

Manitoba Regulation /86

Being

The Oil and Natural Gas Conservation Board

Order No. PM 46

An Order Pertaining to Pressure Maintenance by Water Flooding

Waskada Mission Canyon 3a C Pool

Made and Passed Pursuant to "The Mines Act", Cap. M160, of the
Continuing Consolidation of the Statutes of Manitoba, and
Amendments Thereto, by The Oil and Natural Gas
Conservation Board of Manitoba

(Filed:)

WHEREAS, subsection (9)(d) of Section 62 of "The Mines Act", being Chapter M160 of the Continuing Consolidation of the Statutes of Manitoba, provides as follows:

"62(9) Without restricting the generality of subsection (8) the board, with the approval of the minister, may make orders

(d) requiring the repressuring, recycling, or pressure maintenance, of any pool or portion thereof where it is economical so to do, and for that purpose where necessary requiring the introduction or injection into any pool or portion thereof of gas, air, water or other substance;"

AND WHEREAS, the Board received an application dated January 3, 1986 from Omega Hydrocarbons Ltd. for approval of a project to inject water into the Waskada Mission Canyon 3a C Pool ("the pool") in the Waskada Unit No. 10 area in Manitoba.

AND WHEREAS, the Board has received no objections or interventions with respect to the application by Omega Hydrocarbons Ltd.

AND WHEREAS, Omega Hydrocarbons Ltd. is the Unit Operator of the Waskada Unit No. 10

NOW THEREFORE, the Board orders that:

1. The Unit Operator shall conduct pressure maintenance operations by the injection of water into the Pool underlying the Unit Area.
2. The pressure maintenance operation shall be in accordance with, and subject to, the following rules:

PRESSURE MAINTENANCE RULES

- 1(1) Water shall be injected into the pool through the wells:

Omega Waskada WIW 13-26MC3a-1-26 (WPM)

Omega Waskada WIW 3-27MC3a-1-26 (WPM)

and such other wells in the Unit Area as the Board may approve.

- (2) After the commencement of injection, the Unit Operator shall, subject to any remedial work required to be performed on the wells referred to in subclause (1) of this clause, endeavour to maintain continuous injection.
- (3) Notwithstanding the provisions of subclause (2), the Board may, upon application by the Unit Operator, approve the suspension of water injection into any well or wells, provided that the Board is satisfied that pressure maintenance operations in the Unit Area will not be adversely affected.
- (4) The completion of the wells referred to in subclause (1) will be as prescribed by the Director of the Petroleum Branch.
2. The Unit Operator, upon the request of the Board, shall satisfy the Board as to the source, suitability and method of treatment of the water to be injected.
- 3(1) Before injection of water is commenced, the Unit Operator shall submit, to the Board, results of a survey conducted to determine the static reservoir pressure in a minimum of two wells in the Unit Area.
- (2) The Unit Operator shall, not less than six months nor more than 12 months after the commencement of injection, and at yearly intervals thereafter, conduct a survey to determine the static reservoir pressure in a minimum of two wells in the Unit Area.
- (3) The Unit Operator shall submit the details of the surveys described in subclauses (1) and (2) of this clause to the Petroleum Branch, including a list of the wells to be surveyed, the measurement technique to be used, and the intended shut-in periods for each well, and approval shall be obtained from the Director of the Petroleum Branch before the program is carried out. Within 30 days of the completion date of the surveys, a report shall be submitted to the Petroleum Branch including:
- (a) the static reservoir pressure data obtained from the survey, corrected to a common datum;

- (b) an isobaric map of the Pool within the Unit Area based on the data obtained; and
 - (c) a discussion of the survey results and pressure distribution within the Pool.
- (4) The Board may, at any time, require the Unit Operator to carry out such additional reservoir pressure surveys as it deems necessary.
4. The Unit Operator shall immediately report to the Board any indication of channelling or break-through of injected water to producing wells or any indication of other detrimental effects that may be attributable to the pressure maintenance operations.
5. The maximum wellhead pressure at which water is injected into the wells referred to in subclause (1) of clause 1 hereof shall not exceed 8 000 kPa or such other maximum pressure as the Board may prescribe. The Board may, from time to time, prescribe a maximum or minimum rate at which water shall be injected into any well in the Unit Area.
- 6(1) The Unit Operator shall, not later than the last day of each month, file with the Petroleum Branch, a report of the quantity, source and pressure of water injected during the preceding month into each well referred to in clause 1 hereof.
- (2) The Unit Operator shall, not later than the last day of each month, file with the Petroleum Branch a summary report of production and injection operations during the preceding month. This report shall include:
- (a) a tabulation of total oil, total water and total gas produced;
 - (b) a tabulation of the number of producing wells and injection wells which were active;
 - (c) the results of at least one twenty-four hour production test on each producing well in the Unit including volumes of oil, gas and water produced during the test;
 - (d) a summary of any remedial operations carried out on any well in the Unit Areas.
7. The Unit Operator, shall, within 60 days of the end of each calendar year, file with the Petroleum Branch a report of the pressure maintenance program, setting out graphically such interpretive information necessary to evaluate the efficacy of the waterflood.

OIL AND NATURAL GAS ORDER NO. PM 46,
MADE AND PASSED THIS *25th* DAY OF
February A.D., 1986, AT THE CITY OF
WINNIPEG, IN THE PROVINCE OF MANITOBA,
BY THE OIL AND NATURAL GAS CONSERVATION BOARD



Charles Kang, Chairman
The Oil and Natural Gas
Conservation Board

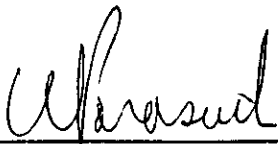


Wm. McDonald, Deputy Chairman
The Oil and Natural Gas
Conservation Board



J. F. Redgwell, Member
The Oil and Natural Gas
Conservation Board

Approved:



Wilson Parasiuk, Minister
Department of Energy and Mines



The Oil and Natural Gas
Conservation Board

Room 309
Legislative Building
Winnipeg, Manitoba, CANADA
R3C 0V8

(204) 945-3130

December 2, 1988

Omega Hydrocarbons Ltd.
1300, 112 - 4th Avenue S.W.
CALGARY, Alberta
T2P 0H3

Attention: R. A. Brekke, P. Eng.
Manitoba District Engineer

Dear Sir:

Re: Suspension of Water Injection
Waskada MC3a C Pool

Your application to suspend water injection in the subject Pool is approved subject to the following conditions:

1. The provisions of Board Order No. PM 46 relating to determination of reservoir pressures and reporting of production operations (monthly and annually) shall remain in force.
2. Omega shall submit to the Board not later than March 1, 1990, a report outlining the optimum depletion strategy for the Pool.
3. Omega shall apply to the Petroleum Branch for approval to suspend the well Omega Waskada WIW 13-26MC3a-1-26 (WPM).

Yours respectfully,

Original Signed by H. C. Moster

H. Clare Moster
Deputy Chairman

cc: C. S. Kang
Chairman

bc: Wm. McDonald,
Member
Petroleum Branch

LRD/HCM/sml

Manitoba



Memorandum

Date December 2, 1988

To The Oil and Natural Gas
Conservation Board

Charles S. Kang - Chairman
H.C. Moster - Deputy Chairman
Wm. McDonald - Member

From L. R. Dubreuil
Director
Petroleum Branch

Subject Telephone

Re: Suspension of Water Injection
Omega Waskada WIW 13-26MC3a-1-26 (WPM)
Omega Waskada WIW 3-27MC3a-1-26 (WPM)

Omega Hydrocarbons Ltd., operator of the Waskada Unit No. 10 has made application under Pressure Maintenance Rule No. 1(3) of Board Order No. PM 46 to temporarily suspend water injection into the subject wells.

Recommendation:

It is recommended that the application be approved. A proposed letter of approval is attached.

Discussion:

Board Order No. PM 46 provides for pressure maintenance operations in the Waskada Unit No. 10. The Unit includes the two subject injection wells and several producers in the Waskada MC3a C Pool (see Fig. No. 1).

Pressure maintenance by water injection in the subject wells commenced in February 1985 and continued until March 1987. Both water injection wells have remained shut in since this date.

Fig. No. 2 is a plot of Unit performance and Table No. 1 shows current producing characteristics of wells in the Unit. Water injection appears to have accelerated water production while having little positive effect on oil production. Further, there is some evidence of improved oil production since injection was terminated in early 1987. Based on these observations, we concur with Omega that water injection has not been an effective enhanced recovery agent. Omega's plans to review Pool performance at year end 1989 to develop an effective reservoir depletion strategy represents a logical approach. On this basis, approval of the application is recommended.

Attached is a proposed letter of approval requiring continued pressure monitoring and progress reporting as required in Board Order No. PM 46.

Original signed by
L. R. Dubreuil

L. R. Dubreuil

LRD/sml

Attachments

First | Fold

251

WASKADA UNIT No. 9

WASKADA UNIT NO 10

- △ Completion MC3a C Pool
- Completion MC3b B Pool

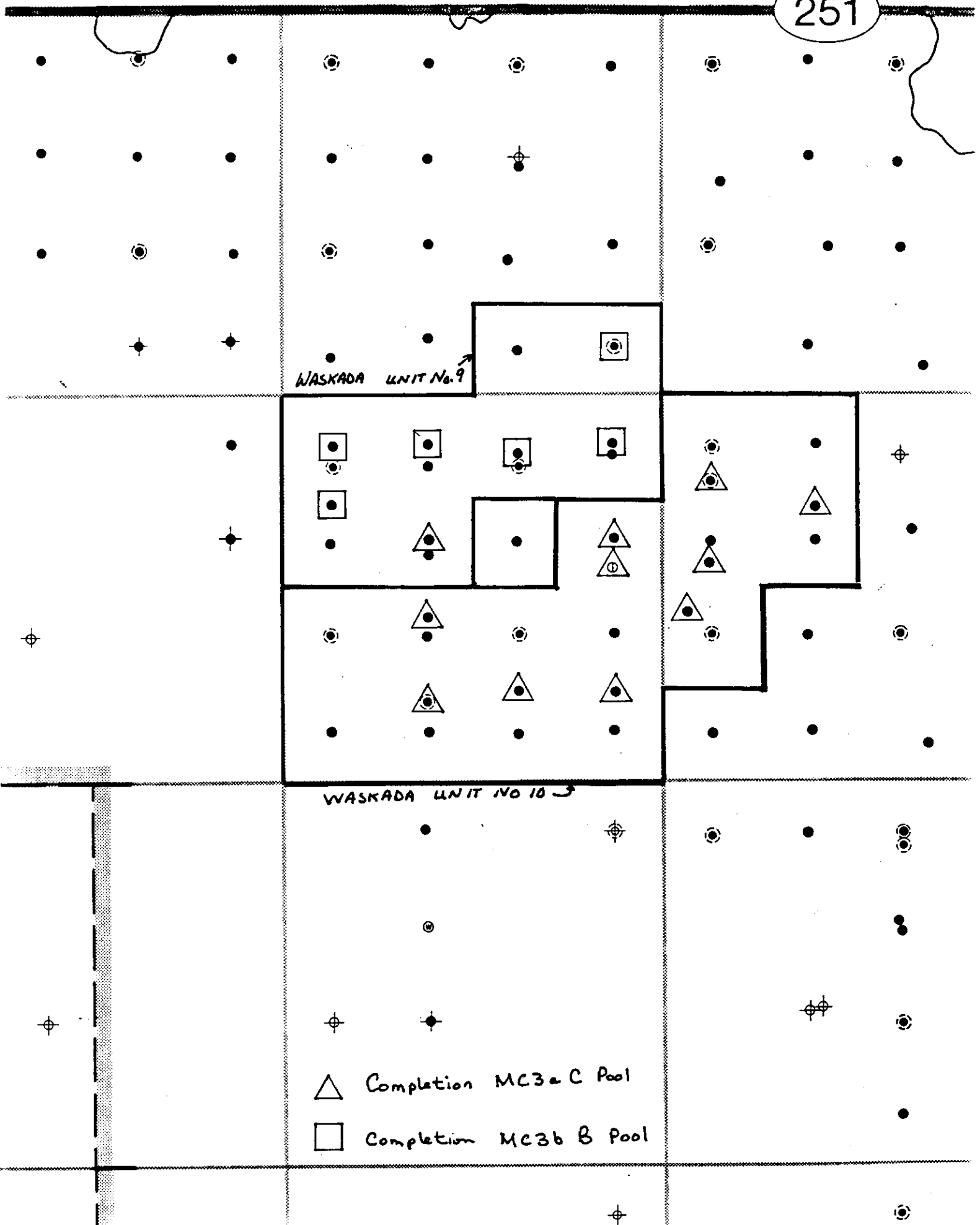


Fig. No. 2

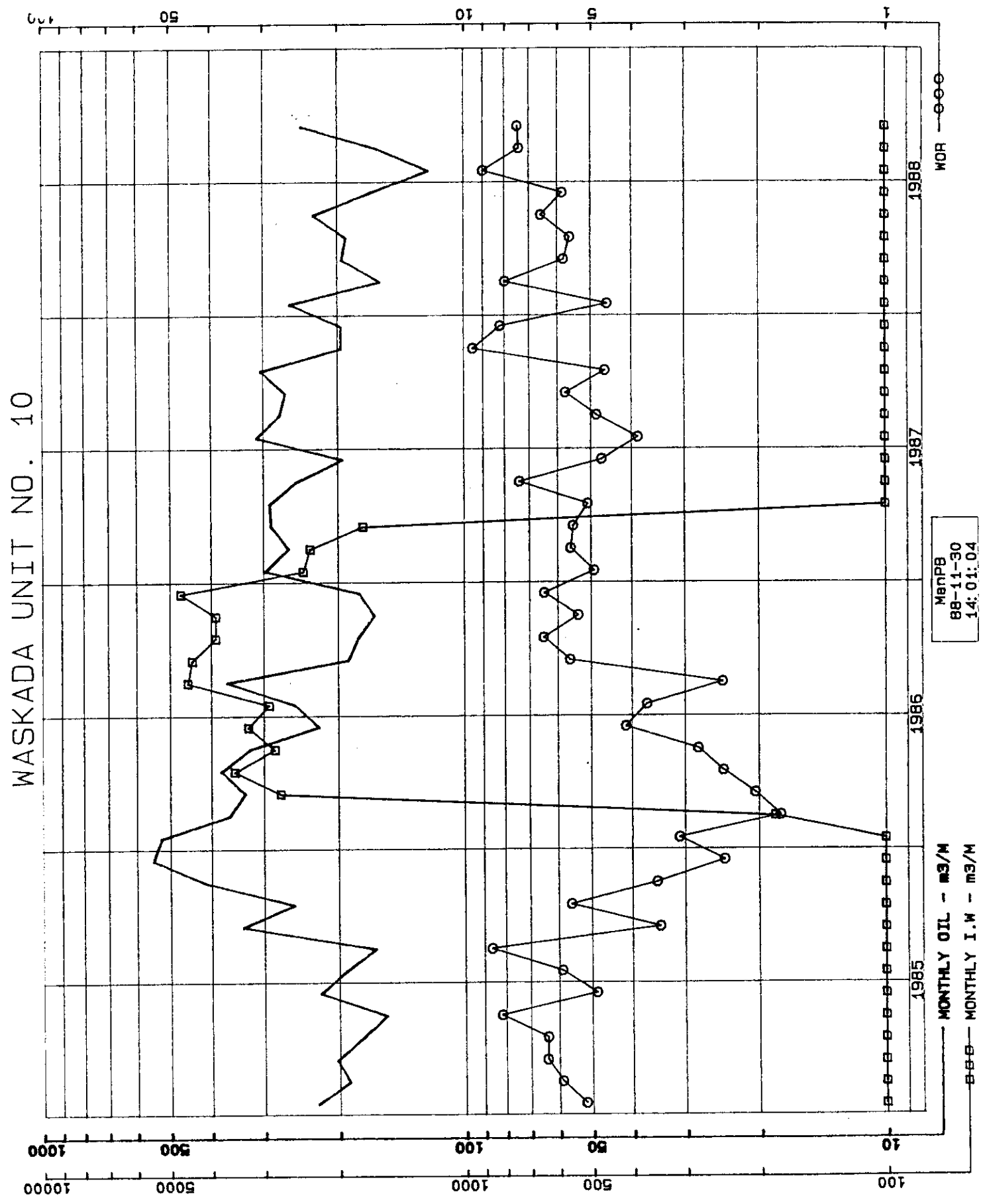


TABLE No. 1

DATE: 11/11/88 5 7 2 5 5 1 1 1
 WASHADAT 68-12-02
 MONTH REPORT: 1988-09 05:13:10

WELL NAME	HOURS	OIL m3/M	WATER m3/M	OIL m3/d	WDR
2005-16-001-26 WIM(01)	720	143.31	336.31	4.81	2.35
0912-26-001-26 WIM(01)	720	5.61	262.01	0.21	46.79
0901-07-001-26 WIM(01)	720	35.81	49.31	1.21	1.38
1201-27-001-26 WIM(01)	672	33.21	45.91	1.21	1.38
1006-07-001-26 WIM(01)	720	25.61	1123.31	0.81	43.68

TOTALS FOR THE MONTH:

3552	1816.8	7.46
=====	=====	=====

247.5
 =====



1300 SUN LIFE PLAZA III
112 - 4th AVENUE S.W.
CALGARY, ALBERTA, CANADA T2P 0H3
TELEPHONE (403) 261-0743

November 28, 1988

The Oil and Natural Gas
Conservation Board
555 - 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3

Attention: Mr. Charles S. Kang
Chairman

Dear Sir:

Re: Board Order No. PM46
Waskada MC3a C Pool

The purpose of this letter is to request approval to suspend water injection at wells:

Omega Waskada WIW 13-26MC3a-1-26 WPM
Omega Waskada WIW 3-27MC3a-1-26 WPM

During the past year Omega Hydrocarbons Ltd. has observed an increasing water/oil ratio trend within Waskada Unit No. 10, refer to Attachment 1. It is this company's opinion that water breakthrough has been accelerated by water injection into the previously mentioned wells. We also now believe that there is an active aquifer to the south and north of the subject pool. In order to confirm this suspicion Omega plans to terminate water injection into wells 13-26MC3a and 3-27MC3a-1-26 WPM and to monitor the pool pressure under conditions of continued production. By the end of 1989 we will have gathered sufficient data to decide on the optimum reservoir depletion strategy to maximize oil recovery from this Lower Alida pool.

If you have any comments or questions related to this letter please contact the undersigned at (403) 261-0743.

Yours truly,

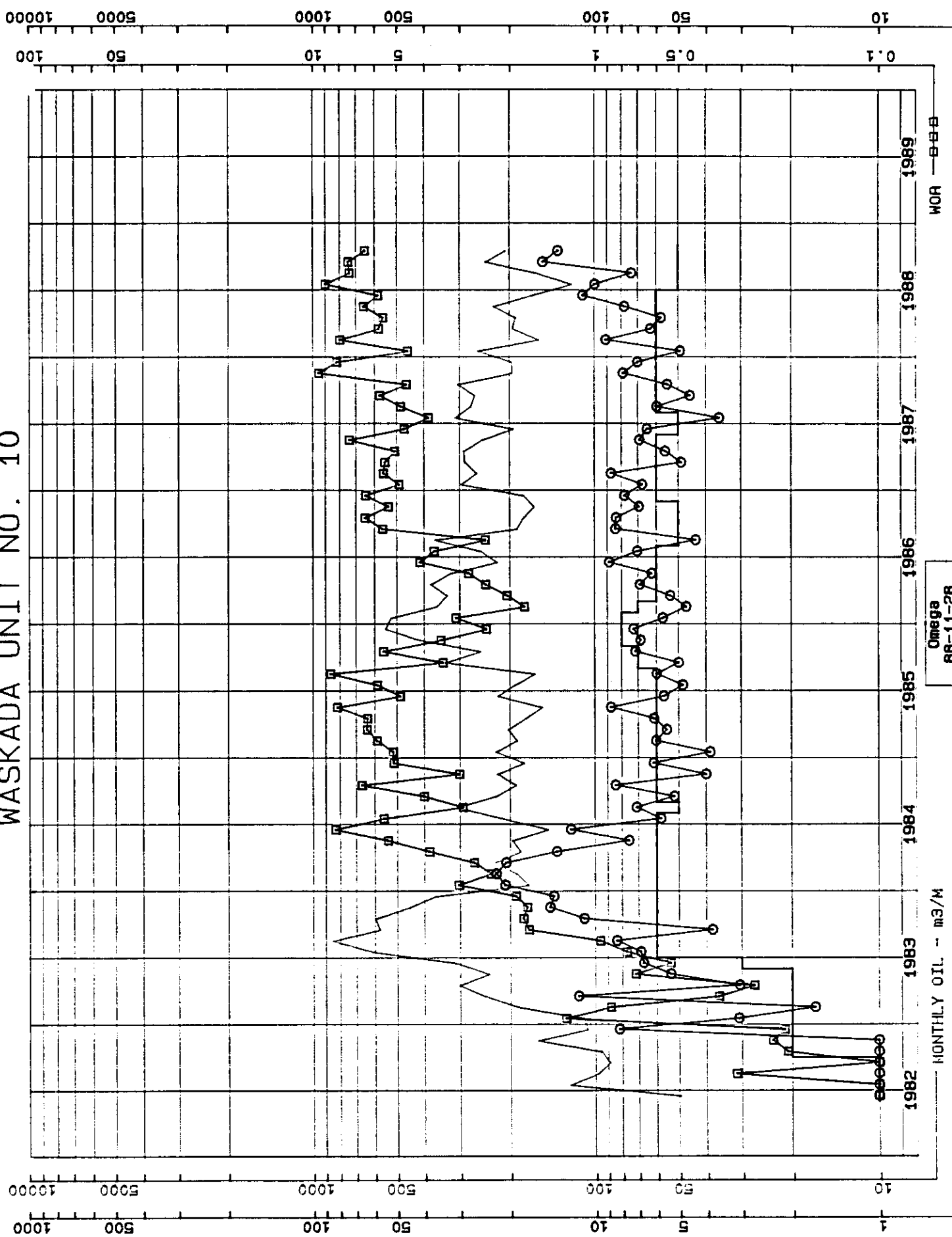
OMEGA HYDROCARBONS LTD.

A handwritten signature in dark ink, appearing to read "R.A. Brekke", followed by a long horizontal line.

R.A. Brekke, P. Eng.
Manitoba District Engineer

c.c.: B. Dubreuil - Petroleum Branch
W. Sharp
Waskada (Mission Canyon) Pressure Maintenance Approvals File

WASKADA UNIT NO. 10



MONTHLY OIL -- m³/M

Omega
88-11-28

WOR -- ---

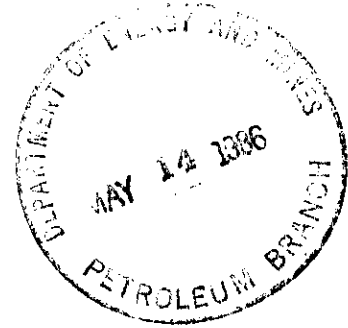


1300 SUN LIFE PLAZA III
112 - 4TH AVENUE S.W.
CALGARY ALBERTA CANADA T2P 0H3
TELEPHONE 403/261-0743

File
Pressure Maintenance Appl.
Waskada MC3a C

0343C

May 6, 1986



Petroleum Resources Branch
Energy, Mines and Resources Canada
28th Floor
580 Booth Street
Ottawa, Ontario
K1A 0E4

Attention: Mr. S.A. Kanik
Chief, PGRT Exemptions

Dear Sir:

Re: Request for Certification
Production PGRT Exemption
Waskada Unit No. 10

Omega Hydrocarbons Ltd. hereby submits for your approval a request for Certification for the new Production PGRT Exemption for the Lower Alida Zone waterflood project recently implemented in Waskada Unit No. 10. It is this Company's opinion that 73.84% of the total oil production produced from Waskada Unit No. 10 is entitled to PGRT Exemption based on the incremental oil reserves arising from the implementation of the previously mentioned waterflood.

The information supplied is in accordance with Information Letter EMR/PRB 86-01, following the general guidelines for a waterflood project and the specific guidelines for Manitoba.

Waskada Unit No. 10 was formed effective February 1, 1986 and a waterflood was instituted by converting to water injection the following wells:

<u>Location</u>	<u>Date on Injection</u>
13-26MC3a-1-26 WPM	1986-02-27
3-27MC3a-1-26 WPM	1986-03-04

It is anticipated that the effective date of exemption will be 1986-02-27.

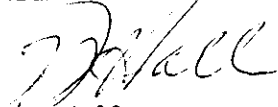
Omega Hydrocarbons Ltd. is operator of this Unit and owns a 100% working interest in all tracts. The production from all wells is classified as New by the Manitoba Government. All wells in the Unit were drilled prior to April 1, 1985.

The following are enclosed in support of this request for certification:

- a) Well Location Map
- b) Attachment No. 1 - Incremental Production Calculation by the Fixed Ratio Method
- c) Attachment No. 2 - Copy of the order approving pressure maintenance (Manitoba Board Order No. PM 46 dated February 27, 1986)
- d) Attachment No. 3 - Copy of the letter approving the Effective Date of the Unit (Manitoba Board letter dated January 28, 1986)
- e) Attachment No. 4 - List of wells and their status

Respectfully submitted,

OMEGA HYDROCARBONS LTD.



T.J. Hall
President

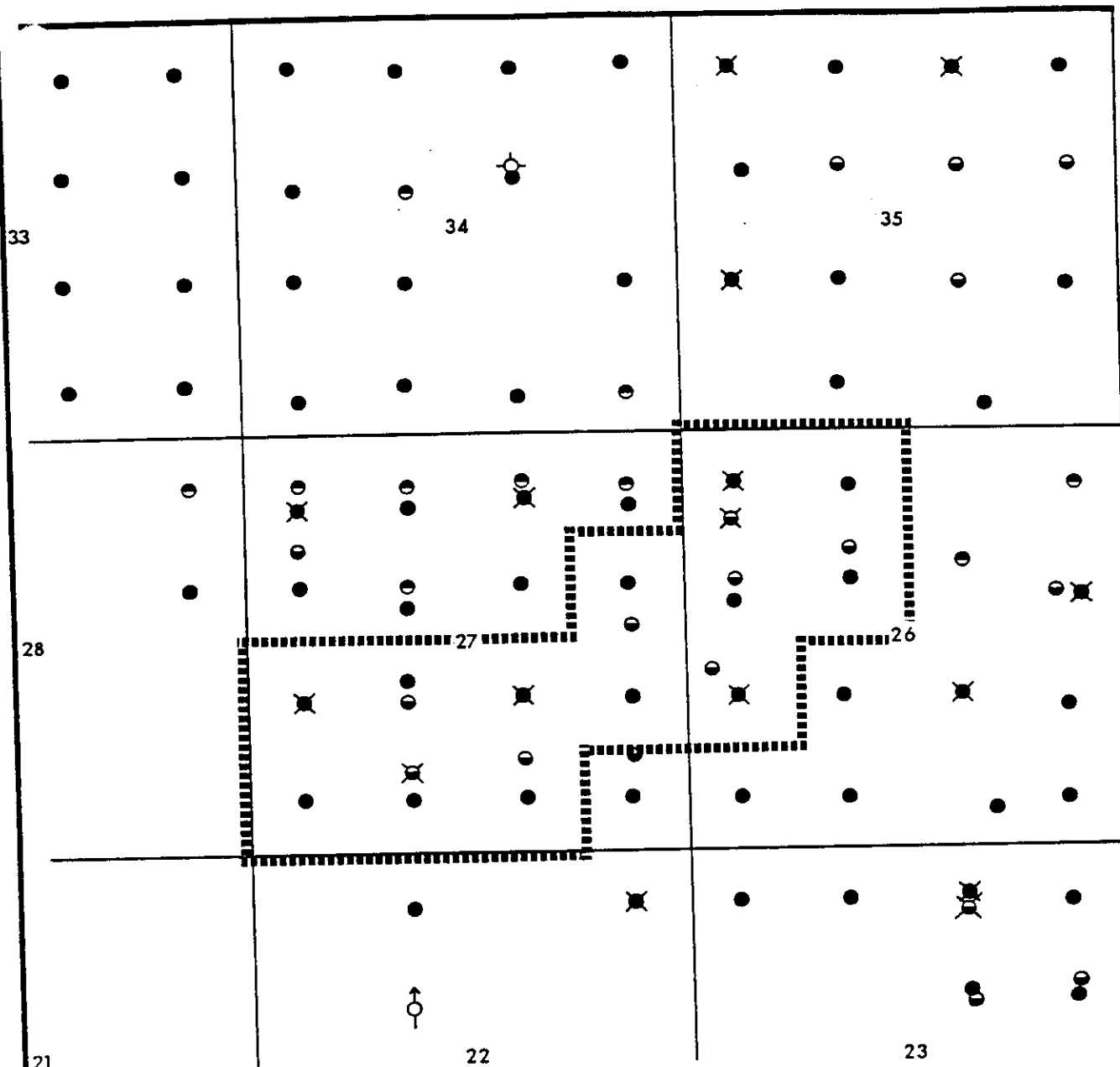
RAB:vb

Encl.

c.c. Bob Dubreuil - Manitoba Petroleum Branch
J. MacLagan
Waskada PGRT Exemption Applications File


R.26 W.1.M.

TP.
1



- SPEAR FISH OIL WELL
- UPPER ALIDA(MC 3b) WELL
- ◐ LOWER ALIDA(MC3a) WELL
- ◑ TILSTON(MC1) WELL
- ✕ WATER INJECTION WELL
- ⊕ WATER SOURCE WELL
- ⊘ SUSPENDED WELL
- ⊙ ABANDONED WELL

UNIT OUTLINE

 HYDROCARBONS LTD	
WASKADA UNIT 10 WELL LOCATION MAP	
Scale 1:25000	Date APR. '86
Geology:	Contour Interval:
Revised:	File: Drafting: PAB

Waskada Unit No. 10
PGRT Exemption Calculation

Original Oil In Place Determination (Based on Log Evaluation)

Assuming that $A\phi h = 108.8 \text{ ha-m}$ $Sw_i = 0.50$ $Bo_i = 1.15 \text{ Rm}^3/\text{m}^3$

$$\text{Waskada Unit No. 10 Original Oil In Place} = \frac{10114 A\phi h(1-Sw_i)}{Bo_i} = 478440\text{m}^3$$

The reservoir parameters used in this calculation are the same as those used in the determination of the Unit tract participation factors.

Recoverable Oil Calculations

Based on decline curve analysis it is anticipated that the primary recovery factor for Waskada Unit No. 10 will be 4.2% OOIP. ⁽¹⁾ Using secondary recovery estimates for similar types of reservoirs we expect an ultimate recovery after waterflooding of approximately 9.2% OOIP. Given the above mentioned assumptions one can calculate the following recoverable reserves,

$$\text{Waskada Unit No. 10 Primary Oil Reserves} = (0.042)(478440) = 20140\text{m}^3$$

$$\text{Waskada Unit No. 10 Ultimate Oil Reserves} = (0.092)(478440) = 44016\text{m}^3$$

PGRT Exemption Calculation

The cumulative oil production up to 1986 03 31 for Waskada Unit No. 10 was 11680m³.

$$\text{Remaining Recoverable Oil} = 44016 - 11680 = 32336\text{m}^3$$

$$\text{Remaining Recoverable Incremental Oil} = 44016 - 20140 = 23876\text{m}^3$$

$$\text{PGRT Exempt Percentage} = \frac{(23876)(100)}{(32336)} = 73.84\%$$

Based on the guidelines contained within Information Letter EMR/PRB 86-01, this calculation indicates that 73.84% of the total oil production produced from Waskada Unit No. 10 is entitled to PGRT Exemption.

(1) Omega Hydrocarbons Ltd., "Waskada Mission Canyon 3aC Pool, Waterflood Application", January, 1986.

*** STORE ***
 OMEGA PRODUCTION DATA BASE
 WASKADA UNIT NO. 10 HISTORY

Omega
 86-05-05
 12:48:48

MONTH	PRDN	WELL COUNT	INJN	P/IN	S/AB	HOURS	OIL	WATER	GAS	I.WATER	WOR	GOR	CUM.OIL	CUM.WAT	CUM.GAS	C.I.WAT
							m3/M	m3/M	km3/M	m3/M	m3/m3	m3	m3	m3	km3	m3
1982-06	1	0	0	0	0	1921	49.61	0.01	0.01	0.01	0.001	01	49.61	0.01	0.01	0.0
1982-07	1	0	0	0	0	6001	124.11	0.01	0.01	0.01	0.001	01	173.71	0.01	0.01	0.0
1982-08	1	0	0	0	0	7201	98.41	30.91	0.01	0.01	0.311	01	272.11	30.91	0.01	0.0
1982-09	1	0	0	0	0	6721	89.71	5.01	0.01	0.01	0.061	01	366.81	35.91	0.01	0.0
1982-10	2	0	0	0	0	5351	95.31	19.81	0.01	0.01	0.211	01	456.11	55.71	0.01	0.0
1982-11	2	0	0	0	0	17121	160.61	37.61	0.01	0.01	0.231	01	616.71	93.31	0.01	0.0
1982-12	2	0	0	0	0	11401	107.11	22.81	2.91	0.01	0.211	821	723.81	116.11	8.81	0.0
1983-01	2	0	0	0	0	13501	110.31	140.71	3.41	0.01	1.281	311	834.11	256.81	12.21	0.0
1983-02	2	0	0	0	0	12721	186.41	164.41	3.11	0.01	0.881	171	1020.51	421.21	15.31	0.0
1983-03	2	0	0	0	0	13281	245.91	89.11	28.31	0.01	0.361	1151	1266.41	510.31	43.61	0.0
1983-04	2	0	0	0	0	14401	303.81	82.51	9.31	0.01	0.271	311	1570.21	572.81	52.91	0.0
1983-05	2	0	0	0	0	14201	238.81	171.51	12.81	0.01	0.721	541	1809.01	764.31	65.71	0.0
1983-06	3	0	0	0	0	15211	312.11	167.71	21.01	0.01	0.541	671	2121.11	932.01	86.71	0.0
1983-07	6	0	0	0	0	28071	608.81	469.61	41.91	0.01	0.771	691	2729.91	1401.61	128.61	0.0
1983-08	6	0	0	0	0	42611	855.61	821.91	71.61	0.01	0.961	841	3585.51	2223.51	200.21	0.0
1983-09	6	0	0	0	0	40231	579.41	998.51	22.11	0.01	1.721	381	4164.91	3222.01	222.31	0.0
1983-10	6	0	0	0	0	44161	599.91	1080.41	65.91	0.01	1.891	1101	4764.81	4302.41	289.21	0.0
1983-11	6	0	0	0	0	43041	454.41	793.41	65.91	0.01	1.751	1451	5219.21	5095.81	354.11	0.0
1983-12	6	0	0	0	0	44641	366.81	701.81	51.51	0.01	1.911	1401	5586.01	5797.61	405.61	0.0
1984-01	6	0	0	0	0	43941	172.81	524.61	36.11	0.01	3.041	2091	5758.81	6322.21	441.71	0.0
1984-02	6	0	0	0	0	41761	190.41	445.61	42.71	0.01	2.341	2241	5949.21	6767.91	484.41	0.0
1984-03	6	0	0	0	0	43361	228.01	611.21	47.21	0.01	2.681	2071	6177.21	7379.01	531.61	0.0
1984-04	6	0	0	0	0	37341	183.91	708.01	25.21	0.01	3.851	1371	6361.11	8087.01	556.81	0.0
1984-05	6	0	0	0	0	36721	196.91	1063.71	14.91	0.01	5.401	761	6558.01	9150.71	571.71	0.0
1984-06	6	0	0	0	0	38241	147.21	1225.11	18.01	0.01	8.321	1221	6705.21	10375.81	589.71	0.0
1984-07	6	0	0	0	0	39311	213.91	1195.71	12.41	0.01	5.591	581	6919.11	11571.51	602.11	0.0
1984-08	5	0	0	1	1	38401	309.41	908.81	22.01	0.01	2.941	711	7228.51	12480.31	624.11	0.0
1984-09	6	0	0	0	0	38441	225.21	903.51	11.71	0.01	4.011	521	7453.71	13383.81	635.81	0.0
1984-10	6	0	0	0	0	44631	190.81	1275.11	16.11	0.01	6.681	841	7644.51	14658.91	651.91	0.0
1984-11	6	0	0	0	0	40971	222.01	669.81	8.91	0.01	3.021	401	7866.51	15328.71	660.81	0.0
1984-12	6	0	0	0	0	42301	178.81	919.61	11.01	0.01	5.141	621	8045.31	16248.31	671.81	0.0
1985-01	6	0	0	0	0	38241	224.61	1163.91	8.71	0.01	5.181	391	8269.91	17412.21	680.51	0.0
1985-02	6	0	0	0	0	40321	189.11	1115.01	11.41	0.01	5.901	601	8459.01	18527.21	691.91	0.0
1985-03	6	0	0	0	0	44321	203.01	1299.41	11.21	0.01	6.401	551	8662.01	19826.61	703.11	0.0
1985-04	6	0	0	0	0	40141	176.31	1124.91	10.81	0.01	6.331	411	8876.31	20951.51	715.91	0.0
1985-05	6	0	0	0	0	44401	154.31	1263.31	15.51	0.01	6.191	371	8992.11	22215.11	727.41	0.0
1985-06	6	0	0	0	0	38221	221.31	1079.41	12.51	0.01	4.881	581	9213.91	23294.51	739.51	0.0
1985-07	6	0	0	0	0	39251	192.51	1133.71	9.31	0.01	5.291	481	9406.41	24428.21	749.21	0.0
1985-08	6	0	0	0	0	35731	163.61	1414.81	9.81	0.01	6.651	601	9570.01	25943.01	759.01	0.0
1985-09	7	0	0	0	0	38661	338.21	1164.31	16.91	0.01	3.441	501	9908.21	27007.31	775.91	0.0
1985-10	7	0	0	0	0	42201	254.41	1422.81	19.21	0.01	5.591	721	10162.61	28430.11	794.11	0.0
1985-11	7	0	0	0	0	40961	293.71	1432.31	19.51	0.01	4.891	631	10456.31	29862.41	812.61	0.0
1985-12	7	0	0	0	0	38951	311.81	1240.61	18.41	0.01	5.981	591	10769.11	31103.01	831.01	0.0
1986-01	7	0	0	0	0	38431	376.91	1463.21	16.01	0.01	3.881	421	11145.01	32566.21	847.01	0.0
1986-02	6	1	0	0	0	28631	285.61	601.91	12.11	183.21	2.111	421	11430.61	33168.11	859.11	183.2
1986-03	5	2	0	0	0	31841	249.51	659.41	13.61	2742.01	2.641	551	11680.11	33327.51	872.71	2925.2

LIST OF WELLS

(2)05-26-001-26 W1M(0) (2)11-26-001-26 W1M(0) (0)12-26-001-26 W1M(0)
 (2)13-26-001-26 W1M(0) (2)02-27-001-26 W1M(0) (2)03-27-001-26 W1M(0)
 (0)06-27-001-26 W1M(0)



Energy and Mines

Petroleum

555 — 330 Graham Avenue
Winnipeg, Manitoba, CANADA
R3C 4E3

(204) 945-6577

February 27, 1986

Omega Hydrocarbons Ltd.
1300 Sun Life Plaza III
112 - 4th Avenue S.W.
Calgary, Alberta
T2P 0H3

Attention: R. A. Beamish, P. Eng.
Manager, Engineering

Dear Bob:

Re: Board Order No. PM 46
Waskada Unit No. 10

Enclosed is Oil & Natural Gas Conservation Board Order No. PM 46 authorizing pressure maintenance operations in the Waskada Unit No. 10.

You are referred to Pressure Maintenance Rule No. 8 which limits injection wellhead pressure to 8 000 kPa.

Please notify the Waskada District Office of the Petroleum Branch prior to initiating water injection.

Yours sincerely,

L. R. Dubreuil
Chief Petroleum Engineer

LRD/lk

c.c. Waskada Office

Manitoba

→ Bob



Memorandum

Date February 20, 1986

To The Oil and Natural Gas Conservation Board

From H. Clare Moster
Director, Petroleum Branch

Charles S. Kang - Chairman
Wm. McDonald - Deputy Chairman
J. F. Redgwell - Member

Telephone

Subject Waskada Mission Canyon 3a C Pool

Pressure Maintenance Operations

Omega Hydrocarbons Ltd. have made application for approval to conduct pressure maintenance operations in the subject Pool by conversion of two wells to water injection. Notice of the application was published in the Manitoba Gazette (January 25, 1986) and was sent to offsetting working interest owners. No objections to the application were received.

Recommendation:

It is recommended that the application be approved and that Board Order No. PM 46 (copies attached) be issued.

Discussion:

The proposed Board Order No. PM 46 includes all the normal relevant provisions included in recent pressure maintenance Board Orders. Note that Pressure Maintenance Rule No. 5 limits wellhead injection pressure to 8 000 kPa to ensure reservoir fracturing does not occur.

Original Signed by H. C. Moster

H. Clare Moster

LRD/1k

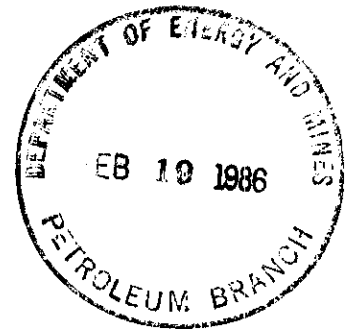
First Fold

Inter-Departmental Memo

To *Mr. Deschamps*Date *February 19, 1986*
From *Louise Lafontaine*
*Legal Translation*Subject *Our file # 29936*Telephone *945-3903*

Please find enclosed the translation of the Certificate
for Order no PM 46. Your original is also attached.

Louise Lafontaine



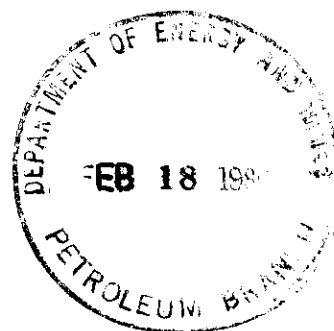
MANIT^{BA}

Inter-Departmental Memo

To *Bob Debraud*Date *February 18, 1980*
From *Genevieve Lafontaine*
*Legal Translation*Subject *Our File # 29912*Telephone *945-2902*

Please find enclosed the translation of the
Order No PM46.

Genevieve Lafontaine





Date: Feb 11, 1986

Action / Route Slip

To: P. BENTZ

From: Bob Dubreuil

LEGAL TRANSLATION

Petroleum Branch

6TH FLOOR

Energy & Mines 555-3306 RM

177 LOMBARD AVE

Telephone: 6574

- | | | | | |
|---|---|--|---|--|
| <input checked="" type="checkbox"/> Take Action | <input type="checkbox"/> Per Your Request | <input type="checkbox"/> Circulate, Initial and Return | <input type="checkbox"/> For Approval and Signature | <input type="checkbox"/> Make _____ Copies |
| <input type="checkbox"/> May We Discuss | <input type="checkbox"/> For Your Information | <input type="checkbox"/> Return With Comments or Revisions | <input type="checkbox"/> Draft Reply for Signature | <input type="checkbox"/> Please File |

Comments: ATTACHED IS CN & NATURAL GAS CONSERVATION
BOARD ORDER NO. PM 46 WHICH REQUIRES
TRANSLATION INTO FRENCH. PLEASE CALL WHEN THE
ORDER IS READY SO WE CAN HAVE IT PICKED UP

Dent Feb 11

January 14, 1986

Queen's Printer
Statutory Publications
200 Vaughan Street

L. R. Dubreuil
Chief, Petroleum Engineer
Petroleum Branch
555 - 330 Graham Avenue

MANITOBA GAZETTE

945-6574

Please have the attached Notice appear in the next issue of the
Manitoba Gazette under The Mines Act.

L. R. Dubreuil

LRD/ch
Attachment



The Oil and Natural Gas
Conservation Board

Room 309
Legislative Building
Winnipeg, Manitoba, CANADA
R3C 0V8

(204) 945-3130

NOTICE

Omega Hydrocarbons Ltd., as operator of the proposed Waskada Unit No. 10, has made application under The Mines Act for approval to conduct pressure maintenance operations in a portion of the Waskada Mission Canyon 3a C Pool. It is proposed to convert the following wells to water injection:

Omega Waskada 13-26MC3a-1-26 (WPM)

Omega Waskada 3-27MC3a-1-26 (WPM)

If no intervention or objection in writing is received by the Board at Room 309, Legislative Building, Winnipeg, Manitoba, R3C 0V8, within 14 days of the publication of this notice, the Board may approve the application.

Dated at Winnipeg, this 10th day of January, 1986.

A handwritten signature in black ink, appearing to read "Charles S. Kang". The signature is written in a cursive, flowing style.

Charles S. Kang
Chairman



Memorandum

Da. January 9, 1986

To The Oil and Natural Gas
Conservation Board

From H. Clare Moster

Charles S. Kang - Chairman

Wm. McDonald - Deputy Chairman

Telephone

J. F. Redgwell - Member

Subject

Pressure Maintenance - Waskada MC3a C Pool

Omega Hydrocarbons Ltd., as operator of the proposed Waskada Unit No. 10, has made application for approval to conduct pressure maintenance operations in the Waskada MC3a C Pool. Omega proposes to inject water in two wells (located in Lsd 13 of Section 26-1-26 and in Lsd 3 of Section 27-1-20).

Recommendations:

It is recommended that notice of the application be published in the Manitoba Gazette and the Melita New Era and sent to offsetting working interest owners. A proposed notice is attached.

In the absence of objections to the notice, it is recommended that the application be approved, and that an appropriate Board Order be issued.

Discussion:

The Waskada MC3a C Pool was discovered in June 1982 with the completion of the well Omega Waskada 6-27-1-26 in the Mission Canyon 3a zone over the interval 922.5 to 928.0 m kB. The Pool has since been developed over an area of 520 acres (208 ha) and currently includes 8 producing wells (see Figure No. 1).

The Mission Canyon 3a zone is the lower porous unit of the Mission Canyon 3 member. This zone can be defined as the interval 958.0 to 967.5 m kB on the BHC Sonic Log for the well Chevron Waskada Prov. 4-20-1-25 (WPM). Where wells are drilled deep enough to penetrate the MC-2 marker (975 m kB on Fig. 2) it is usually quite easy to distinguish the MC3a zone from the overlying MC3b zone. However, in the area of the MC3a C Pool, many wells do not penetrate the MC2 marker. As a result of this, there have been differing interpretations of the extent of this Pool.

A review of Figure No. 1 indicates some discrepancies between the proposed waterflood area and the current Board designated Pool boundaries. These are discussed individually below.

1. Lsd 13-26-1-26 Originally this spacing unit was thought to be productive in the MC3b zone. Review of the logs indicates the well is probably completed in the MC3a. Pool boundaries will be revised to reflect this.
2. Lsd 12-27-1-26 The well in this spacing unit is completed in both the MC3a and MC3b zones. It appears the MC3b zone is tight in this well and that most of the production is originating in the MC3a C Pool.
3. Other areas where the Pool and waterflood areas differ are either not operated by Omega or do not have a completed well. These will be reviewed individually and appropriate modifications to the Pool boundaries will be made.

Figure No. 3 shows Pool Oil Production in m^3 per month. Pool production peaked at approximately $870 \text{ m}^3/\text{month}$ in mid 1983 and has since declined to about $300 \text{ m}^3/\text{month}$. Projecting an average decline curve to abandonment conditions ($120 \text{ m}^3/\text{month}$ - per Omega's application) a remaining primary reserve (as per October 31, 1985) of approximately $8\ 100 \text{ m}^3$ is estimated. This is approximately equivalent to the primary reserves estimated by Omega.

Although it is difficult to quantify the incremental reserves that would be realized through waterflooding, the performance of the only other waterflood in the Mission Canyon (Waskada MC3b A Pool) and the apparent good reservoir continuity suggests that an increase in recoverable reserves may be significant.

Figure No. 4 shows proposed injection locations and estimated ultimate areal sweep. It is estimated that 40 - 50% of the original oil-in-place would be recovered in the swept areas. It is also noted that areal sweep could be substantially improved if wells in Lsd's 1 and 9 of Section 27-1-26 (WPM) were re-activated.

While the proposed waterflood area is wholly owned by Omega (i.e. - 100% working interest), several offset tracts are operated by other companies. Because of this and evidence from the MC3b A Pool waterflood that injection response occurs quite dramatically and could effect wells more than one location removed from injection, notice of the application should be published. It is proposed that the notice be published in the Manitoba Gazette, and the Melita New Era and sent to offsetting working interest owners (see Table No. 1).

Completion of the wells and proposed surface facilities are similar to current facilities in use for the Waskada Lower Amaranth A Pool Waterflood and are acceptable.

Fracture gradient calculations indicate reservoir fracturing could occur at pressures of 8 700 kPa or greater. Inasmuch as it is not normally necessary to fracture the Mississippian on completion, injection pressures should not exceed this pressure. A limiting injection pressure of 8 000 kPa is proposed to provide a margin of safety. This compares to Omega's proposed maximum injection wellhead pressure of 10 000 kPa.

Original Signed by H. C. Moster

H. Clare Moster

LRD/HCM/lk



The Oil and Natural Gas
Conservation Board

Room 309
Legislative Building
Winnipeg, Manitoba, CANADA
R3C 0V8

(204) 945-3130

NOTICE

Omega Hydrocarbons Ltd., as operator of the proposed Waskada Unit No. 10, has made application under The Mines Act for approval to conduct pressure maintenance operations in a portion of the Waskada Mission Canyon 3a C Pool. It is proposed to convert the following wells to water injection:

Omega Waskada 13-26MC3a-1-26 (WPM)

Omega Waskada 3-27MC3a-1-26 (WPM)

If no intervention or objection in writing is received by the Board at Room 309, Legislative Building, Winnipeg, Manitoba, R3C 0V8, within 14 days of the publication of this notice, the Board may approve the application.

Dated at Winnipeg, this day of January, 1986.

Charles S. Kang
Chairman

TABLE NO. 1
WASKADA MC3a C POOL
OFFSETTING WORKING
INTEREST OWNERS

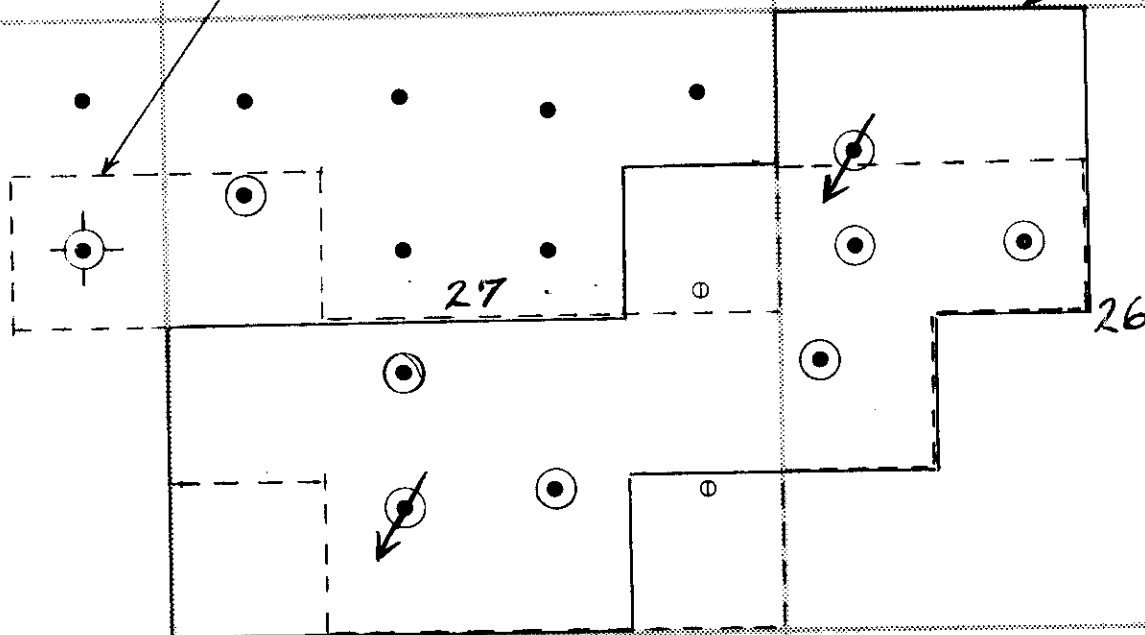
<u>Working Interest Owner</u>	<u>Area</u>
✓ Andex Oil Company Ltd.	NE $\frac{1}{4}$ -26 NE $\frac{1}{4}$ -28 NE $\frac{1}{4}$ -21
✓ Shell Canada Resources	NE $\frac{1}{4}$ -26 NE $\frac{1}{4}$ -28 NE $\frac{1}{4}$ -21
✓ Chauvco Resources Ltd.	NE $\frac{1}{4}$ -28 NE $\frac{1}{4}$ -21
✓ Petro Star Petroleum Ltd.	NE $\frac{1}{4}$ -28 NE $\frac{1}{4}$ -21
✓ Roxy Petroleum Ltd.	NE $\frac{1}{4}$ -28 NE $\frac{1}{4}$ -21

251

FIG. No. 1

CURRENTLY DESIGNATED
WASKADA MC3wC Pool

PROPOSED
BOUNDARY
WASKADA UNIT
No. 10



NOTE: ONLY MISSISSIPPIAN
COMPLETIONS SHOWN

⊙ MC3wC Pool Producers

⊕ FORMER PRODUCER
MC3wC Pool

FIG. No. 2

Gamma Ray - BHC Sonic
Log.

Chevron Waskada Prov
4-20-1-25 (WAM)

00925

MC3b

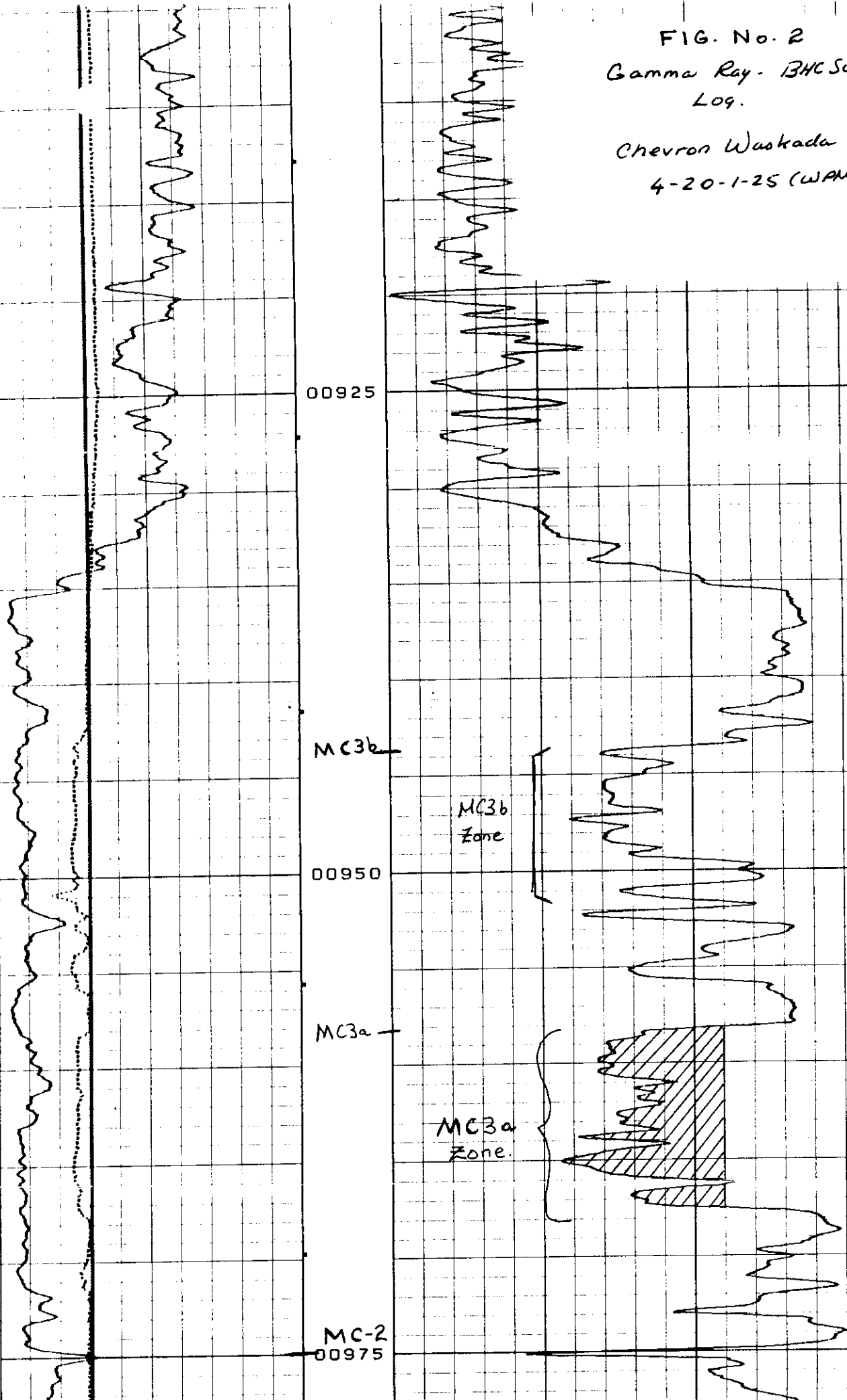
MC3b
Zone

00950

MC3a

MC3a
Zone

MC-2
00975



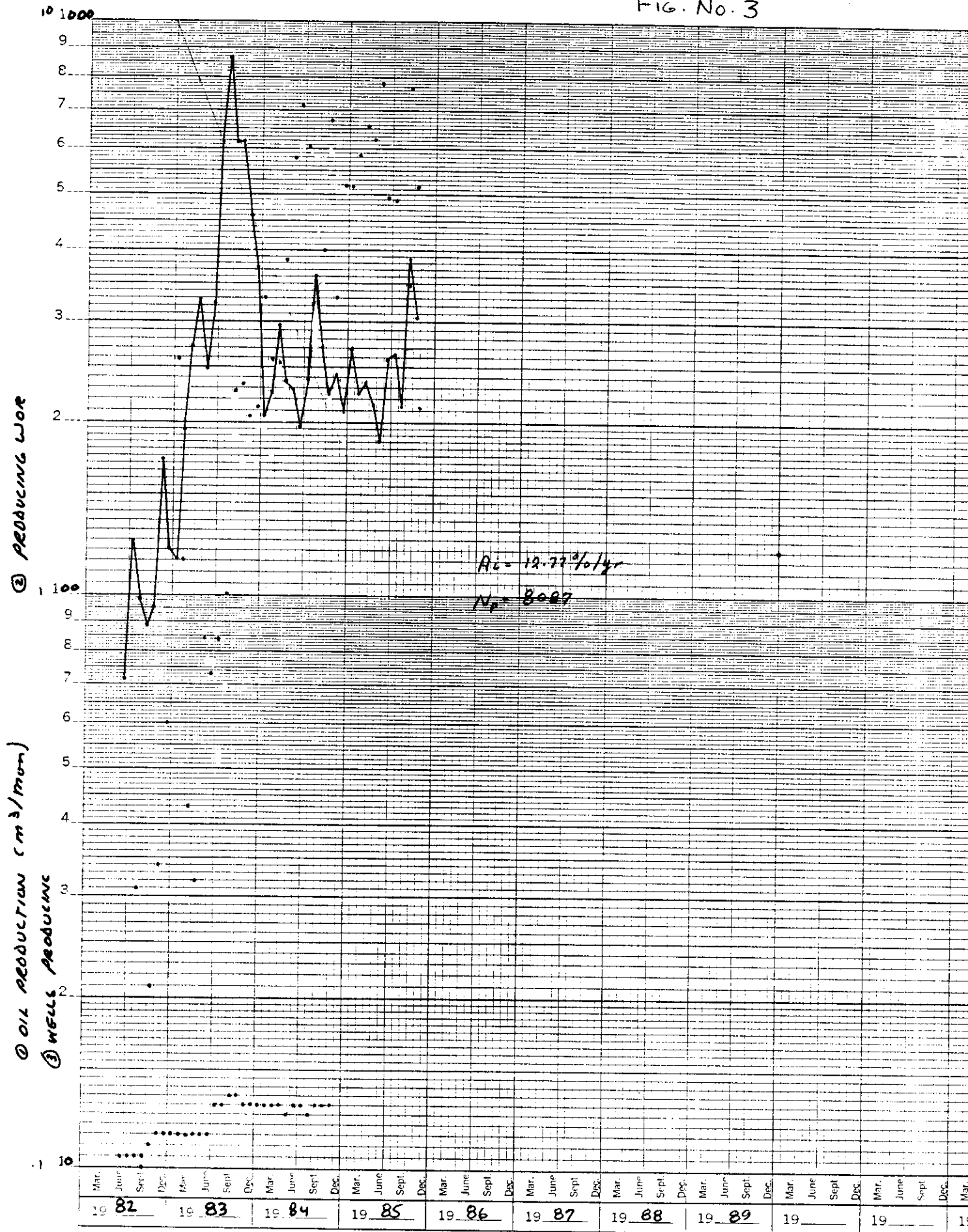
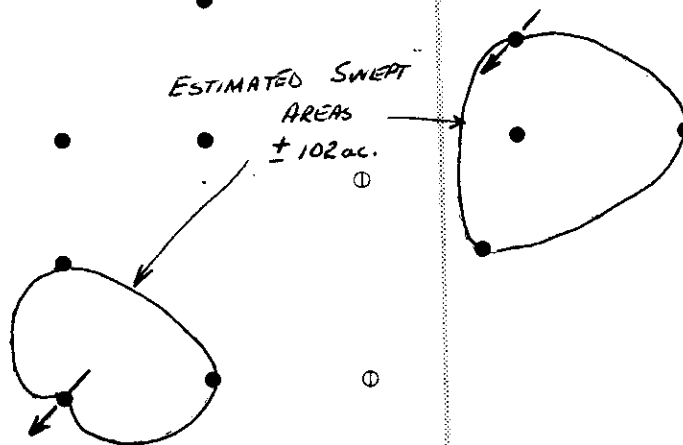


FIG No. 4.
WASKADA MC3aC Pool

Waterflood - Swept Area

251



Proposed Water Injection Wells

Fracture considerations

$$\text{Depth} = 930 \text{ m k B} = 3051 \text{ ft}$$

$$\text{Fracture gradient} = 0.85 \text{ psi/ft} \quad (\text{Fig 1.17 - Hydraulic Fracturing - Howard/Fas})$$

$$\text{Hydrostatic head} = 0.433 \text{ psi/ft}$$

Allowable WHP (ignoring friction)

$$\begin{aligned} &= 3051 (0.85 - 0.433) = 1272 \text{ psi} \\ &= 8771 \text{ kPa} \end{aligned}$$

Recommend limit of 8000 kPa

Manitoba



Action / Route Slip

Date: January 9, 1986

To: Charles S. Kang

From: H. Clare Moser

Telephone: _____

☐ Take Action

☐ Per Your Request

☐ Circulate, Initial
and Return

☒ For Approval and
Signature

☐ Make _____ Copies

☐ May We Discuss

☐ For Your Information

☐ Return With Comments
or Revisions

☐ Draft Reply for
Signature

☐ Please File

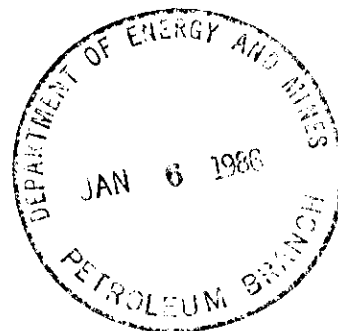
Comments Pressure Maintenance - Waskada Unit No. 10 (MC3a-C)

Please return signed copies of Notice to this Branch.



1300 SUN LIFE PLAZA III
112 - 4th AVENUE S.W.
CALGARY, ALBERTA, CANADA T2P 0H3
TELEPHONE (403) 261-0743

January 3, 1986



The Oil and Natural Gas
Conservation Board
555 - 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3

Attention: Mr. C. Kang, Chairman

Dear Sir:

Re: Pressure Maintenance by Water Injection
Waskada Mission Canyon 3aC Pool

Omega Hydrocarbons Ltd. hereby makes application for approval to conduct an enhanced recovery operation by injection of water into the captioned pool for the purpose of enhancing oil recovery.

The effective area of this pool is shown on Attachment No. 1 by the outline of the boundary of the proposed Waskada Unit No. 10, except for Lsd. 1-27-1-26 WPM. It is anticipated that the unit will be enlarged to include this Lsd. when we have established the production capability of the well 1-27 following its stimulation.

The names of the mineral owners, lessees, and surface owners within and adjoining the scheme area are shown on Attachments No. 2, 3 and 4, respectively. Also enclosed is a copy of the letter used to notify these surface owners of our intentions.

This Mission Canyon pool underlies a portion of the wide spread Lower Amaranth pool, which in this area has been unitized and has enhanced oil recovery by water injection. Satellite battery facilities located in Lsd.'s 7-26 and 7-27 serve the area for both production and water injection supply. These satellites are connected to the main facilities located in Lsd. 11-30-1-25 WPM. Attachment No. 5 is a schematic diagram of the water supply and injection system which will serve this project. Also included on this attachment is a schematic diagram of our standard method for equipping injection wells. Corrosion prevention methods also include cathodic protection, internally coated flowlines and well treatments. Regular chemical treatments

.../2

Mr. C. Kang, Chairman
January 3, 1985
Page 2

with XC-320 at each production well are utilized to combat bacterial corrosion.

It is proposed initially to convert two wells for water injection and these are the Lower Alida wells located in Lsd. 13-26-1-26 WPM and Lsd. 3-27-1-26 WPM. The Alida zone well location in Lsd. 9-27-1-26 WPM will initially serve as an observation well. Prior to commencement of injection bottomhole pressure measurements will be taken at each of the proposed injectors. Wellhead injection pressure will not exceed 10,000 kPa. It is anticipated that production and injection data will require monthly reporting as is done for the existing Lower Amaranth water floods.

The original oil in place in the pool is estimated to be 478,440 m³ based on the following:

- a) porous rock volume of 108.8 ha-m (derived from Attachment No. 1 and utilized for unit participation where the area was in acres, with data developed from sixteen readings per 40 acre tract).
- b) the water saturation is estimated to be 50%, and
- c) the oil formation volume factor utilized is 1.15, based on the Reservoir Fluid Study of the Lower Alida oil sample from well 8-24-1-26 WPM (copy of study enclosed).

Under the current primary producing mechanism the cumulative oil production to 85-11-30 is 10,576.6 m³, and it is estimated that ultimate primary recovery will be 20,140 m³ or 4.2% of the original oil in place. This volume is based on decline from the November, 1985 rate of 420 m³/month at approximately 75% per year to the economic limit for eight wells of 4 m³/day (mid 1989).

It is estimated that an additional recovery of 5% can be achieved by initiating water injection. Commencement of injection will be carried out upon approval of this application and unitization.

Respectively submitted

OMEGA HYDROCARBONS LTD.

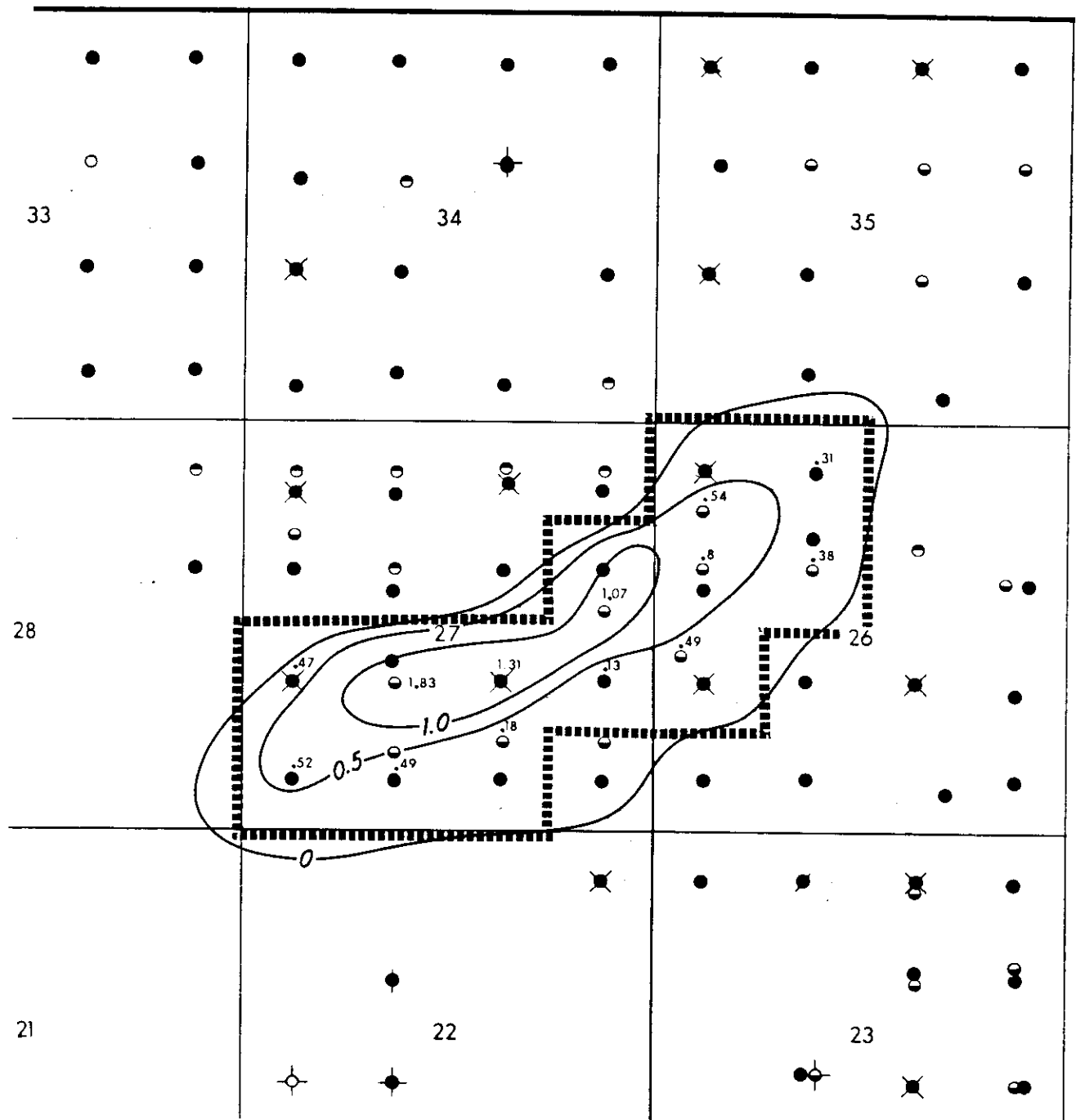
R.A. Beamish

R.A. Beamish
Manager, Engineering

Attachments

c.c. R. Dubreuil - Manitoba Petroleum Branch

R.26W1



T. 1

- SPEAR FISH OIL WELL
- UPPER ALIDA (MC 3b) WELL
- LOWER ALIDA (MC 3a) WELL
- TILSTON (MC 1) WELL
- ◆ SUSPENDED WELL
- PROPOSED DRILLING LOCATION
- ✱ WATER INJECTION WELL
- ✱ GAS INJECTION WELL
- ⊕ WATER SOURCE WELL
- ⊕ ABANDONED WELL

OMEGA HYDROCARBONS LTD

WASKADA MISSION CANYON
WATER FLOOD

PROPOSED UNIT 10

øh MAP

C.I.=.5 POROSITY METRES

----- PROPOSED UNIT OUTLINE

SCALE: 1:25000

DATE: NOV. 1985

ATTACHMENT No. 1

Lessor Map In and Adjoining The

Proposed Waskada Unit No. 10

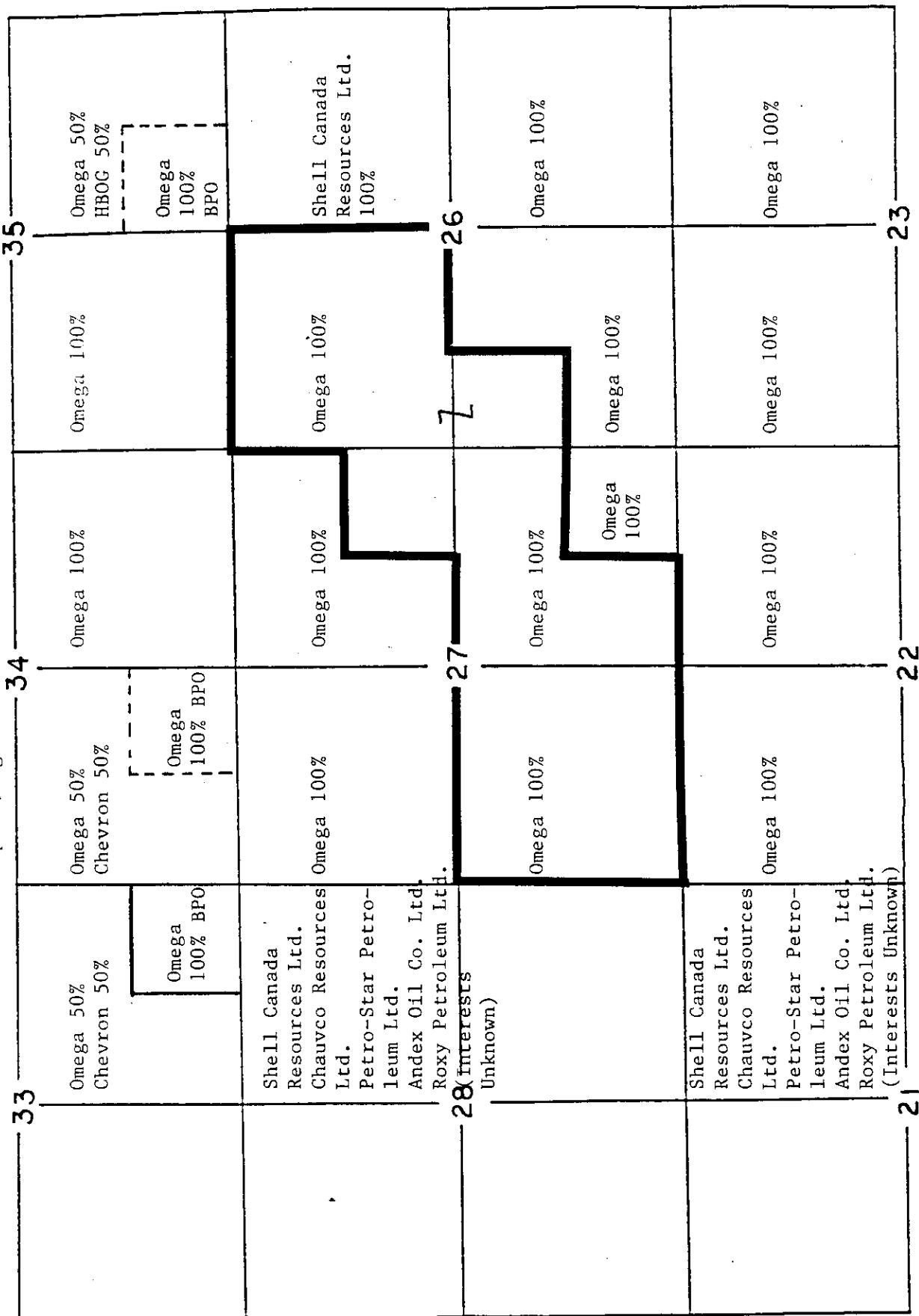
Twp. 1, Rge. 26 WPM

33	S.R. Young 50% Ovey Oils Limited 50%	S.R. Young 100%	Manitoba Dept. of Energy & Mines	Moamco Enterprises Ltd.	Moamco Enterprises Moamco Enterprises Ltd.	35
	60867 Manitoba Ltd. 100%	Pop's Oil Ltd.	Pop's Oil Ltd.	63785 Manitoba Ltd.	Rowe Mini Ltd. 100%	
28	60867 Manitoba Ltd. 100%	Pop's Oil Ltd.	Pop's Oil Ltd.	60785 Manitoba Ltd.	70361 Manitoba Ltd.	26
	60867 Manitoba Ltd.	R.J. Smart	Manitoba Dept. of Energy & Mines	John Wilfred Hainsworth 25% Olive Hainsworth 25% Catherine Mary Thomas 25% Nancy Louise Goede 25%	64440 Manitoba Ltd. 100%	23
21						22

RGE 26 WPM

Lessee Map In And Adjoining The
Proposed Waskada Unit No. 10

Twp. 1, Rge 26 WPM



RGE 26 WPM

33

McKinney Farms
Ltd.

Marvin George
Rowe

Marvin George
Rowe

Marvin George
Rowe

Marvin George
Rowe

Donald Keith
Millar &
Donna Laura Ann
Millar

Larry Millar

Larry Millar

Jean Olson
(As Committee of
the estate of
Mary Doerfler)

Roland J.
Hainsworth

28

Donald Keith
Millar &
Donna Laura Ann
Millar

Larry Millar

Larry Millar

Jean Olson
(As Committee
of the estate of
Mary Doerfler)

Roland J.
Hainsworth

Robert J. Smart

Robert J. Smart

Robert J. Smart

Joyce Elaine
Hainsworth

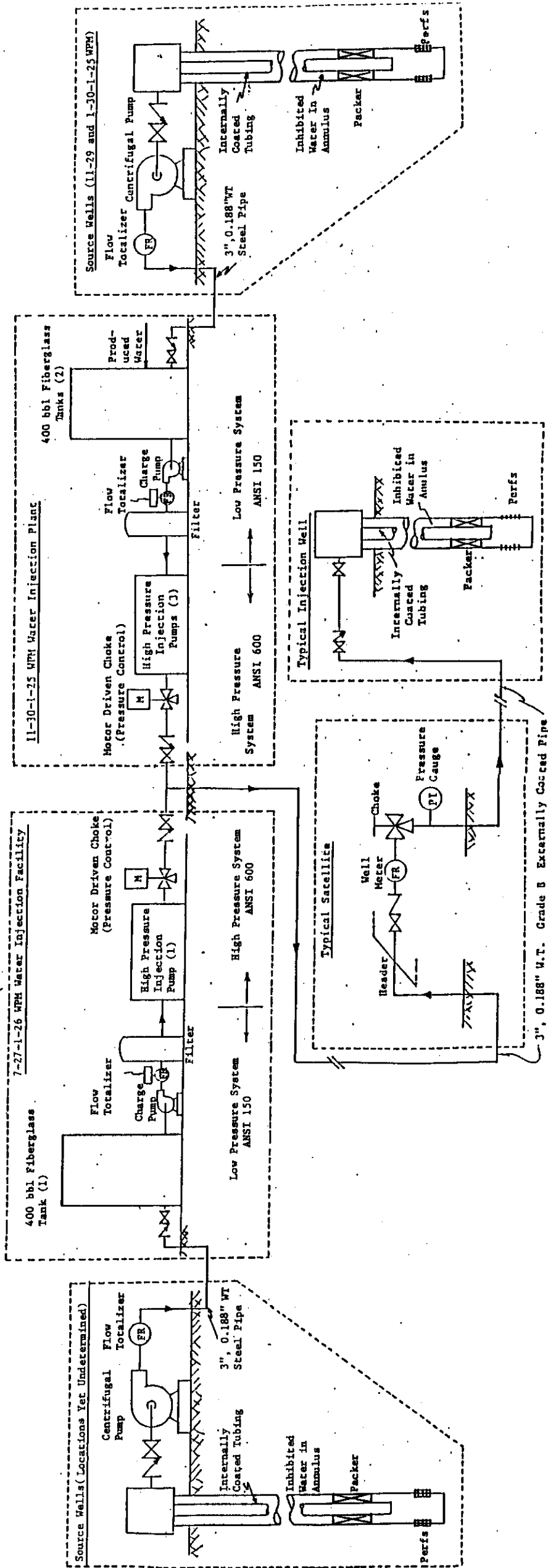
Joyce Elaine
Hainsworth

2

22

23

RG E 26 WPM





1300 SUN LIFE PLAZA III
112 - 4th AVENUE S.W.
CALGARY, ALBERTA, CANADA T2P 0H3
TELEPHONE (403) 261-0743

January 3, 1985

Proposed Waskada Unit No. 10
Surface Owners (In and Adjoining the Unit Area)
(Addressee list attached)

Dear Sir/Madam:

Re: Enhanced Oil Recovery by Water Injection
Proposed Waskada Unit No. 10

The purpose of this letter is to inform you that Omega Hydrocarbons Ltd. intends to initiate enhanced oil recovery by water injection in the captioned unit area, which comprises Lsd.'s 5, 11, 12, 13 and 14 of Section 26-1-26 WPM and Lsd.'s 2, 3, 4, 5, 6, 7, 8 and 9 of Section 27-1-26 WPM.

The enhanced oil recovery scheme for this Lower Alida zone (Mississippian) pool will involve the injection of produced water into wells 13-26-1-26 WPM and 3-27-1-26 WPM to maintain reservoir pressure and "sweep" oil towards the offsetting production wells. The performance of the waterflood will be evaluated by continually monitoring injection and production data.

If you have any comments or questions related to the proposed project please contact either myself or Mr. Richard Brekke at (403) 261-0743.

Yours truly,

OMEGA HYDROCARBONS LTD.

R.A. Beamish
R.A. Beamish, P. Eng.
Manager, Engineering

RAB/cia

c.c. C.S. Kang, Manitoba Board
R. Dubreuil, Manitoba Petroleum Branch

Proposed Waskada Unit No. 10

Surface Owners

ADDRESSEE LIST

McKinney Farms Ltd.
Box 70
Waskada, Manitoba
ROM 2E0

Donald Keith Millar
& Donna Laura Ann Millar
Waskada, Manitoba
ROM 2E0

Robert J. Smart
Box 85
Waskada, Manitoba
ROM 2E0

Marvin George Rowe
Unit 3, 1920 - 31st St. S.W.
Calgary, Alberta
T3E 2M9

Larry Millar
Box 104
Deloraine, Manitoba
ROM 0M0

Jean Olson
(As Committee of the
estate of Mary Doerfler)
Spy Hill, Saskatchewan
SOA 3W0

Roland J. Hainsworth
Box 99
Waskada, Manitoba
ROM 2E0

Joyce Elaine Hainsworth
Box 99
Waskada, Manitoba
ROM 2E0

CORE LABORATORIES - CANADA, LTD.



1982-04-07

Omega Hydrocarbons Ltd.
630, 330 - 5th Ave. S.W.
Calgary, Alberta
T2P 0L4

Attention: Mr. Ed Wyse

Reservoir Fluid Study

Omega Waskada 8-24-1-26 (W1M)
Waskada Field, Manitoba, Canada
Our File Number: 7013-82-34

Gentlemen:

Subsurface samples of reservoir oil were taken from the above subject well by a representative of Core Laboratories-Canada Ltd. on 1982-02-03. The samples were then submitted to our laboratory for a complete reservoir fluid study.

A portion of the reservoir fluid was transferred at high pressure to a high pressure-windowed cell and then heated at constant pressure to the reported reservoir temperature of 45.0°C. The pressure-volume relations of the fluid were measured during a constant expansion down to 1 241 kPa (gauge). The saturation pressure was determined to be 3 158 kPa (gauge) at 45.0°C. The results of this test are shown on pages 1 and 2 of this report.

During differential pressure depletion at 45.0°C, the fluid evolved a total of 45.40 cubic metres of gas at 101.325 kPa (absolute) and 15°C per unit of residual oil at 15°C. The associated formation volume factor was 1.150 units of saturated fluid at 3 158 kPa (gauge) and 45.0°C per unit of residual oil. The density of the liquid phase and the properties of the evolved gases were determined at several pressure levels below the saturation pressure during this depletion. The data obtained from these tests are summarized on page 3. The viscosity of the fluid was measured under similar depletion conditions at 45.0°C, from pressures exceeding the saturation pressure down to atmospheric pressure. The

Omega Hydrocarbons Ltd.

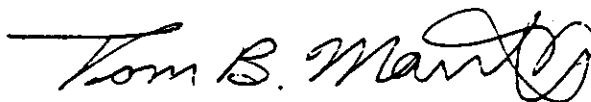
Omega Waskada 8-24-1-26 (WIM)

viscosity of the liquid phase varied from a minimum of 1.154 mPa•s at the saturation pressure to a maximum of 2.581 mPa•s at atmospheric pressure. The viscosity data is summarized on page 4.

The composition of the reservoir fluid was determined by low temperature, fractional distillation and is shown on pages 5 and 6.

Thank you for the opportunity to perform this study for you. Should you have any questions concerning the data, please contact us.

Yours truly,
CORE LABORATORIES-CANADA LTD.



Tom B. Martin

TG:cd

Page 1 of 15
 File 7013-82-34
 Well Omega Waskada
8-24-1-26 (W1M)

VOLUMETRIC DATA OF RESERVOIR FLUID SAMPLE

1. Saturation pressure (bubble point pressure) 3 158 kPa (gauge) @ 45.0 °C
2. Thermal expansion of saturated oil @ 34 474 kPa (gauge) = $\frac{V@ 45.0\text{ °C}}{V@ 22.2\text{ °C}}$ = 1.02196
3. Density at saturation pressure: 780.40 kg/m³ @ 45.0 °C
4. Compressibility of saturated oil @ reservoir temperature: Vol/Vol/MPa:

From	<u>3 158</u>	kPa to	<u>6 895</u>	kPa =	<u>11.29×10^{-4}</u>
From	<u>6 895</u>	kPa to	<u>10 342</u>	kPa =	<u>10.82×10^{-4}</u>
From	<u>10 342</u>	kPa to	<u>13 790</u>	kPa =	<u>9.97×10^{-4}</u>
From	<u>13 790</u>	kPa to	<u>20 684</u>	kPa =	<u>9.45×10^{-4}</u>
From	<u>20 684</u>	kPa to	<u>27 579</u>	kPa =	<u>8.91×10^{-4}</u>
From	<u>27 579</u>	kPa to	<u>34 474</u>	kPa =	<u>8.37×10^{-4}</u>

PRESSURE-VOLUME RELATIONS AT 45.0 °C

<u>Gauge Pressure, kPa</u>	<u>Relative Volume, V/Vsat (1)</u>	<u>Y Function (2)</u>
34 474	0.9707	
31 026	0.9734	
27 579	0.9763	
24 132	0.9792	
20 684	0.9823	
17 237	0.9854	
13 790	0.9887	
10 342	0.9921	
6 895	0.9958	
5 516	0.9974	
4 826	0.9982	
4 137	0.9989	
3 447	0.9997	
<u>3 158</u>	<u>1.0000</u>	
3 068	1.0121	2.356
2 965	1.0273	2.308
2 703	1.0742	2.188
2 448	1.1343	2.073
2 206	1.2103	1.962
1 931	1.3287	1.837
1 689	1.4759	1.724
1 448	1.6838	1.614
1 241	1.9389	1.521

(1) Cubic metres at indicated pressure and temperature per cubic metre of saturated oil.

(2) $Y = \frac{(P_{sat} - P)}{(P + 101.325)(\text{Relative Volume} - 1)}$

CORE LABORATORIES — CANADA LTD.
Petroleum Reservoir Engineering
CALGARY, ALBERTA

Page 3 of 15
File 7013-82-34
Well Omega Waskada
8-24-1-26 (W1M)

DIFFERENTIAL VAPORIZATION AT 45.0 °C

Gauge Pressure, kPa	Oil Density, kg/m ³	Relative Oil Volume (1)	Relative Total Volume (2)	Solution Gas/Oil Ratio (3)	Incremental Gas Density*	Cumulative Gas Density*	Deviation Factor Z	Gas Formation Volume Factor (4)	Gas Expansion Factor (5)
3 158	780.4	1.150	1.150	45.40					
2 772	781.6	1.145	1.226	43.22	0.877	0.877	0.946	0.03691	27.09
2 075	784.1	1.136	1.450	38.95	0.858	0.864	0.946	0.04873	20.52
1 407	787.4	1.124	1.932	33.97	0.878	0.870	0.951	0.07068	14.15
862	791.5	1.110	3.012	28.46	0.962	0.900	0.965	0.11229	8.91
0	817.4	1.025	51.252	0.00	1.175	1.073	1.000	1.10632	0.90

Gravity of Residual Oil = 37.3° API at 15.56°C

Density of Residual Oil = 837.4 kg/m³ at 15.56°C

* Relative Density (AIR = 1.000)

- (1) Cubic metres of oil at indicated pressure and temperature per cubic metre of residual oil at 15°C.
- (2) Cubic metres of oil plus liberated gas at indicated pressure and temperature per cubic metre of residual oil at 15°C.
- (3) Cubic metres of gas at 101.325 kPa (absolute) and 15°C per cubic metre of residual oil at 15°C.
- (4) Cubic metres of gas at indicated pressure and temperature per cubic metre at 101.325 kPa (absolute) and 15°C.
- (5) Cubic metres of gas at 101.325 kPa (absolute) and 15°C per cubic metre at indicated pressure and temperature.

VISCOSITY AT 45.0°C

<u>kPa Pressure, (gauge)</u>	<u>Oil Viscosity mPa·s</u>	<u>Gas Viscosity mPa·s</u>	<u>Oil/Gas Viscosity Ratio</u>
34 474	1.752		
31 026	1.685		
27 579	1.619		
24 132	1.554		
20 684	1.487		
17 237	1.422		
13 790	1.356		
10 342	1.290		
6 895	1.224		
<u>3 158</u>	<u>1.154</u>		
2 772	1.260	0.0113	111.50
2 075	1.532	0.0111	138.02
1 407	1.791	0.0109	164.81
862	2.070	0.0105	197.14
0	2.581	0.0095	271.68



SS481

HYDROCARBON LIQUID ANALYSIS

7013-82-34

CONTAINER IDENTITY

LABORATORY NUMBER

Omega Hydrocarbons Ltd.

5 of 15

PAGE

LSD 8-24-1-26 WTM

Omega Waskada 8-24-1-26

KB ELEV., m

GRD. ELEV., m

LOCATION

WELL OR SAMPLE LOCATION NAME

Waskada, Manitoba

Lower Alida

Core Laboratories

FIELD OR AREA

POOL OR ZONE

SAMPLER

TEST TYPE & NO.

TEST RECOVERY

Bottom Hole

@

°C

POINT OF SAMPLE

AMT. & TYPE CUSHION

MUD RESISTIVITY

PUMPING

FLOWING

GAS LIFT

SWAB

WATER

m³/d

OIL

m³/d

GAS

m³/d

TEST INTERVALS OR PERFS., m

Approx. 20 000

@

°C

@

°C

45.0

SEPARATOR RESERVOIR

CONTAINER WHEN SAMPLED

CONTAINER WHEN RECEIVED

SEPARATOR

PRESSURES, kPa (gauge)

TEMPERATURES, °C

1982-02-03

1982-03-31

DA

DATE SAMPLED (Y/M/D)

DATE RECEIVED (Y/M/D)

DATE ANALYSED (Y/M/D)

ANALYST

REMARKS

COMPONENT	MOLE FRACTION	MASS FRACTION	LIQUID VOL FRACTION
N ₂	.0056	.0011	.0011
CO ₂	.0034	.0010	.0010
H ₂ S	.0000	.0000	.0000
C ₁	.0814	.0092	.0240
C ₂	.0881	.0187	.0410
C ₃	.1072	.0333	.0514
iC ₄	.0184	.0075	.0105
C ₄	.0600	.0246	.0329
iC ₅	.0265	.0135	.0169
C ₅	.0278	.0141	.0176
C ₆ ⁺	.5816	.8770	.8036
TOTAL	1.0000	1.0000	1.0000

OBSERVED PROPERTIES OF C₆⁺ RESIDUE (15/15° C)

855.0
DENSITY kg/m³

.8558
RELATIVE DENSITY

33.9
API @ 15.5° C

214
RELATIVE MOLECULAR MASS

CALCULATED PROPERTIES OF TOTAL SAMPLE (15/15° C)

783.6
DENSITY kg/m³

.7843
RELATIVE DENSITY

49.0
API @ 15.5° C

141.92
RELATIVE MOLECULAR MASS

REMARKS

COMPANY
LOCATION
SAMPLED FROM

Omega Hydrocarbons Ltd.
LSD 8-24-1-26 WIM
Bottom Hole

PAGE
FILE

6 of 15
7013-82-34

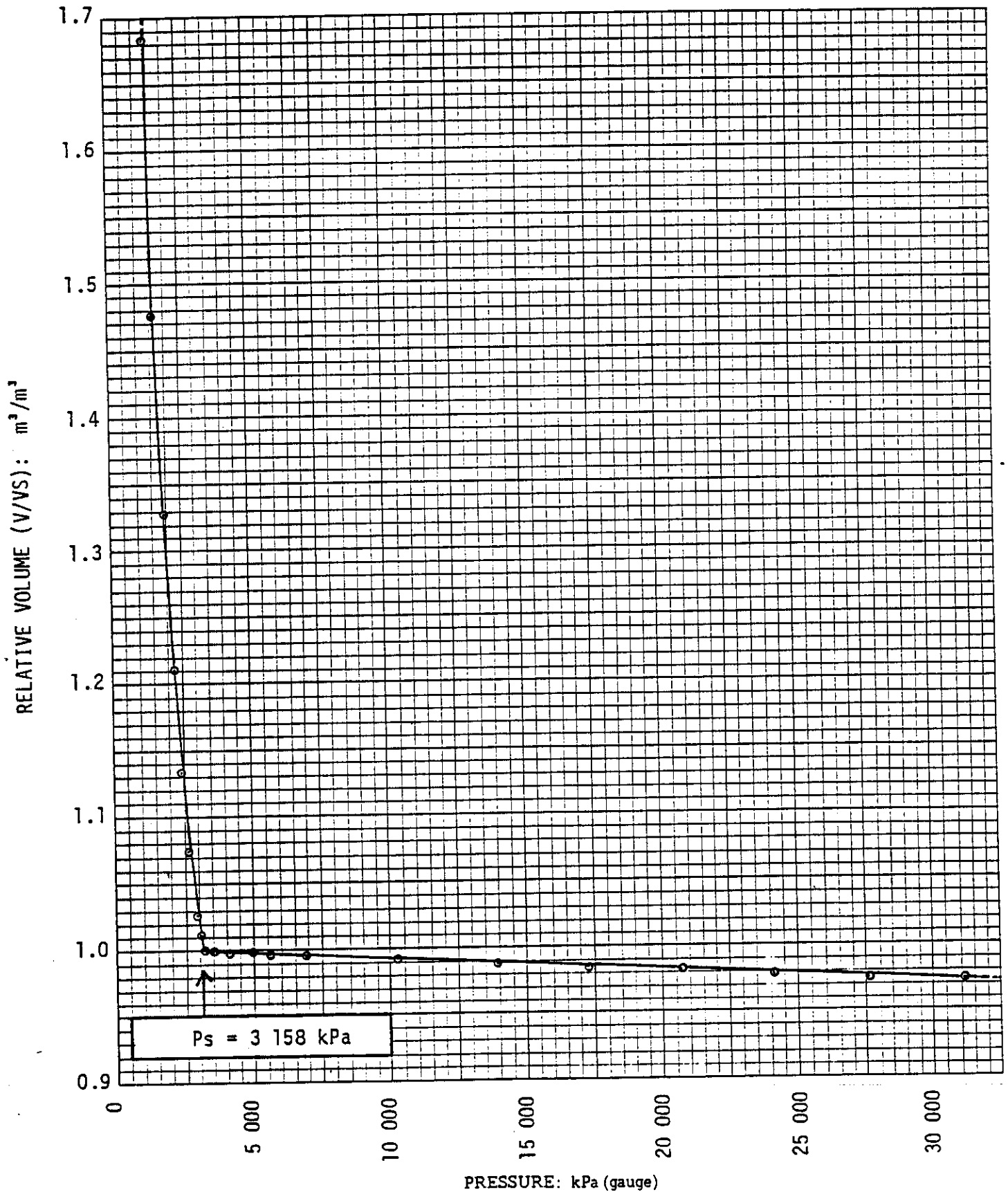
Analysis of C₆+ Fraction to C₃₀+

<u>Boiling Point Range (°C)</u>	<u>Component</u>	<u>Carbon Number</u>	<u>Mole Fraction</u>	<u>Mass Fraction</u>
36.1- 68.9	Hexanes	C6	.0325✓	.0210
68.9- 98.3	Heptanes	C7	.0468✓	.0352
98.3-125.6	Octanes	C8	.0489✓	.0419
125.6-150.6	Nonanes	C9	.0397✓	.0382
150.6-173.9	Decanes	C10	.0386	.0412
173.9-196.1	Undecanes	C11	.0359	.0421
196.1-215.0	Dodecanes	C12	.0282	.0360
215.0-235.0	Tridecanes	C13	.0274	.0378
235.0-252.2	Tetradecanes	C14	.0229	.0341
252.2-270.6	Pentadecanes	C15	.0197	.0314
270.6-287.8	Hexadecanes	C16	.0177	.0301
287.8-302.8	Heptadecanes	C17	.0161	.0290
302.8-317.2	Octadecanes	C18	.0137	.0261
317.2-330.0	Nonadecanes	C19	.0114	.0230
330.0-344.4	Eicosanes	C20	.0099	.0211
344.4-357.2	Heneicosanes	C21	.0091	.0201
357.2-369.4	Docosanes	C22	.0085	.0198
369.4-380.0	Tricosanes	C23	.0073	.0179
380.0-391.1	Tetracosanes	C24	.0068	.0173
391.1-401.7	Pentacosanes	C25	.0063	.0166
401.7-412.2	Hexacosanes	C26	.0053	.0145
412.2-422.2	Heptacosanes	C27	.0048	.0138
422.2-431.7	Octacosanes	C28	.0044	.0130
431.7-441.1	Nonacosanes	C29	.0040	.0123
441.1 Plus	triacontanes Plus	C30+	.0422	.1904
<u>AROMATICS</u>				
80.0	Benzene	C6H6	.0019✓	.0011
110.6	Toluene	C7H8	.0101✓	.0070
136.1-138.9	Ethylbenzene, p + m-Xylene	C8H10	.0108✓	.0086
144.4	o-Xylene	C8H10	.0057✓	.0046
168.9	1,2,4 Trimethylbenzene	C9H12	.0061✓	.0055
<u>NAPHTHENES</u>				
68.9	Cyclopentane	C5H10	.0004✓	.0002
72.2	Methylcyclopentane	C6H12	.0100✓	.0063
81.1	Cyclohexane	C6H12	.0124✓	.0079
101.1	Methylcyclohexane	C7H14	.0161✓	.0119
	TOTAL		.5816	.8770
	Mole Fraction of C7+			.5244
	Mass Fraction of C7+			.8405
	Calculated Relative Molecular Mass of C7+			228.
	Calculated Relative Density of C7+			.8636
	Calculated Density of C7+ (kg/m ³)			862.8

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Other hydrocarbons (aromatics, olefins, naphthenes and branched hydrocarbons) may have higher or lower carbon numbers, but are grouped and reported according to their boiling point.

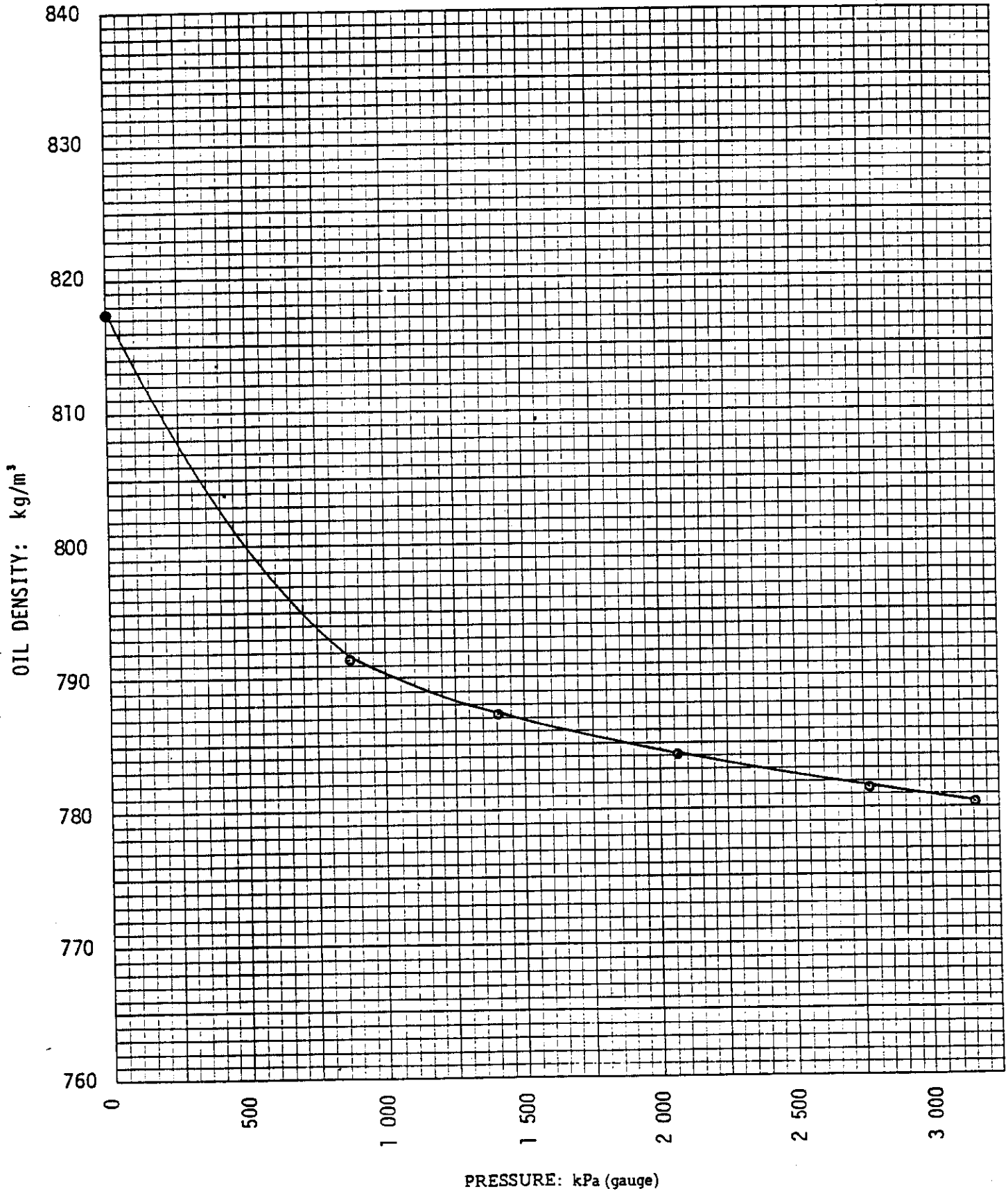
RELATIVE VOLUME (V/V_S) AT 45.0°C

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



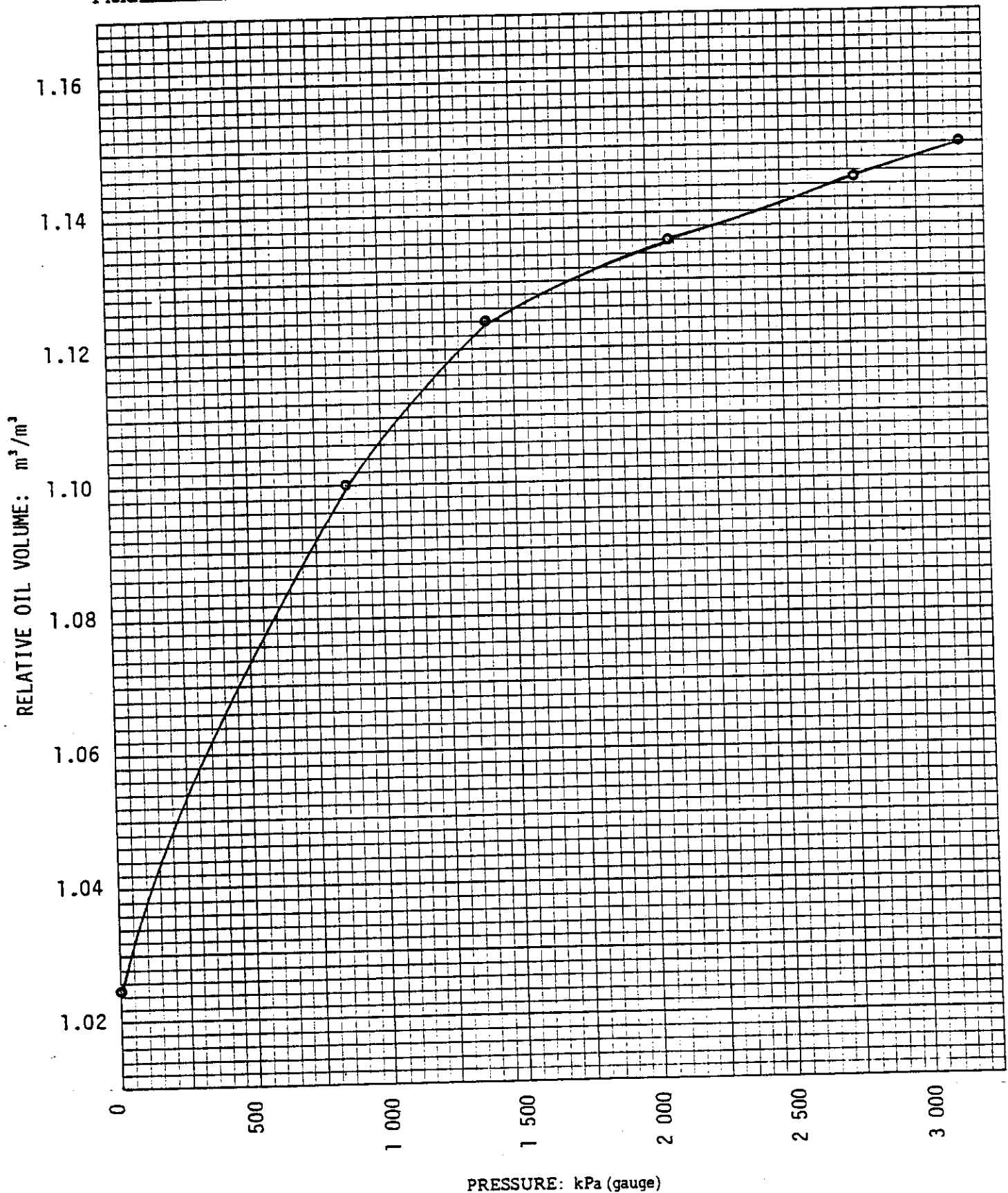
OIL DENSITY

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



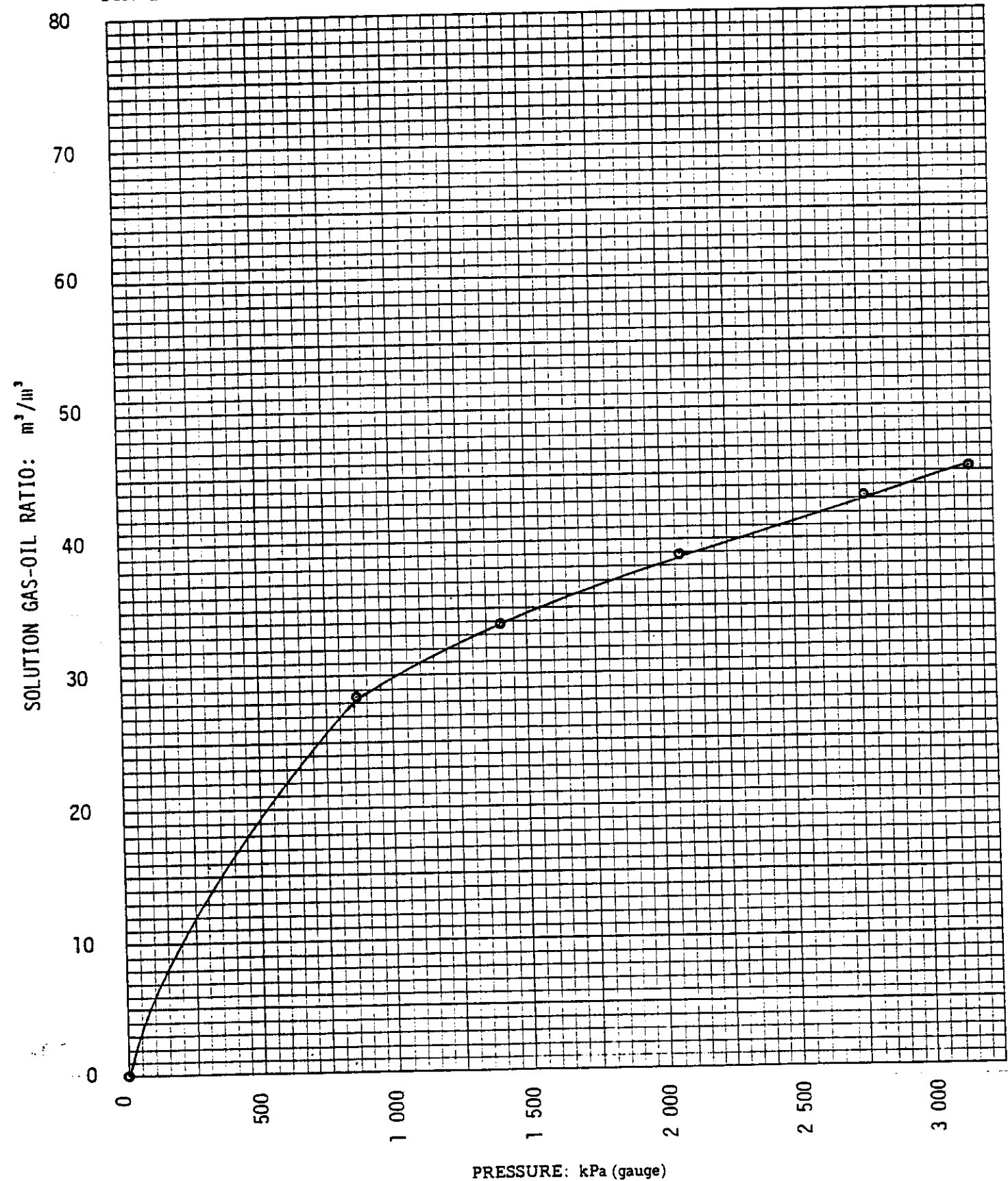
RELATIVE OIL VOLUME (V/VR)

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



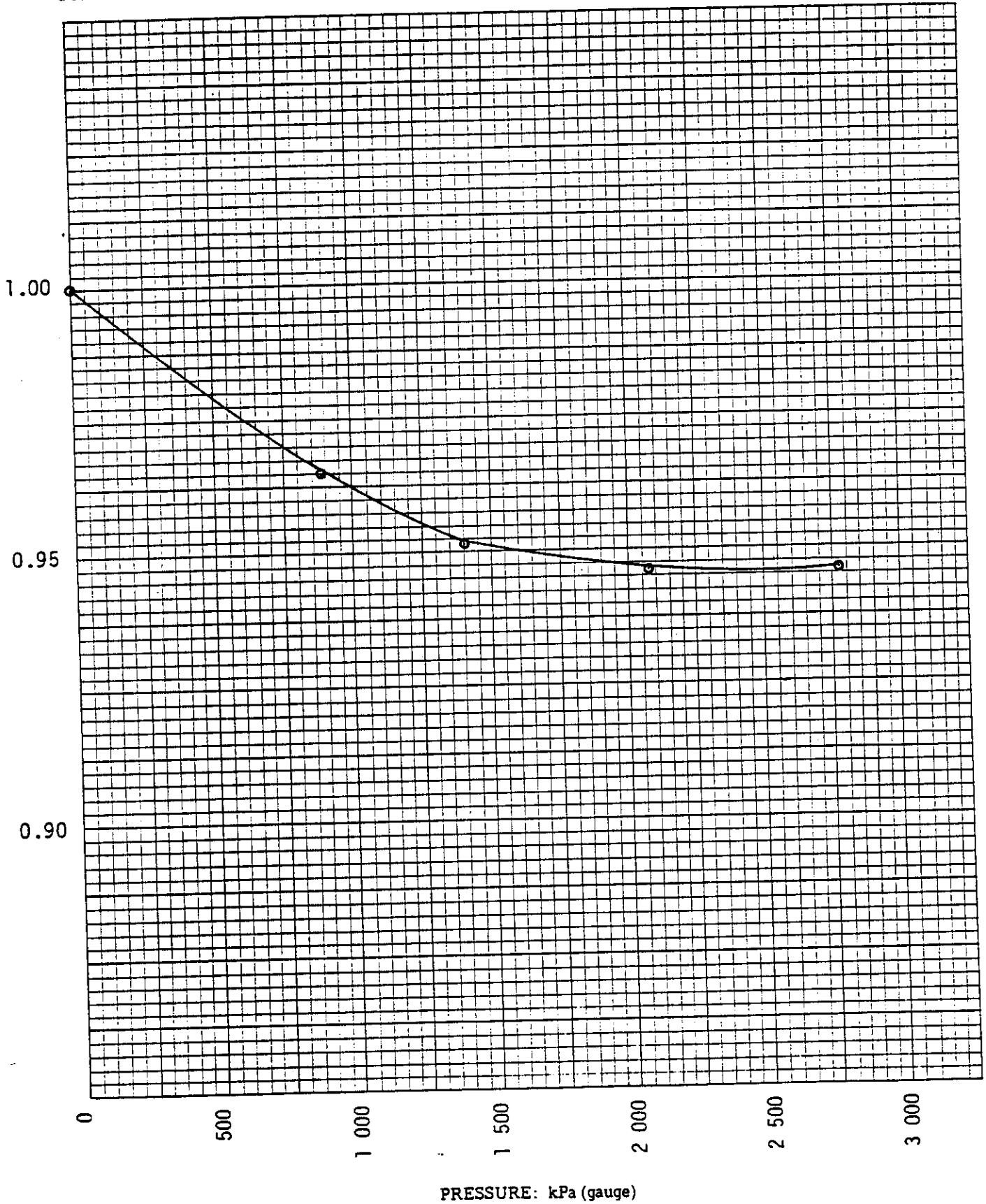
SOLUTION GAS-OIL RATIO

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



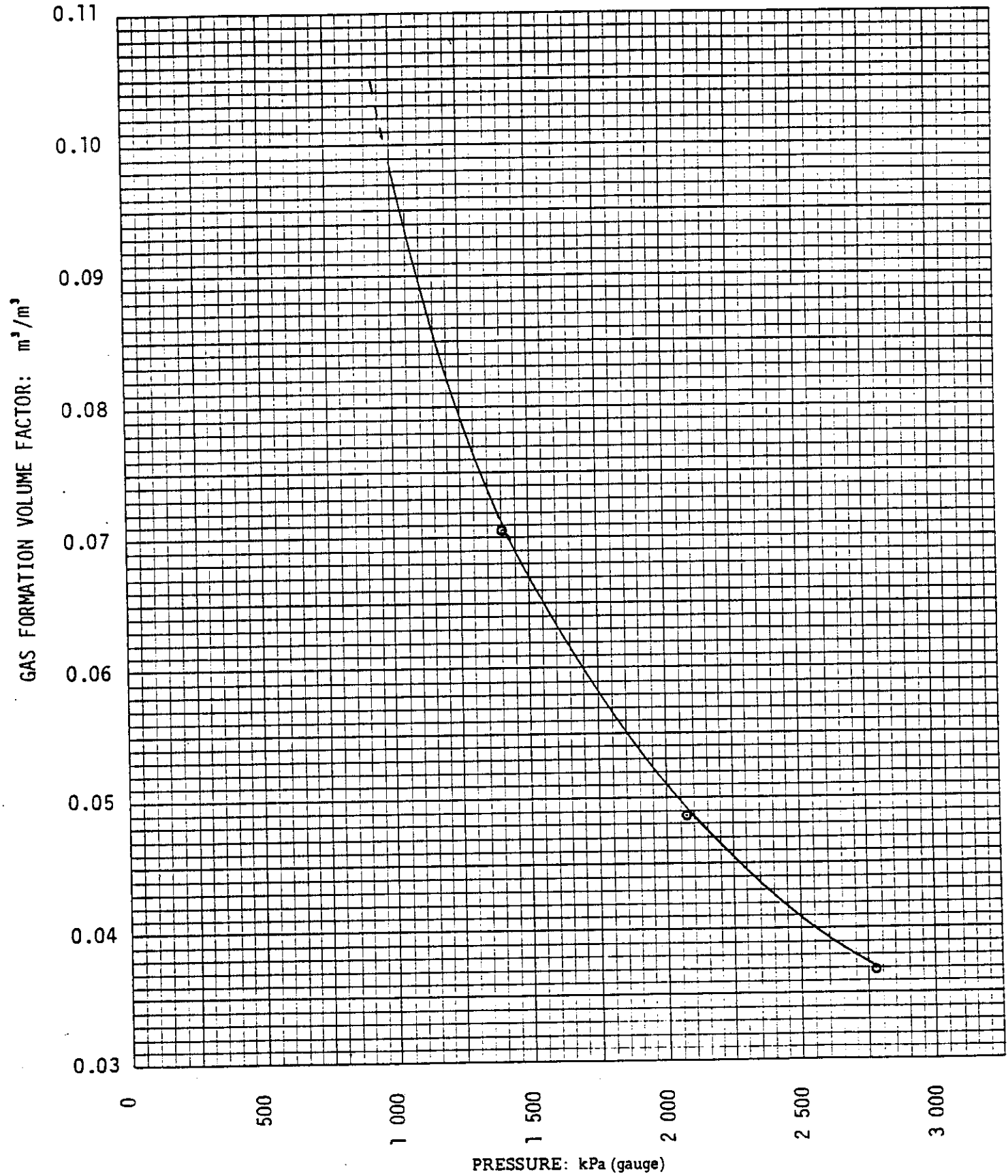
GAS DEVIATION FACTOR (Z)

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



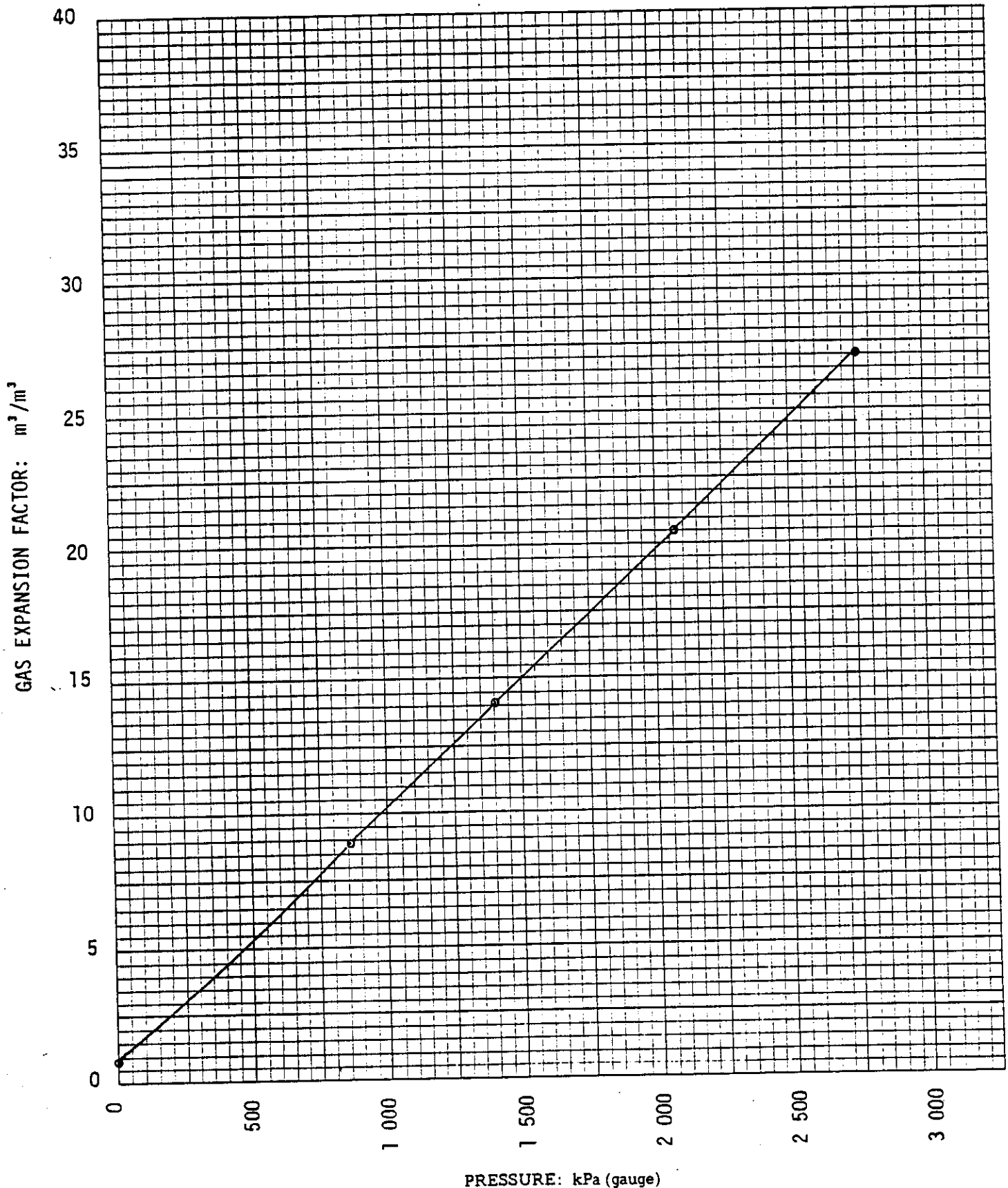
GAS FORMATION VOLUME FACTOR

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



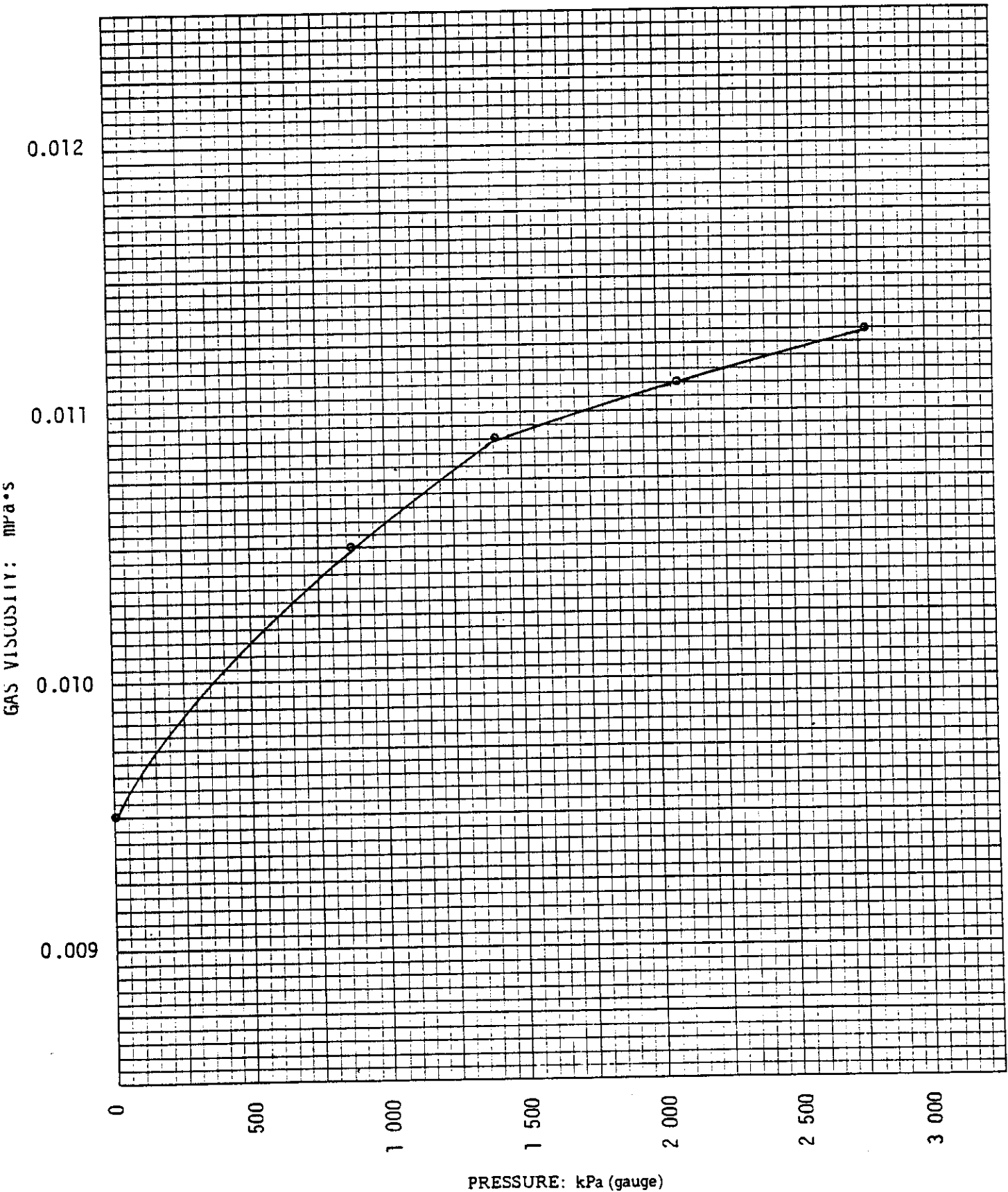
GAS EXPANSION FACTOR

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



GAS VISCOSITY

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (W1M)	Province	Manitoba
Field	Waskada	Country	Canada



OIL VISCOSITY AT 45.0°C

Company	Omega Hydrocarbons Ltd.	Formation	Lower Alida
Well	Omega Waskada 8-24-1-26 (WIM)	Province	Manitoba
Field	Waskada	Country	Canada

