

# Manitoba



The Oil and Natural Gas  
Conservation Board

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

(204) 945-3130

ALL INFORMATION CONTAINED  
HEREIN IS UNCLASSIFIED

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

Attention: Mr. T. J. Hall,  
President

Dear Sirs:

Re: Gas Conservation in Waskada

Your letter dated October 28, 1985, outlining the various options that Omega is considering as alternatives to flaring the gas produced at Waskada, is acknowledged.

The Board shares your desire to find an economically viable alternative to flaring the gas and asks that Omega continue to keep the Board informed, on a regular basis, of any developments in this regard.

Yours sincerely,

ORIGINAL SIGNED BY  
CHARLES S. KANG

Charles S. Kang,  
Chairman

LRD/lk

c.c. Petroleum Branch ✓

b.c. Wm. McDonald  
J. F. Redgwell





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

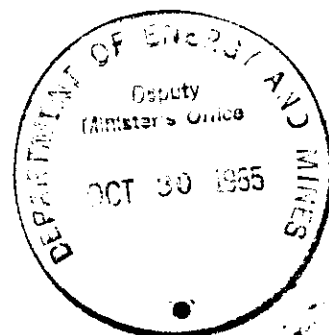
October 28, 1985

The Oil and Natural Gas Conservation Board  
Room 309, Legislative Building  
Winnipeg, Manitoba  
R3C 0V8

**Attention: Charles S. Kang,  
Chairman**

Dear Sirs:

**Re: Omega Waskada GIW 5-13-1-26 WPM  
Omega Waskada GIW 13-13-1-26 WPM  
Omega Waskada GIW 15-13-1-26 WPM  
Omega Waskada GIW 15-14-1-26 WPM  
Waskada Unit No. 4 - Conversion  
from Gas Injection to Water  
Injection**



We are in receipt of your letter dated October 17, 1985 to Mr. G.E. Patey.

In answer specifically to your inquiry respecting alternatives to flaring the gas, we assure you that we are doing our very best to find an economic market for such gas. We have directed our minds and energies to this problem for well over a year and have yet to find a viable alternative to flaring the gas.

We spent some time reviewing the possibility of trucking compressed gas to the Saskatchewan border for sale into the Saskatchewan Power Corporation system. As a consequence, however, of the low volumes of gas and the high transportation costs, we had to discard this plan.

Discussions have been held with ICG Corporation on a plan to transport the gas by pipeline to the Saskatchewan Power Corporation system at Gainsborough and trade out such gas with TransCanada Pipeline at Brandon. Once again, low volumes of gas and high costs do not make this scheme very attractive. One further problem respecting the construction of a pipeline is the jurisdiction of the National Energy Board. If the Board insists on a public hearing respecting such a pipeline, the economics become even less attractive. At the present time, we are discussing this matter with the Board.

Another solution to the problem of flaring gas which Omega is considering involves finding a suitable underground storage reservoir. This is certainly

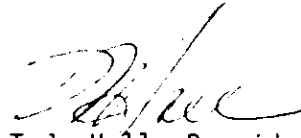
the most attractive alternative at this time. Such a scheme would enable Omega to conserve the gas until a viable market could be found.

We continue to seek out an acceptable solution to this very difficult problem. Many hours and a great deal of effort have been and will be spent by Omega searching for a proper solution. In the meantime, we ask that our application for approval to convert the subject wells to water injection be approved.

Thank you for your consideration and time; we look forward to your favourable response to our application.

Yours very truly,

OMEGA HYDROCARBONS LTD.

A handwritten signature in dark ink, appearing to read 'T.J. Hall', is written over the printed name.

T.J. Hall, President

TJH/sk

# Manitoba



The Oil and Natural Gas  
Conservation Board

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

(204) 945-3130

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

Attention: G. E. Patey,  
Vice President, Production

Dear Sirs:

Re: Omega Waskada GIW 5-13-1-26 WPM  
Omega Waskada GIW 13-13-1-26 WPM  
Omega Waskada GIW 15-13-1-26 WPM  
Omega Waskada GIW 15-14-1-26 WPM

Waskada Unit No. 4 - Conversion from  
Gas Injection to Water Injection

Your application, dated October 1, 1985, for approval to convert the subject wells to water injection is acknowledged.

While it is clear from reservoir performance that gas injection has been unsuccessful in producing production response, your application does not address alternatives to flaring the gas once conversion to water injection occurs. In order that the Board can evaluate your application from a total resource conservation point of view, you are requested to provide an economic evaluation of conservation of the gas produced at Waskada. This should include consideration of as many alternatives as possible.

In addition, you are required to submit application to recomplete forms (MG 416) in triplicate for each well to be converted from gas injection to water injection.

While the processing of your application will be commenced immediately, final approval will be withheld pending receipt of the aforementioned information.

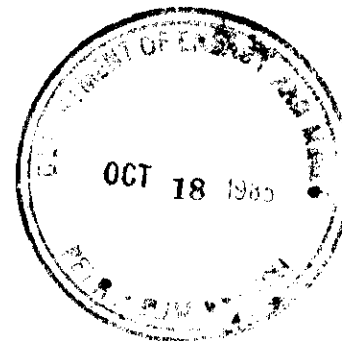
Yours sincerely,

**ORIGINAL SIGNED BY  
CHARLES S. KANG**

Charles S. Kang,  
Chairman

MA/LRD/ik

b.c. Petroleum Branch



## Memorandum

Date October 11, 1985

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 Unit No. 4 - Conversion of Gas Injection to Water Injection

Omega Hydrocarbons Ltd., as operator of Waskada Unit No. 4, has made application to convert the following four (4) wells from gas injection to water injection:

Omega Waskada GIW 5-13-1-26 WPM  
Omega Waskada GIW 13-13-1-26 WPM  
Omega Waskada GIW 15-13-1-26 WPM  
Omega Waskada GIW 15-14-1-26 WPM

### Recommendation:

It is recommended that the attached letter outlining certain questions regarding the application be sent to Omega. Based on additional documentation requested in the deficiency letter, disposition of the application will be recommended.

### Discussion:

Gas injection in Waskada Unit No. 4 commenced in 1983.

Figure No. 1 is a map of Waskada Unit 4 and surrounding area. The map shows former gas injectors (converted to water injectors) and present gas injectors. Gas-oil ratios for producing wells in Unit 4 are listed on the map. Figure 1 shows that GOR's (gas-oil ratios) in Unit 4 are high, particularly in the northern part of the Unit (normal solution GOR is  $50 \text{ m}^3/\text{m}^3$ ).

Figures 2 and 3 are GOR and oil production versus time plots for selected Unit 4 injection patterns. Injectors 7-23, 7-24 and 5-24 were converted from gas injectors to water injectors in April, 1985 as a result of rapid gas breakthrough in offset wells. Gas oil ratios for producers associated with these injectors have decreased, following conversion to water injection (see Figure 2). Pattern GOR's for two of the four wells proposed for conversion have substantially increased since late 1984. Pattern GOR's for the other two wells proposed for conversion have been erratic since gas was first injected in early 1983 to present day. It is noted that little or no production response has occurred since gas injection was initiated.

Production history appears to show that gas injection in Unit 4 results in gas channeling from injectors to producers with little positive production rate response (see Figures 2 and 3). Based on GOR responses in the three well patterns which were converted to water injection, conversion to water injection lowers pattern GOR values (see Figure 2).

Premature gas breakthrough has occurred at 11-13 and 3-24 (see Figure 1). Gas breakthrough may occur in more wells in the gas injection patterns in Unit 4 if gas injection continues.

Whereas water injection has been shown to be effective in producing production rate response, gas injection has not been successful. As indicated by Omega, continued gas injection may jeopardize the chances of subsequent response by water injection. From a reservoir viewpoint, therefore, conversion to water injection is recommended.

Omega has not included its plans for the gas once injection is terminated. Upon discussion of this with Omega, it appears that while various alternatives to conserve the gas are being considered, economics appear to be marginal, and it is likely that the gas be flared. The attached letter requests Omega's comments and economic evaluation. If this evaluation shows gas conservation to be uneconomic, the application should be approved.

Subclause 1(4) of Board Order No. PM 41 empowers the Board to "approve or require the conversion of any well or wells from gas injection to water injection if the Board is of the opinion that continued gas injection would be detrimental to pressure maintenance operations or to ultimate recovery ....."

This clause was designed to accommodate the current situation.

H. Clare Moster

MA/LRD/lk

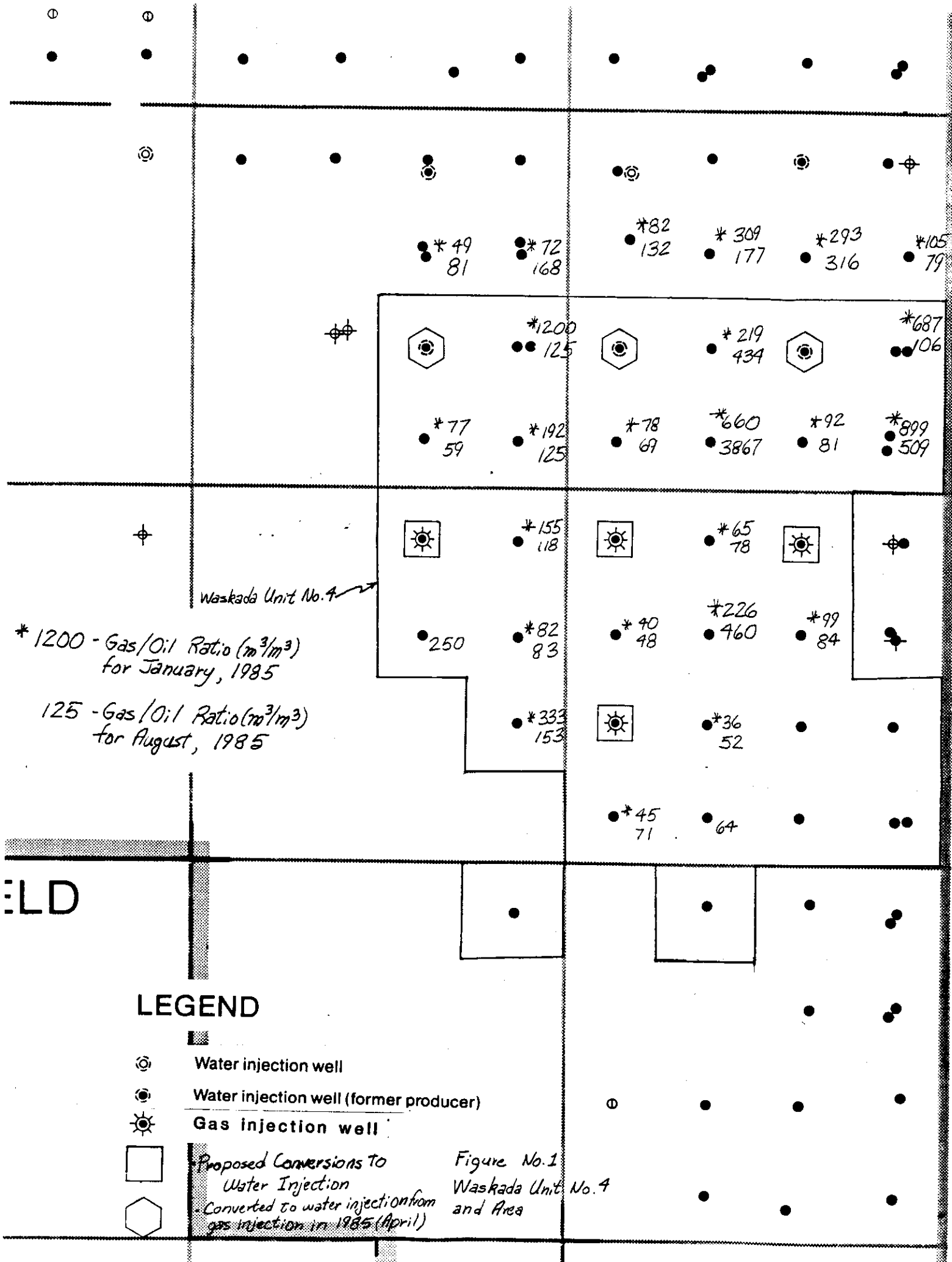


Figure 2

Pattern 7-23-1-26 WPM (former gas injector)

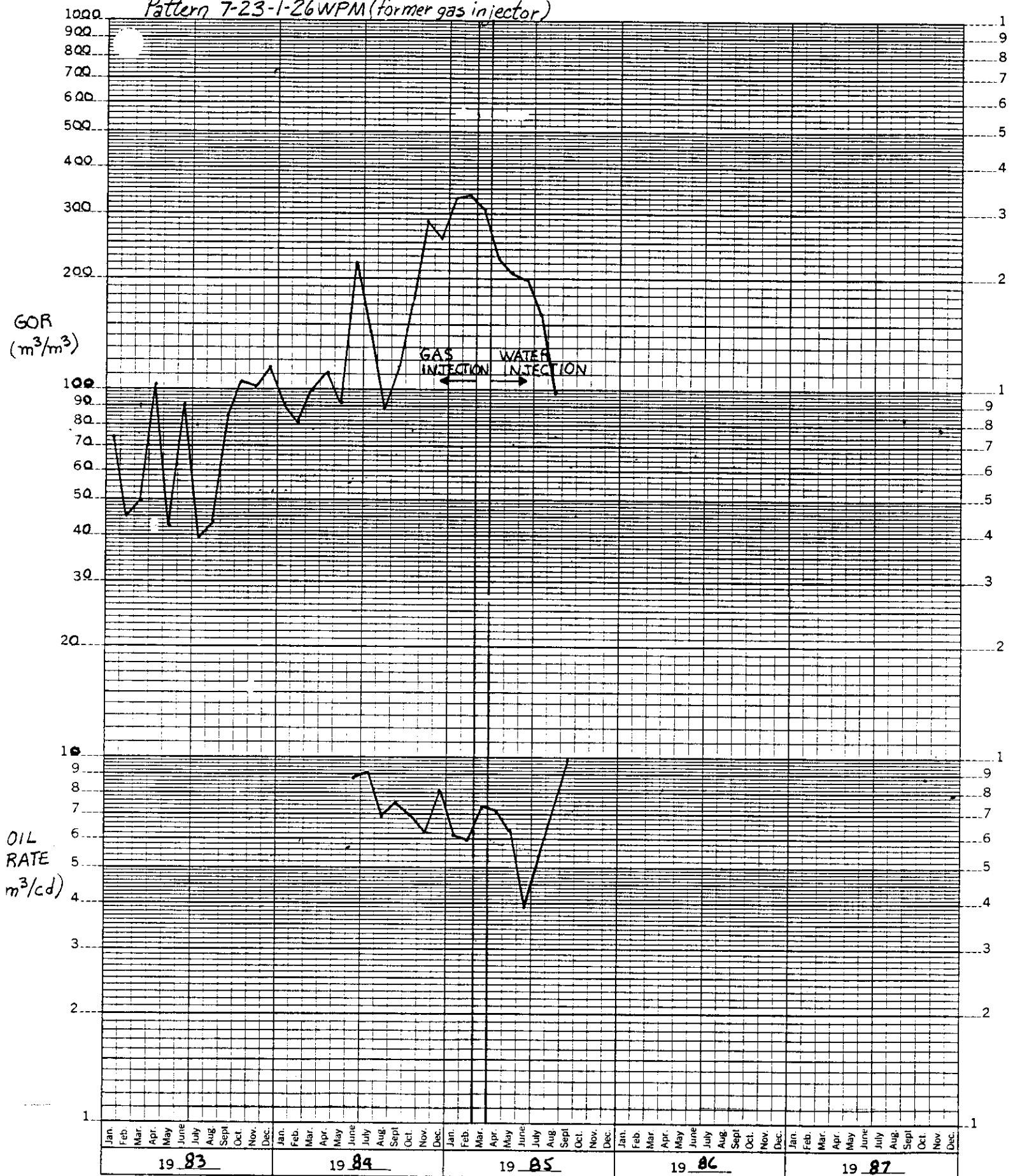
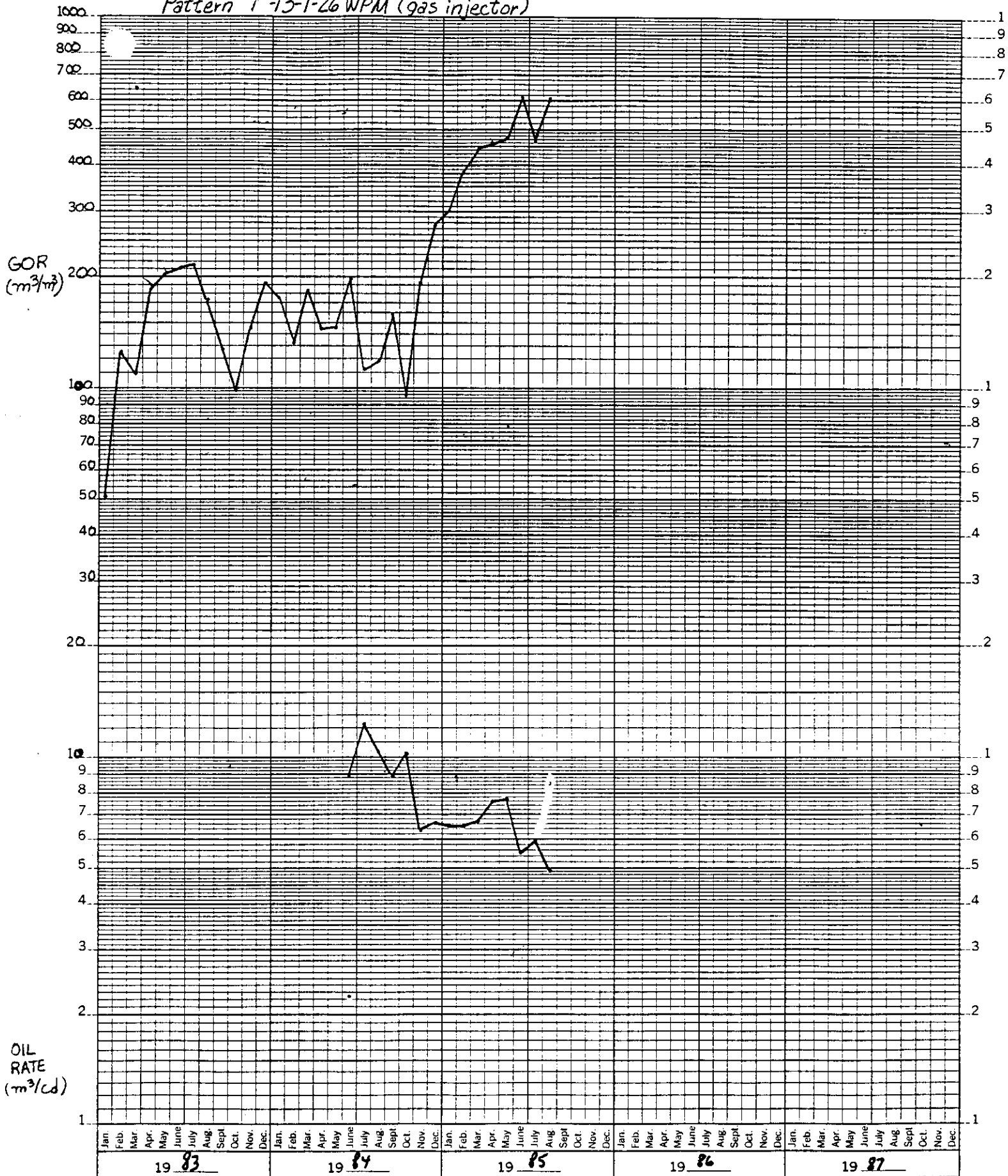




Figure 3.  
Pattern 1-13-1-26 WPM (gas injector)





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

October 1, 1985



The Oil & Natural Gas  
Conservation Board  
309 Legislative Building  
Winnipeg, Manitoba  
R3C 0V8

Attention: Mr. Charles S. Kang  
Deputy Chairman

Dear Sir:

Re: Waskada Unit No. 4  
Board Order No. PM 41

The purpose of this letter is to apply for approval to convert the four (4) remaining gas injection wells inside Waskada Unit No. 4 to water injection as allowed under clause 2 subclause 1 (4) of Board Order No. PM 41. Due to definite signs of gas breakthrough at wells 11-13 and 3-24-1-26 WPM, Omega Hydrocarbons Ltd. requests permission to convert the following gas injectors to water injection:

Omega Waskada GIW 5-13-1-26 WPM  
Omega Waskada GIW 13-13-1-26 WPM  
Omega Waskada GIW 15-13-1-26 WPM  
Omega Waskada GIW 15-14-1-26 WPM

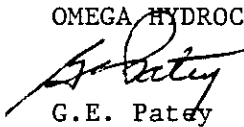
Attached is an internal memo which summarizes in more detail the reasons for converting the above mentioned wells.

It is the company's opinion that the proposed change in injection strategy will improve both the pressure maintenance operations and ultimate recoveries within Waskada Unit No. 4. Any questions related to this application should be directed to either Mr. Bob Beamish or Mr. Richard Brekke at (403) 261-0743.

Your earliest attention to this matter would be appreciated.

Yours truly,

OMEGA HYDROCARBONS LTD.

  
G.E. Patey  
Vice President, Production

GEP:vb  
Encl.

c.c. B. Dubreuil - Manitoba Petroleum Branch  
B. Beamish - w/o attachments  
R. Brekke - w/o attachments  
Waskada Gasflood Approval File

MEMORANDUM

Date: September 18, 1985  
To: George Patey  
From: Bob Beamish  
Re: Waskada Unit No. 4  
Gas Flood Performance

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Premature gas break through has occurred at two additional producers in this gas flood project, namely wells 11-13 and 3-24 Twp. 1 Rge. 26 WPM. (See production plots attached).

It is therefore recommended that the gas flood be terminated and the gas injectors be converted to water injection. Hopefully, permanent gas channels have not been created which will adversely affect oil recovery.

Completion of the water injection pattern can also be achieved by conversion of 5-13-1-26.

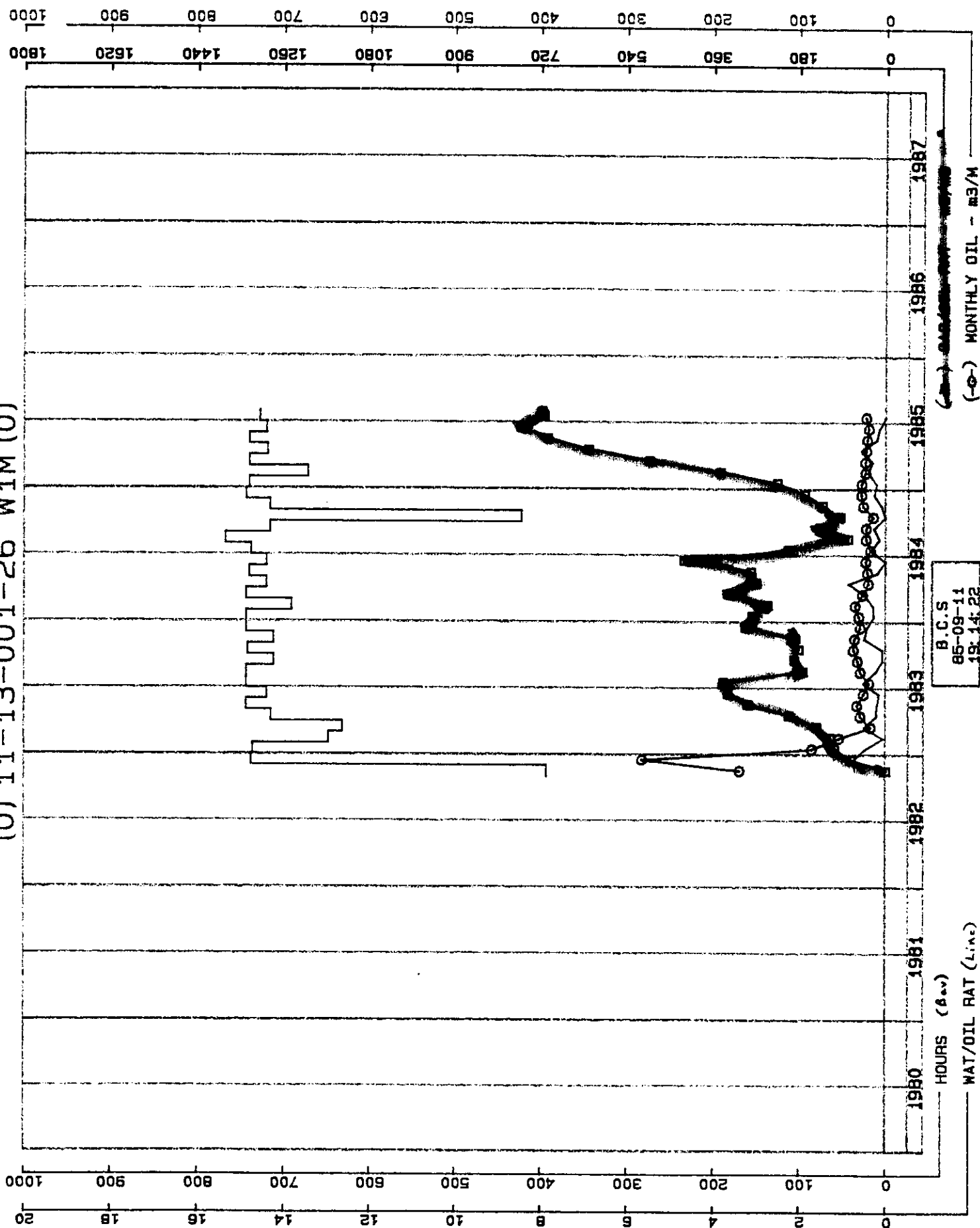
The severe GOR history of 3-24 indicates that the gas flood should be immediately suspended, and an application submitted to the Conservation Board for the necessary conversion of the project to waterflood. Sequential conversion is no longer possible due to the supply line configuration.

Three of the wells which had adverse gas break through have had favorable GOR response since conversion to water injection in their area of the project. The production graphs for these three wells (8-23, 1-24, and 8-24) are also attached.

c.c. File Copy

*Bob Beamish*

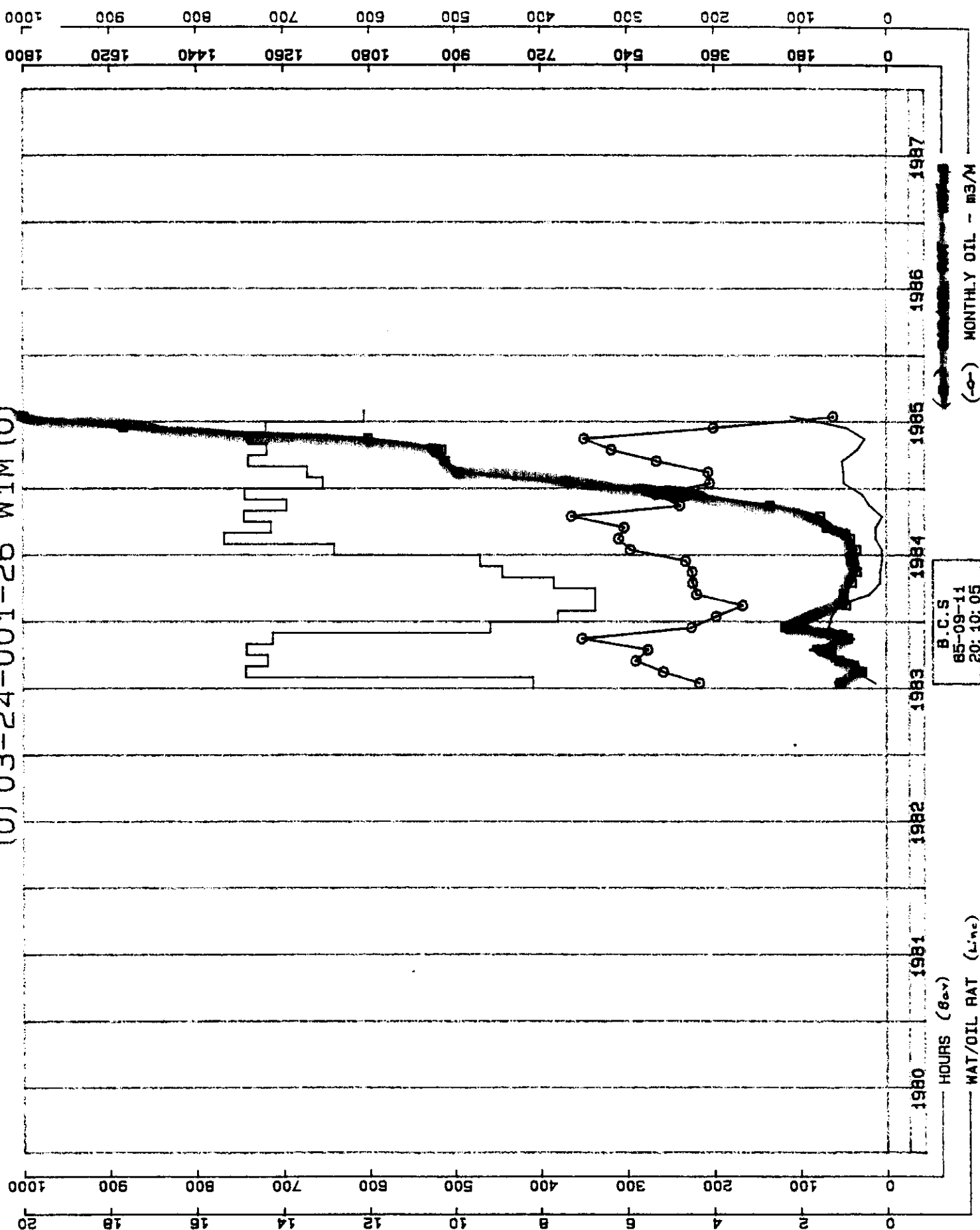
(O) 11-13-001-26 W1M (O)



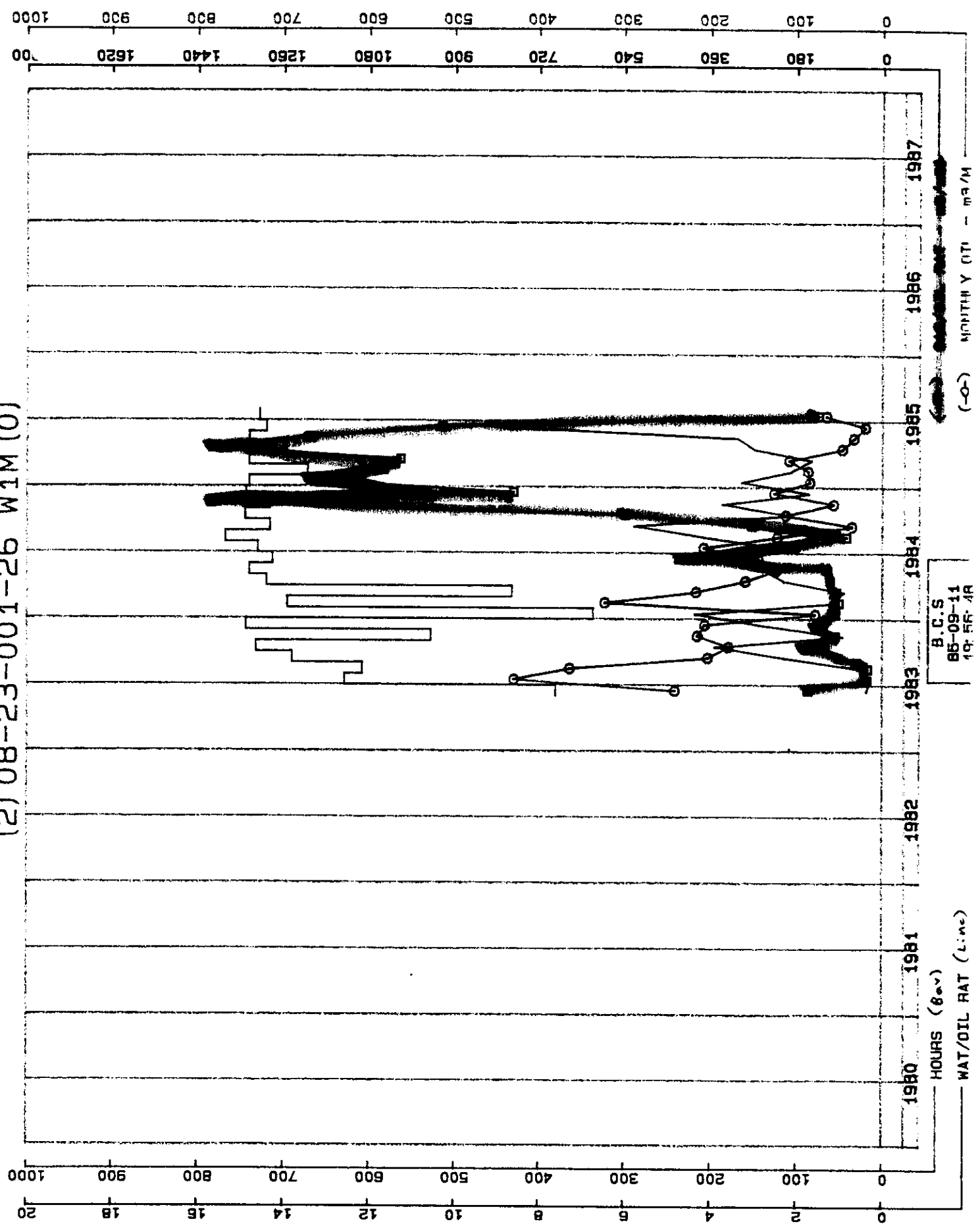
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WAT/OIL RATIO (L/W)  
MONTHLY OIL - M3/M

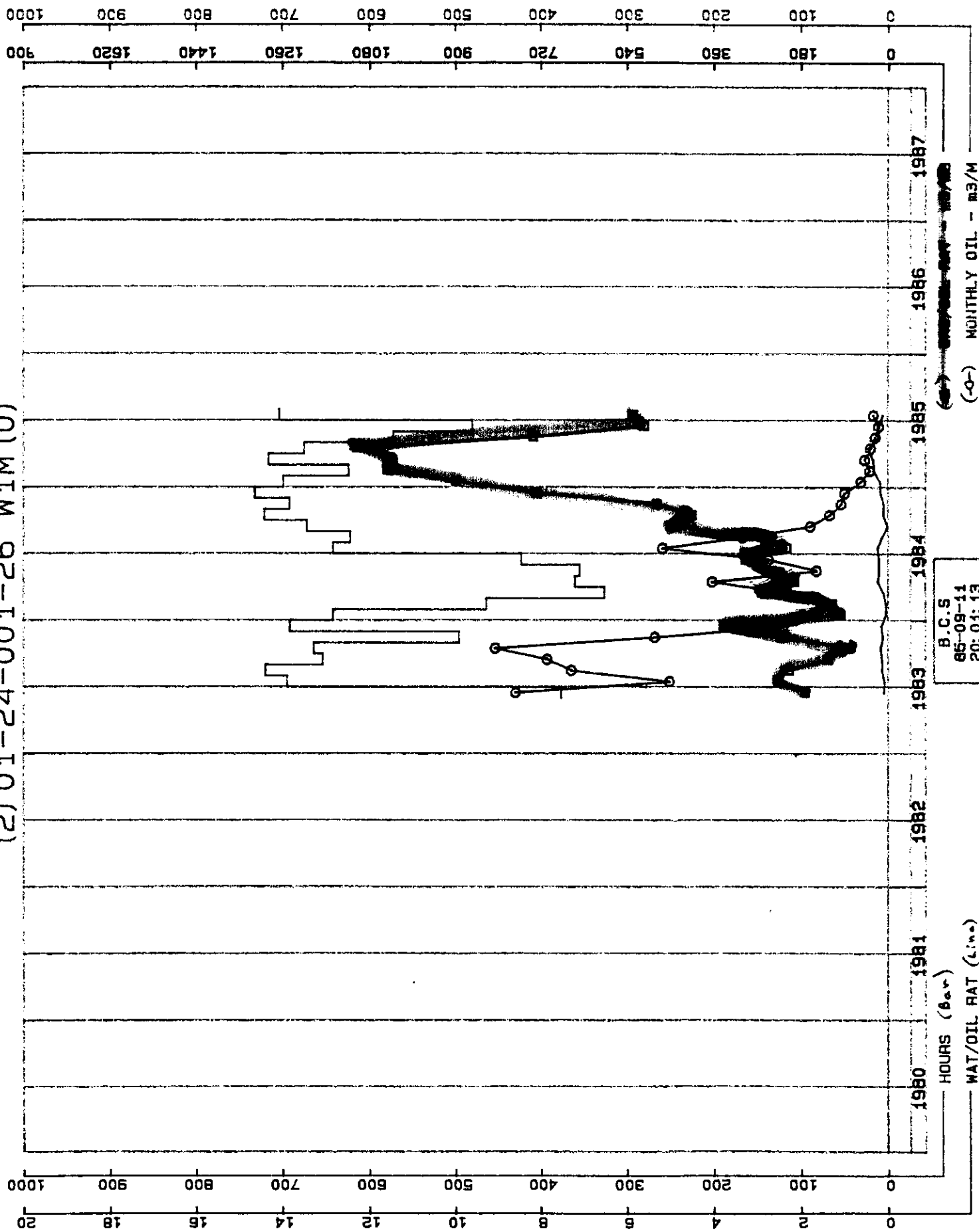
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(2) 01-24-001-26 W1M (0)

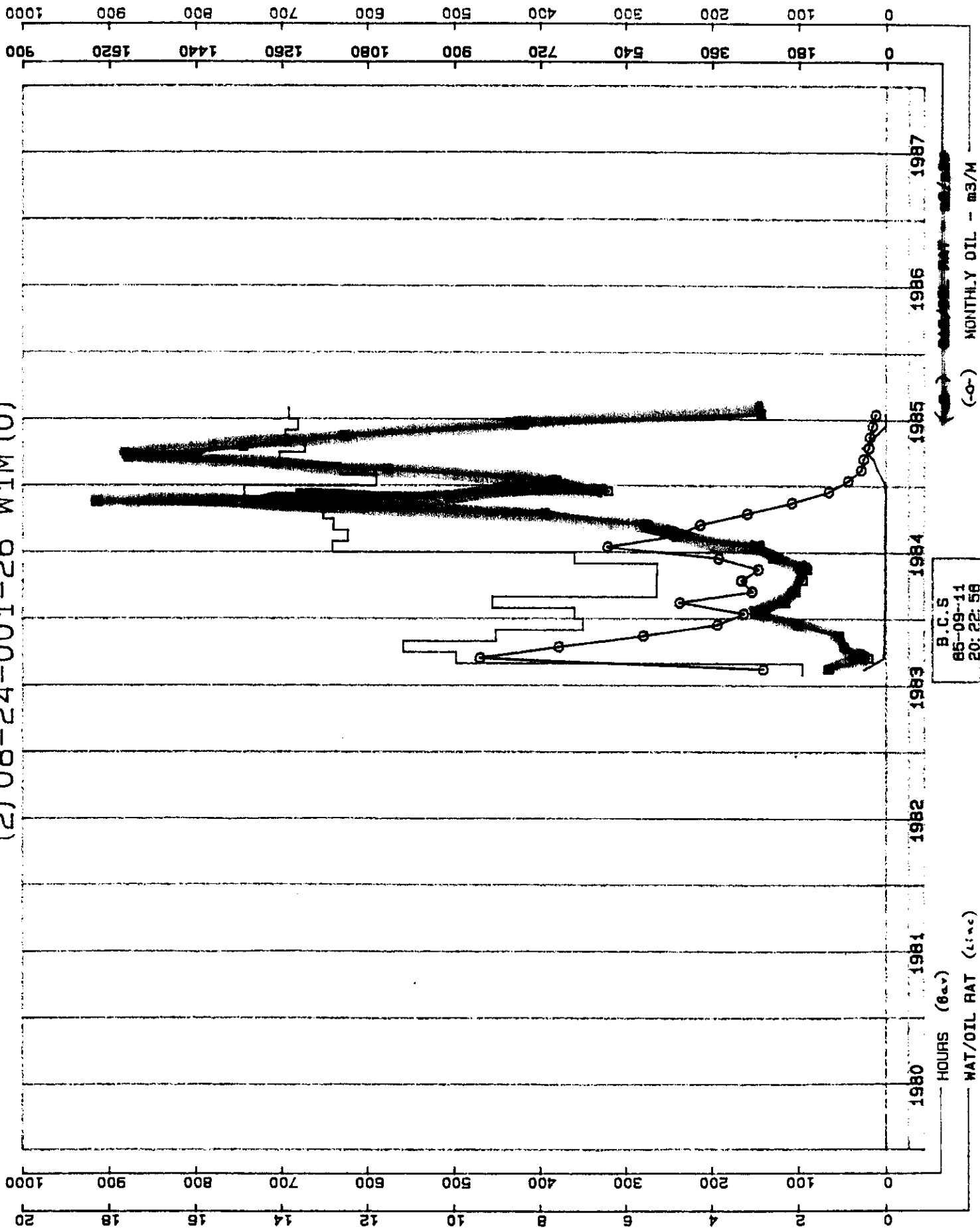


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MONTHLY OIL - m3/M  
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HOURS (Bar)  
WAT/OIL RAT (Line)

(2) 08-24-001-26 W1M (0)







MANITOBA

THE OIL AND NATURAL GAS CONSERVATION BOARD  
309 LEGISLATIVE BUILDING  
WINNIPEG, MANITOBA  
R3C 0V8

March 12, 1985

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

Attention: Mr. G. E. Patey,  
Vice President, Production

Dear Sirs:

Re: Conversion to Water Injection  
Omega Waskada GIW 7-23-1-26  
Omega et al Waskada GIW 5-24-1-26  
Omega Waskada Prov. GIW 7-24-1-26

Your letter of March 7, 1985 requesting approval to convert the subject wells from gas injection wells to water injection wells is acknowledged.

Pursuant to subclause 1(4) of The Oil and Natural Gas Conservation Board Order No. PM 41, you are hereby authorized to convert the subject wells to water injection. Please submit completed application forms (MG 416) for each well to the Petroleum Branch prior to the conversions (a supply of forms is enclosed).

In addition, please ensure that the requirements of Sections 8 and 10 of The Petroleum Drilling and Production Regulations, 1984 relating to well names and well signs are complied with.

Yours sincerely,

Wm. McDonald  
Deputy Chairman

LRD/lk

b.c. Petroleum Branch ✓

## Inter-Departmental Memo

Date March 12, 1985

To The Oil and Natural Gas  
Conservation BoardFrom H. Clare Moster  
Director, Petroleum BranchR. B. Chenier - Chairman  
Wm. McDonald - Deputy Chairman  
J. F. Redgwell - Member

Telephone

Subject Waskada Unit No. 4 - Conversion of Gas

Injection to Water Injection

Omega Hydrocarbons Ltd., as operator of Waskada Unit No. 4, has made application to convert the following three wells from gas injection to water injection:

Omega Waskada GIW 7-23-1-26  
Omega et al Waskada GIW 5-24-1-26  
Omega Waskada Prov. GIW 7-24-1-26

## Recommendation:

It is recommended that the application be approved (draft letter of approval attached).

## Discussion:

Figure No. 1 is a map of Waskada Unit No. 1 and surrounding area showing the location of current gas and water injectors. Also shown are average gas-oil ratios (GOR's) for January 1985. From this map, it is evident in the northern part of the Unit, surrounding the three wells that Omega has requested approval to convert to water injection wells. (Note that the normal solution GOR is about  $50 \text{ m}^3/\text{m}^3$ ).

Production history for wells showing the most drastic increases in GOR do not show any signs of production rate response to injection. This suggests that the high mobility gas has bypassed most of the oil and has travelled to producing wells through high permeability streaks. Continued production in this mode would likely result in only limited additional oil recovery.

Conversion of the subject wells to water injection is more likely to result in production response. While water injection will also be controlled by permeability distribution, the water-to-oil mobility ratio is much less than the gas-to-oil mobility ratio, and therefore the effects of high permeability zones will be lessened.

As Omega notes, patterns in the southern part of the Unit have shown response to gas injection, and GOR's are not excessive. In view of this, there is no reason to terminate gas injection in this area. However, performance monitoring will continue. If gas

breakthrough occurs in another area, future conversions to water injection will be considered.

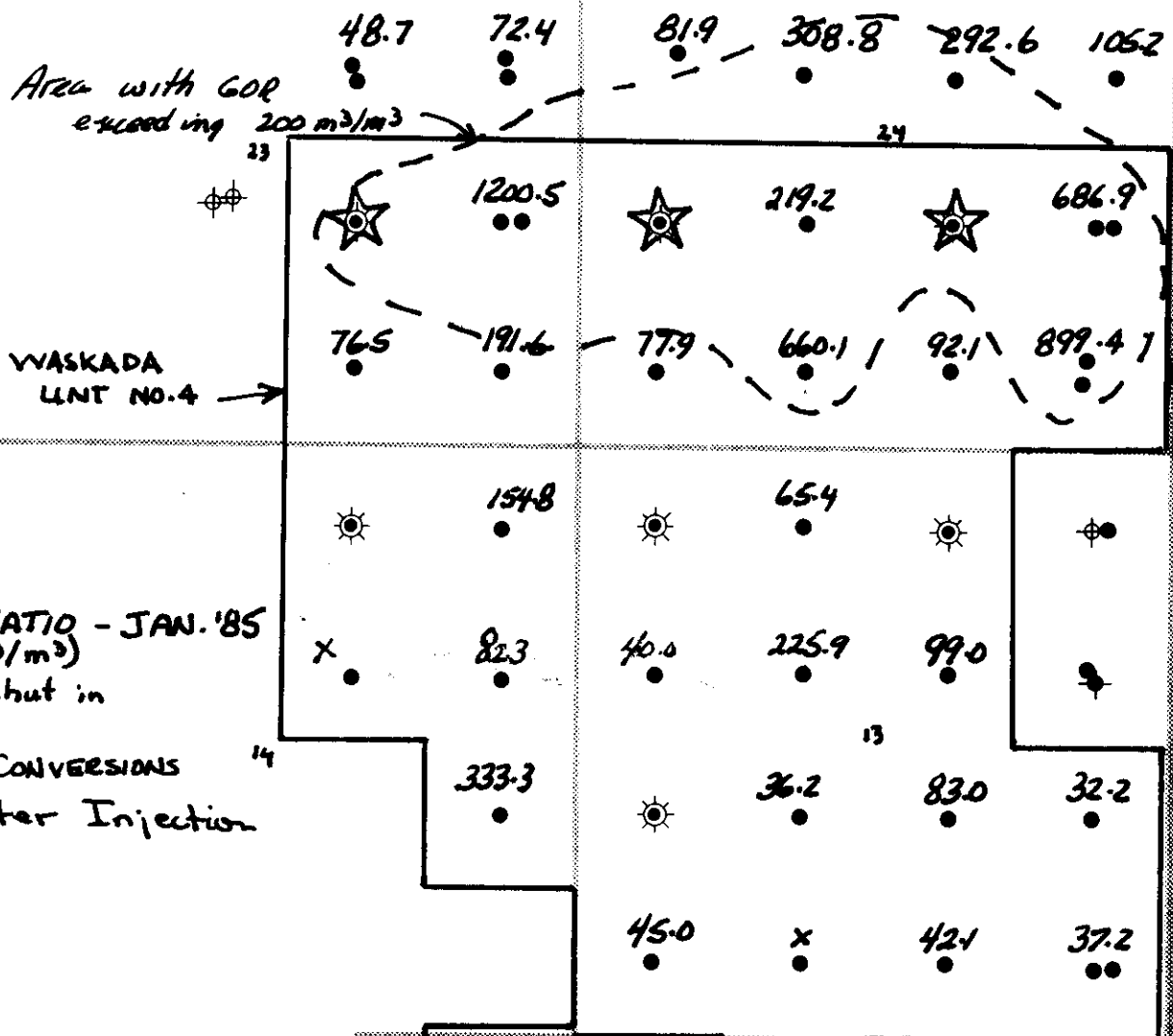
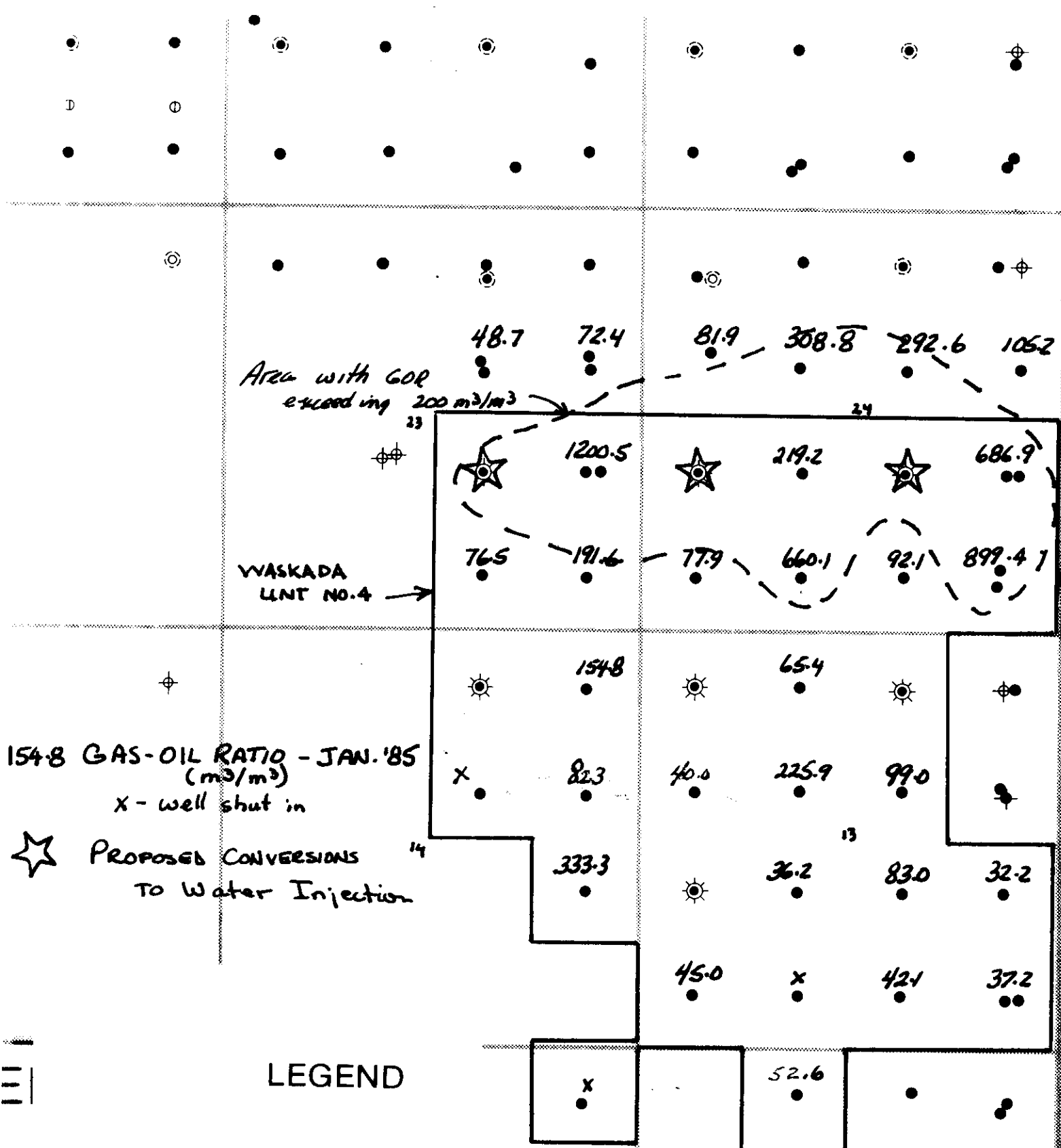
Subclause 1(4) of Board Order No. PM 41 empowers the Board to "approve or require the conversion of any well or wells from gas injection to water injection if the Board is of the opinion that continued gas injection would be detrimental to pressure maintenance operations or to ultimate recovery or if the Board is of the opinion that there is an insufficient supply of gas for injection".

This clause was designed to accommodate the current situation. Attached is a draft of a letter approving Omega's application.

~~Detached Signed by H. C. Moster~~

H. Clare Moster

LRD/HCM/lk



Manitoba Regulation /84

Being

THE OIL AND NATURAL GAS CONSERVATION BOARD

ORDER NO. PM 41

An Order Pertaining to Pressure Maintenance by Gas Flooding

WASKADA LOWER AMARANTH A 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 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 to do so, 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 June 23, 1983 from Omega Hydrocarbons Ltd. for approval of a project to inject water and gas into the Waskada Lower Amaranth A Pool ("the Pool") in Manitoba;

AND WHEREAS, by Board Order No. PM 40 the Board approved injection of water into certain portions of the Pool;

AND WHEREAS, the Board received an intervention to the said application from Chevron Canada Resources Limited dated October 4, 1983 pertaining to certain aspects of the proposed gas injection;

AND WHEREAS, the Board has received a letter from Omega Hydrocarbons Ltd. dated December 8, 1983 requesting that the said application be modified to exclude two wells, Omega Waskada Prov. 16-11-1-26 (WPM) and Omega Waskada 7-13-1-26 (WPM) from the list of proposed gas injection wells;

AND WHEREAS, the Board has received a letter from Chevron Canada Resources Limited, dated December 20, 1983 withdrawing its intervention to the modified application;

AND WHEREAS, the Board has received letters of concern regarding certain aspects of the project from Roxy Petroleum Ltd. dated October 18, 1983, and Tundra Oil and Gas dated October 6, 1983;

AND WHEREAS, Omega Hydrocarbons Ltd. is the Unit Operator of the proposed Waskada Unit No. 4 ("the Unit").

NOW, THEREFORE, the Board orders that:

1. The Unit Operator shall conduct pressure maintenance operations by the injection of gas into the Waskada Lower Amaranth A Pool underlying the area of the proposed Waskada Unit No. 4 ("the Unit Area"):
2. The Pressure maintenance operations shall be in accordance with, and subject to, the following rules:

PRESSURE MAINTENANCE RULES

1. (1) Gas shall be injected into the Lower Amaranth Formation through the wells:

Omega Waskada GIW 5-13-1-26 (WPM)  
Omega Waskada GIW 13-13-1-26 (WPM)  
Omega Waskada GIW 15-13-1-26 (WPM)  
Omega Waskada GIW 15-14-1-26 (WPM)  
Omega Waskada GIW 7-23-1-26 (WPM)  
Omega Waskada GIW 5-24-1-26 (WPM)  
Omega Waskada GIW 7-24-1-26 (WPM)

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

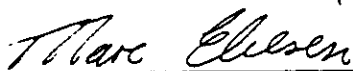
- (2) After the commencement of injection, the Unit Operator shall, subject to any remedial work required to be performed on the wells referred to in subclause (1) of this clause, endeavour to maintain continuous injection.
- (3) Notwithstanding the provisions of subclause (2), the Board may, upon application by the Unit Operator, or on its own motion, approve or require suspension of gas 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 Board may, upon application by the Unit Operator, or on its own motion, approve or require the conversion of any well or wells from gas injection to water injection if the Board is of the opinion that continued gas injection would be detrimental to pressure maintenance operations or to ultimate recovery or if the Board is of the opinion that there is an insufficient supply of gas for injection.

- (5) The completion of the wells referred to in subclause (1) will be as prescribed by the Director of the Petroleum Branch.
2.
  - (1) Before the injection of gas is commenced, the Unit Operator shall submit to the Board the results of a survey conducted to determine the static reservoir pressure in a minimum of six wells in the Unit Area.
  - (2) The Unit Operator shall, not less than six months nor more than twelve months after the commencement of injection, and at yearly intervals thereafter, conduct a survey to determine the static reservoir pressure in a minimum of six 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.
3. The Unit Operator shall immediately report to the Board any indication of channeling or breakthrough of injected gas to producing wells or any indication of other detrimental effects that may be attributable to the pressure maintenance operations.
4. The Unit Operator shall, within 30 days of the effective date of this order, submit to the Director of the Petroleum Branch, for approval, a comprehensive program of incorporation of a chemical or other tracer material in the injected gas, together with a comprehensive program of monitoring gas production from wells in or adjoining the Unit Area and completed in the Mississippian Formation, in order to determine the presence of the tracer material.

5. The maximum wellhead pressure at which gas is injected into the wells referred to in subclause (1) of clause 1 hereof shall not exceed 17 000 kPa or such other maximum pressure as the Board may prescribe. The Board may, from time to time, prescribe a minimum or maximum rate at which gas shall be injected into any well in the Unit Area.
6.
  - (1) The Unit Operators shall, not later than the last day of each month, file with the Petroleum Branch, a report of the quantity and pressure of gas injected during the preceding month into each well referred to in subclause 1(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 Units including volumes of oil, gas and water produced during the test;
    - (d) interpreted results of the monitoring program required pursuant to clause 4 hereof;
    - (e) a summary of any remedial operations carried out on any well in the Unit.
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 gas flood.



Oil and Natural Gas Order No. PM 41,  
made and passed this 31st day of  
January A.D., 1984, at this City  
of Winnipeg, in the Province of  
Manitoba, by The Oil and Natural  
Gas Conservation Board.



Marc Eliesen  
Chairman,  
The Oil and Natural Gas  
Conservation Board



Ian Haugh  
Deputy Chairman,  
The Oil and Natural Gas  
Conservation Board



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

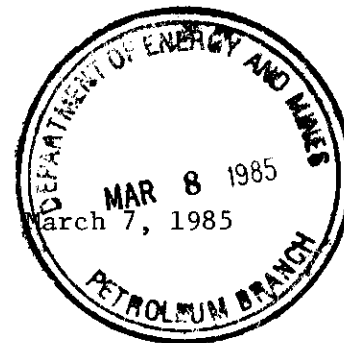
Approved:



Wilson D. Parasiuk  
Minister of Energy and Mines



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



Manitoba Petroleum Branch  
555 - 330 Graham Avenue  
Winnipeg, Manitoba  
R3C 4E3

Attention: Mr. Bob Dubreuil

Dear Sir,

Re: Waskada Unit No. 4  
Board Order No. PM 41

The purpose of this letter is to apply for approval to convert three (3) existing gas injection wells inside Waskada Unit No. 4 to water injection as allowed under clause 2 subclause 1 (4) of Board Order No. PM 41. Due to an insufficient supply of gas for injection as well as early signs of gas breakthrough in certain areas Omega Hydrocarbons Ltd. requests permission to convert the following gas injectors to water injection:

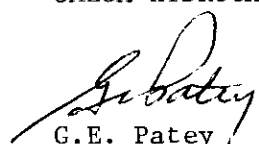
Omega Waskada GIW 7-23-1-26 WPM  
Omega Waskada GIW 5-24-1-26 WPM  
Omega Waskada GIW 7-24-1-26 WPM

Attached is an engineering file note which summarizes in more detail the reasons for converting the above mentioned wells.

It is this company's opinion that the proposed change in injection strategy will improve both the pressure maintenance operations and ultimate recoveries within Waskada Unit No. 4. Any questions related to this application should be directed to either Mr. Richard Brekke or Mr. Bob Beamish at (403) 261-0743.

Your earliest attention to this matter would be appreciated.

Yours truly,  
OMEGA HYDROCARBONS LTD.

  
G.E. Patey  
Vice President, Production

c.c. R. Brekke  
B. Beamish  
Waskada Gasflood Approval File

## Engineering File Note

85-03-05

Subject: Waskada Unit No. 4  
Gasflood Performance Review

Purpose: The purpose of this filenote is to summarize the performance of the Waskada Unit No. 4 gasflood to date.

### Recommendations:

Based on recent production/injection data it is recommended that:

- 1) Gas injection be terminated and water injection started at wells 7-23, 5-24 and 7-24-1-26 WPM. Prior to converting these wells to water injection bottomhole pressure measurements should be obtained.
- 2) Gas injection continue at injection wells 5-13, 13-13, 15-13 and 15-14-1-26 WPM.

### Discussion:

This portion of the Waskada Lower Amaranth pool was produced under primary depletion from 1981 to 1984. In 1984, the Waskada Unit No. 4 was formed with the intent of implementing a pressure maintenance scheme. Lean gas was chosen as the injection fluid and injection began in June 1984. During the period June 1984 to January 1985 varying levels of voidage replacement have been achieved. Attachment 1 contains a summary of the historical individual pattern voidage replacement ratios. The variation in voidage replacement ratios on a month to month basis has been caused by either gas plant downtime or operational difficulties in meeting injection targets. An important point which should be noted is that on a total unit basis voidage replacement has not been met due to an insufficient supply of lean gas. At present essentially all gas production is being processed at the gas plant thus the supply of lean gas for injection is fixed. Rather than cutback production to rectify the voidage replacement problem it is recommended that some gas injectors be converted to water injection.

A review of total unit performance indicates a decrease in the rate of oil decline and an increase in gas/oil ratio since the start of gas injection. Attachment 2 contains a summary of historical data for Waskada Unit No. 4. The reduced rate of oil decline in conjunction with the September 1984 pressure data suggests that gas injection is supplying adequate pressure support to certain portions of the unit. By reviewing individual well performances the source of the increase in total unit gas/oil ratio can be traced to wells 8A-23, 1A-24, 3-24 and 8A-24-1-26 WPM. Based on the data presented in Attachments 3-6 it becomes apparent that significant gas breakthrough is occurring at these wells. Early breakthrough at these wells can possibly be explained by the fact that the northern half of the unit has better reservoir properties than the southern half of the unit. The improved quality of the northern portion of the unit can also be seen by the voidage creation which is occurring within injection patterns 7-23, 5-24 and 7-24-1-26 WPM. Although it is difficult to determine exactly which injection wells have channeled through to cause the gas breakthrough the most likely candidates are wells 7-23, 5-24 and 7-24-1-26 WPM. In an effort to remedy the existing gas breakthrough and to improve ultimate recoveries in all parts of Waskada Unit No. 4 it is recommended that the previously mentioned injectors be converted to water injection as soon as possible. Since no detrimental effects have been observed in the southern half of the unit due to gas injection there is no reason to change the existing injection strategy for wells 5-13, 13-13, 15-13 and 15-14-1-26 WPM at this time.



Richard Brekke

RB:ad

c.c. G.E. Patey  
R. Beamish  
M.Mawdsley/J.Thompson  
Waskada Pressure  
Maintenance Monitoring File

Waskada Unit No. 4  
Injection Pattern VRR Summary

	<u>Production (Res m<sup>3</sup>)</u>	<u>Injection (Res m<sup>3</sup>)</u>	<u>VRR</u>	<u>Average Pattern Pressure(kPag)</u>
<u>Pattern 5-13-1-26 WPM</u>				
June 1984	807.9	418.3	0.518	5500
July 1984	945.2	1697.4	1.796	2939
August 1984	889.1	1764.1	1.984	2939
September 1984	701.4	1034.5	1.475	2939
October 1984	558.4	536.3	0.960	8150
November 1984	321.5	368.7	1.147	8150
December 1984	428.9	403.3	0.940	8150
January 1985	<u>451.2</u>	<u>808.5</u>	<u>1.792</u>	8150
	5103.6	7031.1	1.378	
<u>Pattern 13-13-1-26 WPM</u>				
June 1984	1045.3	582.0	0.557	5500
July 1984	923.5	1275.1	1.381	5500
August 1984	925.2	673.3	0.728	5500
September 1984	945.1	147.7	0.156	5500
October 1984	855.2	1374.1	1.607	5600
November 1984	939.6	2664.0	2.835	5600
December 1984	1370.4	2166.1	1.581	5600
January 1985	<u>1416.3</u>	<u>3350.9</u>	<u>2.366</u>	5600
	8420.6	12233.2	1.453	

	<u>Production (Res m<sup>3</sup>)</u>	<u>Injection (Res m<sup>3</sup>)</u>	<u>VRR</u>	<u>Average Pattern Pressure (kPag)</u>
<u>Pattern 7-23-1-26 WPM</u>				
June 1984	1835.2	-	-	5500
July 1984	1554.9	-	-	5500
August 1984	1036.4	3078.0	2.970	5500
September 1984	835.9	815.7	0.976	5500
October 1984	1037.0	295.8	0.285	8140
November 1984	1079.7	167.7	0.155	8140
December 1984	1397.9	317.3	0.227	8140
January 1985	<u>1454.4</u>	<u>781.9</u>	<u>0.538</u>	8140
	10231.4	5456.4	0.533	

Pattern 5-24-1-26 WPM

June 1984	2510.5	1119.2	0.446	5500
July 1984	2046.9	2510.6	1.227	5500
August 1984	1596.3	1706.9	1.069	5500
September 1984	1491.0	857.8	0.575	5500
October 1984	1914.7	3110.1	1.624	5435
November 1984	2223.1	3012.7	1.355	5435
December 1984	2817.0	1695.2	0.602	5435
January 1985	<u>2864.9</u>	<u>1087.1</u>	<u>0.379</u>	5435
	17464.4	15099.6	0.864	

	<u>Production</u> (Res m <sup>3</sup> )	<u>Injection</u> (Res m <sup>3</sup> )	<u>VRR</u>	<u>Average Pattern</u> <u>Pressure (kPag)</u>
<u>Pattern 15-13-1-26 WPM</u>				
June 1984	1150.8	685.2	0.595	5500
July 1984	1373.8	1758.2	1.280	3351
August 1984	1232.1	1409.2	1.144	3351
September 1984	1383.8	494.3	0.357	3351
October 1984	804.3	1762.2	2.191	4621
November 1984	974.5	1694.4	1.739	4621
December 1984	1451.3	1254.0	0.864	4621
January 1985	<u>1557.6</u>	<u>2271.8</u>	<u>1.458</u>	4621
	9928.2	11329.3	1.141	

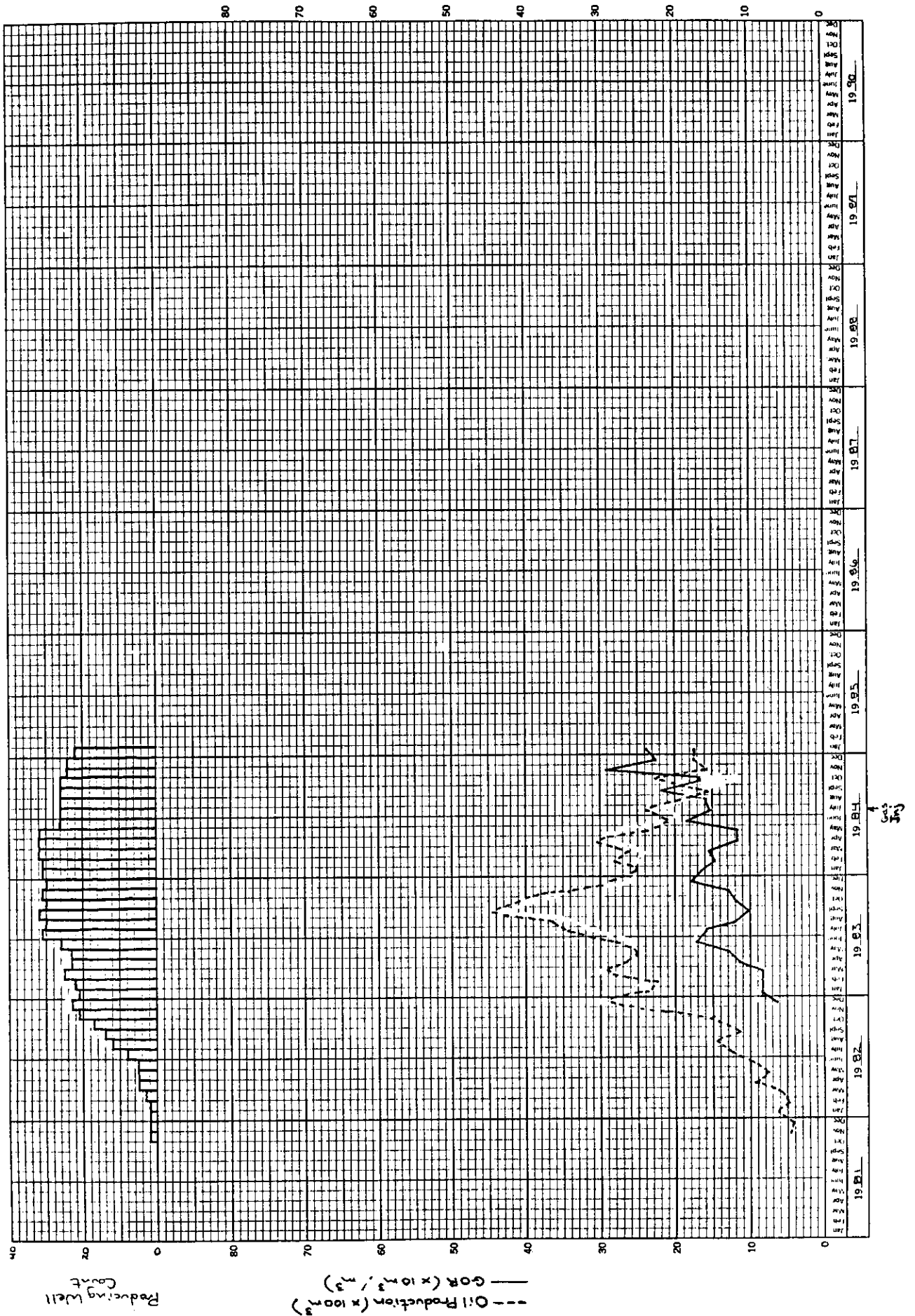
Pattern 15-14-1-26 WPM

June 1984	926.4	199.7	0.216	5500
July 1984	795.1	100.4	0.126	8413
August 1984	480.8	18.7	0.039	8413
September 1984	436.2	82.1	0.188	8413
October 1984	597.2	91.7	0.154	8100
November 1984	1444.0	8.5	0.006	8100
December 1984	403.6	4.1	0.010	8100
January 1985	<u>406.7</u>	<u>305.3</u>	<u>0.751</u>	8100
	5490.0	810.5	0.148	

	<u>Production (Res m<sup>3</sup>)</u>	<u>Injection (Res m<sup>3</sup>)</u>	<u>VRR</u>	<u>Average Pattern Pressure (kPag)</u>
<u>Pattern 7-24-1-26 WPM</u>				
June 1984	2393.5	777.8	0.325	5500
July 1984	3094.1	2021.8	0.653	5500
August 1984	3255.7	3343.9	1.027	5500
September 1984	3376.2	1202.2	0.356	5500
October 1984	2282.5	1198.7	0.525	8278
November 1984	3364.3	557.1	0.166	8278
December 1984	1977.1	516.2	0.261	8278
January 1985	<u>1824.8</u>	<u>1284.8</u>	<u>0.704</u>	8278
	21568.2	10902.5	0.505	
 TOTAL UNIT	 78206.4	 62862.6	 0.804	



Total Unit #4 Production History

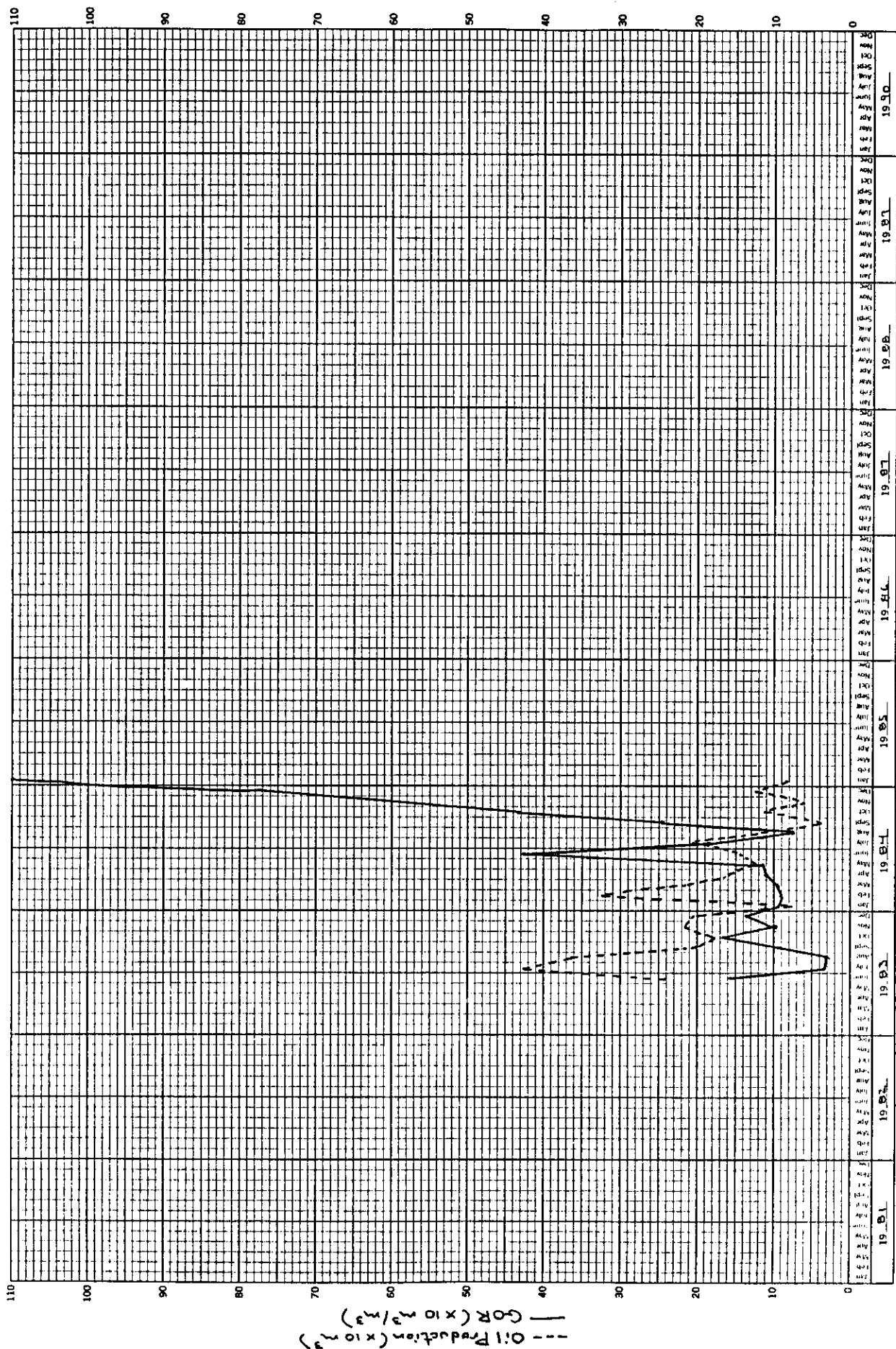


Waskada Unit No. 4 Production / Injection History

Attachment 2 (b)

[illegible]

Well BA-23-1-26 WPM

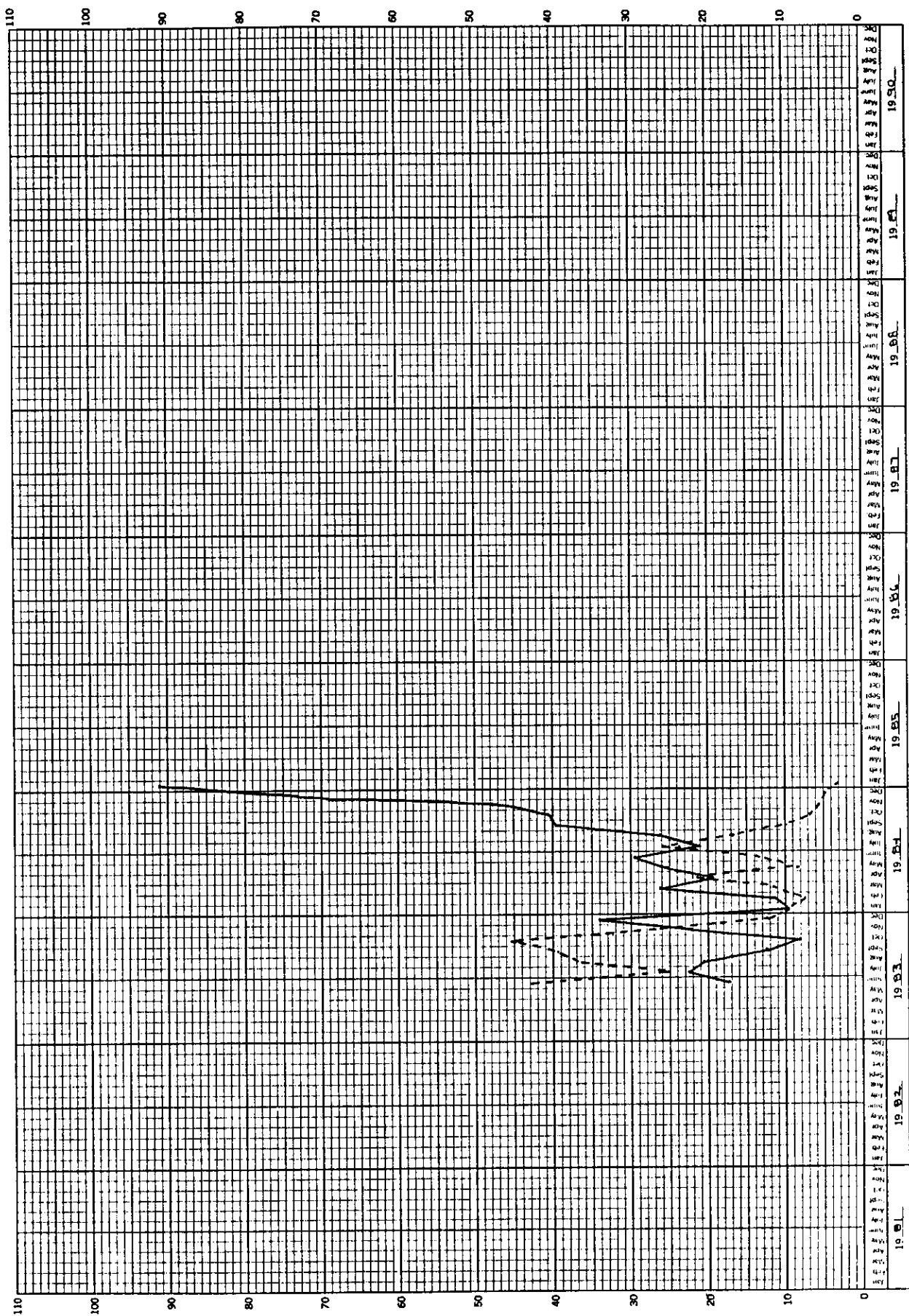


1981

## PRODUCTION/INJECTION HISTORY FOR WELL 0208230012610

ON PRODUCTION DATE: 830625		ZONE IS 01		WAT		GOR		INJECTION		CUMULATIVES				
MNRH	HRS	PRODUCTION		RATES		CUT	GOR	INJECTION		OIL	WATER	GAS	INJUA	INJGAS
		M3	M3	M3/D	M3/D			M3	M3					
8306	380	240.8	86.2	15.2	20.7	26	157	.0	.00	241	86	38	0	0
8307	629	429.3	112.9	13.66	16.4	20.7	21	32	.0	670	199	51	0	0
8308	608	363.3	157.5	11.10	14.3	20.6	30	31	.0	1033	357	62	0	0
8309	690	202.8	460.2	18.60	7.1	23.1	69	92	.00	1236	817	81	0	0
8310	732	178.5	693.5	29.70	5.9	28.6	80	166	.00	1415	1510	111	0	0
8311	528	214.8	195.6	21.20	9.8	18.7	48	99	.00	1630	1706	132	0	0
8312	744	206.3	587.2	28.20	6.7	25.6	74	137	.00	1836	2293	160	0	0
8401	336	77.8	338.8	7.60	5.6	29.8	81	98	.00	1914	2632	168	0	0
8402	696	322.3	383.5	29.20	11.1	24.3	54	91	.00	2236	3015	197	0	0
8403	432	216.3	191.1	20.70	12.0	22.6	47	96	.00	2452	3207	218	0	0
8404	720	159.0	363.8	17.50	5.3	17.4	70	110	.00	2611	3570	235	0	0
8405	740	123.0	336.7	14.20	4.0	14.9	73	115	.00	2734	3907	249	0	0
8406	713	144.5	523.4	61.70	4.9	22.5	78	427	.00	2879	4430	311	0	0
8407	730	207.7	488.1	38.50	6.8	22.9	70	185	.00	3086	4918	350	0	0
8408	768	122.2	507.2	9.20	3.8	19.7	81	75	.00	3209	5426	359	0	0
8409	716	35.0	201.5	9.60	1.2	7.9	85	274	.00	3244	5627	368	0	0
8410	745	112.7	244.7	60.70	3.6	11.5	68	539	.00	3356	5872	429	0	0
8411	716	56.3	209.3	79.60	1.9	8.9	79	***	.00	3413	6081	509	0	0
8412	744	125.8	215.7	97.50	4.1	11.0	63	775	.00	3538	6297	606	0	0
8501	740	84.3	275.6	101.20	2.7	11.7	77	***	.00	3623	6572	707	0	0

Well 1A-24-1-26 WPM

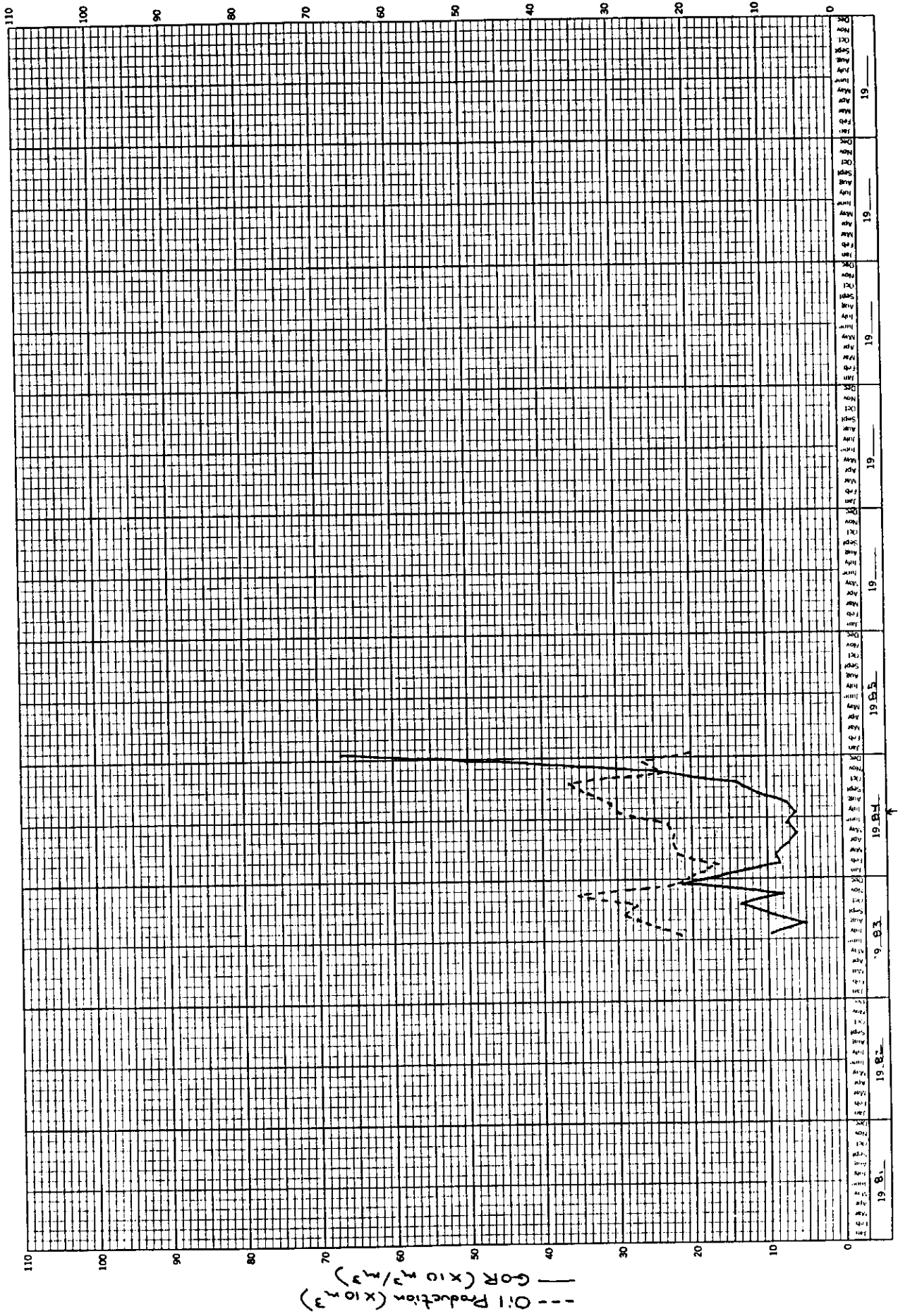


GOR

## PRODUCTION/INJECTION HISTORY FOR WELL 0201240012610

ON PRODUCTION DATE: 830615															ZONE IS 01														
Mnth Yr/M	HRS	PRODUCTION			GAS KM3	RATES			WAT CUT	GOR	INJECTION		CUMULATIVES																
		OIL M3	WATER M3	GAS M3/D		OIL M3/D	FLUID M3/D	WATER M3			GAS KM3	OIL M3	WATER M3	GAS KM3	INJWAT M3	INJGAS KM3													
8306	376	429.4	39.9	74.24	27.4	30.0	9	173		.00	.0	429	40	74	0	0													
8307	695	250.9	17.4	56.99	8.7	9.3	6	227		.00	.0	680	57	131	0	0													
8308	720	364.3	52.1	75.00	12.1	13.9	13	206		.00	.0	1045	109	206	0	0													
8309	654	392.5	52.2	48.80	14.4	16.3	12	124		.00	.0	1437	162	255	0	0													
8310	664	453.3	77.2	36.50	16.4	19.2	15	81		.00	.0	1890	239	292	0	0													
8311	496	268.0	29.2	59.60	13.0	14.4	10	222		.00	.0	2158	268	351	0	0													
8312	692	120.1	18.7	40.90	4.2	4.8	13	341		.00	.0	2279	287	392	0	0													
8401	642	98.3	4.1	9.60	3.7	3.8	4	98		.00	.0	2377	291	402	0	0													
8402	464	75.8	3.3	8.80	3.9	4.1	4	116		.00	.0	2453	294	410	0	0													
8403	326	115.3	12.1	30.10	8.5	9.4	9	261		.00	.0	2568	306	441	0	0													
8404	360	201.7	48.3	39.30	13.4	16.7	19	195		.00	.0	2770	355	480	0	0													
8405	355	82.1	16.0	20.70	5.6	6.6	16	252		.00	.0	2852	371	501	0	0													
8406	423	137.2	28.0	40.68	7.8	9.4	17	296		.00	.0	2989	399	541	0	0													
8407	642	258.8	62.5	54.50	9.7	12.0	19	211		.00	.0	3248	461	596	0	0													
8408	622	167.0	22.0	43.70	6.4	7.3	12	262		.00	.0	3415	483	639	0	0													
8409	672	89.2	.0	39.60	3.2	3.2	0	444		.00	.0	3504	483	679	0	0													
8410	721	66.9	7.3	27.20	2.2	2.5	10	407		.00	.0	3571	490	706	0	0													
8411	692	53.4	4.8	25.60	1.9	2.0	8	479		.00	.0	3624	495	732	0	0													
8412	732	49.4	8.4	36.10	1.6	1.9	15	731		.00	.0	3674	503	768	0	0													
8501	699	30.8	5.6	27.70	1.1	1.2	15	899		.00	.0	3704	509	796	0	0													

Well 3-24-1-26 WPM



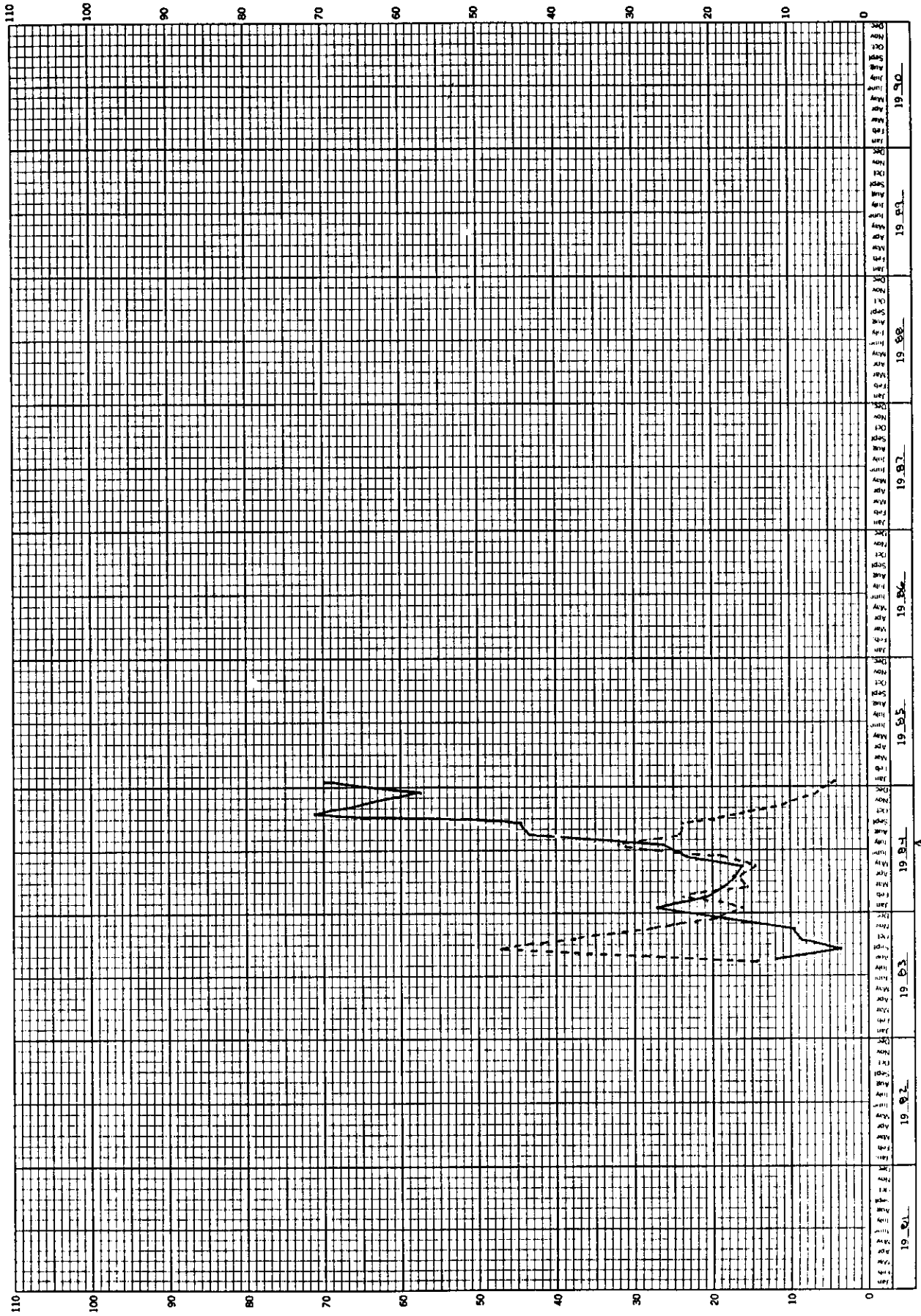
GOR

## PRODUCTION/INJECTION HISTORY FOR WELL 003240012610

ON PRODUCTION DATE: 830715		ZONE IS 01				WAT CUT	GOR	INJECTION		CUMULATIVES			
MNTH YR/M	HRS	PRODUCTION		RATES				WATER	GAS	OIL	WATER	GAS	INJECT
		M3	KM3	M3/D	KM3/D			M3	KM3	M3	KM3	M3	KM3
8307	408	216.2	54.8	20.78	12.7	15.9	20	96	.00	216	55	21	0
8308	743	258.0	181.9	13.00	8.3	14.2	41	50	.00	474	237	34	0
8309	713	289.5	219.1	28.40	9.7	17.0	43	98	.00	764	456	0	0
8310	742	275.8	487.1	37.60	8.9	24.7	64	136	.00	1040	943	100	0
8311	712	351.4	257.6	28.00	11.8	20.5	42	80	.00	1391	1201	138	0
8312	458	225.6	300.8	47.80	11.8	27.6	57	212	.00	1617	1501	176	0
8401	379	197.0	246.7	30.50	12.5	28.1	56	155	.00	1814	1748	206	0
8402	336	166.4	182.7	13.90	11.9	24.9	52	84	.00	1980	1931	220	0
8403	336	219.5	84.1	19.60	15.7	21.7	28	89	.00	2199	2015	240	0
8404	384	223.9	30.9	16.00	14.0	15.9	12	71	.00	2423	2046	256	0
8405	444	224.6	31.5	13.80	12.1	13.8	12	61	.00	2648	2077	269	0
8406	470	232.4	21.1	17.00	11.9	12.9	8	73	.00	2880	2098	286	0
8407	641	295.5	26.7	18.40	11.1	12.1	8	62	.00	3176	2125	305	0
8408	768	309.0	76.5	23.30	9.7	12.0	20	75	.00	3485	2202	328	0
8409	714	302.9	72.7	37.80	10.2	12.6	19	125	.00	3788	2274	366	0
8410	745	363.3	30.7	50.20	11.7	12.7	8	138	.00	4151	2305	416	0
8411	696	238.6	90.7	58.10	8.2	11.4	38	244	.00	4390	2396	474	0
8412	744	266.2	146.6	112.50	8.6	13.3	26	423	.00	4656	2542	587	0
8501	654	204.2	200.1	134.80	7.5	14.8	49	660	.00	4860	2742	721	0



Well BA-24-1-26 WPM



--- Oil Production (x10 m³)  
— GOR (x10 m³/m³)

Gas  
Inj

## PRODUCTION/INJECTION HISTORY FOR WELL 0208240012610

ON PRODUCTION DATE: 830828		ZONE IS 01				GOR		INJECTION		CUMULATIVES				
Mnth YR/M	HRS	PRODUCTION		RATES		WAT CUT	GOR	INJECTION		OIL M3	WATER M3	GAS KM3	INJWAT M3	INJGAS KM3
		OIL M3	WATER M3	OIL M3/D	FLUID M3/D			WATER M3	GAS KM3					
8308	96	140.4	68.5	16.70	35.1	52.2	33	119	.00	140	68	17	0	0
8309	498	470.0	26.9	17.10	22.7	23.9	5	36	.00	610	95	34	0	0
8310	559	377.9	12.0	32.80	16.2	16.7	3	87	.00	988	107	67	0	0
8311	452	279.0	7.3	26.90	14.8	15.2	3	96	.00	1267	115	93	0	0
8312	350	193.2	4.4	35.30	13.2	13.5	2	183	.00	1461	119	129	0	0
8401	360	163.1	2.4	44.10	10.9	11.0	1	270	.00	1624	122	173	0	0
8402	456	236.9	2.9	49.40	12.5	12.6	1	209	.00	1861	124	222	0	0
8403	264	153.4	1.6	28.70	13.9	14.1	1	187	.00	2014	126	251	0	0
8404	264	165.4	1.6	28.50	15.0	15.2	1	172	.00	2179	128	280	0	0
8405	263	146.1	1.6	23.90	13.3	13.5	1	164	.00	2325	129	303	0	0
8406	360	191.7	2.2	44.90	12.8	12.9	1	234	.00	2517	131	348	0	0
8407	641	320.9	7.8	84.80	12.0	12.3	2	264	.00	2838	139	433	0	0
8408	623	243.7	5.5	105.60	9.4	9.6	2	433	.00	3082	145	539	0	0
8409	640	213.0	3.1	106.20	8.0	8.1	1	499	.00	3295	148	645	0	0
8410	652	158.9	3.2	112.90	5.8	6.0	2	711	.00	3454	151	758	0	0
8411	644	107.6	.0	177.40	4.0	4.0	0	**	.00	3561	151	935	0	0
8412	744	65.3	.0	37.70	2.1	2.1	0	577	.00	3627	151	973	0	0
8501	590	42.8	2.3	29.40	1.7	1.8	5	687	.00	3669	153	1002	0	0