

August 26, 1991

Mr. C.R.D. Haywood
Manager, Economics and Planning
Enron Oil Canada Ltd.
1300, 700 - 9th Avenue S.W.
Calgary, Alberta
T2P 3V4

Dear Sir:

RE: Waskada Unit No. 17
Well Conversions to Water Injection

Attached are approved applications to convert the six wells in Waskada Unit No. 17 to water injection. Please note the new well names:

Waskada Unit No. 17 WIW 14-3-2-25 (WPM)
Waskada Unit No. 17 WIW 8-10-2-25 (WPM)
Waskada Unit No. 17 Prov. WIW 11-10-2-25 (WPM)
Waskada Unit No. 17 WIW 1-15-2-25 (WPM)
Waskada Unit No. 17 WIW A4-15-2-25 (WPM)
Waskada Unit No. 17 WIW 6-15-2-25 (WPM)

Your are also reminded that water injection is not authorized until the Board has approved the Unit Agreement for Waskada Unit No. 17. Presently, the Minister on behalf of the Crown is awaiting the Lieutenant Governor in Council's approval to enter into the Unit Agreement. This approval is not expected until after September 4, 1991. Therefore, the earliest the Board approval can be granted is October 1, 1991.

If you have any questions, please contact the undersigned at (204) 945-6574.

Yours truly,

John N. Fox, P. Eng.
Chief Petroleum Engineer

Att'd.



Memorandum

Date June 3, 1991

To The Oil and Natural Gas
Conservation Board
- Ian Haugh, Chairman
- H. Clare Moster, Deputy Chairman
- Wm. McDonald, Member

From John N. Fox
Chief Petroleum Engineer
Petroleum Branch

Subject

Telephone

Re: Waskada Unit No. 17
Pressure Maintenance Application

Enron Oil Canada Ltd.'s application for approval of pressure maintenance operations in the proposed Waskada Unit No. 17 was advertised in the Manitoba Gazette and the Melita New Era. No objections to the application were received.

Recommendations:

It is recommended that the Board approve Enron's application. A copy of Board Order No. PM 66 covering pressure maintenance operations in Waskada Unit No. 16 and the proposed Unit No. 17 is attached. Also attached is a copy of the proposed Board letter of approval to accompany the order.

Discussion:

Enron has made application to expand waterflood operations in the Waskada Lower Amaranth A Pool north and east of Waskada Unit No. 16. Proposed Waskada Unit No. 17 includes the conversion of six wells to water injection to create six full or partial inverted seven-spot injection patterns (Figure 1).

Waterflood Performance - Waskada Unit No. 16

Water injection into Unit No. 16 commenced in June, 1987. The unit was expanded in October, 1988 and injection commenced in the expanded unit area in December, 1988. Cumulative water injection to December 31, 1990 was $113.9 \times 10^3 \text{ m}^3$ resulting in a cumulative voidage-replacement ratio of 0.74.

To December 31, 1990, cumulative oil production totalled $132.1 \times 10^3 \text{ m}^3$ (4.7% OOIP) with a cumulative WOR of 0.26. Most of the produced water is assumed to originate from the underlying Mission Canyon Formation in wells where communication was established during completion.

First | Fold

Water injection in Unit No. 16 has been effective in reducing the annual exponential production decline from approximately 22%/yr (1986-87) to 6.4%/yr (1989-91) (Figure 2).

The injection wells in the inverted seven-spot injection patterns in Unit No. 16 are aligned in a NE-SW direction (Figure 1) parallel to the induced fracture orientation. This injection well alignment appears to have resulted in improved areal sweep efficiency as no off-trend producers have experienced water breakthrough.

Based on Enron's 1988 simulation study, the estimated OOIP in Unit No. 16 is $2\,823 \times 10^3 \text{ m}^3$. The study predicted a primary recovery of 9.3% OOIP and a waterflood recovery of 19.8% OOIP after 20 years (29.1% OOIP after 40 years). The Branch's estimated waterflood recovery of 17.2% OOIP using decline curve analysis (Figure 2) matches closely the 20 year simulation results.

Proposed Waskada Unit No. 17

Enron's OOIP estimates and waterflood recovery predictions for the proposed Waskada Unit No. 17 are based on the results of the 1988 simulation study.


The estimated OOIP in Unit No. 17 is $1967 \times 10^3 \text{ m}^3$ (assumed average OOIP - $85.5 \times 10^3 \text{ m}^3$ per 16 ha). Enron predicts a primary recovery of 7.5% OOIP and a waterflood recovery of 16% after 20 years for Unit No. 17. The slightly lower recovery estimates for Unit No. 17 are based on the higher water-cut in Unit No. 17 - 40% compared to 25% for Unit No. 16 at waterflood start-up (Figure 3).

The Branch agrees with Enron's estimates of increased waterflood recovery and based on the performance of Unit No. 16 recommends the application be approved. Proposed Board Order No. PM 66 covering pressure maintenance operations in both Unit No.'s 16 and 17 is attached. Board Order No. PM 66 rescinds Board Order No. PM 57. Injection in Unit No. 17 is not to commence until the Board has approved the Unit Agreement.

Enron does not wish to convert 15-10-2-25 to injection at this time. The 15-10 well produces $3.2 \text{ m}^3/\text{d}$ compared to an average productivity of $1.3 \text{ m}^3/\text{d}$ for the 6 proposed injectors. Enron proposes to use the 15-10 well to investigate the difference in water breakthrough time between on-trend and off-trend producers. It is also reasonable to assume that the loss of productivity if 15-10-2-25 were converted would have a negative impact on the project economics. It is recommended that the Board request Enron to report annually on the performance of 15-10, its plans for conversion of the well and the effect of reservoir anisotropy on waterflood performance.

The Branch has reviewed the feasibility and desirability of including the NW/4 of Section 11 (Omega), the remainder of the wells in Section 14 and the SE/4 of Section 15, all in Township 2, Range 25 (WPM) in Unit No. 17. The Branch concurs with Enron's position that offset injection in

Unit No.'s 16 and 17 will provide partial pressure support in the NW/4 of Section 11 and the SE/4 of Section 15 until adjacent lands are developed. The remainder of the wells in Section 14 adjacent to Unit No. 17 are completed in an Upper Amaranth porosity stringer, the Mission Canyon or are abandoned. Therefore, inclusion of these wells in Unit No. 17 is not warranted.



John N. Fox
Chief Petroleum Engineer

JNF/sml

Attachment

Recommended for Approval:



L. R. Dubreuil, Director

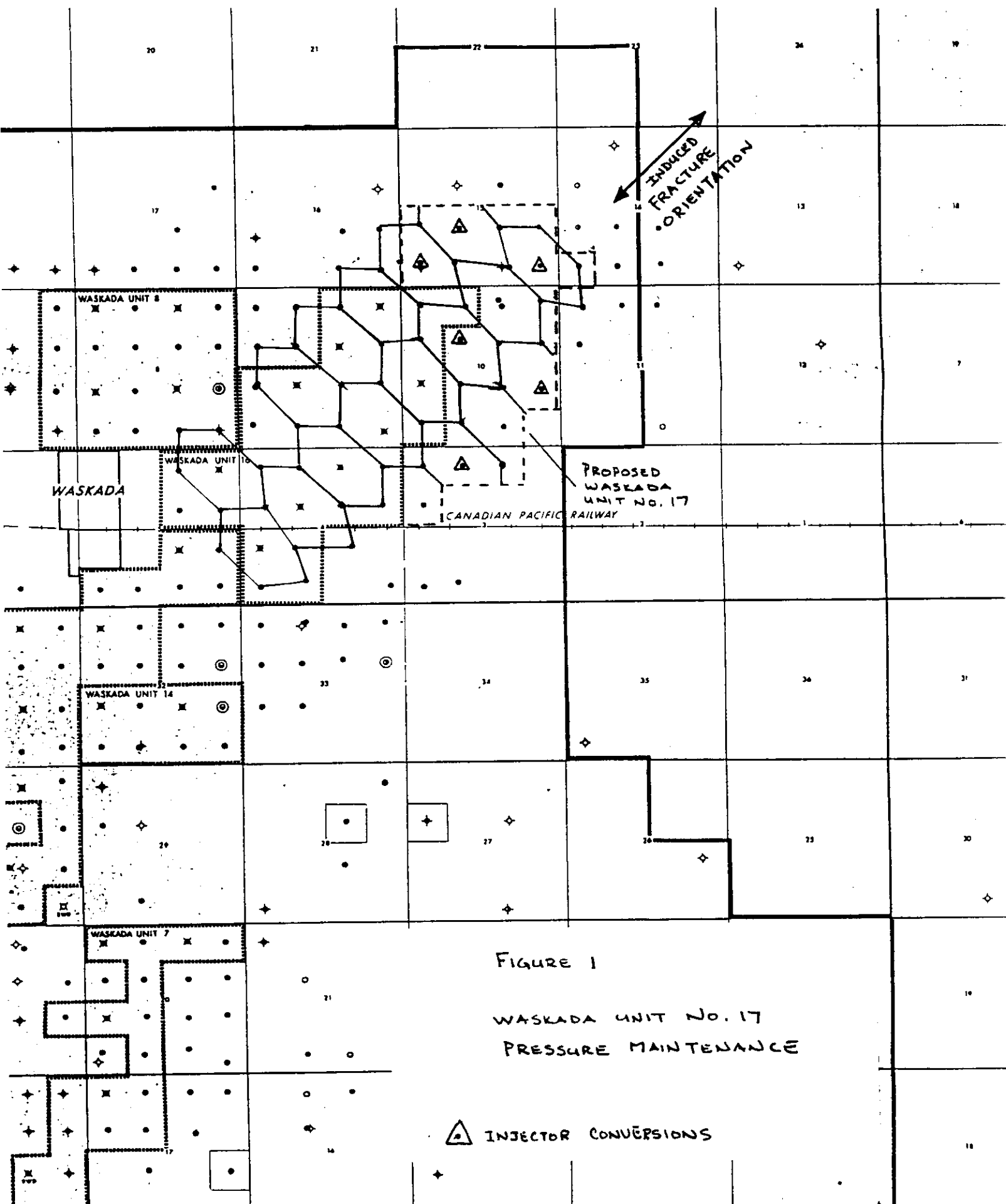


FIGURE 2

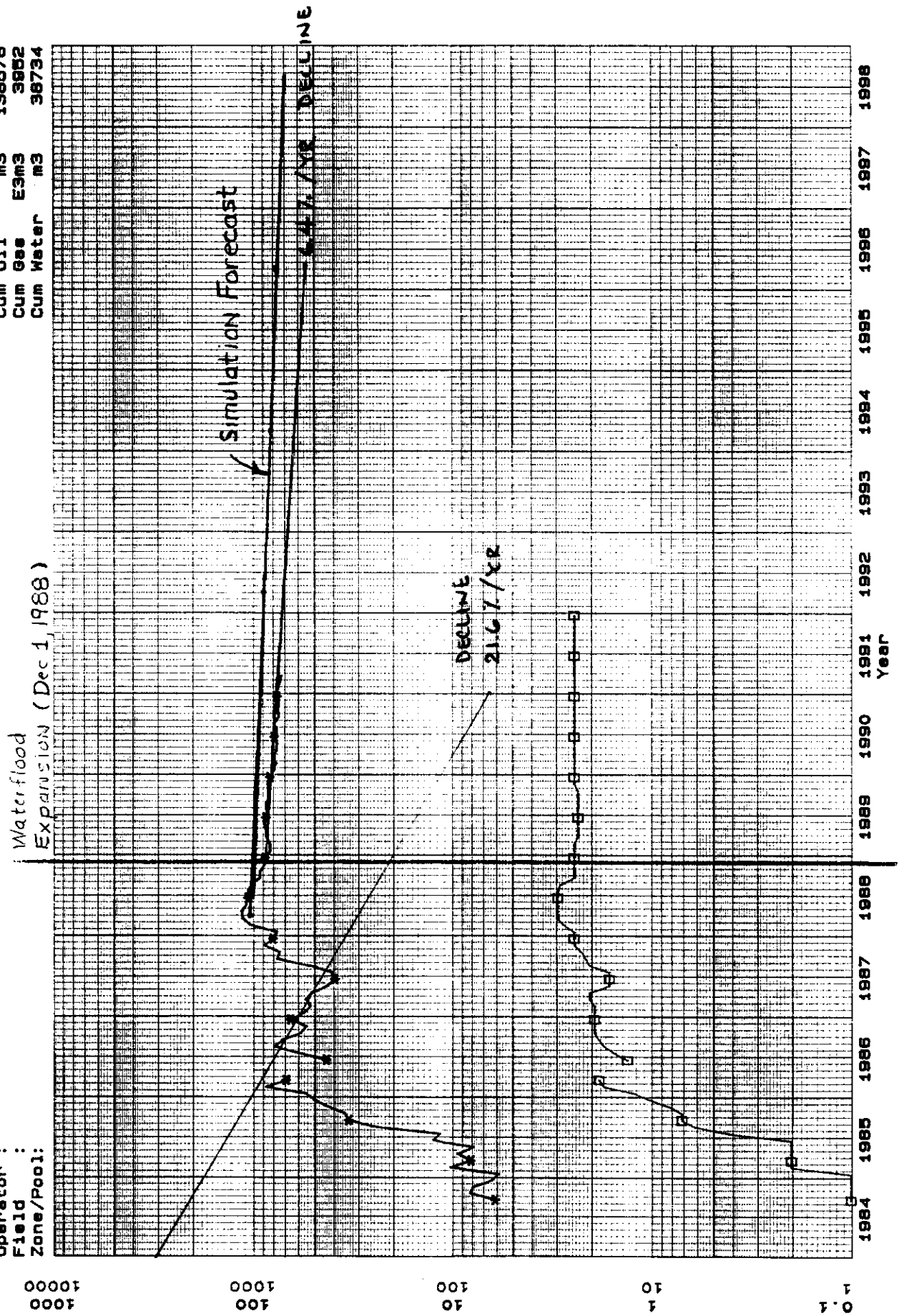
05/14/91 14:15

Date 8408-9112

Operator :
Field :
Zone/Pool:

Type :

Cum Oil m3 138576
Cum Gas E3m3 3852
Cum Water m3 38734



□ * Num Wells
□ * Avg Daily Oil m3/d

WASKADA UNIT # 17

FIGURE 3

05/14/91 13:59

Type :

Date 8510-9112

Operator :

Field :

Zone/Pool:

Cum Oil m3 43542
Cum Gas E3m3 708
Cum Water m3 17304

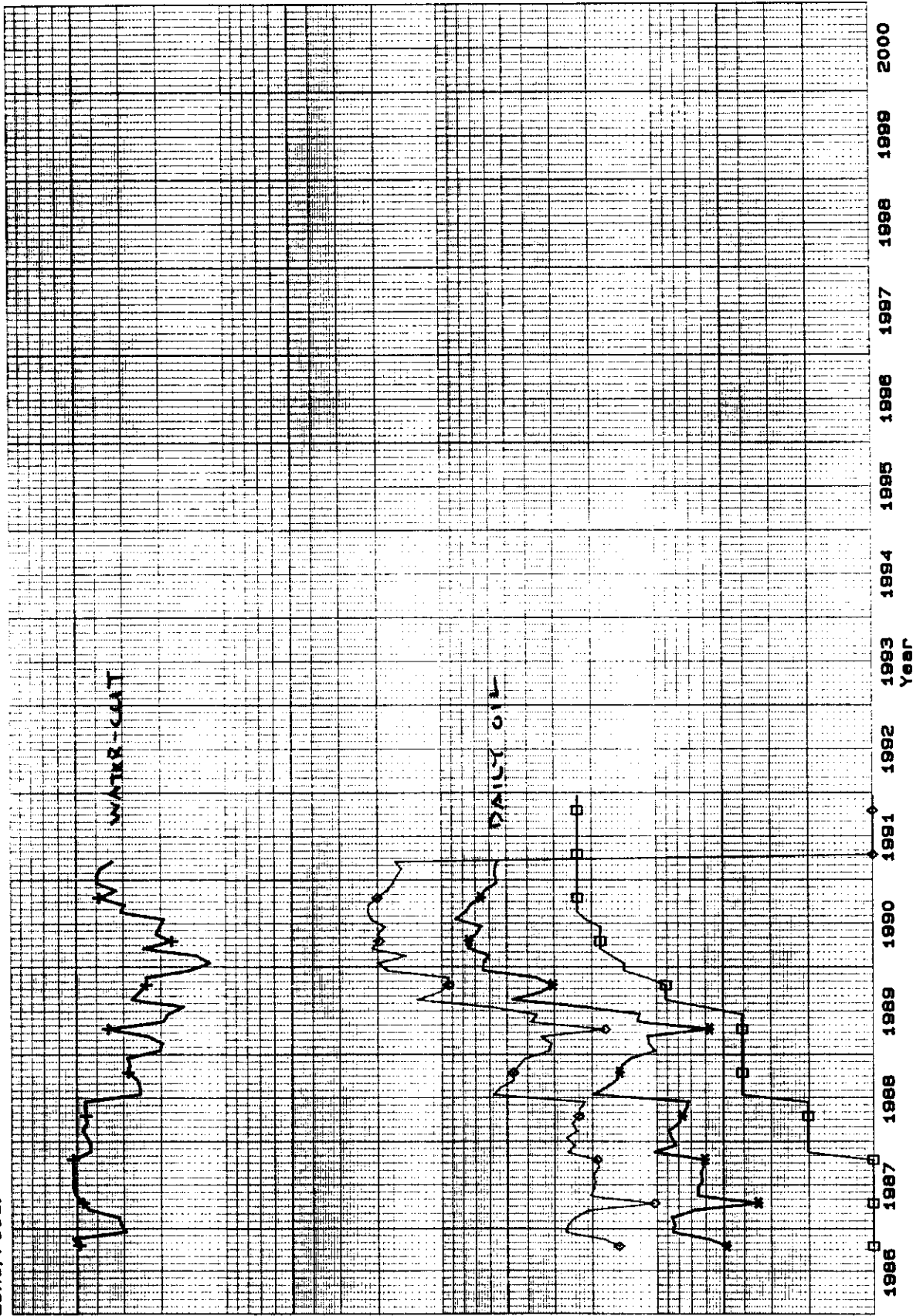
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10
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□ Num Wells
* * AVG Daily Oil m3/d
◇ ◇ Monthly Oil m3

Water Cut

% + + +



Date: June 4, 1991

Action / Route Slip

To: L.R. DUBREUIL

From: H. CLARE MOSTER

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: RE: ENRON'S ORDER No. PM 66:

- Order delivered to I. Haugh on June 4th.
- Approved Order to be returned directly to Petroleum.
- * - Ensure Order is "dated".
- Signed copy of transmittal letter attached.
- * - Ensure letter properly dated before sending. *1 original of order*

Attachment

Manitoba



Action / Route Slip

Date: June 4, 1991

To: Ian Haugh

Deputy Minister

Energy and Mines

✓ cc: L.R. Dubreuil

From: H. Clare Moster

Assistant Deputy Minister

Energy Division

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: Re: Board Order No. PM66 (Enron - Waskada)

Attached and recommended for your signature and the Minister's approval

is Board Order No. PM66.

Please return approved Order directly to Petroleum.



The Oil and Natural Gas
Conservation Board

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

(204) 945-3130

June 17, 1991

Mr. H. Dale Logie, P. Eng.
Chief Reservoir Engineer
Enron Oil Canada Ltd.
1300, 700 - 9th Avenue S.W.
Calgary, Alberta
T2P 3V4

Dear Mr. Logie:

Re: Waskada Unit No. 17
Pressure Maintenance Approval

The Board has completed its review of your application to expand waterflood operations in the Waskada Lower Amaranth A Pool. Attached is a copy of Board Order No. PM 66 authorizing pressure maintenance operations in Waskada Unit No.'s 16 and 17.

Please note that water injection into Waskada Unit No. 17 is not authorized until the Board has approved the Unit Agreement as required by Section 74 of The Mines Act.

The Board requests that Enron, in the annual progress report required under Section 7 of Board Order No. PM 66, include a discussion of the performance of the well, Enron Waskada 15-10-2-25 (WPM), its plans for conversion of the well and the effect of reservoir anisotropy on waterflood performance.

If you have any questions in respect of this matter, please contact L.R. Dubreuil, Director of Petroleum or John N. Fox, Chief Petroleum Engineer, at (204) 945-6573 or 945-6574, respectively.

Yours respectfully,

A handwritten signature in black ink, appearing to read "H. Clare Moster". The signature is fluid and cursive, with a long, sweeping underline that extends to the right.

H. Clare Moster
Deputy Chairman



The Oil and Natural Gas
Conservation Board

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

(204) 945-3130

Order No. PM 66

An Order Pertaining to Pressure Maintenance by Water Flooding
Waskada Lower Amaranth A Pool

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 March 19, 1991 from Enron Oil Canada Ltd. for approval of a project to inject water into the Waskada Lower Amaranth A Pool ("the pool") in the proposed Waskada Unit No. 17.

AND WHEREAS, upon publication of notice of the application the Board received no objections to or interventions in the application.

AND WHEREAS, Enron Oil Canada Ltd. is the unit operator of Waskada Unit No. 16, and the proposed unit operator of the proposed Waskada Unit No. 17 ("the unit areas").

AND WHEREAS, upon due consideration of the said application, the Board has found it is reasonable and desirable to convert the said wells to water injection in the pool.

NOW THEREFORE, the Board orders that:

1. Board Order No. PM 57 is hereby rescinded.
2. The unit operator shall conduct pressure maintenance operations by

the injection of water into the pool underlying the unit areas.

3. 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:

Waskada Unit No. 17 WIW 14-3-2-25
Waskada Unit No. 16 Prov. WIW 5-4-12-25 (WPM)
Waskada Unit No. 16 Prov. WIW 11-4-2-25 (WPM)
Waskada Unit No. 16 Prov. WIW 15-4-2-25 (WPM)
Waskada Unit No. 16 WIW 16-5-2-25 (WPM)
Waskada Unit No. 16 WIW 1-9-2-25 (WPM)
Waskada Unit No. 16 WIW 6-9-2-25 (WPM)
Waskada Unit No. 16 WIW 10-9-2-25 (WPM)
Waskada Unit No. 16 WIW 16-9-2-25 (WPM)
Waskada Unit No. 16 Prov. WIW 5-10-2-25 (WPM)
Waskada Unit No. 17 WIW 8-10-2-25 (WPM)
Waskada Unit No. 17 Prov. WIW 11-10-2-25 (WPM)
Waskada Unit No. 17 WIW 1-15-2-25 (WPM)
Waskada Unit No. 17 WIW A4-15-2-25 (WPM)
Waskada Unit No. 17 WIW 6-15-2-25 (WPM)

and such other wells in the unit areas as the Board may approve.

- 1(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 subsection (1), endeavour to maintain continuous injection.

- 1(3) Notwithstanding the provisions of subsection (2), the Board may, upon its own motion or upon application by the unit operator, order the suspension of water injection into any well or wells, provided that the Board is satisfied that pressure maintenance operations in the unit areas will not be adversely affected.

- 1(4) The completion of the wells referred to in subsection (1) will be as prescribed by the Director of Petroleum.

2 The unit operator, upon the 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 the unit areas.

3(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 the unit areas.

3(3) The unit operator shall submit to the Petroleum Branch, the details of the surveys described in subsections (1) and (2), 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 Petroleum before the program is carried out.

3(4) The unit operator shall submit to the Petroleum Branch, within 30 days of the completion date of the surveys described in subsections (1) and (2), a report which shall include:

- (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 areas based on the data obtained; and

- (c) a discussion of the survey results and pressure distribution within the pool.

3(5) 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 subsection 1(1) shall not exceed 10 000 kPa or such other maximum pressure as the Board may prescribe and 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 areas.

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 subsection 1(1).

6(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, which 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;

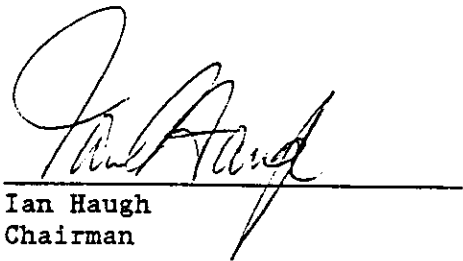
(c) the results of at least one twenty-four hour production test on each producing well in the unit areas including volumes of oil, gas and water produced during the test; and

(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.



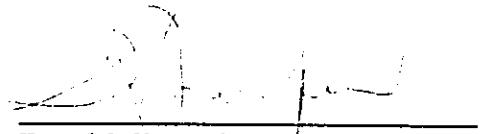
H. Clare Moster
Deputy Chairman



Ian Haugh
Chairman

OIL AND NATURAL GAS CONSERVATION
BOARD ORDER NO. PM 66 APPROVED THIS
7 DAY OF June A.D. 1991
AT THE CITY OF WINNIPEG.

APPROVED:


Harold Neufeld
Minister of Energy and Mines



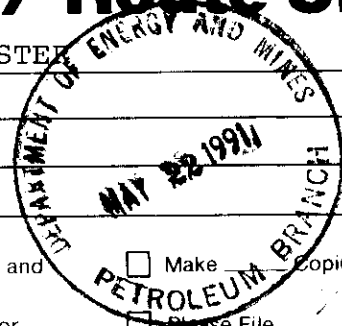
Date: May 22, 1991

To: L.R. DUBREUIL/J. FOX

Action / Route Slip

From: H. CLARE MOSTER

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

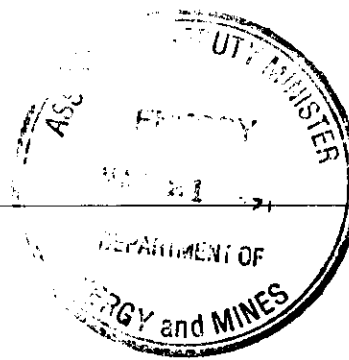
Comments: RE: PRESSURE MAINTENANCE APPLICATION (ENRON) - PROPOSED WASKADA UNIT 17:

Attached is Enron's reply to the Board's May 6/91 deficiency letter.

Note: Please provide me with copy of May 6/91 Board letter.

Attachment

**ENRON
Oil Canada Ltd.**



Tel: (403) 298-2600

15 May 1991

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

Attention: **Mr. H. Clare Moster,**
Deputy Chairman

Dear Mr. Moster:

Re: **Waskada Lower Amaranth "A" Pool**
Application for Pressure Maintenance

Enron Oil Canada Ltd. supplies the following additional information in response to the questions posed in your letter dated May 6, 1991.

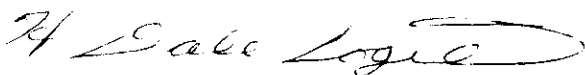
1. The actual Waskada Unit No. 16 oil production performance is presented in Figure 1 attached. When the SW $\frac{1}{4}$ of Section 15 is removed from the May 1988 Computer Simulation Study, the predicted oil production performance comparison is presented in Figure 1. When the additional five wells were converted to water injection in December 1988, the Waskada Unit No. 16 oil production stabilized at a lower rate than predicted in the simulation model. However, the actual oil decline rate is close to that predicted in the simulation model and is considered very favourable if we take into account the decrease in containment of waterflood operations due to offset drilling. The expansion of the waterflood pattern into Waskada Unit No. 17 should assist the recovery in Waskada Unit No. 16 and therefore Enron has not changed the estimated ultimate recovery for Waskada Unit No. 16. Please refer to the recent waterflood progress report submitted on March 12, 1991 for additional performance statistics on Waskada Unit No. 16.
2. The average core pay for wells in Waskada Unit No. 17 is similar to the average core pay for wells in Waskada Unit No. 16. Therefore, the original oil in place within the area of application will be similar to that derived in the May 1988 Computer Simulation Study of $85.5 \times 10^3 \text{ m}^3$ (538 MSTB) per production spacing unit or $1\,967 \times 10^3 \text{ m}^3$ (12.38 MMSTB) for the total twenty-three legal subdivision Waskada Unit No. 17 production area.
3. A historical production plot for wells within the application area is presented in Figure 2.
4. The predicted primary and secondary recoveries after twenty years of production were 9.3% and 19.8% respectively for Waskada Unit No. 16. Waterflood operations in Waskada Unit No. 17 are expected to generate the same doubling of oil recovery. Waskada Unit No. 17 has more wells with fracture stimulation treatments which extended out of zone into the Mississippian formation even though small fracture stimulation treatments were conducted. The predicted primary and secondary recoveries after twenty years of production are estimated to be 7.5% and 16.0% respectively for Waskada Unit No. 17.

ENRON
Oil Canada Ltd.

5. Well 3-14 and 12-14 have a highly productive Upper Amaranth stringer; wells 6-14 and 11-14 have been abandoned; and well 5-14 has yet to be completed in the Lower Amaranth. Thus, these wells were not included in present unitization efforts.
6. Enron is considering the drilling of wells at 10-3, 11-3, 16-3, 1-10 and 12-15 to fill out the seven-spot water injection patterns. Company fiscal constraints combined with other well commitments and land expiries will impact whether these wells will be drilled in 1991.
7. Enron has no reservoir pressures on wells in the application area. After at least six months of water injection, Enron plans to conduct pressure fall-off tests on the six water injection wells in Unit No. 17. Pressure fall-off tests on the nine water injection wells in Waskada Unit No. 16 will be conducted this summer.
8. For the first year of waterflood operation in Waskada Unit No. 17, Enron plans to inject enough water to replace 120 % of calculated Lower Amaranth reservoir production volumes (1.2 voidage replacement ratio).
9. All working interest owners have approved the tract participation factors for Waskada Unit No. 17. A draft copy of the proposed Unit and Unit Operating Agreements have been issued to all Working Interest Owners for comments. Legal council has been retained and put in motion to conduct land title work.
10. All uncoated water injection lines will be cathodically protected and corrosion inhibitors will be added to the injection water.

Yours very truly,

ENRON OIL CANADA LTD.



H. Dale Logie, P.Eng.
Chief Reservoir Engineer

HDL:pd
attach

WASKADA UNIT # 17

FIGURE 2

05/14/91 13:59

Date 8810-9112

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Operator :
Field :
Zone/Pool:
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PILOT

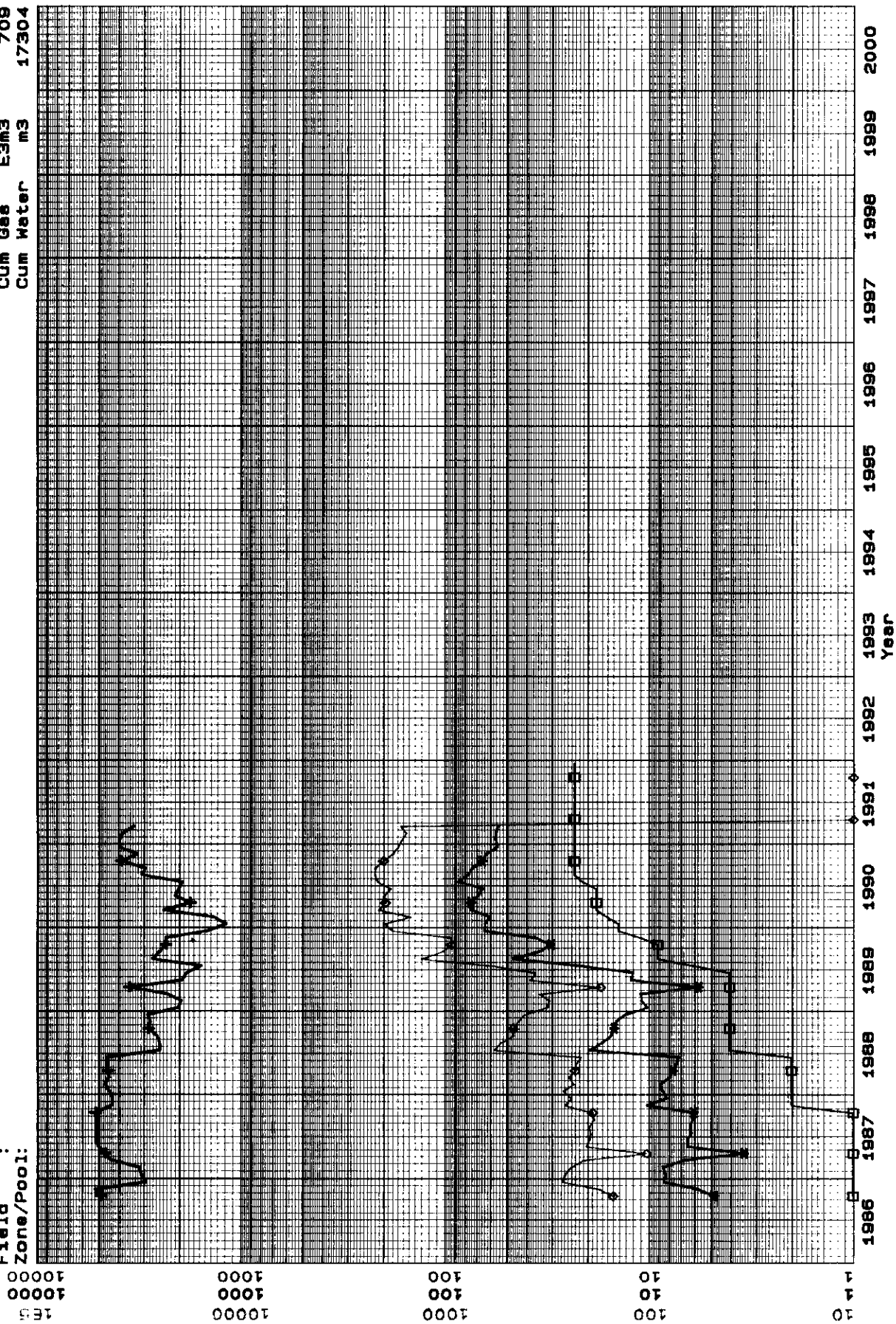
Zone/Pool:

Cum Oil	m3	43542
Cum Gas	E3m3	708
Cum Water	m3	17304

Cum 888 E3m3

Cum	Water	m3	17304
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Type :



<input type="checkbox"/>	<input type="checkbox"/>	Num Wells	
<input type="checkbox"/>	*	Avg Daily Oil	m3/d
<input type="checkbox"/>	◇	Monthly Oil	m3

Water Cut

+

+

✕

FIGURE 1

05/14/91 14:15

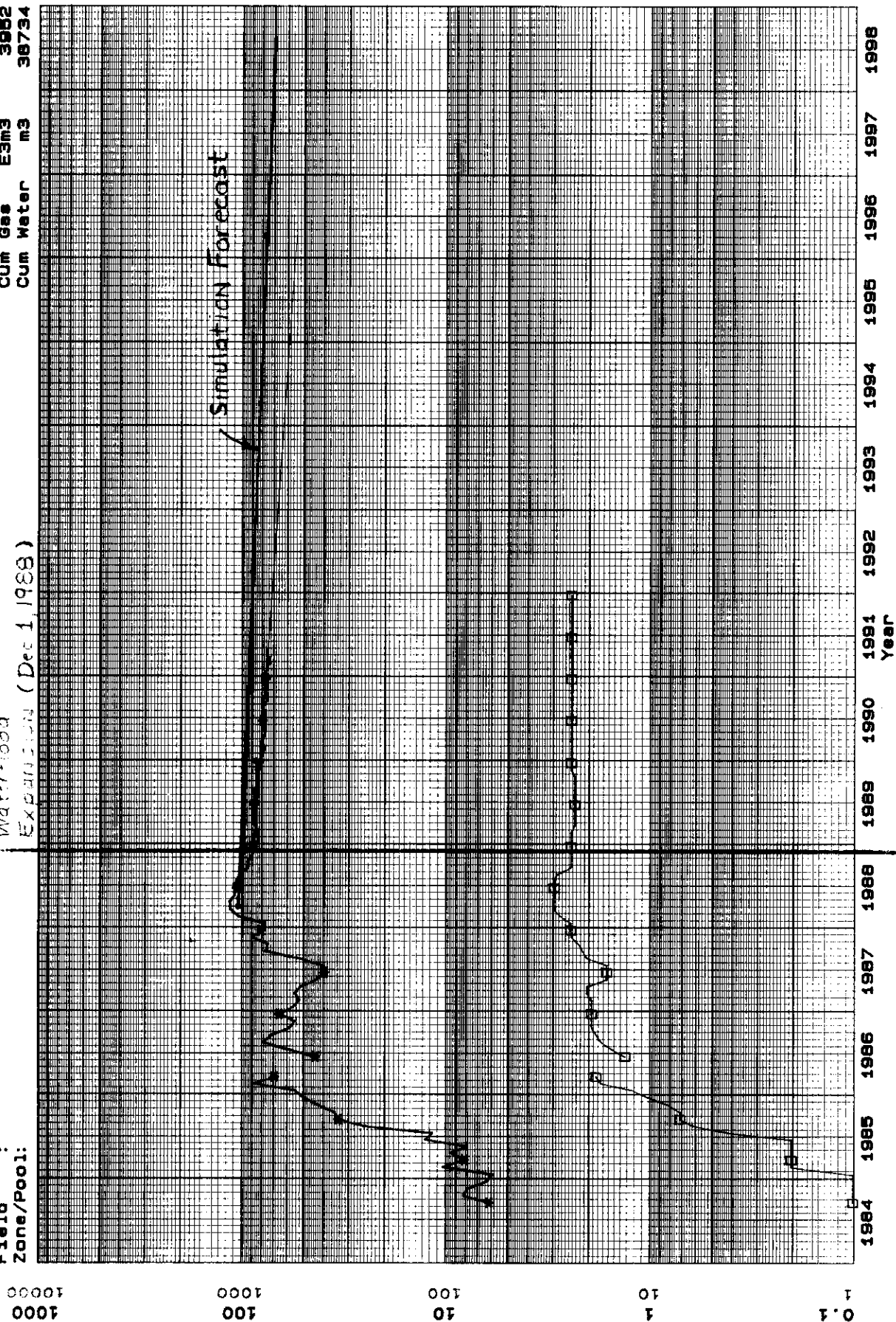
Data 8409-8112

Operator :
Field :
Zone/Pool:

Cum Oil m3 138576
Cum Gas E3m3 3982
Cum Water m3 38734

Type :

Waterflood
Expansion (Dec 1, 1988)



□ * Num Wells
□ * Avg Daily Oil m3/d

ac



Memorandum

Date May 3, 1991

To The Oil and Natural Gas
Conservation Board
- Ian Haugh, Chairman
- H. Clare Moster, Deputy Chairman
- Wm. McDonald, Member

From John N. Fox
Chief Petroleum Engineer
Petroleum Branch

Telephone

Subject

RE: Waskada Lower Amaranth A Pool
Application for Pressure Maintenance

Enron Oil Canada Ltd. has made application to conduct pressure maintenance operations in the northeast portion of the Waskada Lower Amaranth A Pool (Figure 1). Notice of the application has been published in the Melita New Era and the Manitoba Gazette.

RECOMMENDATIONS

It is recommended that the Board request Enron file additional information in support of the application. A copy of the proposed Board deficiency letter is attached.

DISCUSSION

Enron has applied to expand waterflood operations north and east of Waskada Unit No. 16. The project includes the conversion of six wells to water injection to create six full or partial 7-spot injection patterns (Figure 1).

The application states the waterflood in Waskada Unit No. 16 is "performing admirably, so expansion of the existing waterflood pattern is highly recommended". Though the Petroleum Branch does not disagree with this statement, additional performance data for Waskada Unit No. 16 is required. Additional reservoir and production data is also required for the proposed project.

John N. Fox

Approved:

L.R. Dubreuil, Director

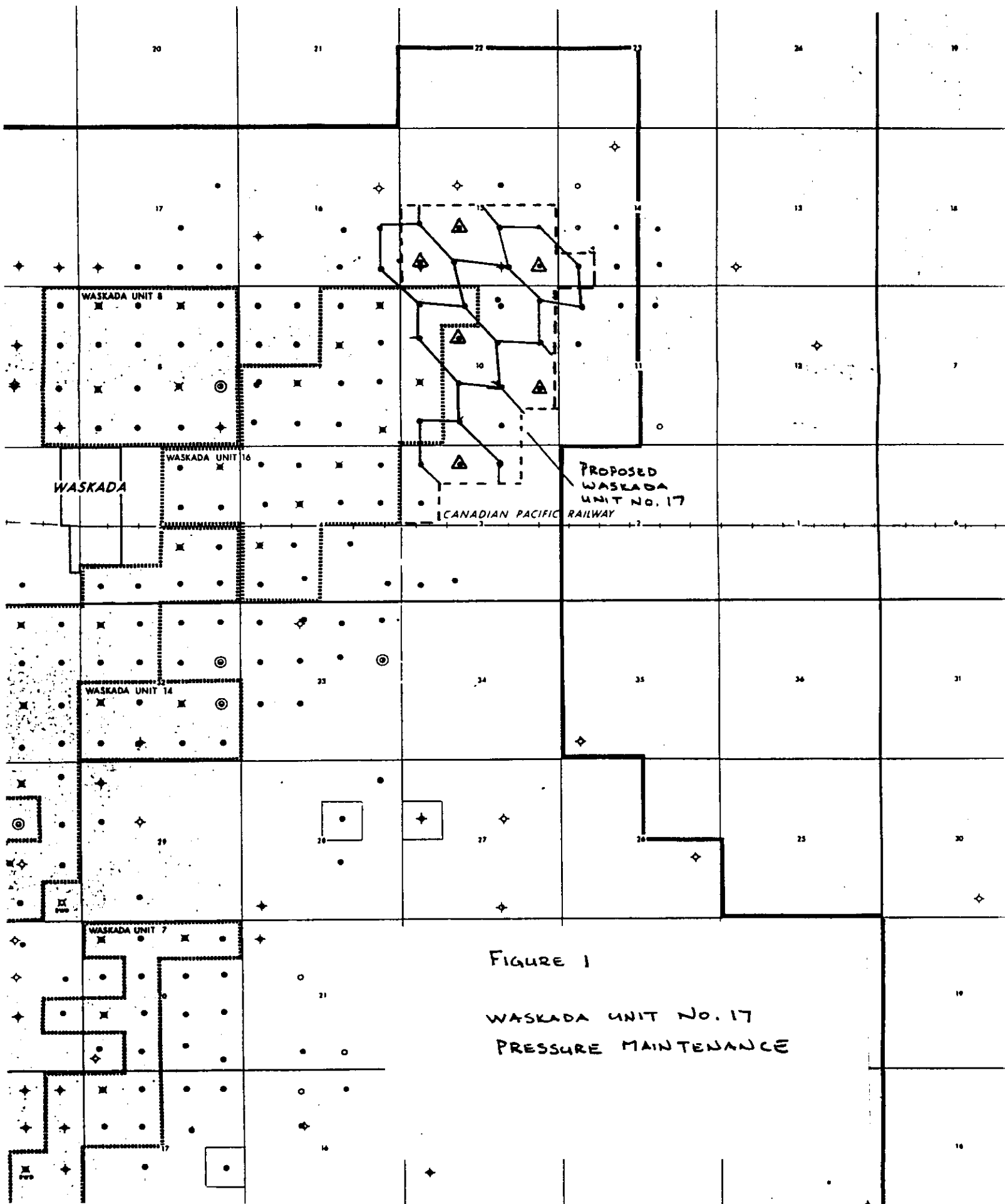


FIGURE 1

WASKADA UNIT NO. 17
PRESSURE MAINTENANCE



The Oil and Natural Gas
Conservation Board

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

(204) 945-3130

May 3, 1991

Mr. H. Dale Logie, P. Eng.
Chief Reservoir Engineer
Enron Oil Canada Ltd.
1300, 700 - 9th Avenue S.W.
Calgary, Alberta
T2P 3V4

Dear Sir:

RE: Waskada Lower Amaranth A Pool
Application for Pressure Maintenance

Your application to expand pressure maintenance operations in the Waskada Lower Amaranth A Pool dated March 19, 1991 has been advertised in the Manitoba Gazette and the Melita New Era. The closing date for objections to or interventions in the application is May 13, 1991. A copy of the notice is attached.

The Board has completed its preliminary review of the application and requests the following additional reservoir and performance information be filed in support of the application:

- (1) Enron, in its application states the waterflood in Waskada Unit No. 16 has "been performing admirably, so expansion of the existing waterflood should be highly recommended". Enron also ran simulation studies for Waskada Unit No. 16 (Waterflood Study - Waskada Lower Amaranth Zone, Proposed Unit No. 16 - October, 1986 and Waskada Lower Amaranth Waterflood Computer Simulation Study - May, 1988) to predict waterflood performance. Please discuss actual versus predicted waterflood performance in Waskada Unit No. 16 to date. What is Enron's latest estimate of ultimate recovery for Waskada Unit No. 16?
- (2) What is the original oil in place in the area of application?
- (3) Please provide a historical production plot showing daily oil production, WOR and number of wells on production for the area of application.
- (4) What is the expected primary recovery and predicted incremental waterflood recovery for the area of application?

- (5) Is there any merit in including additional wells in the W/2 of Section 14-2-25 (WPM) in the area of application to complete the partial 7-spot injection pattern?
- (6) What are Enron's development plans for the NW/4 of Section 2, the N/2 of Section 3, Lsd 1 of Section 10 and the N/2 of Section 15, all in Twp. 2, Rge. 25 (WPM)?
- (7) Does Enron have any reservoir pressure data for wells in the area of application?
- (8) What are Enron's proposed injection targets for the 7-spot injection patterns in the area of application?
- (9) Please advise the Board on Enron's progress with unit negotiations for Waskada Unit No. 17.
- (10) Flowlines from the A4-15-2-25 and 6-15-2-25 are not internally coated. If these lines are to be used for water injection after the wells are converted, please list the corrosion prevention measures Enron will be using?

If you have any questions in respect of this matter, please contact L.R. Dubreuil, Director of Petroleum or John N. Fox, Chief Petroleum Engineer at (204) 945-6573 or 945-6574, respectively.

Yours respectfully,

H. Clare Moster
Deputy Chairman

Manitoba



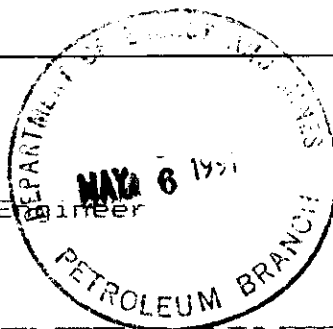
Memorandum

Date April 30, 1991

To John Fox
Chief Petroleum Engineer

From Jed Sanderson
Petroleum Inspector

Subject **ENRON PRESSURE MAINTENANCE APPLICATION**



<u>WELL</u>	<u>F/L LICENCE</u>	<u>LINE STATISTICS</u>
8-10-2-25	N/A	On test tank
A4-15-2-25	03-020-08-02	Not internally coated
6-15-2-25	03-020-09-06	Not internally coated
14-3-2-25	03-020-10-02	Internally coated
11-10-2-25	03-020-09-03	Internally coated
1-15-2-25	03-020-11-02	Internally coated

After reviewing the flow line status for the seven proposed injection conversions, we have the following comments.

To date this has been Enron's Waskada flow line failure:

91-07-W flow line 03-020-05-12

- a past production line (noncoated) converted to an injection line 88/12/01
- cause of leak was internal corrosion on the bottom of the pipe

We recommend:

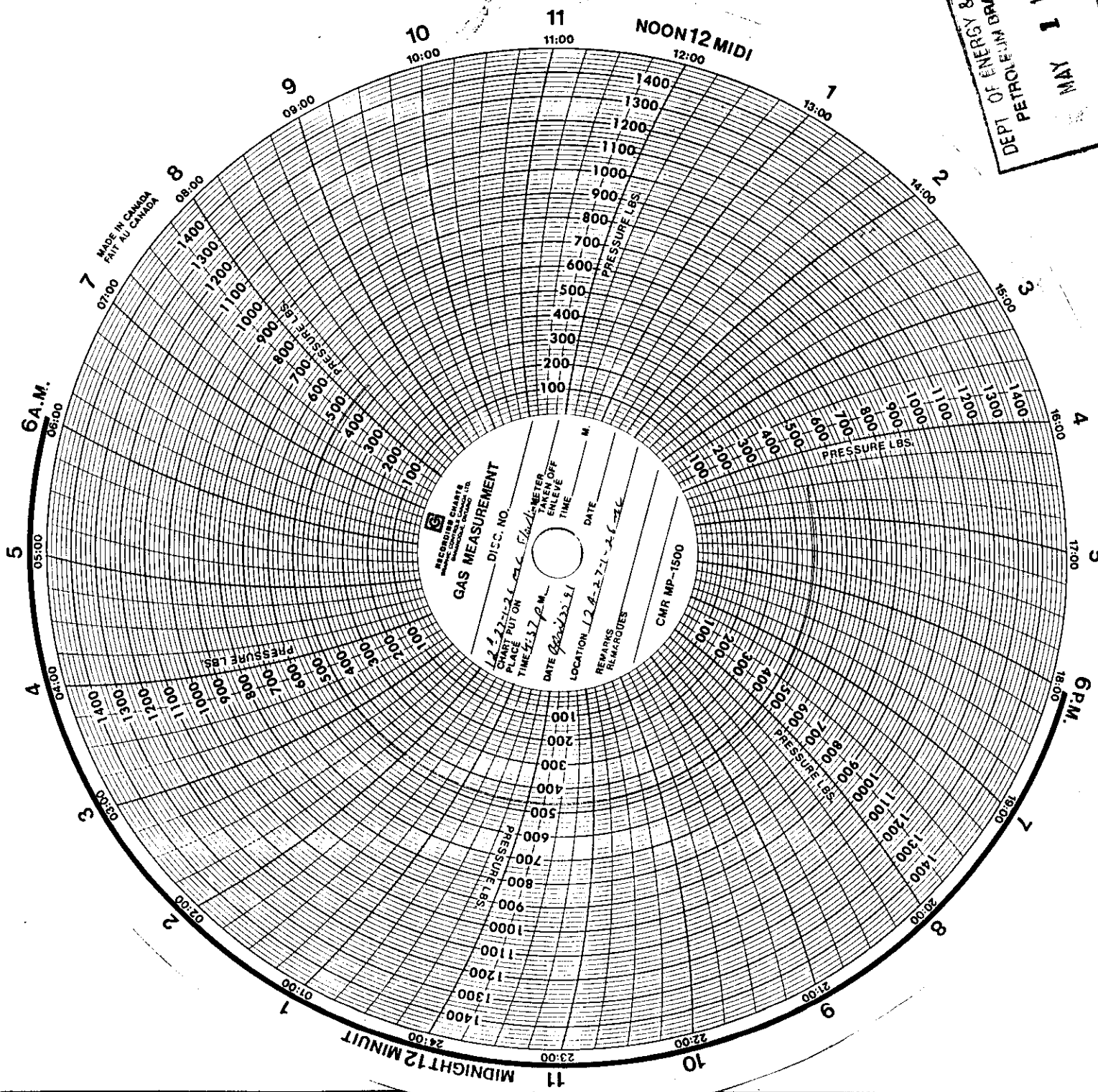
- 1) that Enron run a 'clean-out' scraped pig and shock treat the noncoated line with a biocide and/or inhibitor prior to injection. We will also be requesting the noncoated lines be retested with fresh water prior to injection of fluids.

- 2) a chemical prevention program be continued on these lines for internal protection.

- 3) a low pressure shut-off should also be installed at the battery to prevent excessive fluid loss in the event of an injection line failure.

JS/jm

First | Fold



DEPT OF ENERGY & MINES
PETROLEUM BRANCH
MAY 1 1991
WASKADA DISTRICT OFFICE



Memorandum

Date : April 18, 1991

To : The Oil and Natural Gas
Conservation Board
- Ian Haugh, Chairman
- H. Clare Moster, Deputy Chairman
- Wm. McDonald, Member

From : John N. Fox
Chief Petroleum Engineer
Petroleum Branch

Subject : Telephone :

RE: Pressure Maintenance Project -
Waskada Lower Amaranth A Pool

Enron Oil Canada Ltd. has made application to conduct a waterflood project in a portion of the subject pool. The project area is outlined in Figure No. 1 attached.

RECOMMENDATION

It is recommended that notice of the application be published in the Melita New Era, and the Manitoba Gazette. A copy of the proposed notice is attached.

It is also recommended that the working interest and royalty owners in and within 0.5 km of the project area and the surface owners of the locations that will be converted to water injection be notified of the application directly by the Board.

A technical review of the application is underway and recommendations will be forwarded to the Board when the review is complete.

John N. Fox
Chief Petroleum Engineer

Approved by:

L.R. Dubreuil, Director

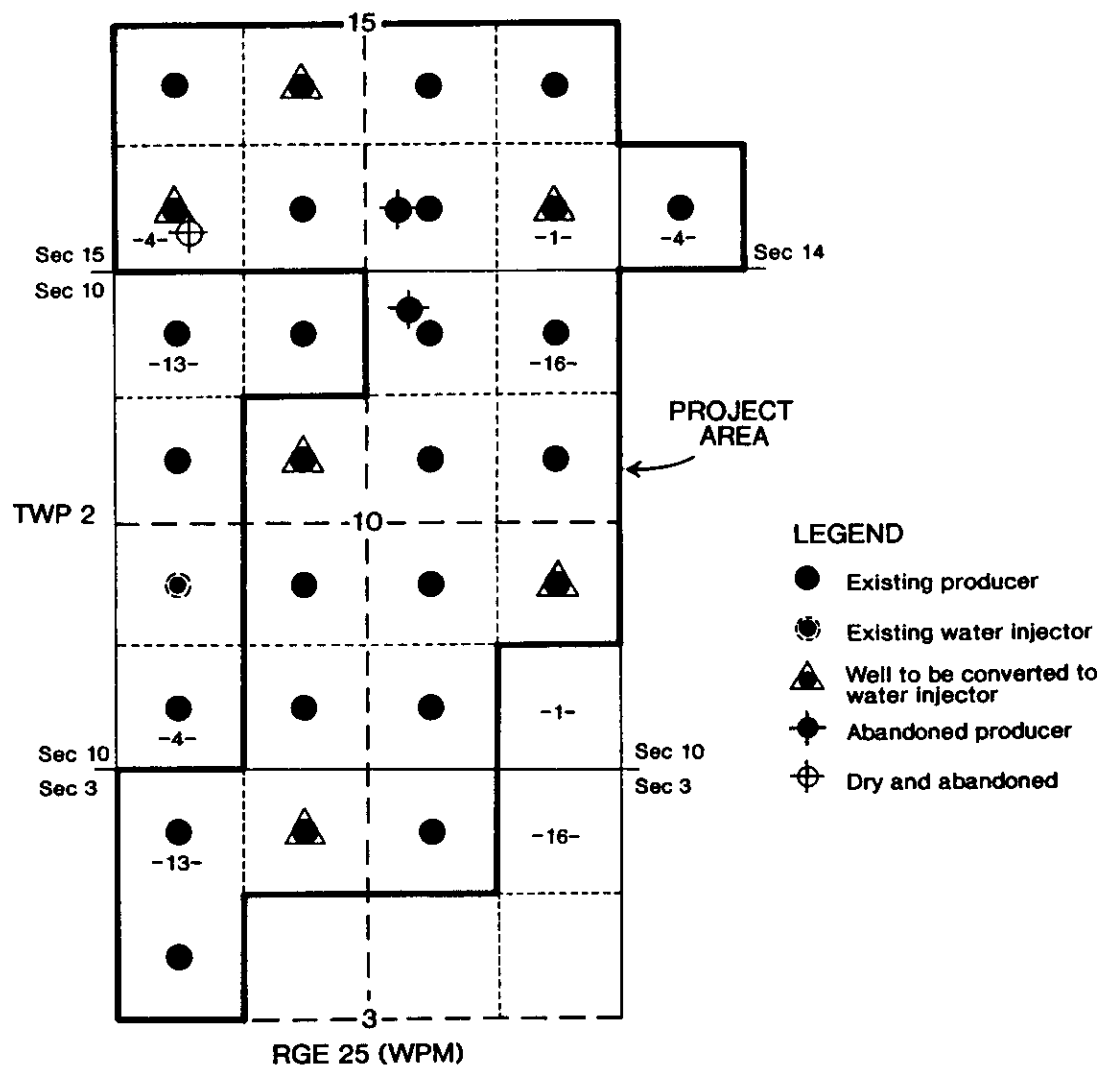


FIG. 1

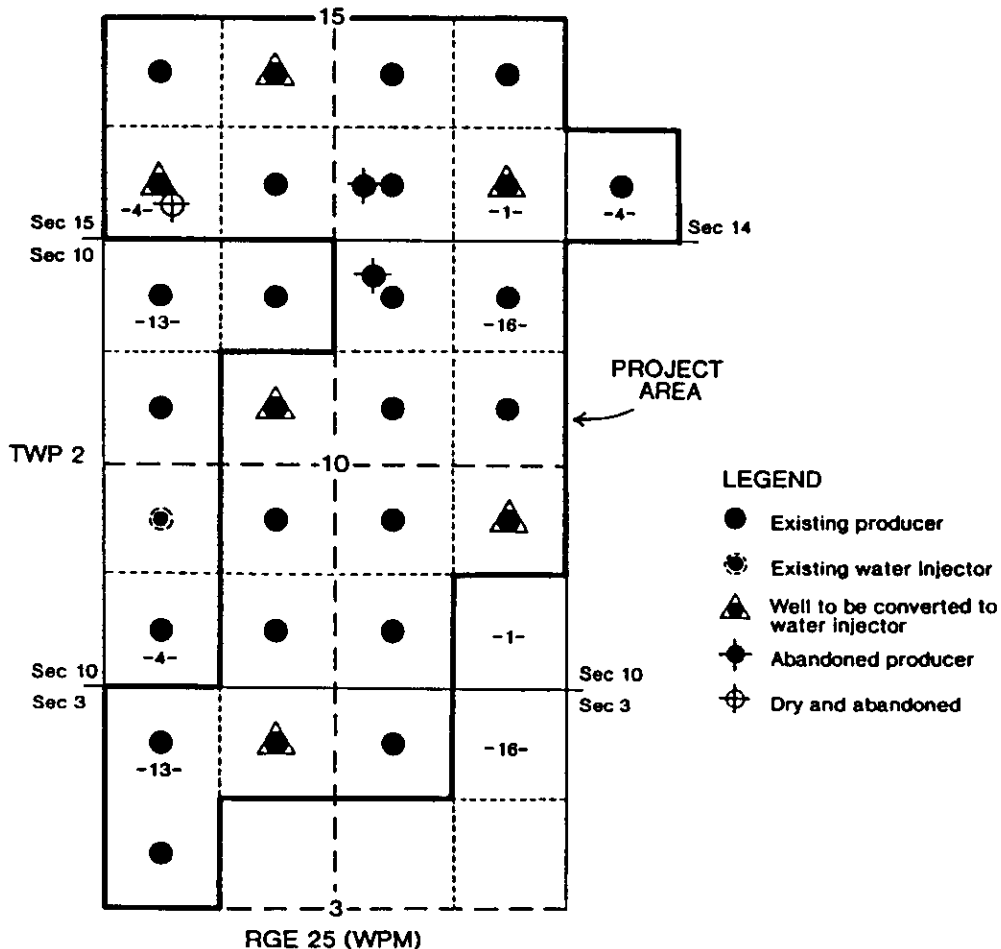


NOTICE

UNDER THE MINES ACT

WASKADA OIL FIELD

Enron Oil Canada Ltd. has made application under The Mines Act to conduct a waterflood project in the Lower Amaranth Formation in that portion of the Waskada Field described as follows: Lsd's 12, 13, 14 and 15 of Section 3-2-25 (WPM), Lsd's 2, 3, 6, 7, 8, 9, 10, 11, 15 and 16 of Section 10-2-25 (WPM), Lsd 4 of Section 14-2-25 (WPM) and the S/2 of Section 15-2-25 (WPM) and shown below.



It is proposed to convert the following wells to water injection.

Enron et al Waskada 14-3-2-25 (WPM)
Enron Waskada 8-10-2-25 (WPM)
Enron et al Waskada Prov. 11-10-2-25 (WPM)
Enron Waskada 1-15-2-25 (WPM)
Enron et al Waskada A4-15-2-25 (WPM)
Enron et al Waskada 6-15-2-25 (WPM)

If no valid objection or intervention in writing is received by The Oil and Natural Gas Conservation Board at 555 - 330 Graham Avenue, Winnipeg, Manitoba, R3C 4E3 before May 13, 1991, the Board may approve the application.

Copies of the application may be obtained from:

Enron Oil Canada Ltd.
1300, 700 - 9th Avenue S.W.
Calgary, Alberta
T2P 3V4
(403) 298-2600

The application may be viewed at the offices of the Petroleum Branch:

555 - 330 Graham Avenue
Winnipeg, Manitoba
(204) 945-6577

Waskada, Manitoba
(204) 673-2472

Dated at Winnipeg, this 19th day of APRIL, 1991.



H. Clare Moster
Deputy Chairman



Date: May 3, 1991

Action / Route Slip

To: L.R. DUBREUIL

From: H. CLARE MOSTER

Telephone:

☐ Take Action

☐ Per Your Request

☐ Circulate, Initial
and Return

☐ For Approval and
Signature

☐ Make _____ Copies

☐ May We Discuss

☒ For Your Information

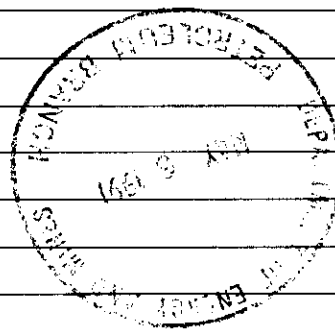
☐ Return With Comments
or Revisions

☐ Draft Reply for
Signature

☐ Please File

Comments: RE: NELSON OILS LIMITED:

Attachment



30 Apr 91

H. Clare Myster

Dear Sir.

I. Lloyd Robinson am the
Secretary for Nelson Oils Ltd, and today
received correspondence directed to my
mother Julia Nelson of Mallett regarding
Nelson Oils Ltd. Mother is now a permanent
resident of a nursing home in Brandon
so I would ask that you direct any
future correspondence to me.

M. L. ROBINSON
Box 86
CRANDALL, M.B.
Saskatchewan

Yours
M. L. Robinson



Box 96
CRANDALL M.B.
ROMOHO.

ADM
Energy div.



H. CLARE MASTER

Room 309

LEGISLATIVE BUSINESS

WHE MB.

RECOVER.

WASKADA OIL FIELD

15

Sec 15

Sec 10

Sec 14

Sec 10

Sec 3

Sec 10

Sec 3

10

13

16

4

1

16

3

TWP 2

RGE 25 (WPM)

PROJECT AREA

LEGEND

- Existing producer
- Existing water injector
- Well to be converted to water injector
- Abandoned producer
- Dry and abandoned

It is proposed to convert the following wells to water injection.

Enron et al Waskada 14-3-2-25 (WPM)
Enron Waskada 8-10-2-25 (WPM)
Enron et al Waskada Prov. 11-10-2-25 (WPM)
Enron Waskada 1-15-2-25 (WPM)
Enron et al Waskada A4-15-2-25 (WPM)
Enron et al Waskada 6-15-2-25 (WPM)

If no valid objection or intervention in writing is received by The Oil and Natural Gas Conservation Board at 555 - 330 Graham Avenue, Winnipeg, Manitoba, R3C 4E3 before May 13, 1991, the Board may approve the application.

Copies of the application may be obtained from:

Enron Oil Canada Ltd.
1300, 700 - 9th Avenue S.W.
Calgary, Alberta
T2P 3V4
(403) 298-2600

The application may be viewed at the offices of the Petroleum Branch:

555 - 330 Graham Avenue
Winnipeg, Manitoba
(204) 945-6577

Waskada, Manitoba
(204) 673-2472

Dated at Winnipeg, this 19th day of APRIL, 1991.



H. Clare Moster
Deputy Chairman

005664 - 17

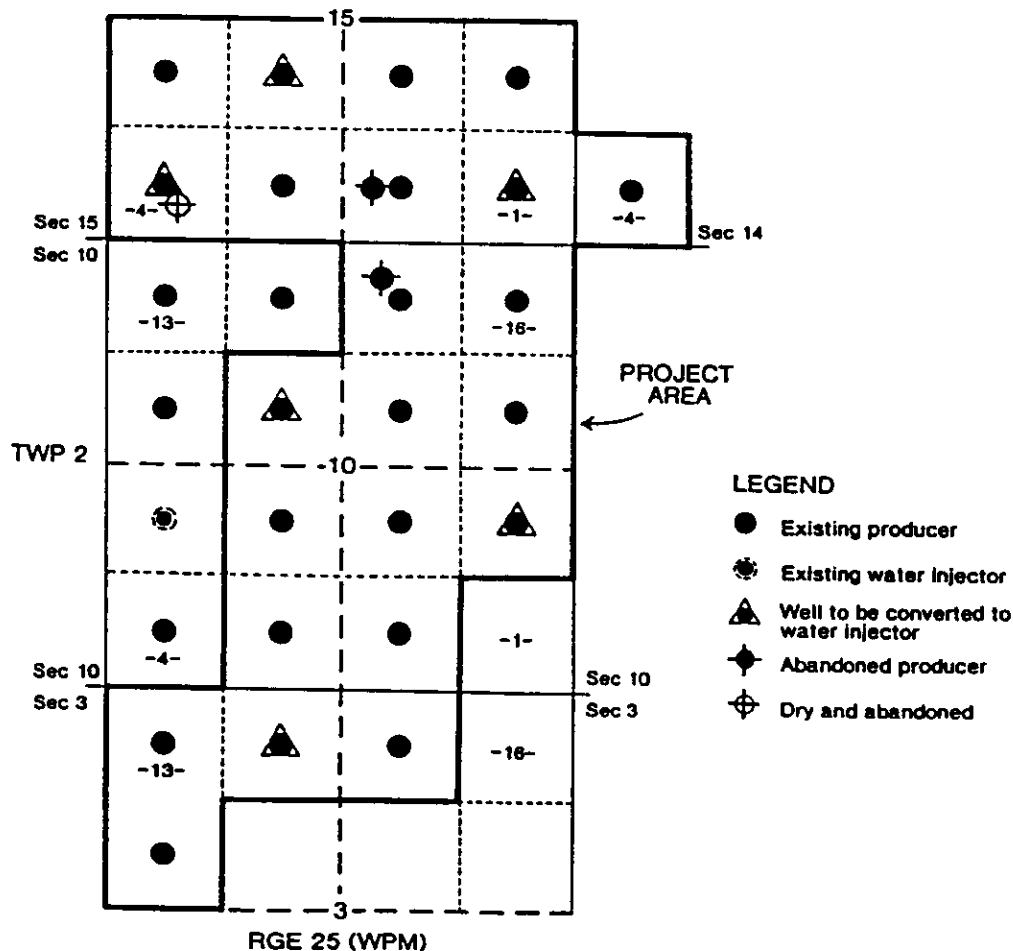


NOTICE

UNDER THE MINES ACT

WASKADA OIL FIELD

Enron Oil Canada Ltd. has made application under The Mines Act to conduct a waterflood project in the Lower Amaranth Formation in that portion of the Waskada Field described as follows: Lsd's 12, 13, 14 and 15 of Section 3-2-25 (WPM), Lsd's 2, 3, 6, 7, 8, 9, 10, 11, 15 and 16 of Section 10-2-25 (WPM), Lsd 4 of Section 14-2-25 (WPM) and the S/2 of Section 15-2-25 (WPM) and shown below.



It is proposed to convert the following wells to water injection.

Enron et al Waskada 14-3-2-25 (WPM)
Enron Waskada 8-10-2-25 (WPM)
Enron et al Waskada Prov. 11-10-2-25 (WPM)
Enron Waskada 1-15-2-25 (WPM)
Enron et al Waskada A4-15-2-25 (WPM)
Enron et al Waskada 6-15-2-25 (WPM)

If no valid objection or intervention in writing is received by The Oil and Natural Gas Conservation Board at 555 - 330 Graham Avenue, Winnipeg, Manitoba, R3C 4E3 before May 13, 1991, the Board may approve the application.

Copies of the application may be obtained from:

Enron Oil Canada Ltd.
1300, 700 - 9th Avenue S.W.
Calgary, Alberta
T2P 3V4
(403) 298-2600

The application may be viewed at the offices of the Petroleum Branch:

555 - 330 Graham Avenue
Winnipeg, Manitoba
(204) 945-6577

Waskada, Manitoba
(204) 673-2472

Dated at Winnipeg, this 19th day of APRIL, 1991.

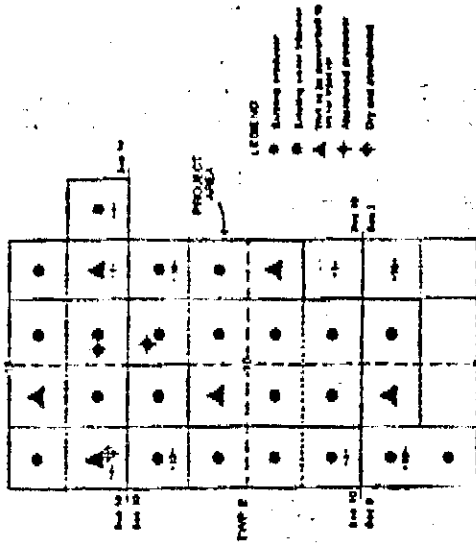


H. Clare Moster
Deputy Chairman

NOTICE

Under the Mines Act-Waskada Oil Field

Enron Oil Canada Ltd. has made application under The Mines Act to conduct a waterflood project in the Lower Amaranth Formation in (part) portion of the Waskada Field described as follows: Lsd's 12, 13, 14 and 15 of Section 3-2-25 (WPM), Lsd's 2, 3, 6, 7, 8, 9, 10, 11, 15 and 16 of Section 10-2-25 (WPM), Lsd 4 of Section 14-2-25 (WPM) and the S/2 of Section 15-2-25 (WPM) and shown below.



It is proposed to convert the following wells to water injection.

- Enron et al Waskada 14-3-2-25 (WPM)
- Enron Waskada 8-10-2-25 (WPM)
- Enron et al Waskada Prov. 11-10-2-25 (WPM)
- Enron Waskada 1-15-2-25 (WPM)
- Enron et al Waskada A4-15-2-25 (WPM)
- Enron et al Waskada 6-15-2-25 (WPM)

If no valid objection or intervention in writing is received by The Oil and Natural Gas Conservation Board at 555-330 Graham Avenue, Winnipeg, Manitoba, R3C 4E3 before May 13, 1991, the Board may approve the application.

Copies of the application may be obtained from:

Enron Oil Canada Ltd.
1300, 700-9th Avenue S.W.
Calgary, Alberta
T2P 3V4

(403) 298-2600

The application may be viewed at the offices of the Petroleum Branch:

555-330 Graham Avenue
Winnipeg, Manitoba
(204) 945-6577

Dated at Winnipeg, this 19th day of April, 1991.

H. Clare Mosler, Deputy Chairman

Printed in Alberta New Era

TUESDAY APRIL 30/91

APR 27
John Fox
P. 10-19

19 March 1991

Manitoba Energy and Mines
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3

Attention: **Mr. L.R. Dubreuil,**
Director

Dear Mr. Dubreuil:

Re: Waskada Lower Amaranth "A" Pool
Pressure Maintenance Application

Enron Oil Canada Ltd. presently operates a pressure maintenance scheme in Waskada Unit No. 16 which commenced water injection in June 1987 and was expanded in December 1988 (Map No. 1). Application is hereby made to create a new waterflood project in the adjacent Enron operated area as shown on Map No. 2. Unitization of the expanded area is presently being negotiated.

Permission is requested to expand the present seven-spot waterflood pattern (Map No. 3) by injecting water into wells Enron et al Waskada 14-3-2-25, Enron Waskada 8-10-2-25, Enron et al Waskada 11-10-2-25, Enron Waskada 1-15-2-25, Enron et al Waskada A4-15-2-25 and Enron et al Waskada 6-15-2-25 coincident with the effective date of the new Unit.

The Waskada Lower Amaranth reservoir and fluid properties are similar to those previously submitted in the Waskada Lower Amaranth Waterflood Computer Simulation Study dated May 1988. The fluid properties from this subject study are enclosed as Table 2. The existing Waskada Unit No. 16 waterflood scheme has been performing admirably, so expansion of the existing waterflood pattern should be highly recommended. The existing Waskada Unit No. 16 waterflood scheme has nine injectors and twenty-four producers for a producer to injector ratio of 2.67 to 1. The proposed new waterflood scheme would have six injectors and seventeen producers for a similar producer to injector ratio of 2.83 to 1.

January 1990 individual well oil productivities in the proposed waterflood area are presented in Table 1. The seven-spot pattern generally results in the conversion of wells with lower oil productivity to water injection. This results in accelerated oil recovery and a better distribution of water injection between layers with an associated reduction of potential water

channelling. The seven-spot pattern decreases the producer to injector ratio over the conventional nine-spot pattern which should result in an increased sweep efficiency. The permeability and induced fracture stimulation trend is in a northeast to southwest direction, and thus, the indicated seven-spot pattern results in a line drive injection pattern which should improve sweep efficiency. Enron does not wish to convert well 15-10-2-25 to an injector at this time. The subject 15-10 well exhibits good oil productivity and Enron wishes to use this well as an experimental candidate to investigate the variation of water breakthrough time between on-trend and off-trend wells. Because of the favourable producer to injector ratio in the proposed new waterflood scheme (2.83 to 1), edge wells 12-3 and 2-10 will not be converted to water injection until offset drilling with associated Unit expansion occurs to the east of the present development.

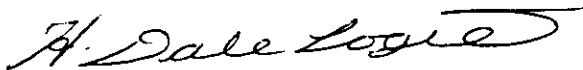
The following items are included in support of this application:

- 1) Maps and Table showing the surface owners, lessors and lessees in and adjoining the area of application (Maps 4 & 5 and Table 3).
- 2) Map of the existing surface facilities, oil lines and water injection lines (Map 6).
- 3) Schematic diagram of a typical injection well completion.
- 4) Schematic of the Waskada water distribution system.

If you have questions concerning this application, please contact the undersigned at (403) 298-2656.

Yours very truly,

ENRON OIL CANADA LTD.



H. Dale Logie, P.Eng.
Chief Reservoir Engineer

HDL:pd
attach

xc: Chauvco Resources Ltd., Attention: Mr. D.L. Robertson
Highridge Exploration Ltd., Attention: Mr. R.T. Vanderham
Trilogy Resources Corporation, Attention: Production Manager
Voyager Energy Inc., Attention: Mr. R.W. Hoover
C. Turnbull - Enron Waskada Field Office

TABLE 1

**WASKADA LOWER AMARANTH
JANUARY 1991 DAILY OIL PRODUCTIVITY
(m³/producing day)**

<u>Location</u>	<u>Oil Production (m³/d)</u>
12-3-2-25 WPM	1.3
13-3	2.9
14-3 *	1.5
15-3	1.4
2-10	2.0
3-10	2.7
6-10	1.6
7-10	3.8
8-10 *	1.1
9-10	4.8
10-10	1.9
11-10 *	1.7
15-10	3.2
16-10	8.2
4-14	0.9
1-15 *	1.5
2-15	3.7
3-15	2.3
4-15 *	0.9
5-15	2.6
6-15 *	0.9
7-15	2.5
8-15	3.3

* Recommended injector locations.

TABLE 2

WASKADA LOWER AMARANTH

FLUID PROPERTY DATA IN BLACK OIL FORMAT

SURFACE GAS SPECIFIC GRAVITY = 0.99500

DENSITY OF OIL AT STOCK TANK = 830.00 KG/M3

BUBBLE POINT PRESSURE = 4220.0 KPA

	OIL FORMATION	SOLUTION	GAS FORMATION	OIL	GAS
PRESSURE	FACTOR	GAS RATIO	FACTOR	VISCOSITY	VISCOSITY
KPA	RM3/SCM3	M3/M3	RM3/SCM3	CP	CP
101.00	1.0250	0.	1.00000	2.90400	0.01020
958.00	1.1190	29.35	0.10363	2.00000	0.01060
1413.00	1.1350	34.86	0.07179	1.54800	0.01080
2082.00	1.1470	39.84	0.04929	1.43200	0.01100
2813.00	1.1560	44.29	0.03658	1.36700	0.01130
3482.00	1.1630	47.49	0.02963	1.31900	0.01150
4220.00	1.1700	51.04	0.02488	1.28500	0.01180
6895.00	1.1660	60.28	0.01543	1.35000	0.01280
10343.00	1.1620	71.98	0.01046	1.45000	0.01400
13790.00	1.1580	84.04	0.00800	1.58000	0.01520

ROCK COMPRESSIBILITY V/V/KPA = 0.6700E-06

b.f

TABLE 3

PROPOSED WASKADA UNIT

TWP 2, RGE 25 WPM

SURFACE OWNERS WITHIN PROPOSED UNIT AREA

Lsd 4	Sec. 14	W & D Howden
W $\frac{1}{2}$ / SW $\frac{1}{4}$	Sec. 15	G.D. Temple
E $\frac{1}{2}$ / SW $\frac{1}{4}$	Sec. 15	D.R. Temple
W $\frac{1}{2}$ / SE $\frac{1}{4}$	Sec. 15	L.J. Crepeele
E $\frac{1}{2}$ / SE $\frac{1}{4}$	Sec. 15	R.C. Howden
Lsd 11	Sec. 10	D.R. Temple
Lsd 3,6	Sec. 10	D.R. Temple
E $\frac{1}{2}$	Sec. 10	L.J. Crepeele
NE $\frac{1}{4}$	Sec. 03	E.L. Griffith
NW $\frac{1}{4}$	Sec. 03	G.D. Temple

MINERAL OWNERS WITHIN PROPOSED UNIT AREA

<u>AREA</u>		<u>LESSOR #1</u>	<u>LESSEE</u>
SW $\frac{1}{4}$	Sec. 15	Tempella Resources	Enron
SE $\frac{1}{4}$	Sec. 15	Nelson Oils	Enron
Lsd 2,7,8	Sec. 10	Nelson Oils	Enron
NE $\frac{1}{4}$	Sec. 10	Nelson Oils	Enron
Lsd 3,6	Sec. 10	Crown	Enron
Lsd 11	Sec. 10	Crown	Enron
Lsd 4	Sec. 14	LVMH Inc.	Enron
Lsd 12,13,14	Sec. 03	Patlet Ventures	Enron
Lsd 15	Sec. 03	Glen Hassett	Enron

ADJOINING MINERAL HOLDERS

Lsd 3,5,6	Sec. 14	Howden/Homestead	Enron
Lsd 4,5	Sec. 10	Crown	Enron
Lsd 12,13,14	Sec. 10	Crown	Enron
NW $\frac{1}{4}$	Sec. 15	W & A Vanderhave	
NE $\frac{1}{4}$	Sec. 15	W & A Vanderhave	
SE $\frac{1}{4}$	Sec. 16		Omega
SW $\frac{1}{4}$	Sec. 03		Omega
Lsd 16	Sec. 03	Glen Hassett	
Lsd 11	Sec. 03	Patlett Ventures (?)	
NE $\frac{1}{4}$	Sec. 04	Crown	Enron
Lsd 10	Sec. 03	Glen Hassett	Enron
Lsd 1	Sec. 10	Nelson Oils	Enron
SW $\frac{1}{4}$	Sec. 11		Omega
NW $\frac{1}{4}$	Sec. 11		Omega

WASKADA UNIT # 16
WATERFLOOD PATTERN
MAP NO 1

17

8

16

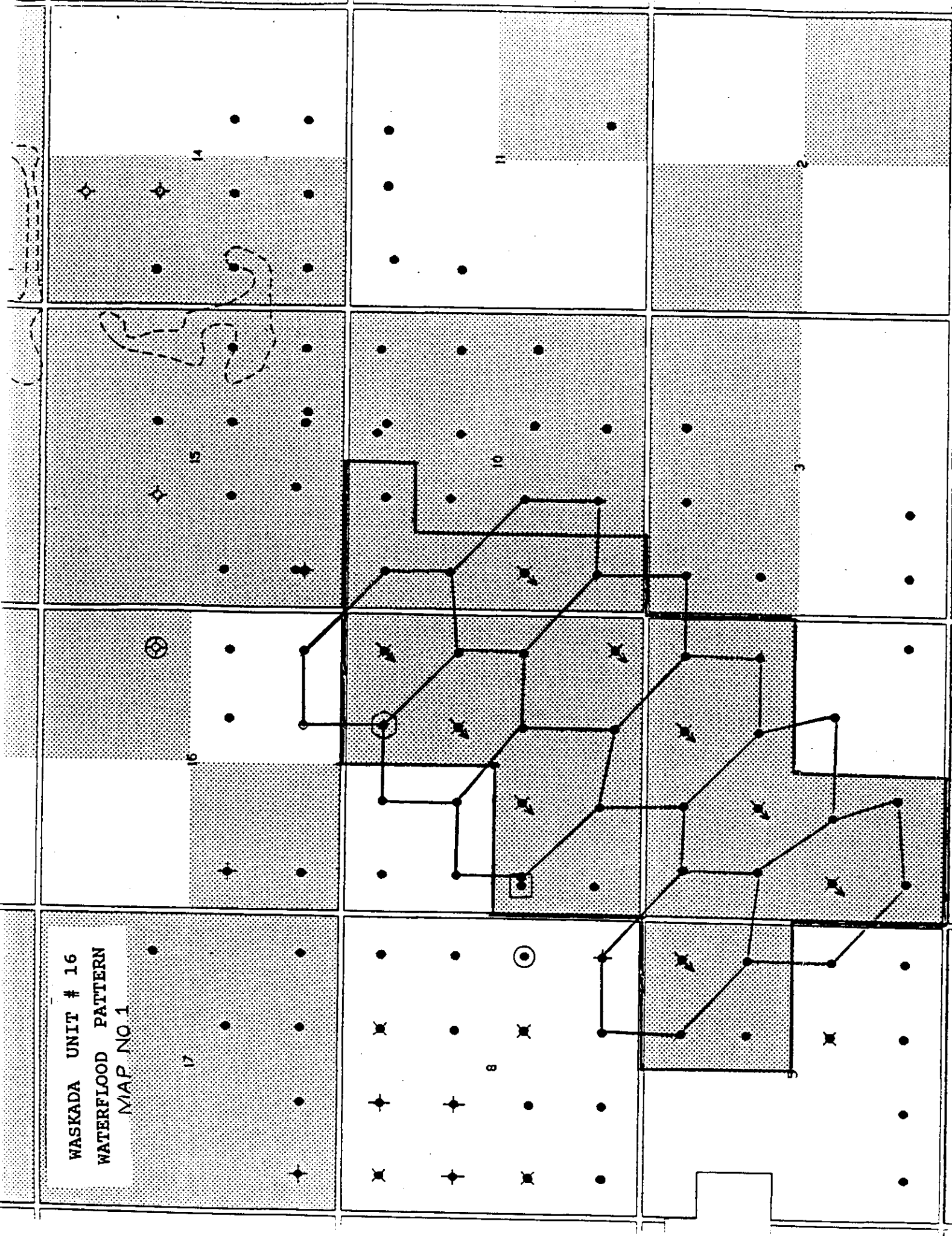
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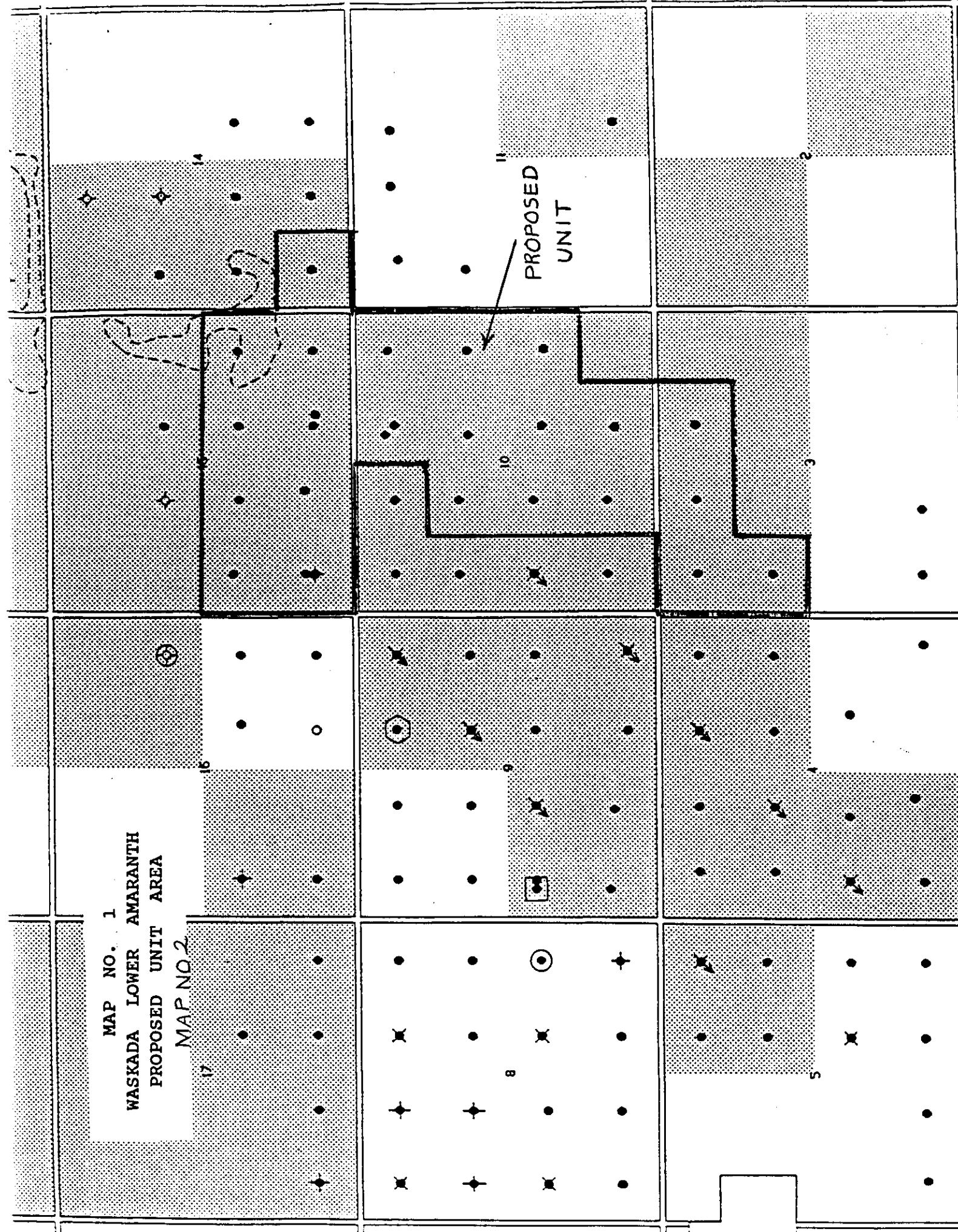
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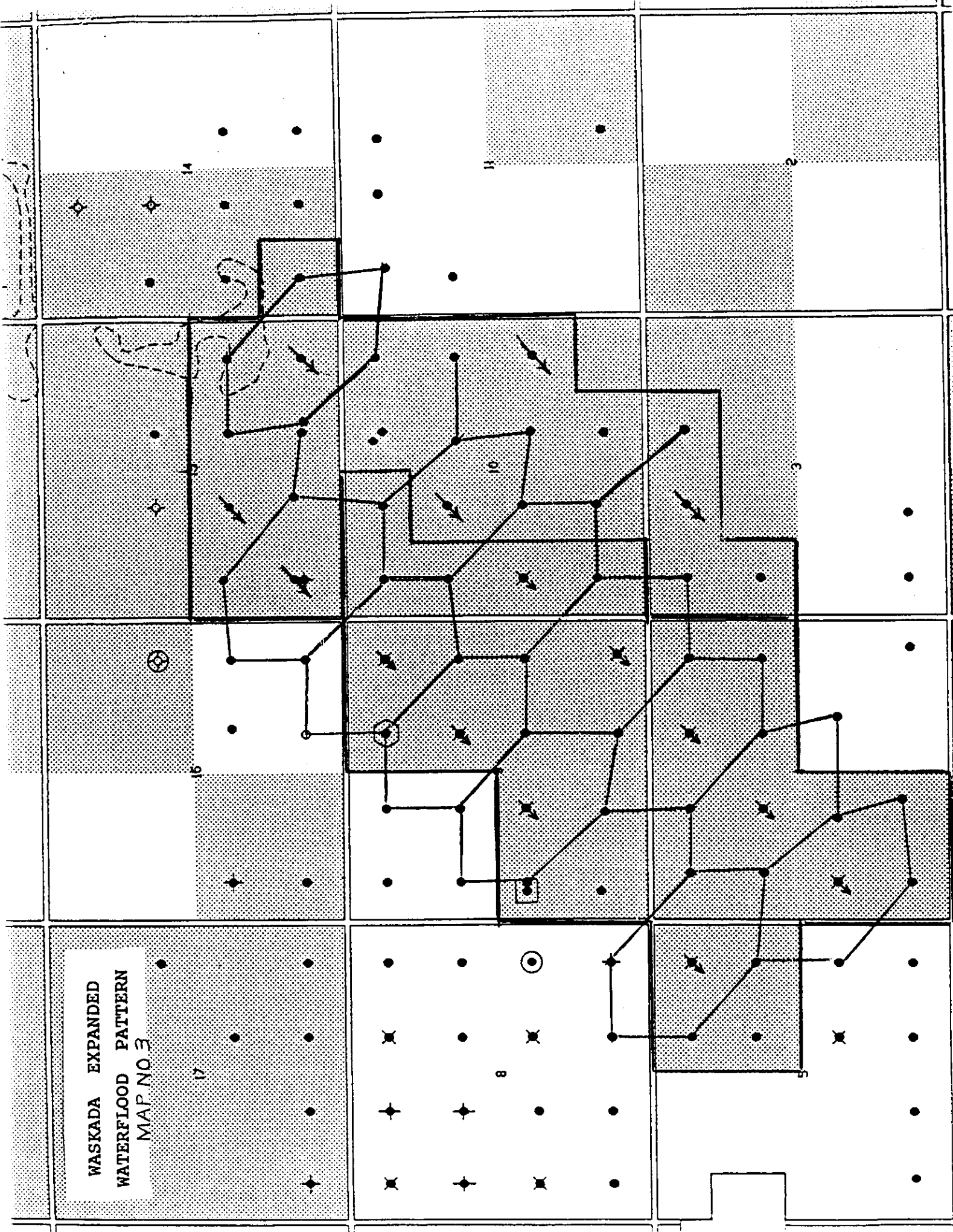
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MAP NO. 1
WASKADA LOWER AMARANTH
PROPOSED UNIT AREA
MAP NO. 2



WASKADA EXPANDED
WATERFLOOD PATTERN
MAP NO 3



T.2

13

12

14

← PROPOSED UNIT

1) Omega

1) Omega

13) WSA Vanderhove
14) WSA Vanderhove
15) WSA Vanderhove
16) WSA Vanderhove
17) WSA Vanderhove
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97) WSA Vanderhove
98) WSA Vanderhove
99) WSA Vanderhove
100) WSA Vanderhove

16

1) Omega

16

17

8

2

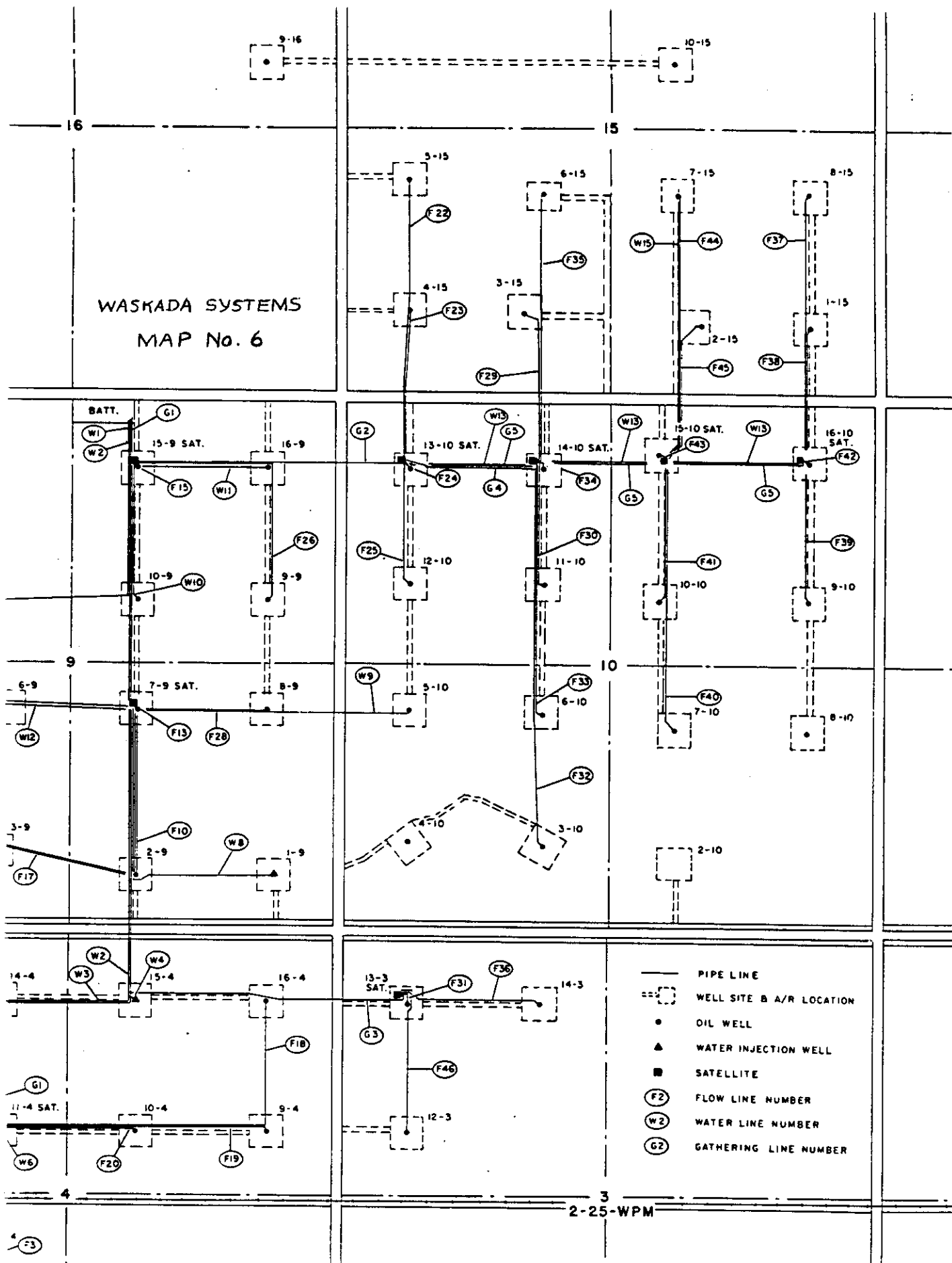
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LEGEND
1) MINERAL OWNER (LESSOR)
2) SURFACE OWNER

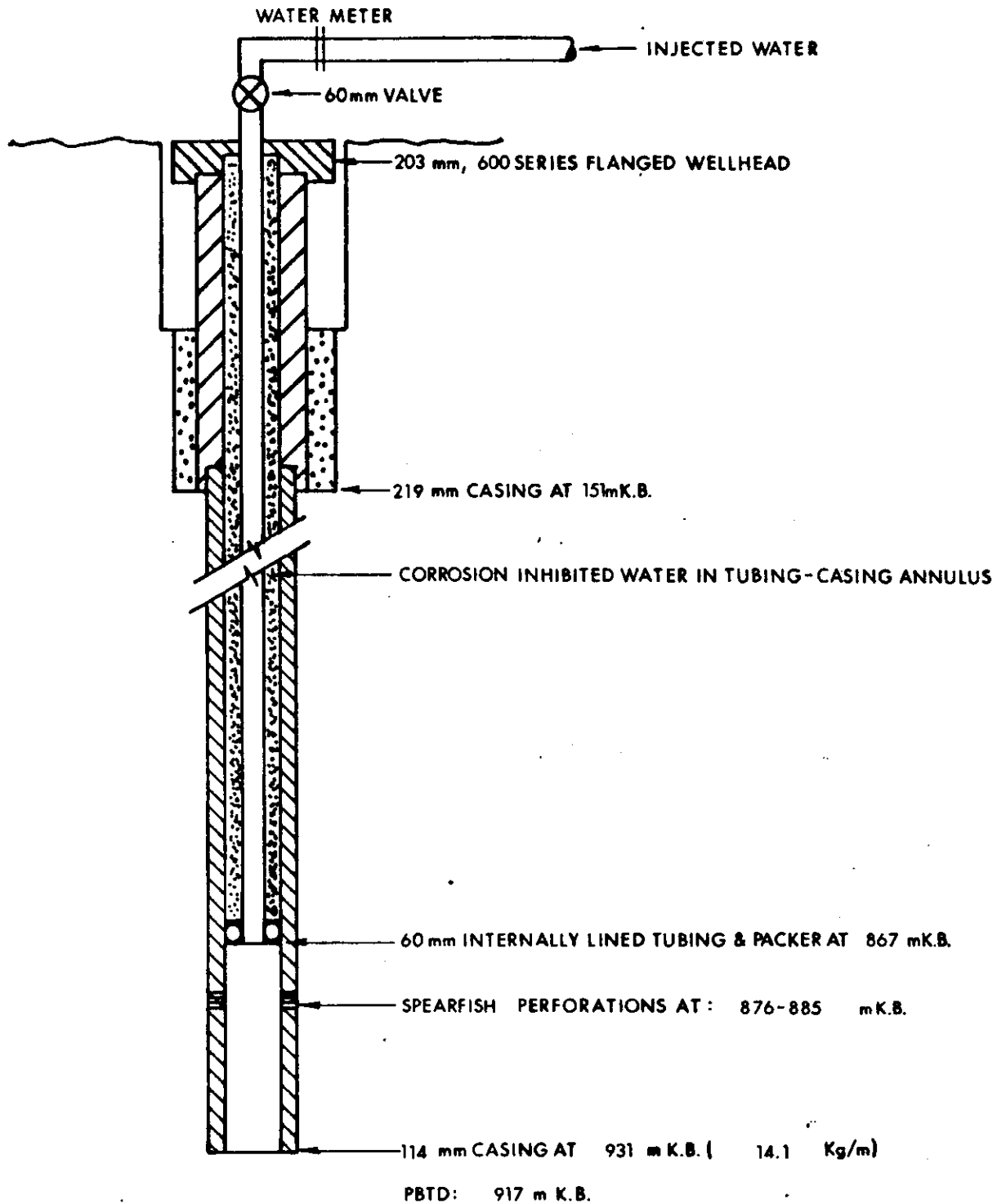
R.25 W.1M.

SURFACE OWNERS & LESSORS MAP NO. 5

WASKADA SYSTEMS
MAP No. 6



PROPOSED INJECTION WELL SUBSURFACE EQUIPMENT

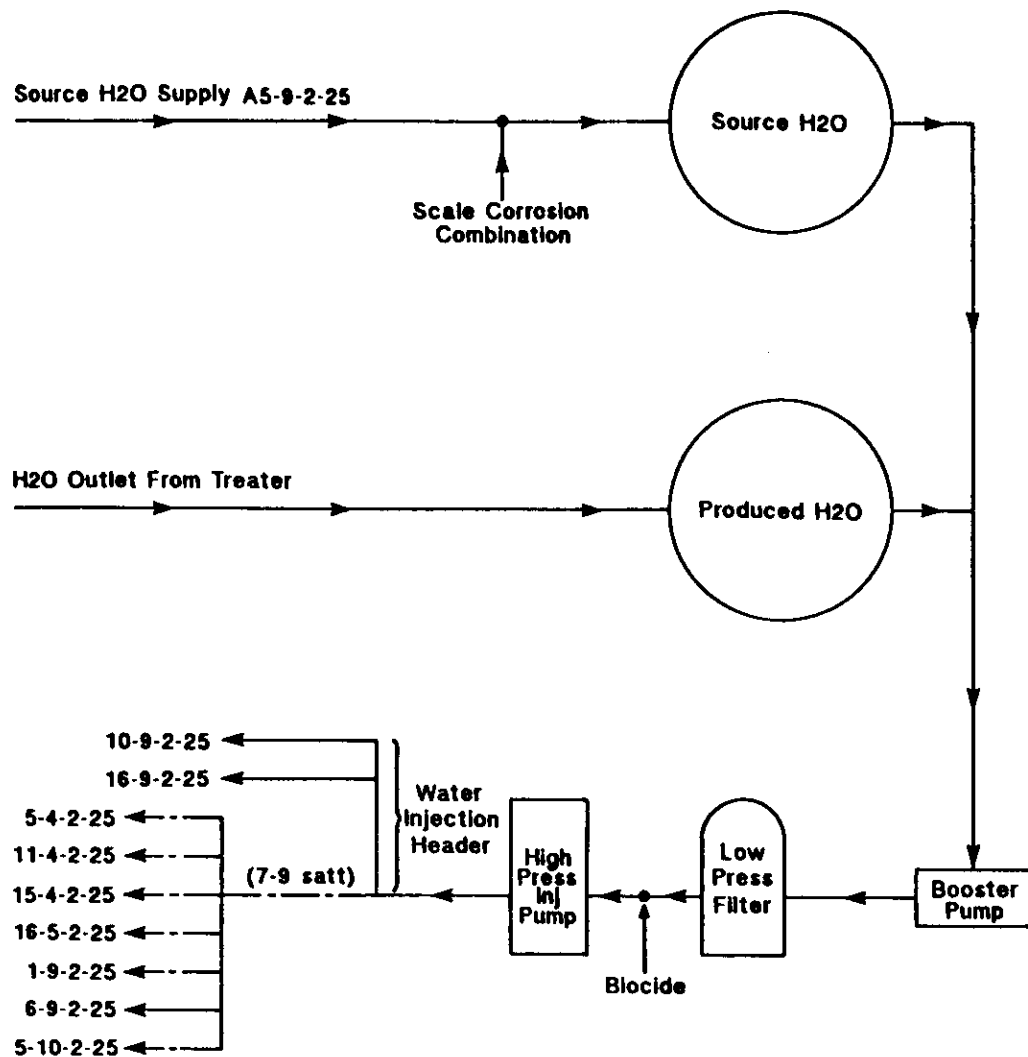


ENRON Oil Canada Ltd.

1300, 700 - 9th AVENUE S.W., CALGARY, ALBERTA PH: 403/298-2600

SCHEMATIC DIAGRAM
ANDEX ET AL WASKADA
11-10-2-25 WPM

DATE: 11-03-91	BY: D. STOODLEY	FILE NO:
SCALE: NTS	REVISIONS:	



LEGEND

- Internally Coated Water Line
- Un-coated Water Line

ENRON Oil Canada Ltd.		
1300, 700 - 66 AVENUE S.W. CALGARY, ALBERTA PH: 403/298-2600		
WASKADA WATER HANDLING FACILITIES 15-9-2-25 BATT.		
DATE: 09-11-89	BY: D. STOODLEY	CONT. INT.:
SCALE:	REVISIONS:	

19 March 1991

Manitoba Energy and Mines
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3

Attention: Mr. L.R. Dubreuil,
Director

Dear Mr. Dubreuil:

Re: **Waskada Lower Amaranth "A" Pool**
Pressure Maintenance Application

Enron Oil Canada Ltd. presently operates a pressure maintenance scheme in Waskada Unit No. 16 which commenced water injection in June 1987 and was expanded in December 1988 (Map No. 1). Application is hereby made to create a new waterflood project in the adjacent Enron operated area as shown on Map No. 2. Unitization of the expanded area is presently being negotiated.

Permission is requested to expand the present seven-spot waterflood pattern (Map No. 3) by injecting water into wells Enron et al Waskada 14-3-2-25, Enron Waskada 8-10-2-25, Enron et al Waskada 11-10-2-25, Enron Waskada 1-15-2-25, Enron et al Waskada A4-15-2-25 and Enron et al Waskada 6-15-2-25 coincident with the effective date of the new Unit.

The Waskada Lower Amaranth reservoir and fluid properties are similar to those previously submitted in the Waskada Lower Amaranth Waterflood Computer Simulation Study dated May 1988. The fluid properties from this subject study are enclosed as Table 2. The existing Waskada Unit No. 16 waterflood scheme has been performing admirably, so expansion of the existing waterflood pattern should be highly recommended. The existing Waskada Unit No. 16 waterflood scheme has nine injectors and twenty-four producers for a producer to injector ratio of 2.67 to 1. The proposed new waterflood scheme would have six injectors and seventeen producers for a similar producer to injector ratio of 2.83 to 1.

January 1990 individual well oil productivities in the proposed waterflood area are presented in Table 1. The seven-spot pattern generally results in the conversion of wells with lower oil productivity to water injection. This results in accelerated oil recovery and a better distribution of water injection between layers with an associated reduction of potential water

channelling. The seven-spot pattern decreases the producer to injector ratio over the conventional nine-spot pattern which should result in an increased sweep efficiency. The permeability and induced fracture stimulation trend is in a northeast to southwest direction, and thus, the indicated seven-spot pattern results in a line drive injection pattern which should improve sweep efficiency. Enron does not wish to convert well 15-10-2-25 to an injector at this time. The subject 15-10 well exhibits good oil productivity and Enron wishes to use this well as an experimental candidate to investigate the variation of water breakthrough time between on-trend and off-trend wells. Because of the favourable producer to injector ratio in the proposed new waterflood scheme (2.83 to 1), edge wells 12-3 and 2-10 will not be converted to water injection until offset drilling with associated Unit expansion occurs to the east of the present development.

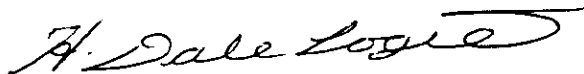
The following items are included in support of this application:

- 1) Maps and Table showing the surface owners, lessors and lessees in and adjoining the area of application (Maps 4 & 5 and Table 3).
- 2) Map of the existing surface facilities, oil lines and water injection lines (Map 6).
- 3) Schematic diagram of a typical injection well completion.
- 4) Schematic of the Waskada water distribution system.

If you have questions concerning this application, please contact the undersigned at (403) 298-2656.

Yours very truly,

ENRON OIL CANADA LTD.



H. Dale Logie, P.Eng.
Chief Reservoir Engineer

HDL:pd
attach

xc: Chauvco Resources Ltd., Attention: Mr. D.L. Robertson
Highridge Exploration Ltd., Attention: Mr. R.T. Vanderham
Trilogy Resources Corporation, Attention: Production Manager
Voyager Energy Inc., Attention: Mr. R.W. Hoover
C. Turnbull - Enron Waskada Field Office

TABLE 1

**WASKADA LOWER AMARANTH
JANUARY 1991 DAILY OIL PRODUCTIVITY
(m³/producing day)**

<u>Location</u>	<u>Oil Production (m³/d)</u>
12-3-2-25 WPM	1.3 11.2
13-3	2.9
14-3 *	1.5 2.7
15-3	1.4
2-10	2.0 4.7
3-10	2.7
6-10	1.6 6.4
7-10	3.8
8-10 *	1.1 5.9
9-10	4.8
10-10	1.9 3.6
11-10 *	1.7
15-10	3.2 11.4
16-10	8.2
4-14	0.9 2.4
1-15 *	1.5
2-15	3.7 5.7
3-15	2.3 3.2
4-15 *	0.9
5-15	2.6 3.5
6-15 *	0.9
7-15	2.5 5.6
8-15	3.3

* Recommended injector locations.

TABLE 2

WASKADA LOWER AMARANTH

FLUID PROPERTY DATA IN BLACK OIL FORMAT

SURFACE GAS SPECIFIC GRAVITY = 0.99500

DENSITY OF OIL AT STOCK TANK = 830.00 KG/M3

BUBBLE POINT PRESSURE = 4220.0 KPA

	OIL FORMATION	SOLUTION	GAS FORMATION	OIL	GAS
PRESSURE	FACTOR	GAS RATIO	FACTOR	VISCOSITY	VISCOSITY
KPA	RM3/SCM3	M3/M3	RM3/SCM3	CP	CP

101.00	1.0250	0.	1.00000	2.90400	0.01020
958.00	1.1190	29.35	0.10363	2.00000	0.01060
1413.00	1.1350	34.86	0.07179	1.54800	0.01080
2082.00	1.1470	39.84	0.04929	1.43200	0.01100
2813.00	1.1560	44.29	0.03658	1.36700	0.01130
3482.00	1.1630	47.49	0.02963	1.31900	0.01150
4220.00	1.1700	51.04	0.02488	1.28500	0.01180
6895.00	1.1660	60.28	0.01543	1.35000	0.01280
10343.00	1.1620	71.98	0.01046	1.45000	0.01400
13790.00	1.1580	84.04	0.00800	1.58000	0.01520

ROCK COMPRESSIBILITY V/V/KPA = 0.6700E-06

Manitoba



Message

To Ingrid

Person calling Jan

Of _____

☒ Telephoned

☐ Will call again

☐ Called to see you

☐ Please call

☐ Returned your call

☐ Will return

4:15

Telephone No.

Time

re. Addresses you requested

Message

LVMH IS IVMH INC.

Box 44

Goodlands, MB

ROMERO

Glen Huset

60145 Manitoba Limited

RR #1, Blackie, Alta

Date 702050

Message taken by

PS-1-36

AP 25/11

A.J.

Manitoba



Message

Corsett
To *Calgary C/O*
Person calling *Shirley K. Corsett*
Of *889-4893*

☐ Telephoned ☐ Will call again ☐ Called to see you
☐ Please call ☐ Returned your call ☐ Will return

Telephone No.	Time
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Message *834 Laxdale Road*
R3R OX1

Date _____ Message taken by _____

*Notice
and Apr. 25+26/97*

3.F

TABLE 3
PROPOSED WASKADA UNIT
TWP 2, RGE 25 WPM

SURFACE OWNERS WITHIN PROPOSED UNIT AREA

Lsd 4	Sec. 14	W & D Howden
W½ / SW¼	Sec. 15	G.D. Temple
E½ / SW¼	Sec. 15	D.R. Temple
W½ / SE¼	Sec. 15	L.J. Crepeele
E½ / SE¼	Sec. 15	R.C. Howden
Lsd 11	Sec. 10	D.R. Temple
Lsd 3,6	Sec. 10	D.R. Temple
E½	Sec. 10	L.J. Crepeele
NE¼	Sec. 03	E.L. Griffith
NW¼	Sec. 03	G.D. Temple

*Port of Waskada
Waskada
(again)*

MINERAL OWNERS WITHIN PROPOSED UNIT AREA

<u>AREA</u>	<u>LESSOR #1</u>	<u>LESSEE</u>
SW¼ Sec. 15	Tempella Resources	Enron
SE¼ Sec. 15	Nelson Oils	Enron
Lsd 2,7,8 Sec. 10	Nelson Oils	Enron
NE¼ Sec. 10	Nelson Oils	Enron
Lsd 3,6 Sec. 10	Crown	Enron
Lsd 11 Sec. 10	Crown	Enron
Lsd 4 Sec. 14	LVMH Inc.	Enron
Lsd 12,13,14 Sec. 03	Patlet Ventures	Enron
Lsd 15 Sec. 03	Glen Hassett	Enron

*Port of Waskada
P.M. 200*

ADJOINING MINERAL HOLDERS

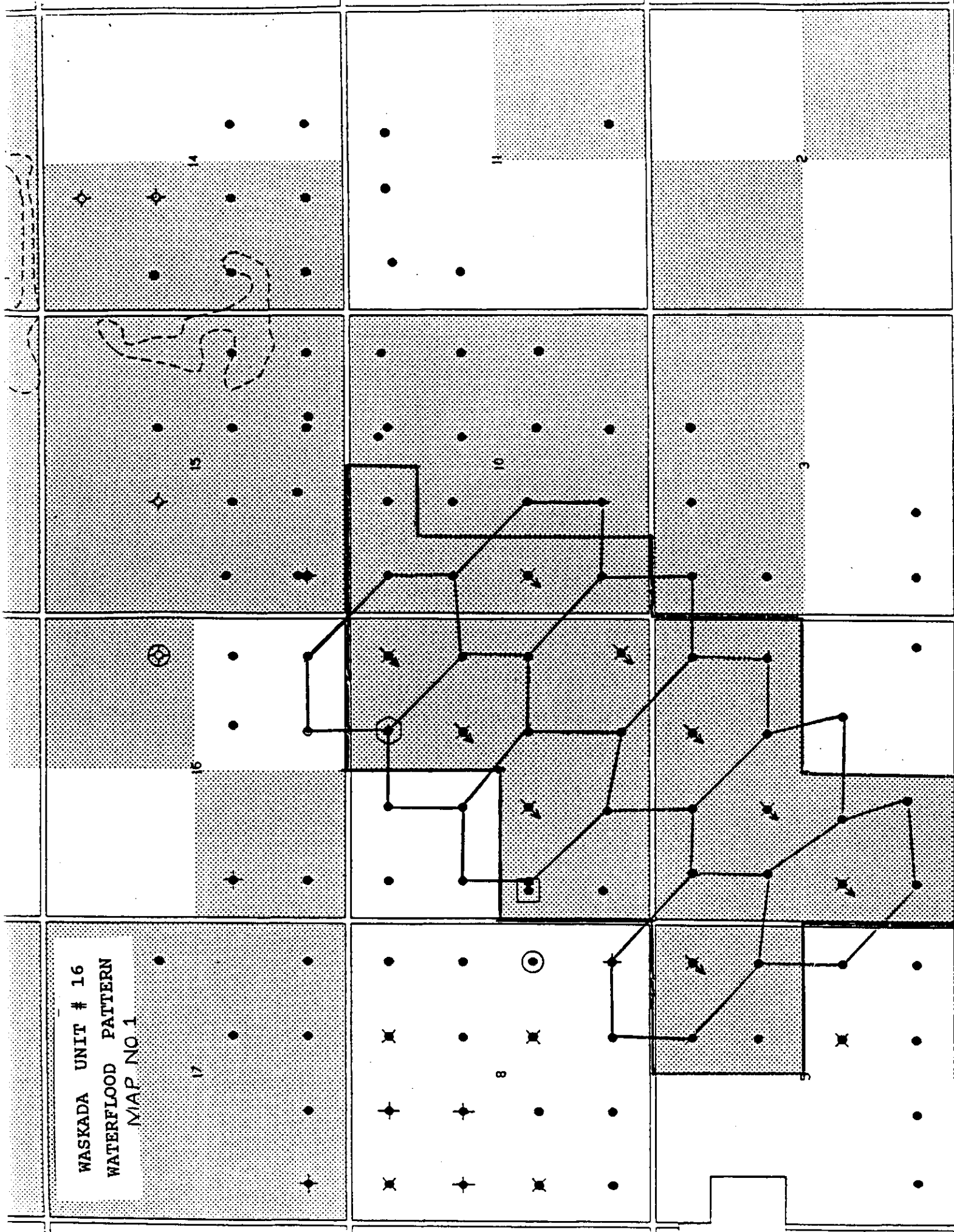
Lsd 3,5,6	Sec. 14	Howden/Homestead	Enron
Lsd 4,5	Sec. 10	Crown	Enron
Lsd 12,13,14	Sec. 10	Crown	Enron
NW¼	Sec. 15	W & A Vanderhave	
NE¼	Sec. 15	W & A Vanderhave	
SE¼	Sec. 16		Omega
SW¼	Sec. 03		Omega
Lsd 16	Sec. 03	Glen Hassett	
Lsd 11	Sec. 03	Patlett Ventures (?)	
NE¼	Sec. 04	Crown	Enron
Lsd 10	Sec. 03	Glen Hassett	Enron
Lsd 1	Sec. 10	Nelson Oils	Enron
SW¼	Sec. 11		Omega
NW¼	Sec. 11		Omega

*263
DIAKALYD
205 INO*

*Port of Waskada
P.M. 200*

*Port of Waskada
P.M. 200*

WASKADA UNIT # 16
WATERFLOOD PATTERN
MAP NO. 1



MAP NO. 1
WASKADA LOWER AMARANTH
PROPOSED UNIT AREA
MAP NO. 2

17

16

CHIEF

14

CHIEF

CHIEF

11

PROPOSED
UNIT

2

3

4

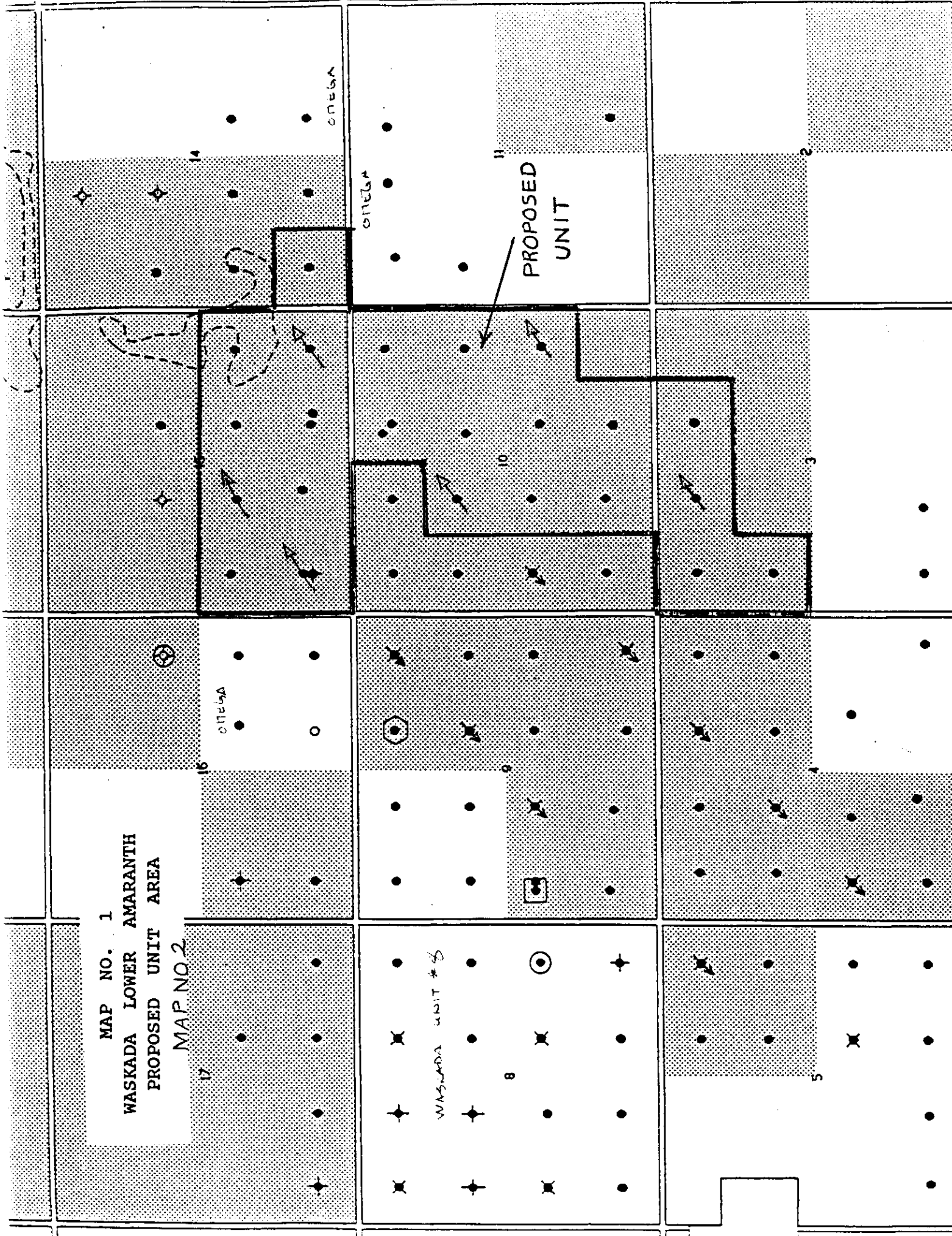
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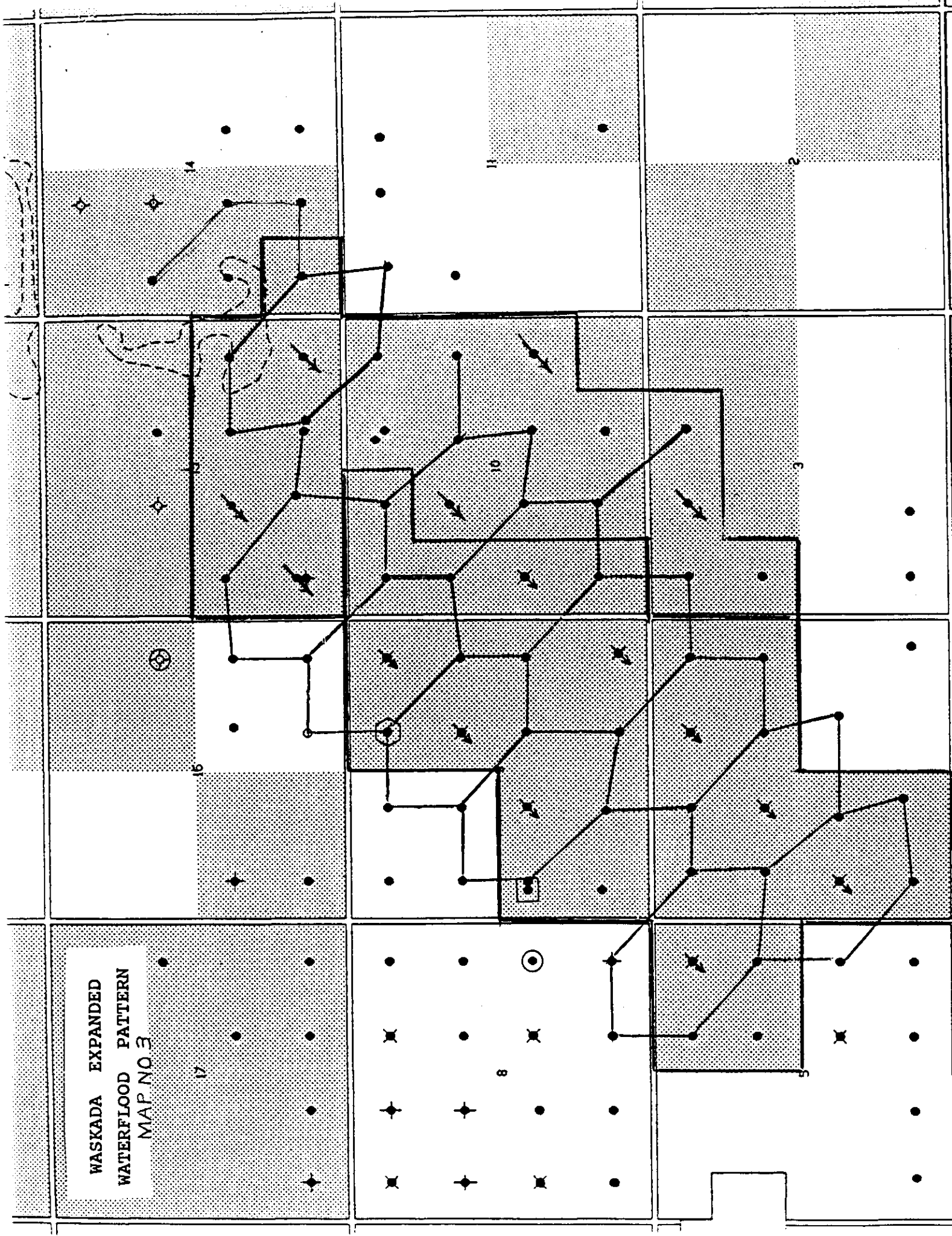
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8

WASKADA UNIT #8



WASKADA EXPANDED
WATERFLOOD PATTERN
MAP NO 3



T.2

13

14

15

17

12

11

8

1

2

5

PROPOSED UNIT

1) Omega

1) Omega

LEGEND
1) MINERAL OWNER (LESSOR)
2) SURFACE OWNER

1) W.S.A. Vandenberg
2) W.S.A. Vandenberg
3) W.S.A. Vandenberg
4) W.S.A. Vandenberg
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99) W.S.A. Vandenberg
100) W.S.A. Vandenberg

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1) Green

R.25 W.1M.

SURFACE OWNERS & LESSORS MAP NO. 5

WASKADA SYSTEMS
MAP No. 6

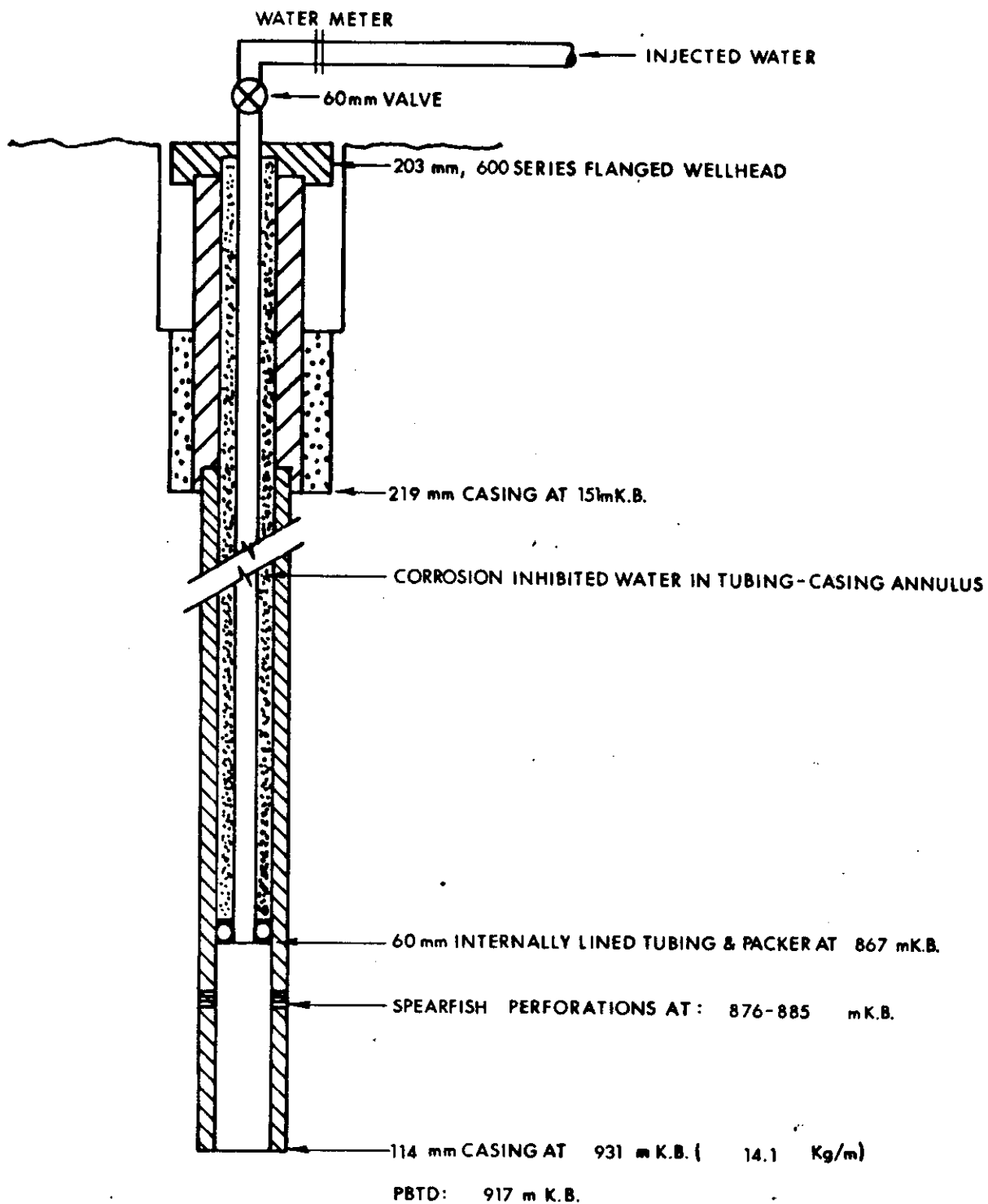
Legend:

- PIPE LINE
- WELL SITE & A/R LOCATION
- OIL WELL
- WATER INJECTION WELL
- SATELLITE
- FLOW LINE NUMBER
- WATER LINE NUMBER
- GATHERING LINE NUMBER

2-25-WPM

2-25-WPM

PROPOSED INJECTION WELL SUBSURFACE EQUIPMENT



ENRON Oil Canada Ltd.

1300, 700-9th AVENUE S.W., CALGARY, ALBERTA PH: 403/298-2600

SCHEMATIC DIAGRAM
ANDEX ET AL WASKADA
11-10-2-25 WPM

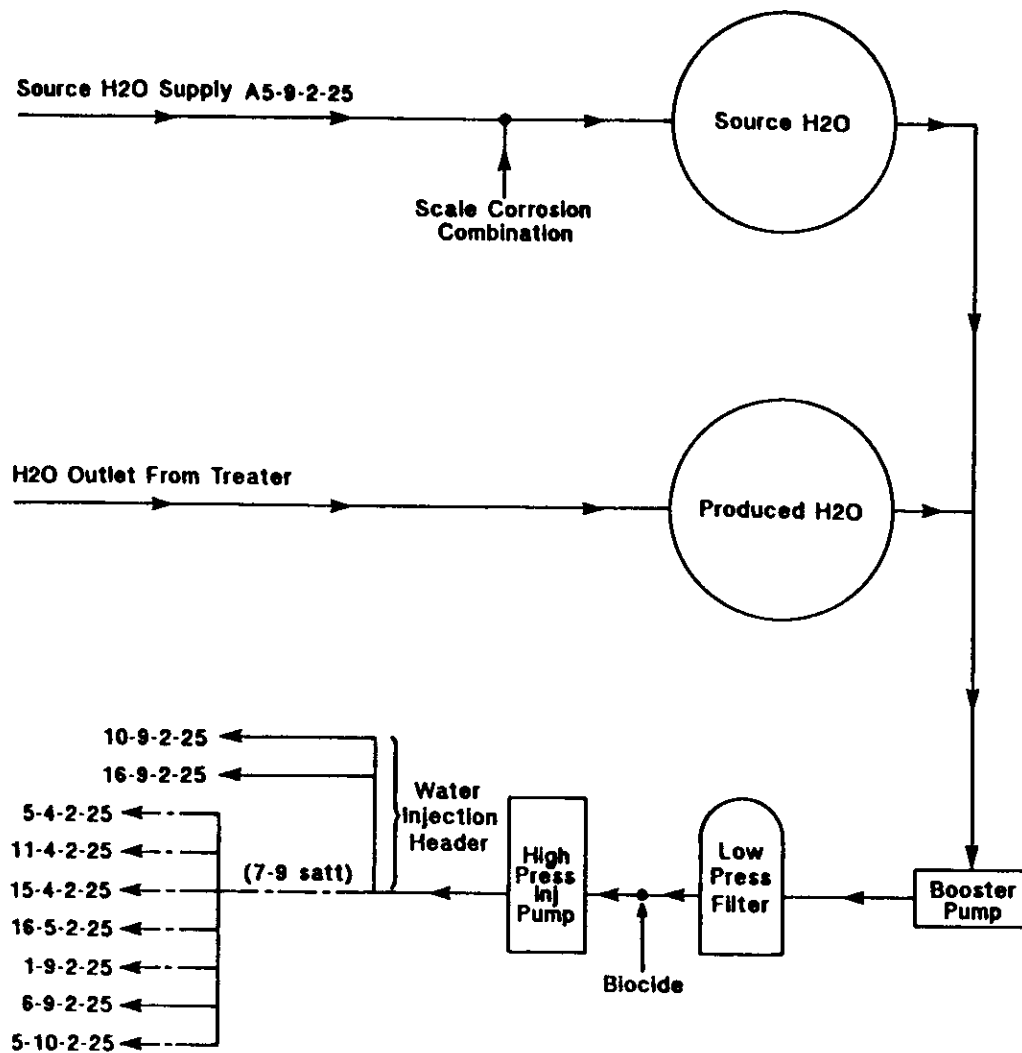
DATE: 11-03-91

BY: D. STOODLEY

FILE NO:

SCALE: NTS

REVISIONS:



LEGEND

- Internally Coated Water Line
- Un-coated Water Line

ENRON Oil Canada Ltd.		
1300 700-TH AVENUE S.W. CALGARY, ALBERTA PH: 403/299-2600		
WASKADA WATER HANDLING FACILITIES 15-9-2-25 BATT.		
DATE: 09-11-89	BY: D. STOODLEY	CONT. INT.1
SCALE:	REVISIONS:	



Energy and Mines

Petroleum

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

(204) 945-6577
FAX: (204) 945-0586

January 22, 1991

Mr. H. Dale Logie, P. Eng.
Chief Reservoir Engineer
Enron Oil Canada Ltd.
1300, 700 - 9th Avenue S.W.
Calgary, Alberta
T2P 3V4

Dear Sir:

Re: Waskada Lower Amaranth A Pool
Expansion of Pressure Maintenance Operations

Drilling in the Waskada Field over the past 2-3 years has resulted in a significant expansion of the Waskada Lower Amaranth A Pool to the north and east. A total of 41 producing wells operated by Enron and Omega now surround Waskada Unit No. 16. Cumulative oil production from these wells had reached a total of $80.7 \times 10^3 \text{ m}^3$ by October 31, 1990, approximately 5% of the total production from the pool.

The Petroleum Branch requests that Enron review, either separately or jointly with Omega, the feasibility of expanding pressure maintenance operations in Sections 3,9,10,11,14,15 & 16 in Township 2-25 (WPM). We request that Enron report on the results of this feasibility study prior to March 31, 1991.

If you have any questions please contact the undersigned at (204) 945-6573 or John N. Fox, Chief Petroleum Engineer at (204) 945-6574.

Yours truly,



L.R. Dubreuil
Director

LRD:cvs

cc: Mr. Dan Boyko
Omega Hydrocarbons Ltd.

WASKADA UNIT NO. 16 WF PERFORMANCE

- ✓ - Water injection in Unit No. 16 commenced in June, 1987
- ✓ - The Unit was expanded in Oct/88 and water inj. commenced in the expanded area in Dec/88 - Fig. 1
- ✓ - To Dec 31/90 cumulat. prod. totaled $132.1 \times 10^3 \text{ L}^3$ (COOP) with a ^{cumulative} WOR of 0.26. Most of the produced water is assumed to be from the underlying PC wells that were located out of zone.
- ✓ Cumulative water injected to Dec 31/90 was $113.9 \times 10^3 \text{ m}^3$, resulting in a cumulat. VRI of 0.74. (The VRI target is 1.2)
- ✓ $B_{oi} = 1.16 \text{ nm}^3/\text{m}^3$
- ✓ - Estimated COIP in Unit #16 is $3165 \times 10^3 \text{ L}^3$
- ✓ - 85.5×4 (OWI - 15 in May/88 simulation study but not in Unit 16) = $2923 \times 10^3 \text{ L}^3$
- ✓ - Predicted primary recovery 9.3% and the predicted waterflood recovery 19.8% after 20 years and 29.1% after 40 years.

The injection pattern in Unit 16 is an inverted 7 spot with the injection wells aligned with the NE-SW induced fracture orientation. This injection orientation appears to have resulted in improved areal sweep efficiency to off-trace producers. Only the 1-9-2-25 well has experienced water breakthrough. This well is planned to be converted to injection in Unit No. 17

- the historical production plot for Unit 16 indicates an annual production decline of 6.4% / yr. and an estimated recovery of $486.9 \times 10^3 \text{ bbl}$ (17.2% OOIP) which matches quite closely the 1988 simulation study results

PROPOSED WASKADA UNIT NO. 17

- proposed unit No. 17 is a continuation of the 7-spot injection pattern established in Unit No. 16 (Fig. 4)

Estimated OOR in Unit No. 17 is 1967 10²±3 based on an OOR of 855 10³L²/spanning unit derived from the 1966 simulation study. This predicts a primary recovery of 7.5% and a secondary recovery of 16%. The lower estimated primary and secondary recoveries for Unit 17 when compared with Unit 16 are based on the difference in water-cut between the 2 units - Unit 16 - 25% (at waterflood shut-in), Unit 17 - 40%.

Not included in Unit 17 are wells in the NW/4 of Section 11-2-25 (OMEGA), 3-14, 5-14, 6-14, 12-14 and the SE/4 of Sec. 15-2-25, however offset injection in Unit 16 & 17 provides ^{partial} pressure support for wells in the SE/4 of Sec 15 and NW/4 of Sec 11.

3-14 & 12-14 combined as Upper Anasazi porosity stringer and 6-14 & 11-14 have been ABD.

Enron does not wish to convert 15-10-2-25 to an injector at this time. The 15-10 well produces 3.2 m^3/d (average productivity of the 6 proposed injectors 1.3 m^3/d) and

Enron proposes to use the 15-10 well to investigate in situ breakthrough time between on-trend and off-trend producers
note: 15-10 is between the ^{proposed} 11-10 and 1-15 injectors

Nov 88 - 4920 acm

Jul 190 7648 acm

to add
various

APR/87 Pressure average = $3577 = 7587 \text{ kPa} = 5321 \text{ acm}$.
see 4d5-2-25

plot

Dec/89 7211 - 9862 acm 8161 kPa

wellhead injection pressure Dec/90 8890 - 9000 kPa

water-cut < 5% in 18 of 20 wells

high we wells

13-4 LAM/ML

16-4 LAM/ML

10-5 LAM/ML

4-9 LAM/ML

4-10 (10.3%)

2-9 (5.7%)

Unit 16 decline

$$q_i = 100 \text{ m}^3/\text{d}$$

$$q_t = 60 \text{ m}^3/\text{d}$$

$$t = 5$$

$$D = 10.2 \% / \text{yr.}$$

RECOVERABLE RESERVES

$$Q_t = 132133 + \frac{365(q_i - q_t)}{D}$$

$$q_i = 74.5$$

$$Q_t = 355785$$

$$q_t = 0.5 \text{ m}^3/\text{d}/\text{well} \times 24 \text{ wells} = 12 \text{ m}^3/\text{d}$$

$q_1 = 295 \text{ m}^3/\text{d}$ $\frac{D}{D_{\text{initial}}}$
 $q_+ = 20 \text{ m}^3/\text{d}$ $31.7\%/\text{yr}$

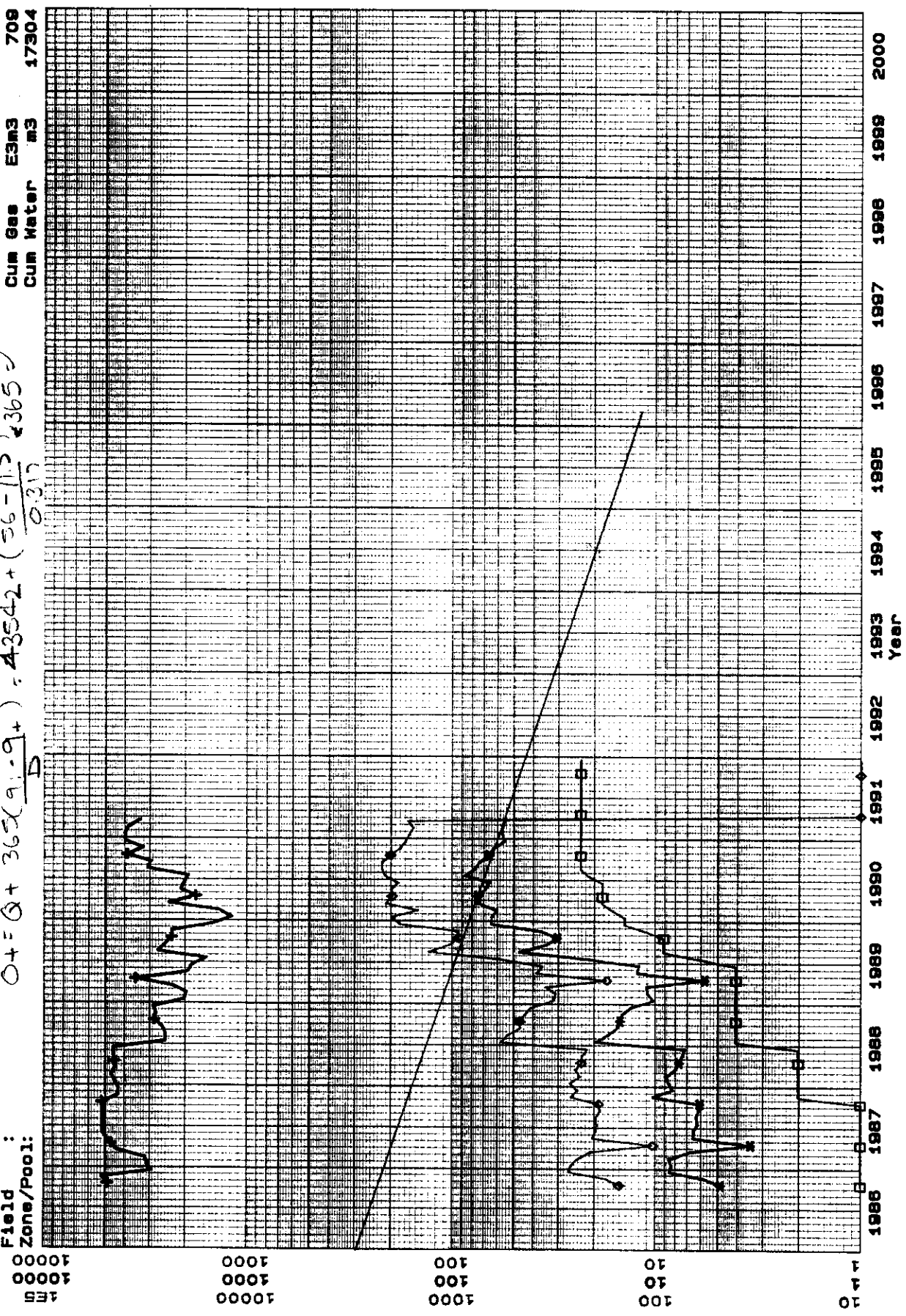
WASKADA UNIT # 17 + = 8.5 yrs

Data 8610-9112
 Operator :
 Field :
 Zone/Pool:

$$Q_+ = Q + 365 \left(\frac{q_+ - q_1}{D} \right) = 43542 + \frac{(56 - 11.5)}{0.317} \times 365 = 43650$$

Type :
 RF = 4.8%

Cum Oil m3 43542
 Cum Gas E3m3 709
 Cum Water m3 17304



□ Num Wells
 * Avg Daily Oil m3/d
 ◇ Monthly Oil m3

Water Cut
 %
 +

0.01

0.1

1

10

100

$q_i = 100 \text{ m}^3/\text{d}$
 $q_+ = 60 \text{ m}^3/\text{d}$
 $t = 8 \text{ yrs}$

$D = 6.4\% / \text{yr}$
 05/14/91 14:15

WASKADA UNIT # 16

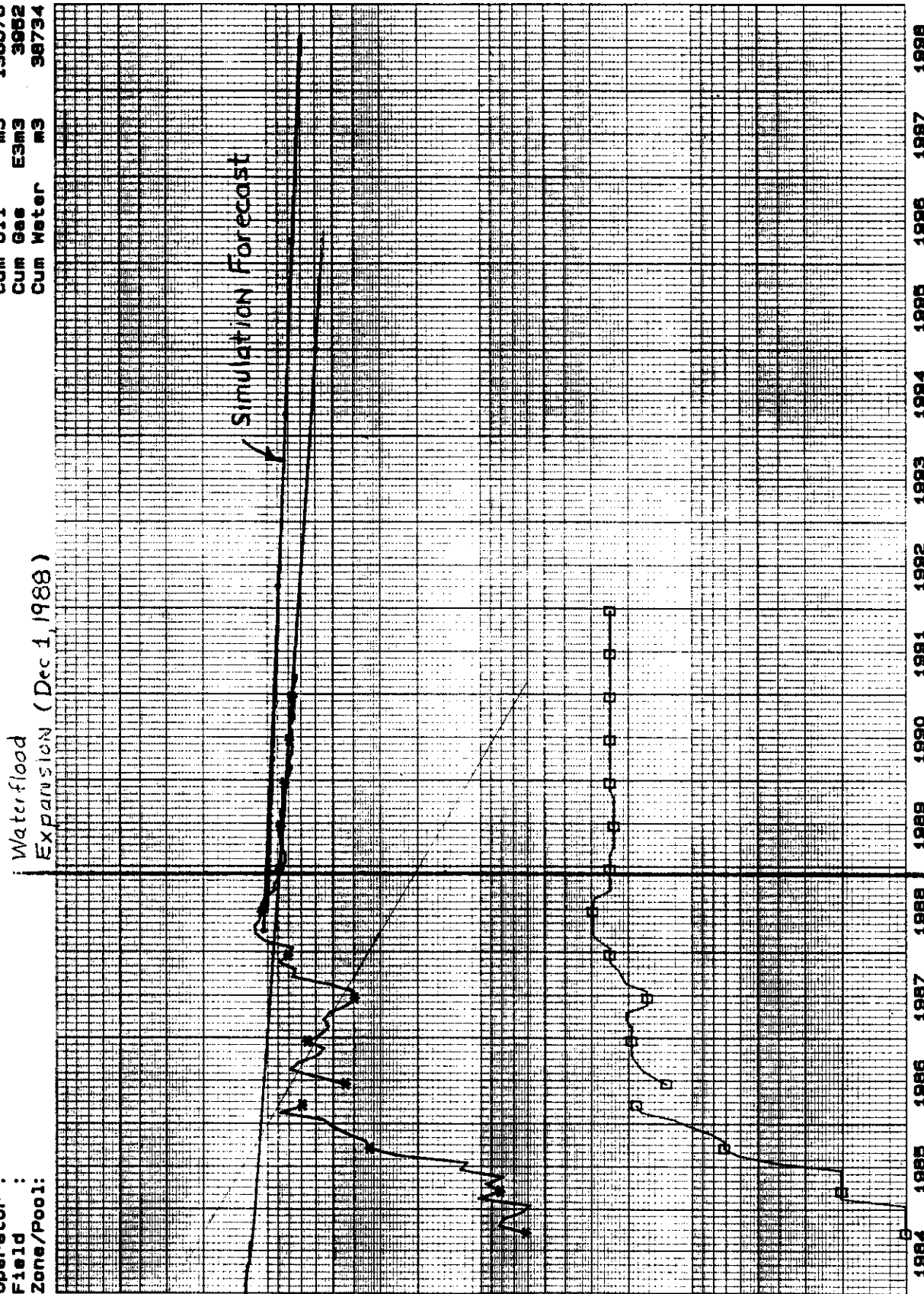
FIGURE 1

Data 8408-9112

Operator :
 Field :
 Zone/Pool:

Cum Oil M3 138576
 Cum Gas E3M3 3952
 Cum Water M3 38734

Type :



$q_i = 300$
 $q_+ = 66$
 $t = 7$
 $D = 21.6\%$

$Q_+ = 132133 + 365(q_+ - q_i)$

$Q_+ = 486867$
 $RF = 17.2\%$

$q_i = 74.2$
 $q_+ = 12$
 $t = 12$
 $D = 0.5\%$

* Num Wells
 * Avg Daily Oil m3/d