week (July 5 - July 12th) I will be at:

The New Dungeon Ghyll Hotel
Great Langdale
Ambleside
Westmorland

Telephone - Grasmere ?

(i.e. I know the telephone is on the Grasmere exchange, but have forgotten the number.)

III

During the second week, I would like you, if you will, to drop me a line to Dungeon Ghyll stating whether I am to go upon the completion of my holiday. Since I have to arrange for a taxi from the Hotel to Windermere station, the sooner I know, the better.

At any rate, I shall probably give you a ring (at Ealing) on Friday July 11th as a final check-up.

What are the chances of my having a whole well all to myself after the holidays? I find two Geologists to one well to be a poor arrangement,

— like two women in one kitchen — when the R.G. is so much younger than his assistant! Indeed, ~~when~~ were not Jones such an exceedingly nice chap I ~~cd~~ could imagine friction arising. Furthermore of course, ~~I~~ if one describes a batch of samples the other doesn't know what they looked like when *his* turn comes, and so on.

You may be interested to learn that Dr. Lees wants me out in Persia this coming autumn — after I've signed on the dotted line. I think I will. Would you kindly inform Correspondent ~~art~~ as to my whereabouts?

Yours

R.G.W. Brunstrom

H.121—C.10.46

COU/16A

Memorandum

From DR. G. M. LEES. **To** EAKRING.

Our Ref. **Your Ref.** **Date** 29th May, 1947.

Subject

We have just had a letter from Professor Kennedy, acknowledging receipt of a collection of rock specimens from Persia for teaching purposes. He adds to his letter the following remarks on his work on our Scottish material:-

> " I should also like to reassure you that my report on the Sedimentation and Tectonics of the Midland Valley of Scotland has not been forgotten. I've been working on it longer than I anticipated and must apologise for the delay. However, it is now approaching completion and some very interesting things have emerged. It will at least give a regional picture and may, I hope, prove of some use. "

G. M. Lees

GML/RJ.

COU/1.

31st December, 1946.

Professor W.Q. Kennedy,
Geological Dept.,
The University,
Leeds.

Dear Kennedy,

We return herewith for your use the three main reports on the Cousland Structure - Reports U.K.17, U.K.45 and U.K.62.

We are retaining the Cousland Monthly reports as they will probably be needed here during the coming weeks, but the data is all reproduced in a more methodical form in U.K.62. Copies of the graphic logs of the deep wells are incorporated in U.K.62, and of the shallow holes in U.K.45.

A fourth deep well, on the Fordel Mains culmination, is due to start this month. So we shall be adding to the data by filling the gap between C.1 and the old D'Arcy Well.

With all good wishes for the New Year,

Yours sincerely,

P.G.R.

3rd December, 1946

Our Ref.
COU/3

Prof. W. Q. Kennedy,
The University,
Leeds.

Dear Kennedy,

Many thanks for the Cousland reports, which arrived safely.

Two of them (including Falcon's compendium) need to be reproduced, and we hope to manage this in a week or two. Copies of all the reports will then be returned to you.

With kind regards.

Yours sincerely,

PK

PEK/DMP

TEL. NO. 20251

W. Q. KENNEDY, D.Sc.,
PROFESSOR OF GEOLOGY.

GEOLOGY DEPARTMENT,
THE UNIVERSITY,
LEEDS, 2.

COU/2

30th November, 1946.

PEK

Dear Kent,

Many thanks for your letter. I have sent off the Cousland reports by registered post and hope that they arrive safely.

If it is no trouble I should very much like to have copies to carry on with particularly as the vacation now offers an opportunity for work on the subject.

Hope you are enjoying the additional work which has come to you since Strong left.

Kindest regards,

Yours sincerely,

W.Q. Kennedy.

Dr. P. E. Kent,
D'Arcy Exploration Company, Ltd.,
P.O. Box 1,
Southwell,
NOTTS.

UK 17
UK 45
UK 62
Monthly Repts
} received separately

MR

COU/2

25th November, 1946.

Professor W.Q. Kennedy,
Geology Dept.,
The University,
Leeds, 2.

Dear Kennedy,

As you may have heard, I am occupying Strong's place for a few months while he is abroad, and my scheduled departure overseas is delayed until the New Year. We are, meanwhile, concerned with the Cousland structure again, and we need to use Falcon's report on the area which is on loan to you. We wonder whether you would, therefore, be good enough to return it to this office. If you are still needing to consult this we will have it copied, so that you need not be without the data for more than a few days.

The non-existence of duplicate copies of our reports is due to the wartime salvage campaign, when all but originals were pulped! For this reason may we trouble you further to send the report by registered post?

Yours sincerely,

C.E.R.

H.119 C.1.40

Memorandum

From DR. P.E. KENT. **To** MR. M.W. STRONG.

Our Ref. **Your Ref.** **Date** SEPT. 10th. 1946

Subject COUSLAND - GAS RESERVES.

The following tentative estimates have been made*:

1248-1279 Sandstone No.1 (1490-1530 Sandstone No.2)

Reservoir content above water level 500 million cu.ft.
Porosity determinations 18%, 23% at No.1; 1.8 and 10% Cousland No.2
Assume average porosity of 10%; pores entirely gas filled
Volume of gas hence 50 M.cu.ft. at "500-600 lbs."
(say 40 atmospheres)
Volume of gas at atmospheric pressure 2,000 M.cu.ft.

1582-1632 Sandstone No.1 (1900-08 Sandstone No.2)

Reservoir c ontent 300 million cu.ft.
Porosity determinations 15%, 17%
Assume average porosity of 8%, pores entirely gas filled
Volume of gas 24 M.cu.ft., at 615 lbs.sq.in.
Volume of gas at atmospheric pressure 1,000 M.cu.ft.

1720-1806 Sandstone No.1 (2045-2136 Sandstone No.2)

Reservoir content 150 million cu.ft.
Porosity determinations - none at No.1; 3.6 - 6.7% Cousland No.2 - assume 5%, water free.
Volume of gas 7.5 million cu.ft.
Pressure initially 650 lbs., falling under test to 555, rising to 593+ when shut in.
Volume of gas initially at atmospheric pressure 325 M.cu.ft.

Total gas present say 3,300 Million cu.ft.

P.E. Kent

* Prepared last May: now (belatedly) put in Memo form for more convenient reference.
P.E.K.

COUSLAND - GAS RESERVES. ESTIMATES BY M.W.STRONG.

1248 - 1279. A

Area	25	million sq.ft.
Volume	500	million cu.ft. if Sst. 20' thick
10% Porosity	50	" "
40 atmospheres	2000	" "

Rev.

1582 - 1632. B

Area	10	million sq.ft.
Volume	300	million cu.ft.
10% Porosity	30	" "
40 atmospheres	1200	" " if all pore spaces gasfilled.

1720 - 1806. C

Area	5	million sq. ft.
Volume	150	million cu.ft.
10% Porosity	15	" "
50 atmospheres	750	" "

Total 4000 million cu.ft.

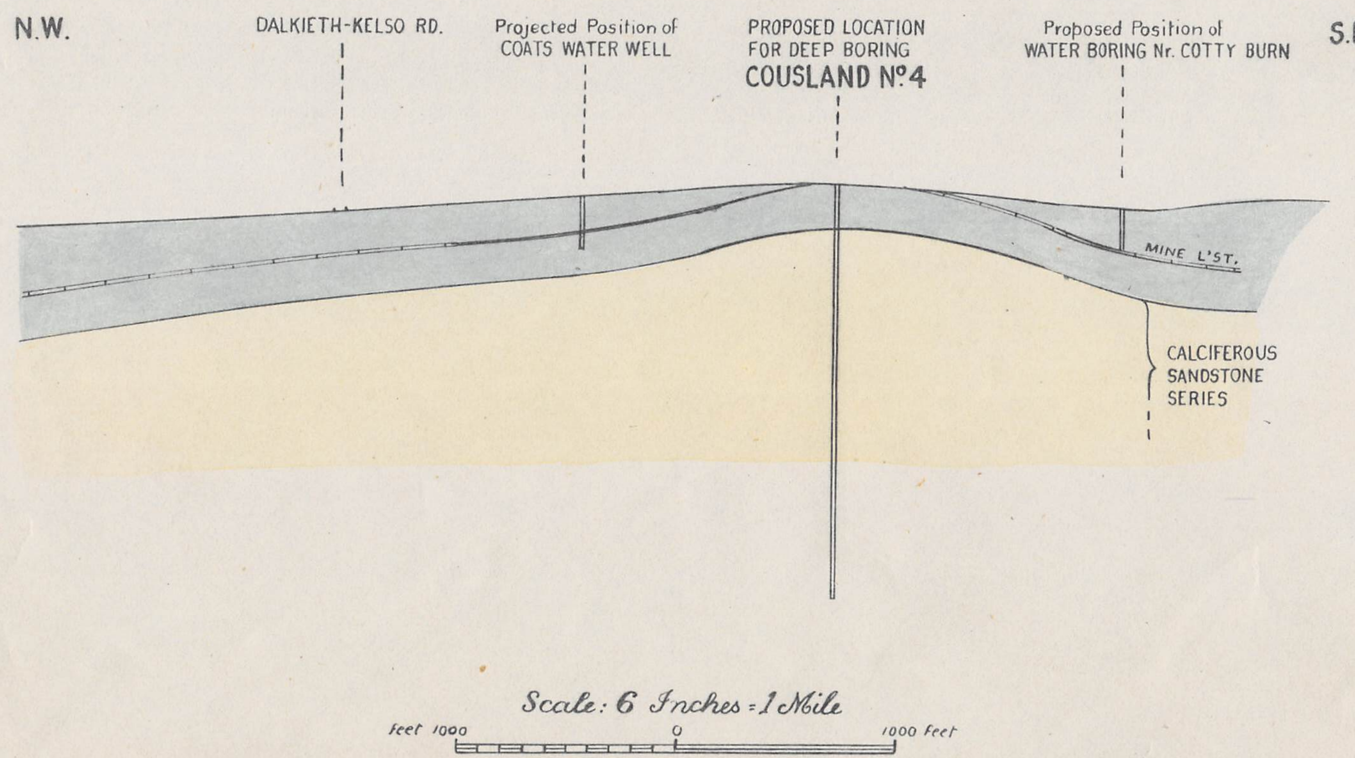
Revision volumes taking ~~for~~ Southerly porosity decrease & alteration in structural interpretation

A	1000 m cu ft.	4000 m cu ft.
B	680	2500 "
C	540	2800 "
		9000.

May 1946.

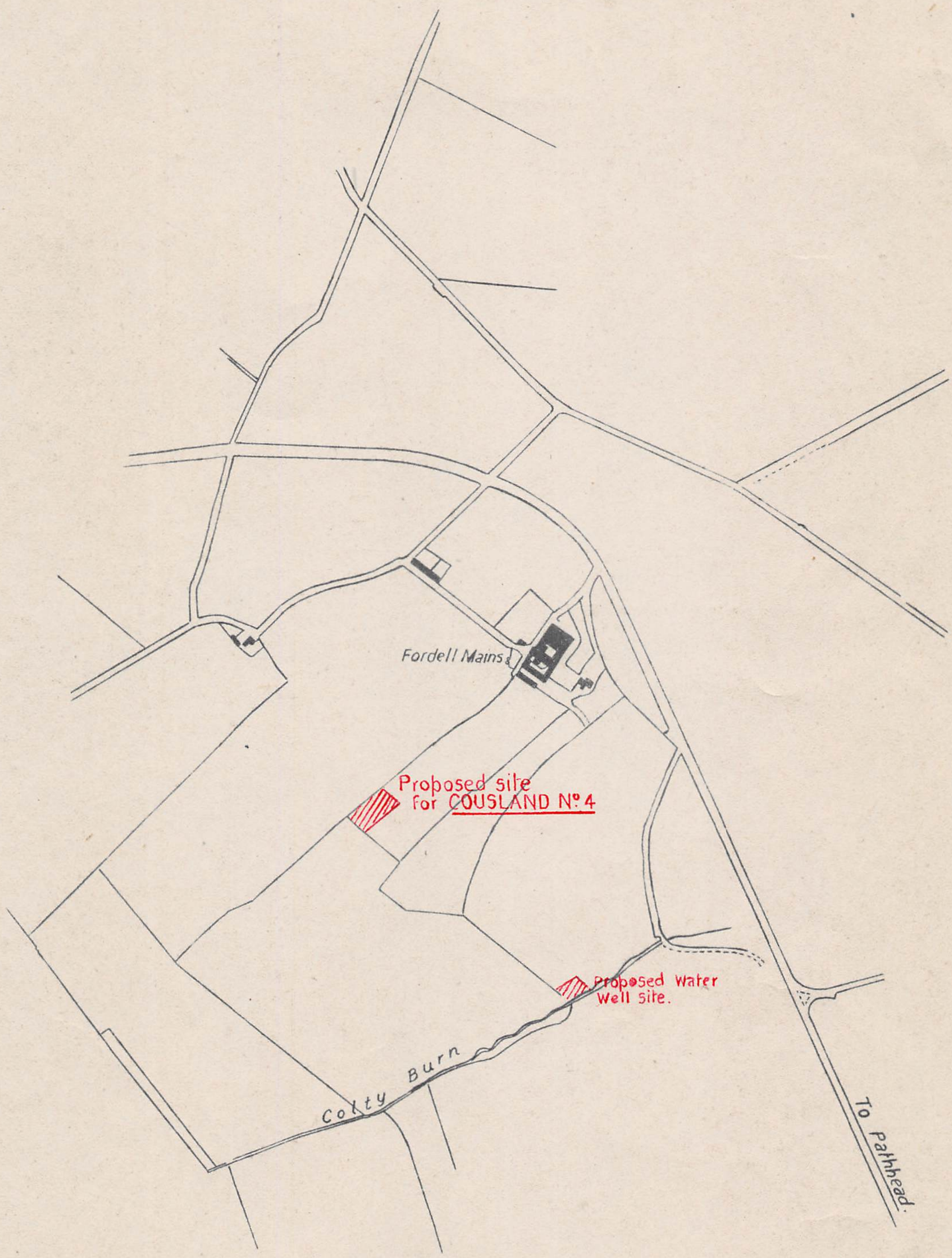
SECTION THROUGH THE COUSLAND ANTICLINE
NEAR
FORDEL MAINS

Illustrating the relationship between the Coats Water Well, the D'Arcy Exploration Company's proposed Cousland Nº4 Well and the proposed Cotty Burn Well. The deep boring will be in beds deeper than those yielding water at the Coats Well and the Cotty Burn Well will be on the opposite Flank of the Anticline.



D'ARCY EXPLORATION Cº Ltd
GEOLOGICAL BR. EAKRING
AREA: COUSLAND
REF.
12 · 11 · 46 P. E. KENT.

AREA: COUSLAND	SITE PLAN FOR Nº 4	PARTS OF O.S. SHEETS MIDLOTHIAN VIII NE & SE IX NE & SE	AREA IN ACRES
LICENCE AREA: A 118 b			



D'ARCY EXPLORATION COMPANY Ltd

S. P. 254.

SCALE: 6 inches = 1 mile

DATE: 17 · 10 · 46

COUSLAND.

In view of the general decision to drill a further test on the Cousland structure, as outlined in your letter of Aug. 28th., we give herewith our detailed support of this recommendation.

In our memo of May 10th. 1946, we estimated the possible gas reserves from all sands as in the region of 4000 million cubic feet.

In this estimate the fundamental supposition was made that the strata between the Lower Limestone Group and the petroliferous sandy group does not increase appreciably between Cousland No.1 and the Fordel Mains culmination. This probability is indicated on Mr. Falcon's isopachyte construction given in his report U.K. 62 but, in view of the lack of information, can be regarded only as a likely interpretation.

If these strata thicken at an even rate from Cousland No.1 to the Midlothian No.2 Borehole, then the reserve estimate would be seriously reduced.

A second assumption was the maintenance of an approximately constant average porosity and permeability of the sands, which are lenticularly developed.

On these two assumptions we do not have very firm control but in view of the importance of gas in this region we support the recommendation to drill a further borehole on the Fordel Mains crest maximum as contoured on the base of the Lower Limestone Group.

Considering the various factors it seems that a location at Fordel Mains culmination should strike the equivalent of the top oil sand of Cousland No.1 between the 10250 and 10420 contours.

In any case it is not possible to estimate the reserves with any accuracy at the moment and a boring at Fordel Mains should prove whether or not sufficient reserves are in sight to justify proceeding with the exploitation of the area.

Even if the structure is favourable, in view of the lenticularity of the sands it will probably require some four or five additional wells at least to produce the gas

As however the possible total reserves approach twice the estimated required quantity the drilling of the present location is felt to be justified.

M.W. Strong
7.9.46.

Enclosed. Geological Longitudinal Section.

Dr. G.M.Lees, Britannic House, London.

File. *WS*

"BP"

Telephone
Central 7422.

Britannic House,
Finsbury Circus,
London, E.C.2.

28th August, 1946.

Dear Taitt,

Your letter to me of 27th August shows that as a result of the delay in negotiations for the Perlethorpe location we must arrange a location elsewhere in order to achieve continuity of operations. On considering our programme as a whole I have decided to recommend a further boring at Cousland on the Fordel Mains crest maximum. Unfortunately, Mr. Jameson will not be in the office this week and I have, therefore not been able to obtain his approval. There will, however, be an opportunity of discussing the matter with him when he visits Eakring next Saturday and I should be glad if you would discuss the case with Comins and Strong and prepare a firm recommendation if you find yourselves in agreement with my line of argument.

The case as I see it is this: now that negotiations with the Brunton Wire Rope Company have broken down the problem of disposal of the Cousland gas requires decision. Sometime ago Lepper had asked me regarding our intentions and I told him that we were reviewing the position to decide whether or not there was a sufficient case for the supply of gas to our own oil shale area at Pumpherstone and that I would let him know the result in due course. I have now had a letter from Dr. Nuttall, who is Lepper's successor, dated 13th August, reading as follows:-

> " I understand that you informed Lepper that D'Arcy were contemplating using their Cousland natural gas supplies at their shale oil refineries. You will recognise that it is most desirable in these times of fuel shortage that these gas reserves should if possible be utilized. I should therefore much appreciate it if you would give me a short note indicating the developments that are taking place with regard to making use of the natural gas in this area. "

During my last visit to Scottish Oils I enquired into the possible requirements of Scottish Oils for our gas and I was informed by Mr. Crichton and Mr. Caldwell that they would be interested in a supply of gas up to one or two million cubic feet per day delivered to the Pumpherstone area for use as fuel to replace coal, the cost

(Contd.)

 28.8.46.

of which has recently been substantially increased compared to pre-war values. If we could guarantee a supply of even one million cu. ft. of gas per day to Pumpherstone for say five years, the proposition would be definitely attractive. The difficulty, however, arises in deciding whether or not we can visualise a gas reserve of anything like this magnitude. Comins's estimates in the past, based on pressure decline during the short production tests, have been something between 250 and 500 million cu.ft. of gas, but he has always made the qualification that the total amount may be substantially greater and that more prolonged production tests would be necessary to arrive at a more certain figure. Last May I asked Strong to calculate the possible gas reserves of Cousland based on an assumption of sand volumes within the reservoir and he supplied figures in his memo. dated 10th May, 1946. His results show that there is a possibility of about 150,000 million (say = 4,000 mill.) cu.ft. from the Cousland dome and possibly an additional 25,000 million cu.ft. from the Carberry Hill dome. These figures are about three hundred times greater than Comins's top estimate and the difference between the two shows clearly that our knowledge of reservoir conditions is very inadequate. It may be that the sandstone thicknesses proved in No.1 well are not representative of the area as a whole due to the lenticularity of sands (such as the Anglo-American have recently proved by their No.6 well) and that the figure arrived at by assuming that the thicknesses proved in No.1 well may be very misleading. On the other hand we expect a considerable amount of minor faulting throughout the unit as a whole and it is possible, therefore, that there is inadequate reservoir connection and that the pressure decline figures used by Comins are not representative of the whole unit but only refer to an isolated faulted compartment. My view is that the truth may lie somewhere in between these two extreme estimates and even if it is half way in between, the amount of gas possible would then be on a sufficiently important scale to justify a pipeline to Pumpherstone.

Before any further action is taken I feel that an additional well should be drilled, and the obvious place is on the Fordel Mains crest maximum about one mile south of Cousland No.1. A well at this point should give important information on the character of the sandstones at a sufficient distance from No.1 well and a production test may indicate whether or not there is immediate reservoir connection between the two.

Will you please give consideration to the matter on these lines and prepare the case for a discussion on Saturday.

Yours sincerely,

G. M. Lees

A. H. Taitt, Esq.,
<u>EAKRING.</u>

H.121—B. (7-45)

Memorandum

From DR. G. M. LEES. **To** MR. M. W. STRONG.

Our Ref. **Your Ref.** **Date** 14th May, 1946.

Subject COUSLAND GAS RESERVES.

With reference to your memo. of 10th May on this subject, will you please amplify your note by giving the contour of the gas-water-level which you have assumed in the various sands. This level was calculated for the 1582-foot sand, but in the case of the other sands certain assumptions have to be made.

G. M. Lees

Sand

1720–1806 water level between 8786 – 8825 40 ft range

~ 1000

original area 5 10^6 ft^2

150 10^6 ft^3 vol

15 10^6

600 10^6

8830

1582/1632 Sand

Gas water level 8830 PGC Pet Division

1248/79 Sand

9000 WG & [illegible] Evidence [illegible] wells

Corr. Cond file

1st April, 1946.

Dear Dr. Kennedy,

Very many thanks for your letter of March 25th. I have discussed the proposition with Dr. Lees, and we feel that it would be desirable for you if possible to include the East Lothian district in the write-up in addition to the General Central Valley area. As regards the scope of the enquiry, I agree that this must essentially be a review of the evidence regarding sedimentation and tectonics in so far as they are pertinent to the problem of oil generation and accummulation. The problem of finding reservoirs with reasonable closures and porosities is obviously difficult, but we feel that an effort should be made to clear up the situation so far as is practicable.

I should be glad to have your reply as to whether you could undertake this additional programme and also a rough estimate of the time you might require for the completion of the work.

With kindest regards,

W W Strong

Dr. W.Q. Kennedy,
Dept. of Geology,
The University,
Leeds 2.

Rlp
wh/26
3pp

2nd May, 1944.

NATURAL GAS IN THE UNITED KINGDOM.

The gas prospects appear to me to be divided into two categories:-

(1) Gas from the Coal Measure series or in traps immediately above the Coal series, but not associated with petroleum, for all practical purposes consisting of pure methane;

(2) Gas associated with petroleum.

If we can show that gas from structures in either of these categories has a definite commercial value and its recovery is of national benefit, then we can consider seriously the search for new sources, for which our technical experience particularly fits us.

From experience to-date, with the knowledge that large volumes of Coal Measure gas have been produced in coal workings and that natural gas associated with petroleum has already been proved in the United Kingdom, we can assume that the best gas structures have not yet been discovered and that there is every likelihood of their discovery if a full-scale search programme is instituted.

To-date our experience in the commercial development of gas already proved in oil exploration drilling at Cousland and Eskdale has been unfortunate, as it has been necessary for us to put a very conservative estimate for the reserves in associating our name with war-time projects for its development. This experience should not deter us from reviewing the question in all its aspects to see if we can recommend a post-war programme designed to locate further and larger natural gas resources in this country.

The first step is to examine the possible uses of such gas and then to estimate what minimum reserve is necessary for commercial exploitation, a figure which will provide the geological target on which to base a future programme.

The commercial uses seem to be limited to:-

(1) Gas fuel for domestic and industrial purposes;

(2) Conversion of methane to acetylene for the chemical industry;

(3) Conversion to gasoline by the Fischer-Tropsch process.

It would appear that for any of the above projects we should have available a reserve of the order of 10,000 million cubic feet per day, giving a daily output of approximately 3 million cubic feet per day, to justify the plant expenditure.

The search for gas in an endeavour to find structures in this country containing this magnitude of reserves would involve, firstly, a geophysical programme of about six months work incurring an expenditure of, say, £12,000, to be followed by the drilling of at least 10 wells with an average depth of, say, 5,000 feet, requiring 50,000 feet of drilling, which, at a cost of £4.0.0. per foot, would give a total expenditure of approximately £200,000. As few wells would be required for exploitation of any gas found, we arrive at a figure of £250,000 to cover the cost of the search for and the development of a gas field.

p.t.o.

The gas has a minimum value at the wellhead of approximately £50 per million cubic feet (based on gas fuel value) and to justify an expenditure of £250,000 we would need to find a minimum gas reserve of the order of 10,000 million cubic feet - a reserve which, as stated above, appears to be of a satisfactory order for commercial development.

On the above basis, geological advice should be obtained to see what prospects there are in this country, and to this end licences should be obtained for geological examination at a cost of, say, £5,000 per annum for two years.

If geological advice is that we can justify a programme involving geophysical work and drilling, then the whole question should be discussed with:-

(1) A well-recognised gas undertaking, such as the United Kingdom Gas Corporation, for the possibility of gas fuel;

(2) The I.C.I., for the possibility of some associated product on the chemical development side, such as acetylene.

At this stage we should, before commiting ourselves to the larger expenditure, endeavour to enter into an undertaking with either of the above to take the gas at an agreed price if we are successful in proving reserves of the order indicated of 10,000 million cubic feet.

The various aspects of these proposals require examination by the experts concerned, following which a definite recommendation can be put forward to take up licences and to develop a post-war programme on the above basis.

(Sgd.) C. A. P. SOUTHWELL

3rd March, 1940

COPY

7.XI.44.

Copies also on:- UK.25 and with Records Office and Burgage Manor, original sent to P.D. - March 1940.

NATURAL GAS RESERVES

Eskdale and Cousland

The following estimates are based on data and tests, details of which are reported in the monthly Returns to your Department. They represent our considered opinion, based on the information available, but you will appreciate the speculative elements which enter into such estimates. In this connection we draw your attention to the following points:-

(1) The extent to which gas pressures are being maintained by water drive;

(2) The extent to which reserves calculated from the pressure behaviour on production tests of a gas well will represent the reserves of the whole gas field.

Bearing in mind the speculative character of such estimates, our view is that Eskdale No.2 well should be capable of supplying half a million cubic feet of roughly 1000 BTU/cubic feet gas per day over a period of at least 3 years at a delivery pressure of at least 1250 lbs. per square inch, and that Cousland No.1 well could supply about the same quantity of roughly the same quality gas from the 1582/1632 sand over a period of about a year to a year and a half at an average delivery pressure of about 400 lbs. per square inch.

There are some prospects that the recoverable reserves from the two fields may exceed those represented by these figures. The position would require review after observation of the behaviour of these wells on production.

ESKDALE.

The production capacity of No.2 well as tested recently was:-

Flowing Pressure.	Production.	
	Gas	Water
lbs/in.	m.c.ft/day	gallons/day
15	1.8	150
100	1.7	Nil
495	1.5	Nil
987	1.2	Nil
1529	0.6	Nil

Minimum reserves recoverable from the well are estimated at 500 million cubic feet, based on an assumption that about 90% of gas produced has been replaced by encroaching edge water, but the possible reserves of the well may be appreciably higher. Reservoir conditions, consisting of a fissured limestone in a very gentle anticline, suggest that the present well may drain the whole unit. It is, therefore, not considered that there is any case for drilling a second well at the present time.

COUSLAND.

The important gas sand is the 1582/1632 feet sand which, together with the 1720/35 sand, is now exposed through gun perforated casing in No.1 well. The productive capacity of the two sands combined is at present approximately 1.0 million cubic feet per day at 550 lbs. flowing pressure. It is difficult to estimate how well this rate will be maintained, a false decline having been caused by water - presumed to be drilling water - rising in the casing. An average working figure of 0.5 million cubic feet per day and 400 lbs. flowing pressure is probable over the first year or more.

Reserves recoverable from the well in its present condition are calculated to be about 250 million cubic feet, assuming partial water drive, and cannot exceed about 450 million cubic feet on present data.

Present evidence as regards the possible value of drilling further wells on the Cousland Dome is conflicting. Reserves of the whole field as calculated from sand volumes, porosities, and estimated gas-water levels would appear to exceed greatly those calculated as recoverable from No.1 well. On the other hand, a substantial fall in water pressure in No.2 well following production tests on No.1 well suggests that the latter is draining a considerable area.

Our opinion is that drilling a second well should be deferred until the economic performance of No.1 on sustained production has been observed.

EAKRING.

As you anticipate, the stripped gas at Eakring will most probably be made use of on the field for steam raising. At 100,000 tons crude production per year, estimated gas production would be 150,000 cubic feet per day. The (gross) calorific value of the stripped gas is about 1480 BTU's per cubic foot.

D'ARCY EXPLORATION COMPANY LIMITED.

TELEPHONES
SOUTHWELL 3261-3262.

TELEGRAMS
DECOL SOUTHWELL.

OUR REFERENCE
DC/85
YOUR REFERENCE

BURGAGE MANOR
SOUTHWELL
NOTTS.

17th July, 1940

C.M.Adcock, Esq.,
D'Arcy Exploration Co.Ltd.,
Eakring,
Newark,
Notts.

Dear Sir,

Cousland Tests

Confirming verbal instructions you will proceed to Cousland as soon as practicable and carry out the following work :-

1. Measure the Closed in Pressure of No.1 well by Dead Weight Tester, noting elevation at which made in relation to that of previous observations and to Rotary Table elevation.

2. Measure the Free Water Level of No.2 well by float or dipper and the pressure at 2016 feet, depth (from Rotary Table) by Amerada. (The top of the fish is at 2063 feet.)

3. Fill three methane cylinders with gas at about 500 lbs per square inch pressure from No.1 well and arrange for despatch of these by passenger train to Chemical Branch, Anglo-Iranian Oil Company Ltd., P.O. Box 1, Chertsey Road, Sunbury-on-Thames, Middlesex, marked for attention Dr.Birch.

4. Have all Petroleum Engineering equipment and apparatus on site (Dead Weight Tester, Halliburton, etc.) crated and sent to Eakring by passenger train.

5. Plot the information asked for by Mr.Lefroy in his memorandum of 16th July (attached), on the 100 ft. to 1" enlargements (attached) of the surround of Nos. 1 and 2 wells. A copy is also attached for your guidance of the map from which the surround of No.1 well was enlarged. This should be returned to Mr. Lefroy. The surround of No. 2 well was enlarged from the 6" Ordnance Survey map.

(If you can get large scale maps in Edinburgh do so, but this may be difficult as a permit is now required).

Any surveying instruments you require may be borrowed from Mapping Section if not available ex Eakring.

NOTES:

1. Mr.Whittingdale, Anglo-American Oil Company, Midlothian, has kindly agreed to supply labour up to three men as required and will probably be agreeable to supplying transport. Such costs will be debitable to us and you should therefore keep a note of times, etc.

2. Stationmaster, Dalkeith, has been requested to deliver the three cylinders to our watchman at Cousland. Please find out how he got the impression that we had no-one there - i.e. is there any question of the watchmen not having been there when they tried to get in touch?

Yours faithfully,
For D'ARCY EXPLORATION CO. LTD.

[signature]

Enclosures
1. Mr.Lefroy's memorandum dated 16.7.40.
2. 100 ft. to 1" enlargements.
3. Map from which surround of No.1 well was enlarged.

DC/VEB

A249/6931. C.11.38

COPY

Memorandum

From Mr. Lefroy **To** Fields Branch

Our Ref. UK/M.1 **Your Ref.** **Date** 16th July, 1940.

Subject Cousland No. 1 and No. 2 Sites

In April last we warned the lawyers to Stair Estates Ltd. that we were contemplating the surrender of the sites taken for these wells, "with the exception of a plot approximately 40 ft. x 20 ft. around the well and a roadway which we shall require for purposes of access". We stated further that we should "require permission to lay a gas line from the well to the quarry situated to the north-west of the site".

The lawyers have not unreasonably asked for plans showing the precise position of the site to be retained, the roadway required for the purposes of access, and the direction of the track for the gas line from the well to the quarry situated to the north-west.

Please put me in a position to reply to these queries.

(Signed) L. Lefroy.

19—C.1.39

562

562

Memorandum

From D'ARCY EXPLORATION CO. LTD., EAKRING (MR. DICKIE).

To D'ARCY EXPLORATION CO. LTD., COUSLAND (MR. C.M.ADCOCK).

Our Ref. **Your Ref.** **Date** 1st November, 1939

Subject PROGRAMME:

The following is the decision regarding Cousland of a conference held at Eakring on 28/10/39 :-

"Approximately 30 million cubic feet of gas to be produced from No.1 well over a period of a month, in order that additional reserves provided by the shooting of the 1582/1632 sand may be estimated. Production rate to be of the order of 1 million cubic feet per day initially, the rate being varied sufficiently later to enable an estimate of the maximum production rate to be made.

Production to be continuous night and day, as considered safe not to burn gas provided that end of flow line is carried up about 20 feet vertically. Dipper and/or float to be run once a week to watch for possible water encroachment.

No.2 well to be retained as water observation well."

On your arrival at Cousland please examine the pressure records of No.1 from the perforation of the 1582/1632 sand, and satisfy yourself that substantial pressure equilibrium has been attained. The flowing test can then proceed. It was emphasized, however, at the conference, that the well should not be flowed initially at a greater rate than about 1 million cubic feet per day. It will be necessary, therefore, to disconnect the burning line at the well head valve, and arrange for the rate of flow to be controlled by a half-inch H.P. needle valve. This is most conveniently connected to the 3" well head side valve, the gas being flowed to the burning line through a short length of 1" hose.

After about a week's flow, or when the flowhead pressure-production relationship is fairly stable, the production can be increased to about 1.5 million cubic feet per day, and held at that production until stable conditions are obtained again. The production will then be cut back to 1 million cubic feet per day to see if any change has taken place in the flowhead pressure-production relationship at the lower rate. Should it be considered advisable, a similar test may be carried out at 2 million cubic feet per day, but a decision regarding this test

2" = .5920
3" = 16.50
4" = 34.10
5" = 60.00
6" = 95.00

will depend on the results of the former.

In the initial stages of these tests it will be advisable to run a float daily to see if any water is entering the hole; the float should also be run when any increase in the rate of flow takes place.

For controlling the rate of flow Olifant's formula is sufficiently accurate; it is:

$$Q = 1008\, a \sqrt{\frac{P_1^2 - P_2^2}{L}} \sqrt{\frac{.6}{G}} \times K$$

where :-

Q = cubic feet of gas per 24 hours.
a = 16.5 for 3" line.
P_1 & P_2 are pressures measured in lbs/sq.in. absolute at a distance of L Miles apart.
G = specific gravity of gas cf. air = 0·6
K = Temperature correction factor =

$$1 - \left(\frac{\text{Temperature of gas} - 60}{500}\right)$$

An approximate temperature correction is add or subtract 1% to or from Q for every 5° F. below or above 60°F.

In addition to the tests on No.1 well arrangements should be made to run a float into No.2 well at intervals, to see if the water level there is at all influenced by the flowing of No.1 well.

A $\frac{1}{2}$" H.P. needle valve and six note books are being despatched to you by parcel post to-day.

As regards records, please submit a weekly report to Eakring giving pressure and temperature observations at $\frac{1}{2}$ hourly intervals, and send a short daily telegram to Eakring and Llandarcy.

RKDickie

P.S. If the float does hold up it may be due to thick oil on the casing or other causes confirm any hold up by running dipper.

RKD

RKD/VEB

28th Sept., 1939.

From MR.COMINS To MR.DICKIE (EAKRING)

COUSLAND RESERVES.

I have been looking into the question as to whether the estimated reserves recoverable from No.1 well from the combined 1720/35 and 1760/1806 sands represents the whole of the gas reserves in those sands. From the 199 foot figure you mention as the F.W.L. of No.2 well at the beginning of September it looks possible that they do not and that additional wells at some unknown spacing say 1000' along the strike might prove additional independent reserves in these sands. I have not yet come, however, to any definite conclusion as it would be rather unsafe to do so without some further data from No.2, particularly as to whether F.W.L. has been rising or falling.

No.2's reservoir pressure at the beginning of September has only fallen about half the amount it should have at that date for equilibrium with No.1. The actual fall appears to have been only (199 - 137.5) x .436 = approx. 27# whereas for equilibrium with No.1 the fall should I make it have been (659 - 591.5) - 28 (.436 - .013) = approx.55#, 28 ft. being my figure for estimated rise of gas water level to 1st September based on data reported by you.

The correct date for comparison of pressures would, however, be 15th May the last date on which, as you point out, calculations of reserves can be based upon No.1's pressure -

the equivalent estimate being 200 m.c.ft. - so that it is a question of whether we have enough data to form any estimate of what No.2's reservoir pressure was on that date.

The fact that the lower (2284-2412) sand's pressure in No.2 was practically the same on 3rd May - i.e. after the main gas production test on No.1 between 17th and 24th April - as that of the upper 2016-2120 sand on 15th April - suggests that No.2's reservoir pressure on 15th May had been barely affected by the gas production from No.1. Unless supported by further pressure data from No.2 this is, however, by no means certain, as, although all data point to the 2016/2120 and 2284/2412 sands being in equilibrium in geological time, they may not be so in production time.

Would you send me any further pressure or F.W.L. observations which have been made on No.2 to date and if you can find time let me have your views on the question as to whether from pressure data we can form any confident opinion as to whether independent reserves are likely to be proved by further wells adequately spaced. Dr.Lees is confidently of the opinion - referred to in my report of 15th May - that on geological grounds (faulting etc.), this is likely.

GL

149/6931—C.7.37

Memorandum

From D'ARCY EXPLORATION CO.LTD. LONDON.

To DR.LEES. MR.SOUTHWELL.

Our Ref. **Your Ref.** **Date** 24th April,1939.

Subject COUSLAND PROGRAMME.

FILE.

At the conference held on 13th April 1939 it was decided that a fourth well should be located between Nos. 1 and 2 in order to determine whether or not any accumulation of oil was present between the gas proved in the 1720-1806ft. sand and higher sands of No.1 and the water proved in the representatives of these sands in No.2.

The production test of the 1720-1806 sand now in progress at Cousland No.1 has provided evidence that gas/water level of the 1720-1806 accumulation is at approximately 1805 ft. (U.G.C.8760). This conclusion is supported by the water pressure data in the representative of this sand in Cousland No.2. From this data it is estimated that, if no oil is present, gas/water level is to be expected at approximately the 8670 U.G.C.

One of the main reasons therefore for locating No.4 between Nos. 1 and 2 is disposed of.

× The presence of formation water in the 1720-1806 gas sand of No.1 precludes the possibility of oil in this sand at lower elevations. The possible gas column and thus the quantity of gas available in the structure is also greatly reduced. On this evidence alone however the structure can not be condemned as a commercial proposition. Oil may be present in the 1582-1632ft. gas sand of No.1 though the fact that this sand was not represented by more than a few feet of sand in No.2 does not enhance its prospects. There is however the possibility that the 1582ft and the 1720-1806 sand with the intervening thinner sands are all part of one gas accumulation in which case the gas column in the structure would be greatly increased and the potential value of the structure as a gas field greatly enhanced.

× Are we satisfied that there is water in the 1720-1806 (1248/79 ft) gas sand and not upper water coming down behind the casing? Could comparative analyses be carried out on upper & lower waters. M

The 1248-1279ft. sand of No.1 holds the greatest hopes of containing an accumulation of oil. In No.1 it contained gas, which was relatively wet, and some oil, and it is correlated with the oil sand of Midlothian No.1.

Apart from these considerations the sub-surface structural conditions of the Cousland anticline are largely hyphothetical.

Cousland No.1 is situated on the northern plunge of the Cousland anticline on about the 103 U.G.C. of the top of the Oil Shale Group. Further south the structure rises to over the 104 U.G.C. It is known that the upper part of the Oil Shale Group thins northwards from Midlothian to Cousland No.1 and it has been assumed that the thinning is regular and culminates at No.1. This assumption may be incorrect and the thinning may all take place between Midlothian No.1 and the crest maximum of the Cousland structure, thus greatly increasing the area of sand above gas/water level in the various reservoirs.

In view of the above considerations the following programme is recommended for the complete investigation of the Cousland, as opposed to the D'Arcy and Carberry, structure.

COUSLAND NO.1.

A. 1. Complete production test of 1760-1806' zone.

2. Bridge casing at 1750' and fill with cement to 1650 ft.

3. Perforate casing between 1582 and 1630 ft.

4. Carry out production test.

5. Bridge casing at say 1500 ft. and fill with cement to say 1300 ft.

6. Perforate casing between 1248 and 1279 ft.

7. Carry out production test.

....

COUSLAND NO.2.

B. 1. Continue coring to ca. 2250ft. to confirm the correlation of the 2016-2120ft. sand with the 1720-1806ft. sand of No.1.

2. Plug hole to ca. 2120'

3. If A.1 already completed, carry out packer test to determine if any decrease in water pressure has occurred as a result of the production test in No.1.

4. Run and cement 8" casing at ca. 2016 ft.

5. Condition as a water observation well.

LOCATION COUSLAND NO.4.

It is recommended that a test well be drilled on the crest maximum of the Cousland structure. Casing (? 11") to be cemented on top of the representative of the 1248' sand and after testing this sand the well to be continued as a test of the lower sands.

If as a result of the production test of the 1248ft. sand of No.1 (A 7) evidence is obtained that indicates an oil column sufficiently great to warrant the development of this sand on a production basis, it is recommended that a well be drilled with a Failing Outfit between Nos. 1 and 2.

Agreed at meeting on 8/5/39 that No 4 will not be drilled until casing on No 1 are completed. [illegible]

I agree with suggested programme A - B and Location No 4 [signature]

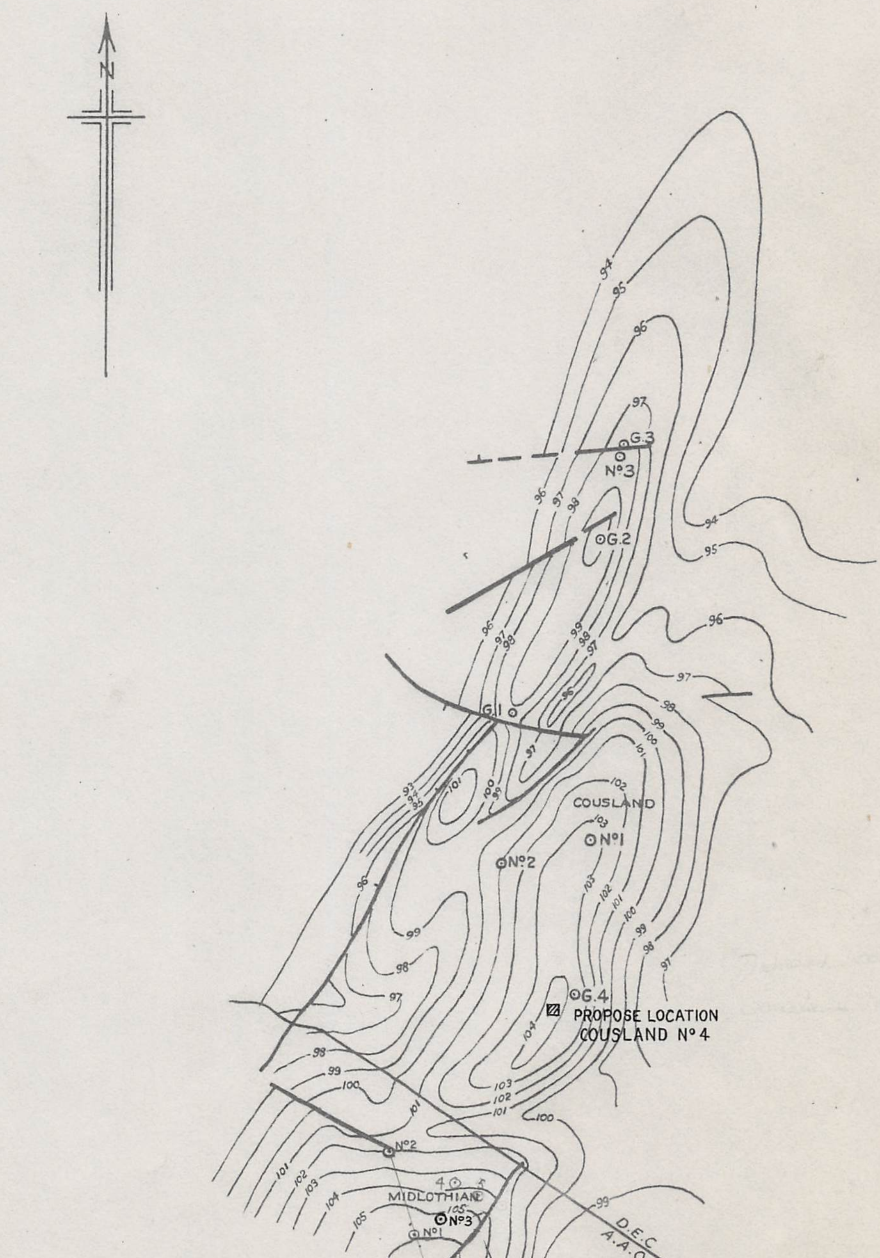
[signature]

I agree except that B 4 and 5 should have reconsideration after production tests A1.

C.A.M.

To accompany memo on Cousland programme. 24·4·39.

COUSLAND

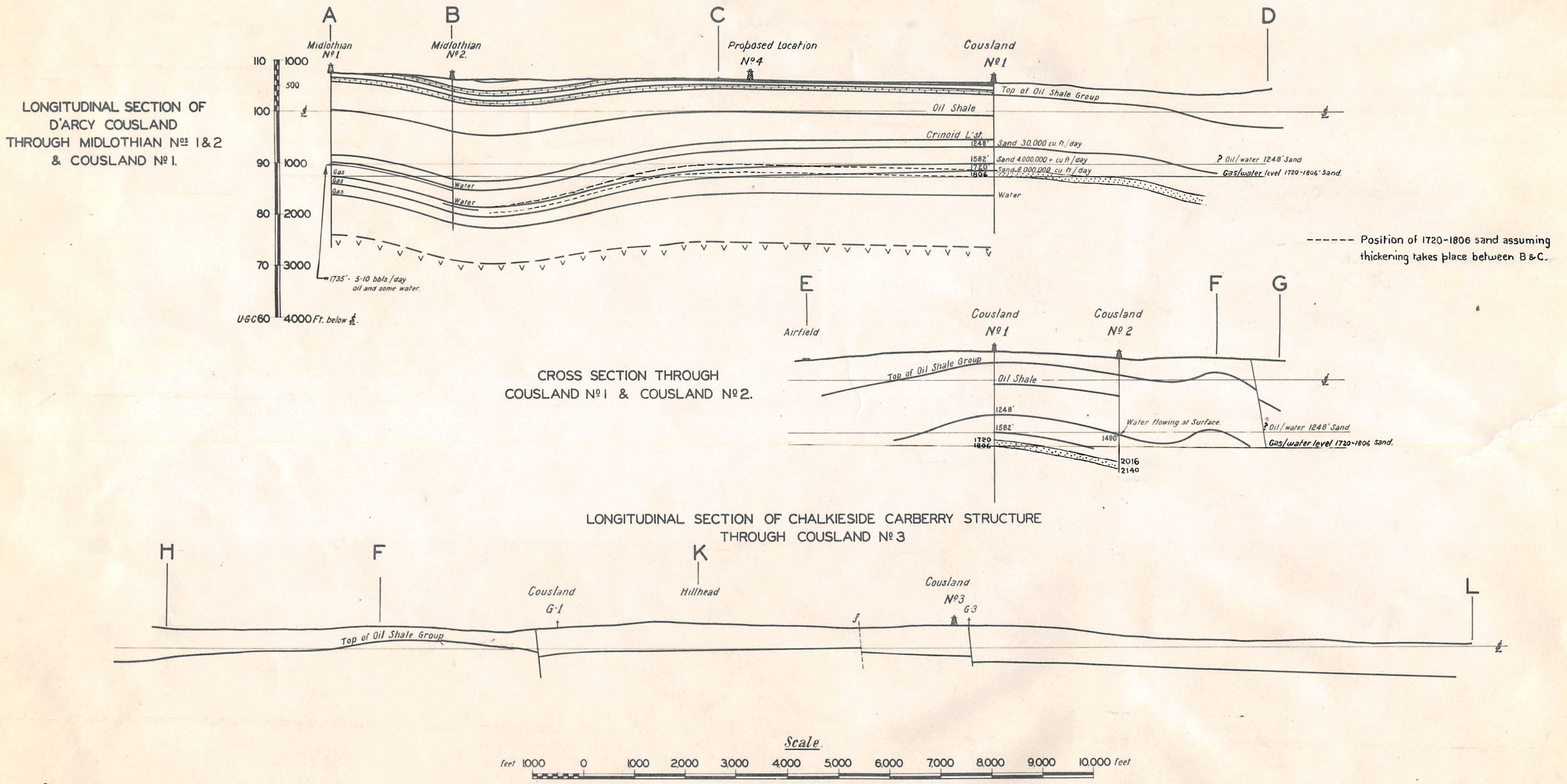


23-2-39

To accompany memo on Cousland programme 24·4·39.

THE D'ARCY COUSLAND STRUCTURE

PROVISIONAL SECTIONS



14·3·39.

8th. June 1938.

COUSLAND.

Notes on a visit by Messrs. Comins & Dickie. 2nd. June 1938.

The following action was taken or arranged:-

I. PETROLEUM ENGINEERING EQUIPMENT.

Equipment was taken up and handed over as per list attached, the bulk of this having been personally selected by Mr.Dickie, from stock available, at short notice. It was arranged with Mr. Falcon that, in order to avoid overlap, he will advise me of any further Petroleum Engineering equipment which he may purchase locally.

II. MEASUREMENT OF CLOSED IN WELLHEAD PRESSURES.

Dead-weight tester installed and use in direct measurement of wellhead pressures demonstrated. This eliminates the use of pressure gauges for this purpose, except as a preliminary guide. Absolute accuracy obtainable: 2½ lbs. in 1000 lbs., and sensitivity: 0.1 lb. per sq.inch. In the absence of a pressure on the well this demonstration was carried out on a large sample of gas at approx. 150 lbs. pressure.

All gauges used in previous closed-in pressure measurements were tested against the dead-weight tester and the mecessary corrections at the significant pressures determined at a temperature of approximately 50° F. It was found that the corrections supplied by the Colliery Company were unreliable.

Results:-

Corrected closed-in pressure when well at 1586' with open hole to 1244', where the 8" casing was set, is 680 lbs. Little reliance can, however, be placed on this figure, as it is based on the memory of Messrs. Falcon and Winter as to what the gauge was reading at the time (640 lbs.) no actual observation having been made. Furthermore, the open hole included the 1248/1279' sand as well as the first 4' of the 1582/1642' sand. There was also an unknown quantity of cavings at the time.

Corrected closed-in pressure when well at 1652' with packer set at 1596' was 615 lbs., the Anglo-American Oil Company's gauge gauge borrowed for this reading proving to be reading 65 lbs. higher. This pressure should be reliable, as it was measured after the well had been flowed and all mud fluid below the packer ejected.

Corrected closed-in pressure of the 1720/1734' sand with the well at a depth of 1758' and the packer set at 1700' is 620 lbs. This was, however, measured before the well was flowed, with certainly mud below the packer and, possibly, up to 40' or so of mud above it. The true pressure would, therefore, probably be something of the order of 30 lbs. more than the observed pressure.

Corrected closed-in pressure of the 1760/1806' sand with the well at a depth of 1806' and the packer set at 1759' is 643 lbs. This should be reliable, as it was measured after flowing the well. The probability is that the pressure of this sand and that of the 1720/1734' sand are the same.

<u>Further action</u>.

(1) Valves temporarily installed on dead weight tester to be replaced by Sunbury Needle valves on arrival. These in turn to be replaced by ¼" Crane Needle valves on arrival (these have been ordered) and Sunbury valves returned to Sunbury (N.F.)

(2) Gauge corrections to be repeated at approx. 70°F for comparison with the corrections at 50°F. (N.F.)

(3) Permanent base to be installed for dead-weight tester with, if possible, levelling arrangements (N.F.)

(4) All future closed-in pressure measurements to be made on well direct by dead-weight tester at any convenient but fixed elevation, which should be reported, the gas being brought to this elevation by means of the high pressure hose supplied. In taking these readings in cases where the time is limited owing to the necessity of pulling out the packer, a graph should always be submitted covering the range of readings before the packer is pulled, in order to ensure that if any slight rise in pressure is still occurring this is known and some estimate of the rate of rise is possible (N.F.).

(5) All closed-in pressure readings to be taken after flow, Specific note to be made as to whether there is still any mud spray in the line. This is best observed not at the flare but by blowing off from a connection in the line, through hose supplied, into a glass container (N.F.)

III. WELLHEAD AND PRODUCTION LINE FLOWING PRESSURES AND GAS PRODUCTION TESTS.

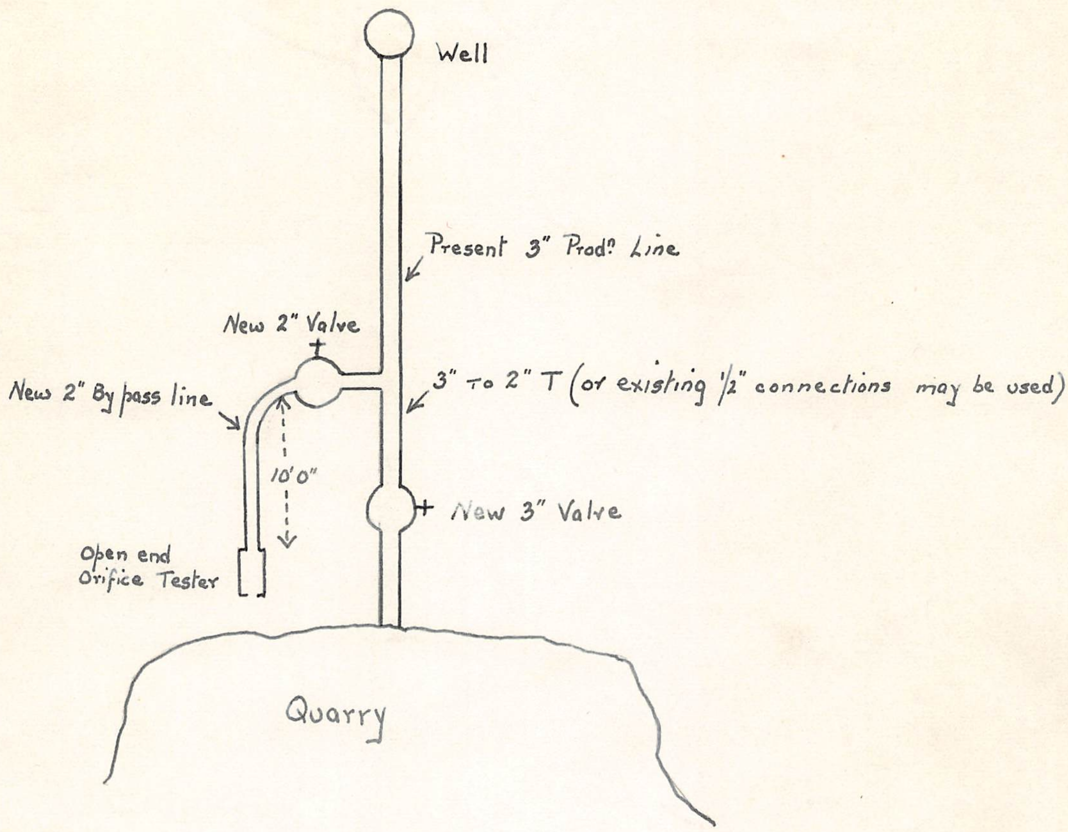
(1) Western gas Chart - based on Oliphants Formula - handed to Mr.Falcon for purposes of preliminary estimates of gas production based on flowing pressure drop through production line.

(2) Flowing pressure measurements to be by either gauge or manometer as convenient. Corrections of gauges used to be determined by dead-weight tester and correct pressuree of previous tests made and revised estimates of production (based on Chart) to be submitted. Accurate observation of wellhead flowing pressure at each production test also essential (N.F.) This has since been done and reported by Mr.Falcon for the 1700-1758' test (with the exception of the wellhead flowing pressure) and for the 1759/1806' test. Similar data still awaited for earlier production tests, including correct wellhead flowing pressures.

(3) Method of determining corrections of gauges at pressures lower than practicable by dead-weight tester explained. This involves the use of tyre pump,and manometer in balance with the pressure gauge. Further Action:- 48" mercury manometer to be supplied (D.C.) Further supply of mercury to be obtained locally (N.F.)

(4) For purposes of accurate calculation of gas productions which will be done in Head Office. flowing temperatures in the line to be observed and reported. For this purpose special ~~type~~ pipe thermometers supplied. Barometric pressure also to be observed and reported. Precise l/d of production line also to be measured and reported (N.F.)

(5) Orifice well tester with full working instructions supplied for measurement of small gas productions where pressure drop through 3" line is anappreciable, and method of use explained. This makes the present 2" and 1" production lines superfluous and they may, if desired, be taken up and in their place a short 2" by-pass installed near the open end of the 3" production line as shown in the sketch below:



(6) To permit attempts at calculation of the bottom-hole flowing pressure during production tests, the size of the drill pipe used always to be reported, and the interval between tool joints. The dimensions (diameter and length) of the bean in the Halliburton flow tester also be measured and reported (N.F.) There does not appear to be a dimensioned drawing of the flow tester in this Office.

1V. <u>MEASUREMENT OF GAS SPECIFIC GRAVITY ON SITE</u>.

Method explained and necessary data supplied. Such measurements are desirable as a routine in order that early information is obtainable regarding any change in the character of the gas in advance of Sunbury's determinations, the results of which would usually be supplied too late for any further tests of a sand to be made should any important changes in the gas occur. Specific Gravity of both the flowing gas on production tests and also of the closed in gas to be determined as a routine and, if any appreciable difference is observed, samples of both to be collected for analysis. <u>Further action</u>:- Supply drying towers and drying agents (D.C.)

V. GAS SAMPLING.

(1) Winchester bottles for gas samples for Petroleum Dept. to be sealed with collodion as well as wax (specified by Petroleum Dept.) as additional precaution against leakage. N.F. to order collodion locallay, cancelling Item 11 of H.O. Indent 475.

(2) When collecting gas samples, gas to be passed through vertical gas-water separator - merely a piece of vertical pipe with gas offtake at top and water offtake at bottom, of which construction to be arranged locally by N.F. This is desirable as it was noticed that a sample at Cousland contained water.

(3) One of the large sample containers ordered by Mr.Seamark from O.W.E. was examined and considered satisfactory. The pressure of this sample, after drawing off a certain amount of gas for dead weight tester demonstration purposes, was 146 lbs. (corrected) at 50° F. and there appeared to be no leak. These containers are, however, too large for routine samples for Sunbury, though very suitable for storage purposes on site, or for sending bulk samples for special investigation.

Further action

(a) Pressure of the sample tested to be re-determined in a week or so to ensure that there is in fact no leakage in these containers, allowance being made for the temperatures of the two tests (N.F.).

(b) Recommended that 5 more of these containers should be ordered for storage purposes, making 8 in all, and that one container full at, say 500 lbs. pressure, of gas from each sand struck should be stored in these at Cousland against possible future demand.

(4) The sample containers at present in routine use were examined and considered unsuitable, partly on account of the type of valve in use and partly because no mechanical protection is provided for this valve in transit. It is also clear that these are unsatisfactory, the last sample having arrived at Sunbury at no pressure. A design is attached for a type of small sample container which it is proposed to order for routine purposes. These will be ordered in two sizes - 2 and 5 litres capacity at atmospheric pressure - both being otherwise the same and capable of withstanding 1500 lbs. test pressure. Normally the 2 litre size will be used for high pressure samples and the 5 litre for low pressure - i.e. flowing - samples. Samples to be sent in duplicate, For Podbielniak analysis

minimum gas requirements are 10 litres, so that a minimum collection pressure of 15 lbs. gauge is desirable for flowing samples in order that each of the two containers sent to Sunbury should contain sufficient gas for a Podbielniak analysis. The 5 litre size of container would, of course, be used if larger samples should for any reason be required. Initially it is proposed to order 12 of each.

Further action:- Order to be placed (D.C.)

(5) Sample containers to be prepared for filling by preliminary heating with primus blow lamp and by evacuation with Geryk vacuum pump supplied, in order to ensure no possibility of contamination; these to be connected to gas supply still under vacuum and to be blown through for some time before sample actually taken.

(6) In despatching samples, a note to be made on the accompanying letter of the correct pressure of the sample when despatched and of the temperature at which the pressure was observed. Sunbury to compare this with the pressure on receipt, making due allowance for temperature, and to report leakage, if any. A note also to be made on the letter of despatch of the condition of the well at the time the sample was collected.

The following points were discussed, and resultant recommendations are given under each heading:-

I. PRODUCTIVE CAPACITY OF INDIVIDUAL SANDS; NECESSITY FOR BOTTOM-HOLE PRESSURE RECORDER.

(1) There is no doubt that very considerable back pressure is being imposed on the sands at any appreciable rate of flow by the ¾" bean in the Halliburton flow tester and by the drill pipe with its enlargement and contraction of section at each joint and still more so at the tool joints, A calculation of the amount of such back pressure is a matter of some difficulty, but it is probably of the order of at least 100 to 200 lbs. at 5 m.cu.ft. per day. A further note on this point will be submitted if any satisfactory results can be calculated. In any case, it is certain that the flush production of wells would be very much more through casing, though not necessarily the sustained production rate, which can only be ascertained by a long production test. The only satisfactory method of measuring the bottom-hole pressure drop is by inserting a bottom

hole pressure recorder in the anchor pipe of the flow tester, and it is recommended that an Amerada instrument should be purchased for this purpose. Enquiries will be made as to specification and cost; an approximate figure of £300-£400 may be taken for purposes of making a decision. The A.I.O.C. bottom hole pressure recorder, though more accurate than the Amerada, would be useless for this purpose, as it is only a single reading instrument. A recording instrument would also have the following advantages:-

(a) that it will give a true picture of the success or otherwise of the shut off of the packer.

(b) that it may be left in site during successive tests at definite rates of flow, whether through casing or through a packer, whereas the A.I.O.C. instrument could not be used with a packer and in casing would have to be withdrawn for reading between each rate of flow.

The construction of a bottom hole differential pressure/production curve for each sand will enable accurate estimates of flush production capacity to be made and provide reliable data on the comparative permeability of the different sands struck.

(2) In the meantime, more information on the productive capacity of the sands than can be obtained from a production test at one flowing pressure would be obtainable by testing the production of each sand at varying wellhead flowing pressures, and it is recommended that this should be done as far as is practicable within the time imposed by the necessity of avoiding any danger of freezing the packer, this being a matter for decision by the Drilling Superintend.

(3) It is also recommended that the next sand struck should be tested with two sizes of pilot hole, the initial pilot hole being reamed to a larger size between the first and second tests. (It is not practicable to ream the pilot hole to full hole between first & second tests, as a packer test in full hole would involve some risk of a fishing job). The results of such successive tests would provide some data as to the extent to which production is dependent on the area of sand exposed and on the permeability of the sand.

II. <u>POROSITY AND PERMEABILITY TEST OF SANDS</u>.

It would appear deirable that porosity and permeability tests of each sand penetrated should be carried out on site, as a great deal depends on the discretion of the resident staff in such tests and their familiarity with the samples. Such work would not, however, be practicable unless or until the present staff is augmented.

III. CORRELATION OF SANDS.

In view of pressure results to-date, it would appear that pressures may not be much help in the reliable correlation of the sands, though opinion on this point is reserved until further accurate dead-weight tester observations of closed in pressures have been taken. It is also understood that there is considerable difficulty in confident geological correlation of the sands from the Anglo American well to our well. Under these conditions, a Schlumberger survey may be of great assistance, and it is recommended that this should be made on the present well before the next string of casing is run and on the next well to bedrilled. If any reasonable correlation is obtained between Schlumberger results and coring results on our two wells to the Anglo American well, it might indeed prove possible to dispense with coring altogether on further wells and rely entirely on Schlumberger correlation. Although no scope can be seen for the application of the Schlumberger methods in our Iranian Limestone fields, it does seem that the conditions of multiple sands which ~~often~~ obtain at Cousland are precisely those under which their methods have proved most successful.

IV. FINAL PROGRAMME ON COMPLETION OF WELL.

This was discussed, but it must be to a large extent dependent on the number, if any, of further sands struck, and their contents, Mr.Taitt's suggestion of running a string of casing to bottom and gun-perforating and re-testing the successive sands proved would appear to be the most reasonable. If no further sands are proved, a packer could be run in the casing, and the main upper sand from 1582/1642 conserved in the annular space, and the two lower sands 1720/34 and 1760/1806, treated as one sand - their pressures being approximately the same - and produced through the packer. Should a number of new sands be proved with varying reservoir pressures, it might be possible to test sands individually by means of a double wall packer. The design of such a packer has already been considered by Mr.Seamark for use in Iran..

V. PETROLEUM ENGINEERING ACCOMMODATION AND STAFF.

It is quite clear that, even with the equipment already supplied, Mr. Falcon's accommodation is very much overcrowded, and it will be essential to erect a small Petroleum Engineering Lab. and Store. Two rooms are required, the Laboratory for office and precise instrumental work, and the Store for dirty work, bins, samples etc. The present General Store is already overcrowded and leaks very badly, which is undesirable with precise instruments, and, in any case, in our experience it is better to keep Petroleum Engineering apparatus out of a general store, otherwise it gets mishandled or used for purposes for which it is not intended.

As regards staff, Mr.Falcon will be able to carry out any Petroleum Engineering work at present necessary, but, should it be decided to carry out porosity and permeability measurements on site, or should oil be struck, he will certainly require assistance. In the latter event, a Petroleum Engineer would be essential. In any case, it is now clear that a man with either Petroleum Engineering or Production experience - preferably both - will eventually be required on this field, as, even if oil is not found, there is no question but that commercial gas has already been proved. It is, therefore, recommended that steps should be taken to allocate such a man to this work although there is no immediate urgency. In the early stages of the field this need not necessarily be a full - time job; he could be based on this Office, where there is plenty of work to keep him employed, and pay extended visits to Cousland as and when necessary until such time as it is obvious that he should be resident there. This proposal has the advantage that the man responsible for the development of production arrangements - which will be comparatively simple - and reservoir control in this field would be familiar with it from its beginning .

Sgd. D.Comins.

25th May, 1938.

COUSLAND : RESERVOIR EQUILIBRIUM CALCULATIONS.

I. BASIC DATA.

(a) Calculation of Reservoir Pressures and pressure/ft. of reservoir gas in the 1580 foot gas sand and the 1720 foot gas sand.

Data - C.P. at 1632' test was 680 # gauge = 695 # Abs.

C.P. at 1734' " " 580 # " = 595 # Abs.

Pressure #/ft. (at assumed Temp. 90°F)

For 695 # $= \frac{.072 \times .58 \times 695}{144 \times 14.7 \times D}$

$D = 1 - \frac{.18 \times 695}{1470} = 1 - .085 = .915$

∴ Pressure #/ft. = .015 # →

∴ R.P. at 1580' = 695 + 1580 x .015

10565
1580
8985

= 695 + 24 = 719 # Abs. →

15
704

For 595 # $= \frac{.072 \times .58 \times 595}{144 \times 14.7 \times D}$

$D = 1 - \frac{.18 \times 595}{1470} = 1 - .0728 = .927$

∴ Pressure #/ft. = .0127 # = .013 (say) →

∴ Pressure at 1720' = 595 + 1720 x .013

10565
1720
8845

= 595 + 22 = 617 # Abs. →

15
602

(b) Water - Assume pressure/ft. between limits of 0.45 and 0.50 #

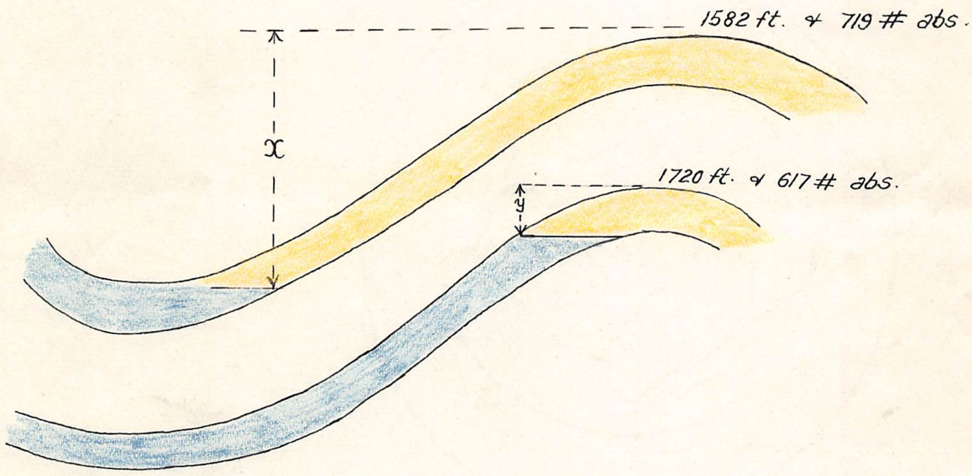
Reservoir Crude (if any) Assume pressure/ft. 0.35 #

II. Now assuming a common water table in the two sands the lower pressure in the lower one may be accounted for by either:-

(a) a longer column of gas in the upper sand than in the lower one.

(b) a longer column of oil in the lower sand than in the upper one.

III. Calculation of (a)



Let x be depth of gas column in upper sand below 1582 ft.

" y " " " " " " lower " " 1720 ft.

Consider equilibrium at gas : water level in the lower sand.

(a) On basis of water 0.45 #/ft.

Pressure calculated from upper sand data :-

$= 719 + .015x - 0.45 \left[x - y - (1720 - 1582)\right]$

$= 719 + .015x - 0.45x + 0.45y + 0.45 \times 138$

$= 781 - 0.435x + 0.45y \longrightarrow (1)$

and from lower sand data

$= 617 + .013y$ ——→ (2)

$\therefore 617 + .013y = 781 - 0.435x + 0.45y$

$\therefore .435x - .437y = 164$

i.e. roughly $x - y = \frac{164}{.435}$ = roughly 380 ft.

and if $y = 0$ this is precise

(b) Repeating on basis of water 0.5 #/ft.

$617 + .013y = 719 + .015x - 0.5x + 0.5y + 0.5 \times 138$

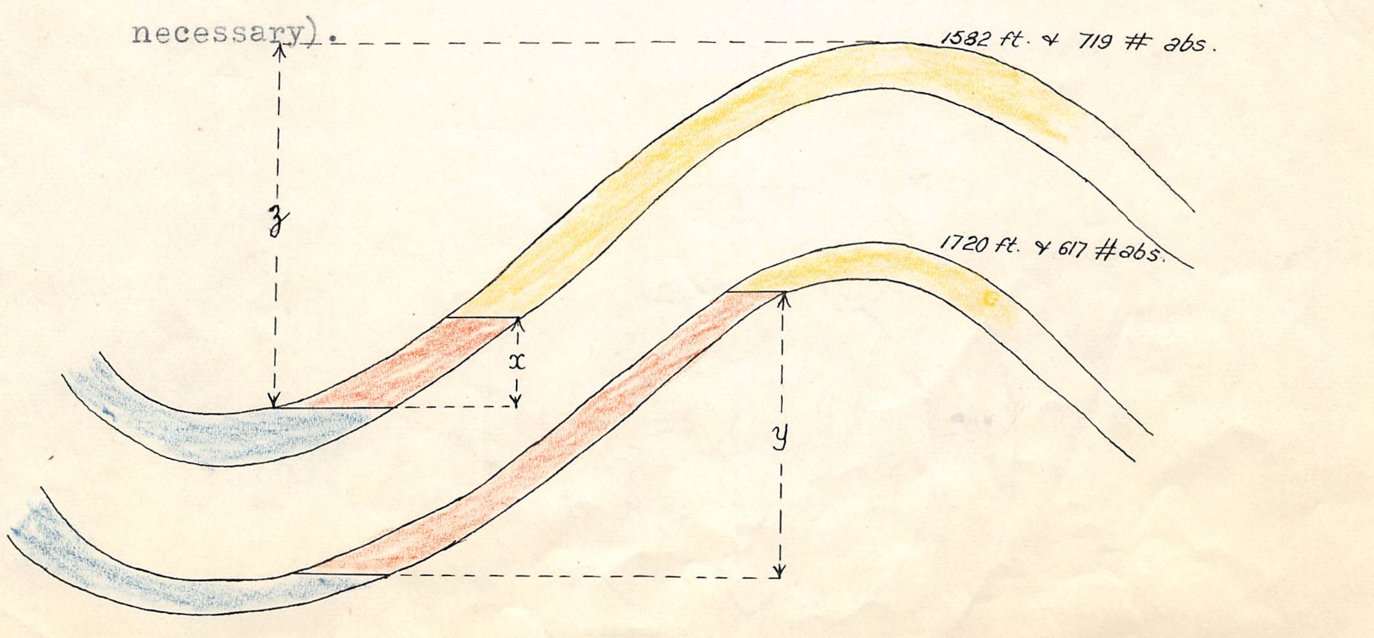
$\therefore .485x - .487y = 171$

i.e. roughly $x - y = \frac{171}{.485}$ = roughly 350 ft.

and if $y = 0$ this is precise.

IV. Calculation of (b).

For the calculation it is necessary to assume that oil : water level is at closure in each sand - a reasonable assumption. (No assumption regarding the depth of closure is however necessary).



Consider equilibrium at oil : water level in the lower sand.

1. <u>On basis of water pressure 0.45 #/ft.</u>

Pressure from upper sand data

= 719 + .015(z - x) + .35x + 0.45 (1720 - 1582)

= 719 + .015 z + .335x + 62

= 781 + .015 z + .335x ⟶

and from lower sand data

= 617 + .013(z - y) + .35y ⟶

= 617 + .013 z + .337 y

∴

∴ 617 + .013z + .337y = 781 + .015z + .335x

∴ .337y - .335x = 164 + .002z

∴ roughly y - x $= \frac{164}{.337} + \frac{.002z}{.337}$

= roughly 490 ft. + .006z

Now .006z is so small that it may be ignored (even if z was 1000 ft as compared with about 400 ft. geologically expected .006z would only be 6 ft.)

If x = o y = 490 ft. say, 500 ft. ⟶

2. <u>On basis of water pressure 0.5 #/ft.</u>

Then 719 + .015 z + .335x + 0.5 (1720 - 1582)

= 617 + .013 z + .337 y

∴ .337y- .335x = 171 + .002z

and roughly y - x $= \frac{171}{.337} + \frac{.002}{.337}$ z = roughly 510 ft.

if x = 0 y = 510 ft. say 500 ft. ⟶

D. COMINS.

A251—C.10.37.

WK/Scot/T.3.

Copy

From MR. A.H. TAITT.

To MR. B.R. JACKSON via CHIEF GEOLOGIST.

Our Ref.

Your Ref.

Date 13th May, 1938.

Subject COUSLAND FURTHER LOCATIONS.

STRUCTURAL CONTOUR MAP.

Accompanying this note is a Structural Contour Map of the Cousland and adjoining structures on the scale of 6" to 1 mile. This map differs in detail from that drawn by Allison. The principal reasons that have necessitated this modification are:-

(1) Information from Cousland No.1 and Midlothian No.1.

(2) Borehole information obtained from manuscripts in the Geological Survey Offices in Edinburgh. The most important of these relate to the synclinal area between the Cousland and Carberry Hill crest maxima.

(3) Unless evidence has been obtained to the contrary, the Sections drawn by the Survey to illustrate the model in Edinburgh Museum and reproduced in Allison's Report, have been assumed to be a true representation of structure and have been used as a basis for the structural map.

(4) It is considered that where the Lower Limestone Group reaches the surface it will have an effect on the topography, (this effect is very marked at Cousland, D'Arcy and Chalkieside) and it is assumed that Carberry Hill and Falside Hill are topographic expressions of the structures of the underlying Lower Limestone Group.

Too great reliance cannot however be placed on the map as the area generally is drift covered and exposures rare. Correlation between widely spaced and even between neighbouring boreholes is difficult, and the thickness variations of the measures between the coals of the Edge Coal Group from one locality to another are by no means negligible.

Correlation between the strata penetrated in Cousland No.1 and D'Arcy No.1 has proved a marked thinning northwards of the Oil Shale Group accompanied by an increase in arenaceous sediments. The structural effect of this thinning has been to make the formation in Cousland No.1 at a depth of 1250 ft. some 370 ft. higher than its equivalent in the D'Arcy boring, and not as the contour map would indicate 200 ft. lower. It is not practicable however at the present stage of our knowledge to draw contours on any particular horizons in the Oil Shale Group, such contours would be too speculative to be of any value.

LOCATIONS.

A production of 4,000,000 cubic ft/day of gas has been proved at Cousland from the 1582-1642 Sandstone zone only part of which has been tested. A further 2 to 3 million cubic feet/day is to be expected from the untested very permeable sand between 1586 and 1596 feet. It is not known however whether this is a dome gas associated with oil accumulation or whether it is part of a gas accumulation only and whichever is the case the extent of the field is unknown. Further wells will have to be drilled to elucidate these points.

New locations can be separated into two categories:-

(1) Exploitation wells drilled as near as possible to the Discovery well but located so as to give maximum information of the fluid content of the reservoir

and (2) Exploration wells drilled as far as possible, consistent with the objective of being potential producers from the Discovery well to obtain maximum stratigraphical and structural information of the field.

It is not easy to arrive at an estimate of the gas column or of the elevation of oil/water level in the field. The effective closure of the structure on the top of the Calciferous Sandstone Series is the 99-100 contour i.e.

300' to 400' below the Cousland crest, but it is to be expected that this limiting closure improves with depth owing to the thinning northwards of the strata.

The following data are available as to oil/water and gas/oil levels

Cousland No.1.		D'Arcy No.1.	
1188' gas	=	1660' salt water	280 ft. structurally lower.
1248' gas	=	1810' oil	370 ft structurally lower
1590' gas	=	? 2000' gas (Midlothian)	200ft. structurally lower

This data is very meagre but indicates that a gas column of over 200 ft. but under 370 ft. is to be anticipated in the 1582' - 1642' sand and therefore that the optimum position for a potential oil producer would be from 250 to 300 ft. below the crest of the structure.

LOCATION A. (see accompanying map).

Location A satisfies as far as is possible the conditions of an Exploitation Well, being 250' to 300' below the presumed crest of the structure and as close as such a control permits to Cousland No.1.

The structure between Cousland No.1 and Location A is fairly well controlled by outcropping limestones and by recent borings and since the distance between the two is only ½ mile it is not anticipated that there will be any great change in the development of the Oil Shale Group.

LOCATION B.

Location B has been selected as one that will give reasonable chances of being a producing well but will at the same time give valuable information on the development of the Oil Shale Group northwards and also on the potential value of the extensive area covered by the Carberry Hill and Falside Hill crest maxima.

If only one well is to be drilled initially I feel that Location A should be given priority as being the one that is the more likely to produce oil. It is strongly urged, however, that a second drilling outfit is obtained so as to accelerate the putting of the field on to a production basis whether for oil or gas.

(Sgd.) A.H. TAITT.

uk/Scot./Geological

S.O., LTD.

Memorandum.

From Mr.N.L.Falcon

To Mr.A.H.Taitt, A.T.
London

Our Ref. Your Ref. Date May 3rd. 1938.

A.ALLISONS CONTOUR MAP OF COUSLAND/D'ARCY ANTICLINE

On page 7 of his report on the Cousland/D'Arcy structure Allison states that he constructed his contour map in the Cousland region taking the thickness from the top of No.2 Limestone to the base of No.1 Limestone as 160' (from the section on H.M. Survey 6" sheet V111 S.E.) We now know that the thickness should be 277'.

This alteration makes the Survey estimate of 1000' for the height of the Great Seam above the top of the Calciferous Sandstone very nearly correct. Allison took this height as 900' in the Cousland region, so all his contours here are 100' too high.

The thickness of 277' is worked out as follows:-

No.2 Limestone	101'(in Easter Cowden bore)
Sandstones	100'(at Cousland)
No.1 Limestone	76'(at Cousland)

Cousland which started in No.2 Limestone, had 64' of it. A 1' 4" Coal seam in the Easter Cowden bore 15' below the base of No.2 Limestone correlates with the Cousland 82/84'coal, which is 18' below No.2 Limestone(the 102/05' Cousland coal is not developed in this bore).

The D'Arcy well drilled through 162'* of beds before reaching the Calciferous Sandstone series although it started below No.2 Limestone, thus confirming the greater thickness.
The 6" Survey sections show variable thickness for the strata including No.1 and No.2 Limestones, but usually well over 200'.

N. L. Falcon.

* Midlothian had 173'

Dr Lees ✓

no amendments.

approved by P. de H. H. for J.B.

[illegible]

2/5

Mr Tait A.S.

please return to Falcon

[illegible]

Returned 4/5.

A249/6931—C.10.36

Memorandum

From RESIDENT GEOLOGIST, COUSLAND, DALKEITH.

To MR. A. H. TAITT, D'ARCY EXPLORATION CO., LONDON.

Our Ref.

Your Ref.

Date 25th April, 1938.

Subject H.M. GEOLOGICAL SURVEY'S PAPER ON COUSLAND CORES FOR THE GLASGOW CONFERENCE ON SHALE AND CANNEL COAL.

Dr. Simpson has asked me to send on this draft of the paper to Dr. Lees. If any corrections are considered necessary they should be forwarded to H.M. Survey, Southpark, Grange Terrace, Edinburgh, as soon as possible. The publication of a paper on these lines was agreed upon when Dr. Lees visited Scotland at the end of last year.

I have read the draft and made two small alterations in pencil.

The Company have not been mentioned presumably because the paper will immediately follow Dr. Lees contribution on the Search for Oil in Scotland.

N. Falcon.

Encl;

A251—C.10.37.

Copy sent to R. Falcon
18/2/38

Copy

From MR.A.H. TAITT.

To MR.B.R.JACKSON.
MR.B.K.N.WYLLIE.

Our Ref. Your Ref. Date 15th February,1938.

Subject FURTHER DRILLING AT COUSLAND.

Cousland No.1 at 1400 ft. has already encountered two zones, 1188'-1209' and 1248'-1279', the cores from which were saturated with oil and which on test have produced 20,000 and 30,000 cubic feet of gas per day respectively, apart from these, higher sandstones were oil impregnated but have either failed to produce any fluid or have produced only water. Of the latter series the zone between 907 and 938 ft. was on core evidence the most impressive but no production at all was obtained during a packer test. Thus in the top 1038 ft. of the Oil Shale Group penetrated at Cousland, 3 major zones of oil impregnated sandstone, totalling 83 ft. have been encountered and from these 50,000 cubic ft. of gas/day have been produced, but no fluid.

At D'Arcy, the Anglo-American Oil Company encountered gas with a production of approximately 1½ million cubic feet/day from thin sandstones at about 1950 ft. from surface, this zone has not yet been reached at Cousland.

The old D'Arcy well drilled by Pearsons obtained a production of some 7 tons of oil from a sand at 1810 ft. from surface.

Oil indications therefore in the Cousland area are by no means unimpressive, but a complication has been introduced by the proved thinning of the Oil Shale Group from D'Arcy to Cousland. The effect of this thinning has been to improve the structural position of the Cousland well relative to D'Arcy in that the 1752' ostracod limestone of D'Arcy is almost certainly to be correlated with the 1228 ft.horizon of Cousland i.e. making allowance for the difference in surface elevation, at a depth of 1300 ft. the Cousland dome is some 300 ft. higher structurally than D'Arcy, but we have no evidence of the direction of maximum thinning. It is possible that the small Chalkie side dome west of Cousland or the Carberry Hill structure to the N.W. are still higher structurally. Due to thinning of the whole group pinching out of individual sands is probable and such a pinching out will control accumulation irrespective of structural position. Again in an area of such unstable deposition it is probable that the porosity or more important, the permeability, of individual sands will be variable. Accumulation and/or productivity will be largely influenced by this control.

We have therefore in the Cousland area 3, as yet, unknown factors apart from surface structure, all or any of which are liable to influence the accumulation of oil.

(1) the position of the subsurface crestal area

(2) the position at which individual oil sands pinch out

and

(3) porosity control of accumulation.

These three factors are in themselves sufficient to justify the location of at least one more well in the Cousland area and the indications of petroleum briefly summarised above make the drilling of further wells a necessity before the potentialities of the area can be said to have been fully tested.

Testing results have so far been far from satisfactory or convincing

(1) the 907-938 ft. sand, cores of which were strongly impregnated and the porosity of which was more than 10%, gave no production at all on test. It was assumed that this was due to lack of pressure in the formation.

(2) the 1188'-1209' sand, cores of which were also oil impregnated and of fair porosity gave only gas without a trace of oil on test. It is of particular interest that although the maximum closed in pressure was over 450 lbs/sq.ins., and the sands from core evidence were of fair porosity, the production was only approximately 20,000 cubic feet/day.

(3) the 1248'-1279' sand. The cores of this sand were in part strongly impregnated with oil which although waxy contained a fair proportion of lighter fractions and the porosity of the sand varied from 18-23%. When tested, exhaustively by bailing, washing and cleaning with solvents only 30,000 cubic ft/day of gas with a total of 3 gallons of oil were produced. The pressure of this show is not known but it is more than 150 lbs/ sq.ins. and it is unlikely to be appreciably less than that of the 1188'-1209' sand.

The poor results obtained may be due in part to semi-permanent mudding off of potentially productive zones, a factor that can only be eliminated by using some special flush, e.g. oil, by controlled circulation or by drilling with a cable tool outfit. It is significant that the D'Arcy well produced some oil, admittedly not a greatquantity, from the 1810' sand which is probably at the same horizon as our 1248'-1279' zone.

I would therefore recommend that any further wells drilled at Cousland be drilled, at least through the more potentially productive zones of the Oil Shale Group, with Cable Tools. Drilling with Cable Tools would also remove the principal causes of slow progress, the necessity for continuous coring and frequent testing.

(Sgd.) A.H. TAITT.

File

23rd December, 1937.

COUSLAND WELL : ESTIMATE OF GAS PRODUCTION CAPACITY.

Data.

"Pressure in inches water 278 feet from end one inch flow line 18.75 temperature 4=1/2 centigrade 18 ft from end 0.85 ins and 4 centigrade closed in pressure maximum recorded 450 probable maximum about 650 details follow = Falcon."

Oliphant Formula.

Q in c.ft./hr = $42a\sqrt{\frac{P1^2 - P2^2}{L}}$ for gas of sp.gr. 0.6

a = 1.0 for 1" pipe.

L = 278 - 18 = 260 ft. = $\frac{260}{5280}$ = 0.04925 miles.

P1 = Barometric Pressure (unrecorded) say 14.4# at elevation of well, 560', + 18.75" water measured at say 40°F.

= 14.4 + 18.75 x .0361
= 14.4 + 0.676 = 15.076#.

P2 = Barometric Pressure say 14.4# + 0.85" water measured at say 40°F.

= 14.4 + 0.85 x .0361
= 14.4 + 0.031 = 14.431#

∴ Q in c.ft./hr. = $42\sqrt{\frac{15.076^2 - 14.431^2}{0.04925}}$

= $42\sqrt{\frac{227.2 - 208.2}{0.04925}}$

∴ Q_o in c.ft./hr. = $42\sqrt{\frac{19}{.04925}}$

= $42\sqrt{385.8}$ = 42 x 19.64

= 824.2

and Q_o in c.ft./24 hrs. = 24 x 824.2

= 19,800 ⟶

Temperature Correction.

Average temperature of flowing gas

$= 4.25^oC. = 40^oF. = 500^oF.$abs.

$\therefore Q_o = 19800 \times \sqrt{\frac{520}{500}} = 20,200$, say, 20,000.

Sp.Gr. Correction.

For example, if sp.gr. was 1.0 instead of the figure of 0.6 assumed in the formula, the volume would be $20,200 \times \sqrt{\frac{.6}{1.0}}$

$= 20,200 \times 0.774$

$= 15,650$ c.ft./day.

= say, 16,000

Molesworth Formula (Probably more accurate for the very low pressure drop in this case.)

$$Q \text{ c.ft./hr.} = 1732 \sqrt{\frac{d^5 h}{Gl}}$$

Where d = 1.0 inches.
h = pressure drop in inches of water = 18.75 - 0.85 = 17.9"
G = 0.6
l = 260 feet.

$$\therefore Q_o \text{ c.ft./day} = 1732 \times 24 \sqrt{\frac{17.9}{0.6 \times 260}}$$

$= 41550 \sqrt{0.1148}$

$= 41550 \times 0.3385$

$= 14,050$ c.ft./day ⟶

Temperature Correction.

$= 14050 \times \sqrt{\frac{520}{500}} = 14300.$

Sp.Gr. Correction.

If sp.gr. was 1.0 volume would be $14300 \times \sqrt{\frac{.6}{1.0}} = 14300 \times .774$

= roughly 11,000 c.ft./day.

Conclusion.

By Oliphant Formula Production between 15,000 and 20,000 depending on the specific gravity of the gas which has still to be measured at Sunbury and by Molesworth Formula, which is probably more accurate for the very low pressure drop in this case, between 10,000 and 15,000 c.ft./day.

A round figure of 15,000 c.ft./day is, therefore, a reasonable estimate on present data.

UK/N/12

5th October 1936.

Dear Allison,

I am forwarding herewith a letter to you from Dr. Mac Gregor which your father kindly sent on to us. We have retained a copy for our files.

Yours sincerely,

(Sgd.) P. T. COX.

Dr.A.Allison,
Masjid-i-Sulaiman.

5th October, 1936.

A.Allison Esq.,
"Gleniffer Cottage",
Barbreck,
By Lochgilphead,
A R G Y L L.

Dear Sir,

In reply to your letter of 3rd October, I acknowledge receipt of the letter from Dr. MacGregor addressed to your son and thank you for forwarding it to us.

Yours faithfully,
For ANGLO-IRANIAN OIL COMPANY LIMITED.,

(Sgd.) P. T. COX.

For CHIEF GEOLOGIST.

RECEIVE[D]
-5 OCT 36

Gleniffer Cottage
Barbreck.
By Lochgilphead
Argyll.
3rd Oct. '36.

The Chief Geologist
Anglo Iranian Oil Co. Ltd.,
Britannic House.
Finsbury Circus
London. E.C.2.

Dear Sir,

My son, Dr A. Allison, before his departure from here a week ago, left instructions that any communications for him from Dr. Murray MacGregor of the Scottish Survey Office, which arrived here after he had gone back to Iran, should be posted direct to you. I accordingly enclose herewith a letter from Dr MacGregor which was delivered here yesterday.

If you will kindly acknowledge receipt by postcard I shall be greatly obliged

Yours v. sincerely
Arch: Allison (Senr).

C O P Y.

UK/IV/12

Geological Survey of Gt.Britain.
(Scottish Office),
Southpark,
19, Grange Terrace,
EDINBURGH.

30. 9. 36.

Dear Allison,

I have been away a good deal lately and have been also flooded out with visitors from the Geodesy and Geophysics Assembly meeting here and with enquiries by various members. I should have written you before but I wanted to look into the question you raise.

It just amounts to this that we really do not have the information necessary to make definite correlation of the horizons met with in the D'Arcy Bore. The material from it came up as sludge and we had no chance, therefore, of receiving a really satisfactory record. I am not willing to attempt correlating with the very full sequence at   and

Certainly it would be somewhat rash to use the Entomostraca in the limestones at 1147-1187 ft. at D'Arcy as a basis for correlating them with the Burdichowse. Any correlation made on the information available is, I am afraid, speculative.

Yours sincerely,

(Sgd.) D. MACGREGOR.

File - Scotland Geological

C O P Y.

GEOLOGICAL SURVEY OF GREAT BRITAIN,

(Scottish Office),

Southpark,

19, Grange Terrace,

Telephone: 42726. Edinburgh.

21. 9. 36.

Dear Allison,

Fakes is an old Scottish mining term used for beds intermediate between sandstone and mudstone. It is defined as a laminated or thin-bedded impure argillaceous sandstone passing on one hand into sandstone through faky sandstone and on other hand through faky blaes into blaes (or mudstone). Kingle (or Kennel) is a very hard pure sandstone usually with a siliceous cement. In terms of composition you might arrange our main Carboniferous sediments roughly in following order :-

Arenaceous	Hard siliceous sandstone or kingle. Sandstone. Faky sandstone, mainly arenaceous.
Intermediate	Fakes. Faky blaes.
Argillaceous	Blaes or mudstone. Fireclay.

Daugh is just a soft, coaly fireclay especially where found in association with a coal, thus a soft coaly fireclay below a coal or occurring as a parting in a coal is generally spoken of as daugh.

I hope you are enjoying your visit to Lochgiefhead.

Yours sincerely,

(Sgd.) M. Macgregor.

Dr Lees Circ
Mr Cox P.ll
File

Miss Hartley

Gleniffer Cott
Barbreck
Lochgilphead
Argyll

21st Sept. 36.

[...]cy Exploration Co Ltd.
London

I am sending by registered post in this mail a copy of my report on Cousland, contour map of the area, table of sections, together with B.K.N. Wyllie's Report, & all the six-inch & one inch maps used by me, also three memoirs viz "Oil-Shales of the Lothians", "Neighbourhood of Edinburgh", "Geology of East Lothian", and [Re]gional Memoir "Midland Valley of Scotland."

Arch: Allison

Dr Lees / Comt
Mr Mayhew
File

Gleniffer Cott
Barbreck
Lochgilphead
Argyll 14.9.36.

To P. T. Cox Esq.
Anglo-Iranian Oil Co Ltd.
London.

I wish to inform you that until further notice my address will be as above.

During the last week I regret that I contracted a severe abscess on my left hand. It is now getting better, but I have been under medical supervision all week, & have made practically no progress with work on my report. Mapping was hopeless, for I tried.

It is all very unfortunate, but I feel quite all right now & am getting something done.

A. Allison

Progress Rept. Dr Lees
Mr Wyllie
Cox
→ file

To D'Arcy Exploration Co. Ltd

7. 9/36

Report for week ending 5th Sept. on Cousland Area.

During the week I checked up various small points in the six inch mapping of the area, around Cousland & D'Arcy, & could not find any glaring faults in interpretation. I collected some further information from a colliery on the N.W. side of the saddle between Cousland & D'Arcy, which helped to trace the outcrop of the Parrot Coal, & verified the absence of any major faulting at that place. This was one of the few places where information was lacking, since the coal was not worked there previous to the making of the original maps.

Towards the end of the week I paid a visit to the Scottish Museum in Edinburgh, & to the Geol. Survey Offices also in Edinburgh. On the original six-inch maps five lines of section have been drawn across the map [illegible] the Cousland — D'Arcy structures at the one end, & continuing across to the N.W., to the Pentland Fault. These sections are shewn, in the Scottish Museum, on the scale 9" = 1m. There is also a solid block model of part of the area, in this museum, on the scale 6" = 1m. Both model & sections end at the edge of the Edinburgh Geol. Sheet (1" = 1mile), & have been drawn with the object of displaying the structure of the

Mid-Lothian Coal Basin, which is the synclinal structure lying between the Cousland-D'Arcy anticline, & the Pentland Fault.

At H.M. Geol. Survey Office Edinburgh, I found that the original six-inch sections, referred to above, were available, & were produced to me later by Dr MacGregor (Scottish Director). I obtained permission to make rough copies of these for reference purposes in my own work. Full copies of these sections can be obtained from the Survey, at a cost of a few pounds, corresponding to Draughtsmans time etc. for copying. It might be of service to the Co. to have these, though my ~~work~~ report should cover, what these sections show, more completely.

While at the Survey Office I had interviews with Dr Richie, Dr MacGregor, & Mr Tate. Dr Richie worked out (circa 1927) a correlation of the limestones exposed on the east of the Mid-Lothian Coal field, with those on the west. Dr MacGregor was able to inform me, & verify by personal opinion, that it had not been found possible so far to correlate the Oil Shale Series of the Calciferous Sst. of Mid Lothian, with any part of the series exposed in East Lothian (i.e. in the Haddington district), or east of the Cousland-D'Arcy anticline. Thus the Cousland-D'Arcy anticline lies in a region where the character of the Calcif. Sst. is changing. Dr MacGregor & Dr Richie recalled that Mr Tate had not been able to correlate the material in the D'Arcy bore, with the Midlothian sections. I was fortunate to meet Mr Tate, who was a Survey collector, now retired, & who used to visit the D'Arcy bore when it was in operation for the purpose of collecting samples. According to Tate, cable tools were used. There was caving at certain parts, & the record of the well is not good. Tate was not able to pick up the Burdiehouse horizon, & he does not know the horizon of the oil sand at the base of the well. In view of the thinning of the Carb. Lst. Series above, & the Calcif. Sst. below, towards the east, & south east, this basal sst. may be the Granton Sst., but that is purely a hazard. Also there is a marine Lst. in the well, which suggests the whole series is more akin to the succession in Fife, or near Dunbar.

A boring log of the D'Arcy well, drawn up by Mr Tate is available for copying in the Edinburgh Survey Office, if the Co. should desire same.

My report on the area is now underway & should be available in from ten to fourteen days at most.

A. Allison

Mr Wyllie forward N/12
" Mayhew
File

PM
31/8

c/o Blair
3 East Saltoun
Pencaitland
East Lothian

24th Aug. 36.

D[ear] P.T.C.

The following is a summary of the work done by me during the last week.

I have visited various exposures of the lower lsts. of the Carb. Lst. Gp., corresponding to the lsts at Cousland, in the neighbourhood of Haddington, East Salton, & Borthwick. Most of these outcrops are isolated quarry sections in either of the lsts at the base of the group. They all have certain points of resemblance, being creamy on weathered surface, & blue on fresh surface. Crinoids are the commonest & most universal fossil, but brachiopods e.g. Productus sp. are fairly common in certain instances. It is clear that these lsts underlie the coals which are worked further to the east. Unfortunately it is not at all clear however what series of rocks underlie the lst. group. Continuous sequences from the lsts down into the Calciferous sst. series, in the vicinity of Haddington (S, & S.E.) are not found. Outcrops of sandstone are quite common, either white or red stained, but none with the oily appearance of the ssts. at Hopetoun. There is one limestone horizon, the Sandersdean lst, which has been picked up at more than one point & is quite recognisable. Its exact position below the Lst. Gp. however is not known. In short there are no good exposures of the Calciferous Sst. in the region between Haddington S.E. to Borthwick.

I have been able to obtain the following information about Cousland which may be of use in the ~~futer~~ future, should the Company decide to drill. The owner, or rather the tenant of the land, on which a location might reasonably be made at Cousland, is Mr Mercer of Southfield, Dalkeith. His landlord is the Earl of Stair whose factor is Mr Robt. Smith, Cranstoun Riddel, Pathhead, East Lothian. The Earl of Stair's land includes most of the Cousland dome, from the railway just north of Cousland, to the edge of the license area. I understand that the structures to the north are in land belonging to Lord Elphinstone, whose factor is Mr Redmond Crossgatehall, Dalkeith. The small dome of Chalkieside east of Cousland is I understand in land belonging to the Duke of Buccleuch. I have visited Mr Robt. Smith only in person. The latter informed me that the biggest fear he had was that drilling would destroy the watersupply of the area around Cousland. Water is apparently derived from wells in the 1st. or below it, by pumping. If the water supply was lost the area would be very badly affected, & Smith stressed the necessity of the suppy not being destroyed. I made no statement one way or another, but you can pass the information on to those concerned.

As to the quarries at Cousland. They belong to the Portland Cement Co. all right. The latter still pay a rental to the Earl of Stair. Their lease however expires in seven years time, & Smith thought the Co. had no interest whatever in the area now. Presumably the rental is being paid under the terms of the lease therefore, & not because the Co. wish to do so.

The above address will be of service for at least another week from now.

Ys.

A. Allison

Mr Mayhew
4 & file

Reply sent PM 18/8

UK/N/12

c/o Blair
3 East Salton
Pencaitland
East Lothian
18.8.36.

Dear P.T.C.

I managed to get a room here last Wednesday after searching far & wide for a better & more convenient place to stay than in Edinburgh. The place is fairly close to Haddington, & as central as any place can be for the Cousland area, which after all, is apparently going to include places as far apart as the Forth Bridge & North Berwick.

In the time I've been here I've visited exposures of the Longcraigs Lst at Aberlady & Longniddry. This is in the Lower Lst. Group, near the base apparently i.e. just above the Oil Shale Series. The shore section is complicated by small faults & folds. I have also visited exposures of the Cousland Lst in quarry sections around Cousland, & sections of the Calciferous Sst. Group near Aberlady & in the Bilston Burn near Loanhead. So far this has had little more effect than to familiarise me with the types of rock met with in the area, but has not enabled me to appreciate any of the correlations made in the mapping.

I have now procured the Memoirs on the Edinburgh District & on East Lothian. I hope by their help to understand a little more of the reason why certain correlations & assumptions have been made, & also by visiting the type sections to get some inside knowledge of the geology of the district. At the moment I find that it is the basic principles behind the whole which evades me.

I enquired of the tenant of the field with the water tank at Couslands, if he knew who had worked the quarries there, & also who was his landlord. The landlord is the Earl of Stair. The quarries were worked by the Portland Cement Co. & according to the tenant of Southfield to whom I spoke, the quarries are still on lease to the Co. I have the address of the Earl of Stair's factor, & will visit him when I have spare time in that area, & get all the information necessary, & forward it to you.

Yo. v. sincerely

R. Allison

Probable location site

UK/N/12

29th July, 1936.

A. Allison, Esq.,
Gleniffer Cottage,
Barbreck, Lochgilphead,
Argyll.

Dear Allison,

Further to my letter of 28th July, I enclose a copy of a note by Mr. Wyllie on 'Oil in the Carboniferous of Scotland' dated 14th June 1933. This note should be regarded as confidential and on completion of your work should be returned to this Office.

Commenting on this note Mr. Dewhurst says "It is clear on present evidence that the Cousland Dome offers a better site for a test well than does the D'Arcy Dome although further work, which should be carried out, may show that the third and most northerly dome is the best for the purpose".

In a letter to Dr. Lees dated 3rd August 1933 Mr. Conacher gives some further information concerning the intrusion on the Dunnet horizon to which he attributes the oil found at Westwood and Breich: he says that this sill is known, from mining data, to have destroyed the Dunnet Shale over an area of 18 sq. miles and it is calculated that the destruction of this area may have set free about 17 million tons of crude oil.

The following references may be of use to you in examining the oil prospects of our Licensed Area No.14:

H.R.J.Conacher: 1928 "Native Hydrocarbons associated with the Oil Shales of the Lothians", Trans.Edin.Geol.Soc.XIII,1.

D. Tait: 1928 "On the occurrence of Petroliferous Sandstones in the Carboniferous Rocks of Scotland and their relation to certain Black Sandstones", Trans.Edin.Geol.Soc.XII,1.

H.R.J.Conacher: 1925 "Some occurrences of Natural Mineral Oil in the Scottish Shale Fields", Trans.Edin.Geol.Soc.XI,3.

I am sending you copies of (1) Geol. Survey Memoir by M. and A.G. Macgregor on "The Midland Valley of Scotland (1936), (ii) Geol. Survey Memoir by R.G. Carruthers on "The Oil Shales of the Lothians" (3rd Edn.1927) for your use in connection with this work.

Yours sincerely,

(Sgd) P.T.COX.

PTC/LH

UK/N/12

28th July 1936.

A. Allison, Esq.,
Gleniffer Cottage,
Barbreck, Lochgilphead,
Argyll.

Dear Allison,

Dr. Lees has passed your letter of 21st July to me for reply. The following instruments have been forwarded to you:-

1 Geological Hammer
1 Clinometer Compass
1 Abney level
1 x10 lens
1 6" to 1 mile scale-protractor
50 Sample Bags (large size)

There is no oil prismatic compass (Army type), Map case or 100 ft. tape in stock here at present but the two former items will be forwarded to you within the course of a few days. If you find that a tape is required, will you obtain one locally.

Referring to your letter to me of 21st July, I note that you have written to Dr. Smellie and that you wish to start work in the Dalkeith area on August 1st. I have since seen Dr. Smellie who has agreed to put you in touch with Geological Survey and Scottish Oils people who are likely to be of use to you.

The main objective of your work is to prepare a structural contour map on a 6" to 1 mile scale of the D'Arcy and Coushlands anticlines, and as much of the surrounding country as is relative to problems of oil accumulation. This will necessarily be based largely on records available but you will need to become familiar with the surface geology and, where necessary, check or amplify material available from other sources. A report covering the work should be prepared in which the oil prospects are briefly reviewed and any new information or analysis of data that may be of use when testing the area are given. Outcrops should be sampled systematically with a view to providing a reference collection for the Resident Geologist at a test well.

One copy of each of the following maps have been sent to you:-

1" to 1 mile (Topographical) Sheet No.74 showing in red the area (No.14) over which the Company holds a license to explore for oil.

1" to 1 mile Geological Sheet No.32.			
1" " " " " " No.33.			
6" " " " " "	Edinburgh IV S.E.	Haddingtonshire	VIII S.E.
" " " " " "	" IX N.W.	"	XIV N.W.
" " " " " "	" IX S.W.	"	XIV S.W.
" " " " " "	" VIII N.E.		
" " " " " "	" VIII N.W.		
" " " " " "	" VIII S.E.		
" " " " " "	" VIII S.W.		
" " " " " "	" XIV N.E.		
" " " " " "	" XIV N.W.		

Yours sincerely,

(Sgd) P.T.COX.

PTC/LH

File Scotland Geological

NOTES ON A VISIT TO COUSLAND AREA - DALKEITH.

March 8th. 1936.

Visited water source _7a_. An important source off the Oxenfoord Estate, but now owned by them: importance due to supplying Oxenfoord Castle, Cranstown Riddle House and certain farms. Rate of 40,000 - 43,000 gallons per day were given. The source is a surface spring which flows by gravity to Sauchenside Farm from where it is pumped up to Chesterhill. The project - i.e. the cleaning up of the site and present distribution of the water, is two years old.

Source _4._ Said to be a good spring, equipped with a small pump: supplies cottages and Fordel Mains. It was established two years ago by following back a spring (?) at the bottom of the field and excavating some 5' or 6' into "clays." Said never to fail.

Source _5._ Not visited: said to fail occasionally.

Source _3._ Has an overflow near the road at N. of "seen." Does not overflow always, but at sometime every day, even in summer: usually in the morning. Is hard water. Four year records show this source has never failed. There is no excavation, but the water is piped from its source somewhere in the middle of the field to the overflow by the road. Figures given for "Fordel Park Roadside" were:-

3500 gallons /day in April 1935
700 " " " July 1936

240 gallons /day	dates not given but were successive figures in Mr. Smith's note book, presumably monthly rates for production during the latter part of 1936.
520 " "	
576 " "	
4500 " "	
2057 " "	
4520 " "	

Source 2. Not in use. Described as a "deep" bore: water stands in the well, but since source 1. is sufficient, 2 is not used.

Source 1. Not such a big supply as 7a. Situated in the Limestone quarry at Westfield and has its outlet and tank just south of Windmill plantation. The water in this mine, which is dammed up in one of the shafts from where it is pumped to the tank, is said never to fail although the level in the summer is said to drop.

Sources 11 and 16. The Geological Survey say that these sources are supplied from 1, by underground pipes.

Source 8. A "deep" bore put by the ? Cement Company. It is important since it supplies the village. Rates quoted were:-

July 1930	1684 gallons	/day.
Dec. 1930	3927 "	/day.
Oct. 1934	4320 "	/day.

Sources 9 and 10. Unimportant and never properly developed surface springs.

File

17th March, 1937.

NOTE ON THE STAIR ESTATE WATER SUPPLY AND POSSIBLE EFFECTS ON THIS SUPPLY OF TEST DRILLING AT COUSLAND.

1. Nature of the present water supply.

The attached map (Fig.1) shows twenty four points, indicated to us by Mr.Robert Smith, from which water is obtained for the Stair Estate. I understand that twenty-three of these points lie within the main boundary of the Stair Estate and that the twenty fourth, numbered 7a on Fig.1, is not situated on the estate but is the property of Stair Estates.

Mr.Smith has informed us that Nos.1, 8 and 7a are the most important sources of supply. No.1 supplies many farms and buildings, No.8 the village of Cousland and No.7a Oxenfoord Castle, the Home Farm and other gardens and houses.

Nos.2 and 8 are derived from boreholes. The former, which probably penetrates rocks of the Carboniferous Limestone Series is not now used and yields no flow at surface. No.8 is a borehole drilled in the floor of a quarry in Carboniferous Limestone and yields a flow of water at surface.

No.1 is obtained by pumping water from small reservoirs formed by damming a roadway in the disused Limestone mine. Nos. 9 and 10 are small springs or seepages in or near the Cousland quarries.

All the other sources indicated, including No.7a, are surface springs or shallow pits into which water seeps from fluvio-glacial drift.

The attached section (Fig.2) illustrates the general sub-surface composition of this area. Thickness of the fluvio-glacial drift layer varies locally from zero to a probable maximum of about thirty feet. Over the greater part of the area there is a continuous sheet of this deposit. Beneath the drift, there is a group of limestones with some interbedded shales, folded into the anticlinal structure shown in the section. The axis of this fold is oriented in an approximately NNE - SSW direction and passes through Cousland and D'Arcy. At D'Arcy a borehole has shown that there is a thickness of 162 ft. of limestones overlying 62 ft. of clays or shales which constitute the uppermost member of the Oil Shale Group of strata. At Cousland approximately the same thickness of limestones is expected to overlie a similar clay group.

The yield of water from springs or pits in the drift layer may be derived from that deposit only or such a supply may be supplemented by seepage from the underlying limestone series. Water obtained from the limestone quarries or mines near Cousland or from the boreholes Nos.2 and 8 is derived from fissures or other cavities in the limestone beds. Maintainance of the supply of water from either drift or limestone is dependent on rainfall. The drift sources are, on account of their shallow depth, more liable to be affected by dry seasons than supplies obtained from deeper limestone sources. Exposure of these limestones in the gorge SE of Chalkieside, at a topographic elevation more than 150 ft. below the surface at Cousland, also makes this source in the quarry workings more subject to variation in rainfall than it would otherwise be.

The attached diagrams (Fig.3) show records of flow of water (i) from the artificially made reservoir inside the Cousland workings, from which No.1 supply is pumped.

(ii) from an outlet of the quarry workings into the gorge SE of Chalkieside.

(iii) from one of the spring sources in fluvio-glacial drift. These diagrams are made from observations of Mr.Robert Smith and though the number of readings and the period over which they were observed are limited, the results leave no doubt that in each case there has been great natural fluctuation in yield between 1930 and 1936.

2. <u>Risk of Possible Damage to Water Supply by a Test Borehole at Cousland</u>.

A borehole drilled at our test location, near Cousland, could conceivably cause (1) contamination, by oil, saline water or mud or cement laden fluid, of the water supplies derived from the limestones within a radius of say 800 yds. The risk of contamination decreases greatly with distance from the borehole and the arbitrary figure of 800 yds. is selected as a reasonable limit, considering the nature of the rocks and their structural form. It is noteworthy that of the twenty four sources of water supply quoted, ten including No. 7a, lie nearer to the test well drilled at D'Arcy and to the probable site of a test well or wells to be drilled in the near future by Anglo-American Oil Coy. Ltd. than to our Cousland site.

(2) diminution of water supplies derived from the limestones within the 800 yds. radius if (a) porous strata should be penetrated by the test well below the limestone series.

(b) such porous strata were dry or contained fluids under lesser pressure than the head of water in the limestone.

(c) insufficient precautions were taken to prevent movement of water from the limestones into the borehole.

A borehole drilled at our test location could have no effect underground on water supplies derived from drift deposits.

<u>Contamination</u>. While drilling through the limestone series (i.e. the first 150-200 ft.) there is a chance that supplies drawn from the limestone close to the borehole

might be contaminated by whatever fluid is put into that hole. We propose therefore to drill this section either by a rotary method using fresh water in circulation or by a percussion method in which there would be fresh water in the hole. Slight and temporary turbidity of near supplies is the worst that could occur during this process.

It is then proposed to cement casing from the clay group below the limestones to surface. This casing, if satisfactorily cemented, will prevent contamination of the limestone waters by any oil or saline waters found at deeper horizons or by mud flush used for further drilling. There is a slight and temporary risk of contaminating the near sources of water by water carrying particles of cement during the few hours after the cement slurry has been introduced into the well.

Diminution. There is no risk of causing diminution of any water supply while drilling in the limestones. Satisfactory cementation of casing, as described above, removes any risk of causing diminution of any water supply even if low pressure, porous horizons are encountered at greater depths.

Summarizing, it can be said that drilling of the test well involves a slight risk of temporary and non-toxic contamination to near sources of water supply while drilling the first 150-200 ft. and while cementing the first string of casing. It also involves a remote risk of causing contamination or less probably diminution of near sources after cementation of that casing. This risk becomes nil if the casing is satisfactorily cemented and in such cases the Company is obliged to satisfy

H.M. Petroleum Dept. inspectors that cementation is satisfactory before drilling may proceed.

Recommendations. In view of this assessement of the risks of possible damage, it seems not entirely unreasonable that the Company should accept onus of proof that any contamination of sources of water within 800 yds. of the test borehole was not caused by their operations.

If any standard could be obtained by which the normal yield of these sources of water, at any future time, could be gauged, the Company might reasonably accept an equal responsibility for diminution but this is not possible. The fluctuations in yield shown in Fig.3. amply demonstrate that there is periodic diminution due to natural causes. It might be extremely difficult if not impossible to establish that diminution at a future date was caused by seasonal changes or other underground operations and not by the Company's borehole. Unless detailed records were available of a large number of water levels over a period of at least several tens of years, the effects of seasonal changes would be incapable of reliable assessment. It is therefore recommended that onus of proof with regard to diminution of any of the sources of water supply should not be accepted by the Company.

(Signed) P.T.Cox.

File
Scotland.

The Stair Estates Limited.

Memorandum for the D'Arcy Exploration Company as to various water supplies on the Estate.

No. 7a (Icehouse).

This spring though not situated on the estate is the property of the Stair Estates and is a very important source of supply as it supplies Oxenfoord Castle, the Home Farm, the gardens and all houses within the policies.

No. 1. This is the position of the plant for pumping water from the limestone mines for the supply of five farms and their cottages and is a most important source of supply.

No. 3. Supplies the farm of Fordel Parks, Fordel Dean Gardens and the workers cottages on both.

No. 4. Is a new and ample source of supply and supplies the farm of Fordel Mains and the workers cottages on the farm.

No. 8. From a bore in quarry is the source of supply for the village of Cousland and Northfield farm.

No. 9. Supplements No. 8.

No. 14. Supplies Airfield Farm.

No. 15. Supplies Oxenfoord Mains Farm.

The Stair Estates Ltd.

Memorandum for the D'Arcy Exploration Coy. as to various water supplies on the Estate.

March 1937.

uk/Scot/T.4

Copy.

From MR.A.H.TAITT. To MR.B.R.JACKSON.

Our Ref. Your Ref. Date 5th August, 1938.

Subject EXPLORATION PROGRAMME - DRILLING.

As far as can be envisaged at the moment, assuming unfavourable results from our Test Wells at Eskdale, Gun Hill and Hardstoft and from the Geological Exploration boreholes at Coalport and excluding the development of the Cousland Structure, there remain two exploratory Test Wells to be drilled, a series of test wells in the Pentland Fault area and boreholes for geological information on the Cousland Structure and at Formby in Lancashire, and in the South of England the Chaldon Down boreholes.

Test Wells.

(1) Ollerton.

Seismic work on the Ollerton Structure is sufficiently far advanced to enable us to confirm the presence of a Carboniferous structure with at least 800 ft. closure and with its crest in the neighbourhood of Eakring. From Hardstoft evidence the depth to the Carboniferous Limestone at Eakring will be of the order of 4500 ft. and to satisfy ourselves as to the productivity of this limestone it will be necessary to drill to closure, a further 800 ft. Seismic work now being carried out between Ollerton and Kelham may, however, enable us to arrive at a more accurate estimate of the depth of the Carboniferous Limestone.

As it is on the results of the Ollerton Test that the value of hidden structures in Lincolnshire will be assessed, it is recommended that this well is put first on the programme.

(2) Balfour, Fyfe.

In view of the results so far obtained from the Oil Shale Group at Cousland and Midlothian the Balfour Structure, although faulted becomes of major importance.

The evidence from the Balfour Mains borehole is conflicting and must be regarded with suspicion. (The Balfour Mains borehole, which was drilled with a Diamond Drill to 4535' and is known to be far from vertical, indicates that the top of the Oil Shale Group is 2000 ft. lower than estimated from sections by the Geological Survey).

The Oil Shale Group is undoubtedly thickly developed in Fyfe and consequently a well to be conclusive, i.e. to penetrate the whole series, may have to drill to 7500 - 8000 ft. on the Balfour Mains borehole evidence or 5500-6000 ft. on the Geological Survey evidence.

(3) Pentland Fault Area (3 tests to 1500', 3000' and 2000')

In my memo. of 11th July I recommended that one of these holes, Location A, should be drilled with the Failing Outfit as it appeared that this outfit would be available and that the structural delimitation wells at Cousland could be drilled by the O.W.E. Portable Drilling Outfit. Mr. Seamark has, however, pointed out that it would not be possible to carry out satisfactory formation tests of the sands of the Oil Shale Group in the Pentland Fault area with the Failing Outfit. I would recommend therefore that the Hardstoft Cable Tool Outfit be transferred to the Pentland Area or should results at Hardstoft be such that it is not possible to transfer the Outfit, then a new medium sized Cable Tool outfit be obtained Such an outfit, if capable of drilling to 3000 ft. could be subsequently used for the development of the Cousland Structure. In view of the increased rentals now being paid for the Licensed Area No.A.14 it is important that potential producing areas within that Licemce, should be delimited as early as possible.

....

Geological Wells.

(4) Cousland. Structural Delimitation Wells.

In my memo. of 11th July I recommended that at least 3 shallow holes should be drilled with the O.W.E. Portable Outfit for the purpose of obtaining further data on the extent of the surface structure at Cousland. It now appears to be improbable that the O.W.E. Portable Outfit will be available for this work, but in view of the inability of the Failing Outfit to test the Pentland Fault Area successfully I would recommend that that outfit on completion of the Coalport Drilling be moved to Cousland so that Location P. (1) (see Falcon's note of 22.5.38) can be drilled before Cousland No. 3 is located.

(5) Formby. Geological Information Wells.

The seepage area in the Formby Licence is covered with recent deposits - peat and clays - overlying the Trias which itself completely masks the underlying Carboniferous Structure. It is presumed that the oil originates in the Carboniferous and reaches the surface by way of faults in the Trias. To obtain information on the behaviour of the Carboniferous it will be necessary to drill a series of shallow boreholes and such drilling can be effectively carried out with the Failing Outfit on completion of the Cousland Structural delimitation wells.

Until the proposed regional geological examination is carried out of the area it is impossible to say how deep or how many boreholes will be required, it is anticipated however that at least 1500 ft. of drilling will be necessary.

(6) Chaldon Down Drilling.

Owing to the impossibility of making a second location until the drilling of the first location is completed and consequent lack of continuity in any programme of drilling necessitating the use of two different outfits, it has been suggested that this drilling be carried out by contractors. In view of the uncertainty of the exact position of the second location forecasts of depths cannot be made except within wide limits. The first well will have to be drilled deeper than 800' but should not exceed 1200' subsequent wells will it is anticipated be between 1200 and 1500 ft. deep.

(Sgd.) A.H.TAITT.

A249/6931—C.1.38.

UK/Scot/T.3.

Memorandum

From	MR. A.H. TAITT.	**To**	Mr Wylie MR. B. R. JACKSON via DR. LEES.
Our Ref.	**Your Ref.**	**Date**	11th July, 1938.

Subject SHALLOW DRILLING AT COUSLAND FOR STRUCTURAL INFORMATION.

22/5/38

The attached note from Mr. Falcon suggests three locations for shallow borings to obtain structural information on the extent of the Cousland Structure.

The surface geology of the Cousland area is largely obscured by a mantle of drift and away from the area of colliery workings (i.e. on the crestal area of the structure) the details of the structure are largely unknown. Pits or auger holes will not supply the necessary information as it is necessary to obtain the lithological sequence, in the absence of palaeontological evidence, over several hundred feet of strata in order to determine, with any reliance, the position in the succession.

Although there is no immediate urgency for this shallow drilling, it is important that it should be completed before locations are selected for delimiting the Cousland Structure. It will enable us to select such locations with a much greater certainty as to their structural position, as far as the surface structure is concerned, and, will also assist in assessing the potential value of the field.

I agree

A. H. Taitt

Mr Taitt

This to come in our programme

BRJ 13/8

A250j6932—C.7.36

uk/Scot./T.3

RECEIVED 23 MAY 38

Memorandum

From Mr. N. L. Falcon **To** Mr. A. H. Taitt.

Our Ref. **Your Ref.** **Date** 22/5/38

Subject "Suggestion for Portable Drilling Outfit Programme on the Axial Region North of Cousland".

sent to Mr. Jackson via Dr. Lees 11/7/38

A note on the above is attached.

returned 14/4/38

N. L. F.

22.5.38

cn

SUGGESTION FOR PORTABLE OUTFIT DRILLING PROGRAMME ON THE AXIAL REGION NORTH OF COUSLAND.

Although thickness variation in the Calciferous Sandstone Series introduces a most uncertain factor at depth, definite knowledge of the position of the top of the Series is the best structural evidence obtainable on which to base locations.

On present information, we must accept the Carberry Hill - Falside Hill area as a crest maximum comparable in size to the Cousland crest maximum, but structurally about 400 feet lower. A shallow saddle, including a N.E.-S.W. fault with downthrow to the N.W., probably separates Carberry Hill and Falside Hill, but is of little practical importance.

At the North and South ends of this crest maximum, information is unsatisfactory.

North of Falside Hill, the topography strongly suggests that an important fault line running S.W.-N.E., with downthrow N.W., cuts across the pitching end of the structure. This fault would unite the Quarry House fault with the supposed large fault bounding the Preston-Roslin Sandstone outcrop on its East side. More knowledge in this region is essential if future well locations are to be made with care.

South of Carberry Hill, the evidence suggests a pitch down towards the Carberry fault. This however is not definite, it is also possible that the fault, which has a downthrow of about 600 feet to the S.W. at Carberry, maintains its importance South of Carberry Hill /

Carberry Hill, i.e., that the Falside-Carberry Crest Maximum, instead of pitching at its Southern end, is chopped off.

If a Portable Drilling Outfit capable of coring to 500 feet is available, it would be useful for solving these problems. The following locations are suggested in order of importance :-

P.1. Near the 350 foot (topographic) contour, 2,000 feet S. of Beattie's row and 2,500 feet N.W. of Myles. This would give definite information at the North end of the Carberry-Falside Crest Maximum, and together with the information from location P.2 would prove or disprove the line of dislocation suggested by the topography. It would also give a standard succession useful in subsequent holes.

P.2. About 1,500 feet South of Dolphingston Farm. An old bore-hole, 1,400 feet S.W. of Dolphingston ruin, recorded limestone at 150 feet, but what limestone is not known. We do not know the position of the top of the Calciferous Sandstone Series here.

P.3. About 1,000 feet S.W. of Backhill. This would check up the presumed Southerly pitch at the South end of the Falside-Carberry Crest Maximum.

These locations are shown on the accompanying tracing from the 6" map. There are many other minor problems which shallow holes could solve, but in view of the uncertain thickness of the different zones of the Calciferous Sandstone, I do not consider them of practical importance at this stage in our knowledge of the area.

N. L. Falcon

22.5.38

AREA NORTH OF COUSLAND

SKETCHED FROM 6" to MILE GEOLOGICAL SURVEY SHEETS.

TO SHOW SUGGESTED POSITION OF SHALLOW HOLES FOR STRUCTURAL INFORMATION.