BENSON-MONTIN-GREER DRILLING CORP.

221 PETROLEUM CENTER BUILDING, FARMINGTON, N.M. 87401 505-325-8874

April 19, 1989

To: WORKING INTEREST OWNERS
EAST HALF SECTION 12, T-25N, R-2W
RIO ARRIBA COUNTY, NEW MEXICO

Re: VOLUNTARY UNITIZATION:
INCLUSION IN CANADA OJITOS UNIT

We refer to letter to you dated April 11, 1989 from Sun Exploration and Production.

We presume you will be responding to Sun. We would appreciate it if you would also advise our company as operator of the Canada Ojitos Unit if you elect to voluntarily join the proposed expanded unit.

Also this letter confirms Sun's estimate of approximately $600 per acre capital expenditure to join the unit. Further we advise that the Unit Agreement has a provision for non-consent participants for those who join but who elect not to make cash settlement of the investment adjustment. The cost recovery for non-consent participants is 300%.

The Canada Ojitos Unit is now under New Mexico statutory unitization regulations; and as such any expansion - even though voluntary - must satisfy the statutory regulations. Accordingly, as Unit Operator, we will be filing for expansion of the unit under the statutory unit regulations. Under the timing of the Commission hearings, we anticipate this matter to be heard May 10.

BENSON-MONTIN-GREER DRILLING CORP.

BEFORE EXAMINER STOGNER
OIL CONSERVATION DIVISION
BMG EXHIBIT NO. 2
CASE NO. 9671 5/10/89

BY: Albert R. Greer, President

ARG/tlp

4/19/89

OWNERSHIP
NW/4 NE/4 SEC. 12, TOWNSHIP 25 NORTH, RANGE 2 WEST

Sun Exploration & Production
P.O. Box 2880
Dallas, TX 75221-2880
Attn: Frank L. McColloch
214-890-5675

Sun Exploration & Production
P.O. Box 1861
Midland, TX 79702
Attn: Linda Guerrero
915-688-0492

Dugan Production Corp.
P.O. Box 420
Farmington, NM 87499-0420
505-325-1821

Reading & Bates Oil & Gas Co.
3200 Mid-Continent Tower
Tulsa, OK 74103
918-583-8180

P.C. Ltd. and Ibex Partnership
P.O. Box 911
Breckenridge, TX 76024-0911
817-559-3355

Hooper, Kimball & Williams, Inc.
P.O. Box 520970
Tulsa, OK 74152
918-585-5788

(Carolyn Clark Oatman
(Warren Clark Trust
(Warren Clark Test. Trust
c/o Wayland Oatman
433 Perry Brooks Building
Austin, TX 78701
512-478-7307

Mountain States Natural Gas
P.O. Box 35426
Tulsa, OK 74135
918-299-4152 or
918-299-8531

Ralph (Alice) Gilliland
c/o Ann G. St. Clair
7420 Caruth
Dallas, TX 7525
214-691-1977

Duer Wagner, Jr. and Duer Wagner III
3400 City Center, Tower II
301 Commerce Street
Fort Worth, TX 76201
817-335-2222

BENSON-MONTIN-GREER DRILLING CORP.

221 PETROLEUM CENTER BUILDING, FARMINGTON, NM. 87401 505-325-6874

May 1, 1989

To: WORKING INTEREST OWNERS
EAST HALF SECTION 12, T-25N, R-2W
RIO ARRIBA COUNTY, NEW MEXICO

Re: VOLUNTARY UNITIZATION:
INCLUSION IN CANADA OJITOS UNIT

We refer to letter to you dated April 11, 1989 from Sun Exploration and Production and our letter of April 19 regarding the same matter.

This is to advise that we made a mistake in our advice as to the cost recovery percentage for non-consent participants. In our letter of April 19, we said it was 300%. The correct recovery is 150% (100% of cost plus 50% penalty).

BENSON-MONTIN-GREER DRILLING CORP.

BY: _____
Albert R. Greer, President

ARG/tlp

Sun Exploration and
Production Company
Four NorthPark East
5656 Blackwell
P O Box 2880
Dallas TX 75221-2880
214 890 6000

April 11, 1989

To: Attached Addressee List

Re: E/2 Section 12-T25N-R2W
Rio Arriba County, New Mexico

Gentlemen:

Sun and Dugan Production Corporation are the leasehold owners of the NE/4 of Section 12-25N-2W and you are the leasehold owners of the SE/4 of Section 12-25N-2W. The Sun/Dugan lease will expire under its own terms July 31, 1989, unless some action is taken to perpetuate the lease.

All three leases covering the E/2 of Section 12 are Federal leases. It should be noted that the E/2 of Section 12 is surrounded by producing wells. We believe that it is imperative that this leasehold be placed in a productive status as soon as possible since development or compensatory royalty could become an issue with the BLM. Also, because of the rough terrain in the area, it is anticipated that access to the well and location preparation will add an estimated $100,000 to the cost of any well drilled in the E/2 of Section 12.

Sun and Dugan are of the opinion that the best course of action to take regarding the E/2 of Section 12 would be to include it in the Canada Ojitos Unit. Our geological data indicates that the E/2 of Section 12 will contribute reserves to the unit. This has already been discussed with the Operator and it was well received.

It is Sun and Dugan's contention that all parties will benefit from the expansion since no additional drilling or compensatory royalty would be required at this time. The anticipated capital expenditure to join the unit will be approximately $600 per acre. Sun proposes that on behalf of the owners in the E/2 of Section 12 that it coordinate with the Operator of the Canada Ojitos Unit the enlargement of the unit to include the E/2 of Section 12-25N-2W.

For your reference, I have attached a list that Sun believes shows each owner and their interest in the E/2 of Section 12. Please advise if Sun's proposal to request inclusion of the E/2 of Section 12 in the Canada Ojitos Unit is acceptable.

Sincerely,

Frank L. McColloch
Manager, Unitization

FLM:pcg
Attachment

1P7/552 - (1)

ADDRESSEE LIST
E/2 SECTION 12-T25N-R2W
RIO ARRIBA COUNTY, NEW MEXICO

Dugan Production Corporation
P. O. Box 420
Farmington, New Mexico 87499-0420

Reading & Bates Oil & Gas Company
3200 Mid-Continent Tower
Tulsa, Oklahoma 74103

P. C. Ltd. and Ibex Partnership
P. O. Box 911
Breckenridge, Texas 76024-0911

Hooper, Kimball & Williams, Inc.
P. O. Box 520970
Tulsa, Oklahoma 74152

Carolyn Clark Oatman,
Warren Clark Trust, and
Warren Clark Test. Trust
c/o Wayland Oatman
433 Perry Brooks Building
Austin, Texas 78701

Mountain States Natural Gas
P. O. Box 35426
Tulsa, Oklahoma 74135

Ralph (Alice) Gilliland
c/o Ann G. St. Clair
7420 Caruth
Dallas, Texas 75225

Duer Wagner, Jr. and Duer Wagner, III
3400 City Center, Tower II
301 Commerce Street
Fort Worth, Texas 76201

PARTY	INTEREST IN E/2 SECT. 12
Sun	43.75%
Dugan	6.25%
Reading & Bates	12.50%
PC LTD	5.853274%
IBEX Partnership	5.853274%
Hooper, Kimball & Williams	12.5%
Carolyn Clark Oatman	.328062%
Warren Clark Trust	.305175%
Warren Clark Testamentary Trust	.160215%
Mountain States	6.25%
Ralph Gilliland	3.125%
Duer Wagner, Jr.	2.90625%
Duer Wagner, III	.21875%

BENSON-MONTIN-GREER DRILLING CORP.

221 PETROLEUM CENTER BUILDING, FARMINGTON, NM. 87401 505-325-8874

April 19, 1989

To: CANADA OJITOS UNIT
WORKING INTEREST OWNERS

Re: CANADA OJITOS UNIT
RIO ARRIBA COUNTY, NEW MEXICO:
PROPOSED 4TH EXPANSION TO INCLUDE
E/2 SECTION 12, T-25N, R-2W

We refer to our letter of April 7 and advise that all ballots received to date approve the inclusion of the captioned tract and we are initiating the process to permit expansion of the unit.

The Canada Ojitos Unit is not only under the federal unit regulations, it is also now under New Mexico statutory unitization regulations; and as such any expansion - even though voluntary - must satisfy the statutory regulations. Accordingly, as Unit Operator, we will be filing for expansion of the unit under the statutory unit regulations. Under the timing of the Commission hearings, we anticipate this matter to be heard May 10 by an Examiner for the New Mexico Oil Conservation Commission.

If the Commission approves the application, all owners will then be polled to determine, formally, their positions respecting admittance of this tract to the unit.

BENSON-MONTIN-GREER DRILLING CORP.

BY: _____
Albert R. Greer, President

ARG/tlp

BENSON-MONTIN-GREER DRILLING CORP.

221 PETROLEUM CENTER BUILDING, FARMINGTON, NM. 87401 505-325-8874

April 7, 1989

To: CANADA OJITOS UNIT
WORKING INTEREST OWNERS

Re: CANADA OJITOS UNIT
RIO ARRIBA COUNTY, NEW MEXICO:
PROPOSED 4TH EXPANSION FO INCLUDE
E/2 SECTION 12, T-25N, R-2W
BALLOT ENCLOSED

Owners under the captioned tract have asked that it be included in the Canada Ojitos Unit.

The Unit Operator recommends that we respond affirmatively to the request: the expansion has benefits for the unit.

We have been advised by those requesting admittance to the unit that they have two other options: drill a well on this tract of land; or pool these lands with the other well in the NW/4 of Section 12 resulting in a 640-acre proration unit. Neither of these latter two options is economically feasible: the area is essentially oil depleted; and the remaining gas volume under the tract is not sufficient to pay the cost of a new well, nor will pooling with the existing well provide income to equal the expense.

There is no assurance that if the owners join the unit that their shares of unit cost will guarantee a profit; but if this course is taken, there is a reasonable opportunity that it will.

Benefit to all concerned by bringing this tract into the unit would be the avoidance of drilling an unncessary well.

Benefit to the unit would be a reduction in reservoir withdrawals adjoining the unit and making less difficult the deterrence of migration of unitized substances from the unit.

The investment adjustment at this time for bringing a new tract of land into the unit approximates $600.00 per acre; or $192,000 for a 320-acre tract. The tract will be credited with approximately 0.6% of unit production.

Owners under the new tract will be allowed, individually,

...

to pay their shares of the investment adjustment or to elect to go "non-consent".

Enclosed is a ballot which we request each owner mark and return to us for our preliminary information with respect to this request. Submittal of this ballot is a non-binding indication of each owner's preliminary position.

If expansion is pursued formally, each owner will later be polled for a binding election of his position.

BENSON-MONTIN-GREER DRILLING CORP.

BY: _____
Albert R. Greer, President

ARG/tlp

Enclosures

CANADA OJITOS UNIT BALLOT

RE: NON-BINDING VOTE
WITH RESPECT TO
ADMISSION OF E/2 OF SECTION 12
TOWNSHIP 25 NORTH, RANGE 2 WEST TO UNIT AREA

APPROVE ADMISSION _____

DISAPPROVE ADMISSION _____

OWNER: DATE:

_____ _____

_____

_____

_____

BENSON-MONTIN-GREER DRILLING CORP.
EXHIBITS IN CASE NO. 9525
BEFORE THE OIL CONSERVATION COMMISSION OF THE
NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

FEBRUARY 1, 1989

BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
BMG EXHIBIT NO. 1
CASE NO. 9525

BENSON-MONTIN-GREER DRILLING CORP.
EXHIBITS IN CASE NO. 9525
BEFORE THE OIL CONSERVATION COMMISSION OF THE
NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

FEBRUARY 1, 1989

INDEX

BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES

IN THE MATTER OF THE APPLICATION OF
BENSON-MONTIN-GREER DRILLING CORP.
FOR AMENDMENT OF ORDER R-6469 TO
RESCIND APPROVAL OF CERTAIN
NON-STANDARD SPACING UNITS,
RIO ARRIBA COUNTY, NEW MEXICO. CASE NO. 9525

APPLICATION

COMES NOW BENSON-MONTIN-GREER DRILLING CORP., by and through its undersigned attorneys, hereby makes application to the Oil Conservation Division for Amendment of Order R-6469 and in support thereof states:

1. Applicant is the operator of the Canada Ojitos Unit which includes lands in Township 24 North, Range 1 West and Township 26 North, Range 1 West as well as other acreage and from which oil and gas are produced from the West Puerto Chiquito-Mancos Oil Pool.

2. In Case 6997, Applicant sought among other things the creation of certain non-standard spacing units which units were approved on September 10, 1980 by Order R-6469.

3. Prudent operation and development of the unit area now requires that approval of the following non-standard proration units be terminated:

TOWNSHIP 24 NORTH, RANGE 1 WEST, N.M.P.M.

a 320-acre unit comprising Section 1: N/2

a 640-acre unit comprising Section 23: N/2
and Section 24: N/2

a 640-acre unit comprising Section 23: S/2
and Section 24: S/2

TOWNSHIP 26 NORTH, RANGE 1 WEST, N.M.P.M.

a 640-acre unit comprising Section 5: W/2
and Section 8: W/2

a 640-acre unit comprising Section 5: E/2
and Section 8: E/2

a 640-acre unit comprising Section 17: W/2
and Section 20: W/2

a 640-acre unit comprising Section 17: E/2
and Section 20: E/2

4. That approval of this application will be in the best interest of conservation, the prevention of waste and the protection of correlative rights.

WHEREFORE, Applicant requests that this matter be set for hearing before a duly appointed Examiner of the Oil Conservation Division and, that after notice and hearing as required by law, the Division enter its Order amending Order R-6469 by deleting therefrom Division approval of those non-standard proration units located in Township 24 North, Range 1 West and Township 26 North, Range 1 West, N.M.P.M., Rio Arriba County, New Mexico.

Respectfully submitted,

CAMPBELL & BLACK, P.A.

By: William F. Carr

WILLIAM F. CARR
Post Office Box 2208
Santa Fe, New Mexico 87504
Telephone: (505) 988-4421

ATTORNEYS FOR BENSON-MONTIN-GREER DRILLING CORP.

INTRODUCTION WITH RESPECT TO THE APPLICATION IN CASE 9525

PURPOSE

The purpose of the application in Case 9525 is to modify well spacing regulations to eliminate certain non-standard proration units so as to permit orderly development of Canada Ojitos Unit wells - both internally and those on the south boundary - and to provide drainage protection for the Canada Ojitos Unit while avoiding the drilling of unnecessary wells.

BACKGROUND ESTABLISHING NEED FOR THE APPLICATION

During early development of the Canada Ojitos Unit, regional migration moved reservoir fluids north across the unit's south boundary. When gas injection commenced in 1968 fluid movement in this area was stabilized at minimal values.

Following production of the Schmitz Anticline #1 well in 1985, and others in this area since then, the direction of drainage reversed and the direction of flow across the boundary now is south, away from the unit.

The Unit Operator proposes to mitigate the drainage now occurring - and the potential for greater future drainage - through the drilling of wells along the south boundary.

Because of the low average per-well recovery anticipated from future wells in this area, it is essential that this development take place without drilling unncessary wells.

This, in turn, requires that, at a minimum, the existing 640-acre spacing be preserved. The non-standard proration units along the south boundary, if drilled, would likely "beg" the drilling of more wells on closer spacing. To avoid this hazard, the Unit Operator now asks that the non-standard proration units be eliminated.

SUPPORT FOR THE APPLICATION

In support of the application, the Unit Operator will show through testimony and the exhibits herein:

1. That drainage across (into) the unit's south boundary area has occurred in the past.

2. That drainage is now occurring across (away from) the unit over its south boundary; and that a high degree of potential exists for future drainage of significant amounts.

3. That the anticipated economics of future wells drilled on 640 acres is marginal; and that drilling of wells on closer spacing would be at an economic loss.

4. That wells drilled on 640-acre spacing will adequately drain the reservoir.

Common Boundary Between East & West Puerto Chiquito Mancos Pools

R1W

R1E

T 27 N

T 26 N

T 25 N

T 24 N

PROPOSED NORTH CANADA OJITOS UNIT BOUNDARY

EAST PUERTO CHIQUITO MANCOS UNIT BOUNDARY

JIC 403

JIC 404

JIC 408

JIC 200

JIC 432

CAÑADA OJITOS UNIT BOUNDARY

Boundary Of East Puerto Chiquito Mancos Pool

Boundary Of West Puerto Chiquito Mancos Pool

Non-Standard Proration Units Of Case No. 9525.

EAST AND WEST PUERTO CHIQUITO MANCOS POOLS

RIO ARRIBA CO., NEW MEXICO

Revised: Oct. 23, 1986
Revised: Feb. 11, 1986
Revised: July 1, 1985 -
Revised: Nov. 1, 1984
Revised: Sept. 27, 1983
Revised: Mar 17, 1982 1-18-89
Revised: Oct. 22, 1980 10-31-88
Revised: Oct. 8, 1980 10-7-85

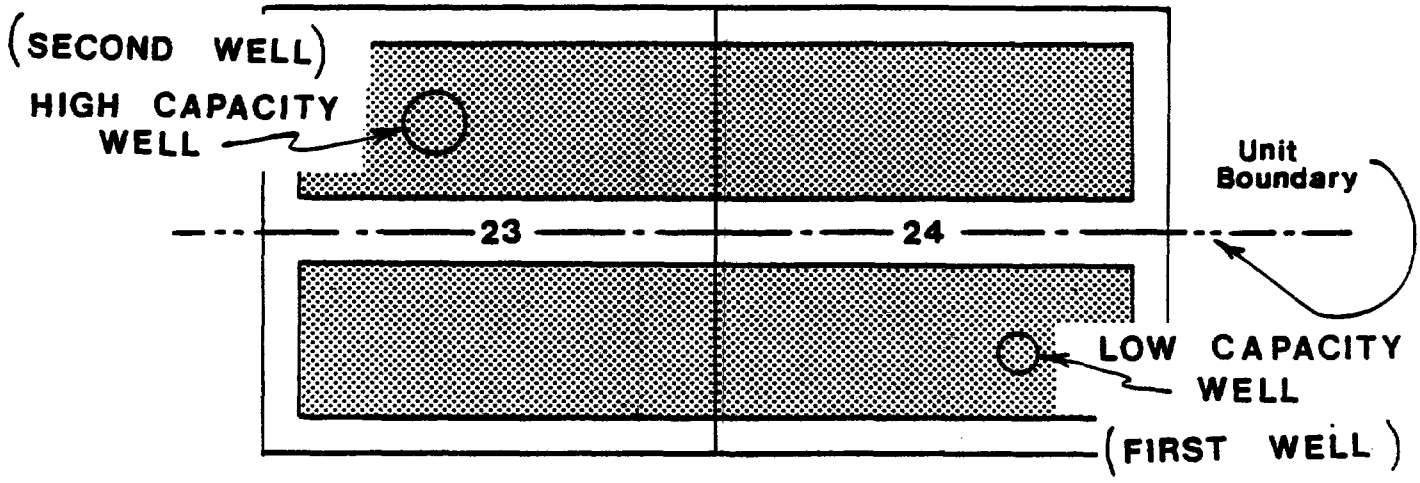
June 15, 1980

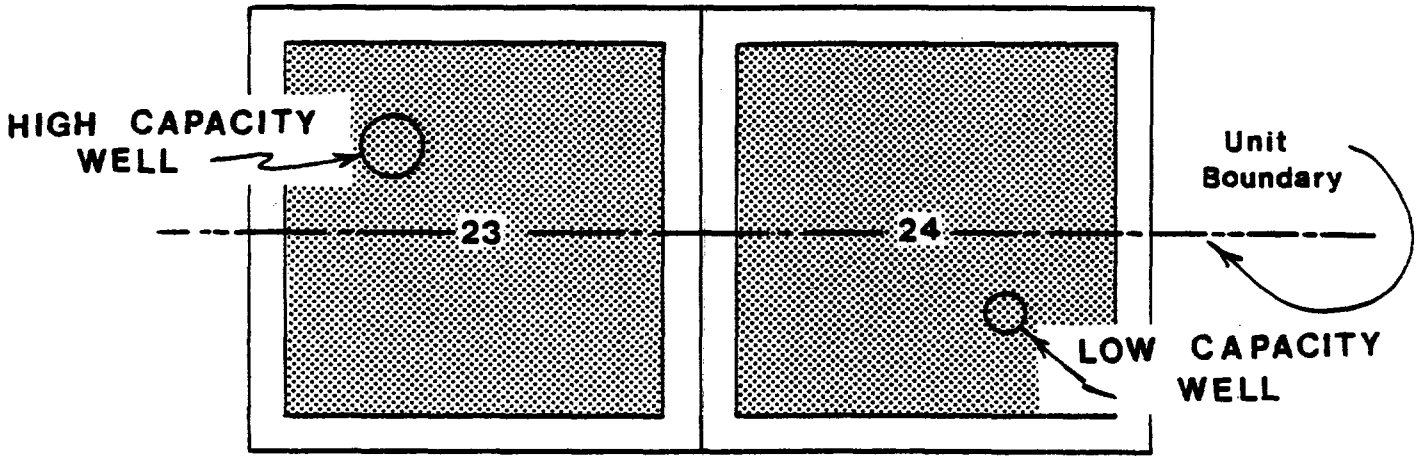
File 152A

Original 6-80 CS

MAIN PROBLEM OF THESE NON-STANDARD PRORATION UNITS IS THAT THEY BEG CLOSER SPACING.

(IN EXAMPLE BELOW, OWNERS OF SOUTH HALF-SECTIONS WOULD PROBABLY WANT TO DRILL A SECOND WELL ON THE SOUTH PRORATION UNIT TO OFFSET THE HIGH CAPACITY WELL IN THE NORTH HALF OF SECTION 23.)





STANDARD PRORATION UNITS ELIMINATE THIS PROBLEM.

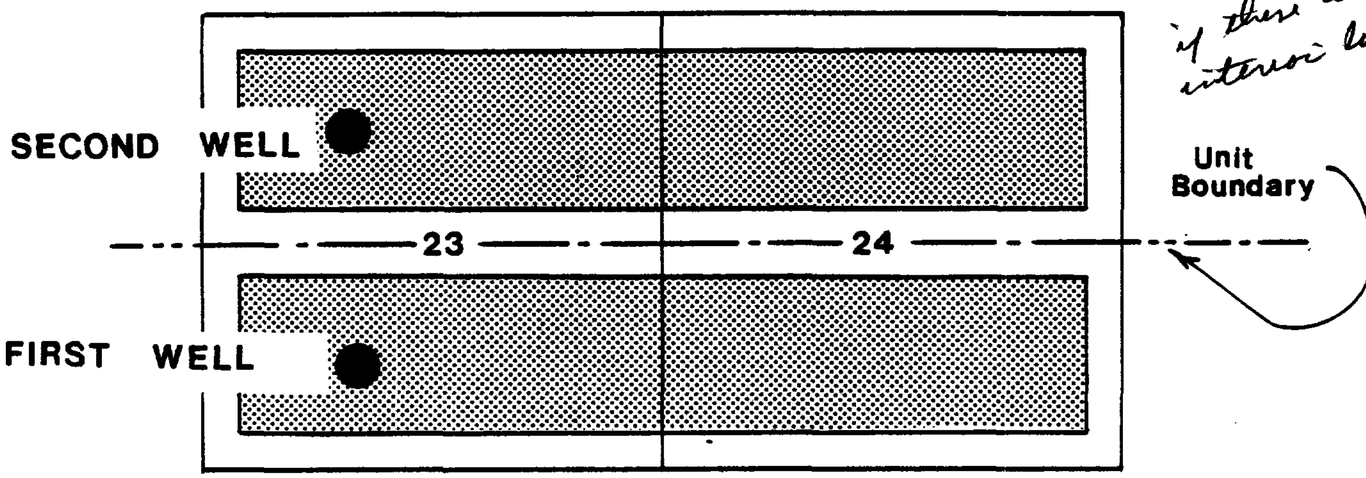
NO NEED TO DRILL UNNECESSARY WELLS FOR PARTIES NORTH AND SOUTH OF BOUNDARY TO OBTAIN THEIR FAIR SHARES OF OIL. PARTIES NORTH AND SOUTH OF BOUNDARY SHARE EQUALLY IN ALL PRODUCTION.

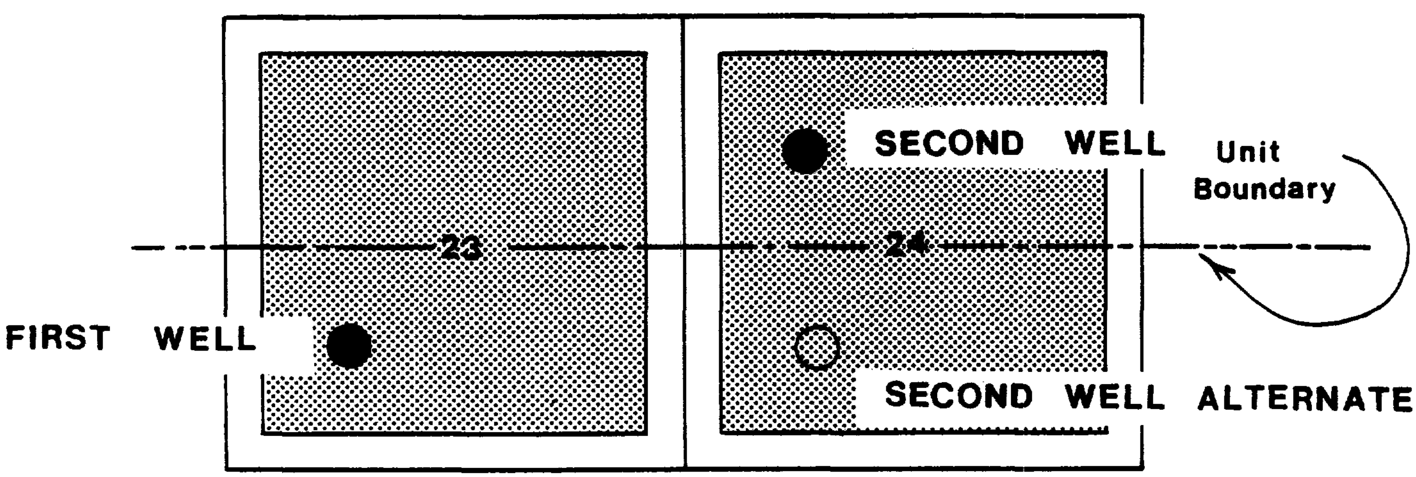
STANDARD SPACING UNITS AVOID PROBLEM OF WELLS PERHAPS BEING LOCATED LONG DISTANCES FROM PRORATION UNIT BOUNDARY AND INVITING THE DRILLING OF UNNECESSARY WELLS.

- -

TOP PANEL: TO ASSURE DRAINAGE PROTECTION FOR UNIT, THE SECOND WELL MUST DIRECTLY OFFSET THE FIRST.

what relevance if there are interior locations





THE PROBLEM IDENTIFIED IN THE UPPER PANEL IS ELIMINATED IF STANDARD PRORATION UNITS ARE UTILIZED.

REGIONAL MIGRATION
MANCOS FORMATION POOLS
EAST SIDE OF THE SAN JUAN BASIN

Regional migration has occurred in a number of areas in the Niobrara member of the Mancos formation in the east side of the San Juan Basin.

The southeast part of the West Puerto Chiquito pool is one example.

If the pressure of a newly discovered area is less than the virgin pressure, it can only be the result of migration away from that area; and clear evidence of communication.

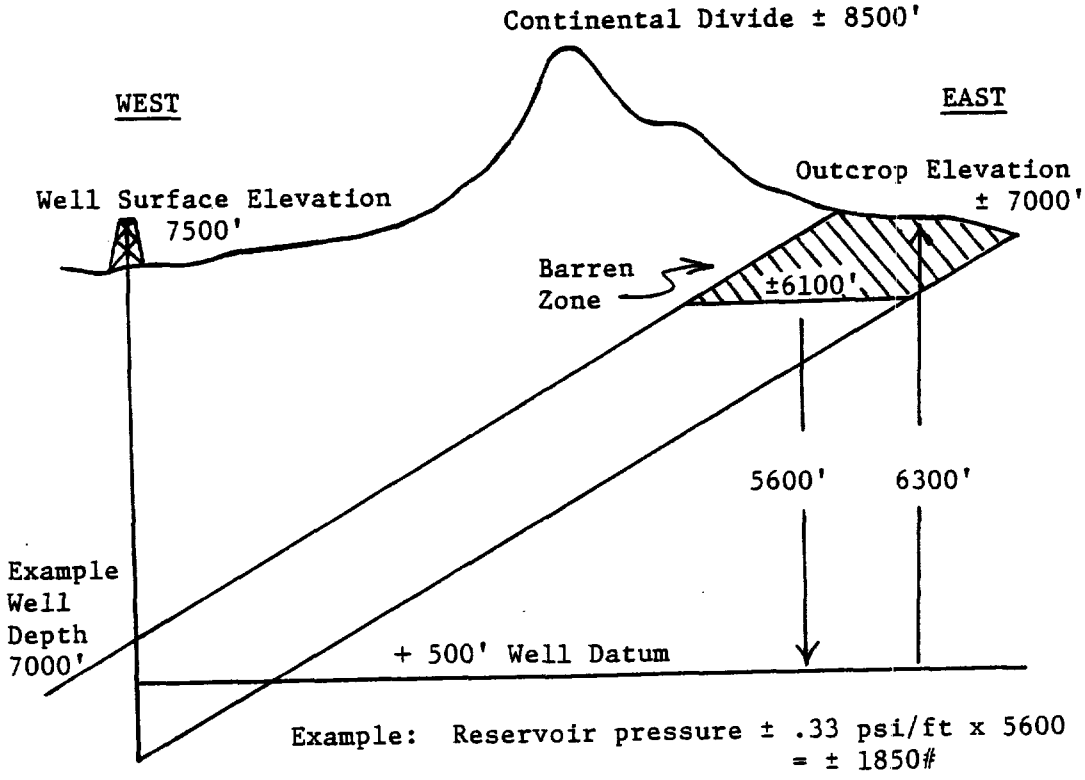
Central to an understanding of regional migration as found in a newly developed area is recognition of the area's virgin pressures; the oil's bubble point of 1520#; and the fact that a relatively small volume of oil moved from an oil zone will bring its pressure down to the bubble point.

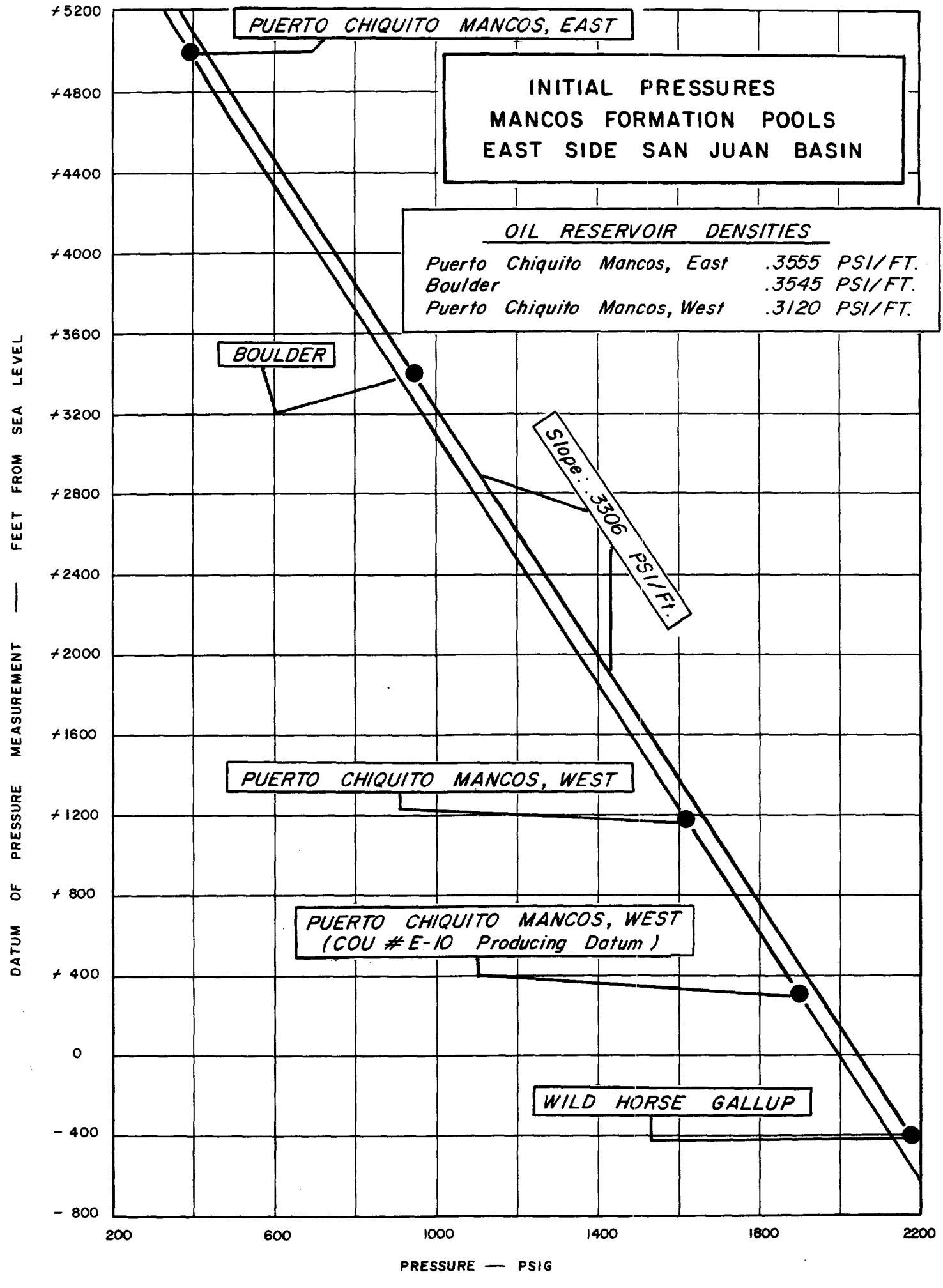
The relation of virgin pressures with depth is described on the next two pages.

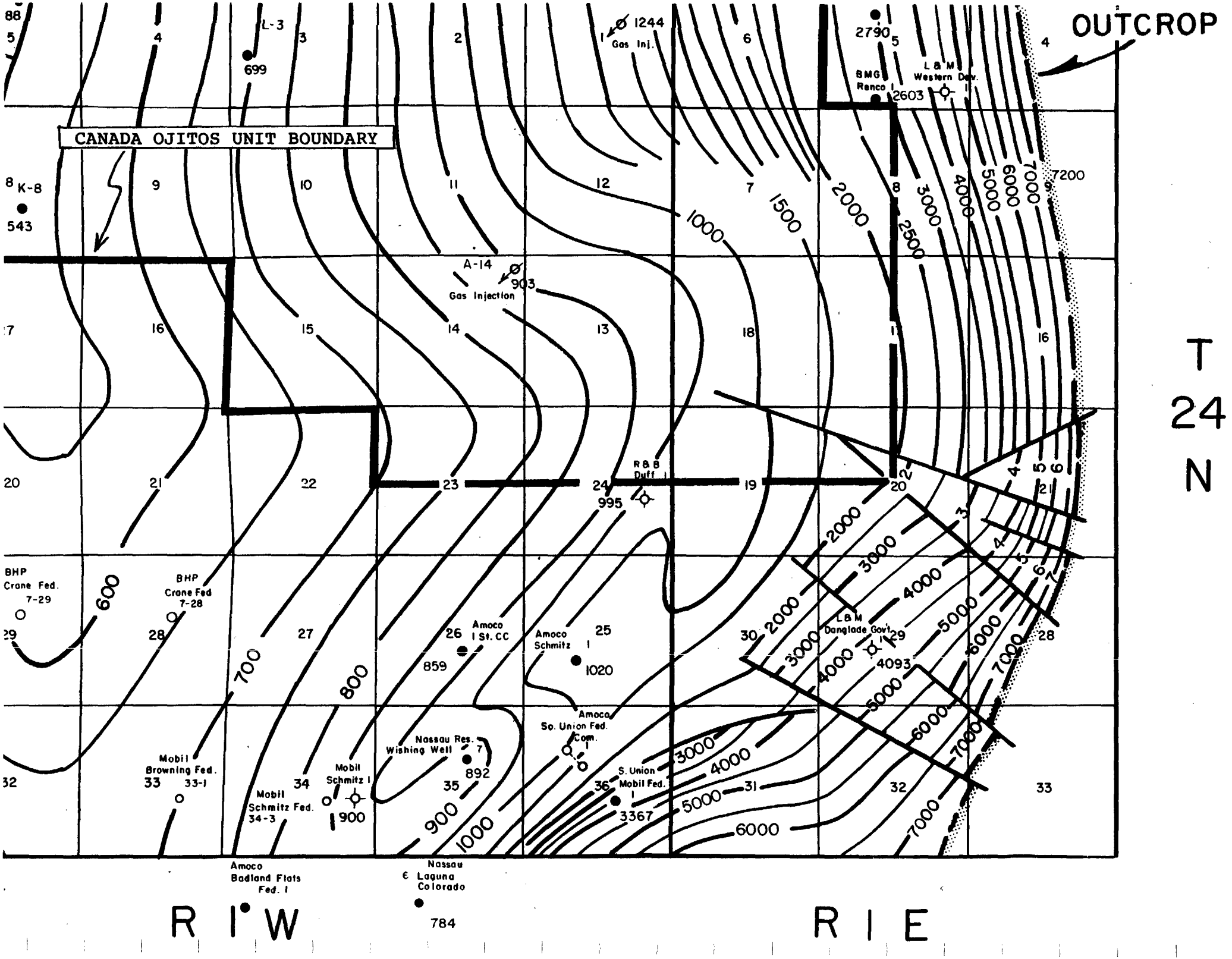
VIRGIN RESERVOIR PRESSURE
MANCOS FORMATION POOLS
EAST SIDE OF THE SAN JUAN BASIN

Although there are areas of tight zones that laterally isolate some pools from others so that no communication is perceptible during the time man produces these pools, there is nevertheless sufficient permeability in the fractured Mancos that, over geologic time, the pressures of the pools in the eastern San Juan Basin have been equalized.

In the same fashion that the pressure of a highly permeable water sand reflects the hydrostatic force as measured by the vertical distance from its outcrop on the surface, so do the pressures of the main producing zone of the Niobrara reflect the "oil static" pressure differential from the elevation of its outcrop (less 800' to 900' of apparent "barren" formation).




INITIAL PRESSURES
MANCOS FORMATION POOLS
EAST SIDE SAN JUAN BASIN
OIL RESERVOIR DENSITIES
Puerto Chiquito Mancos, East .3555 PSI/FT.
Boulder .3545 PSI/FT.
Puerto Chiquito Mancos, West .3120 PSI/FT.
PUERTO CHIQUITO MANCOS, EAST
BOULDER
Slope: .3306 PSI/Ft.
PUERTO CHIQUITO MANCOS, WEST
PUERTO CHIQUITO MANCOS, WEST
(COU # E-10 Producing Datum)
WILD HORSE GALLUP
+5200
+4800
+4400
+4000
+3600
+3200
+2800
+2400
+2000
+1600
+1200
+ 800
+ 400
0
- 400
- 800
200
600
1000
1400
1800
2200
DATUM OF PRESSURE MEASUREMENT — FEET FROM SEA LEVEL
PRESSURE — PSIG


OUTCROP
CANADA OJITOS UNIT BOUNDARY
T 24 N
R 1 W
R 1 E
L-3
699
1244
Gas Inj.
2790
BMG
Renco 1
L & M
Western Dev.
1
2603
K-8
543
A-14
903
Gas Injection
7200
R & B
Duff 1
995
BHP
Crane Fed.
7-29
BHP
Crane Fed
7-28
Amoco
1 St. CC
859
Amoco
Schmitz 1
1020
L & M
Danglade Gov't
1
4093
Amoco
So. Union Fed.
Com.
1
Nassau Res.
Wishing Well 7
892
Mobil
Browning Fed.
33-1
Mobil
Schmitz 1
900
Mobil
Schmitz Fed.
34-3
S. Union
Mobil Fed.
1
3367
Amoco
Badland Flats
Fed. 1
Nassau
& Laguna
Colorado
784
600
700
800
900
1000
1500
2000
2500
3000
4000
5000
6000
7000

REGIONAL MIGRATION
SOUTH PART OF WEST PUERTO CHIQUITO
PAGE 1

Regional migration has occurred across the south boundary of the Canada Ojitos Unit. Migration first was to the south during the 20-year period from initial development of the Canada Ojitos Unit until production south of its boundary occurred in 1985; at which time the direction of migration reversed.

On the plat on the facing page are identified wells in this area which will be referred to in the following sections.

EVIDENCE OF REGIONAL MIGRATION SOUTHEAST PART OF WEST PUERTO CHIQUITO AS SHOWN BY INITIAL PRESSURE BEING SUBSTANTIALLY LESS THAN VIRGIN PRESSURE AND BY COMPARISON OF THESE PRESSURES WITH PRESSURES IN CANADA OJITOS UNIT GAS CAP AREA NEAR SOUTH BOUNDARY

The first oil producing well in the southeast part of West Puerto Chiquito was Amoco's #1 Schmitz Anticline; put on production in 1985. Initial reservoir pressures were not measured in this well. However, initial pressure was measured in the second well, Amoco's C.C. State, in February 1988. Since the first well, the Schmitz Anticline #1 produced for two years with no drop in productivity, its pressure in February 1988 can be expected to be about the same as its initial pressure. There may be other reasons that caused no decline in production of this well - but they would have to be unusual. Moreover, the production-pressure decline coefficient for this area, as shown by the May to September production and pressure decline was approximately 1000 reservoir barrels per pound. So at the outset, its production could have accounted for only 80# of reservoir pressure decline: leaving the initial pressure 300# or so less than virgin.

Accordingly, the February 1988 pressure in the C.C. State is representative of the initial pressure in this area.

Supporting data for the initial pressure in this area in the spring of 1988 is a pressure survey on the third well, Nassau Resources Wishing Well 35-7 taken in May 1988. Prior to this build-up survey (well shut in May 10, 1988 at 1:26 P.M.) the C.C. State had been shut in for about 40 days; and so would have had a minimum interference effect on the build-up of the Wishing Well. Extrapolation of the Wishing Well survey on a Horner plot to Horner P* shows a pressure of 1458 psig when adjusted to the same datum as the C.C. State's 1460#. (Details of this pressure survey are shown later herein.) Since the P* pressure would be the maximum possible for the Wishing Well, the initial pressure of 1460# in the C.C. State is supported as being reasonably accurate; certainly within a few pounds of the true initial pressure in the area.

In September 1988 all wells in the area were shut in and pressures measured. At that time the pressures of the Schmitz Anticline #1 and the Wishing Well were essentially equalized; and the Wishing Well has been shown to be in close communication with the C.C. State. It follows then, that the February pressure in the C.C. State well can be relied upon as being about the same as the Schmitz Anticline, the first well in the area.

Accordingly, the pressure in this area when first drilled at the Schmitz Anticline was 350# to 400# less than virgin pressure: this drop in pressure from that of virgin conditions was caused by migration to the lower pressure Canada Ojitos Unit.

Some of the statistics are on the facing page; and the succeeding two pages show the relation of the gas cap pressure to that of the C.C. State and virgin pressure for the subject range of reservoir datum depths.

EVIDENCE OF REGIONAL MIGRATION SOUTHEAST PART OF WEST PUERTO CHIQUITO AS SHOWN BY INITIAL PRESSURE BEING SUBSTANTIALLY LESS THAN VIRGIN PRESSURE AND BY COMPARISON OF THESE PRESSURES WITH PRESSURES IN CANADA OJITOS UNIT GAS CAP AREA NEAR SOUTH BOUNDARY

Depending upon the distribution of injection to the various injection wells and shut in times in effect, the injection well pressure of the A-14 (T-24N, R-1W) in 1987 and 1988 has been in the range of 1400# to 1600#. Average gas cap pressure at distances of a mile or so from the A-14 are estimated to be in the range of 1400# to 1450# during this time. Comparison of some of these pressures with the initial pressure in Amoco's C.C. State is set out below.

Measured pressures inthe A-14 during OCD-ordered tests of November 1987 and February 1988 show the following (reference NMOCC Case 9111, March 17, 1988, B-M-G Exhibit 1, Section F, Page 6 and Section G, Page 11):

	COU A-14 INJECTION WELL				AMOCO ** C.C. STATE
			Calculated BHP		
Date	Days Shut In	Surface Pressure at Surface Elevation 7130' (psig)	At 6416-44' (C zone) Datum +678'	Adjusted to Datum of +617'*	2-15-88 @ 6687' (617')
11/28/87	12	1167.5	1407	1409	1460
2/23/88	21	1178	1421	1423	

Significant here is not only the fact that the initial pressure in the C.C. State well is approximately the same as in the Canada Ojitos Unit gas cap but also the fact that it is over 300# less than virgin pressure.

---

* Using gas gradient (to adjust to same datum as pressure measured in C.C. State).

** Initial pressure of C zone in Amoco C.C. State (when it was the only zone open to production in this well) reported to Oil Conservation Division was 1460#. Depth was 6687' (top of C zone 6670', perforations 6662' to 6736'). Reference: Transcript of Case 9451, Gary Johnson testimony on page 60; Richard Jones testimony Page 140. Mr. Jones made a "rough" adjustment to a datum of +750' for his exhibits; but the C zone pressure at the C.C. State on 2-15-88 at a depth of 6687' (+617') was 1460#.

EVIDENCE OF REGIONAL MIGRATION SOUTHEAST PART OF WEST PUERTO CHIQUITO
AS SHOWN BY
INITIAL PRESSURE BEING SUBSTANTIALLY LESS THAN VIRGIN PRESSURE
AND BY
COMPARISON OF THESE PRESSURES WITH
PRESSURES IN CANADA OJITOS UNIT GAS CAP AREA NEAR SOUTH BOUNDARY
PAGE 4

The initial pressure of the Amoco C.C. State February 15, 1988 was 350 to 400 psi below virgin* pressure for this area.

Just as significantly it was essentially equalized with the gas cap pressure of the adjoining Canada Ojitos Unit.

Although gas is injected only in the C zone in the Canada Ojitos Unit A-14 (injection well closest to the C.C. State), and the C.C. State was completed only in the C zone when the pressure was run February 15, 1988; it is probable that - as in other parts of West Puerto Chiquito - the zones, reservoir-wide, are equalized.

Since at the time of the C.C. State pressure, February 1988, the mobile fluid in the area around the A-14 injection well was gas, and that around the C.C. State and Schmitz Anticline was oil, a different reservoir gradient (pressure versus depth) existed in the two areas.

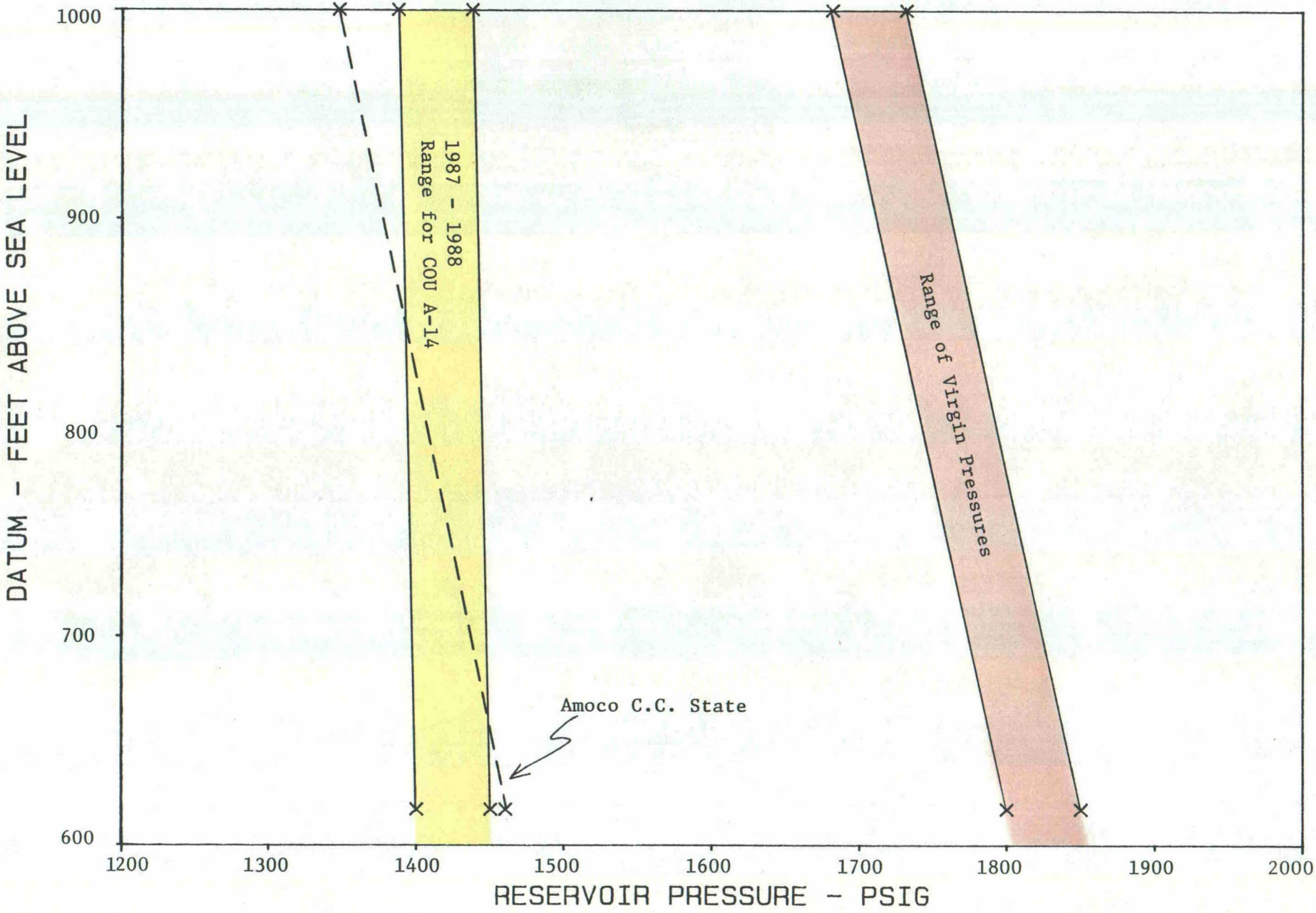
These different pressures at different depths** (result of reservoir fluid gradients) are put in perspective by showing pressures versus reservoir datum depths on the graph on the facing page. Note here the close relationship of pressures - particularly in the C zone (lower part of the graph) - between the C.C. State and the Canada Ojitos Unit gas cap area; as well as the distinct difference of these pressures from virgin pressures at all datum depths.

---

* In transcript of NMOCD Case 9451 August 3, 1988, pages 158 and 159, Amoco's witness, Richard Jones, in response to questioning by Mr. Chavez, noted that exhibits in "all of the Gavilan hearings" stated the virgin pressure to be something around 1800# to 1900#. Mr. Jones did not offer disagreement with this value for virgin pressure.

** The vertical distance of the communicating reservoirs is that from the depth of pressure measurement in the C zone in the State C.C. and the top of the anticline in the Schmitz Anticline (+1020').

PRESSURE COMPARISONS
SOUTHEAST PART OF WEST PUERTO CHIQUITO MANCOS POOL
FEBRUARY 15, 1988



DISPLACEMENT OF THE ATTIC OIL OF THE SCHMITZ ANTICLINE

Given adequate permeability, attic oil such as occupies the Schmitz Anticline, can - under certain conditions - be displaced from its structurally high position by downdip gas injection, as noted by Craft and Hawkins (reference the following three pages).

Applied

PETROLEUM RESERVOIR ENGINEERING

B. C. CRAFT

and

M. F. HAWKINS

Petroleum Engineering Department
Louisiana State University

PRENTICE-HALL, INC.

Englewood Cliffs, N. J. *1959*

$$\text{Recovery} = \frac{\text{Area } B}{\text{Area } A + \text{Area } B} = \frac{32.5}{4.7 + 32.5} = 0.874 \text{ or } 87.4 \text{ per cent}$$

If the gravity segregation had been half as effective, the recovery would have been about 60 per cent; and without gravity segregation, the recovery would have been only 24 per cent. These recoveries are expressed as per cents of the *recoverable oil*. In terms of the *initial oil* in place the recoveries are only 60 per cent as large, or 52.4, 36.0, and 14.4 per cent, respectively. Welge,[2] Shreve and Welch,[3] Kern,[4] and others have extended the concepts presented here to the prediction of gas-oil ratios, production rates, and cumulative recoveries, including the treatment of production from wells which are behind the displacement front. Smith[5] has used the magnitude of the gravity term $[(k_o/\mu_o)(\rho_o - \rho_g) \sin \alpha]$ as a criterion for determining those reservoirs where gravity segregation is likely to be of considerable importance. The data of Table 7.3 indicate that this gravity term must have a value above about 10, in the units used, to be effective. An inspection of Eq. (7.21), however, shows that the throughput velocity (q_t/A) is also of primary importance.

One interesting application of gravity segregation is to the recovery of updip or "attic" oil in active water-drive reservoirs possessing good gravity segregation characteristics. When the structurally highest well(s) has gone to water production, high pressure gas is injected for a period. This gas migrates updip and displaces the oil downdip where it may be produced from the same well in which the gas was injected. The injected gas is, of course, unrecoverable.

It appears from the previous discussions and examples that water is *generally* more efficient than gas in displacing oil from reservoir rocks, mainly because (a) the water viscosity is of the order of 50 times the gas viscosity and (b) the water occupies the less conductive portions of the pore spaces, whereas the gas occupies the more conductive portions. Thus in water displacement the oil is left to the central and more conductive portions of the pore channels, whereas in gas displacement the gas invades and occupies the more conductive portions first, leaving the oil and water to the less conductive portions. What has been said of water displacement is true for preferentially *water wet* (hydrophilic) rock, which is the case of most reservoir rocks. Where the rock is preferentially *oil wet* (hydrophobic), the displacing water will invade the more conductive portions first, just as gas does, resulting in lower displacement efficiencies. In this case the efficiency by water still exceeds that by gas because of the viscosity advantage the water has over the gas.

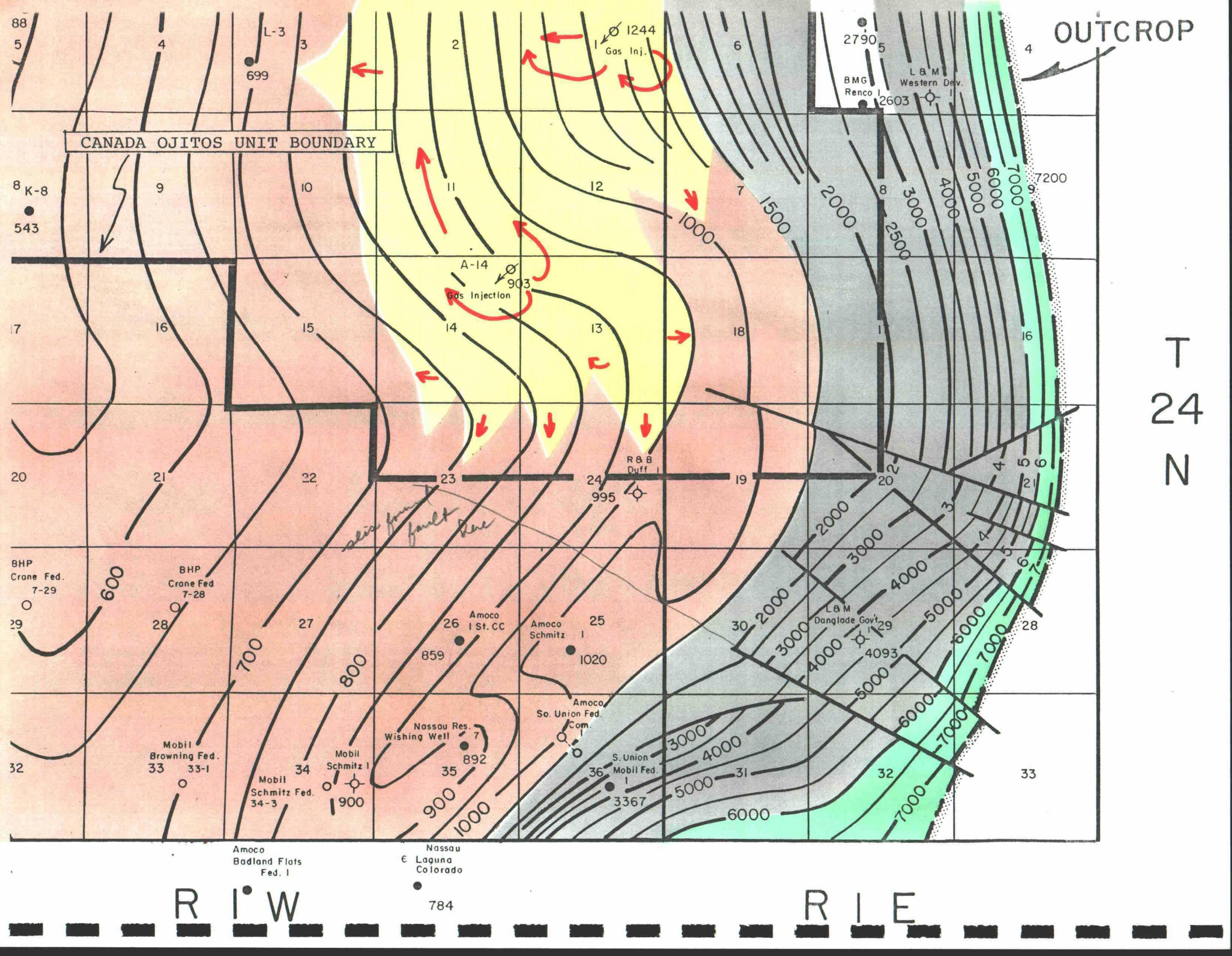
In the displacements discussed in the previous paragraph the distribution of the fluids (gas, oil, and water) in the pore spaces at any set of fluid saturations is determined (a) by the wettability characteristics of the rock, i.e., whether hydrophilic, hydrophobic, or mixed, and (b) by the surface or

obtained with the regular five-spot network; and Matthews and Fischer[45] have used a fluid mapper to study this same problem. [redacted]

Gas-condensate reservoirs are cycled to increase the rate of recovery and/or the ultimate recovery of the liquid products which are vaporized in the gas-condensate fluid. They may be cycled to offset retrograde losses or to recover sooner the liquids where the gas production is limited by demand or some other reason. Where the gas is in contact with an oil zone under active water drive, the oil recovery will be reduced if the gas is produced and the oil invades the gas zone. For example, if the initial oil saturation in the oil zone is 75 per cent, and the residual oil saturation is 25 per cent, if the gas cap contracts so that the oil moves through a volume twice its initial volume, leaving 25 per cent residual oil in each volume, the oil recovery will be zero. In volumetric reservoirs, too, the oil recovery is reduced if the gas cap is produced prior to or along with the oil zone. In these cases, cycling may be used to recover the liquids from the gas-condensate fluid, along with the oil, and when the oil reserve is depleted, then the gas cap may be "blown down" or depleted.

The sweep efficiencies of cycling programs have been studied using models, generally the potentiometric model. Usually a number of studies is made on each reservoir to find the injection and production rates in existing and proposed wells which will give the highest sweep efficiency. Simultaneously the studies are used to plan the operations so that the cycling (gasoline or liquid recovery) plant will operate at full designed capacity up to the cessation of cycling. This means that the dry gas front should break through in all of the production wells at approximately the same time. In the case of multiple reservoirs the design of a program becomes quite complex. In addition, premature breakthrough in some wells may require additional studies to change the program in the light of information discovered during the cycling.

Figure 7.33 shows the results of a potentiometric model study on the gas-condensate reservoir of the Bearden Field superimposed on an isopachous map. The flow lines (arrows) have been drawn from the injection wells, Nos. 1 and 2, to the production wells, Nos. 3, 4, and 5, perpendicular to the isopotential lines. The dry gas front appears to break through into the producing wells almost simultaneously, and the position of the front was obtained exactly as the fronts were obtained in Table 7.9. The sweep efficiency is obtained by planimetering the reservoir *volume* within the swept area. Example 7.2 shows the type of calculations which are made in a cycling study using the results of model work. Marshall and Oliver[47] have reported on the uses and limitations of model studies in cycling.


OUTCROP
CANADA OJITOS UNIT BOUNDARY
T 24 N
R 1 W
R 1 E
L-3
699
1244
Gas Inj.
2790
BMG Renco 1
2603
L & M Western Dev. 1
K-8
543
A-14
903
Gas Injection
R & B Duff 1
995
BHP Crane Fed. 7-29
BHP Crane Fed 7-28
Amoco 1 St. CC
859
Amoco Schmitz 1
1020
L & M Danglade Govt. 1
4093
Amoco So. Union Fed. Com. 1
Nassau Res. Wishing Well 7
892
Mobil Browning Fed. 33-1
Mobil Schmitz 1
900
Mobil Schmitz Fed. 34-3
S. Union Mobil Fed. 1
3367
Amoco Badland Flats Fed. 1
Nassau & Laguna Colorado
784
7200
600
700
800
900
1000
1500
2000
2500
3000
4000
5000
6000
7000

DISPLACEMENT OF ATTIC OIL OF THE SCHMITZ ANTICLINE #1

With respect to the Canada Ojitos Unit A-14 injection well, oil in the Schmitz Anticline #1 is "attic oil". However, this attic oil of the Schmitz Anticline #1 cannot be moved by gravity displacement from downdip gas injection in the Canada Ojitos Unit A-14 because the permeability in this area appears to be too low.

Accordingly, in the area between the tight block in which the A-14 injects and the Schmitz Anticline #1, gas does not displace oil by gravity segregation as in typical attic oil recovery processes. As a consequence, it is to be expected that the injected gas will not, by gravity differences, move rapidly updip; and so will not affect the initial production - particularly the GOR - of the Schmitz Anticline #1 well.

Oil which is moved toward the Schmitz Anticline area as a consequence of gas injection in the A-14 well is displacement by "gas drive" rather than displacement by gravity segregation. It is anticipated that gas drive here will operate initially with a "piston" action forcing oil ahead of it until gas break-through occurs.

Significant displacement by gas will not occur in a given direction until withdrawal from that direction creates reservoir voidage.

The subject affected areas are shown schematically on the facing page.

Also shown on the plat, distinguished by color, are areas which have basic differences in reservoir characteristic of rock and fluid properties. (Pattern of gas flow is shown by red arrows.)

Brown area: Oil saturated: permeability may be adequate to allow commercial production.

Gray area: Oil and high GOR oil area: this area generally exhibits uniformly steep dip which results in compact, exceptionally tight reservoir rock: too tight for commercial production except for occasional areas of flex. This gray is the east boundary of the West Puerto Chiquito pool and is essentially non-productive (for the most part not a good place to drill for oil). (Because of this the small producer, Southern Union Mobil Federal in the SE/4 of Section 36, Township 24 North, Range 1 West, was removed from the West Puerto Chiquito pool years ago. Amoco has not released initial production tests on its well in the NE/4 of this section but as can be seen from the plat, it is bottomed in the "gray" area, and can be expected to have the same minimal productivity.)

Green area: Barren zone between oil saturated area and outcrop.

Yellow area: Gas invaded area.

(The tight block around the A-14 is more specifically described later herein.)

EVIDENCE OF GAS DRIVE
AND POTENTIAL FOR FUTURE INCREASES IN DRAINAGE FROM THE CANADA OJITOS UNIT
AS SHOWN BY
PRESSURE FALL-OFF CURVES IN THE CANADA OJITOS UNIT INJECTION WELL A-14 (24N-1W)

The 15-year history of gas injection in the Canada Ojitos Unit A-14 demonstrates gas drive displacement of oil from tight reservoir rock and underscores the possibility of increases in future drainage from the Canada Ojitos Unit.

As gas drives oil from the tight rock around the A-14 injection well and reduces the oil saturation, the permeability to gas increases.

Pressure fall-off tests conducted on this well show how the permeability to gas has increased over time and with injection - clear evidence of effective displacement of oil by gas drive.

When the gas reaches higher capacity areas in the reservoir, then the process becomes gravity displacement with its higher recovery efficiency.

This increase in gas permeability with time - evidence of continuing reduction in oil saturation - is defined by the pressure fall-off tests shown on the facing page. Here surface pressures are plotted against shut-in time. Values of the slope, m, are determined from the straight line sections of the curves identified by the year of the test.

Concurrent bottom hole pressures and approximate transmissibility values are set out in the table below.

Attention is called to the increasing value of Kh/u with time and increasing cumulative gas injection.

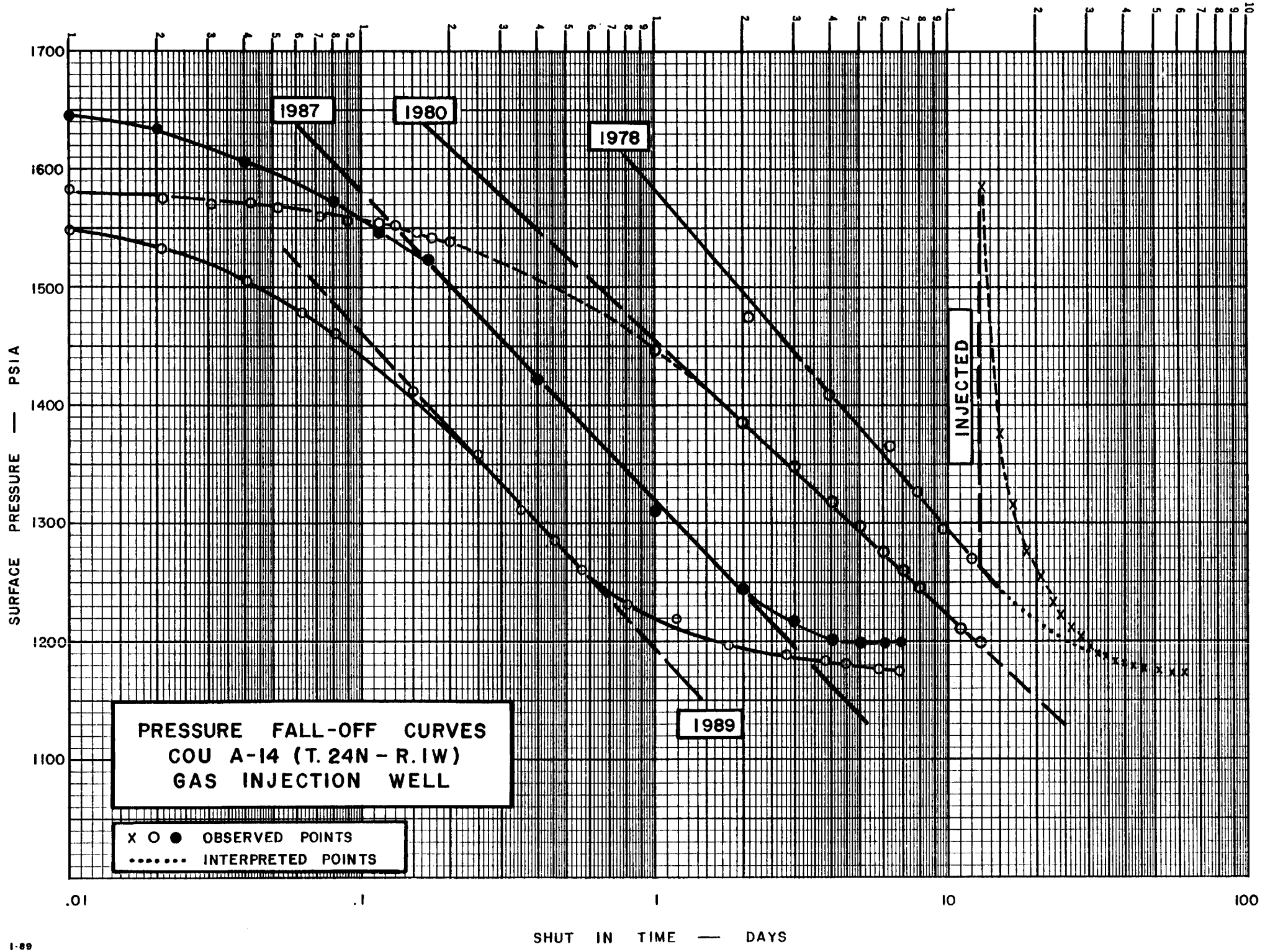
Test Date	Injection Rate Prior to Test (MCF/D)	Slope, m, from plat: Surface Pressure (#/Cycle)	Slope, m, from plat: Bottom Hole Pressure (#/Cycle)	Kh/u *	Kgh **
July 1978	100	290	350	.071	.0012
Nov. 1980	100	235	285	.087	.0015
Nov. 1987	700	265	320	.544	.0092
Jan. 1989	950	265	320	.884	.015

* Kh/u = QTZ/1.22 m (Pavg)
** Kgh = $\pm$ QuTZ/1.22 m (Pavg)

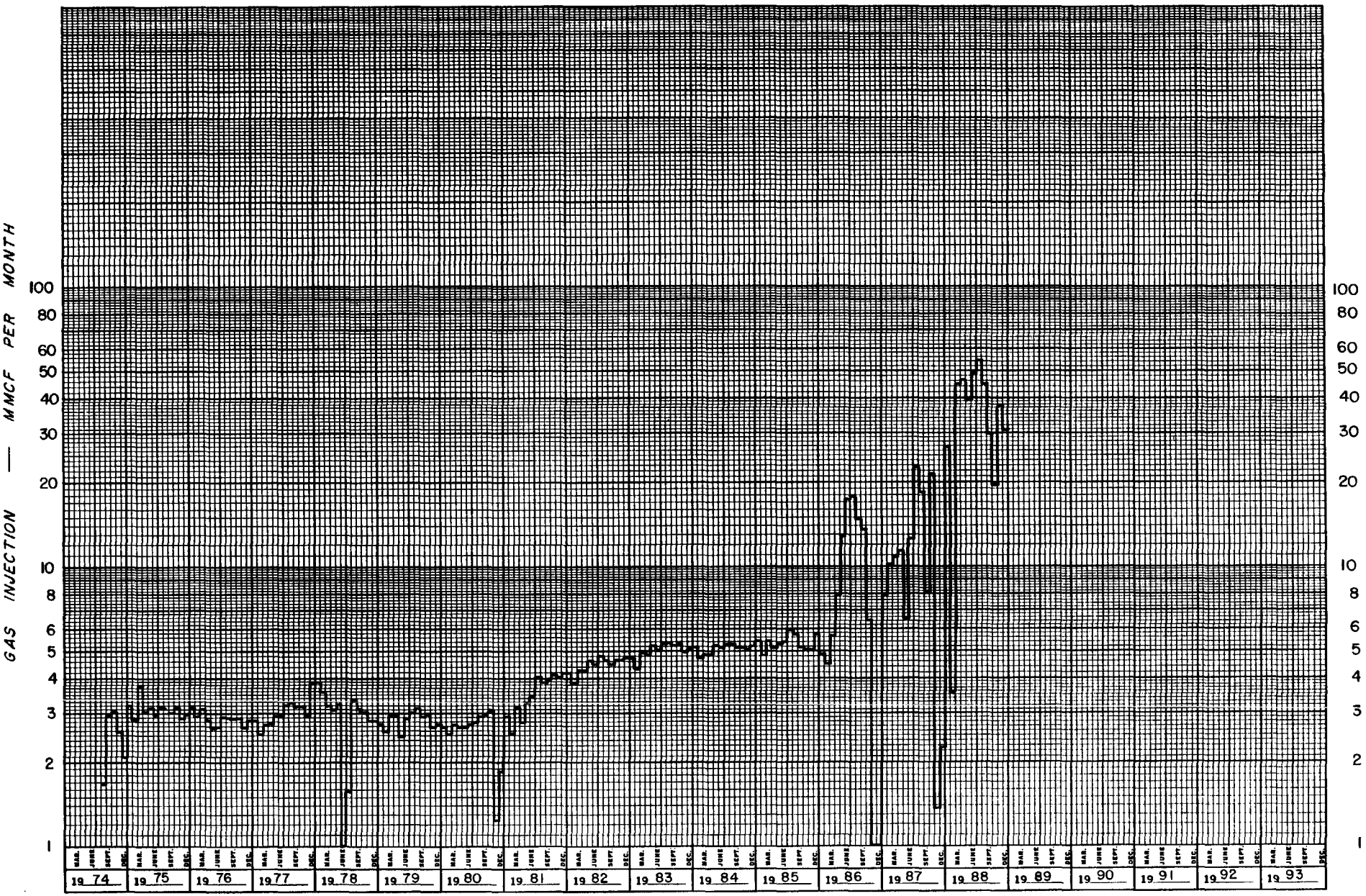
Q = SMCF/D at 14.7 and 60 degrees

P, T, Z, u: at reservoir conditions
m = slope, #/log cycle

Values here:
Pavg = $\pm$ (1900 + 1450)/2 = 1675
T = 160 degrees F = 620 degrees R
Z = .82
u = .017 cp


1700
1600
1500
1400
1300
1200
1100
SURFACE PRESSURE — PSIA
1987
1980
1978
1989
INJECTED
PRESSURE FALL-OFF CURVES
COU A-14 (T. 24N - R. 1W)
GAS INJECTION WELL
X O ● OBSERVED POINTS
••••••• INTERPRETED POINTS
.01
.1
1
10
100
SHUT IN TIME — DAYS

1-89



COU A-14 (T.24N, R.1W) INJECTION WELL

EVIDENCE OF GAS DRIVE
AND POTENTIAL FOR FUTURE INCREASES IN DRAINAGE FROM THE CANADA OJITOS UNIT
AS SHOWN BY
GAS VOLUMES INJECTED IN THE
CANADA OJITOS UNIT A-14 (T-24N, R-1W) INJECTION WELL

As can be inferred from the preceding analysis of increased permeability to gas with time, the A-14's injectivity has increased.

Plot of gas injection in this well with time is shown on the graph on the facing page. Months of low gas injection since 1986 represent periods when some gas was marketed, as opposed to being injected.

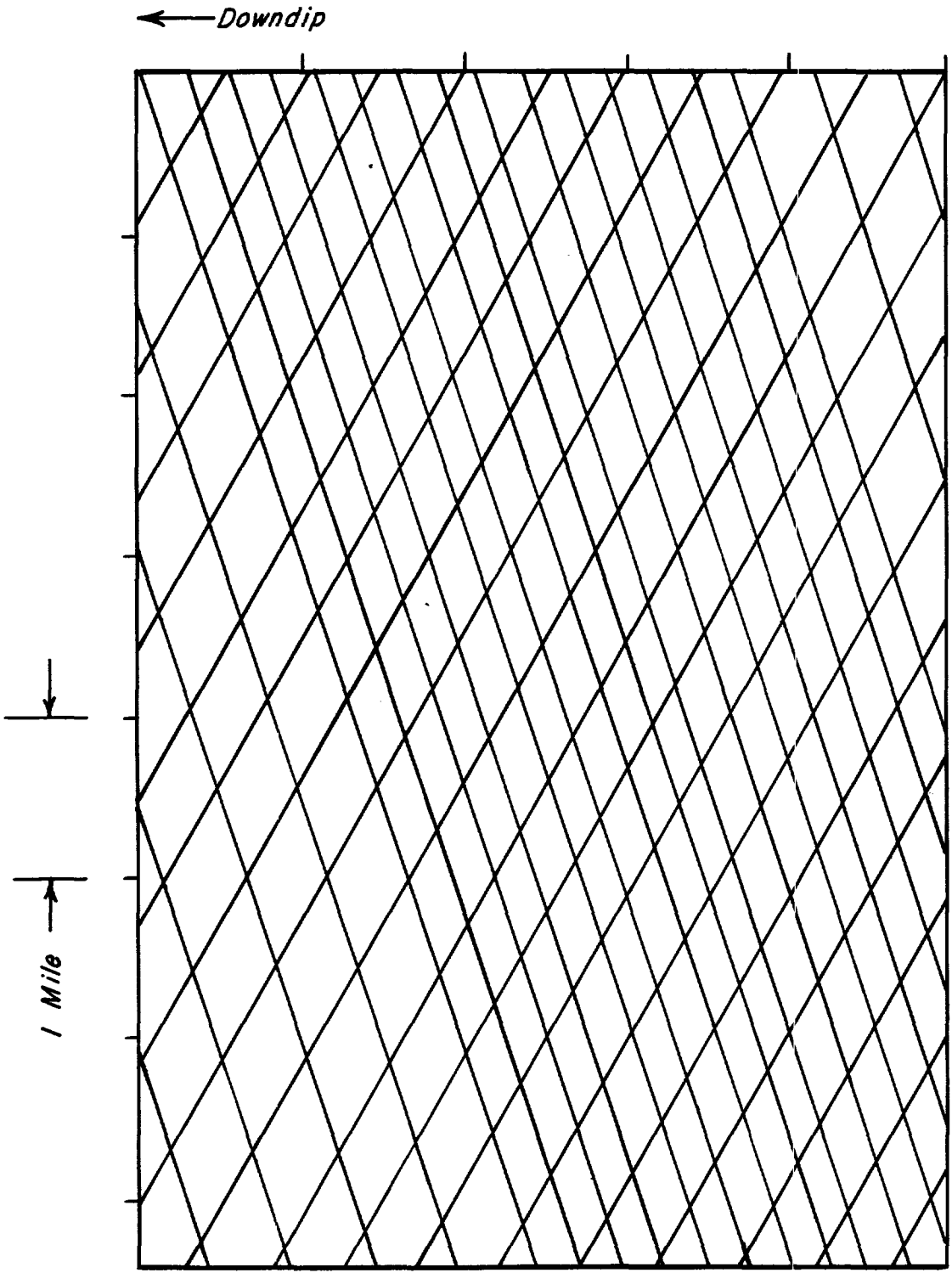
It is interesting to note that despite the low permeability of the tight fracture block in which this well is completed, it has made a good injector: as much as 3,000 barrels of reservoir space per day has been injected in this well; and the cumulative reservoir volume injected exceeds 2,000,000 barrels.

To place this 2,000,000 barrels of reservoir space in perspective, we note that the nearby Gavilan pool has produced a little over 4,000,000 barrels of oil.

The increase in injectivity in this Canada Ojitos Unit A-14 well underscores the potential for increased movement of gas across the unit's south boundry as oil is displaced and the permeability to gas increases.

As oil is produced south of the Canada Ojitos Unit boundary, gas will move to displace it; and just as the injectivity increased in the Canada Ojitos Unit A-14, the high mobility of the gas will cause greater and greater volumes to move south - hence the need for the unit to drill protection wells.

SCHEMATIC FRACTURE SYSTEM
Fracture Blocks ± 80 Ac. & 160 Ac.



SIZE OF FRACTURE BLOCKS AROUND CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

The main producing reservoir of the West Puerto Chiquito pool which lies within the Canada Ojitos Unit comprises a system of fracture blocks believed to be in the range of 20 to 200 acres. The poorer parts of the reservoir may have fracture blocks of larger sizes. The blocks are joined by an interconnecting high capacity fracture system.

Others who have testified with respect to Niobrara pools in this area have suggested that the reservoir might be of dual porosity type; however the production and pressure data do not support this premise. The only reservoir geometry that can be satisfied by the pressure and production tests is the fracture block system described above and shown schematically on the plat on the facing page.

For a well producing from a fracture block - since the high capacity fracture system has a relatively high transmissibility compared to that of the tight fracture block - the flow system is essentially that of "constant pressure at the boundary" for any time in the depletion history. For those parts of the reservoir where pressure is maintained by gas injection, the system is exactly that of constant pressure at the boundary.

For given values of pore volume (ϕh) the minimum size of the fracture block for the Canada Ojitos Unit A-14 injection well is determined as shown on the following pages.

SIZE OF FRACTURE BLOCK
OF THE CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

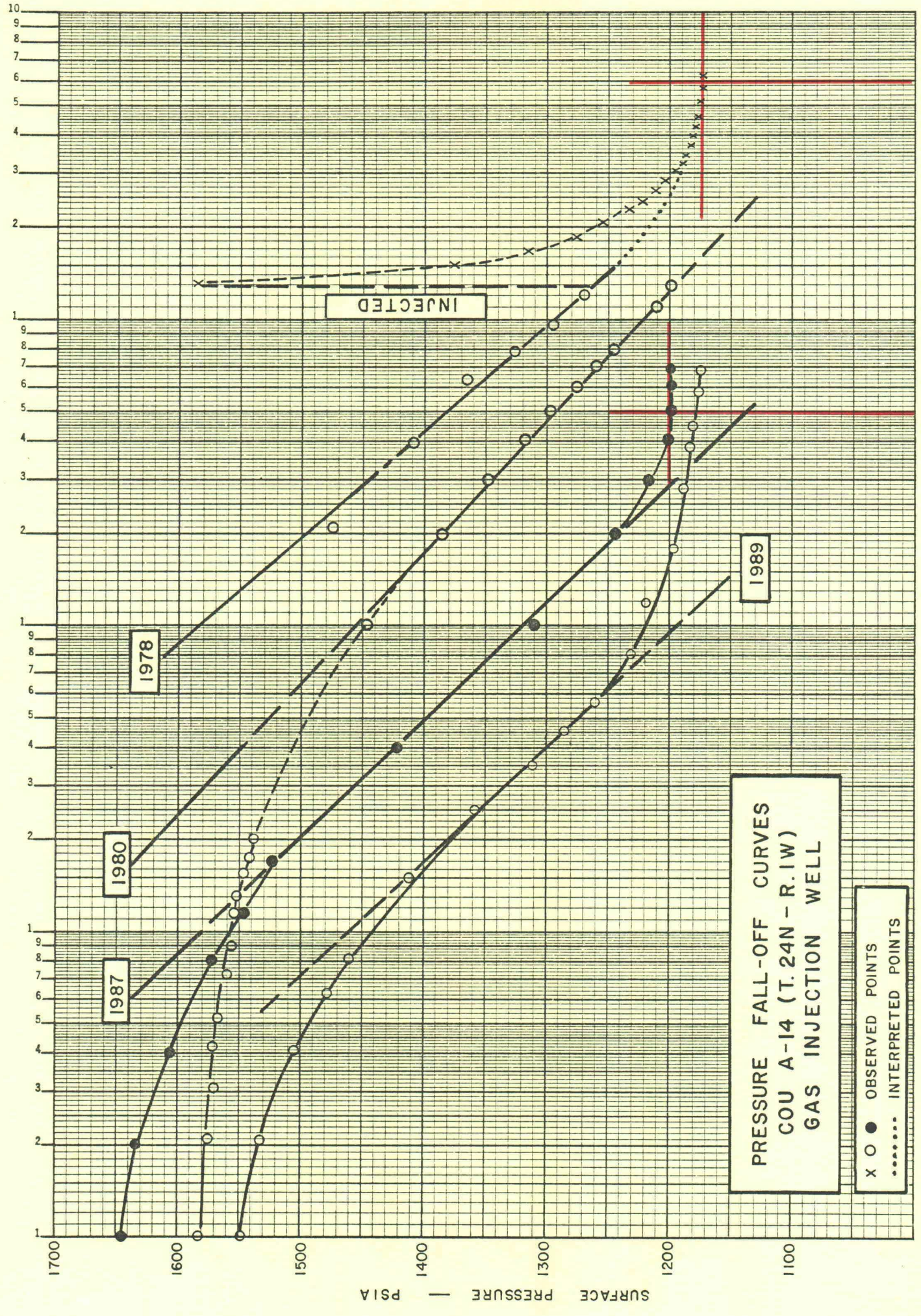
An approximation can be made of the minimum size (through minimum distance from wellbore to edge of fracture block) of the fracture block in which the A-14 is injecting if one knows the time required to reach steady state conditions and the concurrent diffusivity constant.

The times to reach steady state conditions for the 1978 and 1987 tests are shown on the graph on the facing page by the red lines.

The diffusivity constant can be calculated from measured transmissibilty and assumed value for pore volume by the method shown in NMOCC Case 9111, June 13, 1988, B-M-G Exhibit 1, Section H.

No interference test is available to measure directly the pore volume in this area; so the calculations are made for a range of pore volumes, the range being consistent with the measured transmissibility values and experience with testing in other parts of the reservoir.

Calculations for distance from well to edge of fracture block are shown on the following page, along with graph showing this distance as dependent on pore volume expressed as barrels per acre of stock tank oil in place.


PRESSURE FALL-OFF CURVES
COU A-14 (T. 24N - R. 1W)
GAS INJECTION WELL
X O ● OBSERVED POINTS
..... INTERPRETED POINTS
INJECTED
1978
1980
1987
1989
SURFACE PRESSURE — PSIA
SHUT IN TIME — DAYS
60 days
5 days
1-89

CALCULATION OF MINIMUM SIZE OF FRACTURE BLOCK
CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

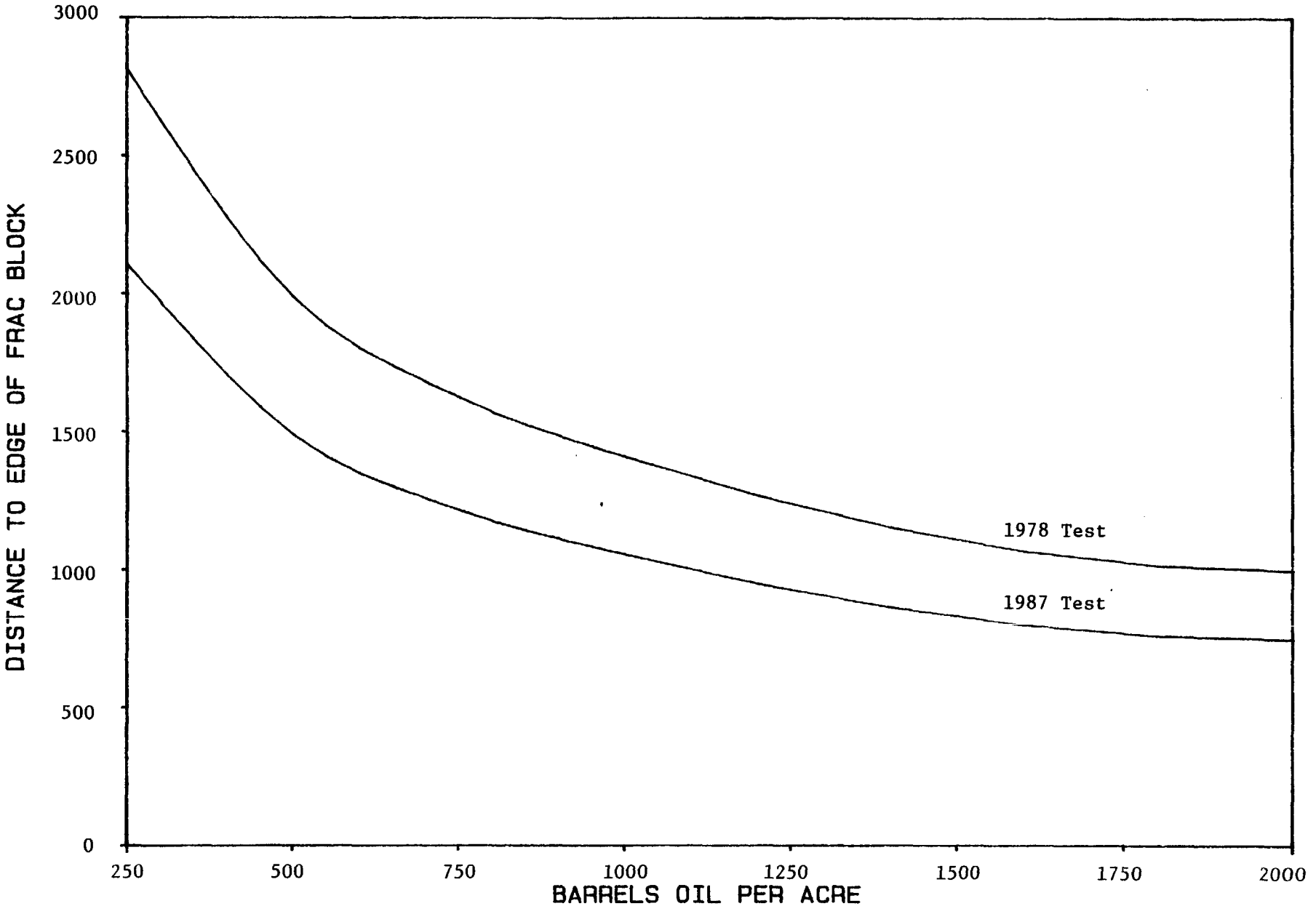
Test (1)	Transmissibility Kh/u (2)	Assumed Sg (3)	CT Vol/Vol/# (4)	Time to Reach Steady State (Days) (5)	Pore Volume Assumed øh (6)	Pore Volume Assumed H.C. S.T. Bbl/Acre (7)	n (8)	$r = \sqrt{4\,n\,t}$ (9)
1978	.071	1%	325×10^{-6}	60	.335	2000	4.13×10^{3}	996
				60	.167	1000	8.28×10^{3}	1410
				60	.084	500	1.65×10^{4}	1990
				60	.042	250	3.29×10^{4}	2810
1987	.544	10%	370×10^{-6}	5	.335	2000	2.78×10^{4}	746
				5	.167	1000	5.57×10^{4}	1056
				5	.084	500	1.11×10^{5}	1490
				5	.042	250	2.22×10^{5}	2107

The above information is summarized by a plot, shown on the facing page, of the figures in Column 7 versus those in Column 9.

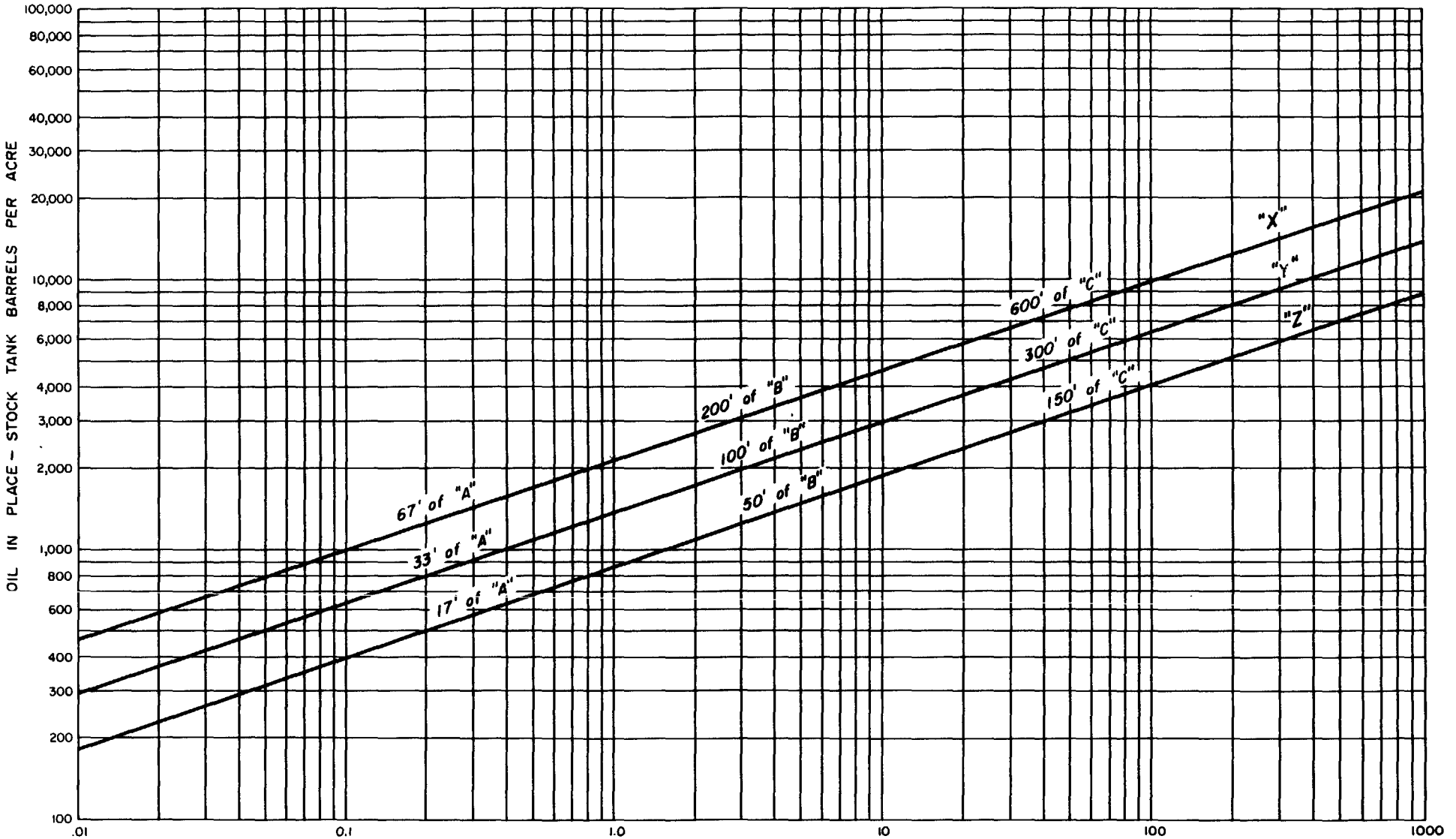
---

1) Year of fall-off test shown previously.
2) From fall-off test.
3) Assumed gas saturation.
4) CT = SoCO + SgCg + Cf (Use Cf = 20×10^{-6}).
5) Time to reach steady state conditions (from fall-off test).
6) øh = porosity feet.
7) Hydrocarbon pore space in terms of S.T. barrels per acre.
8) n = 6.328 x (Kh/u)/(øh)CT. Reference NMOCC Case 9111, June 17, 1988, B-M-G Exhibit 1, Section H.
9) From $r^2 = 4nt$. Reference Muskat, Physical Principles of Oil Production (1949) Page 537 and Craft & Hawkins (1959) Page 275, and NMOCC Case 3455, November 16, 1966.

MINIMUM DISTANCE TO EDGE OF FRACTURE BLOCK
CANADA OJITOS UNIT A-14 INJECTION WELL



RELATION OF OIL IN PLACE
TO
TRANSMISSIBILITY
FOR
POROSITY–PERMEABILITY RELATIONS
"A", "B" & "C"
AND FOR
RESERVOIR THICKNESSES SHOWN
F.V.F.=1.29



File 13A

NMOCC CASE 3455, DEC. 1969
BMG EXHIBIT 2
APPENDIX III FIGURE NO. III-5

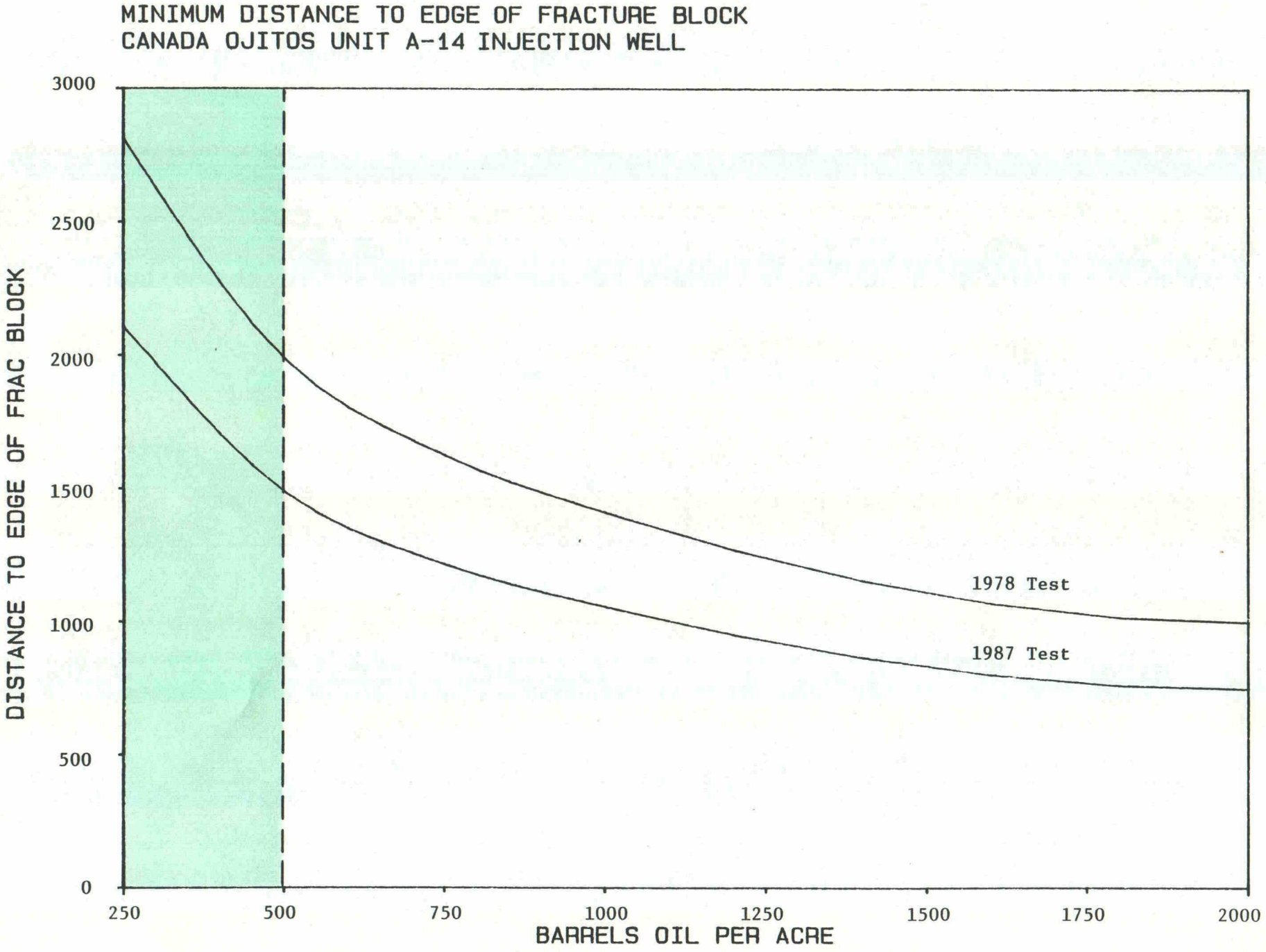
HYDROCARBON PORE SPACE AS A FUNCTION OF Kh

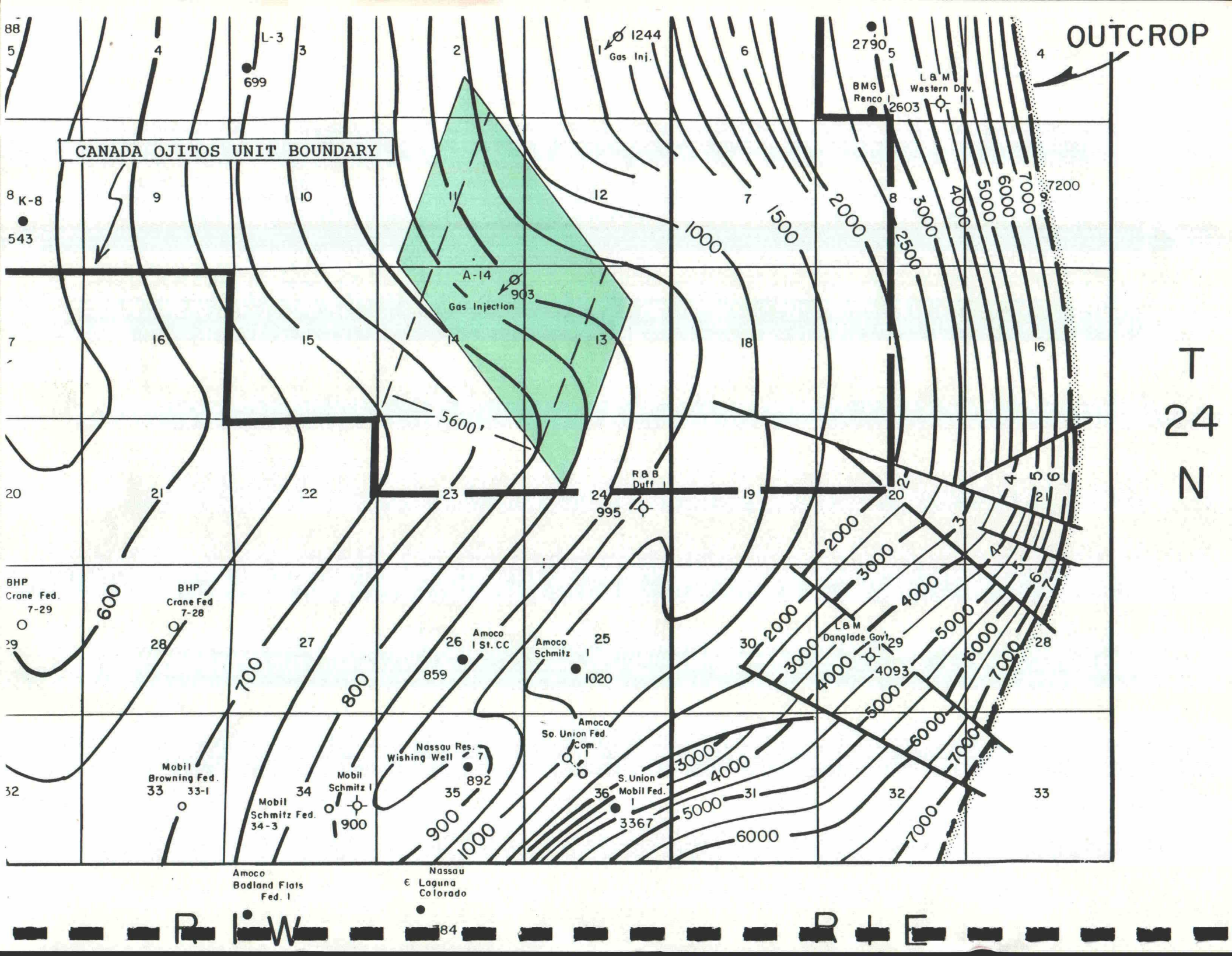
Until a better relation is developed, that shown on the graph on the facing page can be used to estimate pore space as a function of Kh. Interference tests made in West Puerto Chiquito fall generally between or near the lower two lines ("Y" and "Z").

The letters "A", "B" and "C" are not to be confused with the A, B and C zones; rather they are relations described in the study leading to this graph. (Reference Case 3455, December 1969, B-M-G Exhibit 2).

In the instant case (see previous section), the value of Kgh is estimated at .0092. We do not know the value of the relative permeability to gas; but since Kgh has increased about tenfold from 1986 to 1989 to .015, it is probable that the relative permeability to gas in 1989 is approaching 1. If we assume it to be .75 at time of 1987 test, then Kh would be about .02. Entering the graph on the facing page with the value of .02 then stock tank oil in place per acre is determined (between the lower two lines) to approximate 250 to 500 barrels.

This range of 250 barrels to 500 barrels is highlighted on the graph on the next page.


MINIMUM DISTANCE TO EDGE OF FRACTURE BLOCK
CANADA OJITOS UNIT A-14 INJECTION WELL
DISTANCE TO EDGE OF FRAC BLOCK
3000
2500
2000
1500
1000
500
0
250
500
750
1000
1250
1500
1750
2000
BARRELS OIL PER ACRE
1978 Test
1987 Test


OUTCROP
CANADA OJITOS UNIT BOUNDARY
T 24 N
R 1 W
R 1 E
L-3
699
1244
Gas Inj.
2790
BMG
Renco 1
L & M
Western Dev.
1
2603
K-8
543
A-14
Gas Injection
903
5600'
R & B
Duff 1
995
BHP
Crane Fed.
7-29
BHP
Crane Fed
7-28
Amoco
1 St. CC
859
Amoco
Schmitz 1
1020
L & M
Danglade Govt.
4093
Amoco
So. Union Fed.
Com. 1
Nassau Res.
Wishing Well 1
892
Mobil
Browning Fed.
33-1
Mobil
Schmitz 1
900
Mobil
Schmitz Fed.
34-3
S. Union
Mobil Fed.
1
3367
Amoco
Badland Flats
Fed. 1
Nassau
Laguna
Colorado
784
600
700
800
900
1000
1500
2000
2500
3000
4000
5000
6000
7000
7200

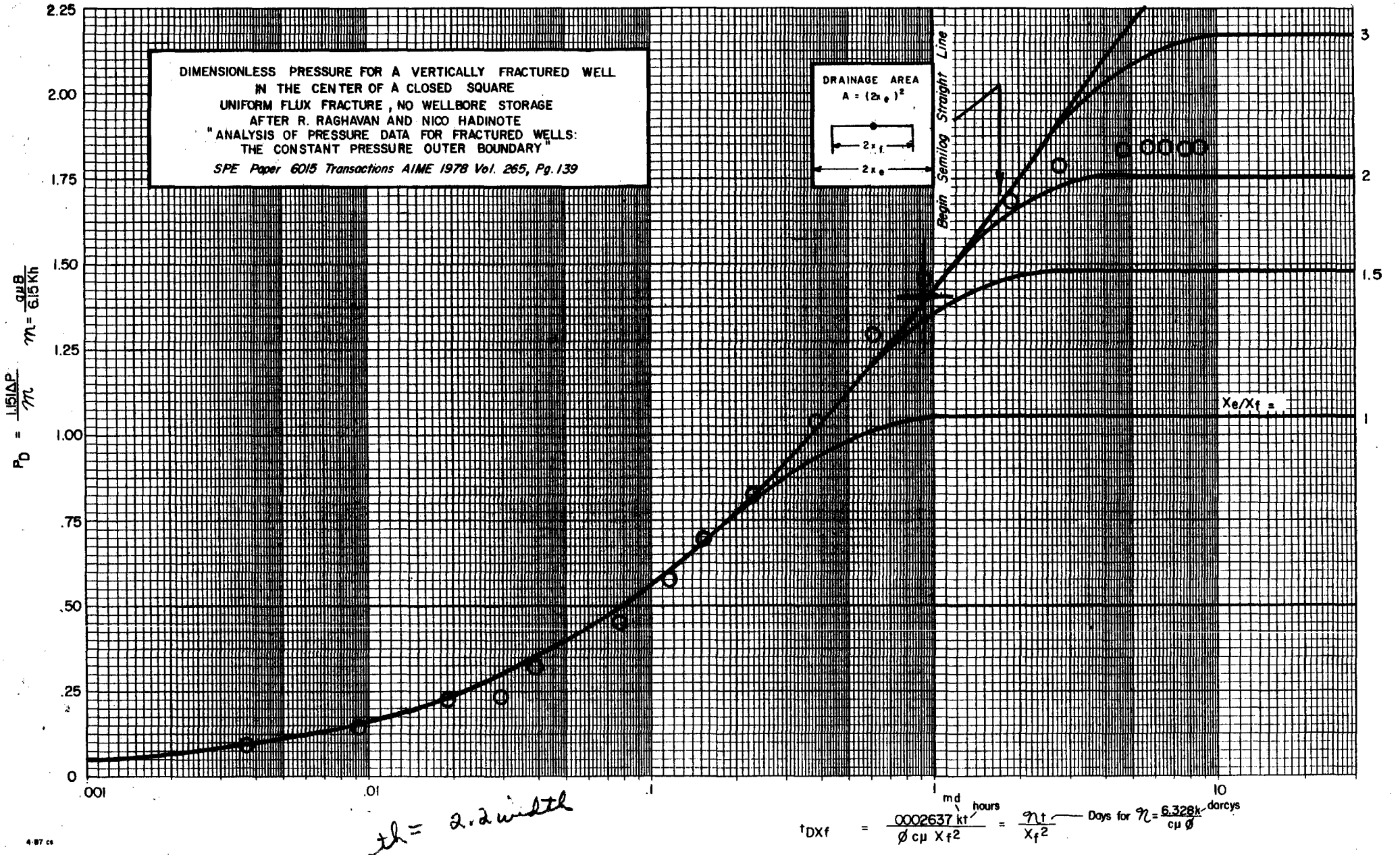
SIZE OF FRACTURE BLOCKS
AROUND CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

Shown on the plat on the facing page is the minimum size of fracture block (postulated in the shape of a parallelogram identified by the dashed lines) around the A-14 injection well for a pore volume of 250 stock tank barrels per acre. If the fracture block is longer than it is wide, then its ends could extend beyond the dashed lines as shown schematically thereon.

The significant issue here with respect to size of the fracture block around this injection well is that it, in effect, moves the point of injection into the reservoir from the wellbore to the boundaries of the fracture block.

So as a practical matter, the gas flow into the reservoir is the same as if the single injection well were replaced by a series of small injectors located on the periphery of the fracture block; so the effective point of injection with support to the south boundary is that it is close indeed.

It is therefore abundantly clear that - absent protection wells along the boundary - the unit is at risk with respect to drainage.


DIMENSIONLESS PRESSURE FOR A VERTICALLY FRACTURED WELL
IN THE CENTER OF A CLOSED SQUARE
UNIFORM FLUX FRACTURE, NO WELLBORE STORAGE
AFTER R. RAGHAVAN AND NICO HADINOTE
"ANALYSIS OF PRESSURE DATA FOR FRACTURED WELLS:
THE CONSTANT PRESSURE OUTER BOUNDARY"
SPE Paper 6015 Transactions AIME 1978 Vol. 265, Pg. 139
DRAINAGE AREA
A = (2x_e)^2
2x_f
2x_e
Begin Semilog Straight Line
Xe/Xf =
1
1.5
2
3
2.25
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
0
.001
.01
.1
1
10
P_D = 1.151ΔP/m
m = qμB/6.15Kh
t_DXf = .0002637 kt/φcμ X_f^2 = ηt/X_f^2 — Days for η = 6.328k/cμφ
md
hours
darcys
length = 2.2 width
4-87 cs

LENGTH OF INDUCED FRACTURE IN CANADA OJITOS UNIT A-14 FRACTURE BLOCK AND DETERMINATION OF OUTER DIMENSION OF FRACTURE BLOCK FROM THIS FRACTURE LENGTH

Finally we look at the length of the induced fracture in the Canada Ojitos Unit A-14 tight fracture block; and an independent method of estimating the size of the fracture block.

The flow system is that of constant pressure at the boundary. Method of analysis is through use of type curves; and is described in New Mexico Oil Conservation Commission Case 9111, June 17, 1988, B-M-G Exhibit 1, Sections V, W, X, Y and Z.

The graph on the facing page shows the match of points on the type curve. The pressure function used is that of the integrated values of the pseudopressures squared (as distinct from the difference of the squares of the pseudopressures). Graphs of pressure versus pseudopressure and pressure versus the integrated value are the last two pages in this section.

The basic data and calculations are summarized on the next two pages for the 1987 pressure fall-off test (reference: graph of pressure fall-off test in preceding section).

The values for Kgh and Kgh/u as determined by this (constant pressure at the boundary) method are more accurate than those shown in the preceding section; however they are not substantially different.

Results of this analysis for the 1987 test are compared with those shown in the previous section:

	By time to reach steady state conditions (previous section)	By constant pressure at the boundary (this section)
Kgh	.0092	.0074
Kgh/u	.544	.46
Length of edge of fracture block for hydrocarbon pore volume equivalent to 250 to 2000 stock tank barrels per acre in place	746' to 2107'	700' to 1960'
Fracture half-length for hydrocarbon pore volume equivalent to 250 to 2000 stock tank barrels per acre	-	158' to 446'
Fracture total length for pore volume equivalent to 250 to 2000 stock tank barrels per acre	-	316' to 892'

CANADA OJITOS UNIT A-14 (24N-1W)
1987 TEST

Time S.I. (Days) (1)	Surface Pressure (Psia) (2)	Psia at 6430' (3)	$2\int_0^{P}\left(\frac{P}{Z\frac{\mu}{\mu_i}}\right)dP$ (4)	$2\int_0^{1995}\left(\frac{P}{Z\frac{\mu}{\mu_i}}\right)dP - col.4$ (5)	Column 5 Converted to use semi-log graph * (6)
0.000	1670	1995	3.82 $\times 10^6$	0.00 $\times 10^6$	0.00 $\times 10^6$
0.005	1660	1983	3.78	0.04	0.04
0.010	1647	1968	3.72	0.10	0.10
0.021	1630	1947	3.64	0.18	0.18
0.042	1607	1920	3.54	0.28	0.28
0.083	1572	1878	3.40	0.42	0.42
0.125	1546	1845	3.29	0.53	0.53
0.167	1521	1814	3.19	0.63	0.63
0.250	1482	1767	3.04	0.78	0.78
0.417	1420	1693	2.80	1.02	1.02
0.667	1355	1615	2.56	1.26	1.26
1.000	1310	1560	2.40	1.42	1.42
2.000	1244	1480	2.17	1.65	1.65
3.000	1217	1446	2.07	1.75	1.75
4.000	1198	1424	2.02	1.80	1.80
5.000	1198	1424	2.02	1.80	1.80
6.000	1198	1424	2.02	1.80	1.80
7.000	1198	1424	2.02	1.80	1.80

* f (ΔP) for semi log plot =

f (ΔP) log-log plot x 1.151/m = f (ΔP)(1.151/1.15 x 10^6)

m from log-log plot 1.15 (log-log plot not shown here)

fracture not > 50'

COU A-14 INJECTION WELL
PRESSURE FALL-OFF TEST
NOV. 1987 - Shut in Oct 29

Injecting 700 MCF/D prior to shut in

FROM SEMI-LOG PLOT: MATCH POINT $\begin{cases} \frac{t}{\Delta P} = 1.33 \\ P_D = 1.41 \end{cases}$ $\begin{cases} t_{DY_f} = .94 \\ t = 1.0 \text{ day} \end{cases}$

$Y_e/Y_f = 2.2$

$$m = 1.151 \frac{\frac{t}{\Delta P}}{P_D} = 1.151 \times \frac{1.33}{1.41} = 1.09 \times 10^6$$

$$Kh = \frac{1000 \times Q \times .0115 \times \left(\frac{610}{610.9}\right)}{m} = \frac{1000 \times 700 \times .0115 \times \left(\frac{610}{610.9}\right)}{1.09 \times 10^6} = .0074 \text{ darcy feet}$$

For assumed approx $\mu = .016$: $\frac{Kh}{\mu} = \frac{.0074}{.016} = .46$ d-f/cp

---

$$\eta/Y_f^2 = \frac{t_D Y_f}{t} = \frac{.94}{1.0} = .94 \qquad Y_f^2 = \eta/.94 \qquad \eta = \frac{6.328 \left(\frac{Kh}{\mu}\right)}{c_T \phi h}$$

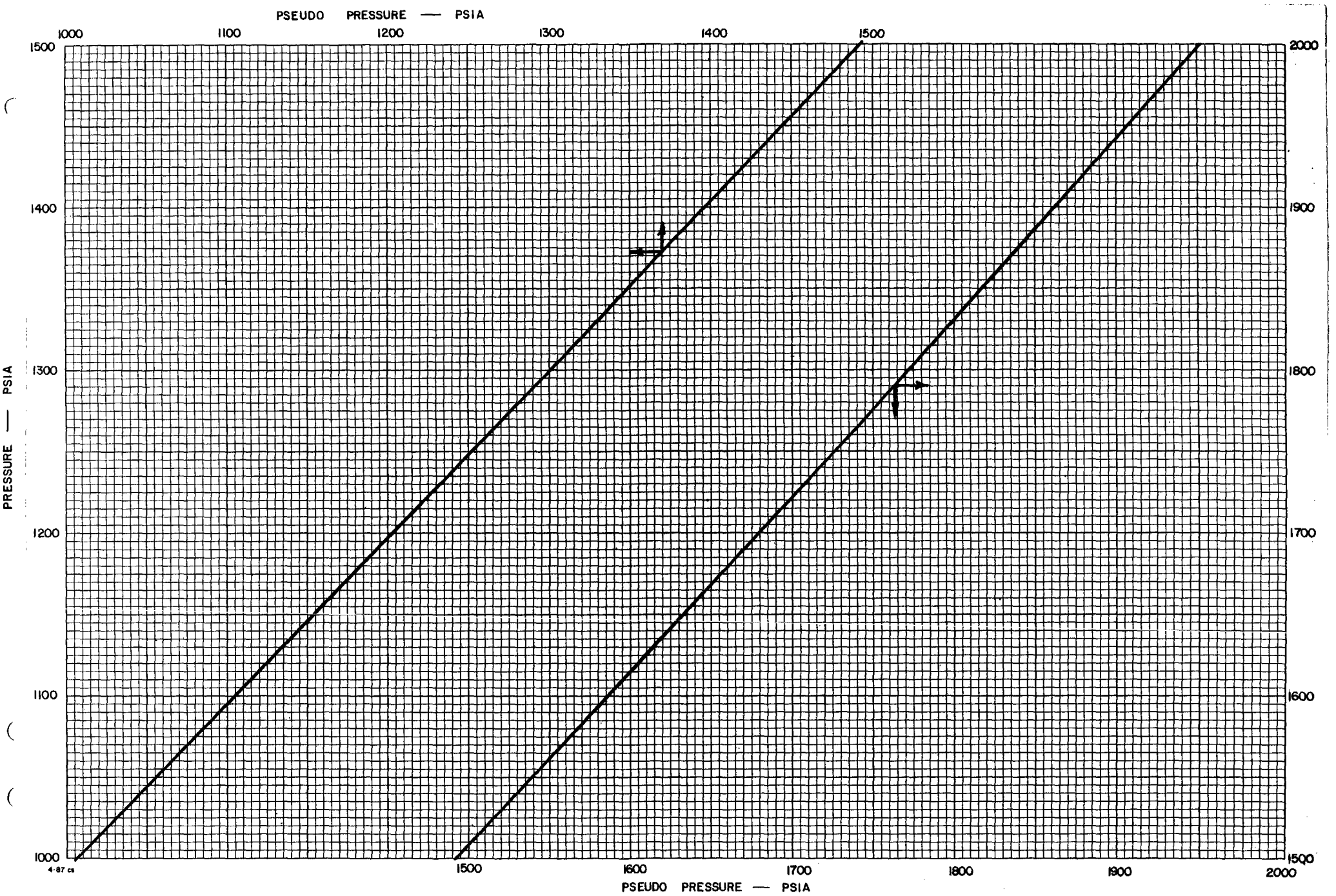
$$\eta = \frac{6.328 \times .46}{370 \times 10^{-6} \phi h} = \frac{7.87 \times 10^3}{\phi h} \qquad Y_f^2 = \eta/.94 = \frac{7.87 \times 10^3}{.94} = \frac{8.37 \times 10^3}{\phi h}$$

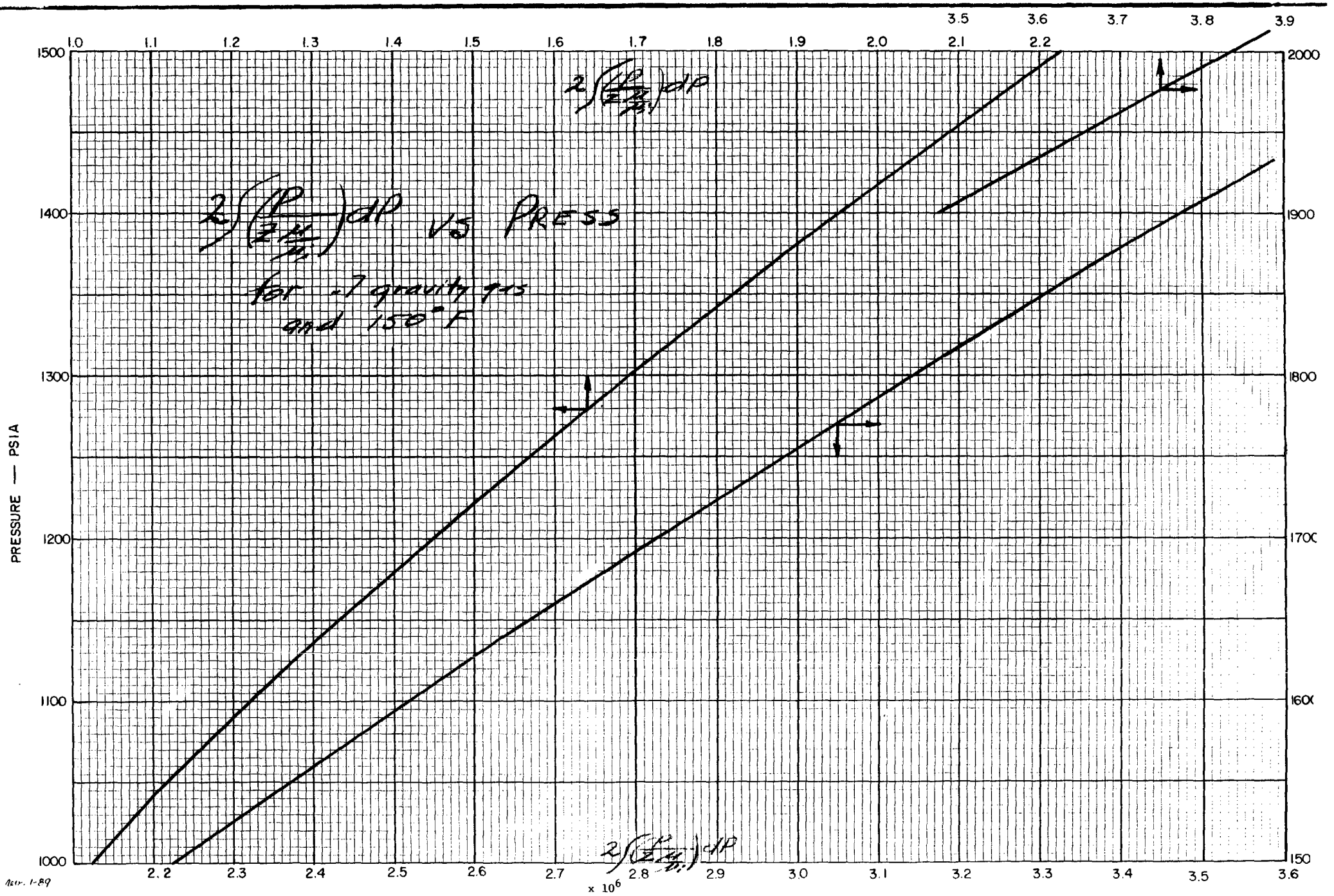
Fracture half length, Y_f:

$$= \sqrt{\eta/.94}$$

$$= \sqrt{\frac{8.37 \times 10^3}{\phi h}}$$

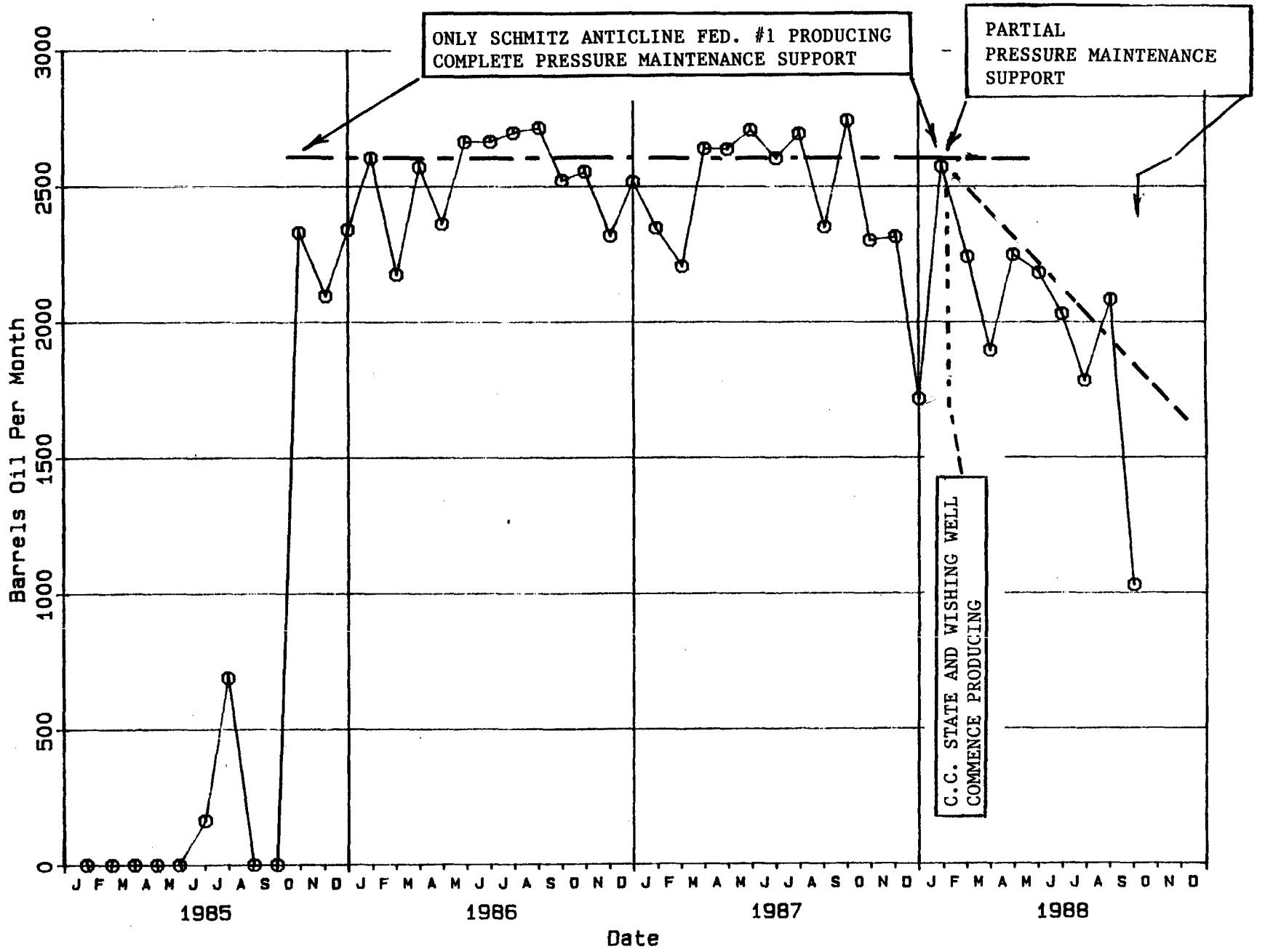
ϕh	HYDRO-CARBON PORE VOL. S.T. BBL/AC	Y_f	$Y_e = 2.2 Y_f$	$2X_e =$ LENGTH of SIDE of FRACTURE BLOCK
.335	2000	158	348	700
.167	1000	224	493	790
.084	500	316	695	1390
.042	250	446	981	1960


PSEUDO PRESSURE — PSIA
1000
1100
1200
1300
1400
1500
1500
1400
1300
1200
1100
1000
PRESSURE — PSIA
2000
1900
1800
1700
1600
1500
1500
1600
1700
1800
1900
2000
PSEUDO PRESSURE — PSIA
4-67 ca


$2\sqrt{\left(\frac{P}{Z\mu}\right)}dP$ vs PR=55
for .7 gravity gas
and 150°F
PRESSURE — PSIA
x 10^6
Nov. 1-89

AMOCO SCHMITZ ANTICLINE FED #1

SEC. 25, T-24N, R-1W



TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Nassau Wishing Well 35-7

ELEVATION 7267' KB

DEPTH OF BOMB 6582'

DATE SHUT IN May 10, 1988

TIME SHUT IN 1:26 PM

PRODUCTION RATE PRIOR TO SHUT-IN 604 BOPD

(est) 410 MCFD

GAS-OIL RATIO (est) .68 MCF/BBL

B_o 1.3

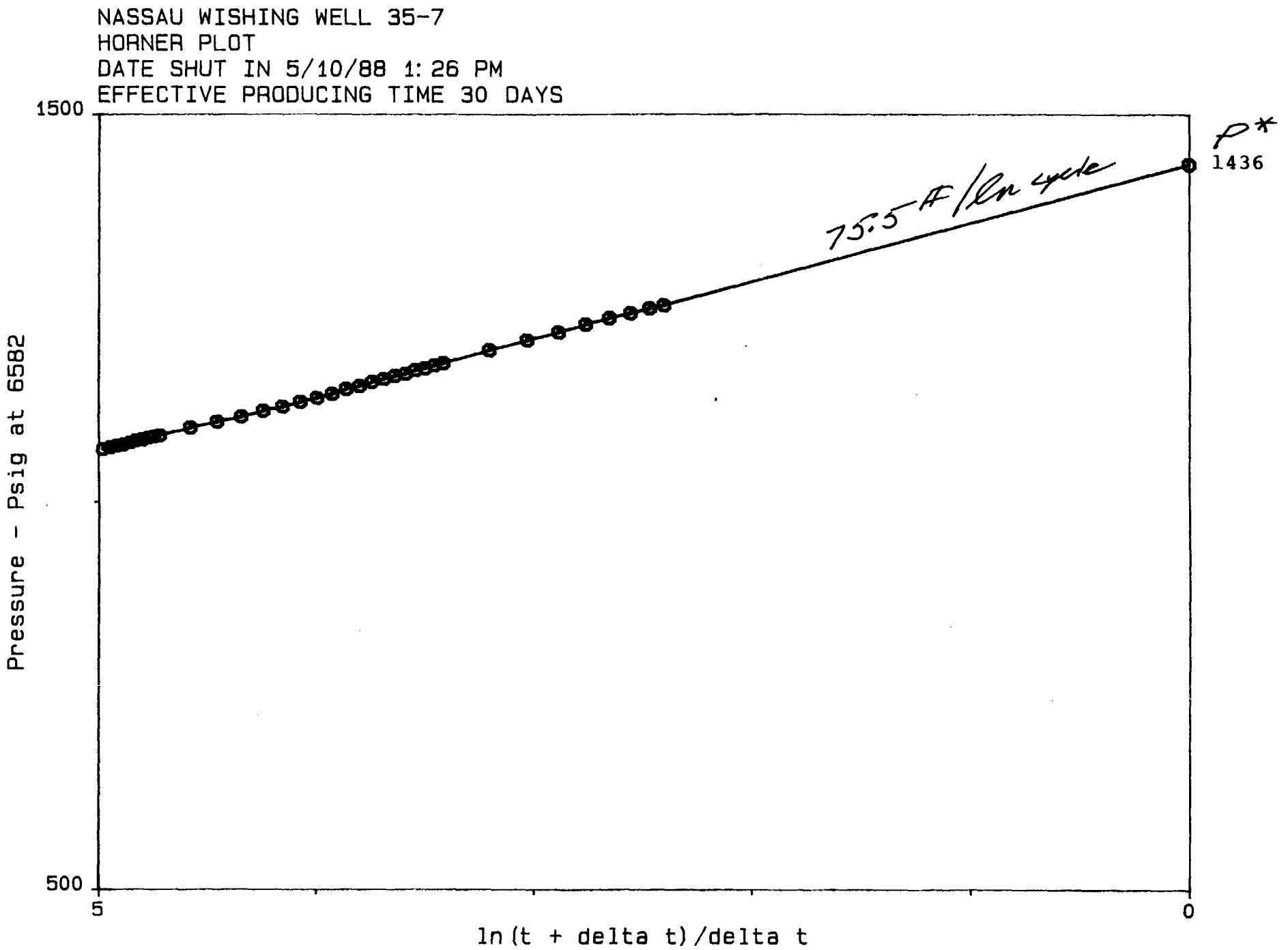
B_T 1.7

slope, m 75.5 /ln cycle

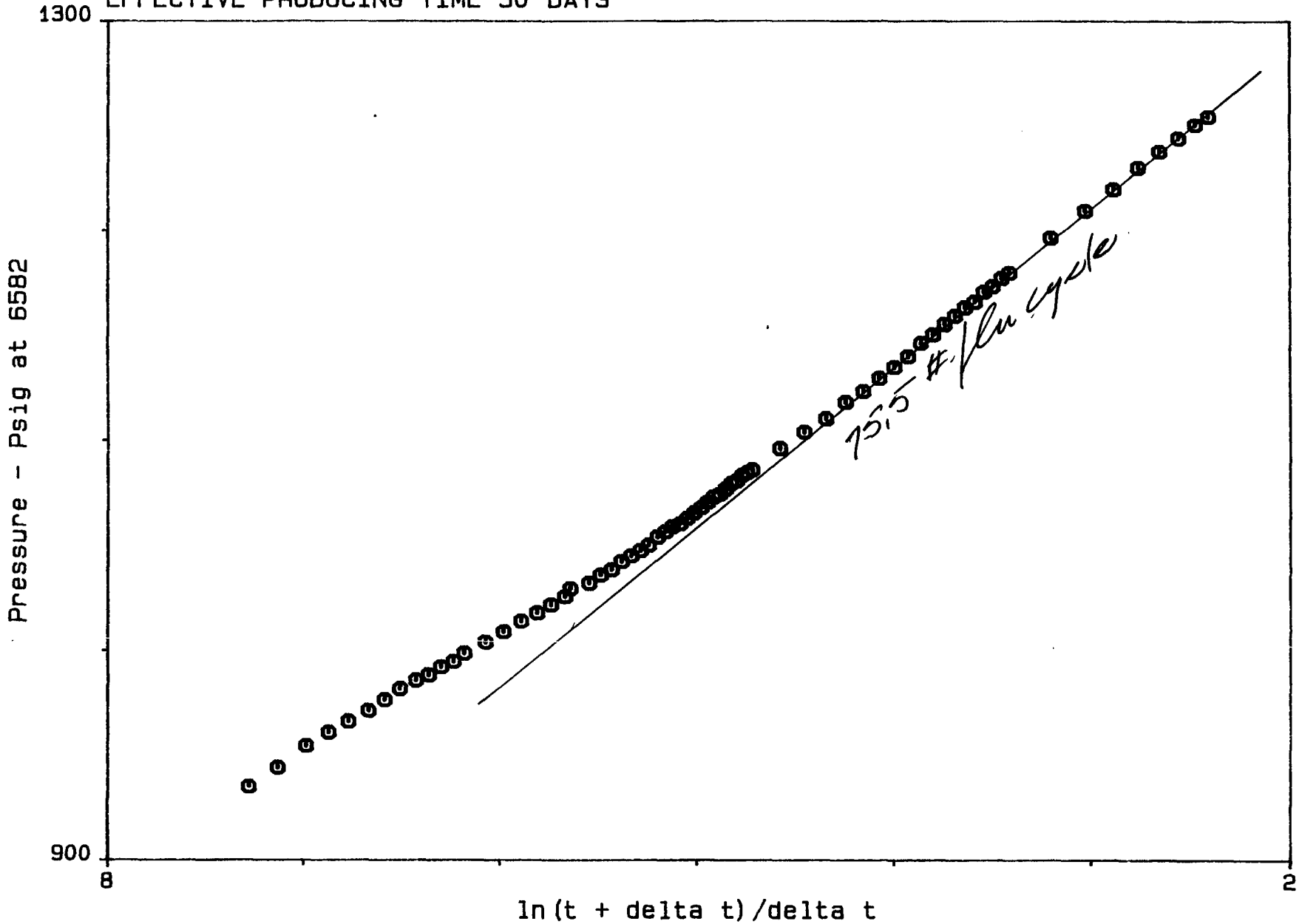
$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\, B_T}{14.16 \times m \text{ (ln cycle)}} = .96 \text{ darcy feet/cp}$$

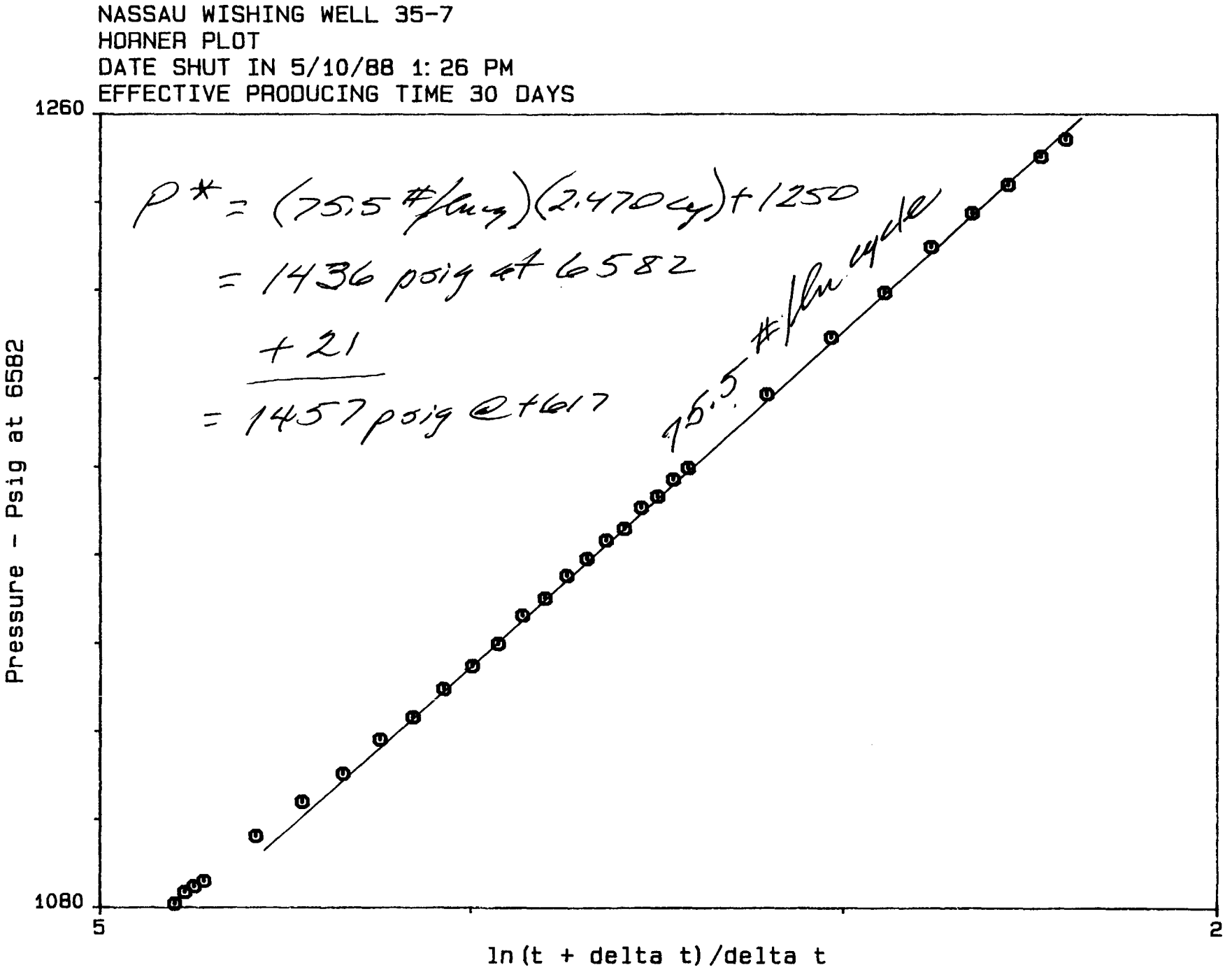
Determination of P* shown on next plot.

Copy of survey and data for Horner plot are at back of this section.


NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 5/10/88 1:26 PM
EFFECTIVE PRODUCING TIME 30 DAYS
1500
500
5
0
P*
1436
75.5 ft/ln cycle
Pressure - Psig at 6582
ln(t + delta t)/delta t

NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 5/10/88 1:26 PM
EFFECTIVE PRODUCING TIME 30 DAYS




NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 5/10/88 1:26 PM
EFFECTIVE PRODUCING TIME 30 DAYS
1260
1080
Pressure - Psig at 6582
5
2
ln (t + delta t)/delta t
P* = (75.5 #/log cy)(2.470 cy) + 1250
= 1436 psig at 6582
+ 21
= 1457 psig @ +617
75.5 #/log cycle

NASSAU RESOURCES, INC. WISHING WELL 35-7
HORNER PLOT OF PRESSURE BUILD-UP
WELL SHUT IN AT 1:26 PM MAY 10, 1988
Δt TIME = BOMB TIME PLUS .5 HOURS
EFFECTIVE PRODUCING TIME 30 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
0.00	0.50	-.301	7.273	935.1	3.83	4.33	0.636	5.120	1059.1
0.08	0.58	-.237	7.125	944.2	4.00	4.50	0.653	5.081	1060.4
0.17	0.67	-.174	6.981	954.6	4.17	4.67	0.669	5.045	1062.9
0.25	0.75	-.125	6.868	961.0	4.33	4.83	0.684	5.011	1065.5
0.33	0.83	-.081	6.767	966.2	4.50	5.00	0.699	4.977	1068.1
0.42	0.92	-.036	6.664	971.4	4.67	5.17	0.713	4.944	1070.6
0.50	1.00	0.000	6.581	976.6	4.83	5.33	0.720	4.913	1073.2
0.58	1.08	0.033	6.504	981.8	5.00	5.50	0.740	4.882	1074.5
0.67	1.17	0.068	6.424	985.7	5.17	5.67	0.754	4.852	1077.1
0.75	1.25	0.097	6.358	988.3	5.33	5.83	0.766	4.824	1079.6
0.83	1.33	0.124	6.296	992.2	5.50	6.00	0.778	4.796	1080.9
0.92	1.42	0.152	6.231	994.8	5.67	6.17	0.790	4.768	1083.5
1.06	1.50	0.176	6.176	998.7	5.83	6.33	0.801	4.743	1084.8
1.17	1.67	0.223	6.069	1003.9	6.00	6.50	0.813	4.716	1086.1
1.33	1.83	0.262	5.977	1009.0	7.00	7.50	0.875	4.575	1096.3
1.50	2.00	0.301	5.889	1014.1	8.00	8.50	0.929	4.451	1104.0
1.67	2.17	0.336	5.808	1018.0	9.00	9.50	0.978	4.341	1110.4
1.83	2.33	0.367	5.737	1021.8	10.00	10.50	1.021	4.242	1118.2
2.00	2.50	0.398	5.666	1025.7	11.00	11.50	1.061	4.153	1123.3
2.17	2.57	0.410	5.639	1029.5	12.00	12.50	1.097	4.071	1129.7
2.33	2.83	0.452	5.543	1032.1	13.00	13.50	1.130	3.995	1134.9
2.50	3.00	0.477	5.485	1036.0	14.00	14.50	1.161	3.925	1140.0
2.67	3.17	0.501	5.430	1038.5	15.00	15.50	1.190	3.860	1146.4
2.83	3.33	0.522	5.381	1042.4	16.00	16.50	1.217	3.799	1150.3
3.00	3.50	0.544	5.331	1045.0	17.00	17.50	1.243	3.741	1155.4
3.17	3.67	0.565	5.284	1047.5	18.00	18.50	1.267	3.687	1159.3
3.33	3.83	0.583	5.242	1050.1	19.00	19.50	1.290	3.636	1163.4
3.50	4.00	0.602	5.198	1053.9	20.00	20.50	1.312	3.587	1166.+
3.67	4.17	0.620	5.157	1056.5	21.00	21.50	1.332	3.541	1170.8

NASSAU RESOURCES, INC. WISHING WELL 35-7
HORNER PLOT OF PRESSURE BUILD-UP
PAGE 2

Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
22.00	22.50	1.352	3.497	1173.4	48.00	48.50	1.686	2.763	1229.9
23.00	23.00	1.362	3.454	1177.2	54.00	54.50	1.736	2.654	1237.6
24.00	24.50	1.389	3.414	1179.8	60.00	60.50	1.782	2.557	1244.0
30.00	30.50	1.498	3.203	1196.5	66.00	66.50	1.823	2.470	1250.4
36.00	36.50	1.562	3.031	1209.4	71.00	71.50	1.854	2.404	1254.3
42.00	42.50	1.628	2.887	1219.6					

B & R SERVICE, INC.

P. O. Box 1048
Farmington, New Mexico 87499
(505) 325-2393

Company NASAU RESOURCES Lease WISHING WELL Well 35-7

County RIO ARRIBA State NM Date 5-10-88

Shut-In FLOWING Zero Point K.B. Tbg. Pressure 171

Casing Pressure 662 Tbg. Depth S.N. @ 6582' Casing Perf.

Max. Temp. Fluid Level

DEPTH	PSIG	GRADIENT	TIME
0	171	----	
1000	263	.092	
2000	368	.105	
3000	433	.065	
4000	516	.083	
5000	601	.085	
6000	713	.112	
6482	778	.135	
6582	792	.140	11:29
	794		11:34
	795		11:38
	796		11:42
	797		11:46
	799		11:52
	800		11:59
	799		12:08
	797		12:24
	796		12:28
	796		12:29

Jerome P. McHugh
Farmington, N.M.

MAY 16 1988

RECEIVED

(1)

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 68478
TICKET NUMBER 901

PREPARED FOR

COMPANY NAME ..... JERRY P. McHUGH

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GAVILAN-MANCOS
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... BUILD-UP
B.H.P. RECORED @ 6582' K.B.
SHUT-IN @ 13:26 5-10-88

(2)

	TIME		PRESSURE PSI
	REAL	ELAPSED	
5-10-88	13:55:00	00:00:00	935.06
	14:00:00	00:05:00	944.16
	14:05:11	00:10:11	954.55
	14:10:17	00:15:17	961.04
	14:15:12	00:20:12	966.23
	14:20:13	00:25:13	971.43
	14:25:13	00:30:13	976.62
	14:30:19	00:35:19	981.82
	14:35:14	00:40:14	985.71
	14:40:15	00:45:15	988.31
	14:45:00	00:50:00	992.21
	14:50:11	00:55:11	994.81
	14:55:17	01:00:17	998.70
	15:05:18	01:10:18	1,003.85
	15:15:03	01:20:03	1,008.99
	15:25:15	01:30:15	1,014.13
	15:35:16	01:40:16	1,017.98
	15:45:01	01:50:01	1,021.83
	15:55:18	02:00:18	1,025.69
	16:05:14	02:10:14	1,029.54
	16:15:15	02:20:15	1,032.11
	16:25:11	02:30:11	1,035.96
	16:35:12	02:40:12	1,038.53
	16:45:13	02:50:13	1,042.38
	16:55:09	03:00:09	1,044.95
	17:05:16	03:10:16	1,047.52
	17:15:17	03:20:17	1,050.09
	17:25:13	03:30:13	1,053.94
	17:35:19	03:40:19	1,056.51
	17:45:04	03:50:04	1,059.08
	17:55:06	04:00:06	1,060.36
	18:05:07	04:10:07	1,062.93
	18:15:13	04:20:13	1,065.50
	18:25:09	04:30:09	1,068.07
	18:35:05	04:40:05	1,070.64
	18:45:16	04:50:16	1,073.21
	18:55:02	05:00:02	1,074.49
	19:05:13	05:10:13	1,077.06
	19:15:09	05:20:09	1,079.63
	19:25:10	05:30:10	1,080.91
	19:35:01	05:40:01	1,083.48
	19:45:08	05:50:08	1,084.77
	19:55:03	06:00:03	1,086.05
	20:55:10	07:00:10	1,096.33
	21:55:07	08:00:07	1,104.03
	22:55:18	09:00:18	1,110.45
	23:55:10	10:00:10	1,118.16
	00:55:16	11:00:16	1,123.30
	01:55:13	12:00:13	1,129.72
	02:55:14	13:00:14	1,134.86
	03:55:00	14:00:00	1,139.99
	04:55:02	15:00:02	1,146.42
	05:55:14	16:00:14	1,150.27
	06:55:05	17:00:05	1,155.41
	07:55:01	18:00:01	1,159.26

5-10-88

5

(3).

08:55:03	17:00:03	-,-
09:55:14	20:00:14	1,166.
10:55:00	21:00:00	1,170.82
11:55:02	22:00:02	1,173.39
12:55:09	23:00:09	1,177.24
13:55:05	24:00:05	1,179.81
19:55:04	30:00:04	1,196.51
01:55:18	36:00:18	1,209.35
07:55:12	42:00:12	1,219.63
13:55:16	48:00:16	1,229.90
19:55:14	54:00:14	1,237.61
01:55:18	60:00:18	1,244.03
07:55:02	66:00:02	1,250.45
12:59:59	71:04:59	1,254.30

5.1 5.10.85

TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Nassau Wishing Well 35-7

ELEVATION 7267' KB

DEPTH OF BOMB 6582'

DATE SHUT IN Sept. 12, 1988

TIME SHUT IN 8:00 AM

PRODUCTION RATE PRIOR TO SHUT-IN 303 BOPD

353 MCFD

GAS-OIL RATIO 1165 MCF/BBL

B_o 1.3

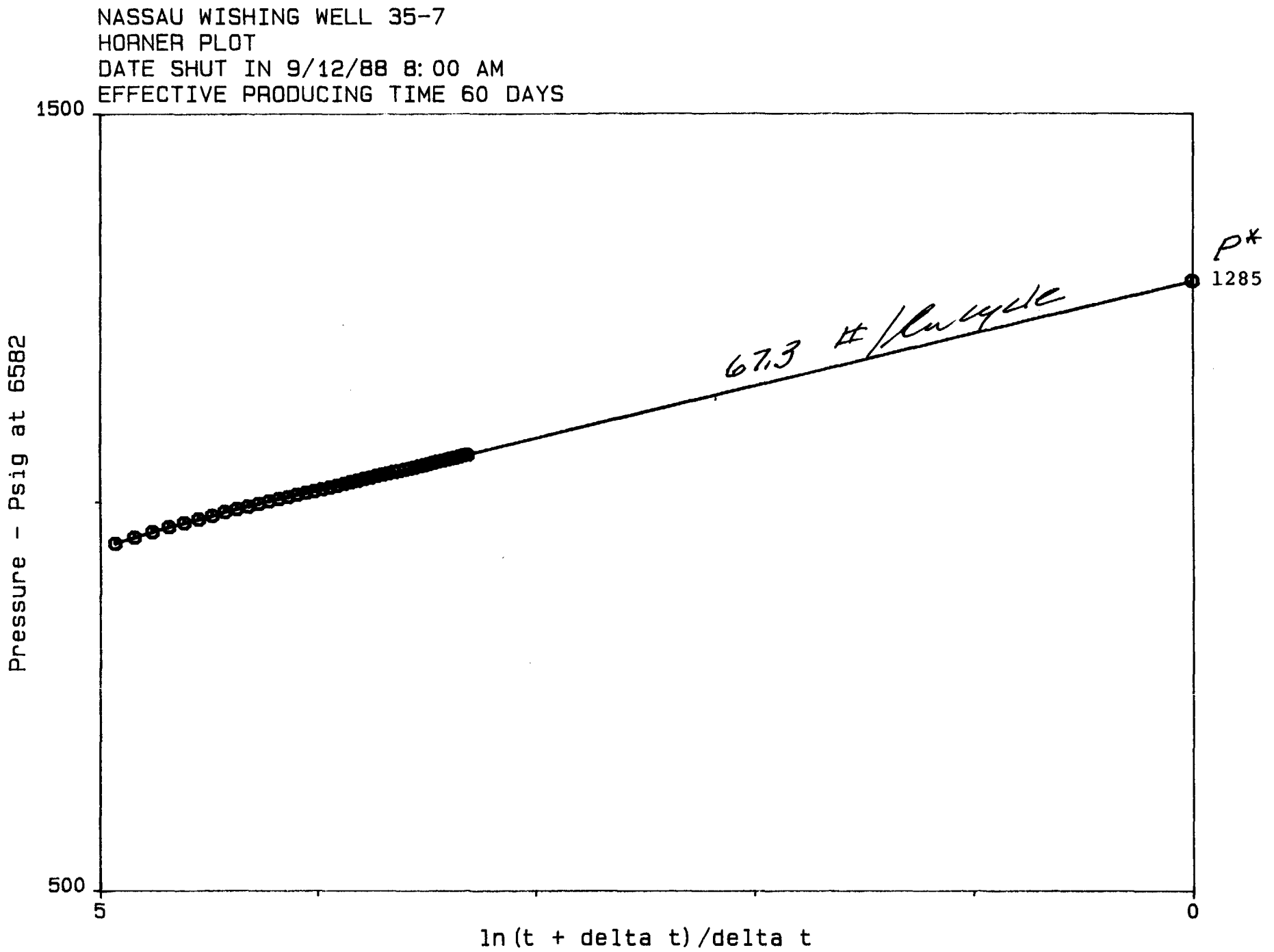
B_T 2.76

slope, m 67.3 /ln cycle

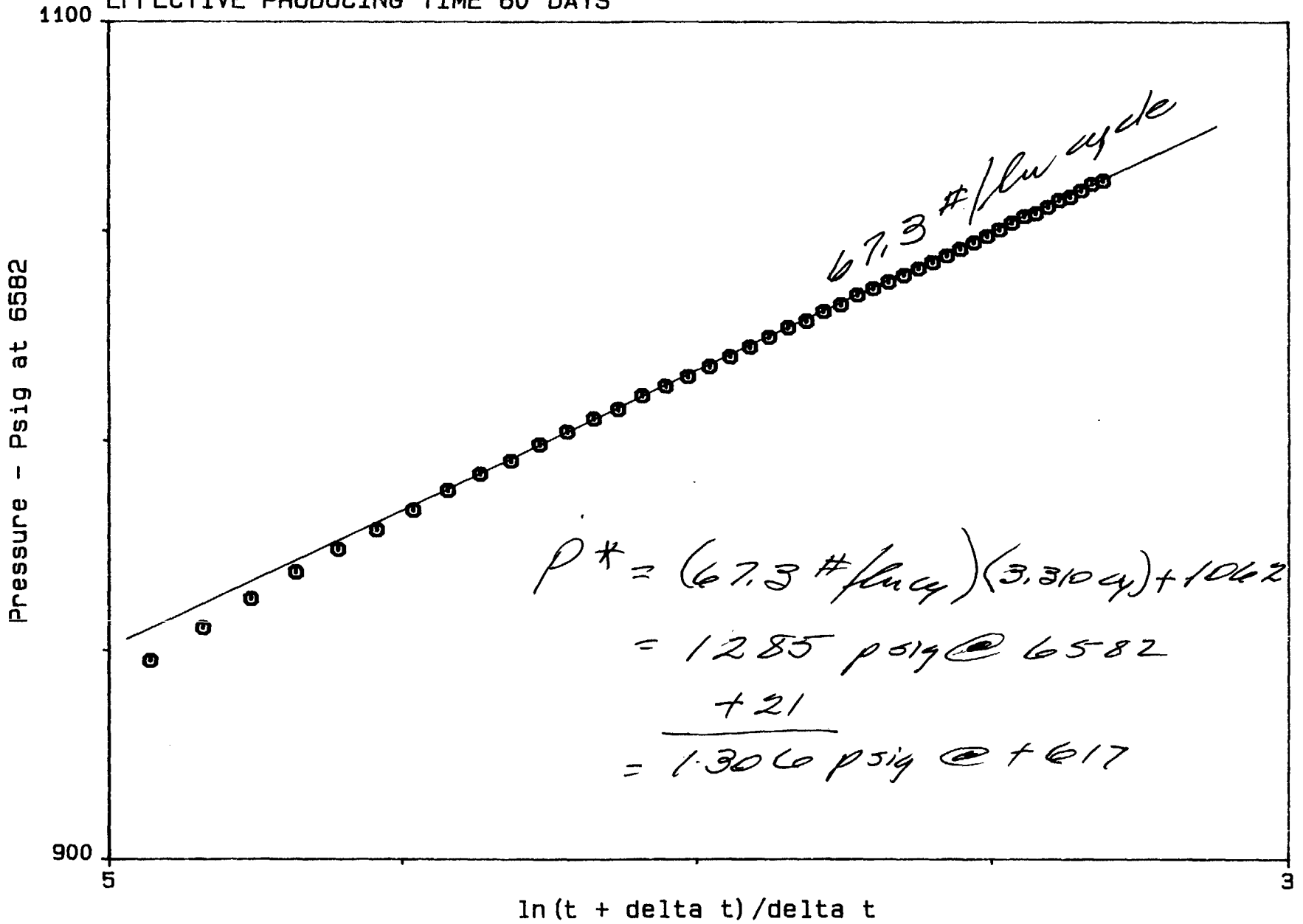
$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\, B_T}{14.16 \times m \text{ (ln cycle)}} = .88 \text{ darcy feet/cp}$$

Determination of P* shown on next plot.

Copy of survey and data for Horner plot are at back of this section.


NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 9/12/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS
1500
500
Pressure - Psig at 6582
5
0
ln (t + delta t)/delta t
67.3 #/log cycle
P*
1285

NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 9/12/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS



NASSAU RESOURCES, INC. WISHING WELL 35-7
HORNER PLOT OF PRESSURE BUILD-UP
WELL SHUT IN AT 8:00 AM SEPTEMBER 12, 1988
Δt TIME = BOMB TIME PLUS 8.5 HOURS
EFFECTIVE PRODUCING TIME 60 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
0.00	8.50	5.138	927.3	24.00	32.50	3.813	1028.6
1.00	9.50	5.028	938.2	25.00	33.50	3.784	1030.9
2.00	10.50	4.925	947.5	26.00	34.50	3.755	1032.5
3.00	11.50	4.838	955.3	27.00	35.50	3.727	1034.8
4.00	12.50	4.755	962.3	28.00	36.50	3.700	1036.4
5.00	13.50	4.679	968.6	29.00	37.50	3.674	1037.9
6.00	14.50	4.608	974.0	30.00	38.50	3.648	1039.5
7.00	15.50	4.542	978.7	31.00	39.50	3.623	1041.0
8.00	16.50	4.480	983.4	32.00	40.50	3.599	1042.6
9.00	17.50	4.422	988.1	33.00	41.50	3.575	1044.2
10.00	18.50	4.367	992.0	34.00	42.50	3.552	1045.7
11.00	19.50	4.315	995.1	35.00	43.50	3.529	1047.3
12.00	20.50	4.266	999.0	36.00	44.50	3.507	1048.8
13.00	21.50	4.219	1002.1	37.00	45.50	3.486	1050.4
14.00	22.50	4.174	1005.2	38.00	46.50	3.465	1052.0
15.00	23.50	4.132	1007.5	39.00	47.50	3.444	1053.5
16.00	24.50	4.091	1010.7	40.00	48.50	3.424	1054.3
17.00	25.50	4.051	1013.0	41.00	49.50	3.404	1055.8
18.00	26.50	4.013	1015.3	42.00	50.50	3.385	1057.4
19.00	27.50	3.977	1017.7	43.00	51.50	3.366	1058.2
20.00	28.50	3.942	1020.0	44.00	52.50	3.347	1059.7
21.00	29.50	3.908	1022.3	45.00	53.50	3.329	1061.3
22.00	30.50	3.876	1024.7	46.13	54.63	3.310	1062.1
23.00	31.50	3.844	1027.0				

WELL CHART ANALYSIS

OCT 27 1988

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 68478
TICKET NUMBER 1000

PREPARED FOR

COMPANY NAME ..... NASSAU RESOURCES

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GALLUP
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... INTERFERENCE

	TIME		PRESSURE PSI
	REAL	ELAPSED	
9-12-88	14:32:00	00:00:00	929.87
	00:32:08	10:00:08	994.81
	10:32:07	20:00:07	1,021.83
	20:32:06	30:00:06	1,041.10
	06:32:05	40:00:05	1,056.51
	12:45:00	46:13:00	1,064.22

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 52219
TICKET NUMBER 902

PREPARED FOR

COMPANY NAME ..... JEROME P. McHUGH

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GAVILAN-MANCOS
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... BUILD-UP

B.H.P. RECORED @ 6582' K.B.
SHUT-IN @ 13:26 5-10-88

	TIME		PRESSURE PSI
	REAL	ELAPSED	
5-10-88	13:55:00	00:00:00	934.08
	23:55:07	10:00:07	1,116.74
	09:55:20	20:00:20	1,165.23
	19:55:17	30:00:17	1,193.97
	07:55:22	42:00:22	1,217.31
	01:55:25	60:00:25	1,242.46
	13:00:00	71:05:00	1,251.44

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 57407
TICKET NUMBER 999

PREPARED FOR

COMPANY NAME ..... NASSAU RESOURCES

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GALLUP
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... INTERFERENCE

	TIME		PRESSURE PSI
	REAL	ELAPSED	
9-12-88	14:32:00	00:00:00	927.27
	15:32:01	01:00:01	938.18
	16:32:02	02:00:02	947.53
	17:32:04	03:00:04	955.32
	18:32:05	04:00:05	962.34
	19:32:01	05:00:01	968.57
	20:32:08	06:00:08	974.03
	21:32:09	07:00:09	978.70
	22:32:00	08:00:00	983.38
	23:32:02	09:00:02	988.05
	00:32:03	10:00:03	991.95
	01:32:05	11:00:05	995.06
	02:32:06	12:00:06	998.96
	03:32:02	13:00:02	1,002.08
	04:32:04	14:00:04	1,005.19
	05:32:05	15:00:05	1,007.53
	06:32:06	16:00:06	1,010.65
	07:32:08	17:00:08	1,012.99
	08:32:04	18:00:04	1,015.32
	09:32:06	19:00:06	1,017.66
	10:32:02	20:00:02	1,020.00
	11:32:09	21:00:08	1,022.34
	12:32:10	22:00:10	1,024.68
	13:32:06	23:00:06	1,027.01
	14:32:02	24:00:02	1,028.57
	15:32:04	25:00:04	1,030.91
	16:32:10	26:00:10	1,032.47
	17:32:01	27:00:01	1,034.81
	18:32:03	28:00:03	1,036.36
	19:32:04	29:00:04	1,037.92
	20:32:00	30:00:00	1,039.48
	21:32:02	31:00:02	1,041.04
	22:32:03	32:00:03	1,042.60
	23:32:10	33:00:10	1,044.16
	00:32:06	34:00:06	1,045.71
	01:32:02	35:00:02	1,047.27
	02:32:04	36:00:04	1,048.83
	03:32:15	37:00:15	1,050.39
	04:32:01	38:00:01	1,051.95
	05:32:03	39:00:03	1,053.51
	06:32:04	40:00:04	1,054.29
	07:32:06	41:00:06	1,055.84
	08:32:07	42:00:07	1,057.40
	09:32:08	43:00:08	1,058.18
	10:32:10	44:00:10	1,059.74
	11:32:06	45:00:06	1,061.30
	12:45:00	46.13:00	1,062.08

TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Nassau Laguna Colo 2-6

ELEVATION 7240' KB

DEPTH OF BOMB 6940'

DATE SHUT IN Sept. 8, 1988

TIME SHUT IN 8:00 AM

PRODUCTION RATE PRIOR TO SHUT-IN 11 BOPD

55 MCFD

GAS-OIL RATIO 5.0 MCF/BBL

B_o 1.3

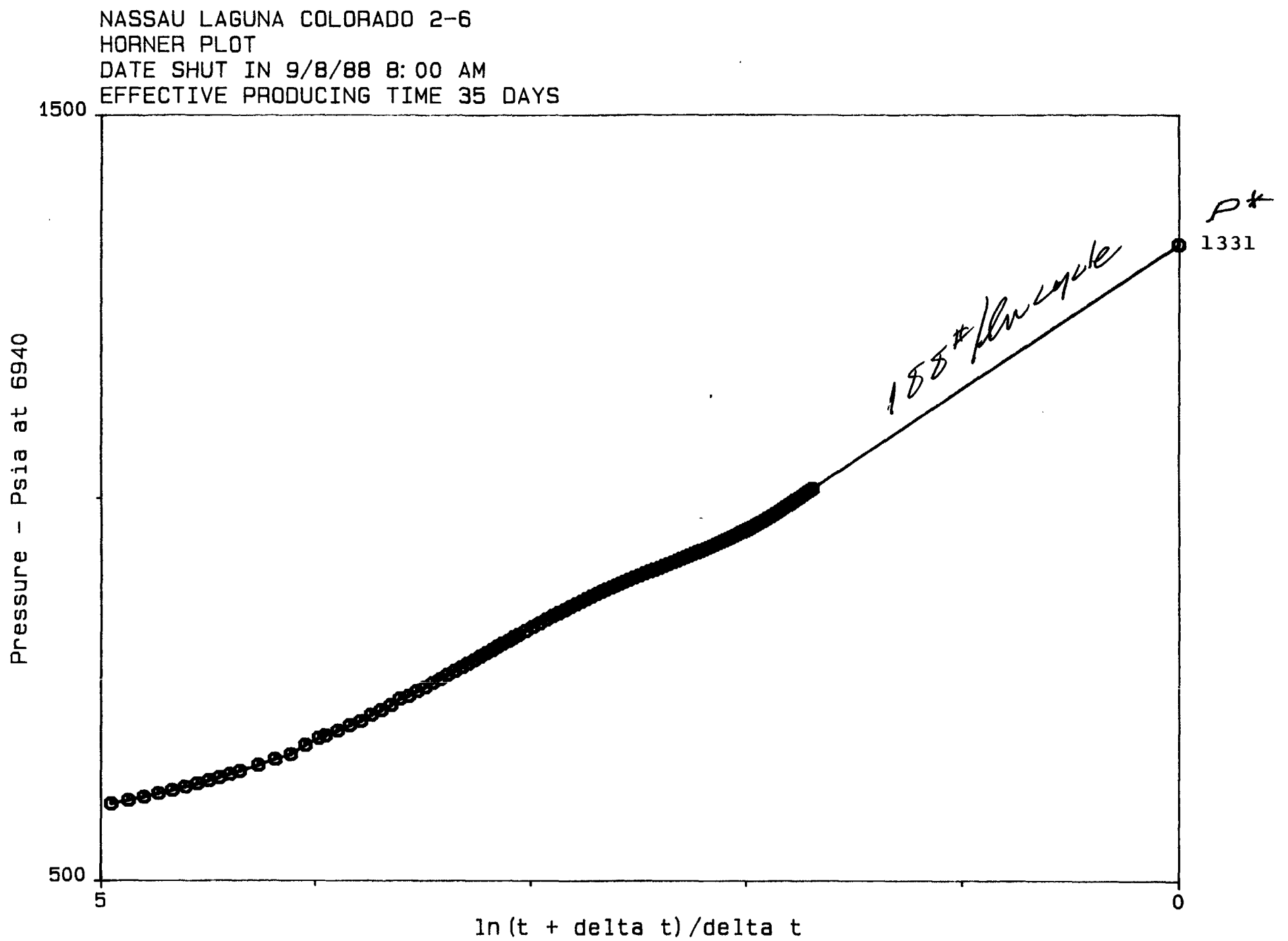
B_T 11.2

slope, m 188# /ln cycle

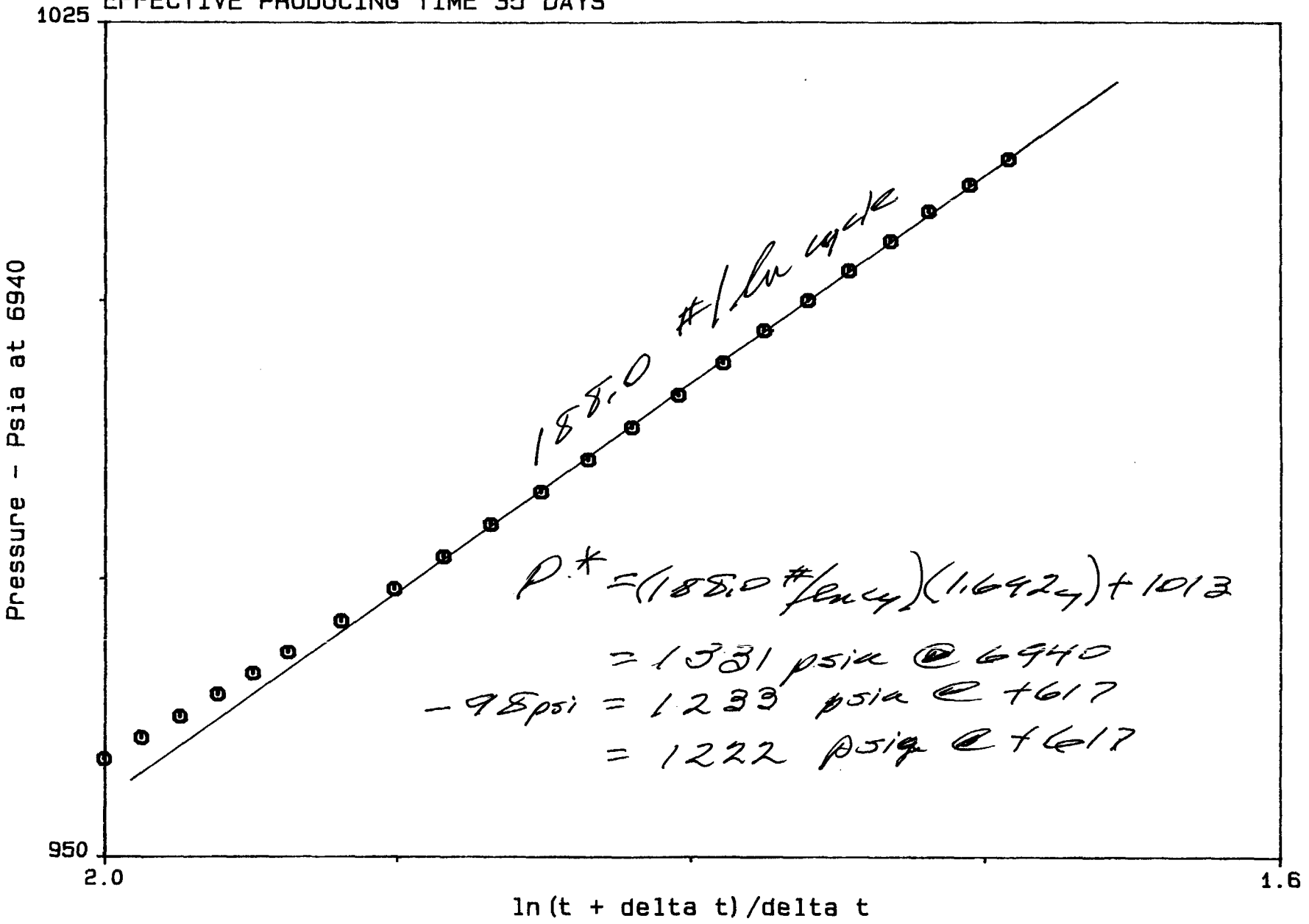
$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\ B_T}{14.16 \times m\ (\text{ln cycle})} = .046 \text{ darcy feet/cp}$$

Determination of P* shown on next plot.

Copy of survey and data for Horner plot are at back of this section.


NASSAU LAGUNA COLORADO 2-6
HORNER PLOT
DATE SHUT IN 9/8/88 8:00 AM
EFFECTIVE PRODUCING TIME 35 DAYS
1500
500
Pressure - Psia at 6940
5
0
ln (t + delta t)/delta t
P*
1331
188# flow cycle

NASSAU LAGUNA COLORADO 2-6
HORNER PLOT
DATE SHUT IN 9/8/88 8:00 AM
EFFECTIVE PRODUCING TIME 35 DAYS



NASSAU RESOURCES, INC. LAGUNA COLORADO 2 #6
HORNER PLOT OF PRESSURE BUILD-UP
WELL SHUT IN AT 8:00 AM SEPTEMBER 8, 1988
Δt TIME = BOMB TIME MINUS 16.5 HOURS
EFFECTIVE PRODUCING TIME 35 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
22.5	6.0	4.949	601.1	46.0	29.5	3.384	770.1
23.0	6.5	4.869	605.7	47.0	30.5	3.351	775.2
23.5	7.0	4.796	610.2	48.0	31.5	3.320	779.8
24.0	7.5	4.727	614.8	49.0	32.5	3.290	785.0
24.5	8.0	4.663	619.0	50.0	33.5	3.261	789.1
25.0	8.5	4.603	623.3	51.0	34.5	3.233	794.0
25.5	9.0	4.547	627.6	52.0	35.5	3.205	798.5
26.0	9.5	4.493	631.7	53.0	36.5	3.179	802.2
26.5	10.0	4.443	635.9	54.0	37.5	3.153	806.8
27.0	10.5	4.394	640.0	55.0	38.5	3.128	810.8
27.5	11.0	4.349	644.0	56.0	39.5	3.103	814.4
28.5	12.0	4.263	651.8	57.0	40.5	3.079	818.5
29.5	13.0	4.184	659.9	58.0	41.5	3.056	822.3
30.5	14.0	4.111	666.0	59.5	43.0	3.022	827.6
31.5	15.0	4.043	678.2	61.0	44.5	2.990	832.6
32.5	16.0	3.980	687.3	62.5	46.0	2.958	837.5
33.0	16.5	3.949	690.6	64.0	47.5	2.928	842.0
34.0	17.5	3.892	696.9	65.5	49.0	2.898	846.6
35.0	18.5	3.837	703.8	67.0	50.5	2.870	850.8
36.0	19.5	3.786	709.5	68.5	52.0	2.842	854.7
37.0	20.5	3.737	717.8	70.0	53.5	2.815	858.8
38.0	21.5	3.691	723.8	71.5	55.0	2.789	862.4
39.0	22.5	3.646	730.4	73.0	56.5	2.764	865.9
40.0	23.5	3.604	738.8	74.5	58.0	2.740	869.2
41.0	24.5	3.563	742.3	76.0	59.5	2.716	872.5
42.0	25.5	3.525	748.3	77.5	61.0	2.693	875.6
43.0	26.5	3.487	753.7	79.0	62.5	2.670	878.5
44.0	27.5	3.451	759.6	80.5	64.0	2.648	881.3
45.0	28.5	3.417	764.7	82.0	65.5	2.626	883.9

NASSAU RESOURCES, INC. LAGUNA COLORADO 2 #6
HORNER PLOT OF PRESSURE BUILD-UP
PAGE 2

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
83.5	67.0	2.605	886.5	138.0	121.5	2.069	949.4
85.0	68.5	2.585	889.0	140.0	123.5	2.054	951.3
86.5	70.0	2.565	891.4	142.0	125.5	2.040	953.2
88.0	71.5	2.545	893.9	144.0	127.5	2.027	955.1
90.0	73.5	2.520	896.7	146.0	129.5	2.013	956.9
92.0	75.5	2.495	899.5	148.0	131.5	2.000	958.8
94.0	77.5	2.471	902.2	150.0	133.5	1.987	960.7
96.0	79.5	2.448	904.8	152.0	135.5	1.974	962.6
98.0	81.5	2.425	907.4	154.0	137.5	1.961	964.6
100.0	83.5	2.403	909.9	156.0	139.5	1.949	966.5
102.0	85.5	2.382	912.3	158.0	141.5	1.937	968.4
104.0	87.5	2.361	914.6	161.0	144.5	1.919	971.2
106.0	89.5	2.340	916.9	164.0	147.5	1.901	974.1
108.0	91.5	2.320	919.1	167.0	150.5	1.884	977.0
110.0	93.5	2.301	921.3	170.0	153.5	1.868	979.9
112.0	95.5	2.282	923.4	173.0	156.5	1.851	982.8
114.0	97.5	2.263	925.5	176.0	159.5	1.835	985.7
116.0	99.5	2.245	927.6	179.0	162.5	1.820	988.6
118.0	101.5	2.227	929.7	182.0	165.5	1.804	991.5
120.0	103.5	2.210	931.7	185.0	168.5	1.789	994.4
122.0	105.5	2.193	933.7	188.0	171.5	1.775	997.3
124.0	107.5	2.176	935.7	191.0	174.5	1.760	1000.0
126.0	109.5	2.160	937.7	194.0	177.5	1.746	1002.7
128.0	111.5	2.144	939.7	197.0	180.5	1.732	1005.3
130.0	113.5	2.128	941.7	200.0	183.5	1.719	1008.0
132.0	115.5	2.113	943.6	203.0	186.5	1.705	1010.4
134.0	117.5	2.098	945.6	206.0	189.5	1.692	1012.7
136.0	119.5	2.083	947.5				

DATE: 9/ 8/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 2

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
19	12:58: 0	21.500	10755.31	591.47	
20	13:13: 0	21.750	7893.63		165.93
21	13:28: 0	22.000	10757.57	596.29	
22	13:43: 0	22.250	7894.17		165.97
23	13:58: 0	22.500	10759.79	601.06	
24	14:13: 0	22.750	7893.87		165.95
25	14:28: 0	23.000	10761.97	605.71	
26	14:43: 0	23.250	7893.20		165.89
27	14:58: 0	23.500	10764.07	610.20	
28	15:13: 0	23.750	7892.82		165.86
29	15:28: 0	24.000	10766.15	614.64	
30	15:43: 0	24.250	7892.18		165.81
31	15:58: 0	24.500	10768.18	618.98	
32	16:13: 0	24.750	7891.46		165.75
33	16:28: 0	25.000	10770.20	623.30	
34	16:43: 0	25.250	7890.69		165.69
35	16:58: 0	25.500	10772.19	627.55	
36	17:13: 0	25.750	7889.89		165.62
37	17:28: 0	26.000	10774.15	631.74	
38	17:43: 0	26.250	7889.15		165.56
39	17:58: 0	26.500	10776.09	635.90	
40	18:13: 0	26.750	7888.45		165.51
41	18:28: 0	27.000	10778.00	639.98	
42	18:43: 0	27.250	7887.71		165.45
43	18:58: 0	27.500	10779.86	643.98	
44	19:13: 0	27.750	7886.94		165.38
45	19:28: 0	28.000	10781.69	647.89	
46	19:43: 0	28.250	7886.28		165.33
47	19:58: 0	28.500	10783.49	651.76	
48	20:13: 0	28.750	7885.55		165.27
49	20:28: 0	29.000	10785.27	655.58	
50	20:43: 0	29.250	7884.21		165.16

GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 2

CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	20:58: 0	29.500	10787.30	659.93	
52	21:13: 0	29.750	7876.75		164.55
53	21:28: 0	30.000	10788.78	663.00	
54	21:43: 0	30.250	7877.27		164.60
55	21:58: 0	30.500	10790.17	666.00	
56	22:13: 0	30.750	7883.59		165.11
57	22:28: 0	31.000	10793.01	672.21	
58	22:43: 0	31.250	7885.24		165.25
59	22:58: 0	31.500	10795.76	678.15	
60	23:13: 0	31.750	7885.36		165.26
61	23:28: 0	32.000	10798.31	683.67	
62	23:43: 0	32.250	7886.84		165.38
63	23:58: 0	32.500	10799.98	687.28	
64	0:13: 0	32.750	7885.46		165.26
65	0:28: 0	33.000	10801.51	690.56	
66	0:43: 0	33.250	7882.40		165.01
67	0:58: 0	33.500	10803.02	693.78	
68	1:13: 0	33.750	7881.15		164.91
69	1:28: 0	34.000	10804.49	696.93	
70	1:43: 0	34.250	7880.11		164.83
71	1:58: 0	34.500	10805.95	700.08	
72	2:13: 0	34.750	7879.48		164.78
73	2:28: 0	35.000	10807.70	703.84	
74	2:43: 0	35.250	7875.29		164.44
75	2:58: 0	35.500	10808.96	706.52	
76	3:13: 0	35.750	7874.61		164.38
77	3:28: 0	36.000	10810.36	709.54	
78	3:43: 0	36.250	7879.49		164.78
79	3:58: 0	36.500	10812.63	714.52	
80	4:13: 0	36.750	7881.18		164.92
81	4:28: 0	37.000	10814.15	717.83	
82	4:43: 0	37.250	7879.59		164.79
83	4:58: 0	37.500	10815.48	720.69	
84	5:13: 0	37.750	7876.38		164.52
85	5:28: 0	38.000	10816.94	723.80	
86	5:43: 0	38.250	7872.62		164.22
87	5:58: 0	38.500	10818.09	726.25	
88	6:13: 0	38.750	7875.86		164.48
89	6:28: 0	39.000	10820.00	730.43	
90	6:43: 0	39.250	7879.28		164.76
91	6:58: 0	39.500	10821.50	733.73	
92	7:13: 0	39.750	7877.04		164.58
93	7:28: 0	40.000	10822.93	736.80	
94	7:43: 0	40.250	7872.10		164.18
95	7:58: 0	40.500	10824.00	739.04	
96	8:13: 0	40.750	7871.88		164.16
97	8:28: 0	41.000	10825.47	742.25	
98	8:43: 0	41.250	7875.85		164.48
99	8:58: 0	41.500	10827.09	745.80	
100	9:13: 0	41.750	7875.49		164.45

DATE: 9/ 9/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 3

COMPANY: BHP
CLIENT: McHugh
WELL NAME: Colorado Laguna Z #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	9:28: 0	42.000	10828.24	748.29	
2	9:43: 0	42.250	7871.07		164.09
3	9:58: 0	42.500	10829.44	750.85	
4	10:13: 0	42.750	7869.56		163.97
5	10:28: 0	43.000	10830.78	753.73	
6	10:43: 0	43.250	7873.71		164.31
7	10:58: 0	43.500	10832.29	757.08	
8	11:13: 0	43.750	7873.62		164.30
9	11:28: 0	44.000	10833.47	759.64	
10	11:43: 0	44.250	7869.15		163.94
11	11:58: 0	44.500	10834.43	761.67	
12	12:13: 0	44.750	7868.96		163.92
13	12:28: 0	45.000	10835.84	764.72	
14	12:43: 0	45.250	7872.37		164.20
15	12:58: 0	45.500	10837.18	767.68	
16	13:13: 0	45.750	7871.49		164.13
17	13:28: 0	46.000	10838.30	770.11	
18	13:43: 0	46.250	7866.80		163.74
19	13:58: 0	46.500	10839.21	772.04	
20	14:13: 0	46.750	7868.47		163.88
21	14:28: 0	47.000	10840.67	775.23	
22	14:43: 0	47.250	7870.94		164.08
23	14:58: 0	47.500	10841.77	777.66	
24	15:13: 0	47.750	7867.57		163.81
25	15:28: 0	48.000	10842.77	779.79	
26	15:43: 0	48.250	7865.34		163.62
27	15:58: 0	48.500	10843.92	782.27	
28	16:13: 0	48.750	7868.84		163.91
29	16:28: 0	49.000	10845.15	785.00	
30	16:43: 0	49.250	7868.53		163.88
31	16:58: 0	49.500	10846.19	787.26	
32	17:13: 0	49.750	7864.15		163.53
33	17:28: 0	50.000	10847.07	789.13	
34	17:43: 0	50.250	7866.94		163.75
35	17:58: 0	50.500	10848.34	791.94	
36	18:13: 0	50.750	7867.65		163.81
37	18:28: 0	51.000	10849.30	794.04	
38	18:43: 0	51.250	7863.37		163.46
39	18:58: 0	51.500	10850.14	795.81	
40	19:13: 0	51.750	7865.29		163.62
41	19:28: 0	52.000	10851.34	798.46	
42	19:43: 0	52.250	7866.81		163.74
43	19:58: 0	52.500	10852.28	800.52	
44	20:13: 0	52.750	7863.00		163.43
45	20:28: 0	53.000	10853.09	802.24	
46	20:43: 0	53.250	7863.76		163.50
47	20:58: 0	53.500	10854.22	804.73	
48	21:13: 0	53.750	7865.75		163.66
49	21:28: 0	54.000	10855.16	806.81	
50	21:43: 0	54.250	7862.70		163.41

DATE: 3/ 3/00
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 3

CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	21:58: 0	54.500	10855.96	808.51	
52	22:13: 0	54.750	7862.23		163.37
53	22:28: 0	55.000	10857.00	810.77	
54	22:43: 0	55.250	7864.65		163.57
55	22:58: 0	55.500	10857.92	812.82	
56	23:13: 0	55.750	7861.89		163.34
57	23:28: 0	56.000	10858.68	814.44	
58	23:43: 0	56.250	7861.33		163.30
59	23:58: 0	56.500	10859.69	816.64	
60	0:13: 0	56.750	7863.30		163.46
61	0:28: 0	57.000	10860.54	818.52	
62	0:43: 0	57.250	7859.91		163.18
63	0:58: 0	57.500	10861.28	820.10	
64	1:13: 0	57.750	7860.99		163.27
65	1:28: 0	58.000	10862.26	822.27	
66	1:43: 0	58.250	7861.99		163.35
67	1:58: 0	58.500	10863.06	824.04	
68	2:13: 0	58.750	7858.40		163.06
69	2:28: 0	59.000	10863.82	825.65	
70	2:43: 0	59.250	7860.87		163.26
71	2:58: 0	59.500	10864.68	827.57	
72	3:13: 0	59.750	7859.97		163.19
73	3:28: 0	60.000	10865.42	829.17	
74	3:43: 0	60.250	7858.49		163.07
75	3:58: 0	60.500	10866.23	830.93	
76	4:13: 0	60.750	7860.39		163.22
77	4:28: 0	61.000	10866.98	832.59	
78	4:43: 0	61.250	7857.19		162.96
79	4:58: 0	61.500	10867.69	834.10	
80	5:13: 0	61.750	7858.73		163.09
81	5:28: 0	62.000	10868.53	835.96	
82	5:43: 0	62.250	7859.04		163.11
83	5:58: 0	62.500	10869.21	837.45	
84	6:13: 0	62.750	7856.62		162.91
85	6:28: 0	63.000	10869.94	839.02	
86	6:43: 0	63.250	7858.68		163.08
87	6:58: 0	63.500	10870.66	840.64	
88	7:13: 0	63.750	7855.57		162.83
89	7:28: 0	64.000	10871.29	841.98	
90	7:43: 0	64.250	7857.38		162.98
91	7:58: 0	64.500	10872.05	843.66	
92	8:13: 0	64.750	7856.73		162.92
93	8:28: 0	65.000	10872.67	845.01	
94	8:43: 0	65.250	7855.83		162.85
95	8:58: 0	65.500	10873.39	846.59	
96	9:13: 0	65.750	7856.76		162.93
97	9:28: 0	66.000	10874.02	847.99	
98	9:43: 0	66.250	7854.00		162.70
99	9:58: 0	66.500	10874.69	849.42	
100	10:13: 0	66.750	7855.93		162.86

DATE: 9/10/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 4

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	10:28: 0	67.000	10875.29	850.75	
2	10:43: 0	67.250	7853.78		162.68
3	10:58: 0	67.500	10875.92	852.11	
4	11:13: 0	67.750	7855.25		162.80
5	11:28: 0	68.000	10876.56	853.53	
6	11:43: 0	68.250	7853.73		162.68
7	11:58: 0	68.500	10877.12	854.73	
8	12:13: 0	68.750	7854.41		162.74
9	12:28: 0	69.000	10877.78	856.20	
10	12:43: 0	69.250	7853.99		162.70
11	12:58: 0	69.500	10878.31	857.36	
12	13:13: 0	69.750	7853.46		162.66
13	13:28: 0	70.000	10878.96	858.78	
14	13:43: 0	70.250	7853.88		162.69
15	13:58: 0	70.500	10879.48	859.92	
16	14:13: 0	70.750	7852.52		162.58
17	14:28: 0	71.000	10880.11	861.28	
18	14:43: 0	71.250	7853.44		162.66
19	14:58: 0	71.500	10880.59	862.36	
20	15:13: 0	71.750	7851.24		162.48
21	15:28: 0	72.000	10881.20	863.67	
22	15:43: 0	72.250	7852.96		162.62
23	15:58: 0	72.500	10881.69	864.76	
24	16:13: 0	72.750	7850.87		162.45
25	16:28: 0	73.000	10882.24	865.96	
26	16:43: 0	73.250	7852.49		162.58
27	16:58: 0	73.500	10882.73	867.05	
28	17:13: 0	73.750	7850.63		162.43
29	17:28: 0	74.000	10883.26	868.20	
30	17:43: 0	74.250	7852.05		162.54
31	17:58: 0	74.500	10883.73	869.25	
32	18:13: 0	74.750	7850.33		162.40
33	18:28: 0	75.000	10884.25	870.37	
34	18:43: 0	75.250	7851.50		162.50
35	18:58: 0	75.500	10884.73	871.43	
36	19:13: 0	75.750	7849.66		162.35
37	19:28: 0	76.000	10885.24	872.53	
38	19:43: 0	76.250	7851.14		162.47
39	19:58: 0	76.500	10885.69	873.53	
40	20:13: 0	76.750	7849.98		162.37
41	20:28: 0	77.000	10886.14	874.51	
42	20:43: 0	77.250	7850.16		162.39
43	20:58: 0	77.500	10886.61	875.56	
44	21:13: 0	77.750	7848.47		162.25
45	21:28: 0	78.000	10887.11	876.63	
46	21:43: 0	78.250	7849.97		162.37
47	21:58: 0	78.500	10887.52	877.55	
48	22:13: 0	78.750	7850.04		162.38
49	22:28: 0	79.000	10887.94	878.47	
50	22:43: 0	79.250	7848.22		162.23

DATE: 9/10/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 4

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	22:58: 0	79.500	10888.39	879.44	
52	23:13: 0	79.750	7849.40		162.33
53	23:28: 0	80.000	10888.81	880.39	
54	23:43: 0	80.250	7848.32		162.24
55	23:58: 0	80.500	10889.22	881.28	
56	0:13: 0	80.750	7848.79		162.28
57	0:28: 0	81.000	10889.64	882.20	
58	0:43: 0	81.250	7847.31		162.16
59	0:58: 0	81.500	10890.04	883.08	
60	1:13: 0	81.750	7848.26		162.23
61	1:28: 0	82.000	10890.44	883.96	
62	1:43: 0	82.250	7848.28		162.24
63	1:58: 0	82.500	10890.83	884.82	
64	2:13: 0	82.750	7848.28		162.24
65	2:28: 0	83.000	10891.22	885.68	
66	2:43: 0	83.250	7848.26		162.23
67	2:58: 0	83.500	10891.61	886.53	
68	3:13: 0	83.750	7848.12		162.22
69	3:28: 0	84.000	10891.98	887.35	
70	3:43: 0	84.250	7847.99		162.21
71	3:58: 0	84.500	10892.36	888.17	
72	4:13: 0	84.750	7847.69		162.19
73	4:28: 0	85.000	10892.73	889.01	
74	4:43: 0	85.250	7847.62		162.18
75	4:58: 0	85.500	10893.09	889.79	
76	5:13: 0	85.750	7847.34		162.16
77	5:28: 0	86.000	10893.45	890.57	
78	5:43: 0	86.250	7847.25		162.15
79	5:58: 0	86.500	10893.81	891.36	
80	6:13: 0	86.750	7847.04		162.14
81	6:28: 0	87.000	10894.17	892.16	
82	6:43: 0	87.250	7846.77		162.11
83	6:58: 0	87.500	10894.53	892.94	
84	7:13: 0	87.750	7846.64		162.10
85	7:28: 0	88.000	10894.87	893.69	
86	7:43: 0	88.250	7846.34		162.08
87	7:58: 0	88.500	10895.21	894.45	
88	8:13: 0	88.750	7846.28		162.07
89	8:28: 0	89.000	10895.55	895.20	
90	8:43: 0	89.250	7846.08		162.06
91	8:58: 0	89.500	10895.88	895.92	
92	9:13: 0	89.750	7845.90		162.04
93	9:28: 0	90.000	10896.22	896.67	
94	9:43: 0	90.250	7845.65		162.02
95	9:58: 0	90.500	10896.54	897.37	
96	10:13: 0	90.750	7845.50		162.01
97	10:28: 0	91.000	10896.86	898.08	
98	10:43: 0	91.250	7845.25		161.99
99	10:58: 0	91.500	10897.19	898.80	
100	11:13: 0	91.750	7845.06		161.97

DATE: 9/11/88 COMPANY: BHG
GAUGE SN #69306 CLIENT: McHugh
WELL # 0 WELL NAME: Colorado Laguna 2 #6
TEST # 1990 TEST OPERATOR: MD
LOCATION:
DATA FILE: 5 COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	11:28: 0	92.000	10897.51	899.49	
2	11:43: 0	92.250	7844.85		161.96
3	11:58: 0	92.500	10897.82	900.19	
4	12:13: 0	92.750	7844.61		161.94
5	12:28: 0	93.000	10898.14	900.87	
6	12:43: 0	93.250	7844.36		161.92
7	12:58: 0	93.500	10898.44	901.54	
8	13:13: 0	93.750	7844.14		161.90
9	13:28: 0	94.000	10898.74	902.21	
10	13:43: 0	94.250	7843.90		161.88
11	13:58: 0	94.500	10899.04	902.86	
12	14:13: 0	94.750	7843.74		161.87
13	14:28: 0	95.000	10899.35	903.53	
14	14:43: 0	95.250	7843.56		161.85
15	14:58: 0	95.500	10899.64	904.19	
16	15:13: 0	95.750	7843.39		161.84
17	15:28: 0	96.000	10899.94	904.84	
18	15:43: 0	96.250	7843.10		161.81
19	15:58: 0	96.500	10900.24	905.50	
20	16:13: 0	96.750	7843.01		161.81
21	16:28: 0	97.000	10900.52	906.12	
22	16:43: 0	97.250	7842.81		161.79
23	16:58: 0	97.500	10900.81	906.76	
24	17:13: 0	97.750	7842.58		161.77
25	17:28: 0	98.000	10901.10	907.39	
26	17:43: 0	98.250	7842.36		161.75
27	17:58: 0	98.500	10901.38	908.01	
28	18:13: 0	98.750	7842.23		161.74
29	18:28: 0	99.000	10901.67	908.64	
30	18:43: 0	99.250	7841.94		161.72
31	18:58: 0	99.500	10901.95	909.25	
32	19:13: 0	99.750	7841.84		161.71
33	19:28: 0	100.000	10902.23	909.87	
34	19:43: 0	100.250	7841.72		161.70
35	19:58: 0	100.500	10902.51	910.48	
36	20:13: 0	100.750	7841.48		161.68
37	20:28: 0	101.000	10902.77	911.07	
38	20:43: 0	101.250	7841.34		161.67
39	20:58: 0	101.500	10903.05	911.67	
40	21:13: 0	101.750	7841.24		161.66
41	21:28: 0	102.000	10903.31	912.26	
42	21:43: 0	102.250	7841.06		161.65
43	21:58: 0	102.500	10903.58	912.85	
44	22:13: 0	102.750	7840.88		161.63
45	22:28: 0	103.000	10903.84	913.43	
46	22:43: 0	103.250	7840.71		161.62
47	22:58: 0	103.500	10904.11	914.02	
48	23:13: 0	103.750	7840.49		161.60
49	23:28: 0	104.000	10904.38	914.59	
50	23:43: 0	104.250	7840.32		161.59

DATE: 9/11/88
GAUGE SN #69308
WELL # 0
TEST # 1990

DATA FILE: S

COMPANY: BHP
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	23:58: 0	104.500	10904.63	915.16	
52	0:13: 0	104.750	7840.17		161.58
53	0:28: 0	105.000	10904.90	915.75	
54	0:43: 0	105.250	7840.02		161.56
55	0:58: 0	105.500	10905.15	916.30	
56	1:13: 0	105.750	7839.88		161.55
57	1:28: 0	106.000	10905.41	916.88	
58	1:43: 0	106.250	7839.62		161.53
59	1:58: 0	106.500	10905.66	917.43	
60	2:13: 0	106.750	7839.45		161.52
61	2:28: 0	107.000	10905.92	917.98	
62	2:43: 0	107.250	7839.19		161.50
63	2:58: 0	107.500	10906.17	918.55	
64	3:13: 0	107.750	7838.97		161.48
65	3:28: 0	108.000	10906.42	919.09	
66	3:43: 0	108.250	7838.73		161.46
67	3:58: 0	108.500	10906.67	919.64	
68	4:13: 0	108.750	7838.64		161.45
69	4:28: 0	109.000	10906.91	920.17	
70	4:43: 0	109.250	7838.48		161.44
71	4:58: 0	109.500	10907.16	920.72	
72	5:13: 0	109.750	7838.18		161.41
73	5:28: 0	110.000	10907.41	921.26	
74	5:43: 0	110.250	7838.06		161.40
75	5:58: 0	110.500	10907.66	921.81	
76	6:13: 0	110.750	7837.92		161.39
77	6:28: 0	111.000	10907.90	922.34	
78	6:43: 0	111.250	7837.70		161.38
79	6:58: 0	111.500	10908.14	922.88	
80	7:13: 0	111.750	7837.59		161.37
81	7:28: 0	112.000	10908.38	923.40	
82	7:43: 0	112.250	7837.36		161.35
83	7:58: 0	112.500	10908.63	923.95	
84	8:13: 0	112.750	7837.12		161.33
85	8:28: 0	113.000	10908.87	924.49	
86	8:43: 0	113.250	7837.02		161.32
87	8:58: 0	113.500	10909.11	925.01	
88	9:13: 0	113.750	7836.88		161.31
89	9:28: 0	114.000	10909.35	925.54	
90	9:43: 0	114.250	7836.62		161.29
91	9:58: 0	114.500	10909.58	926.05	
92	10:13: 0	114.750	7836.50		161.28
93	10:28: 0	115.000	10909.82	926.58	
94	10:43: 0	115.250	7836.31		161.26
95	10:58: 0	115.500	10910.06	927.11	
96	11:13: 0	115.750	7836.15		161.25
97	11:28: 0	116.000	10910.30	927.63	
98	11:43: 0	116.250	7835.95		161.23
99	11:58: 0	116.500	10910.52	928.13	
100	12:13: 0	116.750	7835.74		161.22

DATE: 9/12/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 6

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	12:28: 0	117.000	10910.75	928.63	
2	12:43: 0	117.250	7835.57		161.20
3	12:58: 0	117.500	10910.98	929.14	
4	13:13: 0	117.750	7835.39		161.19
5	13:28: 0	118.000	10911.22	929.67	
6	13:43: 0	118.250	7835.26		161.18
7	13:58: 0	118.500	10911.45	930.16	
8	14:13: 0	118.750	7835.04		161.16
9	14:28: 0	119.000	10911.68	930.67	
10	14:43: 0	119.250	7834.85		161.14
11	14:58: 0	119.500	10911.91	931.18	
12	15:13: 0	119.750	7834.65		161.13
13	15:28: 0	120.000	10912.14	931.69	
14	15:43: 0	120.250	7834.48		161.11
15	15:58: 0	120.500	10912.37	932.18	
16	16:13: 0	120.750	7834.38		161.10
17	16:28: 0	121.000	10912.60	932.70	
18	16:43: 0	121.250	7834.30		161.10
19	16:58: 0	121.500	10912.83	933.21	
20	17:13: 0	121.750	7834.12		161.08
21	17:28: 0	122.000	10913.06	933.71	
22	17:43: 0	122.250	7833.97		161.07
23	17:58: 0	122.500	10913.29	934.22	
24	18:13: 0	122.750	7833.73		161.05
25	18:28: 0	123.000	10913.51	934.71	
26	18:43: 0	123.250	7833.52		161.04
27	18:58: 0	123.500	10913.74	935.21	
28	19:13: 0	123.750	7833.45		161.03
29	19:28: 0	124.000	10913.97	935.73	
30	19:43: 0	124.250	7833.24		161.01
31	19:58: 0	124.500	10914.20	936.23	
32	20:13: 0	124.750	7833.05		161.00
33	20:28: 0	125.000	10914.43	936.74	
34	20:43: 0	125.250	7832.89		160.98
35	20:58: 0	125.500	10914.65	937.23	
36	21:13: 0	125.750	7832.74		160.97
37	21:28: 0	126.000	10914.88	937.73	
38	21:43: 0	126.250	7832.56		160.96
39	21:58: 0	126.500	10915.12	938.25	
40	22:13: 0	126.750	7832.41		160.94
41	22:28: 0	127.000	10915.34	938.74	
42	22:43: 0	127.250	7832.20		160.93
43	22:58: 0	127.500	10915.56	939.22	
44	23:13: 0	127.750	7831.94		160.91
45	23:28: 0	128.000	10915.79	939.73	
46	23:43: 0	128.250	7831.86		160.90
47	23:58: 0	128.500	10916.02	940.23	
48	0:13: 0	128.750	7831.66		160.88
49	0:28: 0	129.000	10916.23	940.70	
50	0:43: 0	129.250	7831.55		160.87

DATE: 9/13/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 6

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	0:58: 0	129.500	10916.46	941.22	
52	1:13: 0	129.750	7831.37		160.86
53	1:28: 0	130.000	10916.68	941.70	
54	1:43: 0	130.250	7831.26		160.85
55	1:58: 0	130.500	10916.90	942.19	
56	2:13: 0	130.750	7831.09		160.84
57	2:28: 0	131.000	10917.12	942.67	
58	2:43: 0	131.250	7830.98		160.83
59	2:58: 0	131.500	10917.34	943.15	
60	3:13: 0	131.750	7830.83		160.82
61	3:28: 0	132.000	10917.56	943.64	
62	3:43: 0	132.250	7830.70		160.81
63	3:58: 0	132.500	10917.78	944.12	
64	4:13: 0	132.750	7830.46		160.79
65	4:28: 0	133.000	10918.00	944.61	
66	4:43: 0	133.250	7830.37		160.78
67	4:58: 0	133.500	10918.22	945.10	
68	5:13: 0	133.750	7830.15		160.76
69	5:28: 0	134.000	10918.43	945.56	
70	5:43: 0	134.250	7830.01		160.75
71	5:58: 0	134.500	10918.65	946.04	
72	6:13: 0	134.750	7829.87		160.74
73	6:28: 0	135.000	10918.87	946.52	
74	6:43: 0	135.250	7829.73		160.73
75	6:58: 0	135.500	10919.09	947.02	
76	7:13: 0	135.750	7829.60		160.72
77	7:28: 0	136.000	10919.31	947.50	
78	7:43: 0	136.250	7829.47		160.71
79	7:58: 0	136.500	10919.53	947.98	
80	8:13: 0	136.750	7829.26		160.69
81	8:28: 0	137.000	10919.74	948.45	
82	8:43: 0	137.250	7829.14		160.68
83	8:58: 0	137.500	10919.96	948.94	
84	9:13: 0	137.750	7829.00		160.67
85	9:28: 0	138.000	10920.17	949.39	
86	9:43: 0	138.250	7828.88		160.66
87	9:58: 0	138.500	10920.39	949.88	
88	10:13: 0	138.750	7828.71		160.64
89	10:28: 0	139.000	10920.60	950.34	
90	10:43: 0	139.250	7828.53		160.63
91	10:58: 0	139.500	10920.81	950.81	
92	11:13: 0	139.750	7828.39		160.62
93	11:28: 0	140.000	10921.03	951.29	
94	11:43: 0	140.250	7828.24		160.61
95	11:58: 0	140.500	10921.23	951.75	
96	12:13: 0	140.750	7828.16		160.60
97	12:28: 0	141.000	10921.45	952.22	
98	12:43: 0	141.250	7827.99		160.58
99	12:58: 0	141.500	10921.66	952.70	
100	13:13: 0	141.750	7827.86		160.57

DATE: 9/13/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 7

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	13:28: 0	142.000	10921.88	953.17	
2	13:43: 0	142.250	7827.75		160.57
3	13:58: 0	142.500	10922.09	953.64	
4	14:13: 0	142.750	7827.61		160.55
5	14:28: 0	143.000	10922.29	954.09	
6	14:43: 0	143.250	7827.49		160.54
7	14:58: 0	143.500	10922.51	954.57	
8	15:13: 0	143.750	7827.32		160.53
9	15:28: 0	144.000	10922.72	955.04	
10	15:43: 0	144.250	7827.25		160.53
11	15:58: 0	144.500	10922.94	955.51	
12	16:13: 0	144.750	7827.13		160.52
13	16:28: 0	145.000	10923.15	955.98	
14	16:43: 0	145.250	7826.96		160.50
15	16:58: 0	145.500	10923.36	956.45	
16	17:13: 0	145.750	7826.84		160.49
17	17:28: 0	146.000	10923.57	956.92	
18	17:43: 0	146.250	7826.77		160.49
19	17:58: 0	146.500	10923.78	957.39	
20	18:13: 0	146.750	7826.62		160.47
21	18:28: 0	147.000	10924.00	957.87	
22	18:43: 0	147.250	7826.52		160.47
23	18:58: 0	147.500	10924.21	958.34	
24	19:13: 0	147.750	7826.39		160.45
25	19:28: 0	148.000	10924.43	958.81	
26	19:43: 0	148.250	7826.24		160.44
27	19:58: 0	148.500	10924.64	959.29	
28	20:13: 0	148.750	7826.17		160.44
29	20:28: 0	149.000	10924.86	959.76	
30	20:43: 0	149.250	7826.03		160.43
31	20:58: 0	149.500	10925.07	960.23	
32	21:13: 0	149.750	7825.93		160.42
33	21:28: 0	150.000	10925.29	960.72	
34	21:43: 0	150.250	7825.76		160.40
35	21:58: 0	150.500	10925.50	961.18	
36	22:13: 0	150.750	7825.66		160.40
37	22:28: 0	151.000	10925.72	961.67	
38	22:43: 0	151.250	7825.52		160.38
39	22:58: 0	151.500	10925.93	962.13	
40	23:13: 0	151.750	7825.40		160.37
41	23:28: 0	152.000	10926.14	962.61	
42	23:43: 0	152.250	7825.28		160.37
43	23:58: 0	152.500	10926.36	963.09	
44	0:13: 0	152.750	7825.16		160.36
45	0:28: 0	153.000	10926.57	963.56	
46	0:43: 0	153.250	7825.07		160.35
47	0:58: 0	153.500	10926.80	964.07	
48	1:13: 0	153.750	7824.92		160.34
49	1:28: 0	154.000	10927.02	964.55	
50	1:43: 0	154.250	7824.79		160.33

DATE: 3/14/90 COMMENT: ENG

GAUGE SN #69306 CLIENT: McHugh

WELL # 0 WELL NAME: Colorado Laguna 2 #6

TEST # 1990 TEST OPERATOR: MD

LOCATION:

DATA FILE: 7 COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	1:58: 0	154.500	10927.23	965.02	
52	2:13: 0	154.750	7824.63		160.31
53	2:28: 0	155.000	10927.45	965.50	
54	2:43: 0	155.250	7824.53		160.30
55	2:58: 0	155.500	10927.67	965.99	
56	3:13: 0	155.750	7824.33		160.29
57	3:28: 0	156.000	10927.89	966.47	
58	3:43: 0	156.250	7824.21		160.28
59	3:58: 0	156.500	10928.11	966.95	
60	4:13: 0	156.750	7824.06		160.27
61	4:28: 0	157.000	10928.33	967.44	
62	4:43: 0	157.250	7823.93		160.25
63	4:58: 0	157.500	10928.54	967.92	
64	5:13: 0	157.750	7823.75		160.24
65	5:28: 0	158.000	10928.76	968.39	
66	5:43: 0	158.250	7823.57		160.23
67	5:58: 0	158.500	10928.97	968.87	
68	6:13: 0	158.750	7823.39		160.21
69	6:28: 0	159.000	10929.19	969.34	
70	6:43: 0	159.250	7823.18		160.19
71	6:58: 0	159.500	10929.40	969.80	
72	7:13: 0	159.750	7823.09		160.19
73	7:28: 0	160.000	10929.62	970.29	
74	7:43: 0	160.250	7822.92		160.17
75	7:58: 0	160.500	10929.83	970.76	
76	8:13: 0	160.750	7822.84		160.17
77	8:28: 0	161.000	10930.05	971.25	
78	8:43: 0	161.250	7822.70		160.15
79	8:58: 0	161.500	10930.27	971.73	
80	9:13: 0	161.750	7822.58		160.14
81	9:28: 0	162.000	10930.48	972.20	
82	9:43: 0	162.250	7822.42		160.13
83	9:58: 0	162.500	10930.70	972.68	
84	10:13: 0	162.750	7822.27		160.12
85	10:28: 0	163.000	10930.92	973.17	
86	10:43: 0	163.250	7822.12		160.11
87	10:58: 0	163.500	10931.13	973.64	
88	11:13: 0	163.750	7822.00		160.10
89	11:28: 0	164.000	10931.34	974.10	
90	11:43: 0	164.250	7821.91		160.09
91	11:58: 0	164.500	10931.56	974.59	
92	12:13: 0	164.750	7821.76		160.08
93	12:28: 0	165.000	10931.77	975.07	
94	12:43: 0	165.250	7821.69		160.07
95	12:58: 0	165.500	10932.00	975.56	
96	13:13: 0	165.750	7821.53		160.06
97	13:28: 0	166.000	10932.22	976.05	
98	13:43: 0	166.250	7821.41		160.05
99	13:58: 0	166.500	10932.42	976.50	
100	14:13: 0	166.750	7821.30		160.04

DATE: 9/14/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 8

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	14:28: 0	167.000	10932.64	976.98	
2	14:43: 0	167.250	7821.14		160.03
3	14:58: 0	167.500	10932.86	977.48	
4	15:13: 0	167.750	7820.98		160.02
5	15:28: 0	168.000	10933.08	977.96	
6	15:43: 0	168.250	7820.87		160.01
7	15:58: 0	168.500	10933.30	978.44	
8	16:13: 0	168.750	7820.79		160.00
9	16:28: 0	169.000	10933.52	978.93	
10	16:43: 0	169.250	7820.71		159.99
11	16:58: 0	169.500	10933.74	979.42	
12	17:13: 0	169.750	7820.50		159.98
13	17:28: 0	170.000	10933.96	979.90	
14	17:43: 0	170.250	7820.33		159.96
15	17:58: 0	170.500	10934.17	980.39	
16	18:13: 0	170.750	7820.12		159.95
17	18:28: 0	171.000	10934.39	980.87	
18	18:43: 0	171.250	7819.94		159.93
19	18:58: 0	171.500	10934.61	981.35	
20	19:13: 0	171.750	7819.73		159.91
21	19:28: 0	172.000	10934.83	981.83	
22	19:43: 0	172.250	7819.62		159.90
23	19:58: 0	172.500	10935.04	982.31	
24	20:13: 0	172.750	7819.51		159.90
25	20:28: 0	173.000	10935.26	982.78	
26	20:43: 0	173.250	7819.43		159.89
27	20:58: 0	173.500	10935.49	983.29	
28	21:13: 0	173.750	7819.26		159.87
29	21:28: 0	174.000	10935.70	983.77	
30	21:43: 0	174.250	7819.07		159.86
31	21:58: 0	174.500	10935.92	984.26	
32	22:13: 0	174.750	7818.96		159.85
33	22:28: 0	175.000	10936.14	984.75	
34	22:43: 0	175.250	7818.84		159.84
35	22:58: 0	175.500	10936.36	985.22	
36	23:13: 0	175.750	7818.73		159.83
37	23:28: 0	176.000	10936.58	985.72	
38	23:43: 0	176.250	7818.64		159.82
39	23:58: 0	176.500	10936.80	986.21	
40	0:13: 0	176.750	7818.54		159.82
41	0:28: 0	177.000	10937.02	986.70	
42	0:43: 0	177.250	7818.48		159.81
43	0:58: 0	177.500	10937.24	987.19	
44	1:13: 0	177.750	7818.33		159.80
45	1:28: 0	178.000	10937.46	987.66	
46	1:43: 0	178.250	7818.28		159.80
47	1:58: 0	178.500	10937.67	988.15	
48	2:13: 0	178.750	7818.18		159.79
49	2:28: 0	179.000	10937.89	988.63	
50	2:43: 0	179.250	7818.06		159.78

DATE: 9/15/88 COMPANY: BHP
GAUGE SN #69306 CLIENT: McHugh
WELL # 0 WELL NAME: Colorado Laguna 2 #6
TEST # 1990 TEST OPERATOR: MD
LOCATION:
DATA FILE: 8 COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	2:58: 0	179.500	10938.11	989.12	
52	3:13: 0	179.750	7817.98		159.77
53	3:28: 0	180.000	10938.33	989.61	
54	3:43: 0	180.250	7817.87		159.76
55	3:58: 0	180.500	10938.54	990.08	
56	4:13: 0	180.750	7817.76		159.75
57	4:28: 0	181.000	10938.77	990.57	
58	4:43: 0	181.250	7817.73		159.75
59	4:58: 0	181.500	10938.98	991.06	
60	5:13: 0	181.750	7817.61		159.74
61	5:28: 0	182.000	10939.20	991.54	
62	5:43: 0	182.250	7817.52		159.73
63	5:58: 0	182.500	10939.43	992.04	
64	6:13: 0	182.750	7817.43		159.73
65	6:28: 0	183.000	10939.64	992.51	
66	6:43: 0	183.250	7817.36		159.72
67	6:58: 0	183.500	10939.86	992.99	
68	7:13: 0	183.750	7817.32		159.72
69	7:28: 0	184.000	10940.07	993.48	
70	7:43: 0	184.250	7817.23		159.71
71	7:58: 0	184.500	10940.28	993.95	
72	8:13: 0	184.750	7817.24		159.71
73	8:28: 0	185.000	10940.51	994.44	
74	8:43: 0	185.250	7817.12		159.70
75	8:58: 0	185.500	10940.72	994.91	
76	9:13: 0	185.750	7817.05		159.70
77	9:28: 0	186.000	10940.93	995.39	
78	9:43: 0	186.250	7817.00		159.69
79	9:58: 0	186.500	10941.14	995.86	
80	10:13: 0	186.750	7816.92		159.68
81	10:28: 0	187.000	10941.36	996.33	
82	10:43: 0	187.250	7816.81		159.68
83	10:58: 0	187.500	10941.57	996.80	
84	11:13: 0	187.750	7816.71		159.67
85	11:28: 0	188.000	10941.77	997.26	
86	11:43: 0	188.250	7816.60		159.66
87	11:58: 0	188.500	10941.99	997.73	
88	12:13: 0	188.750	7816.54		159.65
89	12:28: 0	189.000	10942.19	998.19	
90	12:43: 0	189.250	7816.43		159.65
91	12:58: 0	189.500	10942.41	998.66	
92	13:13: 0	189.750	7816.27		159.63
93	13:28: 0	190.000	10942.61	999.12	
94	13:43: 0	190.250	7816.23		159.63
95	13:58: 0	190.500	10942.81	999.57	
96	14:13: 0	190.750	7816.11		159.62
97	14:28: 0	191.000	10943.02	1000.02	
98	14:43: 0	191.250	7816.07		159.62
99	14:58: 0	191.500	10943.22	1000.47	
100	15:13: 0	191.750	7815.94		159.60

DATE: 9/15/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 9

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	15:28: 0	192.000	10943.43	1000.94	
2	15:43: 0	192.250	7815.81		159.59
3	15:58: 0	192.500	10943.63	1001.39	
4	16:13: 0	192.750	7815.73		159.59
5	16:28: 0	193.000	10943.83	1001.84	
6	16:43: 0	193.250	7815.63		159.58
7	16:58: 0	193.500	10944.03	1002.28	
8	17:13: 0	193.750	7815.60		159.58
9	17:28: 0	194.000	10944.22	1002.70	
10	17:43: 0	194.250	7815.47		159.57
11	17:58: 0	194.500	10944.43	1003.15	
12	18:13: 0	194.750	7815.38		159.56
13	18:28: 0	195.000	10944.62	1003.58	
14	18:43: 0	195.250	7815.28		159.55
15	18:58: 0	195.500	10944.82	1004.03	
16	19:13: 0	195.750	7815.15		159.54
17	19:28: 0	196.000	10945.02	1004.47	
18	19:43: 0	196.250	7815.11		159.54
19	19:58: 0	196.500	10945.21	1004.89	
20	20:13: 0	196.750	7815.02		159.53
21	20:28: 0	197.000	10945.40	1005.32	
22	20:43: 0	197.250	7814.87		159.52
23	20:58: 0	197.500	10945.60	1005.76	
24	21:13: 0	197.750	7814.75		159.51
25	21:28: 0	198.000	10945.79	1006.18	
26	21:43: 0	198.250	7814.64		159.50
27	21:58: 0	198.500	10945.98	1006.61	
28	22:13: 0	198.750	7814.51		159.49
29	22:28: 0	199.000	10946.17	1007.03	
30	22:43: 0	199.250	7814.41		159.48
31	22:58: 0	199.500	10946.36	1007.45	
32	23:13: 0	199.750	7814.29		159.47
33	23:28: 0	200.000	10946.55	1007.86	
34	23:43: 0	200.250	7814.17		159.46
35	23:58: 0	200.500	10946.74	1008.29	
36	0:13: 0	200.750	7814.06		159.45
37	0:28: 0	201.000	10946.92	1008.70	
38	0:43: 0	201.250	7813.98		159.45
39	0:58: 0	201.500	10947.10	1009.09	
40	1:13: 0	201.750	7813.96		159.44
41	1:28: 0	202.000	10947.32	1009.58	
42	1:43: 0	202.250	7813.84		159.43
43	1:58: 0	202.500	10947.49	1009.97	
44	2:13: 0	202.750	7813.68		159.42
45	2:28: 0	203.000	10947.67	1010.36	
46	2:43: 0	203.250	7813.58		159.41
47	2:58: 0	203.500	10947.85	1010.76	
48	3:13: 0	203.750	7813.48		159.41
49	3:28: 0	204.000	10948.02	1011.14	
50	3:43: 0	204.250	7813.38		159.40

DATE: 5/18/90
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 9

CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	3:58: 0	204.500	10948.19	1011.51	
52	4:13: 0	204.750	7813.24		159.39
53	4:28: 0	205.000	10948.36	1011.90	
54	4:43: 0	205.250	7813.16		159.38
55	4:58: 0	205.500	10948.54	1012.29	
56	5:13: 0	205.750	7812.77		159.35
57	5:28: 0	206.000	10948.71	1012.68	
58	5:43: 0	206.250	21811.42		5085.59
59	5:58: 0	206.500	21811.42		5085.59
60	6:13: 0	206.750	21811.42		5085.59
61	6:28: 0	230.000	10939.20	991.54	
62	6:43: 0	230.250	7817.52		159.73
63	6:58: 0	230.500	10939.43	992.04	
64	7:13: 0	230.750	7817.43		159.73
65	7:28: 0	231.000	10939.64	992.51	
66	7:43: 0	231.250	7817.36		159.72
67	7:58: 0	231.500	10939.86	992.99	
68	8:13: 0	231.750	7817.32		159.72
69	8:28: 0	232.000	10940.07	993.48	
70	8:43: 0	232.250	7817.23		159.71
71	8:58: 0	232.500	10940.28	993.95	
72	9:13: 0	232.750	7817.24		159.71
73	9:28: 0	233.000	10940.51	994.44	
74	9:43: 0	233.250	7817.12		159.70
75	9:58: 0	233.500	10940.72	994.91	
76	10:13: 0	233.750	7817.05		159.70
77	10:28: 0	234.000	10940.93	995.39	
78	10:43: 0	234.250	7817.00		159.69
79	10:58: 0	234.500	10941.14	995.86	
80	11:13: 0	234.750	7816.92		159.68
81	11:28: 0	235.000	10941.36	996.33	
82	11:43: 0	235.250	7816.81		159.68
83	11:58: 0	235.500	10941.57	996.80	
84	12:13: 0	235.750	7816.71		159.67
85	12:28: 0	236.000	10941.77	997.26	
86	12:43: 0	236.250	7816.60		159.66
87	12:58: 0	236.500	10941.98	997.73	
88	13:13: 0	236.750	7816.54		159.65
89	13:28: 0	237.000	10942.19	998.19	
90	13:43: 0	237.250	7816.43		159.65
91	13:58: 0	237.500	10942.41	998.66	
92	14:13: 0	237.750	7816.27		159.63
93	14:28: 0	238.000	10942.61	999.12	
94	14:43: 0	238.250	7816.23		159.63
95	14:58: 0	238.500	10942.81	999.57	
96	15:13: 0	238.750	7816.11		159.62
97	15:28: 0	239.000	10943.02	1000.02	
98	15:43: 0	239.250	7816.07		159.62
99	15:58: 0	239.500	10943.22	1000.47	
100	16:13: 0	239.750	7815.94		159.60

TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Amoco Schmitz Ant. Fed.

ELEVATION 7274' KB

DEPTH OF BOMB 6464'

DATE SHUT IN Sept. 10, 1988

TIME SHUT IN 8:00 AM

PRODUCTION RATE PRIOR TO SHUT-IN 70 BOPD

_____ MCFD

GAS-OIL RATIO 500 MCF/BBL
(est. solution GOR)

B_O 1.3

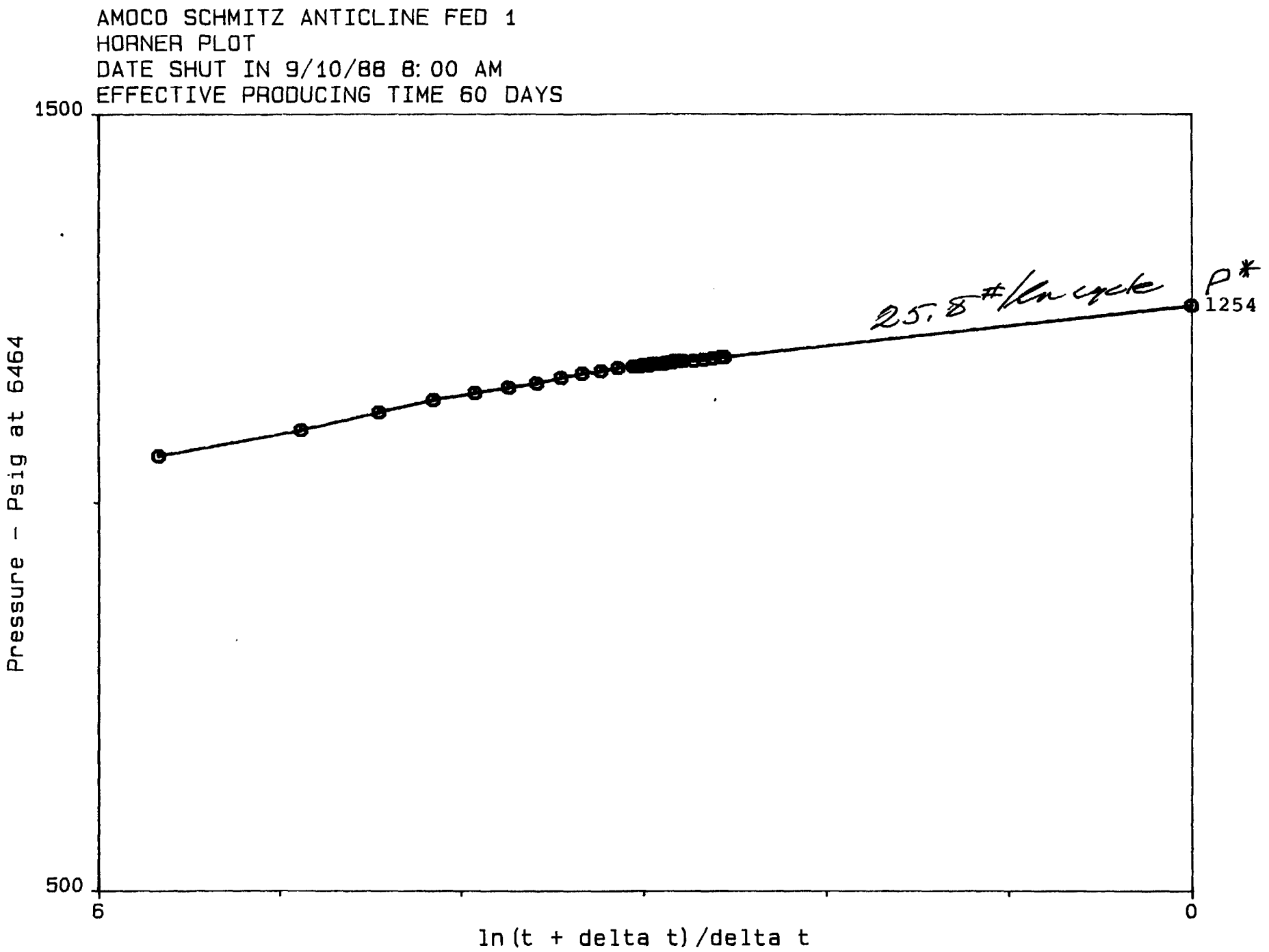
B_T 1.3

first slope, m 40.5 /ln cycle
second slope, m 25.8 /ln cycle

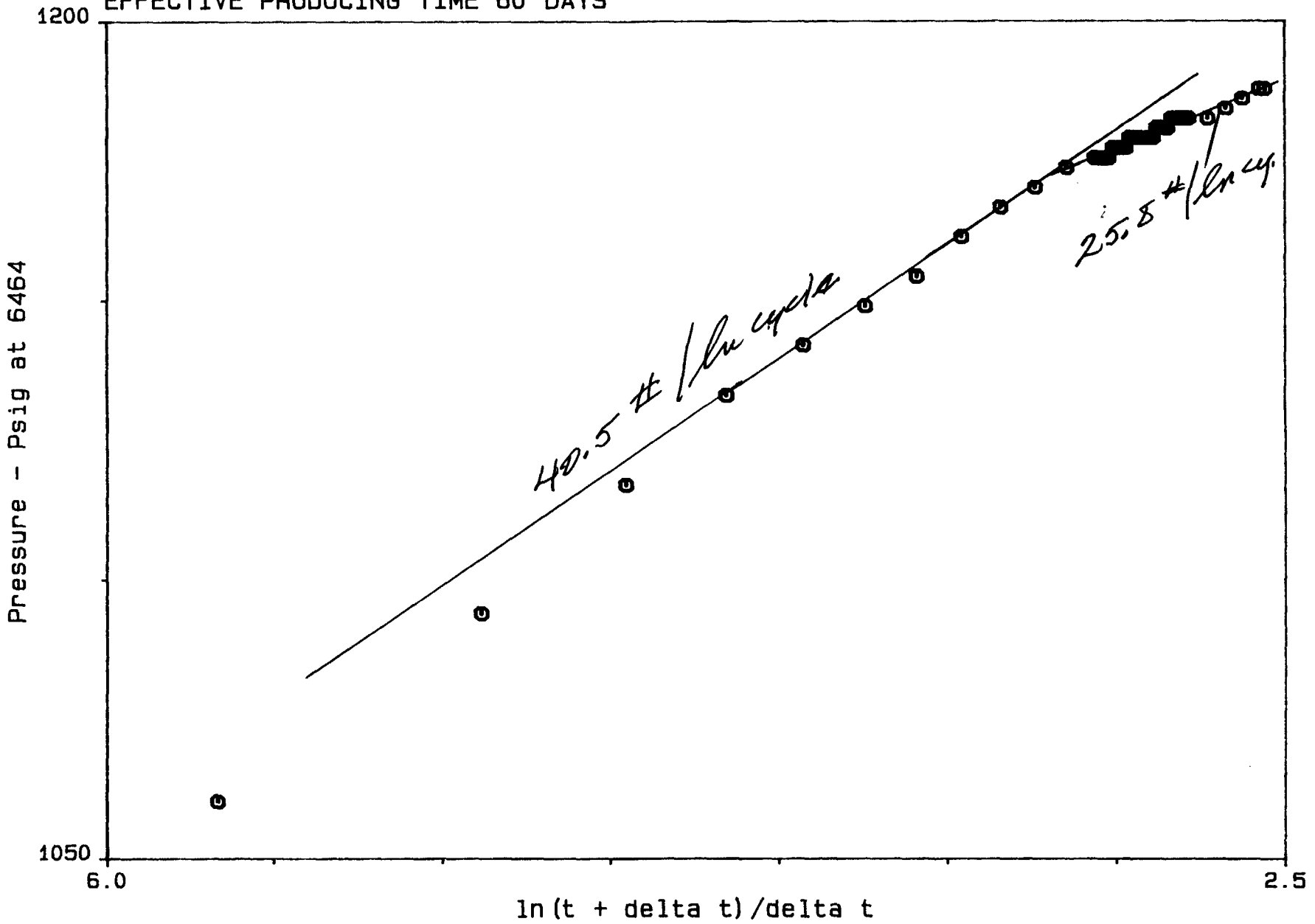
$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\, B_T}{14.16 \times m \text{ (ln cycle)}} = \begin{matrix} .16 \text{ darcy feet/cp 1st slope} \\ .25 \text{ darcy feet/cp 2nd slope} \end{matrix}$$

Plots with expanded scales are next following along with determination of Horner P*.

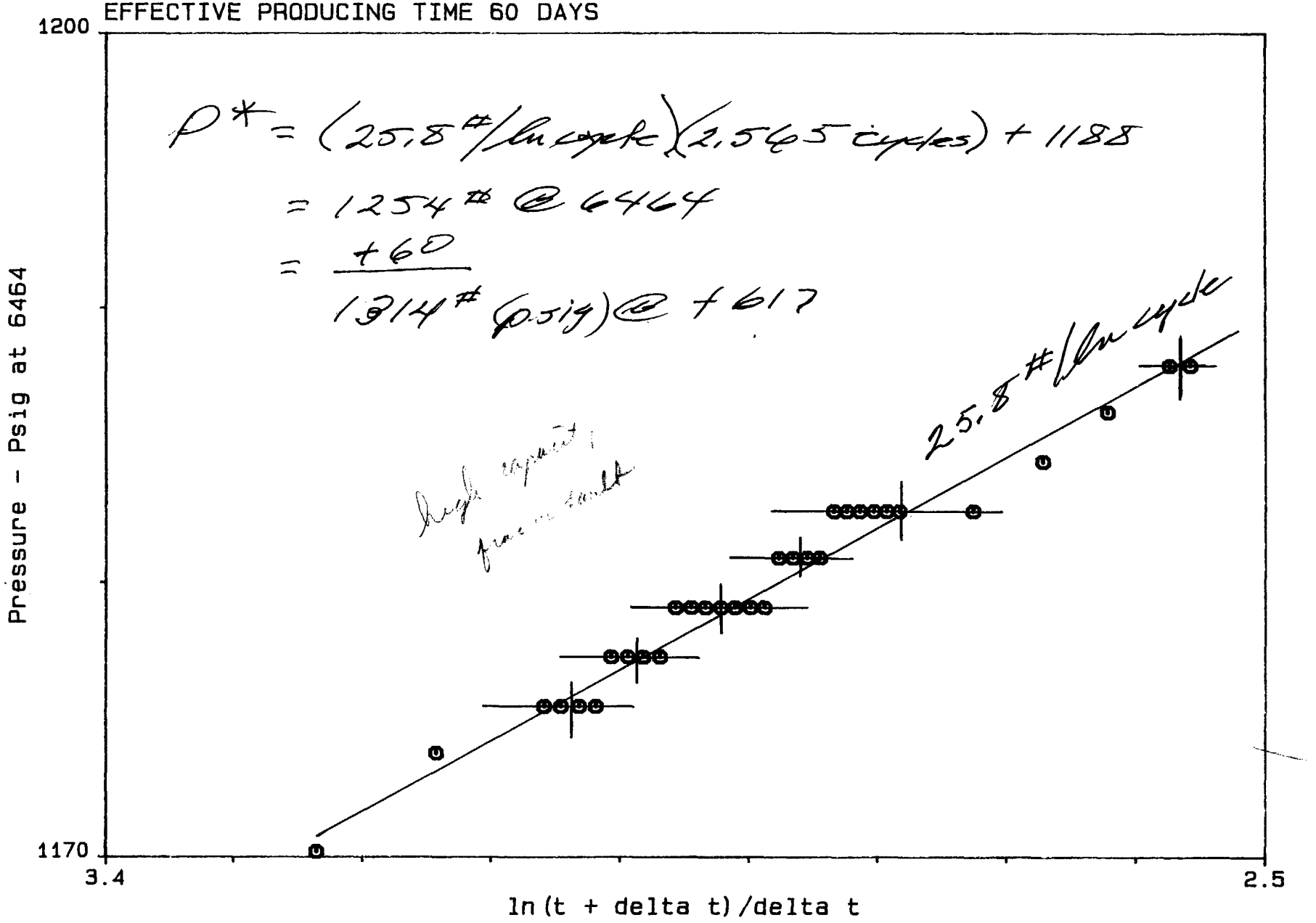
Copy of survey and data for Horner plot are at back of this section.


AMOCO SCHMITZ ANTICLINE FED 1
HORNER PLOT
DATE SHUT IN 9/10/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS
1500
500
Pressure - Psig at 6464
6
0
ln (t + delta t)/delta t
25.8 #/ln cycle
P*
1254

AMOCO SCHMITZ ANTICLINE FED. 1
HORNER PLOT
DATE SHUT IN 9/10/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS



AMOCO SCHMITZ ANTICLINE FED. 1
HORNER PLOT
DATE SHUT IN 9/10/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS



AMOCO SCHMITZ ANTICLINE #1

HORNER PLOT OF PRESSURE BUILD-UP

WELL SHUT IN 8:00 AM SEPTEMBER 10, 1988

Δt TIME = BOMB TIME PLUS 5 HOURS

EFFECTIVE PRODUCING TIME 60 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
0.00	5.00	5.666	1060.3	76.00	81.00	2.933	1179.1
6.00	11.00	4.882	1094.0	77.00	82.00	2.921	1179.1
12.00	17.00	4.451	1117.0	78.00	83.00	2.910	1179.1
18.00	23.00	4.153	1133.0	79.00	84.00	2.898	1179.1
24.00	29.00	3.925	1142.0	80.00	85.00	2.887	1179.1
30.00	35.00	3.741	1149.0	81.00	86.00	2.876	1180.9
36.00	41.00	3.587	1154.3	82.00	87.00	2.895	1180.9
42.00	47.00	3.454	1161.4	83.00	88.00	2.854	1180.9
48.00	53.00	3.338	1166.7	84.00	89.00	2.844	1180.9
54.00	59.00	3.235	1170.2	85.00	90.00	2.833	1182.6
60.00	65.00	3.142	1173.8	86.00	91.00	2.823	1182.6
66.00	71.00	3.058	1175.5	87.00	92.00	2.813	1182.6
67.00	72.00	3.045	1175.5	88.00	93.00	2.802	1182.6
68.00	73.00	3.031	1175.5	89.00	94.00	2.792	1182.6
69.00	71.00	3.018	1175.5	90.00	95.00	2.782	1182.6
70.00	75.00	3.006	1177.3	96.00	101.00	2.725	1182.6
71.00	76.00	2.993	1177.3	102.00	107.00	2.671	1184.4
72.00	77.00	2.981	1177.3	108.00	113.00	2.621	1186.2
73.00	78.00	2.968	1177.3	114.00	119.00	2.573	1187.9
74.00	79.00	2.956	1179.1	116.00	121.00	2.557	1187.9
75.00	80.00	2.944	1179.1				

Amoco Production Company
Southern Division
1670 Broadway
P.O. Box 800
Denver, Colorado 80201
303-830-4040

SEP 29 1988

T. D. Autry
Division Production Manager

September 26, 1988

Benson-Montin Greer Drilling Corp.
221 Petroleum Center Building
Farmington, NM 87401

File: LF-209-WF

Schmitz Anticline No. 1
Bottomhole Pressure Data
Rio Arriba County, New Mexico

We are transmitting the bottomhole pressure data recorded on the subject well which was obtained during the period September 10th through the 15th of 1988.

Please direct questions concerning this data to Richard Jones at (303)830-4085.

T D Autry/67

GRJ47ca

Attachments

WELL CHART ANALYSIS

PERFORMED B

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 27599
TICKET NUMBER 704

PREPARED FOR

COMPANY NAME ..... AMOCO PRODUCTION CO

WELL NAME ..... SCHMITZ-ANTICLINE FED. #1
FIELD NAME ..... GALLUP
LOCATION ..... RIO ARRIBA/N. MEX.
TYPE OF TEST ..... INTERFERENCE
BHP RECORDED @ 6464' G.L

ILLEGIBLE

	TIME		PREV [illegible]
	REAL	ELAPSED	
9-10-88	12:58:00	00:00:00	1,062.50
	00:58:07	12:00:07	1,116.94
	12:59:18	24:00:18	1,143.15
	00:58:07	36:00:07	1,155.24
	12:58:09	48:00:09	1,167.34
	00:58:12	60:00:12	1,175.40
	12:58:14	72:00:14	1,177.42
	00:58:03	84:00:03	1,181.45
	12:58:05	96:00:05	1,183.47
	00:58:17	108:00:07	1,187.50
	09:44:00	116:[illegible]:00	1,189.52

ILLEGIBLE

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME . . . . B&R SERVICE INC.

GAUGE TYPE . . . . . KPG
GAUGE NUMBER . . . . . 0[illegible]351
TICKET NUMBER 703

PREPARED FOR

COMPANY NAME . . . . AMOCO PRODUCTION CO.

WELL NAME . . . . . SCHMITZ-ARTICHOKE STD. #1
FIELD NAME . . . . . GALLUP
LOCATION . . . . . RIO ARRIBA/N.MEX.
TYPE OF TEST . . . . INTERFERENCE

BHP RECORDED @ 6464 G.L.

ILLEGIBLE

	TIME		PRESSURE PSI
	REAL	ELAPSED	
9-10-88	12:58:00	00:00:00	1,060.28
	18:58:09	06:00:09	1,093.97
	00:58:04	12:00:04	1,117.02
	06:58:00	18:00:00	1,132.98
	12:58:09	24:00:09	1,144.84
	18:58:05	30:00:05	1,148.94
	00:58:01	36:00:01	1,154.26
	04:58:10	42:00:10	1,161.35
	12:58:05	48:00:05	1,166.67
	18:58:01	54:00:01	1,170.21
	00:58:10	60:00:10	1,173.76
	06:58:06	66:00:06	1,175.53
	07:58:05	67:00:05	1,175.53
	08:58:04	68:00:04	1,175.53
	09:58:17	69:00:17	1,175.53
	10:58:03	70:00:03	1,177.30
	11:57:49	70:59:49	1,177.30
	12:58:02	72:00:02	1,177.30
	13:58:01	73:00:01	1,177.30
	14:59:00	74:00:00	1,179.08
	15:57:59	74:59:59	1,179.08
	16:58:12	76:00:12	1,179.08
	17:58:11	77:00:11	1,179.08
	18:58:11	78:00:11	1,179.08
	19:58:10	79:00:10	1,179.08
	20:58:09	80:00:09	1,179.08
	21:58:08	81:00:08	1,180.85
	22:58:08	82:00:08	1,180.85
	23:58:07	83:00:07	1,180.85
	00:58:06	84:00:06	1,180.85
	01:58:06	85:00:06	1,182.62
	02:58:05	86:00:05	1,182.62
	03:58:04	87:00:04	1,182.62
	04:58:04	88:00:04	1,182.62
	05:58:03	89:00:03	1,182.62
	06:58:02	90:00:02	1,182.62
	12:58:24	96:00:24	1,182.62
	18:58:07	102:00:07	1,184.40
	00:58:03	108:00:03	1,186.17
	06:58:12	114:00:12	1,187.94
	09:43:00	116:45:00	1,187.94

ILLEGIBLE

SOUTHEAST WEST PUERTO CHIQUITO
COMPARISON OF HORNER P* PRESSURES
FOR SEPTEMBER 1988 SURVEY

The graph on the facing page compares schematically the Horner plots of build-up pressures of the three wells for which we have pressure data.

Note the near uniformity of pressure at a level significantly below the bubble point.

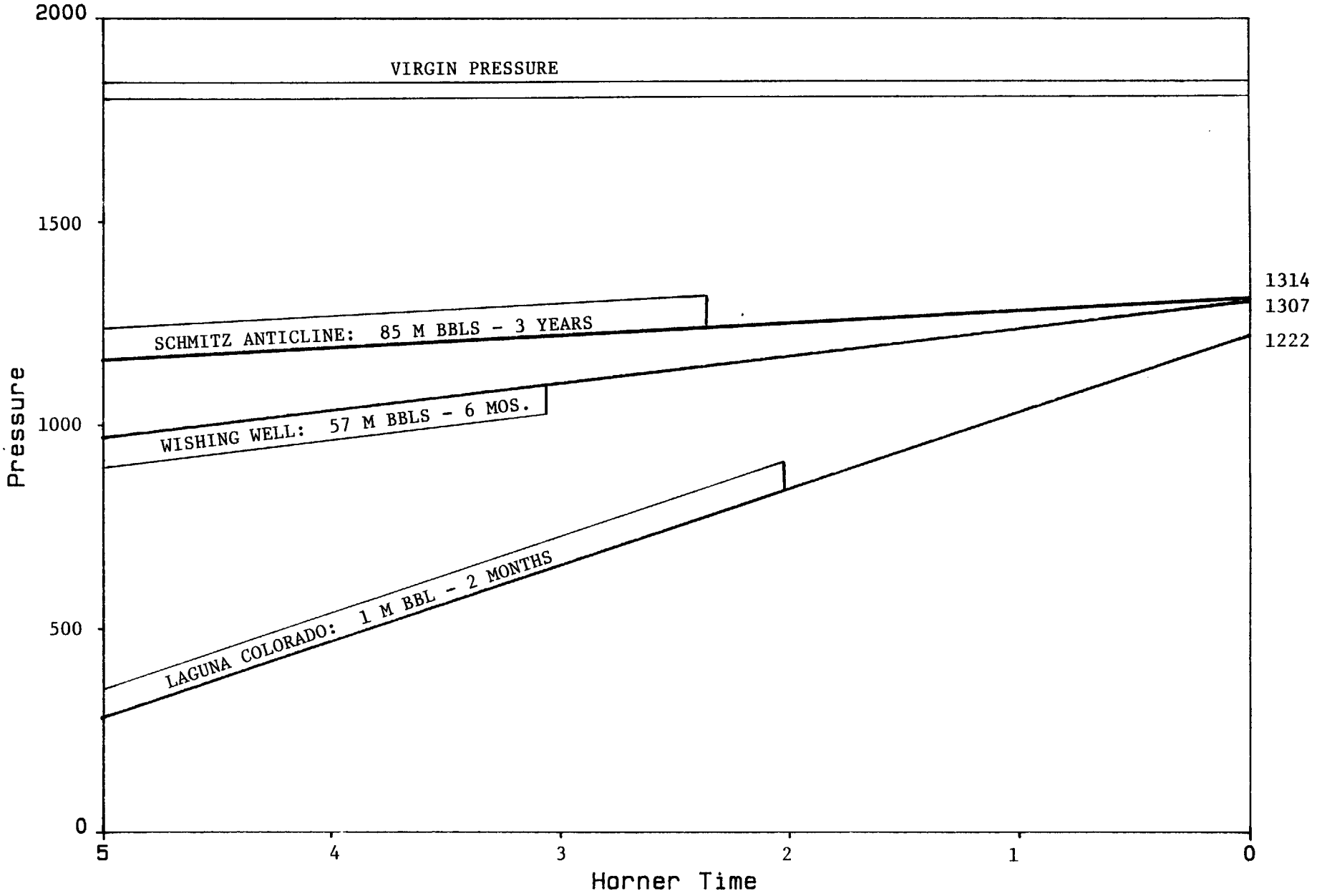
The pressure of the high capacity fracture system is probably about 1250#. (The P* pressures of the Wishing Well and Schmitz Anticline are higher than this pressure - as noted earlier herein.)

For the Laguna Colorado, however its boundary pressure will not be less than the P* pressure.

Note also the extreme difference in cumulative recovery of the Laguna Colorado as compared to the other two wells. Its production clearly has been the cause of pressure depletion by its tight block. This depletion was caused by production of the other wells: clear evidence of the high capacity fracture system affecting this well's tight block.

That other wells - even miles away - can deplete a small well's tight block better than can the well itself has been shown in other cases of the New Mexico Oil Conservation Division. One reference: NMOCC Case 6997, August 6, 1980, B-M-G Exhibit 1, Section D.

SOUTHEAST WEST PUERTO CHIQUITO
SCHEMATIC HORNER PLOT
SEPT. 1988 PRESSURE SURVEYS



ABILITY OF WELLS TO DRAIN THEIR 640-ACRE SPACING UNITS

In West Puerto Chiquito and Gavilan, individual wells have effectively produced from tens of thousands of acres. This was possible because of the high capacity fracture system in these pools. There appears to be a high capacity fracture system in Southeast West Puerto Chiquito that will permit wells to drain thousands of acres - but not tens of thousands - as indications are that the currently developed reservoir does not cover such a large area. Even so, the wells are draining areas much larger than their spacing units.

Currently the two wells with the lowest productivities are the Schmitz Anticline and the Laguna Colorado. On the following pages are analyses showing that even these smaller wells are capable of draining 640 acres of the tighter reservoir rock.

In West Puerto Chiquito and Gavilan, a large part of the resrvoir exists in the high capacity facture system (Reference NMOCC Case 3455, December 1969, B-M-G Exhibit 2, Appendix III). Here, in Southeast West Puerto Chiquito the same will be true; however, for the purpose of demonstrating that the wells can drain their tight blocks, in the following analyses, it is assumed that the well's entire drainage area consists of the tight fracture block with no assistance from a high capacity fracture system.

ABILITY OF WELLS TO DRAIN THEIR 640-ACRE SPACING UNITS

AMOCO SCHMITZ ANTICLINE FEDERAL #1

Here the tightest rock is represented by the first slope 40.5# per cycle, Kh/u of .16 darcy feet (Reference bottom hole pressure build-up survey September 10. 1988).

The well produces very little free gas, so Kro is probably high, ± .9, indicating rock Kh to be about .18 darcy feet. From the graph (previous section) of barrels per acre versus Kh, reservoir pore volume would be ± 500 stock tank barrels per acre, or $\phi h = .084$.

The diffusivity constant, n^*, $= \frac{6.328\ (kh/u)_t}{\phi h\ c_t} = \frac{6.328 \times .16}{.084 \times 400 \times 10^{-6}} = 3 \times 10^4$

for 640-acre spacing average drainage radius at the external boundry is 2879 feet.

Time to reach steady state conditions:

$$t = \frac{r^2}{4n} = \frac{(2879)^2}{4 \times 3 \times 10^4} = 69 \text{ days.}$$

Recovery of oil from reservoir rock of such low Kh will be mostly solution gas drive, ± 6 to 8 percent, or about 30 to 40 barrels per acre. At 40 barrels per acre, oil reocvery from 640 acres of this character of rock would be 25,000 barrels.

If the reservoir were made up entirely of this kind of rock, and all spacing units drilled and produced simultaneously, then for a per well initial production rate of 70 BOPD and constant percentage decline to economic limit of 3 BOPD per well, the resulting decline rate would be 98% per year, with complete depletion in about 3 years.

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* Reference: NMOCC Case 9111, June 1988, B-M-G Exhibit 1, Section H.

ABILITY OF WELLS TO DRAIN THEIR 640-ACRE SPACING UNITS

NASSAU LAGUNA COLORADO 2-6

Here the tightest reservoir rock is that indicated at the end of the bottom hole build-up survey: 188# per ln cycle and Kh/u of .046 darcy feet.

The well has (at time of the test) a GOR of 5000 cubic feet per barrel.

At a GOR of 5000, Koh is approximately 7% of $(Kh/u)_T$, or about .003 darcy feet. Kro is unknown but estimated at about .2; so Kh would be $\pm$ .015 darcy feet. From the graph of oil in place versus Kh, oil in place is $\pm$ 350 stock tank barrels per acre.

At 6 to 8 percent recovery of oil in place, recovery would be 20 to 30 barrels per acre.

For 30 barrels per acre recovery from 640 acres of this character of reservoir rock would be about 20,000 barrels.

At an initial production rate of 11 BOPD and economic limit of 3 BOPD, and constant percentage decline rate, the decline would be 15 percent per year, with complete depletion in about 7 years.

The diffusivity constant, $n = \dfrac{6.328\ (Kh/u)_t}{\phi h\ c_t} = \dfrac{6.328 \times .046}{(.058)\ (450 \times 10^{-6})} = 1.1 \times 10^4$

Time to reach steady state conditions for radius of 2879:

$t = \dfrac{r^2}{4n} = \dfrac{(2879)^2}{4 \times 1.1 \times 10^4} = 188$ days

ANTICIPATED RECOVERIES OF FUTURE WELLS IN THE DEVELOPED PORTION OF SOUTHEAST WEST PUERTO CHIQUITO

In West Puerto Chiquito wells with initial production rates of 500 to 600 BOPD have individually produced cumulative oil volumes of 2 million barrels; and in Gavilan individual wells of similar capacity have produced hundreds of thousands of barrels; and although in Southeast West Puerto Chiquito two of the initial three wells have produced at rates of 500 to 600 BOPD, it is anticipated that this analogy of high capacity wells and large ultimate cumulative recovery will not apply here. Rather it is expected that future wells in Southeast West Puerto Chiquito will realize ultimate recoveries of 60,000 to 90,000 barrels per well if the existing 640-acre spacing is maintained. Closer spacing will result in proportionately lower per well recoveries.

The analyses leading to this conclusion are described in the following pages of this section.

Set out below is a summary of cumulative production for this area along with approximate pressures. This same information is displayed on the graph on the facing page, along with a projection of the path of future pressures assuming no pressure maintenance support.

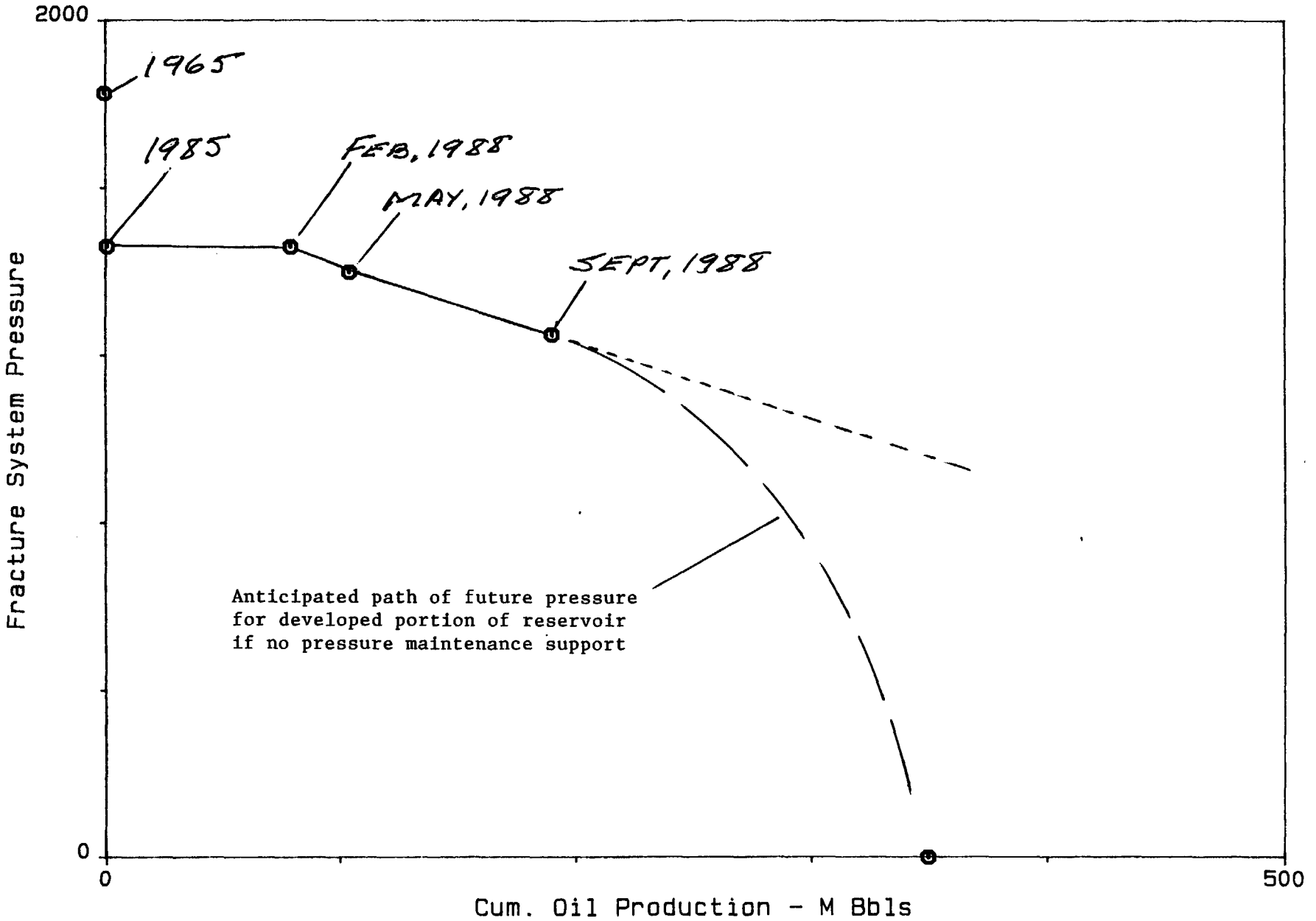
Date	Cumulative Production (Barrels)	Approximate Pressure at +617'
1965	0	1825
1985	1	1460
February 1988	79	1460
May 10, 1988	104	1400
September 10, 1988	190	1250

Part of the analyses are based on the reservoir voidage and pressure decline of the developed area as shown by production and pressures for the period May 10 to September 10, 1988. This production is shown in the table below and the reservoir voidage and pressures for this period are shown on the next two pages.

PRODUCTION MAY 10 TO SEPTEMBER 10, 1988

	Schmitz Ant.		Wishing Well		Laguna Colo.		C.C. State		Total	
	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)
May 10-31	1.0	0.0	7.4	3.0	0.0	0.0	0.0	0.0	8.4	3.0
June	2.0	0.0	11.0	6.8	0.0	0.0	0.0	0.0	13.0	6.8
July	1.8	0.0	9.9	10.8	0.0	0.0	14.9	5.0 Est.	26.6	15.8
Aug.	2.1	0.0	9.7	10.8 Est.	0.5	0.7	15.0	5.0	27.3	16.5
Sept. 1-10	0.7	0.0	3.5	4.0	0.1	0.5	5.0	3.5	9.3	8.0
Total	7.6	0.0	41.5	35.4	0.6	1.2	34.9	13.5	84.6	50.1

SOUTHEAST WEST PUERTO CHIQUITO
RESERVOIR PRESSURE VS. CUMULATIVE PRODUCTION
PRESSURE AT +617



ANTICIPATED RECOVERIES OF FUTURE WELLS IN THE DEVELOPED PORTION OF SOUTHEAST WEST PUERTO CHIQUITO

Voidage of developed reservoir May to September 1988:

84.6 M STBbls

50.1 MMCF

Average GOR 600 CF/Bbl measured

Estimated 150 CF/Bbl not measured

Total 750 CF/Bbl

Reservoir Bbls per S.T. Bbl

$B_T = 1.3 + (.750 - .500) \times 2.2 = 1.85$

Total reservoir voidage 84.6 x 1.85 = 157 M Reservoir Bbls

Reservoir pressure decline May to September 150 psi

$$\frac{157 \text{ M Bbl}}{150 \text{ psi}} = 1050 \text{ Reservoir Bbls/\#}$$

Total Reservoir Volume in close communication
(for system compressibilities of 400×10^{-6} and 450×10^{-6})

$$V = (\Delta V/\Delta P)/c_t$$

$1050/400 \times 10^{-6} = 2600$ M Reservoir Bbls

$c_t = 400 \times 10^{-6}$

and $1050/450 \times 10^{-6} = 2300$ M Reservoir Bbls

$c_t = 450 \times 10^{-6}$

ESTIMATED PRESSURES IN HIGH CAPACITY FRACTURE SYSTEM OF SOUTHEAST WEST PUERTO CHIQUITO

WISHING WELL PRESSURES FOR MAY AND SEPTEMBER 1988: PSIG AT +617' DATUM

	Shut in 24 Hours	Shut in 48 Hours	Modified Muskat $\bar{P}$	MDH (constant press. at boundary) for n of	re = 1000	re = 1500	Horner P*
May 1988	1200	1250	1300	1.1×10^5	1298	1351	1457
Sept. 1988	1030	1075	1120	8.2×10^5	1144	1200	1306
Diff: May-Sept	170	175	180		154	151	151

SUMMARY OF SEPTEMBER 1988 PRESSURE SURVEYS: PSIG AT +617' DATUM

	Shut in 24 Hours	Shut in 48 Hours	Modified Muskat $\bar{P}$	MDH (constant press. at boundary) for n of	re = 1000	re = 1500	Horner P*
Schmitz Ant.	1195	1222	1260	3.4×10^4	1270	1290	1314
Wishing Well	1030	1075	1120	8.2×10^4	1144	1200	1306
Laguna Colo.	631	734	$\pm$ 1015	1.1×10^4	1189	1348	1222

MDH calculations by use of diffusivity constants as shown in NMOCC Case 3455, November 16, 1966, B-M-G Exhibit 1, Figure 18. MDH = Method of Miller, Dyes and Hutchinson.

Diffusivity constants determined from Horner plots for Kh/u and re of 1000' and 1500', $\pm$ 100 to 200 acre fracture blocks.

Assumed pore volumes of fracture blocks (as distinct from total drainage area pore volumes):

Wishing Well. . . . . 1000 stock tank barrels per acre
Schmitz Anticline . . . . . 700 stock tank barrels per acre
Laguna Colorado . . . . . 400 stock tank barrels per acre

CT: for May. . . . . 350×10^{-6}
for Sept . . . . . 400×10^{-6}

Note: For Laguna Colorado, the actual pressure of its surrounding fracture system would probably be near that of the higher capacity wells or about 1250#. Since the pressure for re = 1500' is greater than that, it means that the fracture block minimum distance from the well is probably less than 1500'.

NOTES ON OIL VOLUMES, AREAS AND FUTURE RECOVERIES OF THE DEVELOPED (CLOSE COMMUNICATION) AREA OF SOUTHEAST WEST PUERTO CHIQUITO

Set out in the table below are the areas of the developed part of Southeast West Puerto Chiquito as dependent on reservoir pore space expressed in terms of stock tank barrels per acre.

In the second table are reservoir drainage radii and areas which will reach steady state conditions in 120 days, also shown to be dependent on pore space. These values are based on diffusivity constants resulting from a value of Kh/u of 1 darcy foot (determined for Wishing Well's tight block in May 1988, and also in September 1988), along with an approximate system compressibility of 450 x 10^{-6}.

The reservoir area associated with a reservoir volume of 2500 M stock tank barrels will be as shown below for the given values of per acre oil in place.

Stock Tank Barrels per acre	Total Area (Acres)
2000	1250
1500	1667
1000	2500
750	3330
500	5000

Distance reached for steady state (or pseudo steady state) condition in 120 days for Kh/u = 1 darcy foot (total mobility):

$$\text{Diffusivity constant, } n, = \frac{6.328\ (Kh/u)_T}{\phi h\ c_t}$$

$$= \frac{6.328 \times 1}{450 \times 10^{-6} \times \phi h} = \frac{1.4 \times 10^4}{\phi h}$$

$$r = \sqrt{4\ n\ t} = \sqrt{480\ n}$$

S.T. BOPA	ϕh	n	$r = \sqrt{480\ n}$ (feet)	Circular Area $= \frac{r^2}{43{,}560}$ (acres)
2000	.335	4.18×10^4	4500	1450
1500	.25	5.6×10^4	5200	1900
1000	.168	8.37×10^4	6300	2900
750	.126	1.11×10^5	7300	3800
500	.084	1.67×10^5	9000	5800

The above statistics are shown graphically along with interpretations on the next pages.

SOUTHEAST WEST PUERTO CHIQUITO
COMPARISON OF AREA OF RESERVOIR IN CLOSE COMMUNICATION WITH EQUIVALENT AREA OF 100-DAY PRESSURE STABILIZATION

The lower curve on the graph on the facing page shows the reservoir area of a reservoir with a volume of 2500 M stock tank barrels as dependent on per acre pore volume.

The next curve shows the area in which steady state (or pseudo steady state) conditions are reached by a single well producing for a reservoir with diffusivity constant consistent with a transmissibility of Kh/u = 1 darcy foot and the same per acre pore volume as the lower curve.

The upper curve is the same as the second except that it is based on Kh/u of 3 darcy feet.

If the reservoir diffusivity constant is about like that of the second curve, then it would be possible for there to exist adjoining undeveloped reservoir areas with the same characteristics as that found in the developed portion. However, if the reservoir diffusivity constant is significantly greater than that given by the second curve as, for example, the upper curve, then it is to be expected that adjoining area(s) will have considerably lower values of transmissibility (and production).

Since it does appear* that there exists a fracture system of transmissibility higher than exists for the Wishing Well tight block,
we must conclude that future wells drilled nearby that show the depleted pressure will not establish new reserves, but will share in those remaining, as indicated on the preceding plot of pressure versus production.

It follows then that new nearby wells that show higher pressures will probably have lower transmissibilities unless they encounter a separate reservoir.

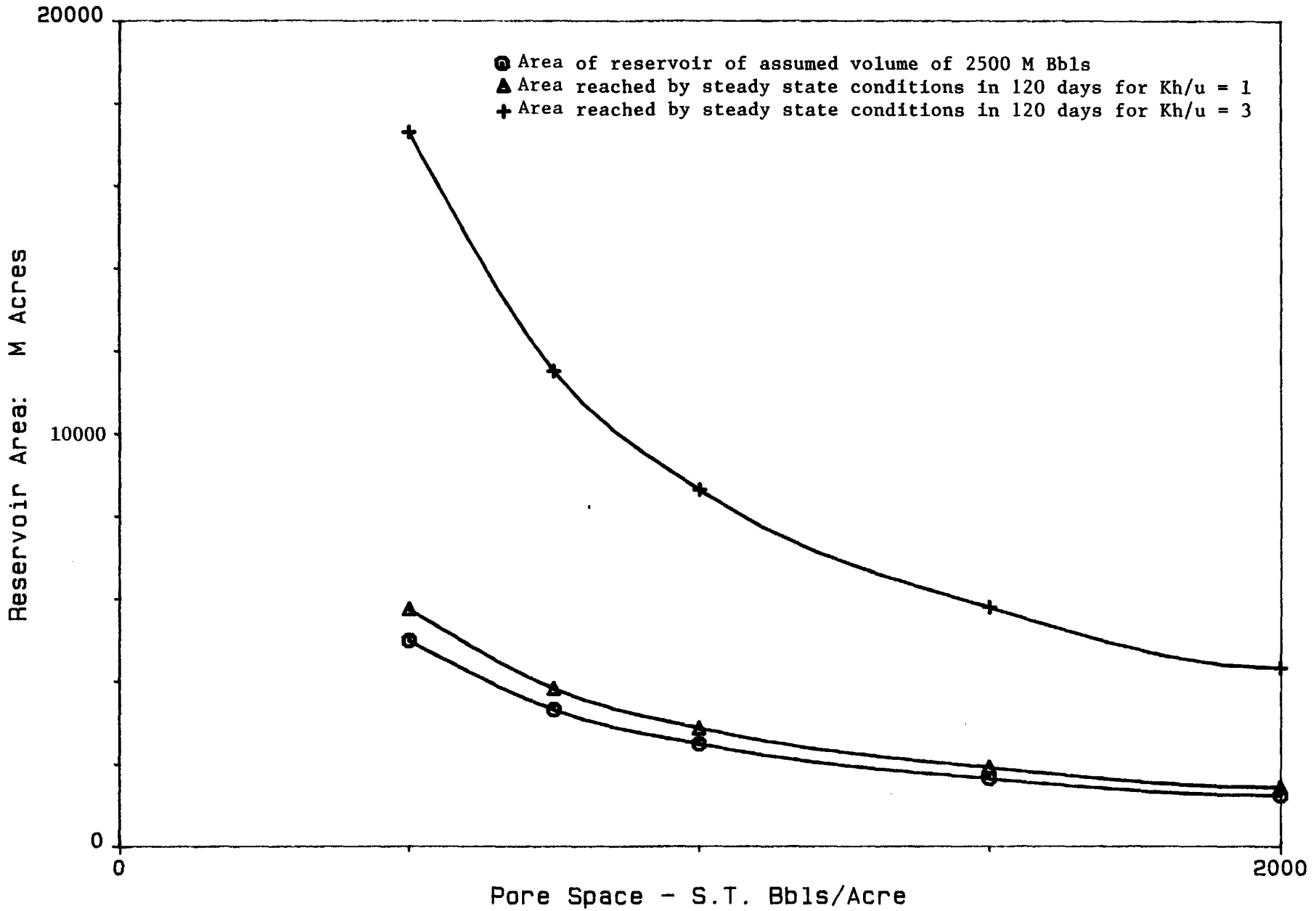
Taken altogether future wells will not drain areas (tens of thousands of acres) as do the wells in the main West Puerto Chiquito pool and as did the early wells in Gavilan and cannot realize large ultimate recoveries.

Rather, they will be limited to their own tracts for support - meaning recoveries of 100 to a maximum of 150 barrels per acre - or average of 60,000 to 90,000 barrels per well if the 640 acre spacing is maintained.

---

* Indications:
1. Equalized pressures.
2. Two slopes, Schmitz Anticline bottom hole pressure build-up survey.
3. Immediate interference Wishing Well and C.C. State: Reference Transcript in NMOCC Case 9451, Page 152, cross-examination of Amoco's witness Richard Jones by W. Thomas Kellahin.
4. P* pressure of Laguna Colorado nearly same as high capacity fracture system.

SOUTHEAST WEST PUERTO CHIQUITO
COMPARISON OF AREA OF RESERVOIR IN CLOSE COMMUNICATION WITH
EQUIVALENT AREA OF 100-DAY PRESSURE STABILIZATION



MANCOS FORMATION ECONOMICS
EAST SIDE SAN JUAN BASIN
FOR OIL RECOVERY OF 100 BARRELS PER ACRE

OIL NET VALUE

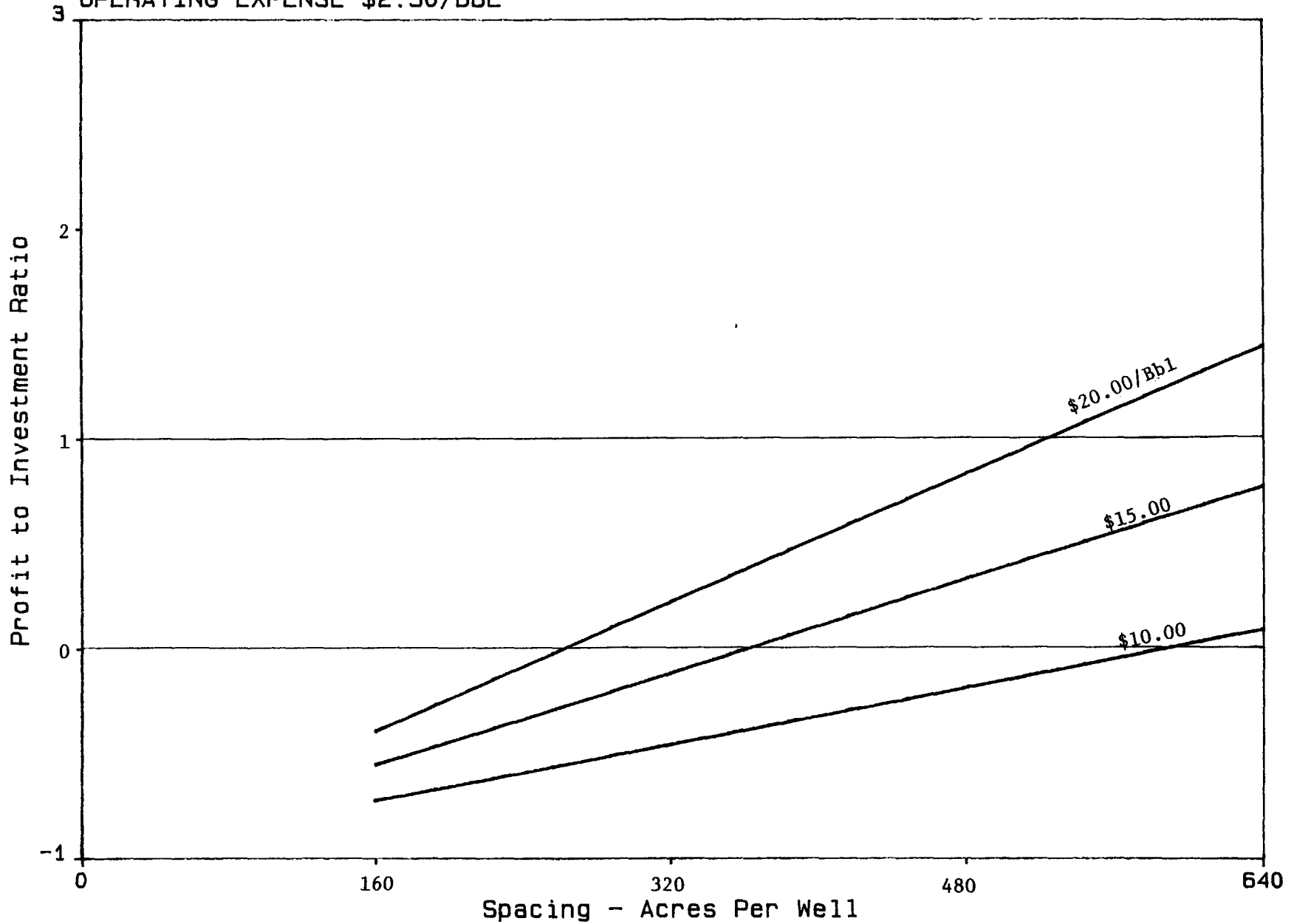
Oil ($/Bbl)	10.00	15.00	20.00
Gas ($/MCF) (± 1/8 of $/bbl)	1.25	1.90	2.50
Gas ($/Bbl) (At 5.6 MCF/Bbl)	7.00	10.60	14.00
Total Gross of Gas and Oil ($/Bbl)	17.00	25.60	34.00
Net After Lease Burdens and Taxes (75%)	12.80	19.20	25.50
After Operating Expense ($2.50/Bbl)	10.30	16.70	23.00
Spacing (Acres/Well)	160	320	640
Ultimate Recovery (M Bbls)	16	32	64
AT $10.00 OIL			
Net Value ($M)	165	330	660
Profit at $600 M Well Cost	(-435)	(-270)	+69
Profit/Investment Ratio (Undiscounted)	(-.725)	(-.45)	+.10
AT $15.00 OIL			
Net Value ($M)	267	534	1070
Profit at $600 M Well Cost	(-333)	-66	470
Profit/Investment Ratio (Undiscounted)	(-.55)	(-.11)	+.78
AT $20.00 OIL			
Net Value ($M)	368	736	1472
Profit at $600 M Well Cost	(-232)	136	872
Profit/Investment Ratio (Undiscounted)	(-.39)	+.23	+1.45

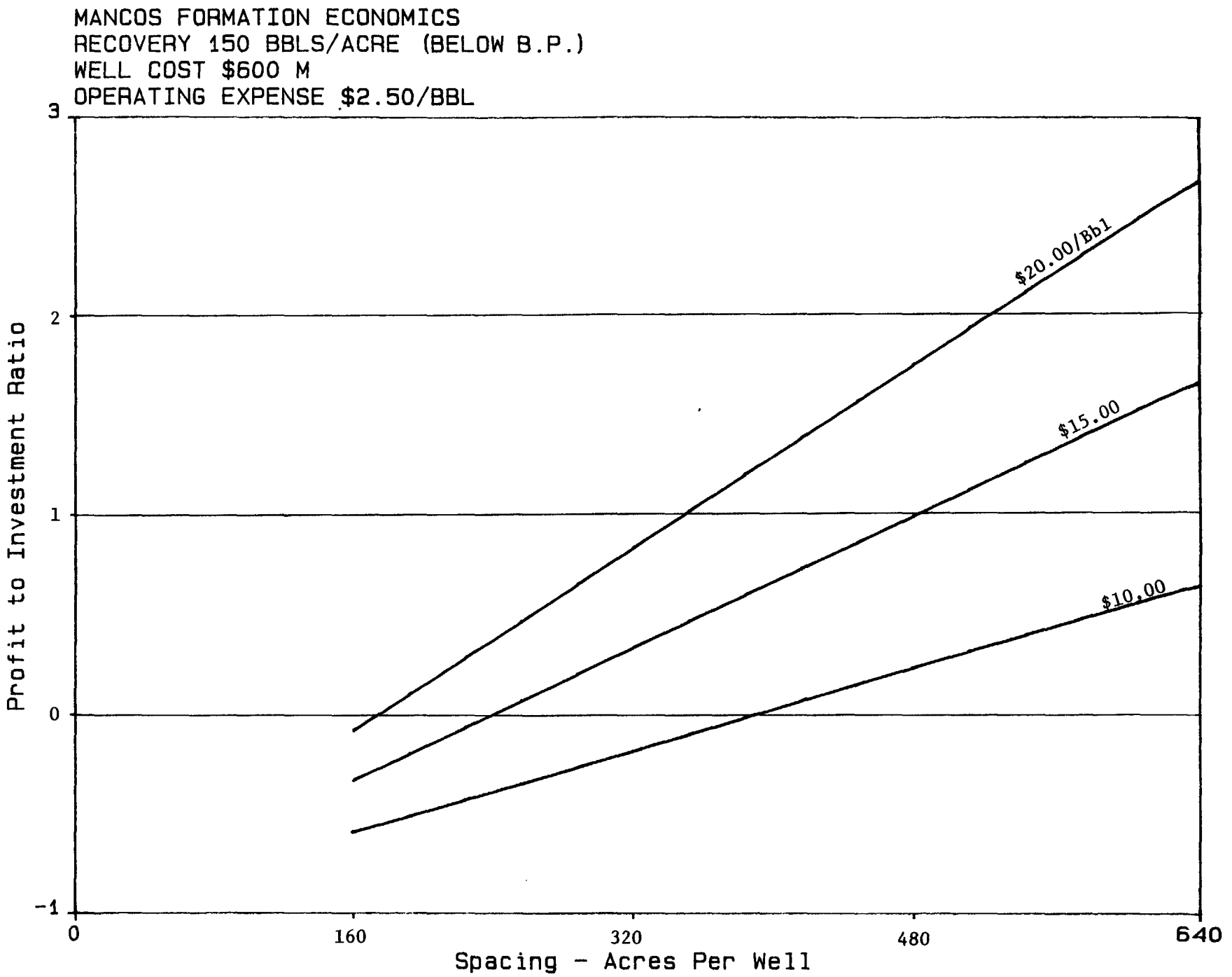
MANCOS FORMATION ECONOMICS
EAST SIDE SAN JUAN BASIN
FOR OIL RECOVERY OF 150 BARRELS PER ACRE

OIL NET VALUE

Oil ($/Bbl) (± 1/8 of $/bbl)	10.00	15.00	20.00
Gas ($/MCF)	1.25	1.90	2.50
Gas ($/Bbl) (At 5.6 MCF/Bbl)	7.00	10.60	14.00
Total Gross of Gas and Oil ($/Bbl)	17.00	25.60	34.00
Net After Lease Burdens and Taxes (75%)	12.80	19.20	25.50
After Operating Expense ($2.50/Bbl)	10.30	16.70	23.00
Spacing (Acres/Well)	160	320	640
Ultimate Recovery (M Bbls)	24	48	96
AT $10.00 OIL			
Net Value ($M)	247	494	989
Profit at $600 M Well Cost	(-353)	(-106)	+389
Profit/Investment Ratio (Undiscounted)	(-.59)	(-.18)	+.65
AT $15.00 OIL			
Net Value ($M)	401	802	1603
Profit at $600 M Well Cost	(-199)	202	1003
Profit/Investment Ratio (Undiscounted)	(-.33)	+.34	+1.67
AT $20.00 OIL			
Net Value ($M)	552	1104	2208
Profit at $600 M Well Cost	(-48)	504	1608
Profit/Investment Ratio (Undiscounted)	(-.08)	+.84	+2.68

MANCOS FORMATION ECONOMICS
RECOVERY 100 BBLS/ACRE (BELOW B.P.)
WELL COST $600 M
OPERATING EXPENSE $2.50/BBL




MANCOS FORMATION ECONOMICS
RECOVERY 150 BBLS/ACRE (BELOW B.P.)
WELL COST $600 M
OPERATING EXPENSE $2.50/BBL
Profit to Investment Ratio
3
2
1
0
-1
$20.00/Bbl
$15.00
$10.00
0
160
320
480
640
Spacing - Acres Per Well

WELL ELEVATIONS AND FORMATIONS
WELLS IN SOUTHEAST WEST PUERTO CHIQUITO

Well	Location	Elevation	A Zone		B Zone		C Zone	
			Depth	Datum	Depth	Datum	Depth	Datum
Wishing Well 35-7	35-24N-1W	7267' KB	6359'	908	6438'	829	6566'	701
State Com C.C.	26-24N-1W	7304' KB	6445'	859	6533'	771	6670'	634
Laguna Colorado 2-6	2-23N-1W	7240' KB	6456'	784	6550'	690	6680'	560
Schmitz Anticline Fed. #1	25-24N-1W	7274' KB	6253'	1020	6310'	964	6444'	830
Canada Ojitos Unit A-14	14-24N-1W	7109' KB	6206'	903	6257'	852	6390'	719

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
NASSAU RESOURCES, INC., WISHING WELL 35-7. (NE 35-24N-1W)

			OIL				GAS			GOR	WATER		
YR	MO	DAYS PRODUCED	BOPM	BOPPD	BOPCD	CUM MBO	MCF/M	MCF/D	CUM MMCF	SCF/BBL	Month	BWPD	CUM MBW
1988	1	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	2	NR	721.0	ERR	24.9	0.7	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	3	14.0	4513.0	322.4	145.6	5.2	5726.0	409.0	5.7	1268.8	378.0	27.0	0.4
1988	4	20.0	5855.0	292.8	195.2	11.1	3827.0	191.4	9.6	653.6	15.0	0.8	0.4
1988	5	25.0	12281.0	491.2	396.2	23.4	4725.0	189.0	14.3	384.7	5.0	0.2	0.4
1988	6	22.0	11034.0	501.5	367.8	34.4	6832.0	310.5	21.1	619.2	5.0	0.2	0.4
1988	7	23.0	9851.0	428.3	317.8	44.3	10786.0	469.0	31.9	1094.9	10.0	0.4	0.4
1988	8	26.0	9736.0	374.5	314.1	54.0	7422.0	285.5	39.3	762.3	10.0	0.4	0.4
1988	9	29.0	8232.0	283.9	274.4	62.2	15658.0	539.9	55.0	1902.1	10.0	0.3	0.4
Subtotal		159.0	62223.0	391.3	255.0		54976.0				433.0		

* BOPPD: BARRELS PER PRODUCING DAY. * BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL. RIO ARRIBA COUNTY, NM
AMOCO PRODUCTION COMPANY, STATE COM CC. (SE 26-24N-1W)

			OIL				GAS			GOR	WATER		
YR	MO	DAYS PRODUCED	BOPM	BOPPD	BOPCD	CUM MBO	MCF/M	MCF/D	CUM MMCF	SCF/BBL	Month	BWPD	CUM MBW
1988	1	NR	458.0	ERR	14.8	0.5	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	2	NR	1822.0	ERR	62.8	2.3	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	3	NR	8872.0	ERR	286.2	11.2	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	4	NR	100.0	ERR	3.3	11.3	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	5	NR	0.0	ERR	0.0	11.3	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	6	NR	0.0	ERR	0.0	11.3	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	7	NR	14873.0	ERR	479.8	26.1	563.0	ERR	0.6	37.9	0.0	ERR	0.0
1988	8	31.0	15022.0	484.6	484.6	41.1	4981.0	160.7	5.5	331.6	3.0	0.1	0.0
1988	9	NR	9033.0	ERR	301.1	50.2	6368.0	ERR	11.9	705.0	4.0	ERR	0.0
Subtotal		31.0	50180.0	1618.7	205.7		11912.0				7.0		

* BOPPD: BARRELS PER PRODUCING DAY. * BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
NASSAU RESOURCES, INC., LAGUNA COLORADO 2-6. (NW 2-23N-1W)

			OIL				GAS			GOR	WATER		
YR	MO	DAYS PRODUCED	BOPM	BOPPD	BOPCD	CUM MBO	MCF/M	MCF/D	CUM MMCF	SCF/BBL	Month	BWPD	CUM MBW
1988	1	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	2	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	3	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	4	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	5	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	6	12.0	726.0	60.5	23.4	0.7	780.0	65.0	0.8	1074.4	0.0	0.0	0.0
1988	7	0.0	0.0	ERR	0.0	0.7	0.0	ERR	0.8	ERR	0.0	ERR	0.0
1988	8	27.0	484.0	17.9	16.1	1.2	731.0	27.1	1.5	1510.3	20.0	0.7	0.0
1988	9	22.0	264.0	12.0	8.5	1.5	1295.0	58.9	2.8	4905.3	5.0	0.2	0.0
Subtotal		61.0	1474.0	24.2	6.0		2806.0				25.0		

* BOPPD: BARRELS PER PRODUCING DAY. * BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
AMOCO PRODUCTION COMPANY, SCHMITZ ANTICLINE FED. #1. (SE 25-24N-1W)

		OIL			GAS	WATER	
YR	MO	BOPM	BOPCD	CUM MBO	MCF/M	Month	CUM MBW
1985	1	0.0	0.0	0.0	NR	0.0	0.0
1985	2	0.0	0.0	0.0	NR	0.0	0.0
1985	3	0.0	0.0	0.0	NR	0.0	0.0
1985	4	0.0	0.0	0.0	NR	5.0	0.0
1985	5	0.0	0.0	0.0	NR	0.0	0.0
1985	6	164.0	5.5	0.2	NR	0.0	0.0
1985	7	690.0	22.3	0.9	NR	0.0	0.0
1985	8	0.0	0.0	0.9	NR	0.0	0.0
1985	9	0.0	0.0	0.9	NR	0.0	0.0
1985	10	2329.0	75.1	3.2	NR	150.0	0.2
1985	11	2097.0	69.9	5.3	NR	0.0	0.2
1985	12	2340.0	75.5	7.6	NR	0.0	0.2
Subtotal		7620.0	20.8		0.0	155.0	
1986	1	2605.0	84.0	10.2	NR	52.0	0.2
1986	2	2174.0	75.0	12.4	NR	47.0	0.3
1986	3	2571.0	82.9	15.0	NR	60.0	0.3
1986	4	2361.0	78.7	17.3	NR	50.0	0.4
1986	5	2665.0	86.0	20.0	NR	50.0	0.4
1986	6	2428.0	80.9	22.4	NR	50.0	0.5
1986	7	2698.0	87.0	25.1	NR	0.0	0.5
1986	8	2715.0	87.6	27.8	NR	40.0	0.5
1986	9	2522.0	84.1	30.4	NR	40.0	0.5
1986	10	2554.0	82.4	32.9	NR	20.0	0.6
1986	11	2317.0	77.2	35.2	NR	0.0	0.6
1986	12	2516.0	81.2	37.7	NR	0.0	0.6
Subtotal		30126.0	82.3		0.0	409.0	

* BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
AMOCO PRODUCTION COMPANY, SCHMITZ ANTICLINE FED. #1. (SE 25-24N-1W)

		OIL			GAS	WATER	
YR	MO	BOPM	BOPCD	CUM MBO	MCF/M	Month	CUM MBW
1987	1	2346.0	75.7	40.1	NR	0.0	0.6
1987	2	2205.0	76.0	42.3	NR	0.0	0.6
1987	3	2640.0	85.2	44.9	NR	40.0	0.6
1987	4	2638.0	87.9	47.6	NR	20.0	0.6
1987	5	2708.0	87.4	50.3	NR	15.0	0.6
1987	6	2603.0	86.8	52.9	NR	125.0	0.8
1987	7	2694.0	86.9	55.6	NR	80.0	0.8
1987	8	2350.0	75.8	57.9	NR	40.0	0.9
1987	9	2743.0	91.4	60.7	NR	0.0	0.9
1987	10	2300.0	74.2	63.0	NR	70.0	1.0
1987	11	2314.0	77.1	65.3	NR	10.0	1.0
1987	12	1716.0	55.4	67.0	NR	70.0	1.0
Subtotal		29257.0	79.9		0.0	470.0	
1988	1	2573.0	83.0	69.6	NR	12.0	1.0
1988	2	2240.0	77.2	71.8	NR	80.0	1.1
1988	3	1895.0	61.1	73.7	NR	50.0	1.2
1988	4	2248.0	74.9	76.0	NR	75.0	1.3
1988	5	2182.0	70.4	78.1	NR	65.0	1.3
1988	6	2030.0	67.7	80.2	NR	1.0	1.3
1988	7	1784.0	57.5	82.0	NR	5.0	1.3
1988	8	2083.0	67.2	84.0	NR	4.0	1.3
1988	9	1029.0	34.3	85.1	NR	9.0	1.3
Subtotal		18064.0	74.0		0.0	301.0	

* BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES

IN THE MATTER OF THE APPLICATION
OF BENSON-MONTIN-GREER DRILLING
CORP. FOR AMENDMENT OF DIVISION
ORDER NO. R-6469, AS AMENDED,
RIO ARRIBA COUNTY, NEW MEXICO. CASE NO. 9525

AFFIDAVIT

STATE OF NEW MEXICO)
)ss.
COUNTY OF SANTA FE)

WILLIAM F. CARR, attorney in fact and authorized representative of Benson-Montin-Greer Drilling Corp., the Applicant herein, being first duly sworn, upon oath, states that the notice provisions of Rule 1207 of the New Mexico Oil Conservation Division have been complied with, that Applicant has caused to be conducted a good faith diligent effort to find the correct addresses of all interested persons entitled to receive notice, as shown by Exhibit "A" attached hereto, and that pursuant to Rule 1207, notice has been given at the correct addresses provided by such rule.

William F. Carr
WILLIAM F. CARR

SUBSCRIBED AND SWORN to before me this 31st day of January, 1989.

Notary Public

My Commission Expires:
August 19, 1991

BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
BWG EXHIBIT NO. 2
CASE NO. 9525

EXHIBIT A

Mobil Exploration and Producing
US Inc.
Post Office Box 5444
Denver, Colorado 80217

CAMPBELL & BLACK, P.A.
LAWYERS

JACK M. CAMPBELL
BRUCE D. BLACK
MICHAEL B. CAMPBELL
WILLIAM F. CARR
BRADFORD C. BERGE
MARK F. SHERIDAN
J. SCOTT HALL
JOHN H. BEMIS
MARTE D. LIGHTSTONE

GUADALUPE PLACE
SUITE 1 - 110 NORTH GUADALUPE
POST OFFICE BOX 2208
SANTA FE, NEW MEXICO 87504-2208
TELEPHONE: (505) 988-4421
TELECOPIER: (505) 983-6043

October 19, 1988

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mobil Exploration & Producing
U.S. Inc.
Post Office Box 5444
Denver, Colorado 80217

Attn: Mr. John Faulhaber

Re: Application of Benson-Montin-Greer Drilling Corp. for Amendment of Order R-6469 to Rescind Approval of Certain Non-Standard Spacing Units, Rio Arriba County, New Mexico

Gentlemen:

This letter is to advise you that Benson-Montin-Greer Drilling Corp. has filed an application with the New Mexico Oil Conservation Division seeking amendment of Division Order R-6469 which was entered on September 10, 1980 (copy enclosed) to rescind approval of those non-standard spacing units approved by said Order in Township 24 North, Range 1 West and Township 26 North, Range 1 West, N.M.P.M., Rio Arriba County, New Mexico.

This application has been set for hearing before a Division Examiner on November 9, 1988. You are not required to attend this hearing, but as an owner of an interest that may be affected by this application, you may appear and present testimony. Failure to appear at that time and become a party of record will preclude you from challenging this matter at a later date.

Very truly yours,

William F. Carr

WILLIAM F. CARR
ATTORNEY FOR BENSON-MONTIN-GREER DRILLING CORP.
WFC:mlh
Enclosure

SENDER: Complete items 1 and 2 when additional services are desired, and complete items 3 and 4.

Put your address in the "RETURN TO" space on the reverse side. Failure to do this will prevent this card from being returned to you. The return receipt fee will provide you the name of the person delivered to and the date of delivery. For additional fees the following services are available. Consult postmaster for fees and check box(es) for additional service(s) requested.

1. ☒ Show to whom delivered, date, and addressee's address. 2. ☐ Restricted Delivery.

3. Article Addressed to:	4. Article Number
Mobil Exploration & Producing U.S. Inc. Post Office Box 5444 Denver, Colorado 80217 Attn: Mr. John Faulhaber	P 784 192 799 **Type of Service:** ☐ Registered ☐ Insured ☒ Certified ☐ COD ☐ Express Mail
	Always obtain signature of addressee or agent and DATE DELIVERED.
5. Signature – Addressee X	8. Addressee's Address *(ONLY if requested and fee paid)*
6. Signature – Agent X	
7. Date of Delivery	

PS Form 3811, Feb. 1986 **DOMESTIC RETURN RECEIPT**

Attn: Mr. John Faulhaber

P 784 192 799

RECEIPT FOR CERTIFIED MAIL

Sent to	Mobil Exploration & Producing US Inc.
Street and No.	Post Office Box 5444
P.O. State and ZIP Code	Denver, Colorado 80217
Postage	$ 1.25
Certified Fee	.85
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt showing to whom and Date Delivered	.10
Return Receipt showing to whom Date, and Address of Delivery	
TOTAL Postage and Fees	$ 2.20
Postmark or Date	OCT 19 1992

PS Form 3800, June 1985

BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES

IN THE MATTER OF THE APPLICATION
OF BENSON-MONTIN-GREER DRILLING
CORP. FOR AMENDMENT OF DIVISION
ORDER NO. R-6469, AS AMENDED,
RIO ARRIBA COUNTY, NEW MEXICO. CASE NO. 9525

AFFIDAVIT

STATE OF NEW MEXICO)
)ss.
COUNTY OF SANTA FE)

WILLIAM F. CARR, attorney in fact and authorized representative of Benson-Montin-Greer Drilling Corp., the Applicant herein, being first duly sworn, upon oath, states that the notice provisions of Rule 1207 of the New Mexico Oil Conservation Division have been complied with, that Applicant has caused to be conducted a good faith diligent effort to find the correct addresses of all interested persons entitled to receive notice, as shown by Exhibit "A" attached hereto, and that pursuant to Rule 1207, notice has been given at the correct addresses provided by such rule.

William F. Carr
WILLIAM F. CARR

SUBSCRIBED AND SWORN to before me this 31st day of January, 1989.

Notary Public

My Commission Expires:
August 19, 1991

BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
BUG EXHIBIT NO. 2
CASE NO. 9525

EXHIBIT A

Mobil Exploration and Producing
US Inc.
Post Office Box 5444
Denver, Colorado 80217

CAMPBELL & BLACK, P.A.
LAWYERS

JACK M. CAMPBELL
BRUCE D. BLACK
MICHAEL B. CAMPBELL
WILLIAM F. CARR
BRADFORD C. BERGE
MARK F. SHERIDAN
J. SCOTT HALL
JOHN H. BEMIS
MARTE D. LIGHTSTONE

GUADALUPE PLACE
SUITE 1 - 110 NORTH GUADALUPE
POST OFFICE BOX 2208
SANTA FE, NEW MEXICO 87504-2208
TELEPHONE: (505) 988-4421
TELECOPIER: (505) 983-6043

October 19, 1988

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mobil Exploration & Producing
U.S. Inc.
Post Office Box 5444
Denver, Colorado 80217

Attn: Mr. John Faulhaber

Re: Application of Benson-Montin-Greer Drilling Corp. for Amendment of Order R-6469 to Rescind Approval of Certain Non-Standard Spacing Units, Rio Arriba County, New Mexico

Gentlemen:

This letter is to advise you that Benson-Montin-Greer Drilling Corp. has filed an application with the New Mexico Oil Conservation Division seeking amendment of Division Order R-6469 which was entered on September 10, 1980 (copy enclosed) to rescind approval of those non-standard spacing units approved by said Order in Township 24 North, Range 1 West and Township 26 North, Range 1 West, N.M.P.M., Rio Arriba County, New Mexico.

This application has been set for hearing before a Division Examiner on November 9, 1988. You are not required to attend this hearing, but as an owner of an interest that may be affected by this application, you may appear and present testimony. Failure to appear at that time and become a party of record will preclude you from challenging this matter at a later date.

Very truly yours,

William F. Carr

WILLIAM F. CARR
ATTORNEY FOR BENSON-MONTIN-GREER DRILLING CORP.
WFC:mlh
Enclosure

SENDER: Complete items 1 and 2 when additional services are desired, and complete items 3 and 4.

Put your address in the "RETURN TO" space on the reverse side. Failure to do this will prevent this card from being returned to you. The return receipt fee will provide you the name of the person delivered to and the date of delivery. For additional fees the following services are available. Consult postmaster for fees and check box(es) for additional service(s) requested.

1. ☒ Show to whom delivered, date, and addressee's address. 2. ☐ Restricted Delivery.

3. Article Addressed to:	4. Article Number
Mobil Exploration & Producing U.S. Inc. Post Office Box 5444 Denver, Colorado 80217 Attn: Mr. John Faulhaber	P 784 192 799
	Type of Service: ☐ Registered ☐ Insured ☒ Certified ☐ COD ☐ Express Mail
	Always obtain signature of addressee or agent and DATE DELIVERED.
5. Signature — Addressee X	8. Addressee's Address *(ONLY if requested and fee paid)*
6. Signature — Agent X	
7. Date of Delivery	

PS Form 3811, Feb. 1986 DOMESTIC RETURN RECEIPT

Attn: Mr. John Faulhaber

P 784 192 799

RECEIPT FOR CERTIFIED MAIL
NO INSURANCE COVERAGE PROVIDED
NOT FOR INTERNATIONAL MAIL
(See Reverse)

Sent to	Mobil Exploration & Producing US Inc.
Street and No.	Post Office Box 5444
P.O. State and ZIP Code	Denver, Colorado 80217
Postage	$ 1.25
Certified Fee	.85
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt showing to whom and Date Delivered	.90
Return Receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	$ 2.90
Postmark or Date	October 19, 1984

PS Form 3800, June 1985

BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES

IN THE MATTER OF THE APPLICATION
OF BENSON-MONTIN-GREER DRILLING
CORP. FOR AMENDMENT OF DIVISION
ORDER NO. R-6469, AS AMENDED,
RIO ARRIBA COUNTY, NEW MEXICO. CASE NO. 9525

AFFIDAVIT

STATE OF NEW MEXICO)
)ss.
COUNTY OF SANTA FE)

WILLIAM F. CARR, attorney in fact and authorized representative of Benson-Montin-Greer Drilling Corp., the Applicant herein, being first duly sworn, upon oath, states that the notice provisions of Rule 1207 of the New Mexico Oil Conservation Division have been complied with, that Applicant has caused to be conducted a good faith diligent effort to find the correct addresses of all interested persons entitled to receive notice, as shown by Exhibit "A" attached hereto, and that pursuant to Rule 1207, notice has been given at the correct addresses provided by such rule.

William F. Carr
WILLIAM F. CARR

SUBSCRIBED AND SWORN to before me this 31st day of January, 1989.

Notary Public

My Commission Expires:
August 19, 1991

BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
BW3 EXHIBIT NO. 2
CASE NO. 9525

EXHIBIT A

Mobil Exploration and Producing
US Inc.
Post Office Box 5444
Denver, Colorado 80217

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TELEPHONE: (505) 988-4421
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October 19, 1988

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mobil Exploration & Producing
U.S. Inc.
Post Office Box 5444
Denver, Colorado 80217

Attn: Mr. John Faulhaber

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This application has been set for hearing before a Division Examiner on November 9, 1988. You are not required to attend this hearing, but as an owner of an interest that may be affected by this application, you may appear and present testimony. Failure to appear at that time and become a party of record will preclude you from challenging this matter at a later date.

Very truly yours,

William F. Carr

WILLIAM F. CARR
ATTORNEY FOR BENSON-MONTIN-GREER DRILLING CORP.
WFC:mlh
Enclosure

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3. Article Addressed to:

Mobil Exploration &
Producing U.S. Inc.
Post Office Box 5444
Denver, Colorado 80217

Attn: Mr. John Faulhaber

4. Article Number
P 784 192 799

Type of Service:
☐ Registered ☐ Insured
☒ Certified ☐ COD
☐ Express Mail

Always obtain signature of addressee or agent and DATE DELIVERED.

5. Signature – Addressee
X

6. Signature – Agent
X

7. Date of Delivery

8. Addressee's Address *(ONLY if requested and fee paid)*

BEVERLY HILLS CA OCT 1988 USPO

PS Form 3811, Feb. 1986 DOMESTIC RETURN RECEIPT

Attn: Mr. John Faulhaber

P 784 192 799

RECEIPT FOR CERTIFIED MAIL
NO INSURANCE COVERAGE PROVIDED
NOT FOR INTERNATIONAL MAIL
(See Reverse)

Sent to	Mobil Exploration & Producing US Inc.
Street and No.	Post Office Box 5444
P.O. State and ZIP Code	Denver, Colorado 80217
Postage	$ 1.25
Certified Fee	.85
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Return Receipt showing to whom and Date Delivered	.90
Return Receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	$ 2.00
Postmark or Date	October 19, 1988

PS Form 3800, June 1985

BENSON-MONTIN-GREER DRILLING CORP.
EXHIBITS IN CASE NO. 9525
BEFORE THE OIL CONSERVATION COMMISSION OF THE
NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

FEBRUARY 1, 1989

BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
BMG EXHIBIT NO. 1
CASE NO. 9525

BENSON-MONTIN-GREER DRILLING CORP.
EXHIBITS IN CASE NO. 9525
BEFORE THE OIL CONSERVATION COMMISSION OF THE
NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

FEBRUARY 1, 1989

INDEX

BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES

IN THE MATTER OF THE APPLICATION OF
BENSON-MONTIN-GREER DRILLING CORP.
FOR AMENDMENT OF ORDER R-6469 TO
RESCIND APPROVAL OF CERTAIN
NON-STANDARD SPACING UNITS,
RIO ARRIBA COUNTY, NEW MEXICO. CASE NO. 9525

APPLICATION

COMES NOW BENSON-MONTIN-GREER DRILLING CORP., by and through its undersigned attorneys, hereby makes application to the Oil Conservation Division for Amendment of Order R-6469 and in support thereof states:

1. Applicant is the operator of the Canada Ojitos Unit which includes lands in Township 24 North, Range 1 West and Township 26 North, Range 1 West as well as other acreage and from which oil and gas are produced from the West Puerto Chiquito-Mancos Oil Pool.

2. In Case 6997, Applicant sought among other things the creation of certain non-standard spacing units which units were approved on September 10, 1980 by Order R-6469.

3. Prudent operation and development of the unit area now requires that approval of the following non-standard proration units be terminated:

TOWNSHIP 24 NORTH, RANGE 1 WEST, N.M.P.M.

a 320-acre unit comprising Section 1: N/2

a 640-acre unit comprising Section 23: N/2
and Section 24: N/2

a 640-acre unit comprising Section 23: S/2
and Section 24: S/2

TOWNSHIP 26 NORTH, RANGE 1 WEST, N.M.P.M.

a 640-acre unit comprising Section 5: W/2
and Section 8: W/2

a 640-acre unit comprising Section 5: E/2
and Section 8: E/2

a 640-acre unit comprising Section 17: W/2
and Section 20: W/2

a 640-acre unit comprising Section 17: E/2
and Section 20: E/2

4. That approval of this application will be in the best interest of conservation, the prevention of waste and the protection of correlative rights.

WHEREFORE, Applicant requests that this matter be set for hearing before a duly appointed Examiner of the Oil Conservation Division and, that after notice and hearing as required by law, the Division enter its Order amending Order R-6469 by deleting therefrom Division approval of those non-standard proration units located in Township 24 North, Range 1 West and Township 26 North, Range 1 West, N.M.P.M., Rio Arriba County, New Mexico.

Respectfully submitted,

CAMPBELL & BLACK, P.A.

By: William F. Carr

WILLIAM F. CARR
Post Office Box 2208
Santa Fe, New Mexico 87504
Telephone: (505) 988-4421

ATTORNEYS FOR BENSON-MONTIN-GREER DRILLING CORP.

INTRODUCTION WITH RESPECT TO THE APPLICATION IN CASE 9525

PURPOSE

The purpose of the application in Case 9525 is to modify well spacing regulations to eliminate certain non-standard proration units so as to permit orderly development of Canada Ojitos Unit wells - both internally and those on the south boundary - and to provide drainage protection for the Canada Ojitos Unit while avoiding the drilling of unnecessary wells.

BACKGROUND ESTABLISHING NEED FOR THE APPLICATION

During early development of the Canada Ojitos Unit, regional migration moved reservoir fluids north across the unit's south boundary. When gas injection commenced in 1968 fluid movement in this area was stabilized at minimal values.

Following production of the Schmitz Anticline #1 well in 1985, and others in this area since then, the direction of drainage reversed and the direction of flow across the boundary now is south, away from the unit.

The Unit Operator proposes to mitigate the drainage now occurring - and the potential for greater future drainage - through the drilling of wells along the south boundary.

Because of the low average per-well recovery anticipated from future wells in this area, it is essential that this development take place without drilling unncessary wells.

This, in turn, requires that, at a minimum, the existing 640-acre spacing be preserved. The non-standard proration units along the south boundary, if drilled, would likely "beg" the drilling of more wells on closer spacing. To avoid this hazard, the Unit Operator now asks that the non-standard proration units be eliminated.

SUPPORT FOR THE APPLICATION

In support of the application, the Unit Operator will show through testimony and the exhibits herein:

1. That drainage across (into) the unit's south boundary area has occurred in the past.

2. That drainage is now occurring across (away from) the unit over its south boundary; and that a high degree of potential exists for future drainage of significant amounts.

3. That the anticipated economics of future wells drilled on 640 acres is marginal; and that drilling of wells on closer spacing would be at an economic loss.

4. That wells drilled on 640-acre spacing will adequately drain the reservoir.

Common Boundary Between East & West Puerto Chiquito Mancos Pools

RIW

RIE

T 27 N

PROPOSED NORTH CAÑADA OJITOS UNIT BOUNDARY

EAST PUERTO CHIQUITO MANCOS UNIT BOUNDARY

JIC 403

JIC 404

JIC 408

JIC. 200

JIC 432

C-7

H-8

O-9

O-18

F-20

O-19

N-22

L-27

G-32

O-33

N-31

CAÑADA OJITOS UNIT BOUNDARY

E-6

J-5

C-2

C-5

E-10

L-11

P-11

J-8

D-17

A-16

A-14

K-13

B-18

Boundary Of East Puerto Chiquito Mancos Pool

A-20

A-22

A-23

F-18

F-19

F-30

B-29

B-32

C-34

K-31

G-5

L-3

G-1

Boundary Of West Puerto Chiquito Mancos Pool

K-8

A-14

T 26 N

T 25 N

T 24 N

Original 6-80 CS

Kempton Colorado

RIW

RIE

Non-Standard Proration Units
Of Case No. 9525.

EAST AND WEST
PUERTO CHIQUITO MANCOS POOLS

RIO ARRIBA CO., NEW MEXICO

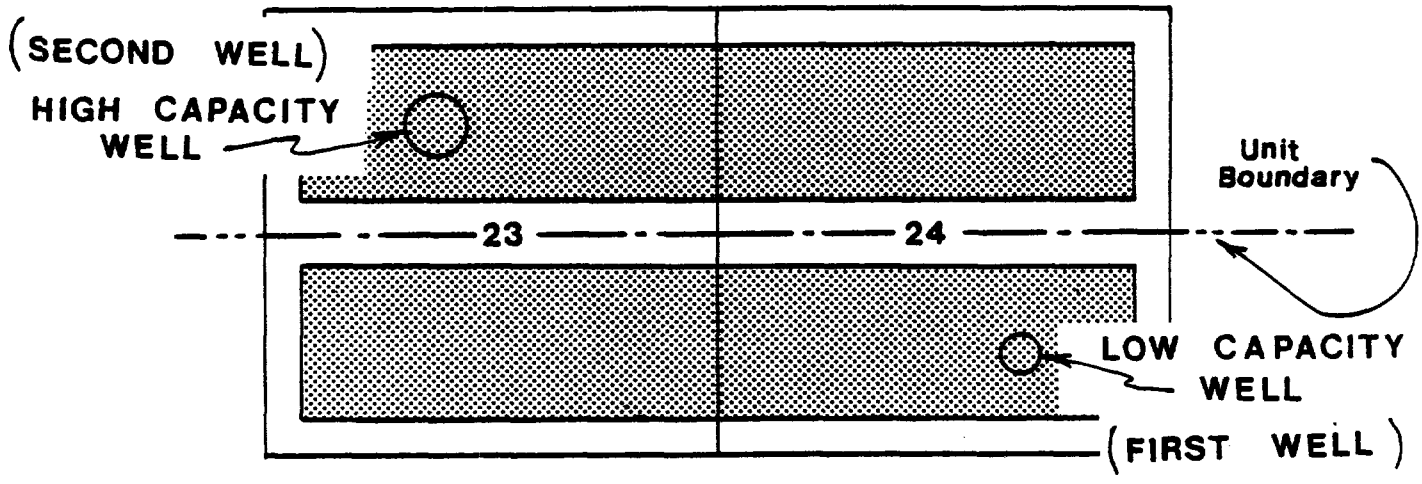
Revised: Oct. 23, 1986
Revised: Feb. 11, 1986
Revised: July 1, 1985
Revised: Nov. 1, 1984
Revised: Sept. 27, 1983
Revised: Mar 17, 1982 1-18-89
Revised: Oct. 22, 1980 10-31-88
Revised: Oct. 8, 1980 10-7-65

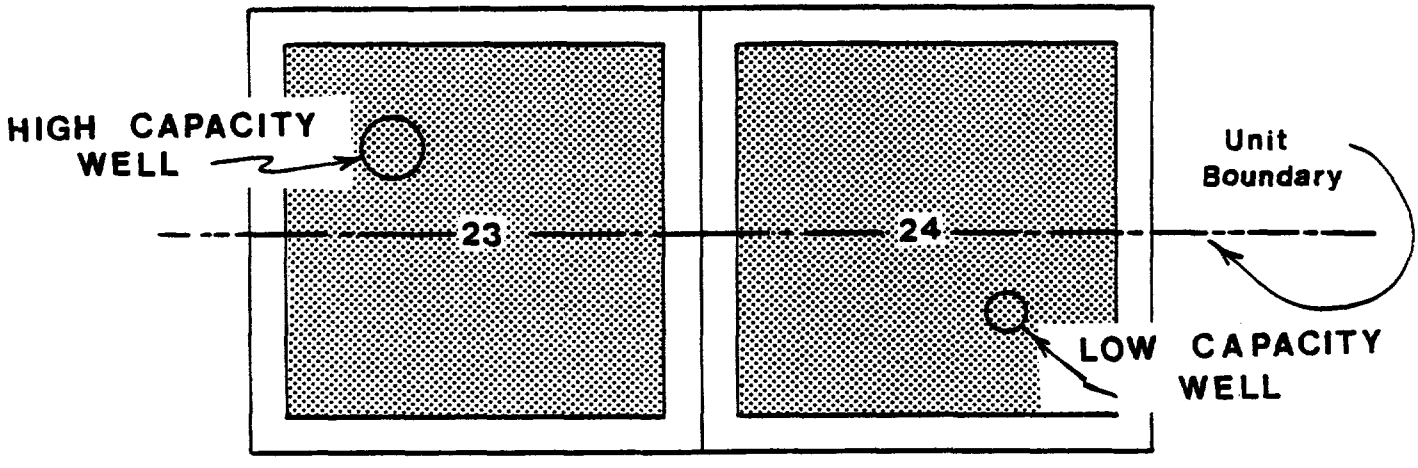
File 152A

June 15, 1980

MAIN PROBLEM OF THESE NON-STANDARD PRORATION UNITS IS THAT THEY BEG CLOSER SPACING.

(IN EXAMPLE BELOW, OWNERS OF SOUTH HALF-SECTIONS WOULD PROBABLY WANT TO DRILL A SECOND WELL ON THE SOUTH PRORATION UNIT TO OFFSET THE HIGH CAPACITY WELL IN THE NORTH HALF OF SECTION 23.)





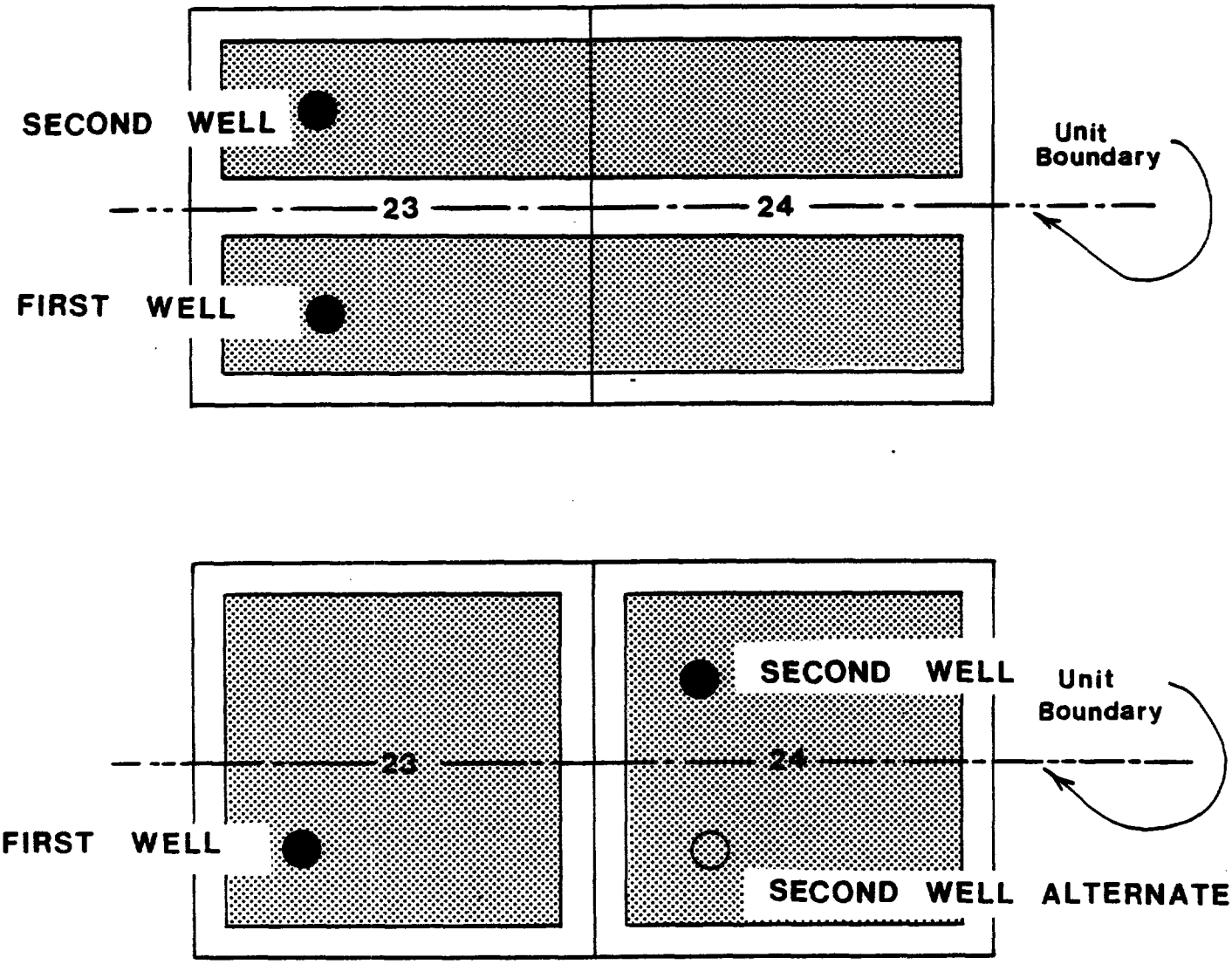
STANDARD PRORATION UNITS ELIMINATE THIS PROBLEM.

NO NEED TO DRILL UNNECESSARY WELLS FOR PARTIES NORTH AND SOUTH OF BOUNDARY TO OBTAIN THEIR FAIR SHARES OF OIL. PARTIES NORTH AND SOUTH OF BOUNDARY SHARE EQUALLY IN ALL PRODUCTION.

STANDARD SPACING UNITS AVOID PROBLEM OF WELLS PERHAPS BEING LOCATED LONG DISTANCES FROM PRORATION UNIT BOUNDARY AND INVITING THE DRILLING OF UNNECESSARY WELLS.

- -

TOP PANEL: TO ASSURE DRAINAGE PROTECTION FOR UNIT, THE SECOND WELL MUST DIRECTLY OFFSET THE FIRST.



THE PROBLEM IDENTIFIED IN THE UPPER PANEL IS ELIMINATED IF STANDARD PRORATION UNITS ARE UTILIZED.

REGIONAL MIGRATION
MANCOS FORMATION POOLS
EAST SIDE OF THE SAN JUAN BASIN

Regional migration has occurred in a number of areas in the Niobrara member of the Mancos formation in the east side of the San Juan Basin.

The southeast part of the West Puerto Chiquito pool is one example.

If the pressure of a newly discovered area is less than the virgin pressure, it can only be the result of migration away from that area; and clear evidence of communication.

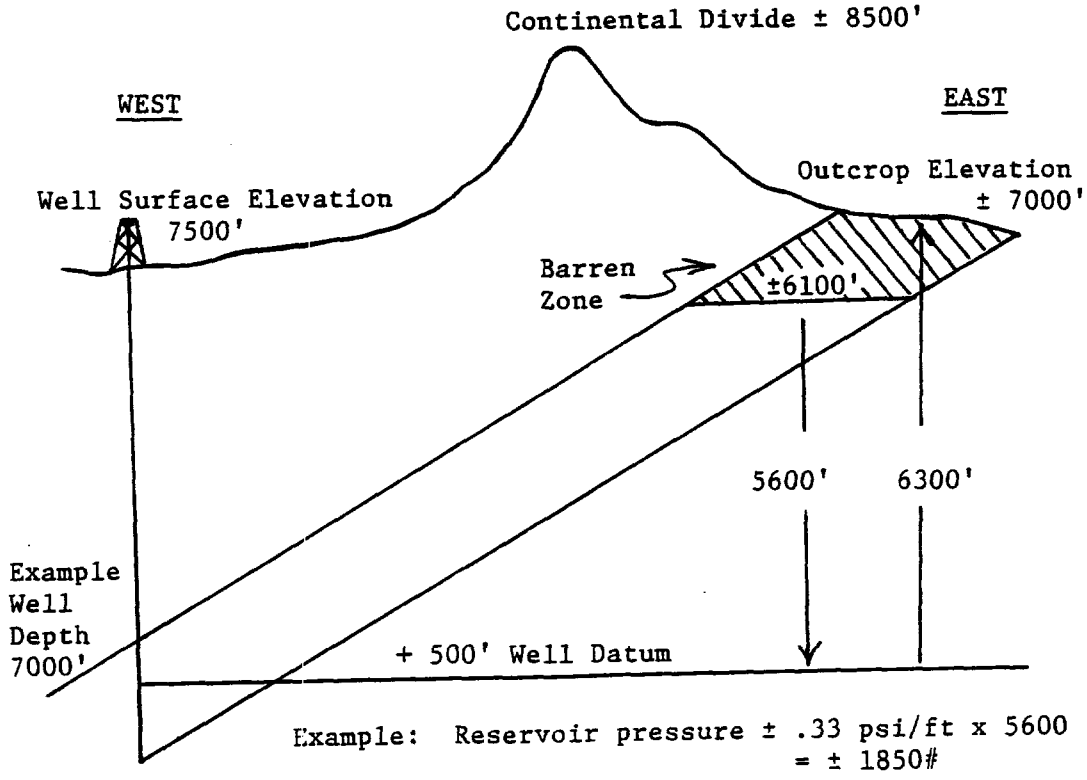
Central to an understanding of regional migration as found in a newly developed area is recognition of the area's virgin pressures; the oil's bubble point of 1520#; and the fact that a relatively small volume of oil moved from an oil zone will bring its pressure down to the bubble point.

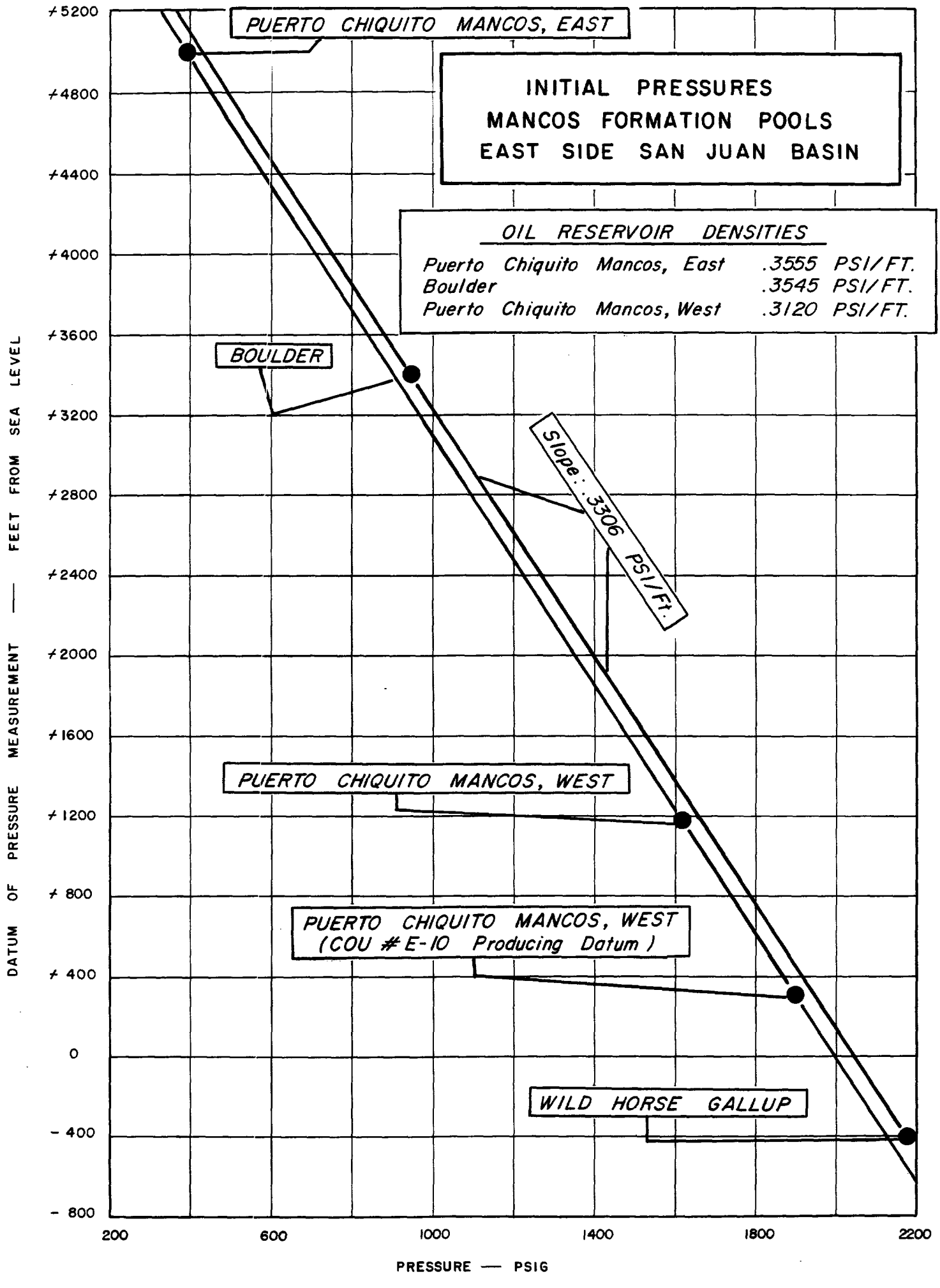
The relation of virgin pressures with depth is described on the next two pages.

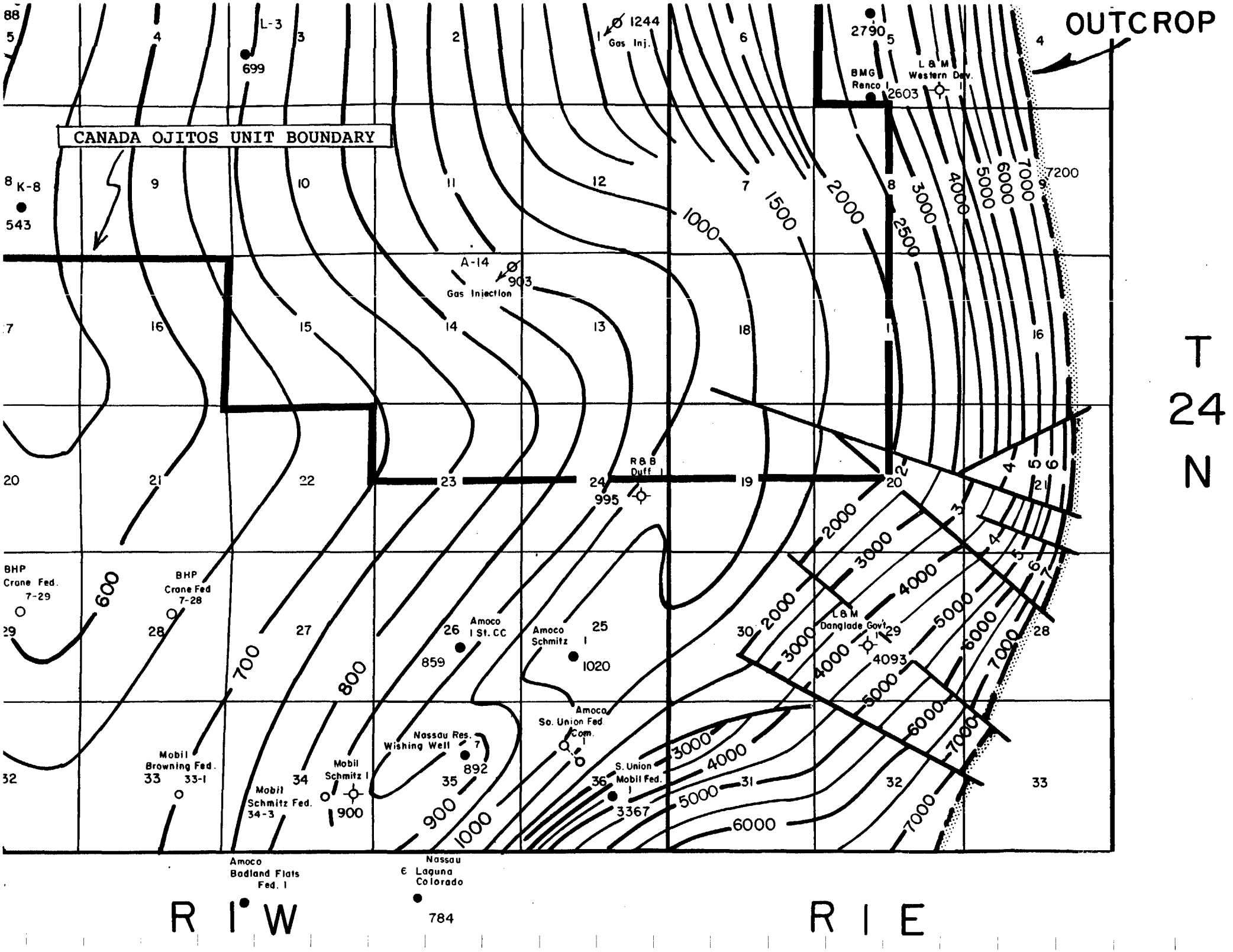
VIRGIN RESERVOIR PRESSURE
MANCOS FORMATION POOLS
EAST SIDE OF THE SAN JUAN BASIN

Although there are areas of tight zones that laterally isolate some pools from others so that no communication is perceptible during the time man produces these pools, there is nevertheless sufficient permeability in the fractured Mancos that, over geologic time, the pressures of the pools in the eastern San Juan Basin have been equalized.

In the same fashion that the pressure of a highly permeable water sand reflects the hydrostatic force as measured by the vertical distance from its outcrop on the surface, so do the pressures of the main producing zone of the Niobrara reflect the "oil static" pressure differential from the elevation of its outcrop (less 800' to 900' of apparent "barren" formation).




PUERTO CHIQUITO MANCOS, EAST
INITIAL PRESSURES
MANCOS FORMATION POOLS
EAST SIDE SAN JUAN BASIN
OIL RESERVOIR DENSITIES
Puerto Chiquito Mancos, East .3555 PSI/FT.
Boulder .3545 PSI/FT.
Puerto Chiquito Mancos, West .3120 PSI/FT.
BOULDER
Slope: .3306 PSI/Ft.
PUERTO CHIQUITO MANCOS, WEST
PUERTO CHIQUITO MANCOS, WEST
(COU # E-10 Producing Datum)
WILD HORSE GALLUP
+5200
+4800
+4400
+4000
+3600
+3200
+2800
+2400
+2000
+1600
+1200
+ 800
+ 400
0
- 400
- 800
200
600
1000
1400
1800
2200
DATUM OF PRESSURE MEASUREMENT — FEET FROM SEA LEVEL
PRESSURE — PSIG


OUTCROP
CANADA OJITOS UNIT BOUNDARY
L-3
699
1244
Gas Inj.
2790
BMG
Renco 1
L & M
Western Dev.
1
2603
K-8
543
A-14
903
Gas Injection
7200
R & B
Duff 1
995
BHP
Crane Fed.
7-29
BHP
Crane Fed
7-28
Amoco
1 St. CC
859
Amoco
Schmitz 1
1020
L & M
Danglade Govt.
1
4093
Amoco
So. Union Fed.
Com.
1
Nassau Res.
Wishing Well
7
892
Mobil
Browning Fed.
33-1
Mobil
Schmitz 1
900
Mobil
Schmitz Fed.
34-3
S. Union
Mobil Fed.
1
3367
Amoco
Badland Flats
Fed. 1
Nassau
& Laguna
Colorado
784
600
700
800
900
1000
1500
2000
2500
3000
4000
5000
6000
7000
T
24
N
R 1° W
R 1 E

REGIONAL MIGRATION
SOUTH PART OF WEST PUERTO CHIQUITO
PAGE 1

Regional migration has occurred across the south boundary of the Canada Ojitos Unit. Migration first was to the south during the 20-year period from initial development of the Canada Ojitos Unit until production south of its boundary occurred in 1985; at which time the direction of migration reversed.

On the plat on the facing page are identified wells in this area which will be referred to in the following sections.

EVIDENCE OF REGIONAL MIGRATION SOUTHEAST PART OF WEST PUERTO CHIQUITO AS SHOWN BY INITIAL PRESSURE BEING SUBSTANTIALLY LESS THAN VIRGIN PRESSURE AND BY COMPARISON OF THESE PRESSURES WITH PRESSURES IN CANADA OJITOS UNIT GAS CAP AREA NEAR SOUTH BOUNDARY

The first oil producing well in the southeast part of West Puerto Chiquito was Amoco's #1 Schmitz Anticline; put on production in 1985. Initial reservoir pressures were not measured in this well. However, initial pressure was measured in the second well, Amoco's C.C. State, in February 1988. Since the first well, the Schmitz Anticline #1 produced for two years with no drop in productivity, its pressure in February 1988 can be expected to be about the same as its initial pressure. There may be other reasons that caused no decline in production of this well - but they would have to be unusual. Moreover, the production-pressure decline coefficient for this area, as shown by the May to September production and pressure decline was approximately 1000 reservoir barrels per pound. So at the outset, its production could have accounted for only 80# of reservoir pressure decline: leaving the initial pressure 300# or so less than virgin.

Accordingly, the February 1988 pressure in the C.C. State is representative of the initial pressure in this area.

Supporting data for the initial pressure in this area in the spring of 1988 is a pressure survey on the third well, Nassau Resources Wishing Well 35-7 taken in May 1988. Prior to this build-up survey (well shut in May 10, 1988 at 1:26 P.M.) the C.C. State had been shut in for about 40 days; and so would have had a minimum interference effect on the build-up of the Wishing Well. Extrapolation of the Wishing Well survey on a Horner plot to Horner P* shows a pressure of 1458 psig when adjusted to the same datum as the C.C. State's 1460#. (Details of this pressure survey are shown later herein.) Since the P* pressure would be the maximum possible for the Wishing Well, the initial pressure of 1460# in the C.C. State is supported as being reasonably accurate; certainly within a few pounds of the true initial pressure in the area.

In September 1988 all wells in the area were shut in and pressures measured. At that time the pressures of the Schmitz Anticline #1 and the Wishing Well were essentially equalized; and the Wishing Well has been shown to be in close communication with the C.C. State. It follows then, that the February pressure in the C.C. State well can be relied upon as being about the same as the Schmitz Anticline, the first well in the area.

Accordingly, the pressure in this area when first drilled at the Schmitz Anticline was 350# to 400# less than virgin pressure: this drop in pressure from that of virgin conditions was caused by migration to the lower pressure Canada Ojitos Unit.

Some of the statistics are on the facing page; and the succeeding two pages show the relation of the gas cap pressure to that of the C.C. State and virgin pressure for the subject range of reservoir datum depths.

EVIDENCE OF REGIONAL MIGRATION SOUTHEAST PART OF WEST PUERTO CHIQUITO
AS SHOWN BY
INITIAL PRESSURE BEING SUBSTANTIALLY LESS THAN VIRGIN PRESSURE
AND BY
COMPARISON OF THESE PRESSURES WITH
PRESSURES IN CANADA OJITOS UNIT GAS CAP AREA NEAR SOUTH BOUNDARY

Depending upon the distribution of injection to the various injection wells and shut in times in effect, the injection well pressure of the A-14 (T-24N, R-1W) in 1987 and 1988 has been in the range of 1400# to 1600#. Average gas cap pressure at distances of a mile or so from the A-14 are estimated to be in the range of 1400# to 1450# during this time. Comparison of some of these pressures with the initial pressure in Amoco's C.C. State is set out below.

Measured pressures inthe A-14 during OCD-ordered tests of November 1987 and February 1988 show the following (reference NMOCC Case 9111, March 17, 1988, B-M-G Exhibit 1, Section F, Page 6 and Section G, Page 11):

	COU A-14 INJECTION WELL				AMOCO ** C.C. STATE
			Calculated BHP		
Date	Days Shut In	Surface Pressure at Surface Elevation 7130' (psig)	At 6416-44' (C zone) Datum +678'	Adjusted to Datum of +617'*	2-15-88 @ 6687' (617')
11/28/87	12	1167.5	1407	1409	1460
2/23/88	21	1178	1421	1423	

Significant here is not only the fact that the initial pressure in the C.C. State well is approximately the same as in the Canada Ojitos Unit gas cap but also the fact that it is over 300# less than virgin pressure.

---

* Using gas gradient (to adjust to same datum as pressure measured in C.C. State).

** Initial pressure of C zone in Amoco C.C. State (when it was the only zone open to production in this well) reported to Oil Conservation Division was 1460#. Depth was 6687' (top of C zone 6670', perforations 6662' to 6736'). Reference: Transcript of Case 9451, Gary Johnson testimony on page 60; Richard Jones testimony Page 140. Mr. Jones made a "rough" adjustment to a datum of +750' for his exhibits; but the C zone pressure at the C.C. State on 2-15-88 at a depth of 6687' (+617') was 1460#.

EVIDENCE OF REGIONAL MIGRATION SOUTHEAST PART OF WEST PUERTO CHIQUITO
AS SHOWN BY
INITIAL PRESSURE BEING SUBSTANTIALLY LESS THAN VIRGIN PRESSURE
AND BY
COMPARISON OF THESE PRESSURES WITH
PRESSURES IN CANADA OJITOS UNIT GAS CAP AREA NEAR SOUTH BOUNDARY
PAGE 4

The initial pressure of the Amoco C.C. State February 15, 1988 was 350 to 400 psi below virgin* pressure for this area.

Just as significantly it was essentially equalized with the gas cap pressure of the adjoining Canada Ojitos Unit.

Although gas is injected only in the C zone in the Canada Ojitos Unit A-14 (injection well closest to the C.C. State), and the C.C. State was completed only in the C zone when the pressure was run February 15, 1988; it is probable that - as in other parts of West Puerto Chiquito - the zones, reservoir-wide, are equalized.

Since at the time of the C.C. State pressure, February 1988, the mobile fluid in the area around the A-14 injection well was gas, and that around the C.C. State and Schmitz Anticline was oil, a different reservoir gradient (pressure versus depth) existed in the two areas.

These different pressures at different depths** (result of reservoir fluid gradients) are put in perspective by showing pressures versus reservoir datum depths on the graph on the facing page. Note here the close relationship of pressures - particularly in the C zone (lower part of the graph) - between the C.C. State and the Canada Ojitos Unit gas cap area; as well as the distinct difference of these pressures from virgin pressures at all datum depths.

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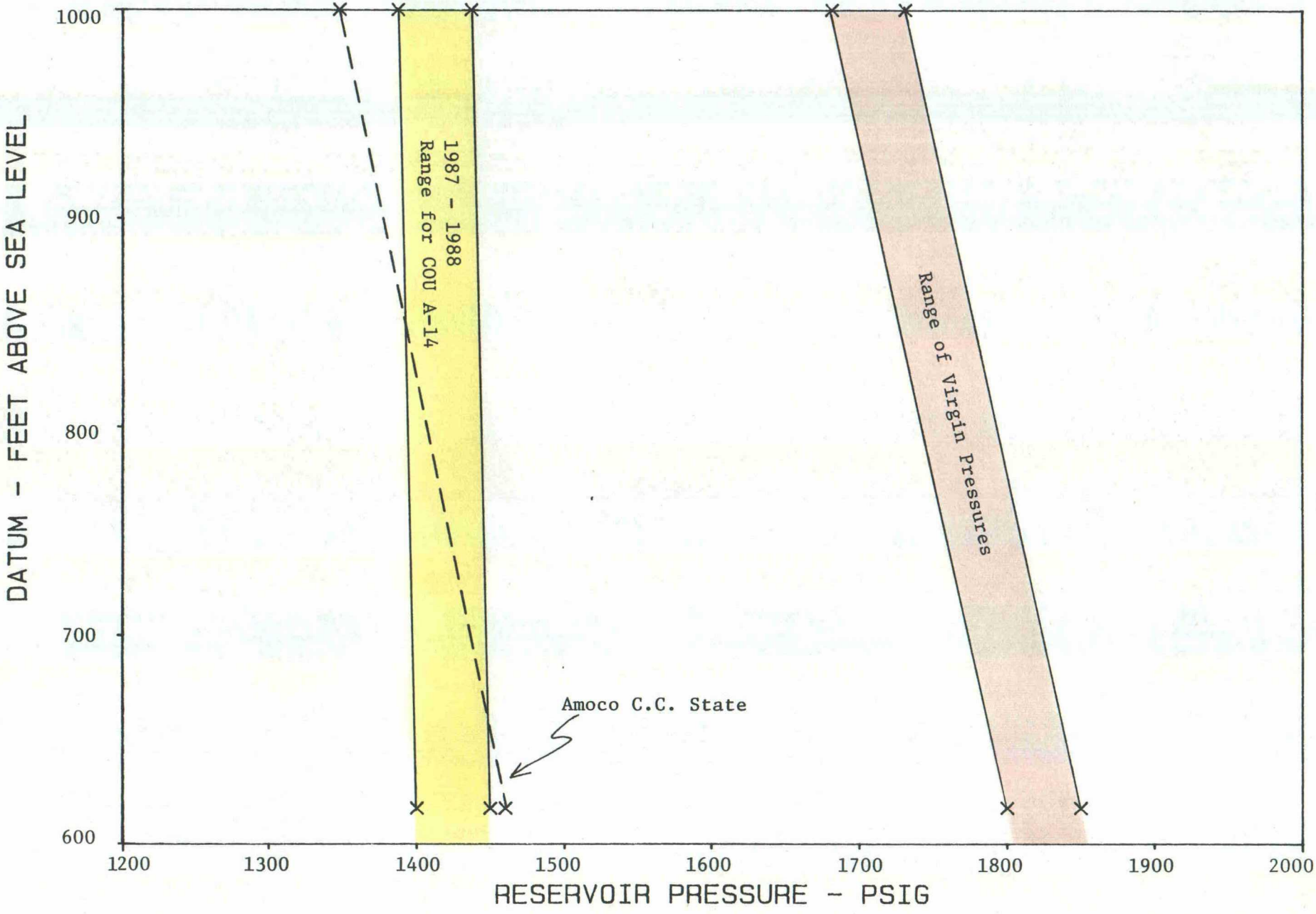
* In transcript of NMOCD Case 9451 August 3, 1988, pages 158 and 159, Amoco's witness, Richard Jones, in response to questioning by Mr. Chavez, noted that exhibits in "all of the Gavilan hearings" stated the virgin pressure to be something around 1800# to 1900#. Mr. Jones did not offer disagreement with this value for virgin pressure.

** The vertical distance of the communicating reservoirs is that from the depth of pressure measurement in the C zone in the State C.C. and the top of the anticline in the Schmitz Anticline (+1020').

PRESSURE COMPARISONS
SOUTHEAST PART OF WEST PUERTO CHIQUITO MANCOS POOL
FEBRUARY 15, 1988



DISPLACEMENT OF THE ATTIC OIL OF THE SCHMITZ ANTICLINE

Given adequate permeability, attic oil such as occupies the Schmitz Anticline, can - under certain conditions - be displaced from its structurally high position by downdip gas injection, as noted by Craft and Hawkins (reference the following three pages).

Applied

PETROLEUM RESERVOIR ENGINEERING

B. C. CRAFT

and

M. F. HAWKINS

Petroleum Engineering Department
Louisiana State University

PRENTICE-HALL, INC.

Englewood Cliffs, N. J. *1959*

$$\text{Recovery} = \frac{\text{Area } B}{\text{Area } A + \text{Area } B} = \frac{32.5}{4.7 + 32.5} = 0.874 \text{ or } 87.4 \text{ per cent}$$

If the gravity segregation had been half as effective, the recovery would have been about 60 per cent; and without gravity segregation, the recovery would have been only 24 per cent. These recoveries are expressed as per cents of the *recoverable oil*. In terms of the *initial oil* in place the recoveries are only 60 per cent as large, or 52.4, 36.0, and 14.4 per cent, respectively. Welge,[2] Shreve and Welch,[3] Kern,[4] and others have extended the concepts presented here to the prediction of gas-oil ratios, production rates, and cumulative recoveries, including the treatment of production from wells which are behind the displacement front. Smith[5] has used the magnitude of the gravity term $[(k_o/\mu_o)(\rho_o - \rho_g) \sin \alpha]$ as a criterion for determining those reservoirs where gravity segregation is likely to be of considerable importance. The data of Table 7.3 indicate that this gravity term must have a value above about 10, in the units used, to be effective. An inspection of Eq. (7.21), however, shows that the throughput velocity (q_t/A) is also of primary importance.

[illegible]

It appears from the previous discussions and examples that water is *generally* more efficient than gas in displacing oil from reservoir rocks, mainly because (a) the water viscosity is of the order of 50 times the gas viscosity and (b) the water occupies the less conductive portions of the pore spaces, whereas the gas occupies the more conductive portions. Thus in water displacement the oil is left to the central and more conductive portions of the pore channels, whereas in gas displacement the gas invades and occupies the more conductive portions first, leaving the oil and water to the less conductive portions. What has been said of water displacement is true for preferentially *water wet* (hydrophilic) rock, which is the case of most reservoir rocks. Where the rock is preferentially *oil wet* (hydrophobic), the displacing water will invade the more conductive portions first, just as gas does, resulting in lower displacement efficiencies. In this case the efficiency by water still exceeds that by gas because of the viscosity advantage the water has over the gas.

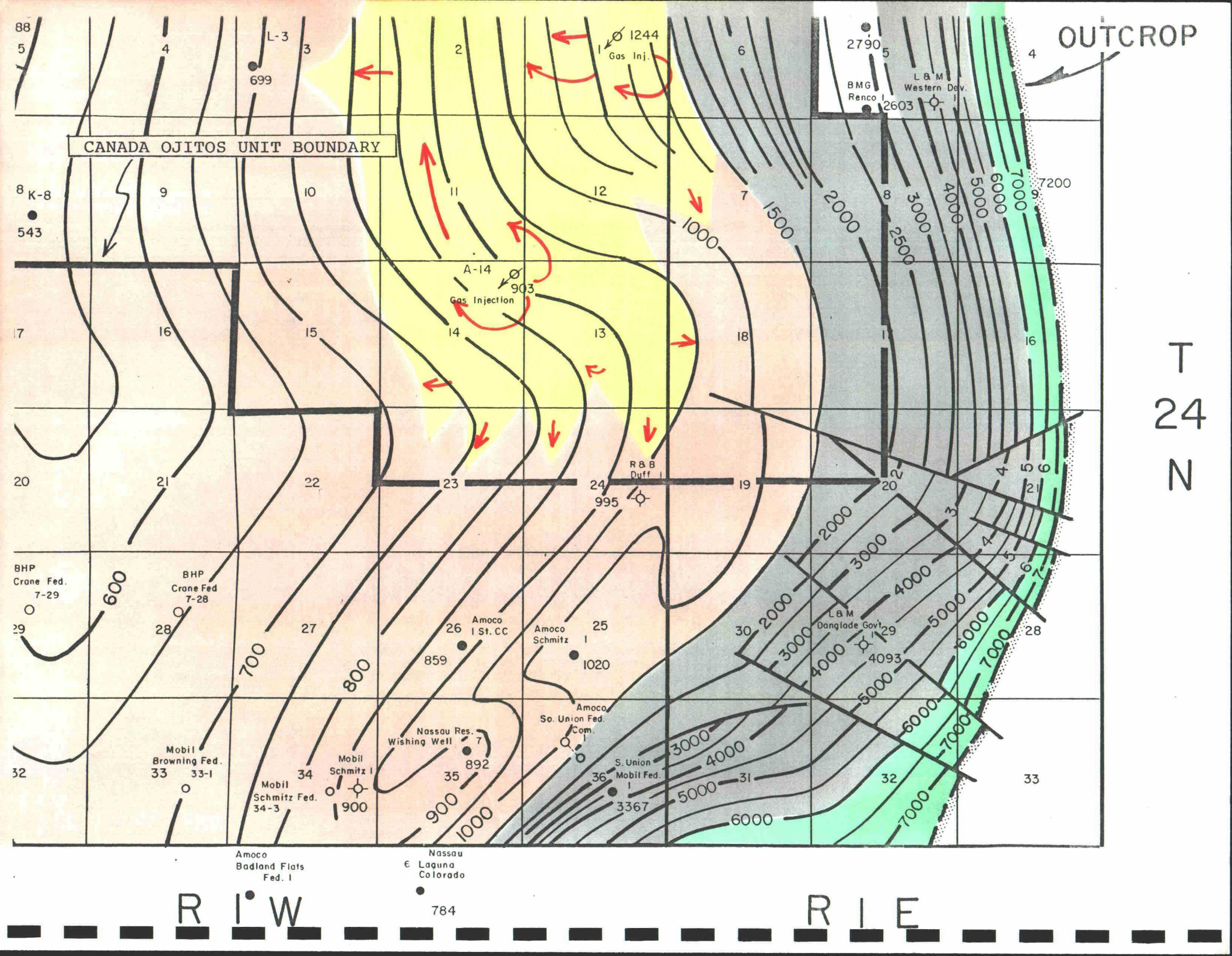
In the displacements discussed in the previous paragraph the distribution of the fluids (gas, oil, and water) in the pore spaces at any set of fluid saturations is determined (a) by the wettability characteristics of the rock, i.e., whether hydrophilic, hydrophobic, or mixed, and (b) by the surface or

obtained with the regular five-spot network; and Matthews and Fischer[46] have used a fluid mapper to study this same problem. [redacted]

Gas-condensate reservoirs are cycled to increase the rate of recovery and/or the ultimate recovery of the liquid products which are vaporized in the gas-condensate fluid. They may be cycled to offset retrograde losses or to recover sooner the liquids where the gas production is limited by demand or some other reason. Where the gas is in contact with an oil zone under active water drive, the oil recovery will be reduced if the gas is produced and the oil invades the gas zone. For example, if the initial oil saturation in the oil zone is 75 per cent, and the residual oil saturation is 25 per cent, if the gas cap contracts so that the oil moves through a volume twice its initial volume, leaving 25 per cent residual oil in each volume, the oil recovery will be zero. In volumetric reservoirs, too, the oil recovery is reduced if the gas cap is produced prior to or along with the oil zone. In these cases, cycling may be used to recover the liquids from the gas-condensate fluid, along with the oil, and when the oil reserve is depleted, then the gas cap may be "blown down" or depleted.

The sweep efficiencies of cycling programs have been studied using models, generally the potentiometric model. Usually a number of studies is made on each reservoir to find the injection and production rates in existing and proposed wells which will give the highest sweep efficiency. Simultaneously the studies are used to plan the operations so that the cycling (gasoline or liquid recovery) plant will operate at full designed capacity up to the cessation of cycling. This means that the dry gas front should break through in all of the production wells at approximately the same time. In the case of multiple reservoirs the design of a program becomes quite complex. In addition, premature breakthrough in some wells may require additional studies to change the program in the light of information discovered during the cycling.

Figure 7.33 shows the results of a potentiometric model study on the gas-condensate reservoir of the Bearden Field superimposed on an isopachous map. The flow lines (arrows) have been drawn from the injection wells, Nos. 1 and 2, to the production wells, Nos. 3, 4, and 5, perpendicular to the isopotential lines. The dry gas front appears to break through into the producing wells almost simultaneously, and the position of the front was obtained exactly as the fronts were obtained in Table 7.9. The sweep efficiency is obtained by planimetering the reservoir *volume* within the swept area. Example 7.2 shows the type of calculations which are made in a cycling study using the results of model work. Marshall and Oliver[47] have reported on the uses and limitations of model studies in cycling.


OUTCROP
CANADA OJITOS UNIT BOUNDARY
T 24 N
R 1 W
R 1 E
L-3
699
1244
Gas Inj.
2790
BMG Renco 1
2603
L & M Western Dev. 1
K-8
543
A-14
903
Gas Injection
R & B Duff 1
995
BHP Crane Fed. 7-29
BHP Crane Fed 7-28
Amoco 1 St. CC
859
Amoco Schmitz 1
1020
L & M Danglade Govt. 1
4093
Amoco So. Union Fed. Com. 1
Nassau Res. Wishing Well 7
892
Mobil Browning Fed. 33-1
Mobil Schmitz 1
900
Mobil Schmitz Fed. 34-3
S. Union Mobil Fed. 1
3367
Amoco Badland Flats Fed. 1
Nassau & Laguna Colorado
784
1500
2000
2500
3000
4000
5000
6000
7000
7200
1000
600
700
800
900

DISPLACEMENT OF ATTIC OIL OF THE SCHMITZ ANTICLINE #1

With respect to the Canada Ojitos Unit A-14 injection well, oil in the Schmitz Anticline #1 is "attic oil". However, this attic oil of the Schmitz Anticline #1 cannot be moved by gravity displacement from downdip gas injection in the Canada Ojitos Unit A-14 because the permeability in this area appears to be too low.

Accordingly, in the area between the tight block in which the A-14 injects and the Schmitz Anticline #1, gas does not displace oil by gravity segregation as in typical attic oil recovery processes. As a consequence, it is to be expected that the injected gas will not, by gravity differences, move rapidly updip; and so will not affect the initial production - particularly the GOR - of the Schmitz Anticline #1 well.

Oil which is moved toward the Schmitz Anticline area as a consequence of gas injection in the A-14 well is displacement by "gas drive" rather than displacement by gravity segregation. It is anticipated that gas drive here will operate initially with a "piston" action forcing oil ahead of it until gas break-through occurs.

Significant displacement by gas will not occur in a given direction until withdrawal from that direction creates reservoir voidage.

The subject affected areas are shown schematically on the facing page.

Also shown on the plat, distinguished by color, are areas which have basic differences in reservoir characteristic of rock and fluid properties. (Pattern of gas flow is shown by red arrows.)

Brown area: Oil saturated: permeability may be adequate to allow commercial production.

Gray area: Oil and high GOR oil area: this area generally exhibits uniformly steep dip which results in compact, exceptionally tight reservoir rock: too tight for commercial production except for occasional areas of flex. This gray is the east boundary of the West Puerto Chiquito pool and is essentially non-productive (for the most part not a good place to drill for oil). (Because of this the small producer, Southern Union Mobil Federal in the SE/4 of Section 36, Township 24 North, Range 1 West, was removed from the West Puerto Chiquito pool years ago. Amoco has not released initial production tests on its well in the NE/4 of this section but as can be seen from the plat, it is bottomed in the "gray" area, and can be expected to have the same minimal productivity.)

Green area: Barren zone between oil saturated area and outcrop.

Yellow area: Gas invaded area.

(The tight block around the A-14 is more specifically described later herein.)

EVIDENCE OF GAS DRIVE
AND POTENTIAL FOR FUTURE INCREASES IN DRAINAGE FROM THE CANADA OJITOS UNIT
AS SHOWN BY
PRESSURE FALL-OFF CURVES IN THE CANADA OJITOS UNIT INJECTION WELL A-14 (24N-1W)

The 15-year history of gas injection in the Canada Ojitos Unit A-14 demonstrates gas drive displacement of oil from tight reservoir rock and underscores the possibility of increases in future drainage from the Canada Ojitos Unit.

As gas drives oil from the tight rock around the A-14 injection well and reduces the oil saturation, the permeability to gas increases.

Pressure fall-off tests conducted on this well show how the permeability to gas has increased over time and with injection - clear evidence of effective displacement of oil by gas drive.

When the gas reaches higher capacity areas in the reservoir, then the process becomes gravity displacement with its higher recovery efficiency.

This increase in gas permeability with time - evidence of continuing reduction in oil saturation - is defined by the pressure fall-off tests shown on the facing page. Here surface pressures are plotted against shut-in time. Values of the slope, m, are determined from the straight line sections of the curves identified by the year of the test.

Concurrent bottom hole pressures and approximate transmissibility values are set out in the table below.

Attention is called to the increasing value of Kh/u with time and increasing cumulative gas injection.

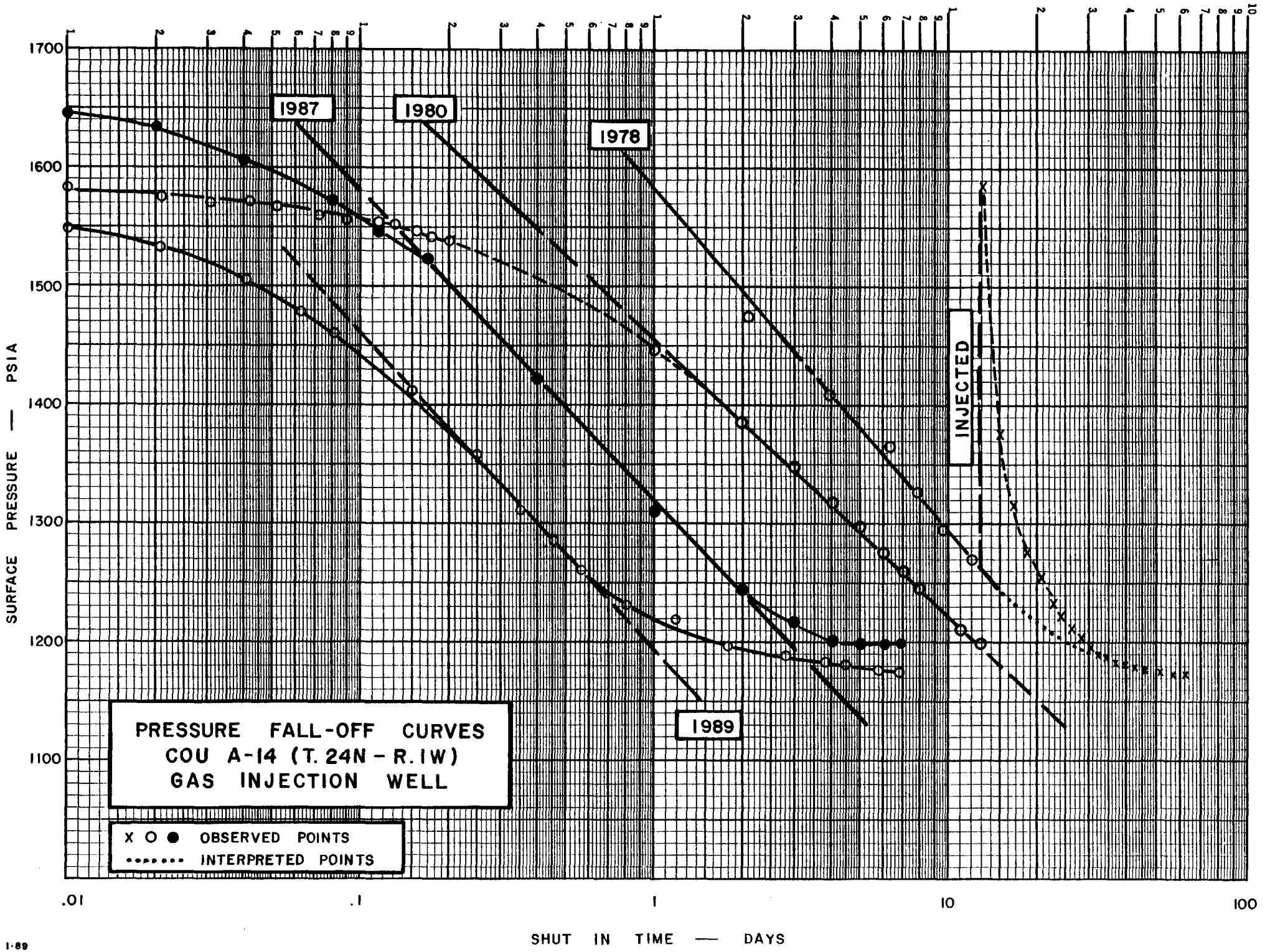
Test Date	Injection Rate Prior to Test (MCF/D)	Slope, m, from plat: Surface Pressure (#/Cycle)	Slope, m, from plat: Bottom Hole Pressure (#/Cycle)	Kh/u *	Kgh **
July 1978	100	290	350	.071	.0012
Nov. 1980	100	235	285	.087	.0015
Nov. 1987	700	265	320	.544	.0092
Jan. 1989	950	265	320	.884	.015

* Kh/u = QTZ/1.22 m (Pavg)
** Kgh = $\pm$ QuTZ/1.22 m (Pavg)

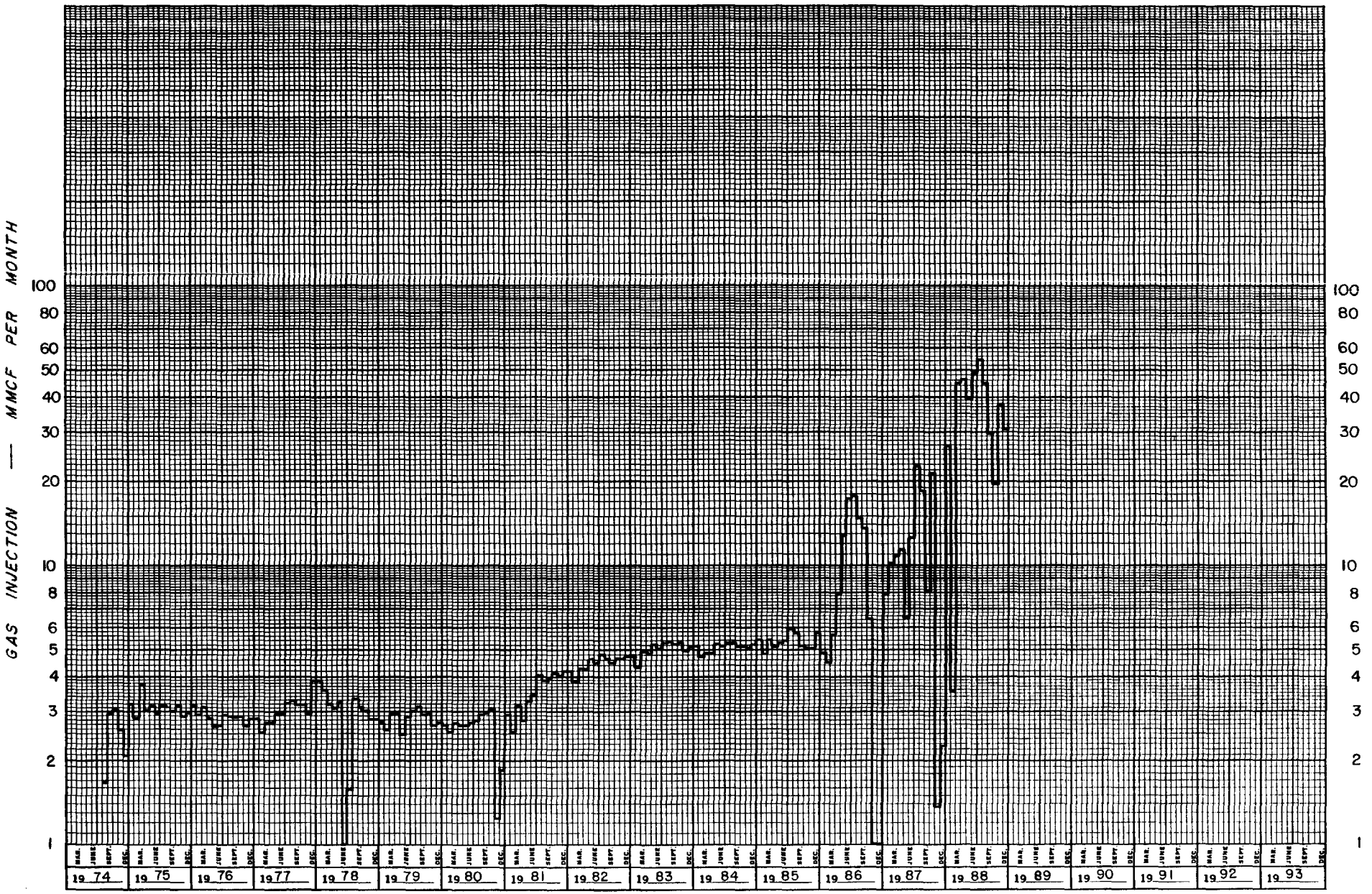
Q = SMCF/D at 14.7 and 60 degrees

P, T, Z, u: at reservoir conditions
m = slope, #/log cycle

Values here:
Pavg = $\pm$ (1900 + 1450)/2 = 1675
T = 160 degrees F = 620 degrees R
Z = .82
u = .017 cp


1700
1600
1500
1400
1300
1200
1100
SURFACE PRESSURE — PSIA
1987
1980
1978
1989
INJECTED
PRESSURE FALL-OFF CURVES
COU A-14 (T. 24N - R. 1W)
GAS INJECTION WELL
X O ● OBSERVED POINTS
INTERPRETED POINTS
.01
.1
1
10
100
SHUT IN TIME — DAYS

1-89



COU A-14 (T.24N, R.1W) INJECTION WELL

EVIDENCE OF GAS DRIVE
AND POTENTIAL FOR FUTURE INCREASES IN DRAINAGE FROM THE CANADA OJITOS UNIT
AS SHOWN BY
GAS VOLUMES INJECTED IN THE
CANADA OJITOS UNIT A-14 (T-24N, R-1W) INJECTION WELL

As can be inferred from the preceding analysis of increased permeability to gas with time, the A-14's injectivity has increased.

Plot of gas injection in this well with time is shown on the graph on the facing page. Months of low gas injection since 1986 represent periods when some gas was marketed, as opposed to being injected.

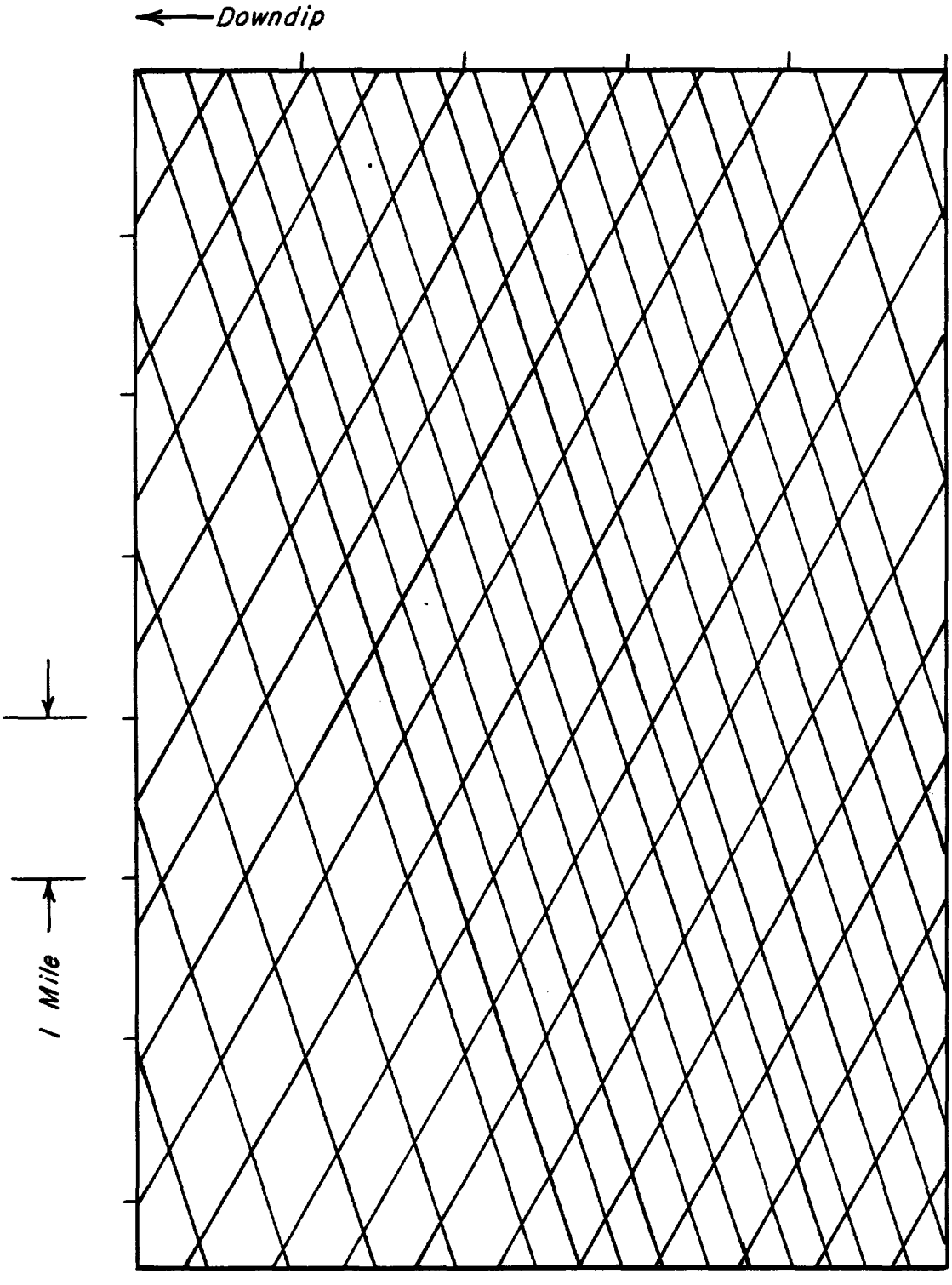
It is interesting to note that despite the low permeability of the tight fracture block in which this well is completed, it has made a good injector: as much as 3,000 barrels of reservoir space per day has been injected in this well; and the cumulative reservoir volume injected exceeds 2,000,000 barrels.

To place this 2,000,000 barrels of reservoir space in perspective, we note that the nearby Gavilan pool has produced a little over 4,000,000 barrels of oil.

The increase in injectivity in this Canada Ojitos Unit A-14 well underscores the potential for increased movement of gas across the unit's south boundry as oil is displaced and the permeability to gas increases.

As oil is produced south of the Canada Ojitos Unit boundary, gas will move to displace it; and just as the injectivity increased in the Canada Ojitos Unit A-14, the high mobility of the gas will cause greater and greater volumes to move south - hence the need for the unit to drill protection wells.

SCHEMATIC FRACTURE SYSTEM
Fracture Blocks ± 80 Ac. & 160 Ac.



SIZE OF FRACTURE BLOCKS AROUND CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

The main producing reservoir of the West Puerto Chiquito pool which lies within the Canada Ojitos Unit comprises a system of fracture blocks believed to be in the range of 20 to 200 acres. The poorer parts of the reservoir may have fracture blocks of larger sizes. The blocks are joined by an interconnecting high capacity fracture system.

Others who have testified with respect to Niobrara pools in this area have suggested that the reservoir might be of dual porosity type; however the production and pressure data do not support this premise. The only reservoir geometry that can be satisfied by the pressure and production tests is the fracture block system described above and shown schematically on the plat on the facing page.

For a well producing from a fracture block - since the high capacity fracture system has a relatively high transmissibility compared to that of the tight fracture block - the flow system is essentially that of "constant pressure at the boundary" for any time in the depletion history. For those parts of the reservoir where pressure is maintained by gas injection, the system is exactly that of constant pressure at the boundary.

For given values of pore volume (ϕh) the minimum size of the fracture block for the Canada Ojitos Unit A-14 injection well is determined as shown on the following pages.

SIZE OF FRACTURE BLOCK
OF THE CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

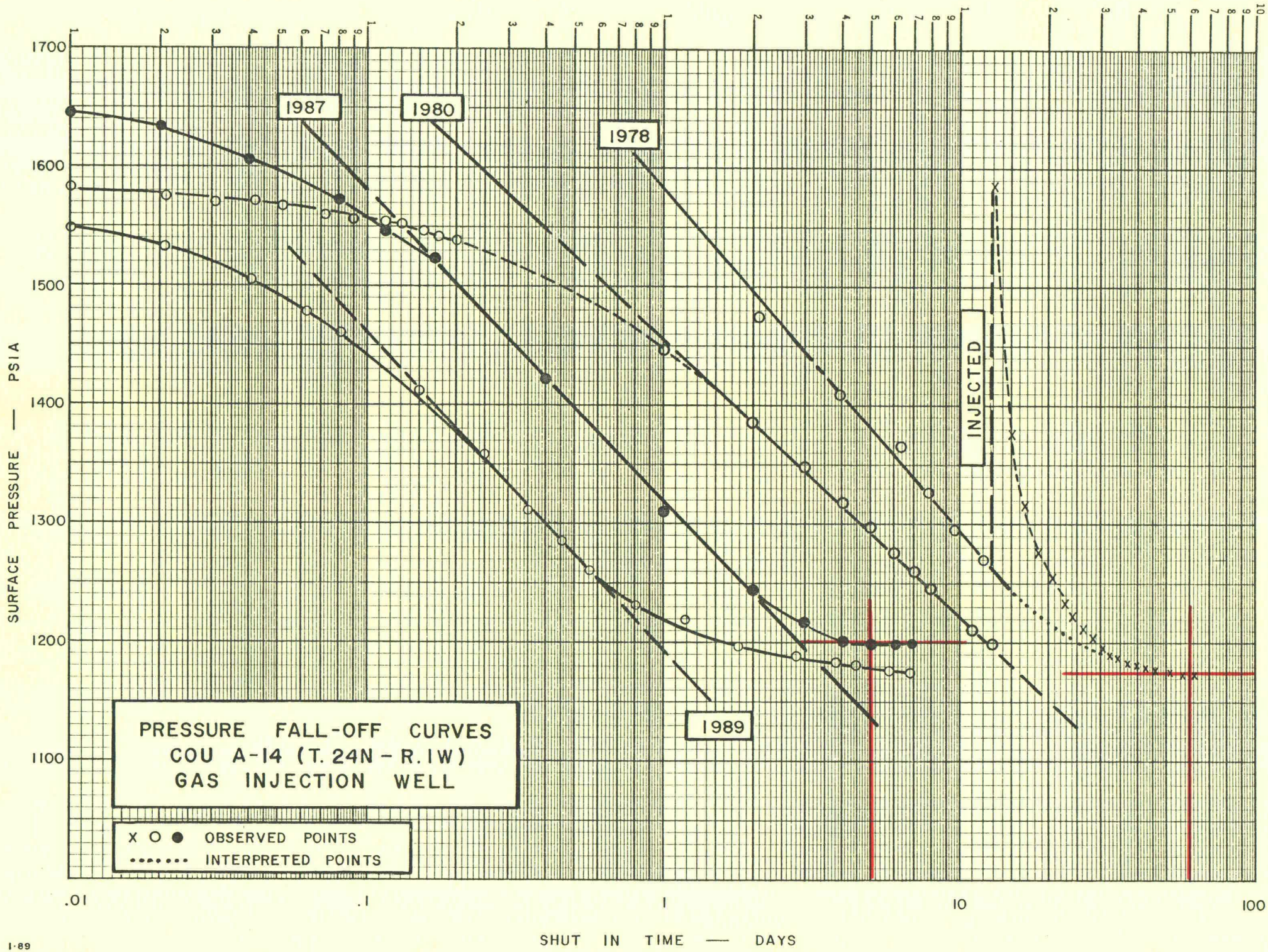
An approximation can be made of the minimum size (through minimum distance from wellbore to edge of fracture block) of the fracture block in which the A-14 is injecting if one knows the time required to reach steady state conditions and the concurrent diffusivity constant.

The times to reach steady state conditions for the 1978 and 1987 tests are shown on the graph on the facing page by the red lines.

The diffusivity constant can be calculated from measured transmissibilty and assumed value for pore volume by the method shown in NMOCC Case 9111, June 13, 1988, B-M-G Exhibit 1, Section H.

No interference test is available to measure directly the pore volume in this area; so the calculations are made for a range of pore volumes, the range being consistent with the measured transmissibility values and experience with testing in other parts of the reservoir.

Calculations for distance from well to edge of fracture block are shown on the following page, along with graph showing this distance as dependent on pore volume expressed as barrels per acre of stock tank oil in place.


1700
1600
1500
1400
1300
1200
1100
SURFACE PRESSURE — PSIA
1987
1980
1978
1989
INJECTED
PRESSURE FALL-OFF CURVES
COU A-14 (T. 24N - R. 1W)
GAS INJECTION WELL
X O ● OBSERVED POINTS
••••••• INTERPRETED POINTS
.01
.1
1
10
100
SHUT IN TIME — DAYS

1-89

CALCULATION OF MINIMUM SIZE OF FRACTURE BLOCK
CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

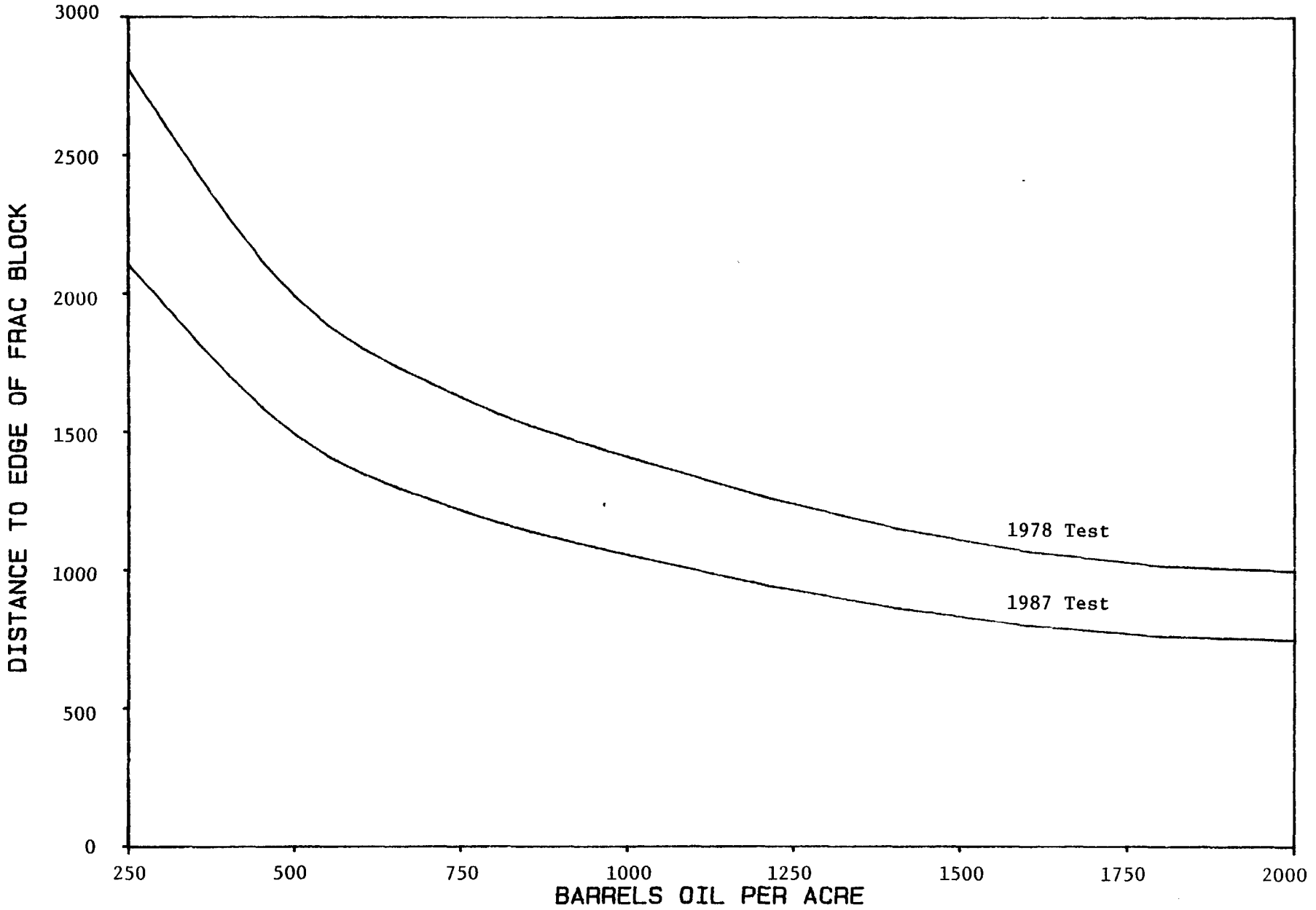
Test (1)	Transmissibility Kh/u (2)	Assumed Sg (3)	CT Vol/Vol/# (4)	Time to Reach Steady State (Days) (5)	Pore Volume Assumed øh (6)	Pore Volume Assumed H.C. S.T. Bbl/Acre (7)	n (8)	$r = \sqrt{4\,n\,t}$ (9)
1978	.071	1%	325×10^{-6}	60	.335	2000	$4.13 \times 10^{3}_{3}$	996
				60	.167	1000	8.28×10^{4}	1410
				60	.084	500	1.65×10^{4}	1990
				60	.042	250	3.29×10^{4}	2810
1987	.544	10%	370×10^{-6}	5	.335	2000	$2.78 \times 10^{4}_{4}$	746
				5	.167	1000	$5.57 \times 10^{4}_{5}$	1056
				5	.084	500	1.11×10^{5}	1490
				5	.042	250	2.22×10^{5}	2107

The above information is summarized by a plot, shown on the facing page, of the figures in Column 7 versus those in Column 9.

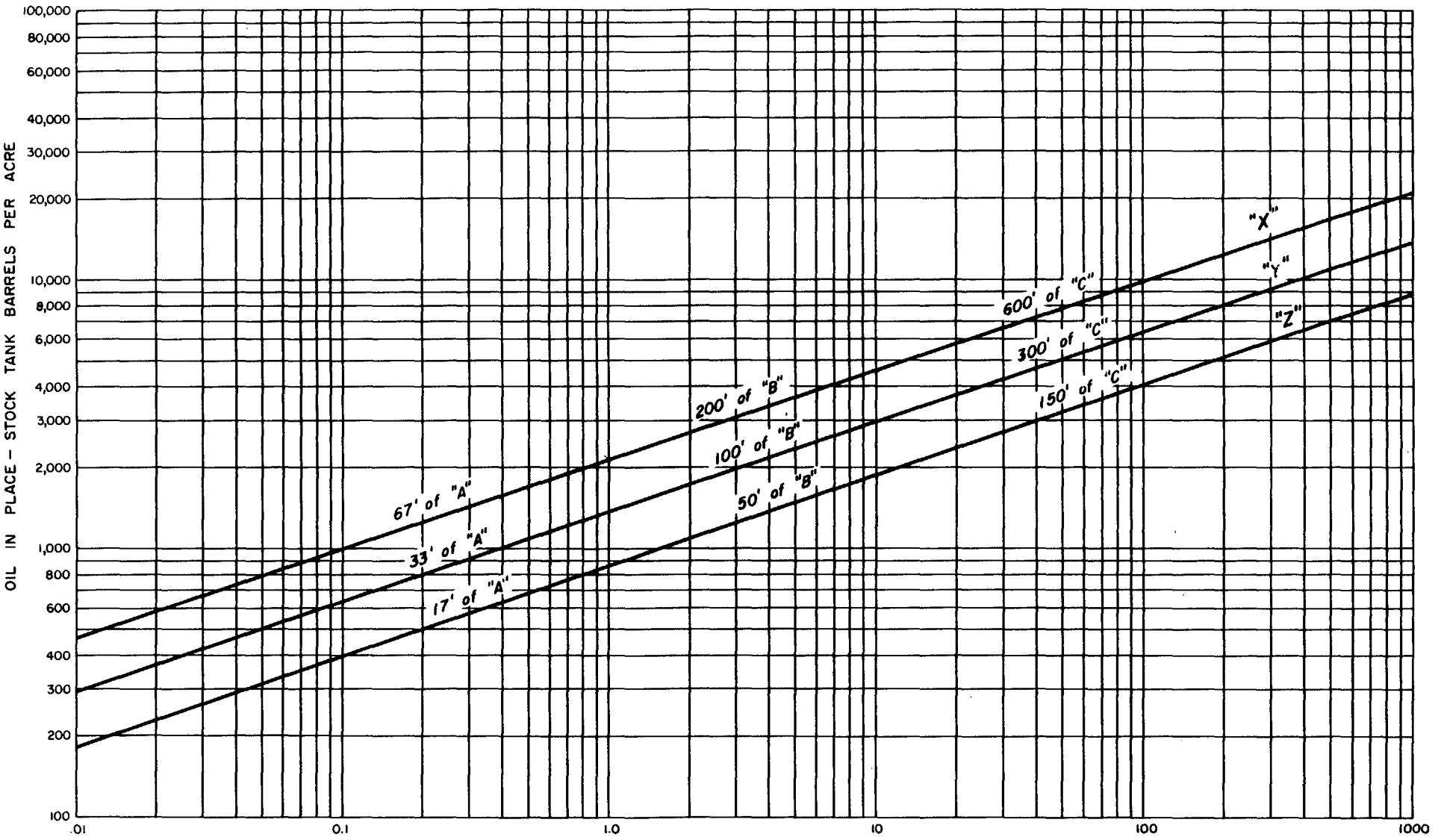
---

1) Year of fall-off test shown previously.
2) From fall-off test.
3) Assumed gas saturation.
4) CT = SoCO + SgCg + Cf (Use Cf = 20×10^{-6}).
5) Time to reach steady state conditions (from fall-off test).
6) øh = porosity feet.
7) Hydrocarbon pore space in terms of S.T. barrels per acre.
8) $n = 6.328 \times (Kh/u)/(øh)CT$. Reference NMOCC Case 9111, June 17, 1988, B-M-G Exhibit 1, Section H.
9) From $r^2 = 4nt$. Reference Muskat, Physical Principles of Oil Production (1949) Page 537 and Craft & Hawkins (1959) Page 275, and NMOCC Case 3455, November 16, 1966.

MINIMUM DISTANCE TO EDGE OF FRACTURE BLOCK
CANADA OJITOS UNIT A-14 INJECTION WELL



RELATION OF OIL IN PLACE
TO
TRANSMISSIBILITY
FOR
POROSITY–PERMEABILITY RELATIONS
"A", "B" & "C"
AND FOR
RESERVOIR THICKNESSES SHOWN
F.V.F.=1.29



File 13A

NMOCC CASE 3455, DEC. 1969
BMG EXHIBIT 2
APPENDIX III FIGURE NO. III-5

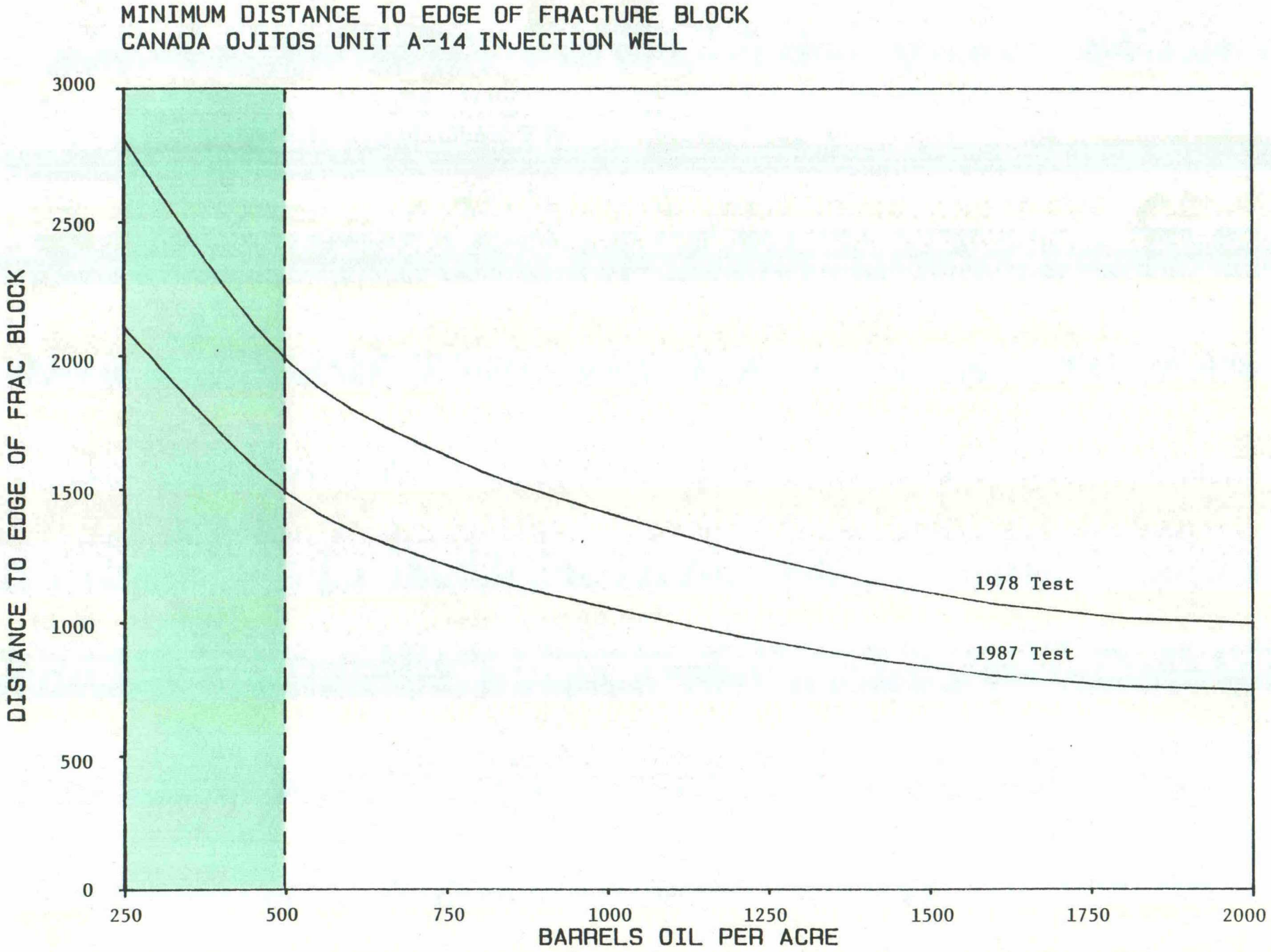
HYDROCARBON PORE SPACE AS A FUNCTION OF Kh

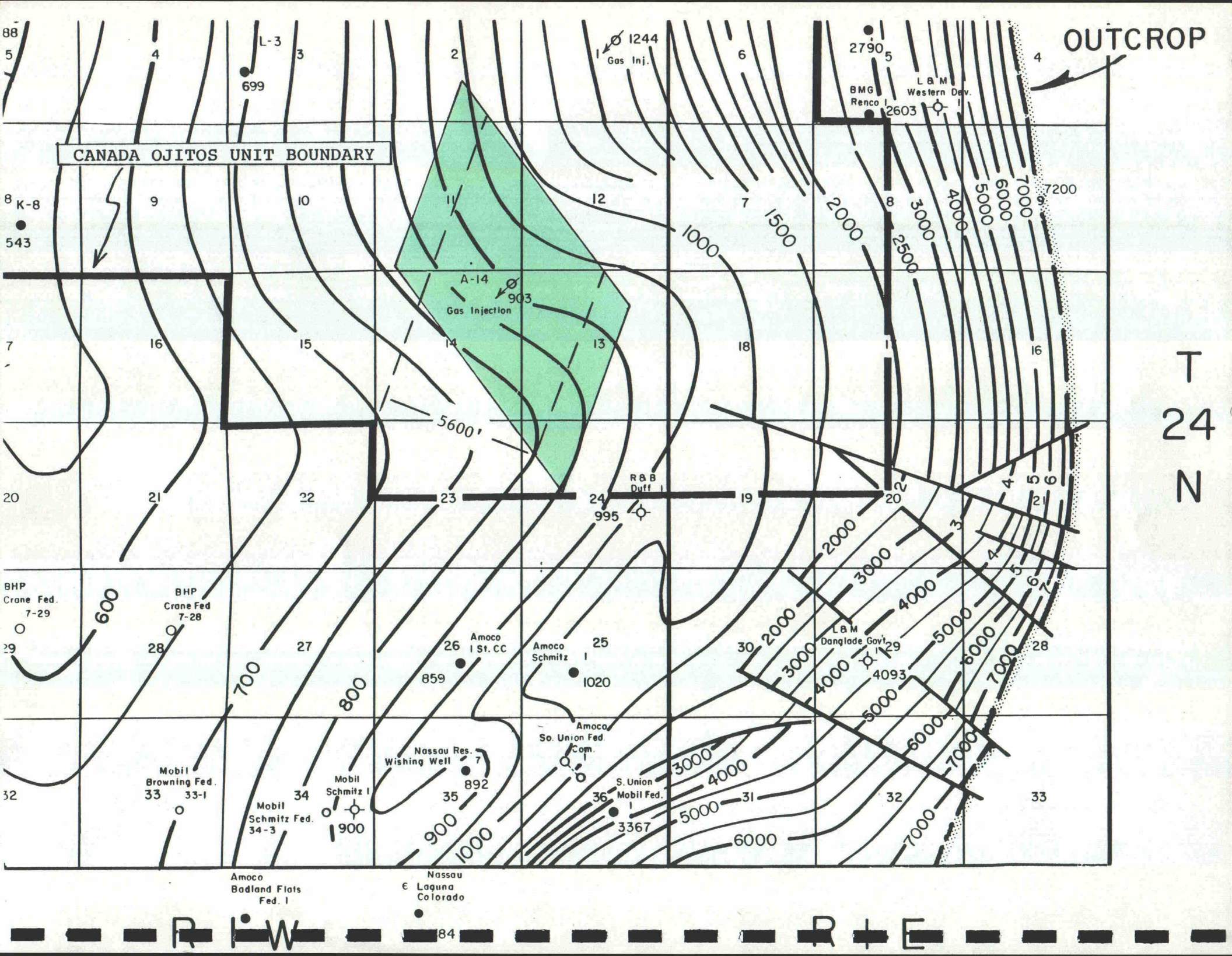
Until a better relation is developed, that shown on the graph on the facing page can be used to estimate pore space as a function of Kh. Interference tests made in West Puerto Chiquito fall generally between or near the lower two lines ("Y" and "Z").

The letters "A", "B" and "C" are not to be confused with the A, B and C zones; rather they are relations described in the study leading to this graph. (Reference Case 3455, December 1969, B-M-G Exhibit 2).

In the instant case (see previous section), the value of Kgh is estimated at .0092. We do not know the value of the relative permeability to gas; but since Kgh has increased about tenfold from 1986 to 1989 to .015, it is probable that the relative permeability to gas in 1989 is approaching 1. If we assume it to be .75 at time of 1987 test, then Kh would be about .02. Entering the graph on the facing page with the value of .02 then stock tank oil in place per acre is determined (between the lower two lines) to approximate 250 to 500 barrels.

This range of 250 barrels to 500 barrels is highlighted on the graph on the next page.


MINIMUM DISTANCE TO EDGE OF FRACTURE BLOCK
CANADA OJITOS UNIT A-14 INJECTION WELL
DISTANCE TO EDGE OF FRAC BLOCK
3000
2500
2000
1500
1000
500
0
250
500
750
1000
1250
1500
1750
2000
BARRELS OIL PER ACRE
1978 Test
1987 Test


OUTCROP
CANADA OJITOS UNIT BOUNDARY
T 24 N
R 1 W
R 1 E
L-3
699
1244
Gas Inj.
2790
BMG
Renco 1
L & M
Western Dev.
1
2603
K-8
543
A-14
903
Gas Injection
7200
5600'
R & B
Duff 1
995
BHP
Crane Fed.
7-29
BHP
Crane Fed
7-28
Amoco
1 St. CC
859
Amoco
Schmitz 1
1020
L & M
Danglade Govt.
4093
Amoco
So. Union Fed.
Com. 1
Nassau Res.
Wishing Well 1
892
Mobil
Browning Fed.
33-1
Mobil
Schmitz 1
900
Mobil
Schmitz Fed.
34-3
S. Union
Mobil Fed.
1
3367
Amoco
Badland Flats
Fed. 1
Nassau
Laguna
Colorado

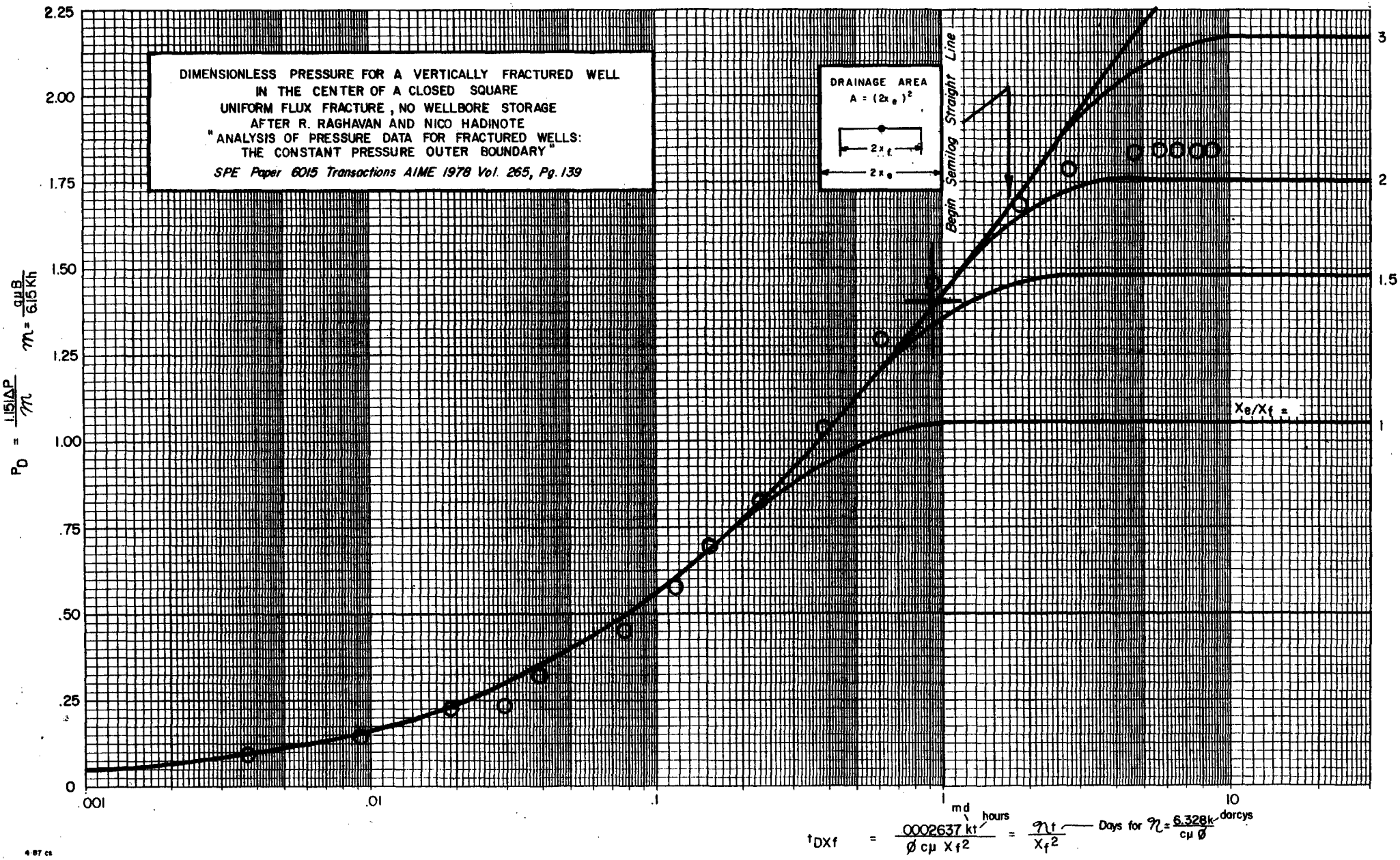
SIZE OF FRACTURE BLOCKS
AROUND CANADA OJITOS UNIT A-14 INJECTION WELL (24N-1W)

Shown on the plat on the facing page is the *minimum* size of fracture block (postulated in the shape of a parallelogram identified by the dashed lines) around the A-14 injection well for a pore volume of 250 stock tank barrels per acre. If the fracture block is longer than it is wide, then its ends could extend beyond the dashed lines as shown schematically thereon.

The significant issue here with respect to size of the fracture block around this injection well is that it, in effect, moves the point of injection into the reservoir from the wellbore to the boundaries of the fracture block.

So as a practical matter, the gas flow into the reservoir is the same as if the single injection well were replaced by a series of small injectors located on the periphery of the fracture block; so the effective point of injection with support to the south boundary is that it is close indeed.

It is therefore abundantly clear that - absent protection wells along the boundary - the unit is at risk with respect to drainage.


DIMENSIONLESS PRESSURE FOR A VERTICALLY FRACTURED WELL
IN THE CENTER OF A CLOSED SQUARE
UNIFORM FLUX FRACTURE, NO WELLBORE STORAGE
AFTER R. RAGHAVAN AND NICO HADINOTE
"ANALYSIS OF PRESSURE DATA FOR FRACTURED WELLS:
THE CONSTANT PRESSURE OUTER BOUNDARY"
SPE Paper 6015 Transactions AIME 1978 Vol. 265, Pg. 139
DRAINAGE AREA
A = (2x_e)^2
2x_f
2x_e
Begin Semilog Straight Line
Xe/Xf =
P_D = 1.151ΔP/m
m = qμB/6.15Kh
2.25
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
0
.001
.01
.1
1
10
md
3
2
1.5
1
t_DXf = 0002637 kt/ø cμ Xf^2 = η t/Xf^2 — Days for η = 6.328k/cμø darcys
hours
4-87 cs

LENGTH OF INDUCED FRACTURE IN CANADA OJITOS UNIT A-14 FRACTURE BLOCK AND DETERMINATION OF OUTER DIMENSION OF FRACTURE BLOCK FROM THIS FRACTURE LENGTH

Finally we look at the length of the induced fracture in the Canada Ojitos Unit A-14 tight fracture block; and an independent method of estimating the size of the fracture block.

The flow system is that of constant pressure at the boundary. Method of analysis is through use of type curves; and is described in New Mexico Oil Conservation Commission Case 9111, June 17, 1988, B-M-G Exhibit 1, Sections V, W, X, Y and Z.

The graph on the facing page shows the match of points on the type curve. The pressure function used is that of the integrated values of the pseudopressures squared (as distinct from the difference of the squares of the pseudopressures). Graphs of pressure versus pseudopressure and pressure versus the integrated value are the last two pages in this section.

The basic data and calculations are summarized on the next two pages for the 1987 pressure fall-off test (reference: graph of pressure fall-off test in preceding section).

The values for Kgh and Kgh/u as determined by this (constant pressure at the boundary) method are more accurate than those shown in the preceding section; however they are not substantially different.

Results of this analysis for the 1987 test are compared with those shown in the previous section:

	By time to reach steady state conditions (previous section)	By constant pressure at the boundary (this section)
Kgh	.0092	.0074
Kgh/u	.544	.46
Length of edge of fracture block for hydrocarbon pore volume equivalent to 250 to 2000 stock tank barrels per acre in place	746' to 2107'	700' to 1960'
Fracture half-length for hydrocarbon pore volume equivalent to 250 to 2000 stock tank barrels per acre	-	158' to 446'
Fracture total length for pore volume equivalent to 250 to 2000 stock tank barrels per acre	-	316' to 892'

CANADA OJITOS UNIT A-14 (24N-1W)
1987 TEST

Time S.I. (Days) (1)	Surface Pressure (Psia) (2)	Psia at 6430' (3)	$2\int_0^{P}\left(\frac{P}{Z\frac{\mu}{\mu_i}}\right)dP$ (4)	$2\int_0^{1995}\left(\frac{P}{Z\frac{\mu}{\mu_i}}\right)dP - \text{col 4}$ (5)	Column 5 Converted to use semi-log graph * (6)
0.000	1670	1995	3.82 $\times 10^6$	0.00 $\times 10^6$	0.00 $\times 10^6$
0.005	1660	1983	3.78	0.04	0.04
0.010	1647	1968	3.72	0.10	0.10
0.021	1630	1947	3.64	0.18	0.18
0.042	1607	1920	3.54	0.28	0.28
0.083	1572	1878	3.40	0.42	0.42
0.125	1546	1845	3.29	0.53	0.53
0.167	1521	1814	3.19	0.63	0.63
0.250	1482	1767	3.04	0.78	0.78
0.417	1420	1693	2.80	1.02	1.02
0.667	1355	1615	2.56	1.26	1.26
1.000	1310	1560	2.40	1.42	1.42
2.000	1244	1480	2.17	1.65	1.65
3.000	1217	1446	2.07	1.75	1.75
4.000	1198	1424	2.02	1.80	1.80
5.000	1198	1424	2.02	1.80	1.80
6.000	1198	1424	2.02	1.80	1.80
7.000	1198	1424	2.02	1.80	1.80

* f (ΔP) for semi log plot =

f (ΔP) log-log plot x 1.151/m = f (ΔP)(1.151/1.15 x 10^6)

m from log-log plot 1.15 (log-log plot not shown here)

COU A-14 INJECTION WELL
PRESSURE FALL-OFF TEST
NOV. 1987 - Shut in Oct 29

Injecting 700 MCF/D prior to shut in

FROM SEMI-LOG PLOT: MATCH POINT $\begin{cases} \frac{t}{\Delta P} = 1.33 \\ P_D = 1.41 \end{cases}$ $\begin{cases} t_{DY_f} = .94 \\ t = 1.0 \text{ day} \end{cases}$

$Y_e/Y_f = 2.2$

$$m = 1.151 \frac{\frac{t}{\Delta P}}{P_D} = 1.151 \times \frac{1.33}{1.41} = 1.09 \times 10^6$$

$$Kh = \frac{1000 \times Q \times .0115 \times \left(\frac{610}{610.9}\right)}{m} = \frac{1000 \times 700 \times .0115 \times \left(\frac{610}{610.9}\right)}{1.09 \times 10^6} = .0074 \text{ darcy feet}$$

For assumed approx $\mu = .016$; $\frac{Kh}{\mu} = \frac{.0074}{.016} = .46$ d-ft/cp

---

$$\frac{n}{Y_f^2} = \frac{t_D Y_f}{t} = \frac{.94}{1.0} = .94 \qquad Y_f^2 = n/.94 \qquad n = \frac{6.328 \left(\frac{Kh}{\mu}\right)}{c_T \phi h}$$

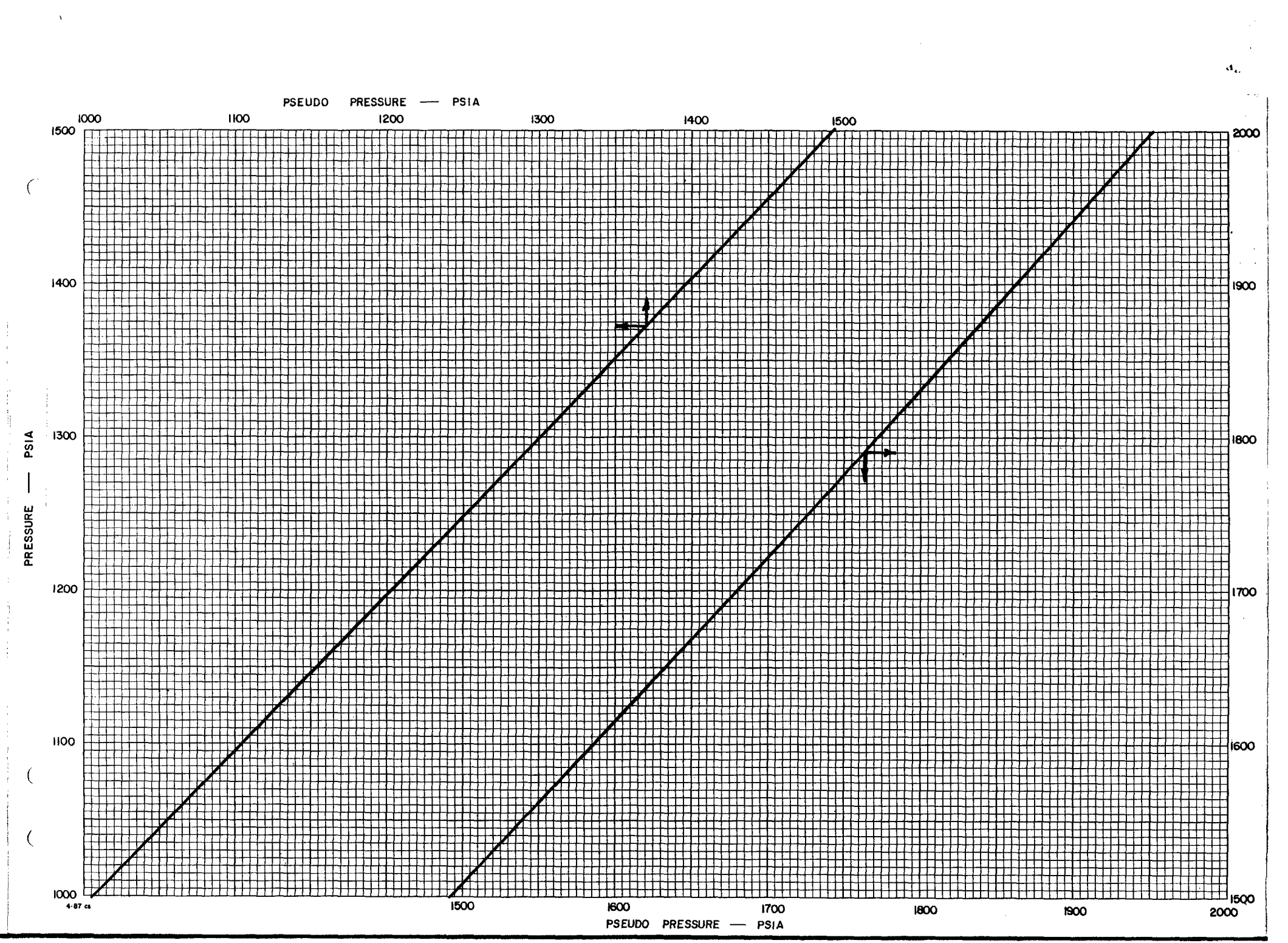
$$n = \frac{6.328 \times .46}{370 \times 10^{-6} \phi h} = \frac{7.87 \times 10^3}{\phi h} \qquad Y_f^2 = n/.94 = \frac{7.87 \times 10^3}{.94} = \frac{8.37 \times 10^3}{\phi h}$$

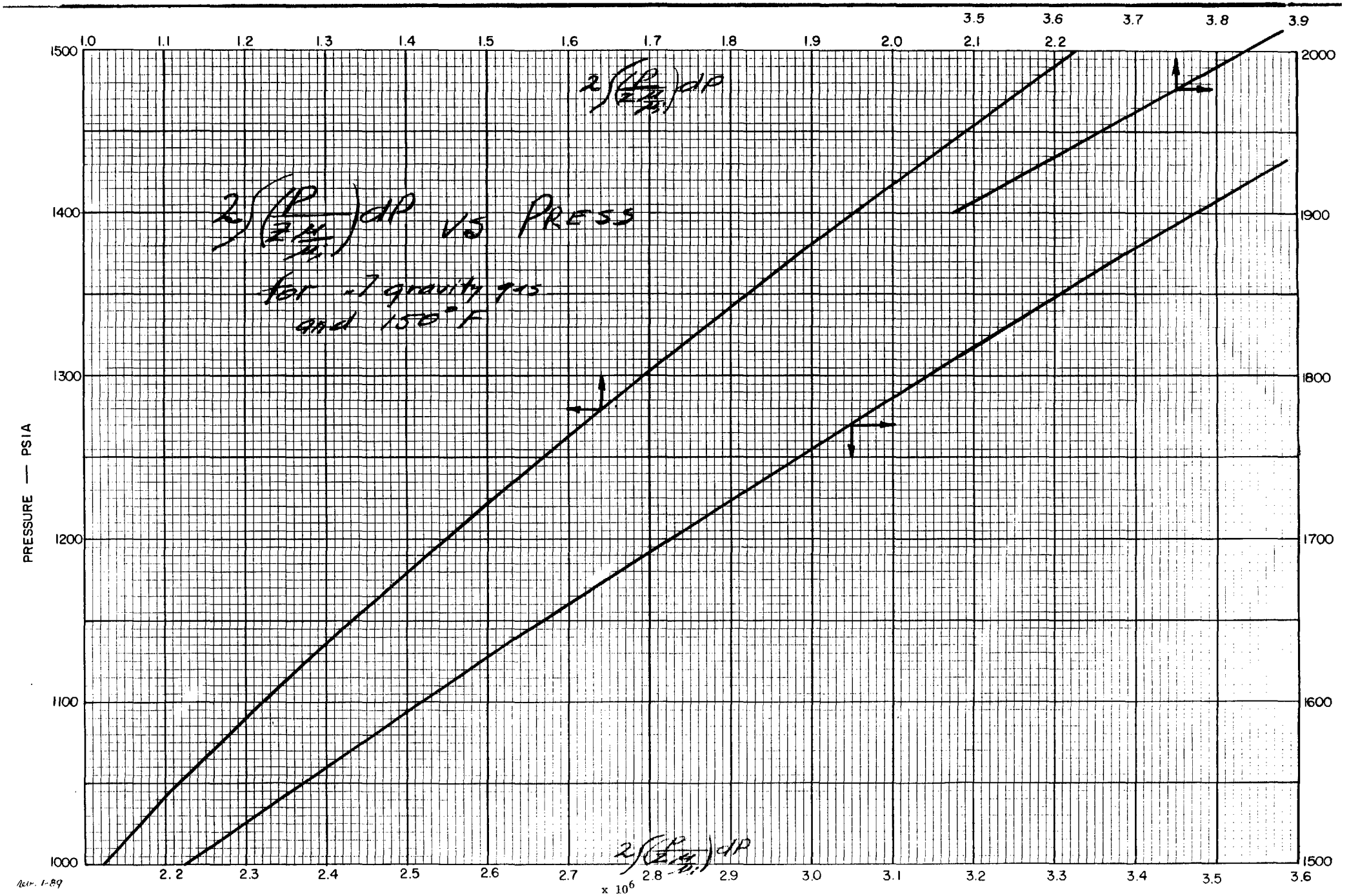
Fracture half length, Y_f,

$$= \sqrt{n/.94}$$

$$= \sqrt{\frac{8.37 \times 10^3}{\phi h}}$$

ϕh	HYDRO-CARBON PORE VOL. B.T. BBL/AC	Y_f	$Y_e = 2.2 Y_f$	$2X_e$ = LENGTH OF SIDE OF FRACTURE BLOCK
.335	2000	158	348	700
.167	1000	224	493	790
.084	500	316	695	1390
.042	250	446	981	1960

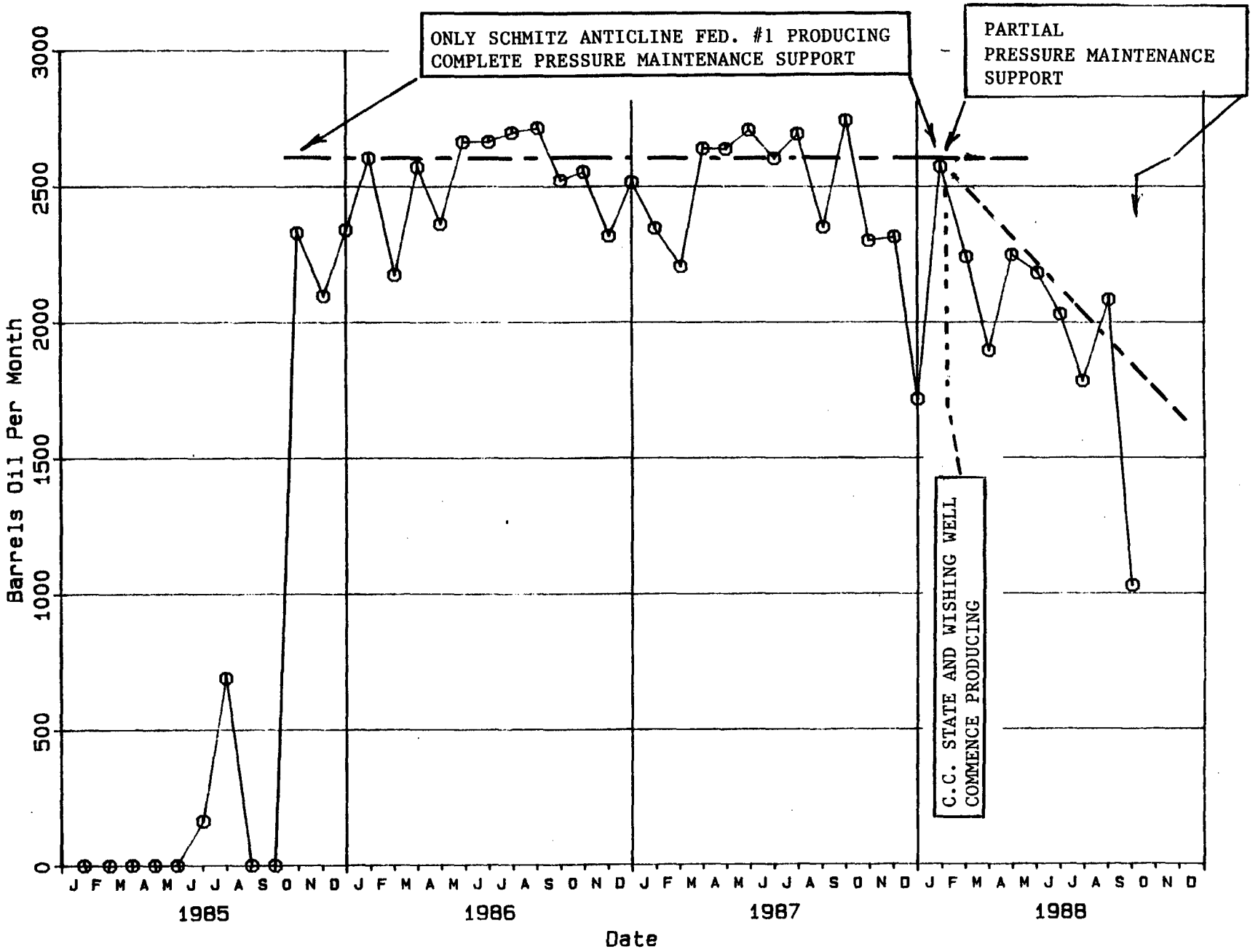

PSEUDO PRESSURE — PSIA
1000
1100
1200
1300
1400
1500
PRESSURE — PSIA
1500
1400
1300
1200
1100
1000
2000
1900
1800
1700
1600
1500
4-87 cs
1500
1600
1700
1800
1900
2000
PSEUDO PRESSURE — PSIA


$2\int\left(\frac{P}{ZT}\right)dP$ vs Press
for .7 gravity gas
and 150°F
$2\int\left(\frac{P}{ZT}\right)dP$
$2\int\left(\frac{P}{ZT}\right)dP$
PRESSURE — PSIA
1500
1400
1300
1200
1100
1000
2000
1900
1800
1700
1600
1500
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 3.5 3.6 3.7 3.8 3.9
2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6
x 10^6

Rev. 1-89

AMOCO SCHMITZ ANTICLINE FED #1

SEC. 25, T-24N, R-1W



TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Nassau Wishing Well 35-7

ELEVATION 7267' KB

DEPTH OF BOMB 6582'

DATE SHUT IN May 10, 1988

TIME SHUT IN 1:26 PM

PRODUCTION RATE PRIOR TO SHUT-IN 604 BOPD

(est) 410 MCFD

GAS-OIL RATIO (est) .68 MCF/BBL

B_O 1.3

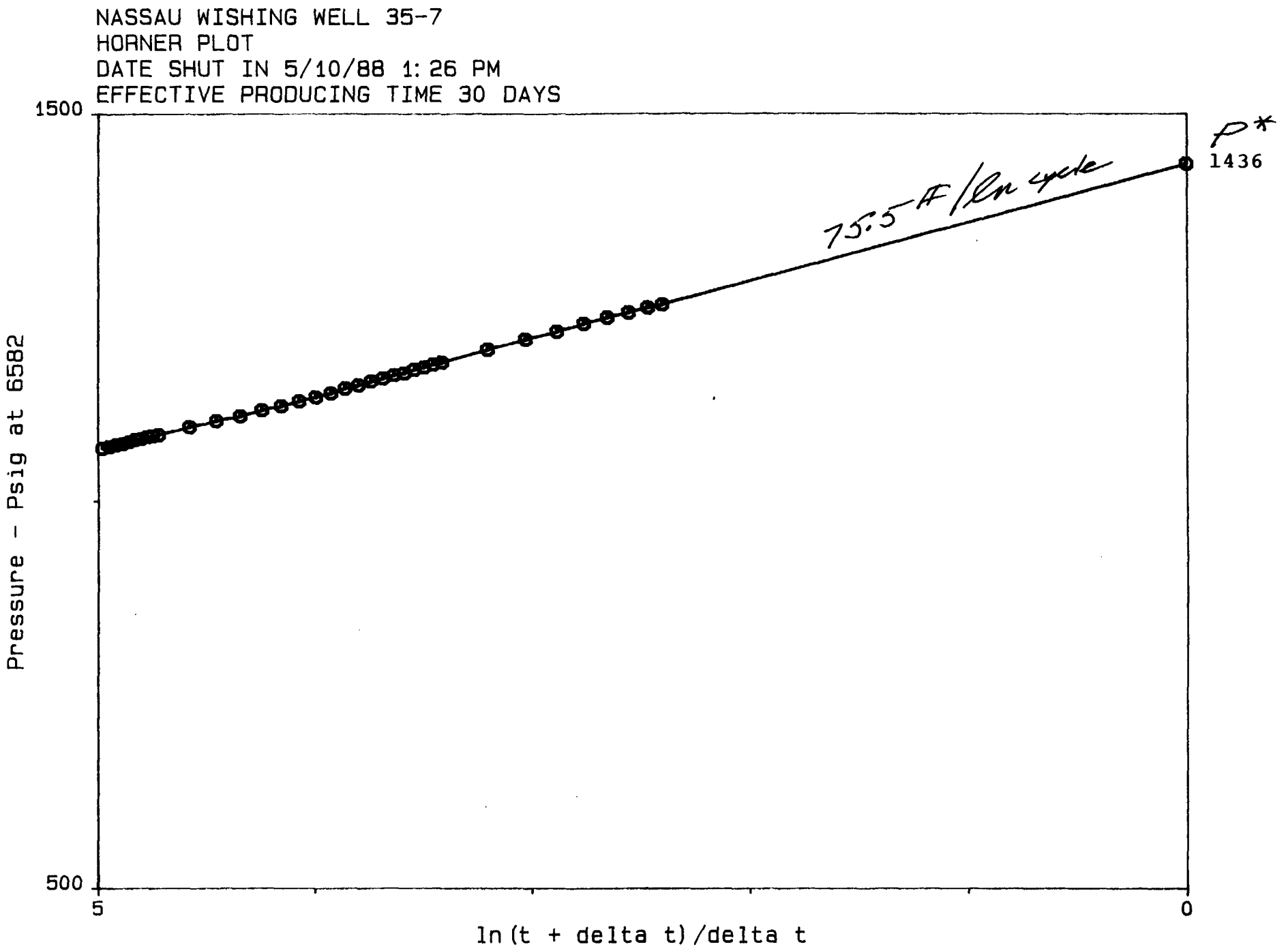
B_T 1.7

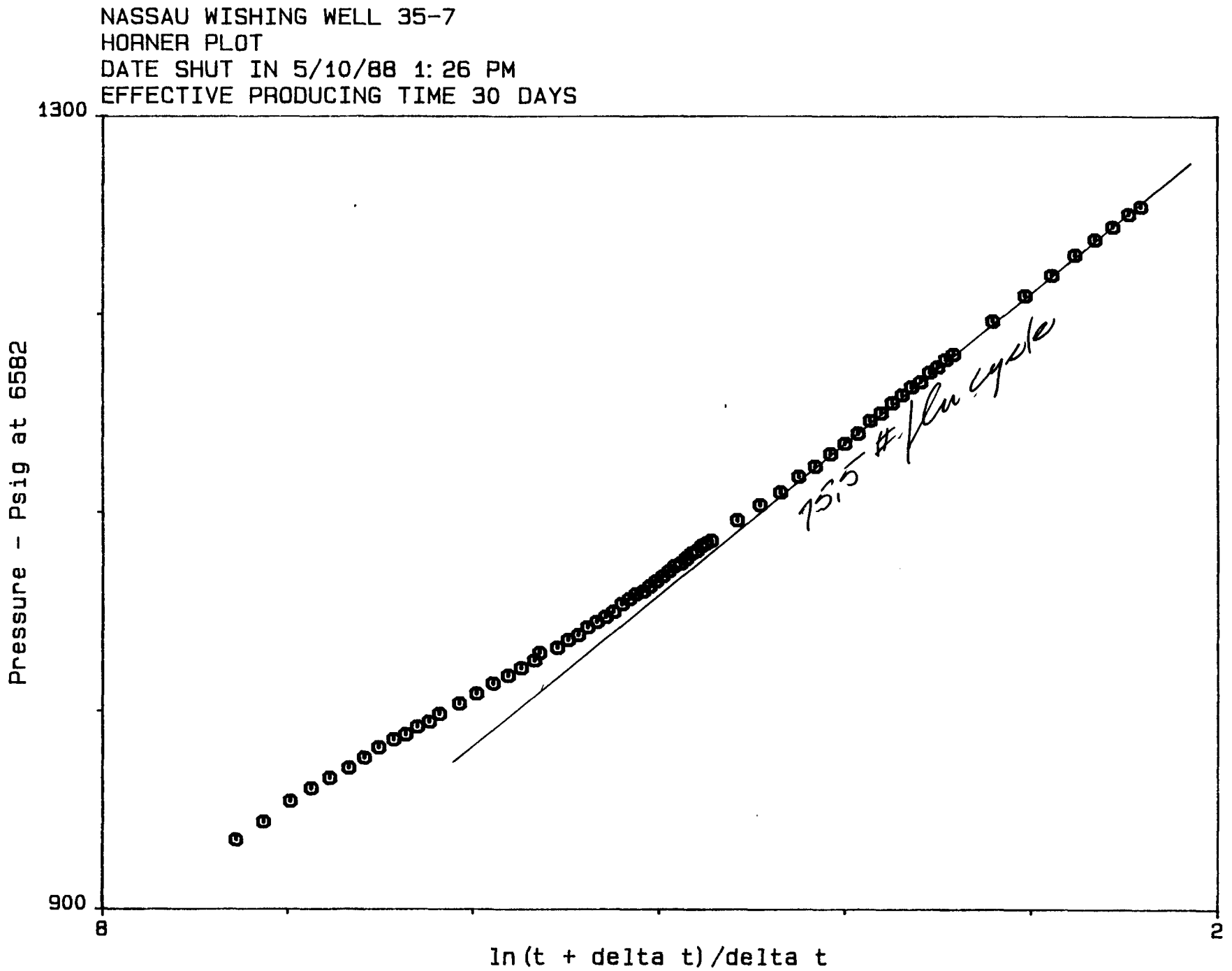
slope, m 75.5 /ln cycle

$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\, B_T}{14.16 \times m \text{ (ln cycle)}} = .96 \text{ darcy feet/cp}$$

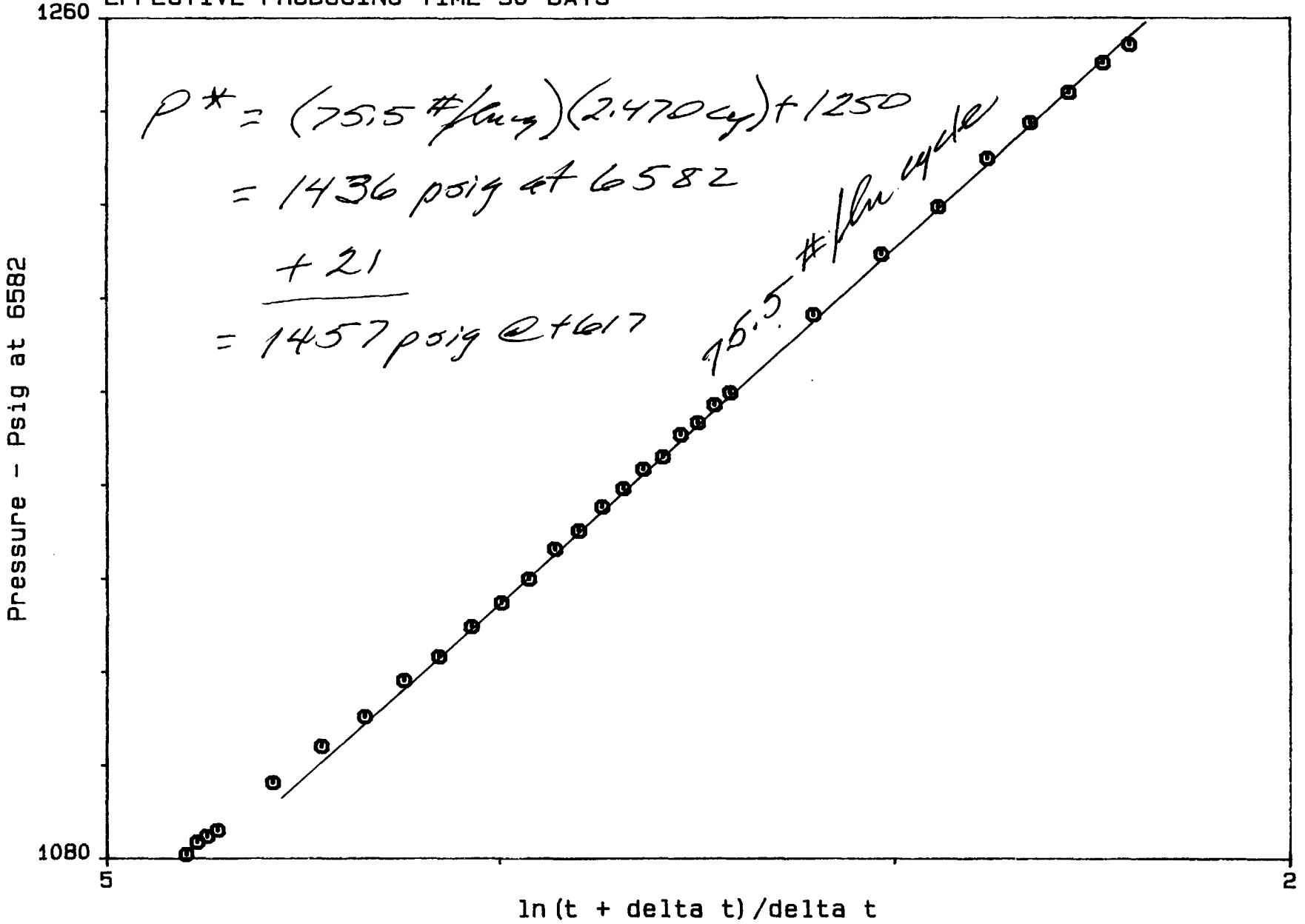
Determination of P* shown on next plot.

Copy of survey and data for Horner plot are at back of this section.


NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 5/10/88 1:26 PM
EFFECTIVE PRODUCING TIME 30 DAYS
1500
500
5
0
p*
1436
75.5 # / ln cycle
Pressure - Psig at 6582
ln (t + delta t)/delta t


NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 5/10/88 1:26 PM
EFFECTIVE PRODUCING TIME 30 DAYS
1300
900
Pressure - Psig at 6582
8
2
ln(t + delta t)/delta t
75.5 #/lb cycle

NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 5/10/88 1:26 PM
EFFECTIVE PRODUCING TIME 30 DAYS



NASSAU RESOURCES, INC. WISHING WELL 35-7
HORNER PLOT OF PRESSURE BUILD-UP
WELL SHUT IN AT 1:26 PM MAY 10, 1988
Δt TIME = BOMB TIME PLUS .5 HOURS
EFFECTIVE PRODUCING TIME 30 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
0.00	0.50	-.301	7.273	935.1	3.83	4.33	0.636	5.120	1059.1
0.08	0.58	-.237	7.125	944.2	4.00	4.50	0.653	5.081	1060.4
0.17	0.67	-.174	6.981	954.6	4.17	4.67	0.669	5.045	1062.9
0.25	0.75	-.125	6.868	961.0	4.33	4.83	0.684	5.011	1065.5
0.33	0.83	-.081	6.767	966.2	4.50	5.00	0.699	4.977	1068.1
0.42	0.92	-.036	6.664	971.4	4.67	5.17	0.713	4.944	1070.6
0.50	1.00	0.000	6.581	976.6	4.83	5.33	0.720	4.913	1073.2
0.58	1.08	0.033	6.504	981.8	5.00	5.50	0.740	4.882	1074.5
0.67	1.17	0.068	6.424	985.7	5.17	5.67	0.754	4.852	1077.1
0.75	1.25	0.097	6.358	988.3	5.33	5.83	0.766	4.824	1079.6
0.83	1.33	0.124	6.296	992.2	5.50	6.00	0.778	4.796	1080.9
0.92	1.42	0.152	6.231	994.8	5.67	6.17	0.790	4.768	1083.5
1.06	1.50	0.176	6.176	998.7	5.83	6.33	0.801	4.743	1084.8
1.17	1.67	0.223	6.069	1003.9	6.00	6.50	0.813	4.716	1086.1
1.33	1.83	0.262	5.977	1009.0	7.00	7.50	0.875	4.575	1096.3
1.50	2.00	0.301	5.889	1014.1	8.00	8.50	0.929	4.451	1104.0
1.67	2.17	0.336	5.808	1018.0	9.00	9.50	0.978	4.341	1110.4
1.83	2.33	0.367	5.737	1021.8	10.00	10.50	1.021	4.242	1118.2
2.00	2.50	0.398	5.666	1025.7	11.00	11.50	1.061	4.153	1123.3
2.17	2.57	0.410	5.639	1029.5	12.00	12.50	1.097	4.071	1129.7
2.33	2.83	0.452	5.543	1032.1	13.00	13.50	1.130	3.995	1134.9
2.50	3.00	0.477	5.485	1036.0	14.00	14.50	1.161	3.925	1140.0
2.67	3.17	0.501	5.430	1038.5	15.00	15.50	1.190	3.860	1146.4
2.83	3.33	0.522	5.381	1042.4	16.00	16.50	1.217	3.799	1150.3
3.00	3.50	0.544	5.331	1045.0	17.00	17.50	1.243	3.741	1155.4
3.17	3.67	0.565	5.284	1047.5	18.00	18.50	1.267	3.687	1159.3
3.33	3.83	0.583	5.242	1050.1	19.00	19.50	1.290	3.636	1163.4
3.50	4.00	0.602	5.198	1053.9	20.00	20.50	1.312	3.587	1166.+
3.67	4.17	0.620	5.157	1056.5	21.00	21.50	1.332	3.541	1170.8

NASSAU RESOURCES, INC. WISHING WELL 35-7
HORNER PLOT OF PRESSURE BUILD-UP
PAGE 2

Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	Log 10 Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
22.00	22.50	1.352	3.497	1173.4	48.00	48.50	1.686	2.763	1229.9
23.00	23.00	1.362	3.454	1177.2	54.00	54.50	1.736	2.654	1237.6
24.00	24.50	1.389	3.414	1179.8	60.00	60.50	1.782	2.557	1244.0
30.00	30.50	1.498	3.203	1196.5	66.00	66.50	1.823	2.470	1250.4
36.00	36.50	1.562	3.031	1209.4	71.00	71.50	1.854	2.404	1254.3
42.00	42.50	1.628	2.887	1219.6					

B & R SERVICE, INC.

P. O. Box 1048
Farmington, New Mexico 87499
(505) 325-2393

Company NASAU RESOURCES Lease WISHING WELL Well 35-7

County RIO ARRIBA State NM Date 5-10-88

Shut-In FLOWING Zero Point K.B. Tbg. Pressure 171

Casing Pressure 662 Tbg. Depth S.N. @ 6582' Casing Perf.

Max. Temp. Fluid Level

DEPTH	PSIG	GRADIENT	TIME
0	171	----	
1000	263	.092	
2000	368	.105	
3000	433	.065	
4000	516	.083	
5000	601	.085	
6000	713	.112	
6482	778	.135	
6582	792	.140	11:29
	794		11:34
	795		11:38
	796		11:42
	797		11:46
	799		11:52
	800		11:59
	799		12:08
	797		12:24
	796		12:28
	796		12:29

Jerome P. McHugh
Farmington, N.M.

MAY 16 1988

RECEIVED

(1)

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 68478
TICKET NUMBER 901

PREPARED FOR

COMPANY NAME ..... JEROME P. McHUGH

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GAVILAN-MANCOS
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... BUILD-UP
B.H.P. RECORED @ 6582' K.B.
SHUT-IN @ 13:26 5-10-88

(2)

	TIME		PRESSURE PSI
	REAL	ELAPSED	
5-10-88	13:55:00	00:00:00	935.06
	14:00:00	00:05:00	944.16
	14:05:11	00:10:11	954.55
	14:10:17	00:15:17	961.04
	14:15:12	00:20:12	966.23
	14:20:13	00:25:13	971.43
	14:25:13	00:30:13	976.62
	14:30:19	00:35:19	981.82
	14:35:14	00:40:14	985.71
	14:40:15	00:45:15	988.31
	14:45:00	00:50:00	992.21
	14:50:11	00:55:11	994.81
	14:55:17	01:00:17	998.70
	15:05:18	01:10:18	1,003.85
	15:15:03	01:20:03	1,008.99
	15:25:15	01:30:15	1,014.13
	15:35:16	01:40:16	1,017.98
	15:45:01	01:50:01	1,021.83
	15:55:18	02:00:18	1,025.69
	16:05:14	02:10:14	1,029.54
	16:15:15	02:20:15	1,032.11
	16:25:11	02:30:11	1,035.96
	16:35:12	02:40:12	1,038.53
	16:45:13	02:50:13	1,042.38
	16:55:09	03:00:09	1,044.95
	17:05:16	03:10:16	1,047.52
	17:15:17	03:20:17	1,050.09
	17:25:13	03:30:13	1,053.94
	17:35:19	03:40:19	1,056.51
	17:45:04	03:50:04	1,059.08
	17:55:06	04:00:06	1,060.36
	18:05:07	04:10:07	1,062.93
	18:15:13	04:20:13	1,065.50
	18:25:09	04:30:09	1,068.07
	18:35:05	04:40:05	1,070.64
	18:45:16	04:50:16	1,073.21
	18:55:02	05:00:02	1,074.49
	19:05:13	05:10:13	1,077.06
	19:15:09	05:20:09	1,079.63
	19:25:10	05:30:10	1,080.91
	19:35:01	05:40:01	1,083.48
	19:45:08	05:50:08	1,084.77
	19:55:03	06:00:03	1,086.05
	20:55:10	07:00:10	1,096.33
	21:55:07	08:00:07	1,104.03
	22:55:18	09:00:18	1,110.45
	23:55:10	10:00:10	1,118.16
	00:55:16	11:00:16	1,123.30
	01:55:13	12:00:13	1,129.72
	02:55:14	13:00:14	1,134.86
	03:55:00	14:00:00	1,139.99
	04:55:02	15:00:02	1,146.42
	05:55:14	16:00:14	1,150.27
	06:55:05	17:00:05	1,155.41
	07:55:01	18:00:01	1,159.26

5-11-88

51

(3).

08:55:03	17:00:03	[illegible]
09:55:14	20:00:14	1,166.
10:55:00	21:00:00	1,170.82
11:55:02	22:00:02	1,173.39
12:55:09	23:00:09	1,177.24
13:55:05	24:00:05	1,179.81
19:55:04	30:00:04	1,196.51
01:55:18	36:00:18	1,209.35
07:55:12	42:00:12	1,219.63
13:55:16	48:00:16	1,229.90
19:55:14	54:00:14	1,237.61
01:55:18	60:00:18	1,244.03
07:55:02	66:00:02	1,250.45
12:59:59	71:04:59	1,254.30

5.10.85

TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Nassau Wishing Well 35-7

ELEVATION 7267' KB

DEPTH OF BOMB 6582'

DATE SHUT IN Sept. 12, 1988

TIME SHUT IN 8:00 AM

PRODUCTION RATE PRIOR TO SHUT-IN 303 BOPD

353 MCFD

GAS-OIL RATIO 1165 MCF/BBL

B_O 1.3

B_T 2.76

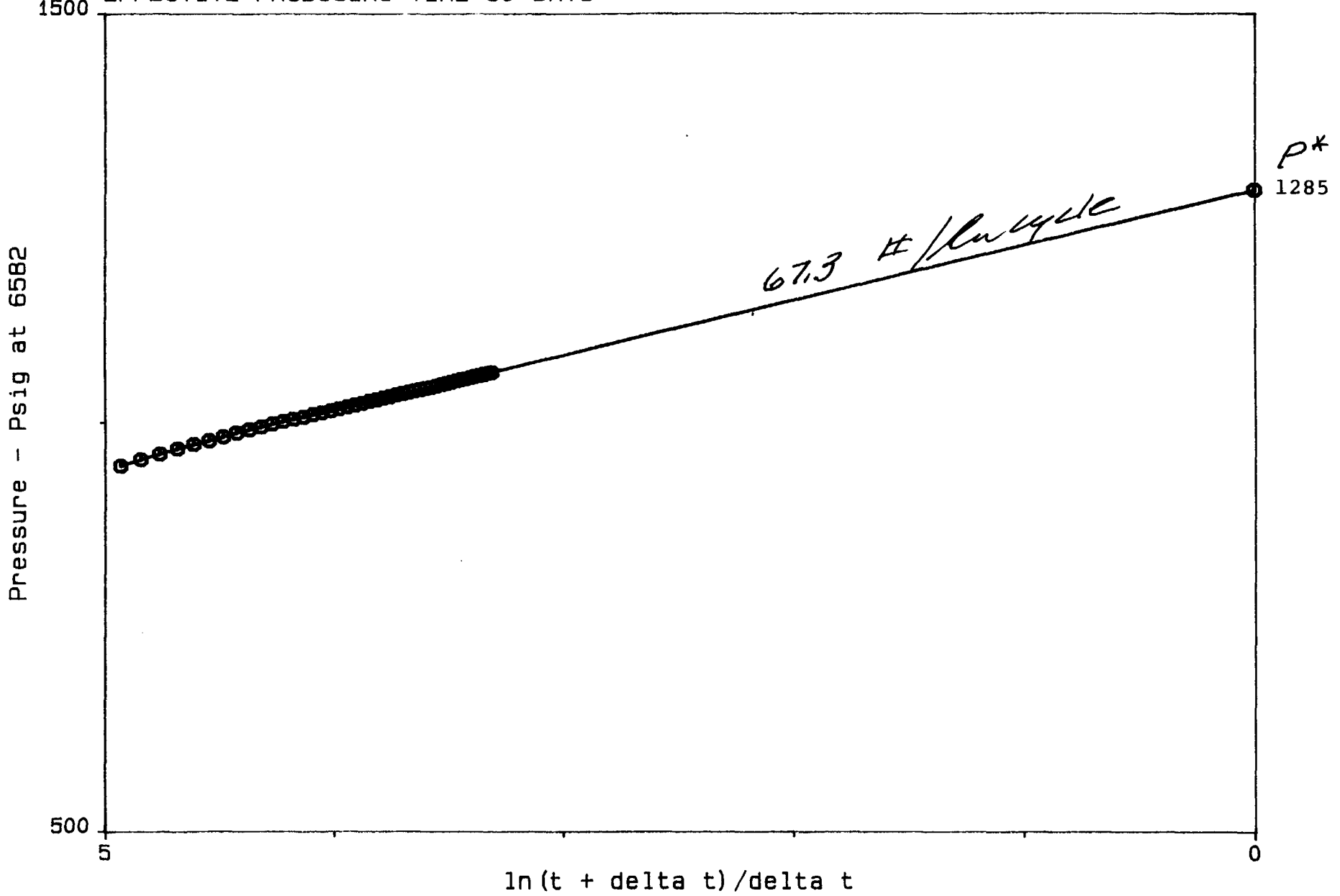
slope, m 67.3 /ln cycle

$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\ B_T}{14.16 \times m\ (\text{ln cycle})} = .88 \text{ darcy feet/cp}$$

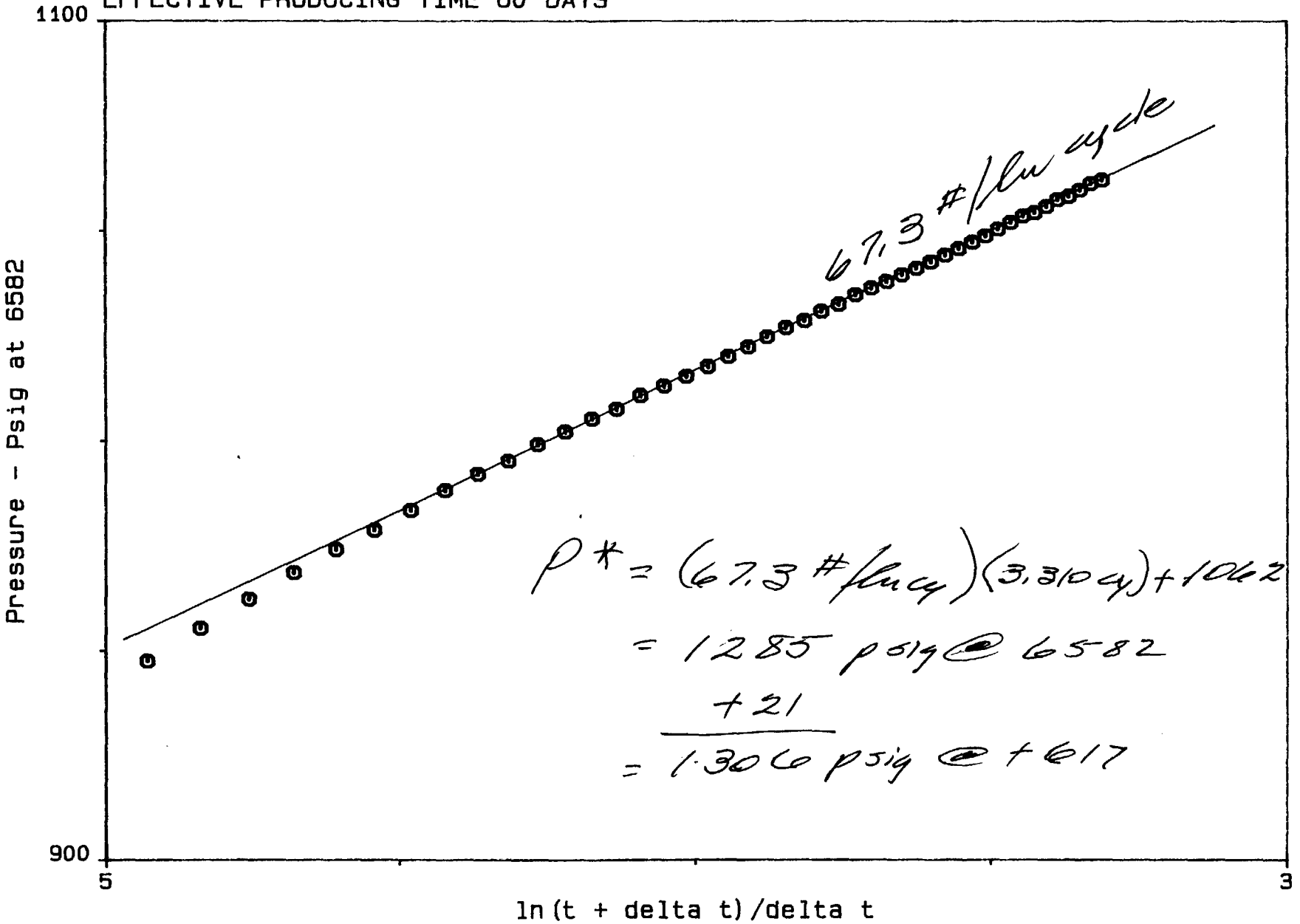
Determination of P* shown on next plot.

Copy of survey and data for Horner plot are at back of this section.

NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 9/12/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS



NASSAU WISHING WELL 35-7
HORNER PLOT
DATE SHUT IN 9/12/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS



NASSAU RESOURCES, INC. WISHING WELL 35-7
HORNER PLOT OF PRESSURE BUILD-UP
WELL SHUT IN AT 8:00 AM SEPTEMBER 12, 1988
Δt TIME = BOMB TIME PLUS 8.5 HOURS
EFFECTIVE PRODUCING TIME 60 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
0.00	8.50	5.138	927.3	24.00	32.50	3.813	1028.6
1.00	9.50	5.028	938.2	25.00	33.50	3.784	1030.9
2.00	10.50	4.925	947.5	26.00	34.50	3.755	1032.5
3.00	11.50	4.838	955.3	27.00	35.50	3.727	1034.8
4.00	12.50	4.755	962.3	28.00	36.50	3.700	1036.4
5.00	13.50	4.679	968.6	29.00	37.50	3.674	1037.9
6.00	14.50	4.608	974.0	30.00	38.50	3.648	1039.5
7.00	15.50	4.542	978.7	31.00	39.50	3.623	1041.0
8.00	16.50	4.480	983.4	32.00	40.50	3.599	1042.6
9.00	17.50	4.422	988.1	33.00	41.50	3.575	1044.2
10.00	18.50	4.367	992.0	34.00	42.50	3.552	1045.7
11.00	19.50	4.315	995.1	35.00	43.50	3.529	1047.3
12.00	20.50	4.266	999.0	36.00	44.50	3.507	1048.8
13.00	21.50	4.219	1002.1	37.00	45.50	3.486	1050.4
14.00	22.50	4.174	1005.2	38.00	46.50	3.465	1052.0
15.00	23.50	4.132	1007.5	39.00	47.50	3.444	1053.5
16.00	24.50	4.091	1010.7	40.00	48.50	3.424	1054.3
17.00	25.50	4.051	1013.0	41.00	49.50	3.404	1055.8
18.00	26.50	4.013	1015.3	42.00	50.50	3.385	1057.4
19.00	27.50	3.977	1017.7	43.00	51.50	3.366	1058.2
20.00	28.50	3.942	1020.0	44.00	52.50	3.347	1059.7
21.00	29.50	3.908	1022.3	45.00	53.50	3.329	1061.3
22.00	30.50	3.876	1024.7	46.13	54.63	3.310	1062.1
23.00	31.50	3.844	1027.0				

WELL CHART ANALYSIS

OCT 27 1988

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 68478
TICKET NUMBER 1000

PREPARED FOR

COMPANY NAME ..... NASSAU RESOURCES

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GALLUP
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... INTERFERENCE

	TIME		PRESSURE PSI
	REAL	ELAPSED	
9-12-88	14:32:00	00:00:00	929.87
	00:32:08	10:00:08	994.81
	10:32:07	20:00:07	1,021.83
	20:32:06	30:00:06	1,041.10
	06:32:05	40:00:05	1,056.51
	12:45:00	46:13:00	1,064.22

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 52219
TICKET NUMBER 902

PREPARED FOR

COMPANY NAME ..... JEROME P. McHUGH

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GAVILAN-MANCOS
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... BUILD-UP

B.H.P. RECORED @ 6582' K.B.
SHUT-IN @ 13:26 5-10-88

	TIME		PRESSURE PSI
	REAL	ELAPSED	
5-10-88	13:55:00	00:00:00	934.08
	23:55:07	10:00:07	1,116.74
	09:55:20	20:00:20	1,165.23
	19:55:17	30:00:17	1,193.97
	07:55:22	42:00:22	1,217.31
	01:55:25	60:00:25	1,242.46
	13:00:00	71:05:00	1,251.44

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE. ..... KPG
GAUGE NUMBER 57407
TICKET NUMBER 999

PREPARED FOR

COMPANY NAME ..... NASSAU RESOURCES

WELL NAME ..... WISHING WELL 35-7
FIELD NAME ..... GALLUP
LOCATION ..... RIO ARRIBA/N.MEX.
TYPE OF TEST ..... INTERFERENCE

	TIME		PRESSURE PSI
	REAL	ELAPSED	
9-12-88	14:32:00	00:00:00	927.27
	15:32:01	01:00:01	938.18
	16:32:02	02:00:02	947.53
	17:32:04	03:00:04	955.32
	18:32:05	04:00:05	962.34
	19:32:01	05:00:01	968.57
	20:32:08	06:00:08	974.03
	21:32:09	07:00:09	978.70
	22:32:00	08:00:00	983.38
	23:32:02	09:00:02	988.05
	00:32:03	10:00:03	991.95
	01:32:05	11:00:05	995.06
	02:32:06	12:00:06	998.96
	03:32:02	13:00:02	1,002.08
	04:32:04	14:00:04	1,005.19
	05:32:05	15:00:05	1,007.53
	06:32:06	16:00:06	1,010.65
	07:32:08	17:00:08	1,012.99
	08:32:04	18:00:04	1,015.32
	09:32:06	19:00:06	1,017.66
	10:32:02	20:00:02	1,020.00
	11:32:08	21:00:08	1,022.34
	12:32:10	22:00:10	1,024.68
	13:32:06	23:00:06	1,027.01
	14:32:02	24:00:02	1,028.57
	15:32:04	25:00:04	1,030.91
	16:32:10	26:00:10	1,032.47
	17:32:01	27:00:01	1,034.81
	18:32:03	28:00:03	1,036.36
	19:32:04	29:00:04	1,037.92
	20:32:00	30:00:00	1,039.48
	21:32:02	31:00:02	1,041.04
	22:32:03	32:00:03	1,042.60
	23:32:10	33:00:10	1,044.16
	00:32:06	34:00:06	1,045.71
	01:32:02	35:00:02	1,047.27
	02:32:04	36:00:04	1,048.83
	03:32:15	37:00:15	1,050.39
	04:32:01	38:00:01	1,051.95
	05:32:03	39:00:03	1,053.51
	06:32:04	40:00:04	1,054.29
	07:32:06	41:00:06	1,055.84
	08:32:07	42:00:07	1,057.40
	09:32:08	43:00:08	1,058.18
	10:32:10	44:00:10	1,059.74
	11:32:06	45:00:06	1,061.30
	12:45:00	46:13:00	1,062.08

TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Nassau Laguna Colo 2-6

ELEVATION 7240' KB

DEPTH OF BOMB 6940'

DATE SHUT IN Sept. 8, 1988

TIME SHUT IN 8:00 AM

PRODUCTION RATE PRIOR TO SHUT-IN 11 BOPD

55 MCFD

GAS-OIL RATIO 5.0 MCF/BBL

B_o 1.3

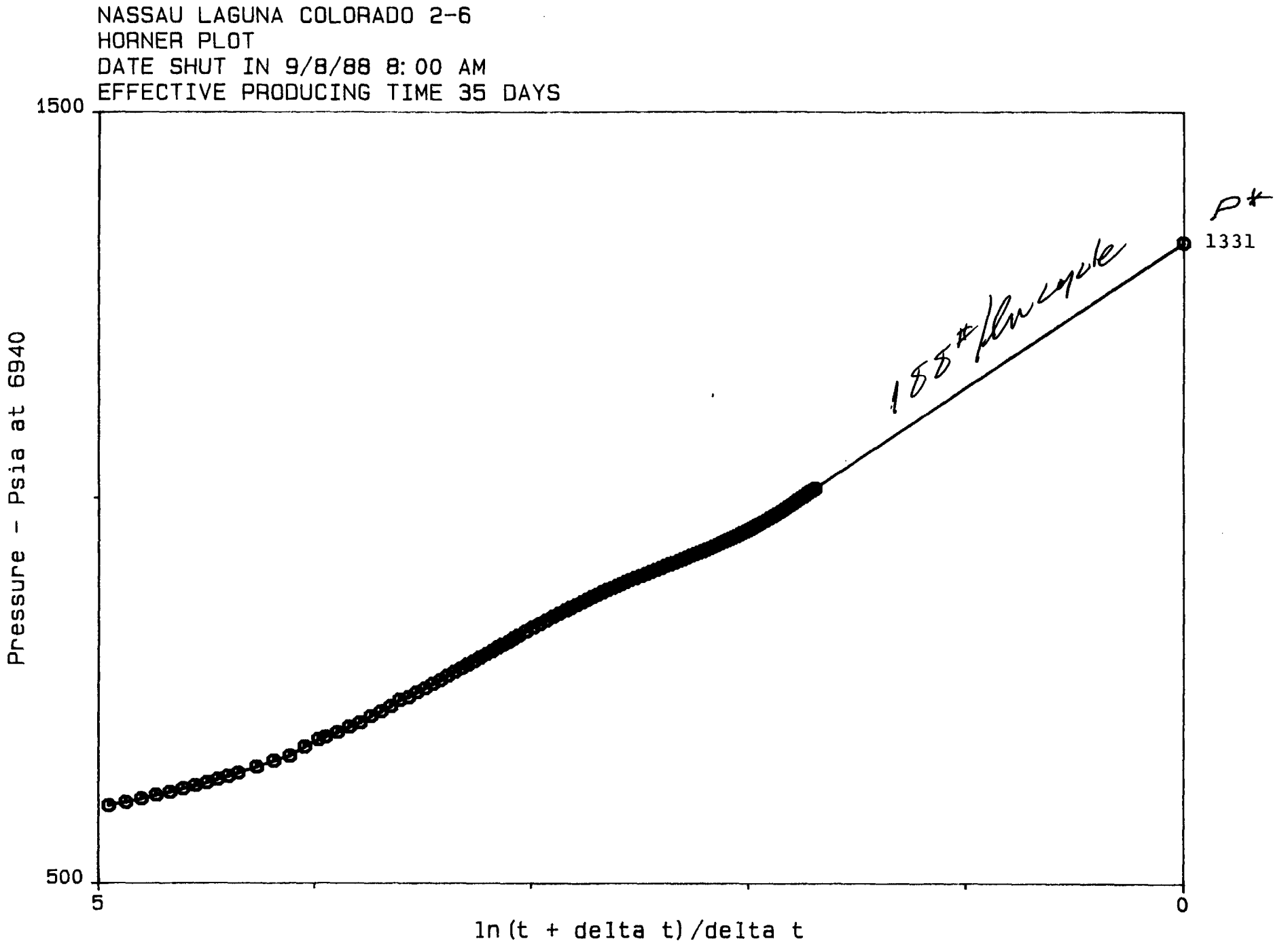
B_T 11.2

slope, m 188# /ln cycle

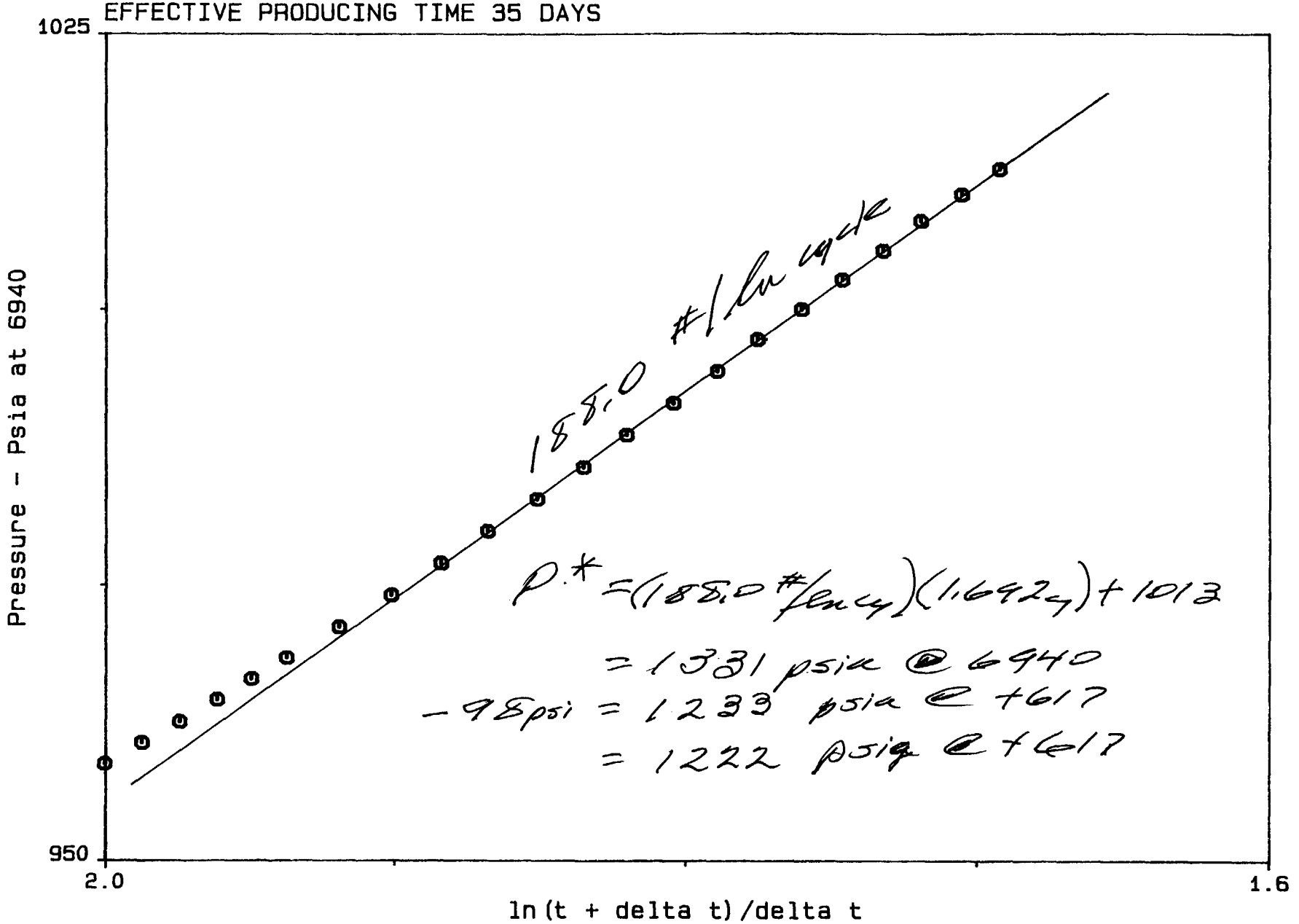
$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\, B_T}{14.16 \times m \text{ (ln cycle)}} = .046 \text{ darcy feet/cp}$$

Determination of P* shown on next plot.

Copy of survey and data for Horner plot are at back of this section.


NASSAU LAGUNA COLORADO 2-6
HORNER PLOT
DATE SHUT IN 9/8/88 8:00 AM
EFFECTIVE PRODUCING TIME 35 DAYS
1500
500
Pressure - Psia at 6940
5
0
ln (t + delta t)/delta t
P*
1331
188 #/log cycle

NASSAU LAGUNA COLORADO 2-6
HORNER PLOT
DATE SHUT IN 9/8/88 8:00 AM
EFFECTIVE PRODUCING TIME 35 DAYS



NASSAU RESOURCES, INC. LAGUNA COLORADO 2 #6
HORNER PLOT OF PRESSURE BUILD-UP
WELL SHUT IN AT 8:00 AM SEPTEMBER 8, 1988
Δt TIME = BOMB TIME MINUS 16.5 HOURS
EFFECTIVE PRODUCING TIME 35 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
22.5	6.0	4.949	601.1	46.0	29.5	3.384	770.1
23.0	6.5	4.869	605.7	47.0	30.5	3.351	775.2
23.5	7.0	4.796	610.2	48.0	31.5	3.320	779.8
24.0	7.5	4.727	614.8	49.0	32.5	3.290	785.0
24.5	8.0	4.663	619.0	50.0	33.5	3.261	789.1
25.0	8.5	4.603	623.3	51.0	34.5	3.233	794.0
25.5	9.0	4.547	627.6	52.0	35.5	3.205	798.5
26.0	9.5	4.493	631.7	53.0	36.5	3.179	802.2
26.5	10.0	4.443	635.9	54.0	37.5	3.153	806.8
27.0	10.5	4.394	640.0	55.0	38.5	3.128	810.8
27.5	11.0	4.349	644.0	56.0	39.5	3.103	814.4
28.5	12.0	4.263	651.8	57.0	40.5	3.079	818.5
29.5	13.0	4.184	659.9	58.0	41.5	3.056	822.3
30.5	14.0	4.111	666.0	59.5	43.0	3.022	827.6
31.5	15.0	4.043	678.2	61.0	44.5	2.990	832.6
32.5	16.0	3.980	687.3	62.5	46.0	2.958	837.5
33.0	16.5	3.949	690.6	64.0	47.5	2.928	842.0
34.0	17.5	3.892	696.9	65.5	49.0	2.898	846.6
35.0	18.5	3.837	703.8	67.0	50.5	2.870	850.8
36.0	19.5	3.786	709.5	68.5	52.0	2.842	854.7
37.0	20.5	3.737	717.8	70.0	53.5	2.815	858.8
38.0	21.5	3.691	723.8	71.5	55.0	2.789	862.4
39.0	22.5	3.646	730.4	73.0	56.5	2.764	865.9
40.0	23.5	3.604	738.8	74.5	58.0	2.740	869.2
41.0	24.5	3.563	742.3	76.0	59.5	2.716	872.5
42.0	25.5	3.525	748.3	77.5	61.0	2.693	875.6
43.0	26.5	3.487	753.7	79.0	62.5	2.670	878.5
44.0	27.5	3.451	759.6	80.5	64.0	2.648	881.3
45.0	28.5	3.417	764.7	82.0	65.5	2.626	883.9

NASSAU RESOURCES, INC. LAGUNA COLORADO 2 #6
HORNER PLOT OF PRESSURE BUILD-UP
PAGE 2

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
83.5	67.0	2.605	886.5	138.0	121.5	2.069	949.4
85.0	68.5	2.585	889.0	140.0	123.5	2.054	951.3
86.5	70.0	2.565	891.4	142.0	125.5	2.040	953.2
88.0	71.5	2.545	893.9	144.0	127.5	2.027	955.1
90.0	73.5	2.520	896.7	146.0	129.5	2.013	956.9
92.0	75.5	2.495	899.5	148.0	131.5	2.000	958.8
94.0	77.5	2.471	902.2	150.0	133.5	1.987	960.7
96.0	79.5	2.448	904.8	152.0	135.5	1.974	962.6
98.0	81.5	2.425	907.4	154.0	137.5	1.961	964.6
100.0	83.5	2.403	909.9	156.0	139.5	1.949	966.5
102.0	85.5	2.382	912.3	158.0	141.5	1.937	968.4
104.0	87.5	2.361	914.6	161.0	144.5	1.919	971.2
106.0	89.5	2.340	916.9	164.0	147.5	1.901	974.1
108.0	91.5	2.320	919.1	167.0	150.5	1.884	977.0
110.0	93.5	2.301	921.3	170.0	153.5	1.868	979.9
112.0	95.5	2.282	923.4	173.0	156.5	1.851	982.8
114.0	97.5	2.263	925.5	176.0	159.5	1.835	985.7
116.0	99.5	2.245	927.6	179.0	162.5	1.820	988.6
118.0	101.5	2.227	929.7	182.0	165.5	1.804	991.5
120.0	103.5	2.210	931.7	185.0	168.5	1.789	994.4
122.0	105.5	2.193	933.7	188.0	171.5	1.775	997.3
124.0	107.5	2.176	935.7	191.0	174.5	1.760	1000.0
126.0	109.5	2.160	937.7	194.0	177.5	1.746	1002.7
128.0	111.5	2.144	939.7	197.0	180.5	1.732	1005.3
130.0	113.5	2.128	941.7	200.0	183.5	1.719	1008.0
132.0	115.5	2.113	943.6	203.0	186.5	1.705	1010.4
134.0	117.5	2.098	945.6	206.0	189.5	1.692	1012.7
136.0	119.5	2.083	947.5				

DATE: 9/ 8/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 2

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE °F
19	12:58: 0	21.500	10755.31	591.47	
20	13:13: 0	21.750	7893.63		165.93
21	13:28: 0	22.000	10757.57	596.29	
22	13:43: 0	22.250	7894.17		165.97
23	13:58: 0	22.500	10759.79	601.06	
24	14:13: 0	22.750	7893.87		165.95
25	14:28: 0	23.000	10761.97	605.71	
26	14:43: 0	23.250	7893.20		165.89
27	14:58: 0	23.500	10764.07	610.20	
28	15:13: 0	23.750	7892.82		165.86
29	15:28: 0	24.000	10766.15	614.64	
30	15:43: 0	24.250	7892.18		165.81
31	15:58: 0	24.500	10768.18	618.98	
32	16:13: 0	24.750	7891.46		165.75
33	16:28: 0	25.000	10770.20	623.30	
34	16:43: 0	25.250	7890.69		165.69
35	16:58: 0	25.500	10772.19	627.55	
36	17:13: 0	25.750	7889.89		165.62
37	17:28: 0	26.000	10774.15	631.74	
38	17:43: 0	26.250	7889.15		165.56
39	17:58: 0	26.500	10776.09	635.90	
40	18:13: 0	26.750	7888.45		165.51
41	18:28: 0	27.000	10778.00	639.98	
42	18:43: 0	27.250	7887.71		165.45
43	18:58: 0	27.500	10779.86	643.98	
44	19:13: 0	27.750	7886.94		165.38
45	19:28: 0	28.000	10781.69	647.89	
46	19:43: 0	28.250	7886.28		165.33
47	19:58: 0	28.500	10783.49	651.76	
48	20:13: 0	28.750	7885.55		165.27
49	20:28: 0	29.000	10785.27	655.58	
50	20:43: 0	29.250	7884.21		165.16

GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 2

CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	20:58: 0	29.500	10787.30	659.93	
52	21:13: 0	29.750	7876.75		164.55
53	21:28: 0	30.000	10788.78	663.00	
54	21:43: 0	30.250	7877.27		164.60
55	21:58: 0	30.500	10790.17	666.00	
56	22:13: 0	30.750	7883.59		165.11
57	22:28: 0	31.000	10793.01	672.21	
58	22:43: 0	31.250	7885.24		165.25
59	22:58: 0	31.500	10795.76	678.15	
60	23:13: 0	31.750	7885.36		165.26
61	23:28: 0	32.000	10798.31	683.67	
62	23:43: 0	32.250	7886.84		165.38
63	23:58: 0	32.500	10799.98	687.28	
64	0:13: 0	32.750	7885.46		165.26
65	0:28: 0	33.000	10801.51	690.56	
66	0:43: 0	33.250	7882.40		165.01
67	0:58: 0	33.500	10803.02	693.78	
68	1:13: 0	33.750	7881.15		164.91
69	1:28: 0	34.000	10804.49	696.93	
70	1:43: 0	34.250	7880.11		164.83
71	1:58: 0	34.500	10805.95	700.08	
72	2:13: 0	34.750	7879.48		164.78
73	2:28: 0	35.000	10807.70	703.84	
74	2:43: 0	35.250	7875.29		164.44
75	2:58: 0	35.500	10808.96	706.52	
76	3:13: 0	35.750	7874.61		164.38
77	3:28: 0	36.000	10810.36	709.54	
78	3:43: 0	36.250	7879.49		164.78
79	3:58: 0	36.500	10812.63	714.52	
80	4:13: 0	36.750	7881.18		164.92
81	4:28: 0	37.000	10814.15	717.83	
82	4:43: 0	37.250	7879.59		164.79
83	4:58: 0	37.500	10815.48	720.69	
84	5:13: 0	37.750	7876.38		164.52
85	5:28: 0	38.000	10816.94	723.80	
86	5:43: 0	38.250	7872.62		164.22
87	5:58: 0	38.500	10818.09	726.25	
88	6:13: 0	38.750	7875.86		164.48
89	6:28: 0	39.000	10820.00	730.43	
90	6:43: 0	39.250	7879.28		164.76
91	6:58: 0	39.500	10821.50	733.73	
92	7:13: 0	39.750	7877.04		164.58
93	7:28: 0	40.000	10822.93	736.80	
94	7:43: 0	40.250	7872.10		164.18
95	7:58: 0	40.500	10824.00	739.04	
96	8:13: 0	40.750	7871.88		164.16
97	8:28: 0	41.000	10825.47	742.25	
98	8:43: 0	41.250	7875.85		164.48
99	8:58: 0	41.500	10827.09	745.80	
100	9:13: 0	41.750	7875.49		164.45

DATE: 9/ 9/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 3

COMPANY: BHP
CLIENT: McHugh
WELL NAME: Colorado Laguna Z #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	9:28: 0	42.000	10828.24	748.29	
2	9:43: 0	42.250	7871.07		164.09
3	9:58: 0	42.500	10829.44	750.85	
4	10:13: 0	42.750	7869.56		163.97
5	10:28: 0	43.000	10830.78	753.73	
6	10:43: 0	43.250	7873.71		164.31
7	10:58: 0	43.500	10832.29	757.08	
8	11:13: 0	43.750	7873.62		164.30
9	11:28: 0	44.000	10833.47	759.64	
10	11:43: 0	44.250	7869.15		163.94
11	11:58: 0	44.500	10834.43	761.67	
12	12:13: 0	44.750	7868.96		163.92
13	12:28: 0	45.000	10835.84	764.72	
14	12:43: 0	45.250	7872.37		164.20
15	12:58: 0	45.500	10837.18	767.68	
16	13:13: 0	45.750	7871.49		164.13
17	13:28: 0	46.000	10838.30	770.11	
18	13:43: 0	46.250	7866.80		163.74
19	13:58: 0	46.500	10839.21	772.04	
20	14:13: 0	46.750	7868.47		163.88
21	14:28: 0	47.000	10840.67	775.23	
22	14:43: 0	47.250	7870.94		164.08
23	14:58: 0	47.500	10841.77	777.66	
24	15:13: 0	47.750	7867.57		163.81
25	15:28: 0	48.000	10842.77	779.79	
26	15:43: 0	48.250	7865.34		163.62
27	15:58: 0	48.500	10843.92	782.27	
28	16:13: 0	48.750	7868.84		163.91
29	16:28: 0	49.000	10845.15	785.00	
30	16:43: 0	49.250	7868.53		163.88
31	16:58: 0	49.500	10846.19	787.26	
32	17:13: 0	49.750	7864.15		163.53
33	17:28: 0	50.000	10847.07	789.13	
34	17:43: 0	50.250	7866.94		163.75
35	17:58: 0	50.500	10848.34	791.94	
36	18:13: 0	50.750	7867.65		163.81
37	18:28: 0	51.000	10849.30	794.04	
38	18:43: 0	51.250	7863.37		163.46
39	18:58: 0	51.500	10850.14	795.81	
40	19:13: 0	51.750	7865.29		163.62
41	19:28: 0	52.000	10851.34	798.46	
42	19:43: 0	52.250	7866.81		163.74
43	19:58: 0	52.500	10852.28	800.52	
44	20:13: 0	52.750	7863.00		163.43
45	20:28: 0	53.000	10853.09	802.24	
46	20:43: 0	53.250	7863.76		163.50
47	20:58: 0	53.500	10854.22	804.73	
48	21:13: 0	53.750	7865.75		163.66
49	21:28: 0	54.000	10855.16	806.81	
50	21:43: 0	54.250	7862.70		163.41

DATE: 9/ 9/88 COMPANY: BHI
GAUGE SN #69306 CLIENT: McHugh
WELL # 0 WELL NAME: Colorado Laguna 2 #6
TEST # 1990 TEST OPERATOR: MD
LOCATION:
DATA FILE: 3 COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	21:58: 0	54.500	10855.96	808.51	
52	22:13: 0	54.750	7862.23		163.37
53	22:28: 0	55.000	10857.00	810.77	
54	22:43: 0	55.250	7864.65		163.57
55	22:58: 0	55.500	10857.92	812.82	
56	23:13: 0	55.750	7861.89		163.34
57	23:28: 0	56.000	10858.68	814.44	
58	23:43: 0	56.250	7861.33		163.30
59	23:58: 0	56.500	10859.69	816.64	
60	0:13: 0	56.750	7863.30		163.46
61	0:28: 0	57.000	10860.54	818.52	
62	0:43: 0	57.250	7859.91		163.18
63	0:58: 0	57.500	10861.28	820.10	
64	1:13: 0	57.750	7860.99		163.27
65	1:28: 0	58.000	10862.26	822.27	
66	1:43: 0	58.250	7861.99		163.35
67	1:58: 0	58.500	10863.06	824.04	
68	2:13: 0	58.750	7858.40		163.06
69	2:28: 0	59.000	10863.82	825.65	
70	2:43: 0	59.250	7860.87		163.26
71	2:58: 0	59.500	10864.68	827.57	
72	3:13: 0	59.750	7859.97		163.19
73	3:28: 0	60.000	10865.42	829.17	
74	3:43: 0	60.250	7858.49		163.07
75	3:58: 0	60.500	10866.23	830.93	
76	4:13: 0	60.750	7860.39		163.22
77	4:28: 0	61.000	10866.98	832.59	
78	4:43: 0	61.250	7857.19		162.96
79	4:58: 0	61.500	10867.69	834.10	
80	5:13: 0	61.750	7858.73		163.09
81	5:28: 0	62.000	10868.53	835.96	
82	5:43: 0	62.250	7859.04		163.11
83	5:58: 0	62.500	10869.21	837.45	
84	6:13: 0	62.750	7856.62		162.91
85	6:28: 0	63.000	10869.94	839.02	
86	6:43: 0	63.250	7858.68		163.08
87	6:58: 0	63.500	10870.66	840.64	
88	7:13: 0	63.750	7855.57		162.83
89	7:28: 0	64.000	10871.29	841.98	
90	7:43: 0	64.250	7857.38		162.98
91	7:58: 0	64.500	10872.05	843.66	
92	8:13: 0	64.750	7856.73		162.92
93	8:28: 0	65.000	10872.67	845.01	
94	8:43: 0	65.250	7855.83		162.85
95	8:58: 0	65.500	10873.39	846.59	
96	9:13: 0	65.750	7856.76		162.93
97	9:28: 0	66.000	10874.02	847.99	
98	9:43: 0	66.250	7854.00		162.70
99	9:58: 0	66.500	10874.69	849.42	
100	10:13: 0	66.750	7855.93		162.86

DATE: 9/10/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 4

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	10:28: 0	67.000	10875.29	850.75	
2	10:43: 0	67.250	7853.78		162.68
3	10:58: 0	67.500	10875.92	852.11	
4	11:13: 0	67.750	7855.25		162.80
5	11:28: 0	68.000	10876.56	853.53	
6	11:43: 0	68.250	7853.73		162.68
7	11:58: 0	68.500	10877.12	854.73	
8	12:13: 0	68.750	7854.41		162.74
9	12:28: 0	69.000	10877.78	856.20	
10	12:43: 0	69.250	7853.99		162.70
11	12:58: 0	69.500	10878.31	857.36	
12	13:13: 0	69.750	7853.46		162.66
13	13:28: 0	70.000	10878.96	858.78	
14	13:43: 0	70.250	7853.88		162.69
15	13:58: 0	70.500	10879.48	859.92	
16	14:13: 0	70.750	7852.52		162.58
17	14:28: 0	71.000	10880.11	861.28	
18	14:43: 0	71.250	7853.44		162.66
19	14:58: 0	71.500	10880.59	862.36	
20	15:13: 0	71.750	7851.24		162.48
21	15:28: 0	72.000	10881.20	863.67	
22	15:43: 0	72.250	7852.96		162.62
23	15:58: 0	72.500	10881.69	864.76	
24	16:13: 0	72.750	7850.87		162.45
25	16:28: 0	73.000	10882.24	865.96	
26	16:43: 0	73.250	7852.49		162.58
27	16:58: 0	73.500	10882.73	867.05	
28	17:13: 0	73.750	7850.63		162.43
29	17:28: 0	74.000	10883.26	868.20	
30	17:43: 0	74.250	7852.05		162.54
31	17:58: 0	74.500	10883.73	869.25	
32	18:13: 0	74.750	7850.33		162.40
33	18:28: 0	75.000	10884.25	870.37	
34	18:43: 0	75.250	7851.50		162.50
35	18:58: 0	75.500	10884.73	871.43	
36	19:13: 0	75.750	7849.66		162.35
37	19:28: 0	76.000	10885.24	872.53	
38	19:43: 0	76.250	7851.14		162.47
39	19:58: 0	76.500	10885.69	873.53	
40	20:13: 0	76.750	7849.98		162.37
41	20:28: 0	77.000	10886.14	874.51	
42	20:43: 0	77.250	7850.16		162.39
43	20:58: 0	77.500	10886.61	875.56	
44	21:13: 0	77.750	7848.47		162.25
45	21:28: 0	78.000	10887.11	876.63	
46	21:43: 0	78.250	7849.97		162.37
47	21:58: 0	78.500	10887.52	877.55	
48	22:13: 0	78.750	7850.04		162.38
49	22:28: 0	79.000	10887.94	878.47	
50	22:43: 0	79.250	7848.22		162.23

DATE: 9/10/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 4

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	22:58: 0	79.500	10888.39	879.44	
52	23:13: 0	79.750	7849.40		162.33
53	23:28: 0	80.000	10888.81	880.39	
54	23:43: 0	80.250	7848.32		162.24
55	23:58: 0	80.500	10889.22	881.28	
56	0:13: 0	80.750	7848.79		162.28
57	0:28: 0	81.000	10889.64	882.20	
58	0:43: 0	81.250	7847.31		162.16
59	0:58: 0	81.500	10890.04	883.08	
60	1:13: 0	81.750	7848.26		162.23
61	1:28: 0	82.000	10890.44	883.96	
62	1:43: 0	82.250	7848.28		162.24
63	1:58: 0	82.500	10890.83	884.82	
64	2:13: 0	82.750	7848.28		162.24
65	2:28: 0	83.000	10891.22	885.68	
66	2:43: 0	83.250	7848.26		162.23
67	2:58: 0	83.500	10891.61	886.53	
68	3:13: 0	83.750	7848.12		162.22
69	3:28: 0	84.000	10891.98	887.35	
70	3:43: 0	84.250	7847.99		162.21
71	3:58: 0	84.500	10892.36	888.17	
72	4:13: 0	84.750	7847.69		162.19
73	4:28: 0	85.000	10892.73	889.01	
74	4:43: 0	85.250	7847.62		162.18
75	4:58: 0	85.500	10893.09	889.79	
76	5:13: 0	85.750	7847.34		162.16
77	5:28: 0	86.000	10893.45	890.57	
78	5:43: 0	86.250	7847.25		162.15
79	5:58: 0	86.500	10893.81	891.36	
80	6:13: 0	86.750	7847.04		162.14
81	6:28: 0	87.000	10894.17	892.16	
82	6:43: 0	87.250	7846.77		162.11
83	6:58: 0	87.500	10894.53	892.94	
84	7:13: 0	87.750	7846.64		162.10
85	7:28: 0	88.000	10894.87	893.69	
86	7:43: 0	88.250	7846.34		162.08
87	7:58: 0	88.500	10895.21	894.45	
88	8:13: 0	88.750	7846.28		162.07
89	8:28: 0	89.000	10895.55	895.20	
90	8:43: 0	89.250	7846.08		162.06
91	8:58: 0	89.500	10895.88	895.92	
92	9:13: 0	89.750	7845.90		162.04
93	9:28: 0	90.000	10896.22	896.67	
94	9:43: 0	90.250	7845.65		162.02
95	9:58: 0	90.500	10896.54	897.37	
96	10:13: 0	90.750	7845.50		162.01
97	10:28: 0	91.000	10896.86	898.08	
98	10:43: 0	91.250	7845.25		161.99
99	10:58: 0	91.500	10897.19	898.80	
100	11:13: 0	91.750	7845.06		161.97

DATE: 9/11/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 5

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	11:28: 0	92.000	10897.51	899.49	
2	11:43: 0	92.250	7844.85		161.96
3	11:58: 0	92.500	10897.82	900.19	
4	12:13: 0	92.750	7844.61		161.94
5	12:28: 0	93.000	10898.14	900.87	
6	12:43: 0	93.250	7844.36		161.92
7	12:58: 0	93.500	10898.44	901.54	
8	13:13: 0	93.750	7844.14		161.90
9	13:28: 0	94.000	10898.74	902.21	
10	13:43: 0	94.250	7843.90		161.88
11	13:58: 0	94.500	10899.04	902.86	
12	14:13: 0	94.750	7843.74		161.87
13	14:28: 0	95.000	10899.35	903.53	
14	14:43: 0	95.250	7843.56		161.85
15	14:58: 0	95.500	10899.64	904.19	
16	15:13: 0	95.750	7843.39		161.84
17	15:28: 0	96.000	10899.94	904.84	
18	15:43: 0	96.250	7843.10		161.81
19	15:58: 0	96.500	10900.24	905.50	
20	16:13: 0	96.750	7843.01		161.81
21	16:28: 0	97.000	10900.52	906.12	
22	16:43: 0	97.250	7842.81		161.79
23	16:58: 0	97.500	10900.81	906.76	
24	17:13: 0	97.750	7842.58		161.77
25	17:28: 0	98.000	10901.10	907.39	
26	17:43: 0	98.250	7842.36		161.75
27	17:58: 0	98.500	10901.38	908.01	
28	18:13: 0	98.750	7842.23		161.74
29	18:28: 0	99.000	10901.67	908.64	
30	18:43: 0	99.250	7841.94		161.72
31	18:58: 0	99.500	10901.95	909.25	
32	19:13: 0	99.750	7841.84		161.71
33	19:28: 0	100.000	10902.23	909.87	
34	19:43: 0	100.250	7841.72		161.70
35	19:58: 0	100.500	10902.51	910.48	
36	20:13: 0	100.750	7841.48		161.68
37	20:28: 0	101.000	10902.77	911.07	
38	20:43: 0	101.250	7841.34		161.67
39	20:58: 0	101.500	10903.05	911.67	
40	21:13: 0	101.750	7841.24		161.66
41	21:28: 0	102.000	10903.31	912.26	
42	21:43: 0	102.250	7841.06		161.65
43	21:58: 0	102.500	10903.58	912.85	
44	22:13: 0	102.750	7840.88		161.63
45	22:28: 0	103.000	10903.84	913.43	
46	22:43: 0	103.250	7840.71		161.62
47	22:58: 0	103.500	10904.11	914.02	
48	23:13: 0	103.750	7840.49		161.60
49	23:28: 0	104.000	10904.38	914.59	
50	23:43: 0	104.250	7840.32		161.59

DATE: 9/11/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: S

COMPANY: BHP
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	23:58: 0	104.500	10904.63	915.16	
52	0:13: 0	104.750	7840.17		161.58
53	0:28: 0	105.000	10904.90	915.75	
54	0:43: 0	105.250	7840.02		161.56
55	0:58: 0	105.500	10905.15	916.30	
56	1:13: 0	105.750	7839.88		161.55
57	1:28: 0	106.000	10905.41	916.88	
58	1:43: 0	106.250	7839.62		161.53
59	1:58: 0	106.500	10905.66	917.43	
60	2:13: 0	106.750	7839.45		161.52
61	2:28: 0	107.000	10905.92	917.98	
62	2:43: 0	107.250	7839.19		161.50
63	2:58: 0	107.500	10906.17	918.55	
64	3:13: 0	107.750	7838.97		161.48
65	3:28: 0	108.000	10906.42	919.09	
66	3:43: 0	108.250	7838.73		161.46
67	3:58: 0	108.500	10906.67	919.64	
68	4:13: 0	108.750	7838.64		161.45
69	4:28: 0	109.000	10906.91	920.17	
70	4:43: 0	109.250	7838.48		161.44
71	4:58: 0	109.500	10907.16	920.72	
72	5:13: 0	109.750	7838.18		161.41
73	5:28: 0	110.000	10907.41	921.26	
74	5:43: 0	110.250	7838.06		161.40
75	5:58: 0	110.500	10907.66	921.81	
76	6:13: 0	110.750	7837.92		161.39
77	6:28: 0	111.000	10907.90	922.34	
78	6:43: 0	111.250	7837.70		161.38
79	6:58: 0	111.500	10908.14	922.88	
80	7:13: 0	111.750	7837.59		161.37
81	7:28: 0	112.000	10908.38	923.40	
82	7:43: 0	112.250	7837.36		161.35
83	7:58: 0	112.500	10908.63	923.95	
84	8:13: 0	112.750	7837.12		161.33
85	8:28: 0	113.000	10908.87	924.49	
86	8:43: 0	113.250	7837.02		161.32
87	8:58: 0	113.500	10909.11	925.01	
88	9:13: 0	113.750	7836.88		161.31
89	9:28: 0	114.000	10909.35	925.54	
90	9:43: 0	114.250	7836.62		161.29
91	9:58: 0	114.500	10909.58	926.05	
92	10:13: 0	114.750	7836.50		161.28
93	10:28: 0	115.000	10909.82	926.58	
94	10:43: 0	115.250	7836.31		161.26
95	10:58: 0	115.500	10910.06	927.11	
96	11:13: 0	115.750	7836.15		161.25
97	11:28: 0	116.000	10910.30	927.63	
98	11:43: 0	116.250	7835.95		161.23
99	11:58: 0	116.500	10910.52	928.13	
100	12:13: 0	116.750	7835.74		161.22

DATE: 9/12/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 6

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	12:28: 0	117.000	10910.75	928.63	
2	12:43: 0	117.250	7835.57		161.20
3	12:58: 0	117.500	10910.98	929.14	
4	13:13: 0	117.750	7835.39		161.19
5	13:28: 0	118.000	10911.22	929.67	
6	13:43: 0	118.250	7835.26		161.18
7	13:58: 0	118.500	10911.45	930.16	
8	14:13: 0	118.750	7835.04		161.16
9	14:28: 0	119.000	10911.68	930.67	
10	14:43: 0	119.250	7834.85		161.14
11	14:58: 0	119.500	10911.91	931.18	
12	15:13: 0	119.750	7834.65		161.13
13	15:28: 0	120.000	10912.14	931.69	
14	15:43: 0	120.250	7834.48		161.11
15	15:58: 0	120.500	10912.37	932.18	
16	16:13: 0	120.750	7834.38		161.10
17	16:28: 0	121.000	10912.60	932.70	
18	16:43: 0	121.250	7834.30		161.10
19	16:58: 0	121.500	10912.83	933.21	
20	17:13: 0	121.750	7834.12		161.08
21	17:28: 0	122.000	10913.06	933.71	
22	17:43: 0	122.250	7833.97		161.07
23	17:58: 0	122.500	10913.29	934.22	
24	18:13: 0	122.750	7833.73		161.05
25	18:28: 0	123.000	10913.51	934.71	
26	18:43: 0	123.250	7833.52		161.04
27	18:58: 0	123.500	10913.74	935.21	
28	19:13: 0	123.750	7833.45		161.03
29	19:28: 0	124.000	10913.97	935.73	
30	19:43: 0	124.250	7833.24		161.01
31	19:58: 0	124.500	10914.20	936.23	
32	20:13: 0	124.750	7833.05		161.00
33	20:28: 0	125.000	10914.43	936.74	
34	20:43: 0	125.250	7832.89		160.98
35	20:58: 0	125.500	10914.65	937.23	
36	21:13: 0	125.750	7832.74		160.97
37	21:28: 0	126.000	10914.88	937.73	
38	21:43: 0	126.250	7832.56		160.96
39	21:58: 0	126.500	10915.12	938.25	
40	22:13: 0	126.750	7832.41		160.94
41	22:28: 0	127.000	10915.34	938.74	
42	22:43: 0	127.250	7832.20		160.93
43	22:58: 0	127.500	10915.56	939.22	
44	23:13: 0	127.750	7831.94		160.91
45	23:28: 0	128.000	10915.79	939.73	
46	23:43: 0	128.250	7831.86		160.90
47	23:58: 0	128.500	10916.02	940.23	
48	0:13: 0	128.750	7831.66		160.88
49	0:28: 0	129.000	10916.23	940.70	
50	0:43: 0	129.250	7831.55		160.87

DATE: 9/13/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 6

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	0:58: 0	129.500	10916.46	941.22	
52	1:13: 0	129.750	7831.37		160.86
53	1:28: 0	130.000	10916.68	941.70	
54	1:43: 0	130.250	7831.26		160.85
55	1:58: 0	130.500	10916.90	942.19	
56	2:13: 0	130.750	7831.09		160.84
57	2:28: 0	131.000	10917.12	942.67	
58	2:43: 0	131.250	7830.98		160.83
59	2:58: 0	131.500	10917.34	943.15	
60	3:13: 0	131.750	7830.83		160.82
61	3:28: 0	132.000	10917.56	943.64	
62	3:43: 0	132.250	7830.70		160.81
63	3:58: 0	132.500	10917.78	944.12	
64	4:13: 0	132.750	7830.46		160.79
65	4:28: 0	133.000	10918.00	944.61	
66	4:43: 0	133.250	7830.37		160.78
67	4:58: 0	133.500	10918.22	945.10	
68	5:13: 0	133.750	7830.15		160.76
69	5:28: 0	134.000	10918.43	945.56	
70	5:43: 0	134.250	7830.01		160.75
71	5:58: 0	134.500	10918.65	946.04	
72	6:13: 0	134.750	7829.87		160.74
73	6:28: 0	135.000	10918.87	946.52	
74	6:43: 0	135.250	7829.73		160.73
75	6:58: 0	135.500	10919.09	947.02	
76	7:13: 0	135.750	7829.60		160.72
77	7:28: 0	136.000	10919.31	947.50	
78	7:43: 0	136.250	7829.47		160.71
79	7:58: 0	136.500	10919.53	947.98	
80	8:13: 0	136.750	7829.26		160.69
81	8:28: 0	137.000	10919.74	948.45	
82	8:43: 0	137.250	7829.14		160.68
83	8:58: 0	137.500	10919.96	948.94	
84	9:13: 0	137.750	7829.00		160.67
85	9:28: 0	138.000	10920.17	949.39	
86	9:43: 0	138.250	7828.88		160.66
87	9:58: 0	138.500	10920.38	949.88	
88	10:13: 0	138.750	7828.71		160.64
89	10:28: 0	139.000	10920.60	950.34	
90	10:43: 0	139.250	7828.53		160.63
91	10:58: 0	139.500	10920.81	950.81	
92	11:13: 0	139.750	7828.39		160.62
93	11:28: 0	140.000	10921.03	951.29	
94	11:43: 0	140.250	7828.24		160.61
95	11:58: 0	140.500	10921.23	951.75	
96	12:13: 0	140.750	7828.16		160.60
97	12:28: 0	141.000	10921.45	952.22	
98	12:43: 0	141.250	7827.99		160.58
99	12:58: 0	141.500	10921.66	952.70	
100	13:13: 0	141.750	7827.86		160.57

DATE: 9/13/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 7

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	13:28: 0	142.000	10921.88	953.17	
2	13:43: 0	142.250	7827.75		160.57
3	13:58: 0	142.500	10922.09	953.64	
4	14:13: 0	142.750	7827.61		160.55
5	14:28: 0	143.000	10922.29	954.09	
6	14:43: 0	143.250	7827.49		160.54
7	14:58: 0	143.500	10922.51	954.57	
8	15:13: 0	143.750	7827.32		160.53
9	15:28: 0	144.000	10922.72	955.04	
10	15:43: 0	144.250	7827.25		160.53
11	15:58: 0	144.500	10922.94	955.51	
12	16:13: 0	144.750	7827.13		160.52
13	16:28: 0	145.000	10923.15	955.98	
14	16:43: 0	145.250	7826.96		160.50
15	16:58: 0	145.500	10923.36	956.45	
16	17:13: 0	145.750	7826.84		160.49
17	17:28: 0	146.000	10923.57	956.92	
18	17:43: 0	146.250	7826.77		160.49
19	17:58: 0	146.500	10923.78	957.39	
20	18:13: 0	146.750	7826.62		160.47
21	18:28: 0	147.000	10924.00	957.87	
22	18:43: 0	147.250	7826.52		160.47
23	18:58: 0	147.500	10924.21	958.34	
24	19:13: 0	147.750	7826.39		160.45
25	19:28: 0	148.000	10924.43	958.81	
26	19:43: 0	148.250	7826.24		160.44
27	19:58: 0	148.500	10924.64	959.29	
28	20:13: 0	148.750	7826.17		160.44
29	20:28: 0	149.000	10924.86	959.76	
30	20:43: 0	149.250	7826.03		160.43
31	20:58: 0	149.500	10925.07	960.23	
32	21:13: 0	149.750	7825.93		160.42
33	21:28: 0	150.000	10925.29	960.72	
34	21:43: 0	150.250	7825.76		160.40
35	21:58: 0	150.500	10925.50	961.18	
36	22:13: 0	150.750	7825.66		160.40
37	22:28: 0	151.000	10925.72	961.67	
38	22:43: 0	151.250	7825.52		160.38
39	22:58: 0	151.500	10925.93	962.13	
40	23:13: 0	151.750	7825.40		160.37
41	23:28: 0	152.000	10926.14	962.61	
42	23:43: 0	152.250	7825.28		160.37
43	23:58: 0	152.500	10926.36	963.09	
44	0:13: 0	152.750	7825.16		160.36
45	0:28: 0	153.000	10926.57	963.56	
46	0:43: 0	153.250	7825.07		160.35
47	0:58: 0	153.500	10926.80	964.07	
48	1:13: 0	153.750	7824.92		160.34
49	1:28: 0	154.000	10927.02	964.55	
50	1:43: 0	154.250	7824.79		160.33

DATE: 9/14/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 7

COMPANY: BHP
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	1:58: 0	154.500	10927.23	965.02	
52	2:13: 0	154.750	7824.63		160.31
53	2:28: 0	155.000	10927.45	965.50	
54	2:43: 0	155.250	7824.53		160.30
55	2:58: 0	155.500	10927.67	965.99	
56	3:13: 0	155.750	7824.33		160.29
57	3:28: 0	156.000	10927.89	966.47	
58	3:43: 0	156.250	7824.21		160.28
59	3:58: 0	156.500	10928.11	966.95	
60	4:13: 0	156.750	7824.06		160.27
61	4:28: 0	157.000	10928.33	967.44	
62	4:43: 0	157.250	7823.93		160.25
63	4:58: 0	157.500	10928.54	967.92	
64	5:13: 0	157.750	7823.75		160.24
65	5:28: 0	158.000	10928.76	968.39	
66	5:43: 0	158.250	7823.57		160.23
67	5:58: 0	158.500	10928.97	968.87	
68	6:13: 0	158.750	7823.39		160.21
69	6:28: 0	159.000	10929.19	969.34	
70	6:43: 0	159.250	7823.18		160.19
71	6:58: 0	159.500	10929.40	969.80	
72	7:13: 0	159.750	7823.09		160.19
73	7:28: 0	160.000	10929.62	970.29	
74	7:43: 0	160.250	7822.92		160.17
75	7:58: 0	160.500	10929.83	970.76	
76	8:13: 0	160.750	7822.84		160.17
77	8:28: 0	161.000	10930.05	971.25	
78	8:43: 0	161.250	7822.70		160.15
79	8:58: 0	161.500	10930.27	971.73	
80	9:13: 0	161.750	7822.58		160.14
81	9:28: 0	162.000	10930.48	972.20	
82	9:43: 0	162.250	7822.42		160.13
83	9:58: 0	162.500	10930.70	972.68	
84	10:13: 0	162.750	7822.27		160.12
85	10:28: 0	163.000	10930.92	973.17	
86	10:43: 0	163.250	7822.12		160.11
87	10:58: 0	163.500	10931.13	973.64	
88	11:13: 0	163.750	7822.00		160.10
89	11:28: 0	164.000	10931.34	974.10	
90	11:43: 0	164.250	7821.91		160.09
91	11:58: 0	164.500	10931.56	974.59	
92	12:13: 0	164.750	7821.76		160.08
93	12:28: 0	165.000	10931.77	975.07	
94	12:43: 0	165.250	7821.69		160.07
95	12:58: 0	165.500	10932.00	975.56	
96	13:13: 0	165.750	7821.53		160.06
97	13:28: 0	166.000	10932.22	976.05	
98	13:43: 0	166.250	7821.41		160.05
99	13:58: 0	166.500	10932.42	976.50	
100	14:13: 0	166.750	7821.30		160.04

DATE: 9/14/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 8

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	14:28: 0	167.000	10932.64	976.99	
2	14:43: 0	167.250	7821.14		160.03
3	14:58: 0	167.500	10932.86	977.48	
4	15:13: 0	167.750	7820.98		160.02
5	15:28: 0	168.000	10933.08	977.96	
6	15:43: 0	168.250	7820.87		160.01
7	15:58: 0	168.500	10933.30	978.44	
8	16:13: 0	168.750	7820.79		160.00
9	16:28: 0	169.000	10933.52	978.93	
10	16:43: 0	169.250	7820.71		159.99
11	16:58: 0	169.500	10933.74	979.42	
12	17:13: 0	169.750	7820.50		159.98
13	17:28: 0	170.000	10933.96	979.90	
14	17:43: 0	170.250	7820.33		159.96
15	17:58: 0	170.500	10934.17	980.39	
16	18:13: 0	170.750	7820.12		159.95
17	18:28: 0	171.000	10934.39	980.87	
18	18:43: 0	171.250	7819.94		159.93
19	18:58: 0	171.500	10934.61	981.35	
20	19:13: 0	171.750	7819.73		159.91
21	19:28: 0	172.000	10934.83	981.83	
22	19:43: 0	172.250	7819.62		159.90
23	19:58: 0	172.500	10935.04	982.31	
24	20:13: 0	172.750	7819.51		159.90
25	20:28: 0	173.000	10935.26	982.78	
26	20:43: 0	173.250	7819.43		159.89
27	20:58: 0	173.500	10935.49	983.29	
28	21:13: 0	173.750	7819.26		159.87
29	21:28: 0	174.000	10935.70	983.77	
30	21:43: 0	174.250	7819.07		159.86
31	21:58: 0	174.500	10935.92	984.26	
32	22:13: 0	174.750	7818.96		159.85
33	22:28: 0	175.000	10936.14	984.75	
34	22:43: 0	175.250	7818.84		159.84
35	22:58: 0	175.500	10936.36	985.22	
36	23:13: 0	175.750	7818.73		159.83
37	23:28: 0	176.000	10936.58	985.72	
38	23:43: 0	176.250	7818.64		159.82
39	23:58: 0	176.500	10936.80	986.21	
40	0:13: 0	176.750	7818.54		159.82
41	0:28: 0	177.000	10937.02	986.70	
42	0:43: 0	177.250	7818.48		159.81
43	0:58: 0	177.500	10937.24	987.19	
44	1:13: 0	177.750	7818.33		159.80
45	1:28: 0	178.000	10937.46	987.66	
46	1:43: 0	178.250	7818.28		159.80
47	1:58: 0	178.500	10937.67	988.15	
48	2:13: 0	178.750	7818.18		159.79
49	2:28: 0	179.000	10937.89	988.63	
50	2:43: 0	179.250	7818.06		159.78

DATE: 9/15/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 8

COMPANY: BHS
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	2:58: 0	179.500	10938.11	989.12	
52	3:13: 0	179.750	7817.98		159.77
53	3:28: 0	180.000	10938.33	989.61	
54	3:43: 0	180.250	7817.87		159.76
55	3:58: 0	180.500	10938.54	990.08	
56	4:13: 0	180.750	7817.76		159.75
57	4:28: 0	181.000	10938.77	990.57	
58	4:43: 0	181.250	7817.73		159.75
59	4:58: 0	181.500	10938.98	991.06	
60	5:13: 0	181.750	7817.61		159.74
61	5:28: 0	182.000	10939.20	991.54	
62	5:43: 0	182.250	7817.52		159.73
63	5:58: 0	182.500	10939.43	992.04	
64	6:13: 0	182.750	7817.43		159.73
65	6:28: 0	183.000	10939.64	992.51	
66	6:43: 0	183.250	7817.36		159.72
67	6:58: 0	183.500	10939.86	992.99	
68	7:13: 0	183.750	7817.32		159.72
69	7:28: 0	184.000	10940.07	993.48	
70	7:43: 0	184.250	7817.23		159.71
71	7:58: 0	184.500	10940.28	993.95	
72	8:13: 0	184.750	7817.24		159.71
73	8:28: 0	185.000	10940.51	994.44	
74	8:43: 0	185.250	7817.12		159.70
75	8:58: 0	185.500	10940.72	994.91	
76	9:13: 0	185.750	7817.05		159.70
77	9:28: 0	186.000	10940.93	995.39	
78	9:43: 0	186.250	7817.00		159.69
79	9:58: 0	186.500	10941.14	995.86	
80	10:13: 0	186.750	7816.92		159.68
81	10:28: 0	187.000	10941.36	996.33	
82	10:43: 0	187.250	7816.81		159.68
83	10:58: 0	187.500	10941.57	996.80	
84	11:13: 0	187.750	7816.71		159.67
85	11:28: 0	188.000	10941.77	997.26	
86	11:43: 0	188.250	7816.60		159.66
87	11:58: 0	188.500	10941.99	997.73	
88	12:13: 0	188.750	7816.54		159.65
89	12:28: 0	189.000	10942.19	998.19	
90	12:43: 0	189.250	7816.43		159.65
91	12:58: 0	189.500	10942.41	998.66	
92	13:13: 0	189.750	7816.27		159.63
93	13:28: 0	190.000	10942.61	999.12	
94	13:43: 0	190.250	7816.23		159.63
95	13:58: 0	190.500	10942.81	999.57	
96	14:13: 0	190.750	7816.11		159.62
97	14:28: 0	191.000	10943.02	1000.02	
98	14:43: 0	191.250	7816.07		159.62
99	14:58: 0	191.500	10943.22	1000.47	
100	15:13: 0	191.750	7815.94		159.60

DATE: 9/15/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 9

COMPANY: BMG
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
1	15:28: 0	192.000	10943.43	1000.94	
2	15:43: 0	192.250	7815.81		159.59
3	15:58: 0	192.500	10943.63	1001.39	
4	16:13: 0	192.750	7815.73		159.59
5	16:28: 0	193.000	10943.83	1001.84	
6	16:43: 0	193.250	7815.63		159.58
7	16:58: 0	193.500	10944.03	1002.28	
8	17:13: 0	193.750	7815.60		159.58
9	17:28: 0	194.000	10944.22	1002.70	
10	17:43: 0	194.250	7815.47		159.57
11	17:58: 0	194.500	10944.43	1003.15	
12	18:13: 0	194.750	7815.38		159.56
13	18:28: 0	195.000	10944.62	1003.58	
14	18:43: 0	195.250	7815.28		159.55
15	18:58: 0	195.500	10944.82	1004.03	
16	19:13: 0	195.750	7815.15		159.54
17	19:28: 0	196.000	10945.02	1004.47	
18	19:43: 0	196.250	7815.11		159.54
19	19:58: 0	196.500	10945.21	1004.89	
20	20:13: 0	196.750	7815.02		159.53
21	20:28: 0	197.000	10945.40	1005.32	
22	20:43: 0	197.250	7814.87		159.52
23	20:58: 0	197.500	10945.60	1005.76	
24	21:13: 0	197.750	7814.75		159.51
25	21:28: 0	198.000	10945.79	1006.18	
26	21:43: 0	198.250	7814.64		159.50
27	21:58: 0	198.500	10945.98	1006.61	
28	22:13: 0	198.750	7814.51		159.49
29	22:28: 0	199.000	10946.17	1007.03	
30	22:43: 0	199.250	7814.41		159.48
31	22:58: 0	199.500	10946.36	1007.45	
32	23:13: 0	199.750	7814.29		159.47
33	23:28: 0	200.000	10946.55	1007.86	
34	23:43: 0	200.250	7814.17		159.46
35	23:58: 0	200.500	10946.74	1008.29	
36	0:13: 0	200.750	7814.06		159.45
37	0:28: 0	201.000	10946.92	1008.70	
38	0:43: 0	201.250	7813.98		159.45
39	0:58: 0	201.500	10947.10	1009.09	
40	1:13: 0	201.750	7813.96		159.44
41	1:28: 0	202.000	10947.32	1009.58	
42	1:43: 0	202.250	7813.84		159.43
43	1:58: 0	202.500	10947.49	1009.97	
44	2:13: 0	202.750	7813.68		159.42
45	2:28: 0	203.000	10947.67	1010.36	
46	2:43: 0	203.250	7813.58		159.41
47	2:58: 0	203.500	10947.85	1010.76	
48	3:13: 0	203.750	7813.48		159.41
49	3:28: 0	204.000	10948.02	1011.14	
50	3:43: 0	204.250	7813.38		159.40

DATE: 9/18/88
GAUGE SN #69306
WELL # 0
TEST # 1990

DATA FILE: 9

COMPANY: BHC
CLIENT: McHugh
WELL NAME: Colorado Laguna 2 #6
TEST OPERATOR: MD
LOCATION:
COMMENTS: BHP @ 6940' GL

DATA PT	TIME	DELTA T (HRS)	FREQUENCY	PRESSURE PSIA	TEMPERATURE 'F
51	3:58: 0	204.500	10948.19	1011.51	
52	4:13: 0	204.750	7813.24		159.39
53	4:28: 0	205.000	10948.36	1011.90	
54	4:43: 0	205.250	7813.16		159.38
55	4:58: 0	205.500	10948.54	1012.29	
56	5:13: 0	205.750	7812.77		159.35
57	5:28: 0	206.000	10948.71	1012.68	
58	5:43: 0	206.250	21811.42		5085.59
59	5:58: 0	206.500	21811.42		5085.59
60	6:13: 0	206.750	21811.42		5085.59
61	6:28: 0	230.000	10939.20	991.54	
62	6:43: 0	230.250	7817.52		159.73
63	6:58: 0	230.500	10939.43	992.04	
64	7:13: 0	230.750	7817.43		159.73
65	7:28: 0	231.000	10939.64	992.51	
66	7:43: 0	231.250	7817.36		159.72
67	7:58: 0	231.500	10939.86	992.99	
68	8:13: 0	231.750	7817.32		159.72
69	8:28: 0	232.000	10940.07	993.48	
70	8:43: 0	232.250	7817.23		159.71
71	8:58: 0	232.500	10940.28	993.95	
72	9:13: 0	232.750	7817.24		159.71
73	9:28: 0	233.000	10940.51	994.44	
74	9:43: 0	233.250	7817.12		159.70
75	9:58: 0	233.500	10940.72	994.91	
76	10:13: 0	233.750	7817.05		159.70
77	10:28: 0	234.000	10940.93	995.39	
78	10:43: 0	234.250	7817.00		159.69
79	10:58: 0	234.500	10941.14	995.86	
80	11:13: 0	234.750	7816.92		159.68
81	11:28: 0	235.000	10941.36	996.33	
82	11:43: 0	235.250	7816.81		159.68
83	11:58: 0	235.500	10941.57	996.80	
84	12:13: 0	235.750	7816.71		159.67
85	12:28: 0	236.000	10941.77	997.26	
86	12:43: 0	236.250	7816.60		159.66
87	12:58: 0	236.500	10941.98	997.73	
88	13:13: 0	236.750	7816.54		159.65
89	13:28: 0	237.000	10942.19	998.19	
90	13:43: 0	237.250	7816.43		159.65
91	13:58: 0	237.500	10942.41	998.66	
92	14:13: 0	237.750	7816.27		159.63
93	14:28: 0	238.000	10942.61	999.12	
94	14:43: 0	238.250	7816.23		159.63
95	14:58: 0	238.500	10942.81	999.57	
96	15:13: 0	238.750	7816.11		159.62
97	15:28: 0	239.000	10943.02	1000.02	
98	15:43: 0	239.250	7816.07		159.62
99	15:58: 0	239.500	10943.22	1000.47	
100	16:13: 0	239.750	7815.94		159.60

TOTAL MOBILITY FROM ANALYSIS OF BOTTOM HOLE PRESSURE SURVEY

WELL Amoco Schmitz Ant. Fed.

ELEVATION 7274' KB

DEPTH OF BOMB 6464'

DATE SHUT IN Sept. 10, 1988

TIME SHUT IN 8:00 AM

PRODUCTION RATE PRIOR TO SHUT-IN 70 BOPD

_____ MCFD

GAS-OIL RATIO (est. solution GOR) 500 MCF/BBL

B_O 1.3

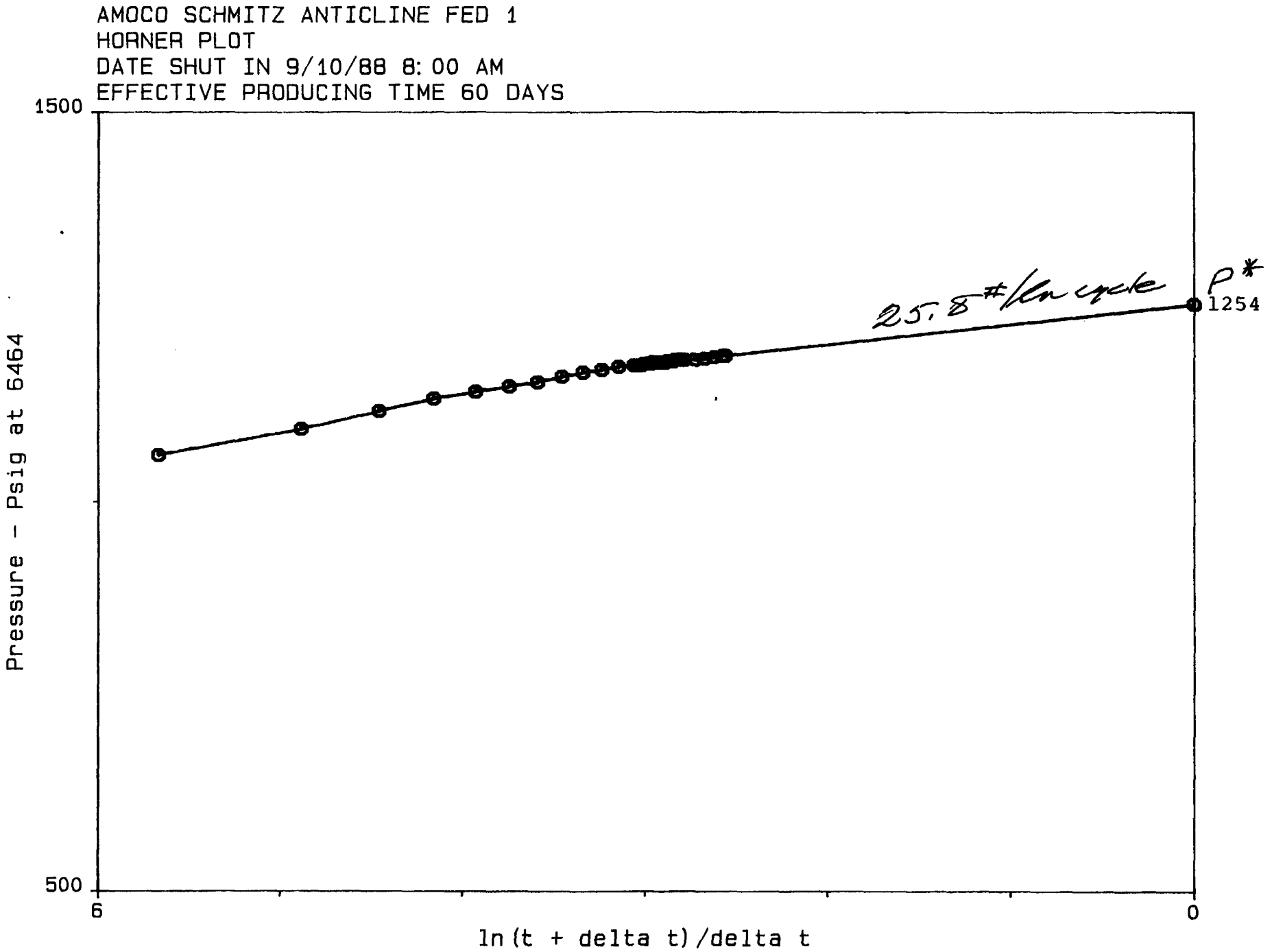
B_T 1.3

first slope, m 40.5 /ln cycle
second slope, m 25.8 /ln cycle

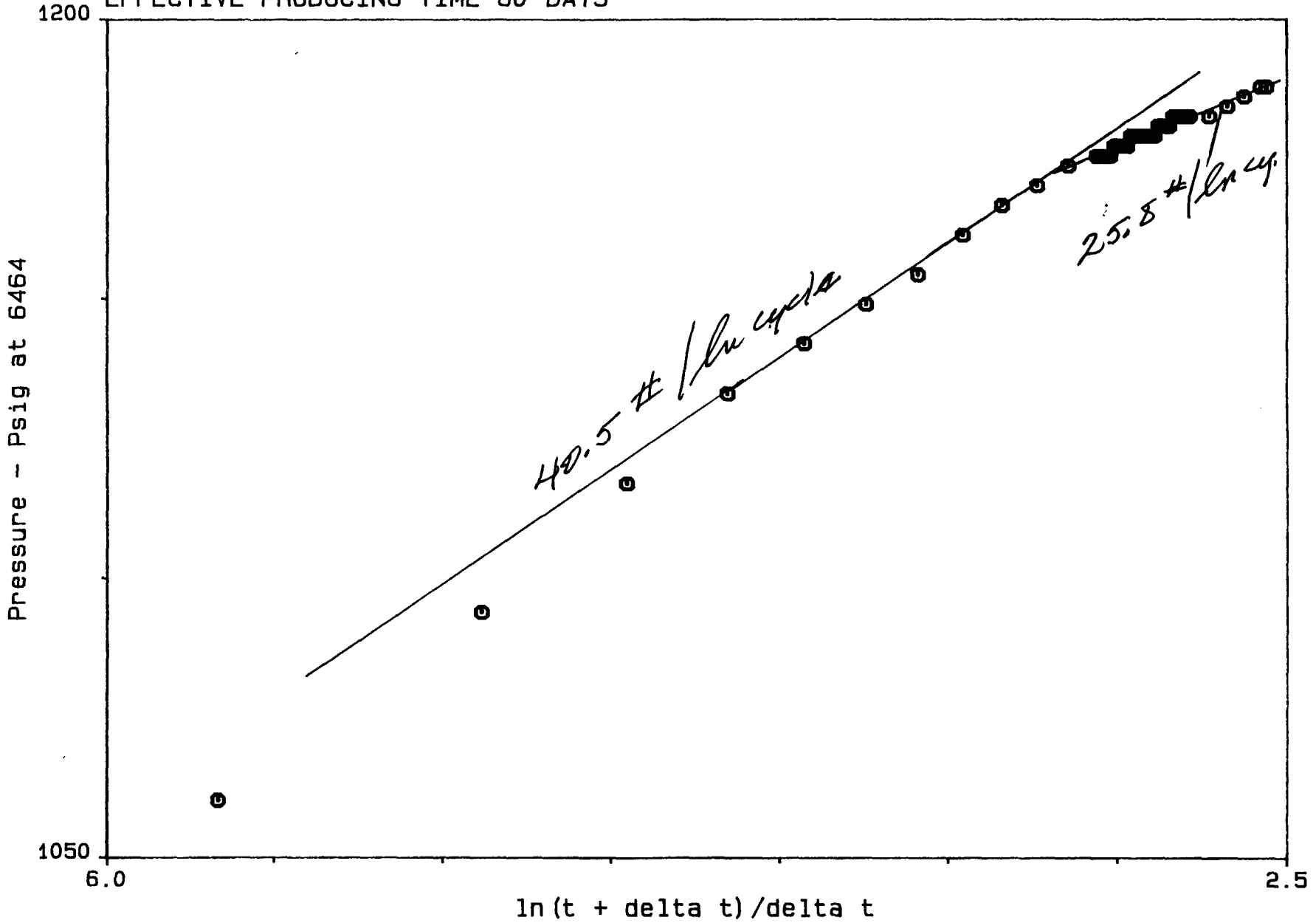
$$\text{TOTAL MOBILITY } (Kh/u)_T = \frac{q\, B_T}{14.16 \times m \text{ (ln cycle)}} = \begin{matrix} .16 \text{ darcy feet/cp 1st slope} \\ .25 \text{ darcy feet/cp 2nd slope} \end{matrix}$$

Plots with expanded scales are next following along with determination of Horner P*.

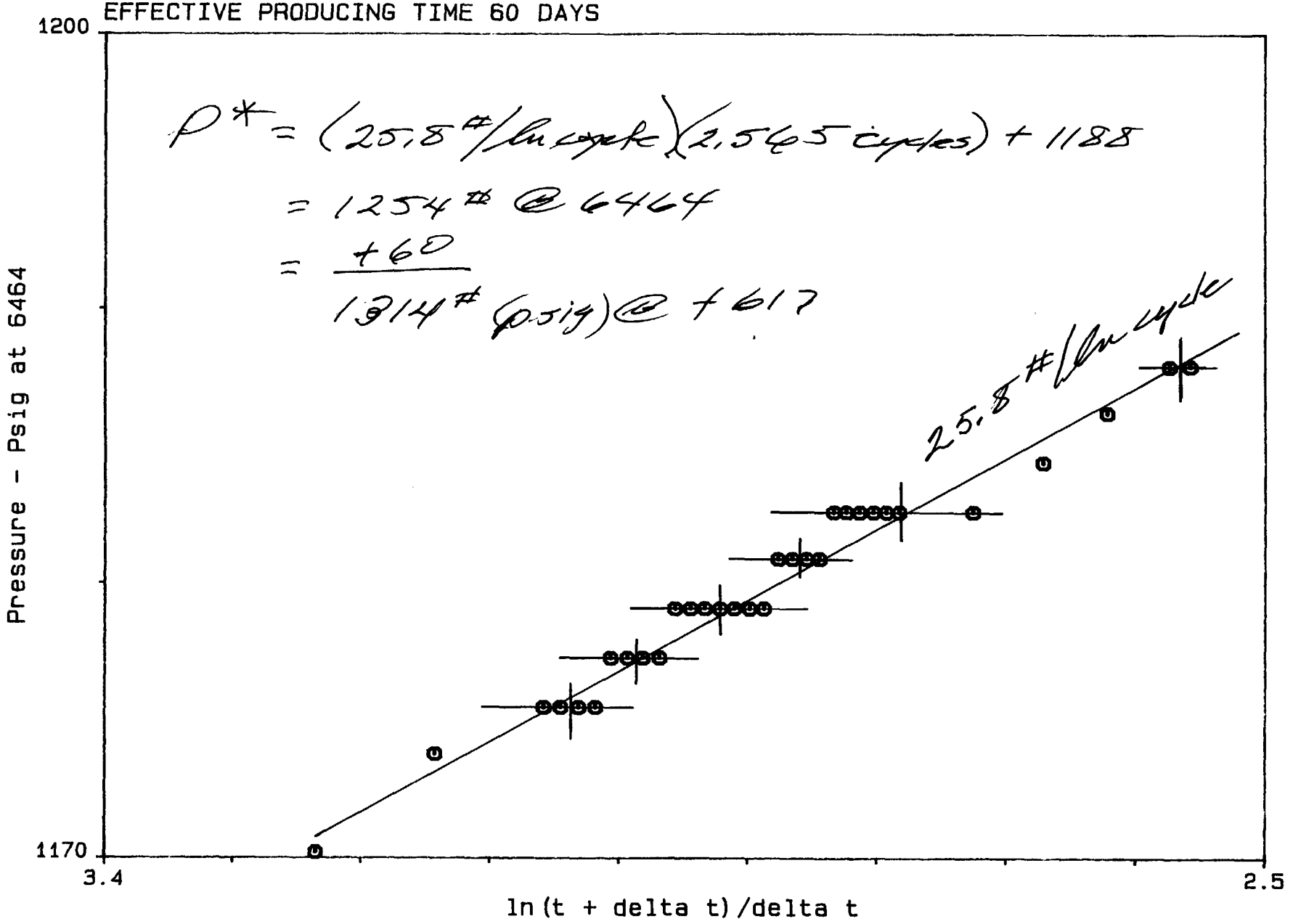
Copy of survey and data for Horner plot are at back of this section.


AMOCO SCHMITZ ANTICLINE FED 1
HORNER PLOT
DATE SHUT IN 9/10/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS
1500
500
6
0
Pressure - Psig at 6464
ln (t + delta t)/delta t
25.8 #/ln cycle
P*
1254

AMOCO SCHMITZ ANTICLINE FED. 1
HORNER PLOT
DATE SHUT IN 9/10/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS



AMOCO SCHMITZ ANTICLINE FED. 1
HORNER PLOT
DATE SHUT IN 9/10/88 8:00 AM
EFFECTIVE PRODUCING TIME 60 DAYS



AMOCO SCHMITZ ANTICLINE #1
HORNER PLOT OF PRESSURE BUILD-UP
WELL SHUT IN 8:00 AM SEPTEMBER 10, 1988
Δt TIME = BOMB TIME PLUS 5 HOURS
EFFECTIVE PRODUCING TIME 60 DAYS

Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)	Bomb Time (Hours)	Shut in Δt Time (Hours)	$\ln \frac{t+\Delta t}{\Delta t}$	Pressure (Psia)
0.00	5.00	5.666	1060.3	76.00	81.00	2.933	1179.1
6.00	11.00	4.882	1094.0	77.00	82.00	2.921	1179.1
12.00	17.00	4.451	1117.0	78.00	83.00	2.910	1179.1
18.00	23.00	4.153	1133.0	79.00	84.00	2.898	1179.1
24.00	29.00	3.925	1142.0	80.00	85.00	2.887	1179.1
30.00	35.00	3.741	1149.0	81.00	86.00	2.876	1180.9
36.00	41.00	3.587	1154.3	82.00	87.00	2.895	1180.9
42.00	47.00	3.454	1161.4	83.00	88.00	2.854	1180.9
48.00	53.00	3.338	1166.7	84.00	89.00	2.844	1180.9
54.00	59.00	3.235	1170.2	85.00	90.00	2.833	1182.6
60.00	65.00	3.142	1173.8	86.00	91.00	2.823	1182.6
66.00	71.00	3.058	1175.5	87.00	92.00	2.813	1182.6
67.00	72.00	3.045	1175.5	88.00	93.00	2.802	1182.6
68.00	73.00	3.031	1175.5	89.00	94.00	2.792	1182.6
69.00	71.00	3.018	1175.5	90.00	95.00	2.782	1182.6
70.00	75.00	3.006	1177.3	96.00	101.00	2.725	1182.6
71.00	76.00	2.993	1177.3	102.00	107.00	2.671	1184.4
72.00	77.00	2.981	1177.3	108.00	113.00	2.621	1186.2
73.00	78.00	2.968	1177.3	114.00	119.00	2.573	1187.9
74.00	79.00	2.956	1179.1	116.00	121.00	2.557	1187.9
75.00	80.00	2.944	1179.1				

Amoco Production Company
Southern Division
1670 Broadway
P.O. Box 800
Denver, Colorado 80201
303-830-4040

SEP 29 1988

T. D. Autry
Division Production Manager

September 26, 1988

Benson-Montin Greer Drilling Corp.
221 Petroleum Center Building
Farmington, NM 87401

File: LF-209-WF

Schmitz Anticline No. 1
Bottomhole Pressure Data
Rio Arriba County, New Mexico

We are transmitting the bottomhole pressure data recorded on the subject well which was obtained during the period September 10th through the 15th of 1988.

Please direct questions concerning this data to Richard Jones at (303)830-4085.

T D Autry/kf

GRJ47ca

Attachments

WELL CHART ANALYSIS

PERFORMED B

COMPANY NAME ..... B&R SERVICE INC.

GAUGE TYPE ..... KPG
GAUGE NUMBER 27599
TICKET NUMBER 704

PREPARED FOR

COMPANY NAME ..... AMOCO PRODUCTION CO

WELL NAME ..... SCHMITZ-ANTICLINE FED. #1
FIELD NAME ..... GALLUP
LOCATION ..... RIO ARRIBA/N. MEX.
TYPE OF TEST ..... INTERFERENCE
BHP RECORDED @ 6464' G.L

	TIME		PRES[illegible]
	REAL	ELAPSED	
9-10-88	12:58:00	00:00:00	1,062.50
	00:58:07	12:00:07	1,116.94
	12:58:18	24:00:18	1,143.15
	00:58:07	36:00:07	1,155.24
	12:58:09	48:00:09	1,167.34
	00:58:12	60:00:12	1,175.40
	12:58:14	72:00:14	1,177.42
	00:59:03	84:00:03	1,181.45
	12:58:05	96:00:05	1,183.47
	00:58:07	108:00:07	1,187.50
	09:41:09	116:39:09	1,189.52

WELL CHART ANALYSIS

PERFORMED BY

COMPANY NAME . . . B&R SERVICE INC.

GAUGE TYPE . . . . . KPE
GAUGE NUMBER 0500251
TICKET NUMBER 103

PREPARED FOR

COMPANY NAME . . . . AMOCO PRODUCTION CO.

WELL NAME . . . . . SCHMITZ-AUSTIN #1 FED. #1
FIELD NAME . . . . . GALLUP
LOCATION . . . . . RIO ARRIBA/N.MEX.
TYPE OF TEST . . . . . INTERFERENCE

BHP RECORDED @ 6464 G.L.

	TIME		PRESSURE PSI
	REAL	ELAPSED	
9-10-88	12:58:00	00:00:00	1,060.28
	18:58:09	06:00:09	1,093.97
	00:58:04	12:00:04	1,117.02
	06:58:00	18:00:00	1,132.98
	12:58:09	24:00:09	1,144.84
	18:58:05	30:00:05	1,148.94
	00:59:01	36:00:01	1,154.26
	06:59:10	42:00:10	1,161.35
	12:59:05	48:00:05	1,166.67
	18:58:01	54:00:01	1,170.21
	00:59:10	60:00:10	1,173.76
	06:58:06	66:00:06	1,175.53
	07:58:05	67:00:05	1,175.53
	08:58:04	68:00:04	1,175.53
	09:58:17	69:00:17	1,175.53
	10:58:03	70:00:03	1,177.30
	11:57:49	70:59:49	1,177.30
	12:58:02	72:00:02	1,177.30
	13:58:01	73:00:01	1,177.30
	14:59:00	74:00:00	1,179.08
	15:57:59	74:59:59	1,179.08
	16:58:12	75:00:12	1,179.08
	17:58:11	77:00:11	1,179.08
	18:58:11	78:00:11	1,179.08
	19:58:10	79:00:10	1,179.08
	20:58:09	80:00:09	1,179.08
	21:58:08	81:00:08	1,180.85
	22:58:08	82:00:08	1,180.85
	23:58:07	83:00:07	1,180.85
	00:58:06	84:00:06	1,180.85
	01:58:06	85:00:06	1,182.62
	02:58:05	86:00:05	1,182.62
	03:58:04	87:00:04	1,182.62
	04:58:04	88:00:04	1,182.62
	05:58:05	89:00:05	1,182.62
	06:58:02	90:00:02	1,182.62
	12:59:24	96:00:24	1,182.62
	18:59:07	102:00:07	1,184.40
	00:58:03	108:00:03	1,186.17
	06:58:12	114:00:12	1,187.94
	07:00:00	116:44:00	1,187.94

SOUTHEAST WEST PUERTO CHIQUITO
COMPARISON OF HORNER P* PRESSURES
FOR SEPTEMBER 1988 SURVEY

The graph on the facing page compares schematically the Horner plots of build-up pressures of the three wells for which we have pressure data.

Note the near uniformity of pressure at a level significantly below the bubble point.

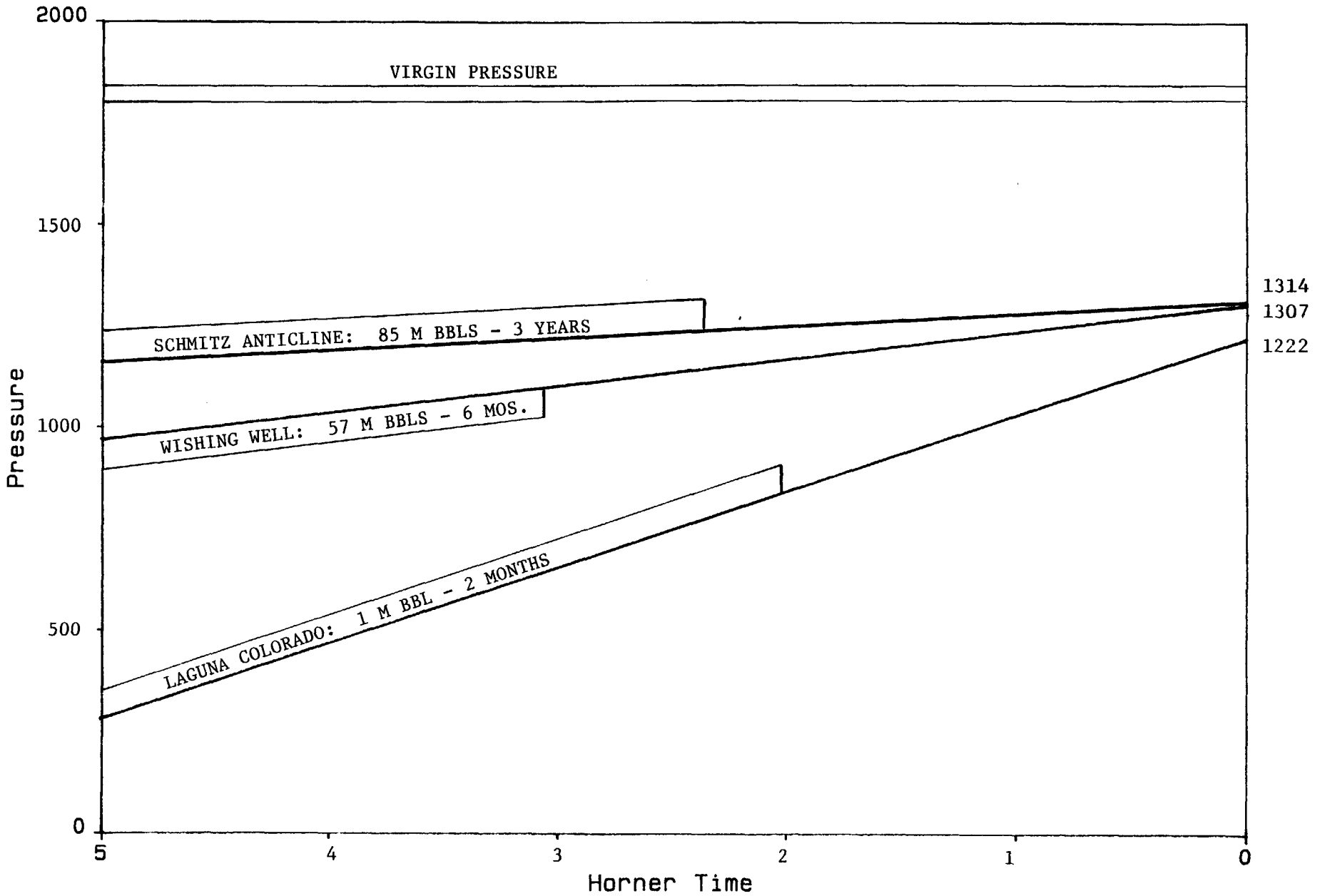
The pressure of the high capacity fracture system is probably about 1250#. (The P* pressures of the Wishing Well and Schmitz Anticline are higher than this pressure - as noted earlier herein.)

For the Laguna Colorado, however its boundary pressure will not be less than the P* pressure.

Note also the extreme difference in cumulative recovery of the Laguna Colorado as compared to the other two wells. Its production clearly has been the cause of pressure depletion by its tight block. This depletion was caused by production of the other wells: clear evidence of the high capacity fracture system affecting this well's tight block.

That other wells - even miles away - can deplete a small well's tight block better than can the well itself has been shown in other cases of the New Mexico Oil Conservation Division. One reference: NMOCC Case 6997, August 6, 1980, B-M-G Exhibit 1, Section D.

SOUTHEAST WEST PUERTO CHIQUITO
SCHEMATIC HORNER PLOT
SEPT. 1988 PRESSURE SURVEYS



ABILITY OF WELLS TO DRAIN THEIR 640-ACRE SPACING UNITS

In West Puerto Chiquito and Gavilan, individual wells have effectively produced from tens of thousands of acres. This was possible because of the high capacity fracture system in these pools. There appears to be a high capacity fracture system in Southeast West Puerto Chiquito that will permit wells to drain thousands of acres - but not tens of thousands - as indications are that the currently developed reservoir does not cover such a large area. Even so, the wells are draining areas much larger than their spacing units.

Currently the two wells with the lowest productivities are the Schmitz Anticline and the Laguna Colorado. On the following pages are analyses showing that even these smaller wells are capable of draining 640 acres of the tighter reservoir rock.

In West Puerto Chiquito and Gavilan, a large part of the resrvoir exists in the high capacity facture system (Reference NMOCC Case 3455, December 1969, B-M-G Exhibit 2, Appendix III). Here, in Southeast West Puerto Chiquito the same will be true; however, for the purpose of demonstrating that the wells can drain their tight blocks, in the following analyses, it is assumed that the well's entire drainage area consists of the tight fracture block with no assistance from a high capacity fracture system.

ABILITY OF WELLS TO DRAIN THEIR 640-ACRE SPACING UNITS

AMOCO SCHMITZ ANTICLINE FEDERAL #1

Here the tightest rock is represented by the first slope 40.5# per cycle, Kh/u of .16 darcy feet (Reference bottom hole pressure build-up survey September 10. 1988).

The well produces very little free gas, so Kro is probably high, $\pm$ .9, indicating rock Kh to be about .18 darcy feet. From the graph (previous section) of barrels per acre versus Kh, reservoir pore volume would be $\pm$ 500 stock tank barrels per acre, or $\phi h = .084$.

The diffusivity constant, n^*, $= \dfrac{6.328\ (kh/u)_t}{\phi h\ c_t} = \dfrac{6.328 \times .16}{.084 \times 400 \times 10^{-6}} = 3 \times 10^4$

for 640-acre spacing average drainage radius at the external boundry is 2879 feet.

Time to reach steady state conditions:

$$t = \frac{r^2}{4n} = \frac{(2879)^2}{4 \times 3 \times 10^4} = 69 \text{ days.}$$

Recovery of oil from reservoir rock of such low Kh will be mostly solution gas drive, $\pm$ 6 to 8 percent, or about 30 to 40 barrels per acre. At 40 barrels per acre, oil reocvery from 640 acres of this character of rock would be 25,000 barrels.

If the reservoir were made up entirely of this kind of rock, and all spacing units drilled and produced simultaneously, then for a per well initial production rate of 70 BOPD and constant percentage decline to economic limit of 3 BOPD per well, the resulting decline rate would be 98% per year, with complete depletion in about 3 years.

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* Reference: NMOCC Case 9111, June 1988, B-M-G Exhibit 1, Section H.

ABILITY OF WELLS TO DRAIN THEIR 640-ACRE SPACING UNITS

NASSAU LAGUNA COLORADO 2-6

Here the tightest reservoir rock is that indicated at the end of the bottom hole build-up survey: 188# per ln cycle and Kh/u of .046 darcy feet.

The well has (at time of the test) a GOR of 5000 cubic feet per barrel.

At a GOR of 5000, Koh is approximately 7% of $(Kh/u)_T$, or about .003 darcy feet. Kro is unknown but estimated at about .2; so Kh would be $\pm$ .015 darcy feet. From the graph of oil in place versus Kh, oil in place is $\pm$ 350 stock tank barrels per acre.

At 6 to 8 percent recovery of oil in place, recovery would be 20 to 30 barrels per acre.

For 30 barrels per acre recovery from 640 acres of this character of reservoir rock would be about 20,000 barrels.

At an initial production rate of 11 BOPD and economic limit of 3 BOPD, and constant percentage decline rate, the decline would be 15 percent per year, with complete depletion in about 7 years.

The diffusivity constant, $$n = \frac{6.328\ (Kh/u)_t}{\phi h\ c_t} = \frac{6.328 \times .046}{(.058)\ (450 \times 10^{-6})} = 1.1 \times 10^4$$

Time to reach steady state conditions for radius of 2879:

$$t = \frac{r^2}{4n} = \frac{(2879)^2}{4 \times 1.1 \times 10^4} = 188 \text{ days}$$

ANTICIPATED RECOVERIES OF FUTURE WELLS IN THE DEVELOPED PORTION OF SOUTHEAST WEST PUERTO CHIQUITO

In West Puerto Chiquito wells with initial production rates of 500 to 600 BOPD have individually produced cumulative oil volumes of 2 million barrels; and in Gavilan individual wells of similar capacity have produced hundreds of thousands of barrels; and although in Southeast West Puerto Chiquito two of the initial three wells have produced at rates of 500 to 600 BOPD, it is anticipated that this analogy of high capacity wells and large ultimate cumulative recovery will not apply here. Rather it is expected that future wells in Southeast West Puerto Chiquito will realize ultimate recoveries of 60,000 to 90,000 barrels per well if the existing 640-acre spacing is maintained. Closer spacing will result in proportionately lower per well recoveries.

The analyses leading to this conclusion are described in the following pages of this section.

Set out below is a summary of cumulative production for this area along with approximate pressures. This same information is displayed on the graph on the facing page, along with a projection of the path of future pressures assuming no pressure maintenance support.

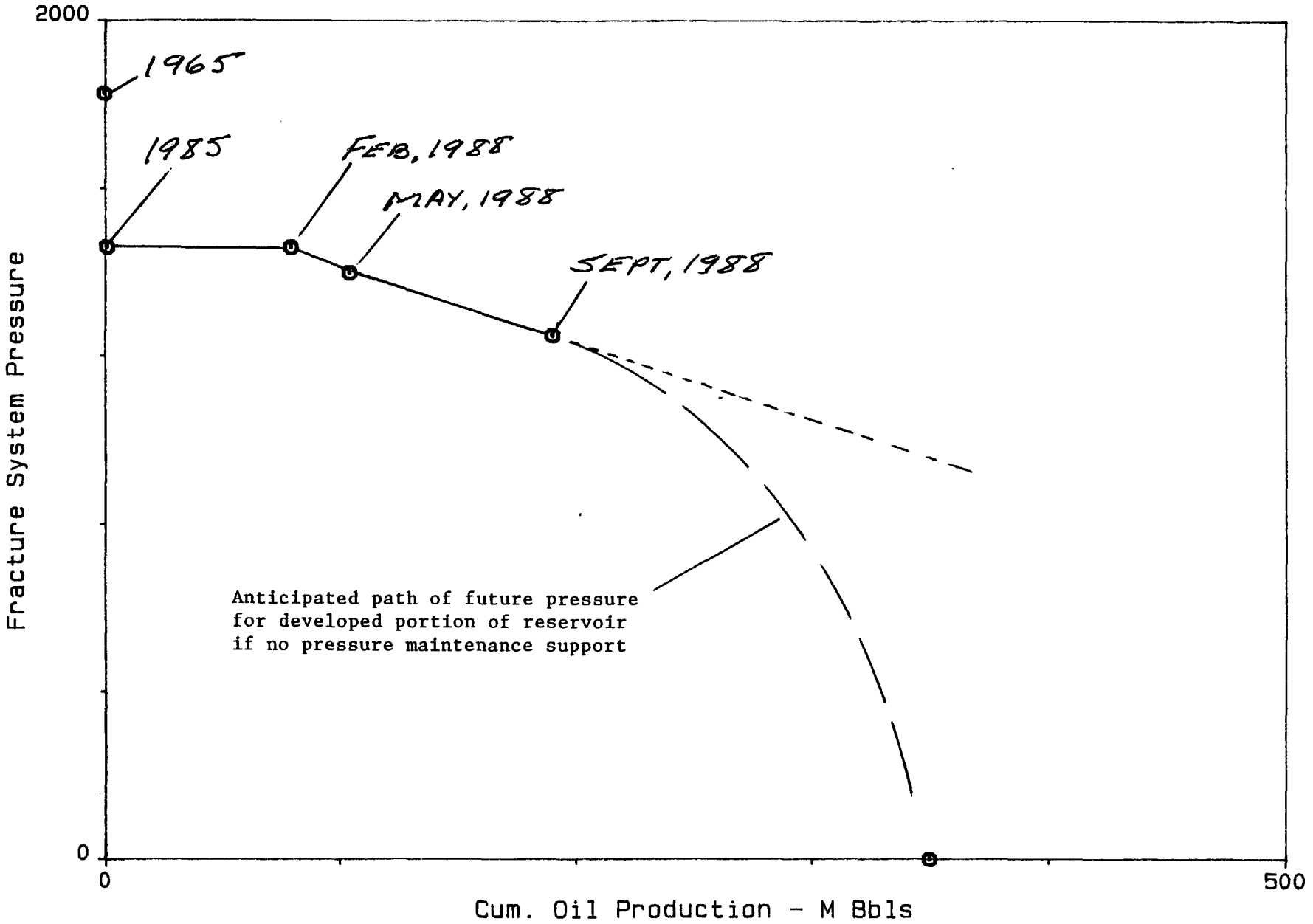
Date	Cumulative Production (Barrels)	Approximate Pressure at +617'
1965	0	1825
1985	1	1460
February 1988	79	1460
May 10, 1988	104	1400
September 10, 1988	190	1250

Part of the analyses are based on the reservoir voidage and pressure decline of the developed area as shown by production and pressures for the period May 10 to September 10, 1988. This production is shown in the table below and the reservoir voidage and pressures for this period are shown on the next two pages.

PRODUCTION MAY 10 TO SEPTEMBER 10, 1988

	Schmitz Ant.		Wishing Well		Laguna Colo.		C.C. State		Total	
	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)	Oil (MBbls)	Gas (MMCF)
May 10-31	1.0	0.0	7.4	3.0	0.0	0.0	0.0	0.0	8.4	3.0
June	2.0	0.0	11.0	6.8	0.0	0.0	0.0	0.0	13.0	6.8
July	1.8	0.0	9.9	10.8	0.0	0.0	14.9	5.0 Est.	26.6	15.8
Aug.	2.1	0.0	9.7	10.8 Est.	0.5	0.7	15.0	5.0	27.3	16.5
Sept. 1-10	0.7	0.0	3.5	4.0	0.1	0.5	5.0	3.5	9.3	8.0
Total	7.6	0.0	41.5	35.4	0.6	1.2	34.9	13.5	84.6	50.1

SOUTHEAST WEST PUERTO CHIQUITO
RESERVOIR PRESSURE VS. CUMULATIVE PRODUCTION
PRESSURE AT +617



ANTICIPATED RECOVERIES OF FUTURE WELLS IN THE DEVELOPED PORTION OF SOUTHEAST WEST PUERTO CHIQUITO

Voidage of developed reservoir May to September 1988:

84.6 M STBbls

50.1 MMCF

Average GOR 600 CF/Bbl measured

Estimated 150 CF/Bbl not measured

Total 750 CF/Bbl

Reservoir Bbls per S.T. Bbl

$B_T = 1.3 + (.750 - .500) \times 2.2 = 1.85$

Total reservoir voidage 84.6 x 1.85 = 157 M Reservoir Bbls

Reservoir pressure decline May to September 150 psi

$$\frac{157 \text{ M Bbl}}{150 \text{ psi}} = 1050 \text{ Reservoir Bbls/\#}$$

Total Reservoir Volume in close communication
(for system compressibilities of 400×10^{-6} and 450×10^{-6})

$V = (\Delta V/\Delta P)/c_t$

$1050/400 \times 10^{-6} = 2600$ M Reservoir Bbls

$c_t = 400 \times 10^{-6}$

and $1050/450 \times 10^{-6} = 2300$ M Reservoir Bbls

$c_t = 450 \times 10^{-6}$

ESTIMATED PRESSURES IN HIGH CAPACITY FRACTURE SYSTEM OF SOUTHEAST WEST PUERTO CHIQUITO

WISHING WELL PRESSURES FOR MAY AND SEPTEMBER 1988: PSIG AT +617' DATUM

	Shut in 24 Hours	Shut in 48 Hours	Modified Muskat P	MDH (constant press. at boundary) for n of	re = 1000	re = 1500	Horner P*
May 1988	1200	1250	1300	1.1×10^5	1298	1351	1457
Sept. 1988	1030	1075	1120	8.2×10^5	1144	1200	1306
Diff: May-Sept	170	175	180		154	151	151

SUMMARY OF SEPTEMBER 1988 PRESSURE SURVEYS: PSIG AT +617' DATUM

	Shut in 24 Hours	Shut in 48 Hours	Modified Muskat P	MDH (constant press. at boundary) for n of	re = 1000	re = 1500	Horner P*
Schmitz Ant.	1195	1222	1260	3.4×10^4	1270	1290	1314
Wishing Well	1030	1075	1120	8.2×10^4	1144	1200	1306
Laguna Colo.	631	734	$\pm$ 1015	1.1×10^4	1189	1348	1222

MDH calculations by use of diffusivity constants as shown in NMOCC Case 3455, November 16, 1966, B-M-G Exhibit 1, Figure 18. MDH = Method of Miller, Dyes and Hutchinson.

Diffusivity constants determined from Horner plots for Kh/u and re of 1000' and 1500', $\pm$ 100 to 200 acre fracture blocks.

Assumed pore volumes of fracture blocks (as distinct from total drainage area pore volumes):

Wishing Well. . . . . 1000 stock tank barrels per acre
Schmitz Anticline . . . . . 700 stock tank barrels per acre
Laguna Colorado . . . . . 400 stock tank barrels per acre

CT: for May. . . . . 350×10^{-6}
for Sept . . . . . 400×10^{-6}

Note: For Laguna Colorado, the actual pressure of its surrounding fracture system would probably be near that of the higher capacity wells or about 1250#. Since the pressure for re = 1500' is greater than that, it means that the fracture block minimum distance from the well is probably less than 1500'.

NOTES ON OIL VOLUMES, AREAS AND FUTURE RECOVERIES OF THE DEVELOPED (CLOSE COMMUNICATION) AREA OF SOUTHEAST WEST PUERTO CHIQUITO

Set out in the table below are the areas of the developed part of Southeast West Puerto Chiquito as dependent on reservoir pore space expressed in terms of stock tank barrels per acre.

In the second table are reservoir drainage radii and areas which will reach steady state conditions in 120 days, also shown to be dependent on pore space. These values are based on diffusivity constants resulting from a value of Kh/u of 1 darcy foot (determined for Wishing Well's tight block in May 1988, and also in September 1988), along with an approximate system compressibility of 450 x 10^{-6}.

The reservoir area associated with a reservoir volume of 2500 M stock tank barrels will be as shown below for the given values of per acre oil in place.

Stock Tank Barrels per acre	Total Area (Acres)
2000	1250
1500	1667
1000	2500
750	3330
500	5000

Distance reached for steady state (or pseudo steady state) condition in 120 days for Kh/u = 1 darcy foot (total mobility):

$$\text{Diffusivity constant, } n, = \frac{6.328\ (Kh/u)_T}{\phi h\ c_t}$$

$$= \frac{6.328 \times 1}{450 \times 10^{-6} \times \phi h} = \frac{1.4 \times 10^4}{\phi h}$$

$$r = \sqrt{4\ n\ t} = \sqrt{480\ n}$$

S.T. BOPA	ϕh	n	$r = \sqrt{480\ n}$ (feet)	Circular Area $= \frac{r^2}{43{,}560}$ (acres)
2000	.335	4.18×10^4	4500	1450
1500	.25	5.6×10^4	5200	1900
1000	.168	8.37×10^4	6300	2900
750	.126	1.11×10^5	7300	3800
500	.084	1.67×10^5	9000	5800

The above statistics are shown graphically along with interpretations on the next pages.

SOUTHEAST WEST PUERTO CHIQUITO
COMPARISON OF AREA OF RESERVOIR IN CLOSE COMMUNICATION WITH EQUIVALENT AREA OF 100-DAY PRESSURE STABILIZATION

The lower curve on the graph on the facing page shows the reservoir area of a reservoir with a volume of 2500 M stock tank barrels as dependent on per acre pore volume.

The next curve shows the area in which steady state (or pseudo steady state) conditions are reached by a single well producing for a reservoir with diffusivity constant consistent with a transmissibility of Kh/u = 1 darcy foot and the same per acre pore volume as the lower curve.

The upper curve is the same as the second except that it is based on Kh/u of 3 darcy feet.

If the reservoir diffusivity constant is about like that of the second curve, then it would be possible for there to exist adjoining undeveloped reservoir areas with the same characteristics as that found in the developed portion. However, if the reservoir diffusivity constant is significantly greater than that given by the second curve as, for example, the upper curve, then it is to be expected that adjoining area(s) will have considerably lower values of transmissibility (and production).

Since it does appear* that there exists a fracture system of transmissibility higher than exists for the Wishing Well tight block,
we must conclude that future wells drilled nearby that show the depleted pressure will not establish new reserves, but will share in those remaining, as indicated on the preceding plot of pressure versus production.

It follows then that new nearby wells that show higher pressures will probably have lower transmissibilities unless they encounter a separate reservoir.

Taken altogether future wells will not drain areas (tens of thousands of acres) as do the wells in the main West Puerto Chiquito pool and as did the early wells in Gavilan and cannot realize large ultimate recoveries.

Rather, they will be limited to their own tracts for support - meaning recoveries of 100 to a maximum of 150 barrels per acre - or average of 60,000 to 90,000 barrels per well if the 640 acre spacing is maintained.

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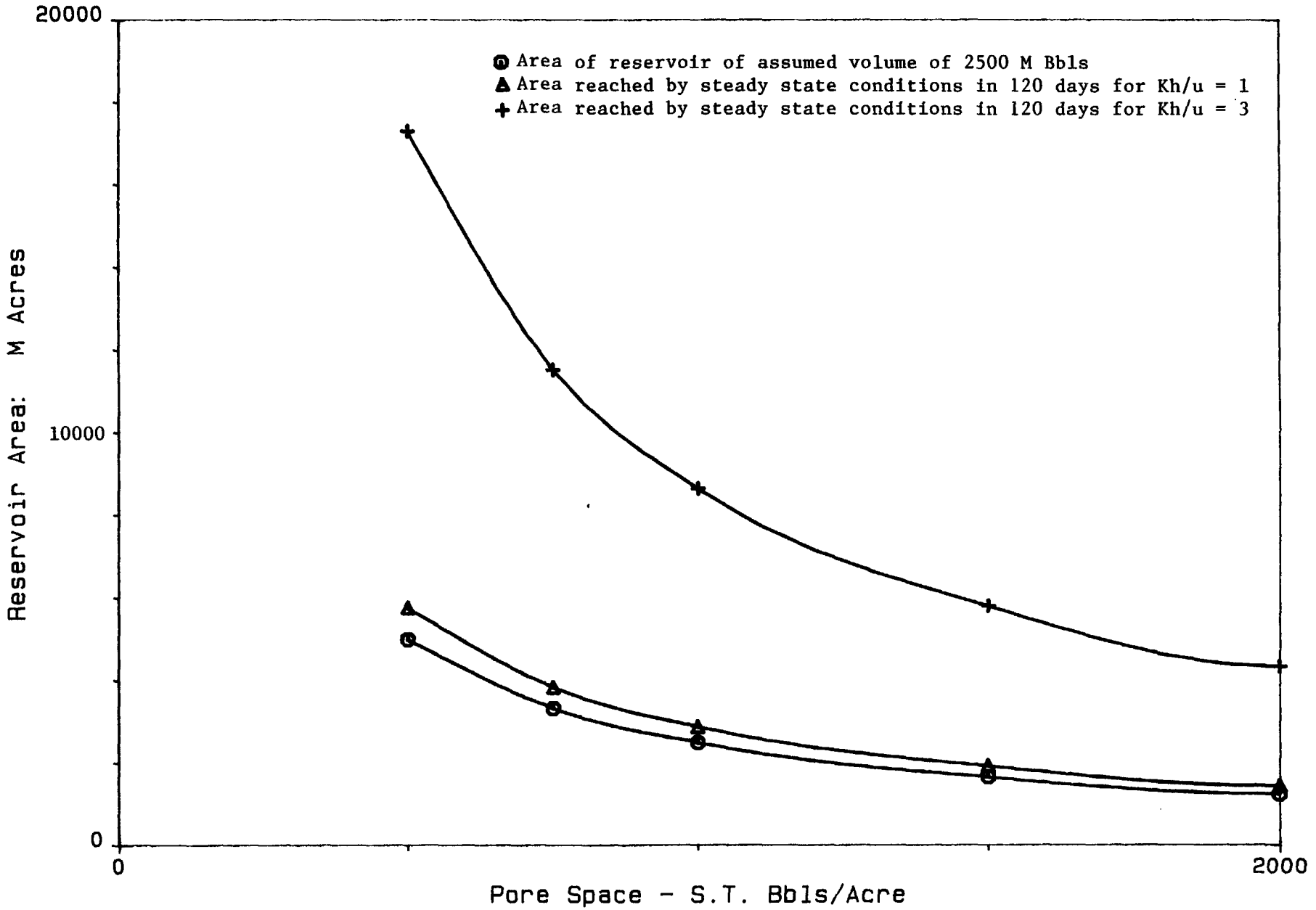
* Indications:
1. Equalized pressures.
2. Two slopes, Schmitz Anticline bottom hole pressure build-up survey.
3. Immediate interference Wishing Well and C.C. State: Reference Transcript in NMOCC Case 9451, Page 152, cross-examination of Amoco's witness Richard Jones by W. Thomas Kellahin.
4. P* pressure of Laguna Colorado nearly same as high capacity fracture system.

SOUTHEAST WEST PUERTO CHIQUITO
COMPARISON OF AREA OF RESERVOIR IN CLOSE COMMUNICATION WITH
EQUIVALENT AREA OF 100-DAY PRESSURE STABILIZATION



MANCOS FORMATION ECONOMICS
EAST SIDE SAN JUAN BASIN
FOR OIL RECOVERY OF 100 BARRELS PER ACRE

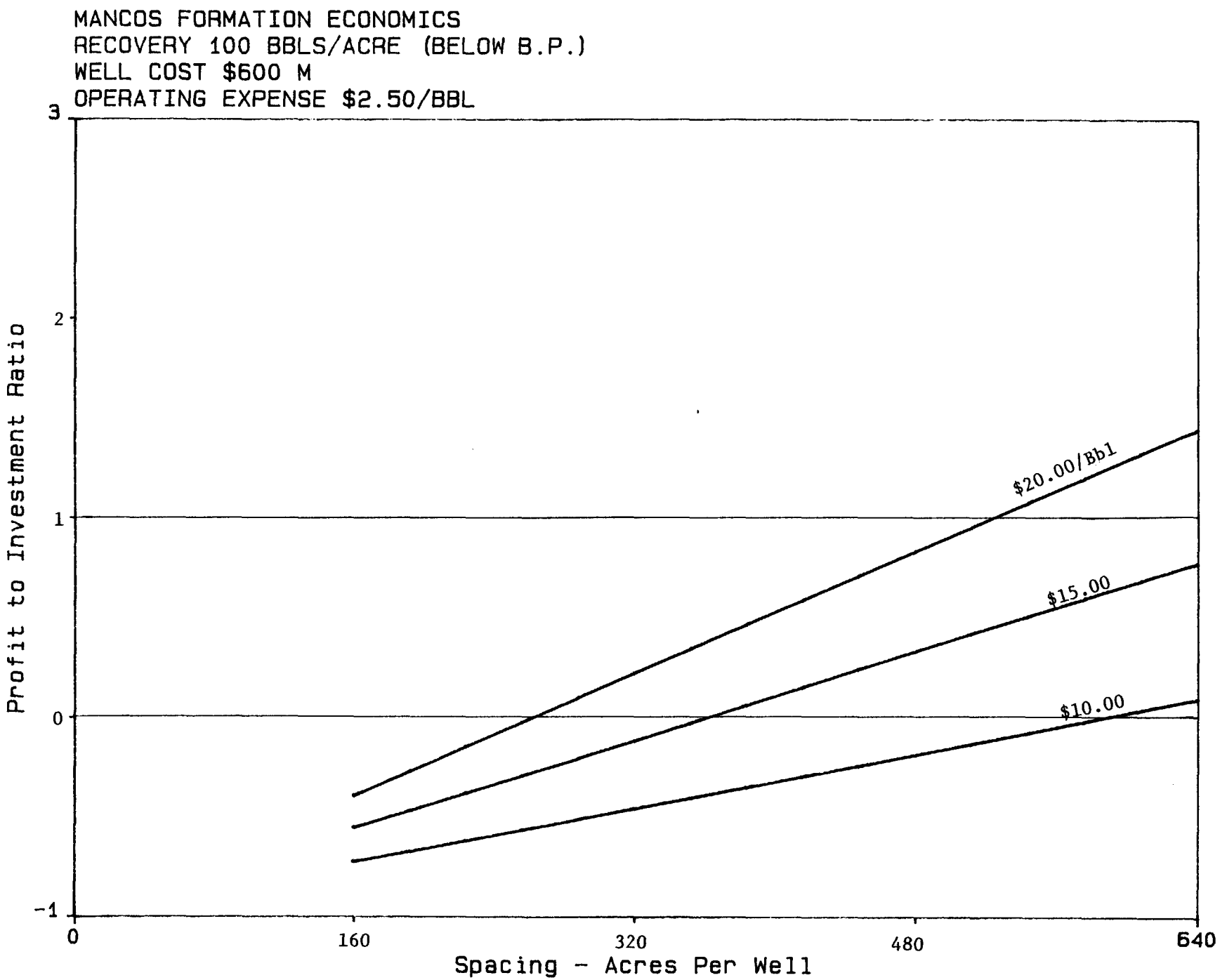
OIL NET VALUE

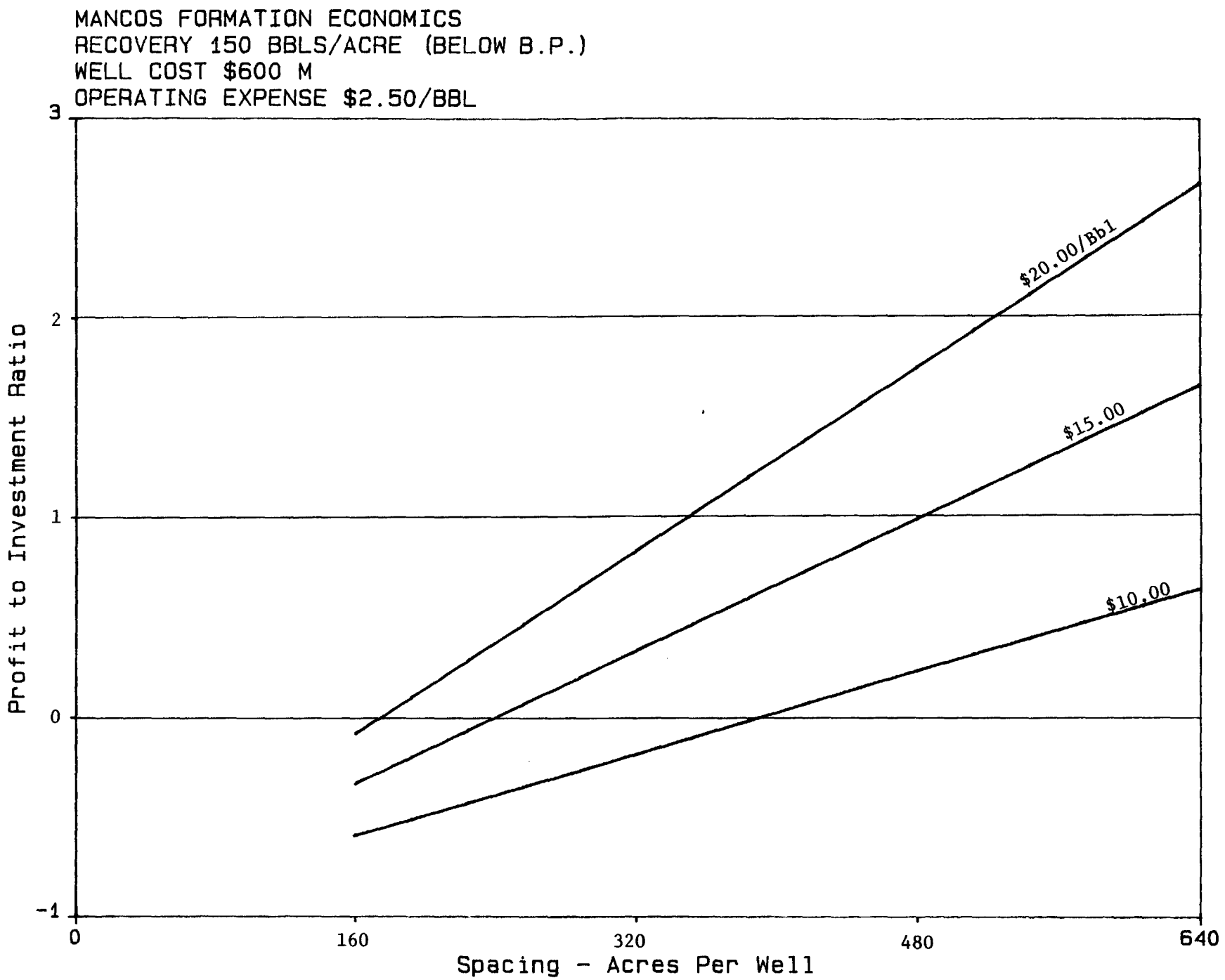
Oil ($/Bbl)	10.00	15.00	20.00
Gas ($/MCF) (± 1/8 of $/bbl)	1.25	1.90	2.50
Gas ($/Bbl) (At 5.6 MCF/Bbl)	7.00	10.60	14.00
Total Gross of Gas and Oil ($/Bbl)	17.00	25.60	34.00
Net After Lease Burdens and Taxes (75%)	12.80	19.20	25.50
After Operating Expense ($2.50/Bbl)	10.30	16.70	23.00
Spacing (Acres/Well)	160	320	640
Ultimate Recovery (M Bbls)	16	32	64
AT $10.00 OIL			
Net Value ($M)	165	330	660
Profit at $600 M Well Cost	(-435)	(-270)	+69
Profit/Investment Ratio (Undiscounted)	(-.725)	(-.45)	+.10
AT $15.00 OIL			
Net Value ($M)	267	534	1070
Profit at $600 M Well Cost	(-333)	-66	470
Profit/Investment Ratio (Undiscounted)	(-.55)	(-.11)	+.78
AT $20.00 OIL			
Net Value ($M)	368	736	1472
Profit at $600 M Well Cost	(-232)	136	872
Profit/Investment Ratio (Undiscounted)	(-.39)	+.23	+1.45

MANCOS FORMATION ECONOMICS
EAST SIDE SAN JUAN BASIN
FOR OIL RECOVERY OF 150 BARRELS PER ACRE

OIL NET VALUE

Oil ($/Bbl) (± 1/8 of $/bbl)	10.00	15.00	20.00
Gas ($/MCF)	1.25	1.90	2.50
Gas ($/Bbl) (At 5.6 MCF/Bbl)	7.00	10.60	14.00
Total Gross of Gas and Oil ($/Bbl)	17.00	25.60	34.00
Net After Lease Burdens and Taxes (75%)	12.80	19.20	25.50
After Operating Expense ($2.50/Bbl)	10.30	16.70	23.00
Spacing (Acres/Well)	160	320	640
Ultimate Recovery (M Bbls)	24	48	96
AT $10.00 OIL			
Net Value ($M)	247	494	989
Profit at $600 M Well Cost	(-353)	(-106)	+389
Profit/Investment Ratio (Undiscounted)	(-.59)	(-.18)	+.65
AT $15.00 OIL			
Net Value ($M)	401	802	1603
Profit at $600 M Well Cost	(-199)	202	1003
Profit/Investment Ratio (Undiscounted)	(-.33)	+.34	+1.67
AT $20.00 OIL			
Net Value ($M)	552	1104	2208
Profit at $600 M Well Cost	(-48)	504	1608
Profit/Investment Ratio (Undiscounted)	(-.08)	+.84	+2.68


MANCOS FORMATION ECONOMICS
RECOVERY 100 BBLS/ACRE (BELOW B.P.)
WELL COST $600 M
OPERATING EXPENSE $2.50/BBL
Profit to Investment Ratio
3
2
1
0
-1
0
160
320
480
640
Spacing - Acres Per Well
$20.00/Bbl
$15.00
$10.00


MANCOS FORMATION ECONOMICS
RECOVERY 150 BBLS/ACRE (BELOW B.P.)
WELL COST $600 M
OPERATING EXPENSE $2.50/BBL
Profit to Investment Ratio
3
2
1
0
-1
$20.00/Bbl
$15.00
$10.00
0
160
320
480
640
Spacing - Acres Per Well

WELL ELEVATIONS AND FORMATIONS
WELLS IN SOUTHEAST WEST PUERTO CHIQUITO

Well	Location	Elevation	A Zone		B Zone		C Zone	
			Depth	Datum	Depth	Datum	Depth	Datum
Wishing Well 35-7	35-24N-1W	7267' KB	6359'	908	6438'	829	6566'	701
State Com C.C.	26-24N-1W	7304' KB	6445'	859	6533'	771	6670'	634
Laguna Colorado 2-6	2-23N-1W	7240' KB	6456'	784	6550'	690	6680'	560
Schmitz Anticline Fed. #1	25-24N-1W	7274' KB	6253'	1020	6310'	964	6444'	830
Canada Ojitos Unit A-14	14-24N-1W	7109' KB	6206'	903	6257'	852	6390'	719

WEST PUERTO CHIQUITO MANCOS POOL. RIO ARRIBA COUNTY, NM
NASSAU RESOURCES, INC., WISHING WELL 35-7. (NE 35-24N-1W)

			OIL				GAS			GOR	WATER		
YR	MO	DAYS PRODUCED	BOPM	BOPPD	BOPCD	CUM MBO	MCF/M	MCF/D	CUM MMCF	SCF/BBL	Month	BWPD	CUM MBW
1988	1	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	2	NR	721.0	ERR	24.9	0.7	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	3	14.0	4513.0	322.4	145.6	5.2	5726.0	409.0	5.7	1268.8	378.0	27.0	0.4
1988	4	20.0	5855.0	292.8	195.2	11.1	3827.0	191.4	9.6	653.6	15.0	0.8	0.4
1988	5	25.0	12281.0	491.2	396.2	23.4	4725.0	189.0	14.3	384.7	5.0	0.2	0.4
1988	6	22.0	11034.0	501.5	367.8	34.4	6832.0	310.5	21.1	619.2	5.0	0.2	0.4
1988	7	23.0	9851.0	428.3	317.8	44.3	10786.0	469.0	31.9	1094.9	10.0	0.4	0.4
1988	8	26.0	9736.0	374.5	314.1	54.0	7422.0	285.5	39.3	762.3	10.0	0.4	0.4
1988	9	29.0	8232.0	283.9	274.4	62.2	15658.0	539.9	55.0	1902.1	10.0	0.3	0.4
Subtotal		159.0	62223.0	391.3	255.0		54976.0				433.0		

* BOPPD: BARRELS PER PRODUCING DAY. * BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
AMOCO PRODUCTION COMPANY, STATE COM CC. (SE 26-24N-1W)

			OIL				GAS			GOR	WATER		
YR	MO	DAYS PRODUCED	BOPM	BOPPD	BOPCD	CUM MBO	MCF/M	MCF/D	CUM MMCF	SCF/BBL	Month	BWPD	CUM MBW
1988	1	NR	458.0	ERR	14.8	0.5	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	2	NR	1822.0	ERR	62.8	2.3	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	3	NR	8872.0	ERR	286.2	11.2	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	4	NR	100.0	ERR	3.3	11.3	NR	ERR	0.0	0.0	NR	ERR	0.0
1988	5	NR	0.0	ERR	0.0	11.3	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	6	NR	0.0	ERR	0.0	11.3	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	7	NR	14873.0	ERR	479.8	26.1	563.0	ERR	0.6	37.9	0.0	ERR	0.0
1988	8	31.0	15022.0	484.6	484.6	41.1	4981.0	160.7	5.5	331.6	3.0	0.1	0.0
1988	9	NR	9033.0	ERR	301.1	50.2	6368.0	ERR	11.9	705.0	4.0	ERR	0.0
Subtotal		31.0	50180.0	1618.7	205.7		11912.0				7.0		

* BOPPD: BARRELS PER PRODUCING DAY. * BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
NASSAU RESOURCES, INC., LAGUNA COLORADO 2-6. (NW 2-23N-1W)

			OIL				GAS			GOR	WATER		
YR	MO	DAYS PRODUCED	BOPM	BOPPD	BOPCD	CUM MBO	MCF/M	MCF/D	CUM MMCF	SCF/BBL	Month	BWPD	CUM MBW
1988	1	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	2	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	3	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	4	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	5	0.0	0.0	ERR	0.0	0.0	0.0	ERR	0.0	ERR	0.0	ERR	0.0
1988	6	12.0	726.0	60.5	23.4	0.7	780.0	65.0	0.8	1074.4	0.0	0.0	0.0
1988	7	0.0	0.0	ERR	0.0	0.7	0.0	ERR	0.8	ERR	0.0	ERR	0.0
1988	8	27.0	484.0	17.9	16.1	1.2	731.0	27.1	1.5	1510.3	20.0	0.7	0.0
1988	9	22.0	264.0	12.0	8.5	1.5	1295.0	58.9	2.8	4905.3	5.0	0.2	0.0
Subtotal		61.0	1474.0	24.2	6.0		2806.0				25.0		

* BOPPD: BARRELS PER PRODUCING DAY. * BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
AMOCO PRODUCTION COMPANY, SCHMITZ ANTICLINE FED. #1. (SE 25-24N-1W)

		OIL			GAS	WATER	
YR	MO	BOPM	BOPCD	CUM MBO	MCF/M	Month	CUM MBW
1985	1	0.0	0.0	0.0	NR	0.0	0.0
1985	2	0.0	0.0	0.0	NR	0.0	0.0
1985	3	0.0	0.0	0.0	NR	0.0	0.0
1985	4	0.0	0.0	0.0	NR	5.0	0.0
1985	5	0.0	0.0	0.0	NR	0.0	0.0
1985	6	164.0	5.5	0.2	NR	0.0	0.0
1985	7	690.0	22.3	0.9	NR	0.0	0.0
1985	8	0.0	0.0	0.9	NR	0.0	0.0
1985	9	0.0	0.0	0.9	NR	0.0	0.0
1985	10	2329.0	75.1	3.2	NR	150.0	0.2
1985	11	2097.0	69.9	5.3	NR	0.0	0.2
1985	12	2340.0	75.5	7.6	NR	0.0	0.2
Subtotal		7620.0	20.8		0.0	155.0	
1986	1	2605.0	84.0	10.2	NR	52.0	0.2
1986	2	2174.0	75.0	12.4	NR	47.0	0.3
1986	3	2571.0	82.9	15.0	NR	60.0	0.3
1986	4	2361.0	78.7	17.3	NR	50.0	0.4
1986	5	2665.0	86.0	20.0	NR	50.0	0.4
1986	6	2428.0	80.9	22.4	NR	50.0	0.5
1986	7	2698.0	87.0	25.1	NR	0.0	0.5
1986	8	2715.0	87.6	27.8	NR	40.0	0.5
1986	9	2522.0	84.1	30.4	NR	40.0	0.5
1986	10	2554.0	82.4	32.9	NR	20.0	0.6
1986	11	2317.0	77.2	35.2	NR	0.0	0.6
1986	12	2516.0	81.2	37.7	NR	0.0	0.6
Subtotal		30126.0	82.3		0.0	409.0	

* BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.

WEST PUERTO CHIQUITO MANCOS POOL, RIO ARRIBA COUNTY, NM
AMOCO PRODUCTION COMPANY, SCHMITZ ANTICLINE FED. #1. (SE 25-24N-1W)

		OIL			GAS	WATER	
YR	MO	BOPM	BOPCD	CUM MBO	MCF/M	Month	CUM MBW
1987	1	2346.0	75.7	40.1	NR	0.0	0.6
1987	2	2205.0	76.0	42.3	NR	0.0	0.6
1987	3	2640.0	85.2	44.9	NR	40.0	0.6
1987	4	2638.0	87.9	47.6	NR	20.0	0.6
1987	5	2708.0	87.4	50.3	NR	15.0	0.6
1987	6	2603.0	86.8	52.9	NR	125.0	0.8
1987	7	2694.0	86.9	55.6	NR	80.0	0.8
1987	8	2350.0	75.8	57.9	NR	40.0	0.9
1987	9	2743.0	91.4	60.7	NR	0.0	0.9
1987	10	2300.0	74.2	63.0	NR	70.0	1.0
1987	11	2314.0	77.1	65.3	NR	10.0	1.0
1987	12	1716.0	55.4	67.0	NR	70.0	1.0
Subtotal		29257.0	79.9		0.0	470.0	
1988	1	2573.0	83.0	69.6	NR	12.0	1.0
1988	2	2240.0	77.2	71.8	NR	80.0	1.1
1988	3	1895.0	61.1	73.7	NR	50.0	1.2
1988	4	2248.0	74.9	76.0	NR	75.0	1.3
1988	5	2182.0	70.4	78.1	NR	65.0	1.3
1988	6	2030.0	67.7	80.2	NR	1.0	1.3
1988	7	1784.0	57.5	82.0	NR	5.0	1.3
1988	8	2083.0	67.2	84.0	NR	4.0	1.3
1988	9	1029.0	34.3	85.1	NR	9.0	1.3
Subtotal		18064.0	74.0		0.0	301.0	

* BOPCD: BARRELS PER CALENDAR DAY. * NR: NOT REPORTED.