Chesapeake ENERGY

# WATERFLOOD FEASIBILITY STUDY FOR THE PROPOSED QUAIL QUEEN UNIT (QQU)

LEA COUNTY,

NEW MEXICO

CHESAPEAKE ENERGY CORPORATION

AUGUST, 2007

**WATERFLOOD FEASIBILITY STUDY FOR THE QUAIL QUEEN UNIT (QQU) PROJECT**

## TABLE OF CONTENTS

# Quail Queen Waterflood Feasibility Study
# List of Attachments/Appendices

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# List of Attachments/Appendices

| Description | Attachment No. | Appendix |
|---|---|---|

# EXECUTIVE SUMMARY

## QUAIL QUEEN UNIT (QQU)
## PROPOSED WATERFLOOD

I. Purpose

Determine the feasibility of unitizing and implementing secondary recovery operations in the Queen sandstone in the Quail Field in Lea County, New Mexico.

II. Description

Location ........................................................................Lea Co., NM
Producing Formation ......................................................Queen
Number of Wells..............................................................12 Active, 3 TA, 5 P&A,1 DH
Daily Production (average over three mos.) .........................23 BO, 0 MCF, 56 BW
Reservoir Parameters
    Depth, average ...................................................5,100'
    Productive Area ..................................................1,150 acres
    Unitized Area......................................................840 acres
    Reservoir Temperature.........................................113°F
    Initial Reservoir Pressure ......................................1,848 Psi
    Bubble Point Pressure ..........................................1255 Psi
    Current Reservoir Pressure ....................................450 Psi
    Oil Gravity ..........................................................33°API
    Gas Gravity ..........................................................0.9
    Initial Solution GOR, est........................................300 Scf/Bbl

III. Recovery and Reserves

Original Oil In Place ........................................................4,467 Mbo
Cumulative Primary Recovery 7/1/2007 ..............................788 Mbo
Cumulative Secondary Recovery, estimated to 7/1/2007......11.4 Mbo
Remaining Developed Primary............................................78.7 Mbo
Proved Behind Pipe............................................................0 Mbo
Ultimate Primary................................................................867 Mbo
Ultimate Primary Recovery Efficiency.................................19 %
Percent of Primary Recovered to 7/1/2007...........................91%
Secondary Reserves ..........................................................725 Mbo
Estimate of Total Recovery ...............................................1,592 Mbo
Estimate of Total Recovery Efficiency................................36 %

IV. Capital Requirements

<u>Initial Phase (Phase I) Capital Requirement</u>:

*Convert six wells to injection ($100k, each)* ....................... $ 600,000
Re-Enter and Restore Csg Integrity, Quail State SWD 1 .... $ 125,000
Injection Lines 10,030 feet x $12/ft.................................... $ 120,360

| | |
|---|---|
| Water Supply, Hornet St 1 Workover/Pipeline | $ 250,000 |
| Battery Upgrades/Centralization | $ 500,000 |
| Injection Facility | $ 500,000 |
| **Sub-Total** | **$ 2,095,360** |

<u>Second Phase (Phase II) Capital Requirement</u>:

| | |
|---|---|
| Drill 1 Injector ($1MM) & One Producer($1.2MM) | $ 2,200,000 |
| Re-Enter Mobil 1 as injection well | $ 200,000 |
| Battery Upgrades/Centralization | $ 500,000 |
| **Sub Total** | **$ 2,900,000** |
| **Grand Total** | **$ 4,995,360** |

## INTRODUCTION

The purpose of this engineering and geological study is to determine the feasibility of conducting secondary recovery waterflood operations in the Queen sand in the Quail Field; and whether these waterflood operations can recover additional reserves in sufficient quantities to be economically successful.

The Quail Field is located approximately 25 miles southwest of Hobbs, New Mexico in Lea County as shown in Attachment No. 1. The field was discovered in 1967 by Atlantic Richfield's State BG Well No. 1. After drilling to a total depth of 10,350' and finding the targeted Bone Springs non-commercial, the well was plugged back to the Queen, at 5,126'-5,336', and a completion was made in May, 1967.

The Queen sands that are continuous throughout the field and the most consistently productive have been sub-divided into two distinct zones, B and C. These two Queen sands will be the focus of this study. The "C" sand has the most prolific pore volume and areal extent of the two intervals. Several wells were cored with a maximum permeability range of 20-40 md and maximum porosity range of 20-23%. Logs from eighteen of the twenty wells were analyzed by NuTech Energy Alliance. PVT data was determined based on petroleum engineering correlations and not actual reservoir samples due to the lack of early time fluid samples and the existing advanced state of reservoir depletion. The reservoir is solution gas drive based on production performance. The estimated original reservoir pressure was 1,848 psi and engineering correlations indicate a bubble point pressure of 1,255 psi. Estimated current reservoir pressure is between 400 and 500 psi based on recent testing in Atlantic Richfield No. 1 during 2006.

The proposed 840 acre unit is made up of 9 tracts in Sections 11, 13 and 14 in Township 19 South and Range 34 East. Participation in the unit by working interest and royalty owners is determined by prorating each tract's contribution to the unit in four categories including: useable wellbores, average rate of production, ultimate primary recovery and reservoir pore volume.

There are twelve current producers, three temporarily abandoned wells and three plugged and abandoned wells in the field. The field has been developed on forty acre spacing. Current production is 23 Bopd, 0 Mcfpd and 56 Bwpd. Cumulative production from the Queen is 799,248 BO, 524,385 MCF and 1,590,829 BW. Remaining primary PDP reserves are 78.7 MSTBO. Current watercut is 70 percent.

Information upon which this study and the estimates are based was obtained from Chesapeake, third parties and public records and is assumed to be correct. The study was conducted utilizing methods and procedures regularly used by petroleum engineers to estimate oil and gas reserves for properties of this type and character. However, future performance is dependent on many variables and often unpredictable factors. For this reason, Chesapeake cannot be held liable for the accuracy or completeness of these estimates.

## FIELD DEVELOPMENT

After the discovery by Atlantic Richfield's State BG No. 1 in 1967, development continued for several years with the drilling of five additional wells but during the early and mid-seventies development drilling stalled. With the rising oil prices in the late seventies there was a resurgence of drilling when the well count peaked at 15 wells by the early eighties. Since then, primary depletion occurred up until 1997 when disposal of the fields produced water began in the Queen sand that was opened in the Quail State SWD No. 1. The total disposal volume for the field increased to approximately 100 bwpd by the year 2000 and continued at this rate through 2003. Oil response was observed in several of the offsets to the SWD during 2000-2003. The disposal was decreased and sporadic from 2004 until 2005 when casing problems occurred and the disposal well was temporarily abandoned. The current field map is included as Attachment No. 2 with well names and locations. Oil production is currently 23 bopd from twelve wells declining at an exponential yearly rate of approximately 5 percent. The field production plot as well as the individual well production plots, are included in Appendix A.

## GENERAL GEOLOGY

The Quail Queen Field, covering approximately 800 acres, is situated locally in western central Lea County, New Mexico and regionally near the Northwest Shelf shelf margin of the Delaware Basin. The field consists of several thin north-northwest to south-southeast trending sandstones that pinch out to the east and west. The Queen Formation is Middle Guadalupian (Permian) in age overlain by the Seven Rivers and underlain by the Grayburg, both of which produce on the Northwest Shelf. During Guadalupian time, the Northwest Shelf was dominated by mixed shallow-water carbonate and siliciclastic sedimentation on a broad low-relief ramp.

## DETAILED GEOLOGY

The Queen Formation was deposited on the Northwest Shelf in a backreef, shallow, evaporitic, marginal marine environment behind the Goat Seep shelf-edge complex. In general these deposits are composed of interfingering siliciclastics, carbonates, and evaporates (sandstone, dolomite, sandy and anhydritic dolomite, and shale). The Queen pay is described as a medium to fine-grained, subangular to subrounded friable sandstone with slight dolomite cement, silt, and occasional large round frosted quartz grains. Queen pay can get up to 10 feet thick with porosities ranging from 8-22%.

## PRIMARY PERFORMANCE AND RESERVES

The current state of primary depletion is approximately 91 percent in this field and the average well produces a little less than 2 BOPD. The remaining primary reserves of approximately 79 MBO will predominantly come from three wells, the Quail State 2, State BG 2 and 3. The remaining nine active producers are at or near their ultimate primary performance capacity. Unless it is determined to waterflood this field soon, then the economic viability of this field will end. Attachment No. 3 is a structure map with the ultimate oil and gas recoveries along with the cumulative water production posted for each well. Ultimate recoveries were determined by decline curve analysis on each producing well. Production is more controlled by stratigraphy than structure as illustrated by the structure map. The structure dips from north to south at a rate of approximately 100 feet per mile. The best ultimate well in the field, the Atlantic Richfield No. 1 is one of the lowest structurally but is near the thickest part of the Queen sand. The average ultimate oil produced per well is approximately 44 MBO.

As mentioned earlier, the Queen sand has been subdivided into the Queen B and Queen C sands which are consistently present throughout the proposed unit area. Attachment 4 is a cross section with every well log in the field showing the Queen B & C which is the targeted common source of supply. This cross section also contains the perforated intervals for each well. Net isopach maps with over 14 percent density porosity over the Queen B and Queen C are included as Attachments 5 and 6. These maps were used to calculate the reservoir pore volume. Also shown is the proposed waterflood unit boundary. Average porosity and water saturations for the Queen B and Queen C were determined based on the Nu-Tech log analysis. Cross plots of porosity versus water saturation are included as Attachment Nos. 7 and 8. Volumetric original oil in place (OOIP) for the Queen B and Queen C sands has been calculated and is included in Appendix B. The OOIP for the Queen B is 988,800 STB and for the Queen C is 3,478,673 STB. The combined OOIP is 4,467,473 STB. Seventy-eight percent of the OOIP is in the Queen C sand.

Based on an investigation of all the pertinent data including well files, well logs and well histories, all of the current wells in the field have been perforated and adequately stimulated in the Queen B and Queen C sand intervals. Hence there are no remaining behind pipe or non-producing reserves in this field in the targeted waterflood sand intervals. The remaining secondary reserve potential and how best to recover it will be the focus as the study continues.

## SECONDARY RESERVE ANALYSIS

Based on the historical performance, the Quail Queen Field is a solution gas drive reservoir. Primary recovery will be approximately 19 percent of the OOIP leaving 81 percent of the OOIP in play. The approach to water flood recovery potential in the Quail Queen Field includes the analysis of an actual case example, within the field, of sustained low volume disposal of produced water into the producing Queen zones of interest in the Quail State SWD #1. Also a nearby Queen waterflood analogy, the West Pearl Queen Unit, that was unitized and flooded beginning in 1964 will be evaluated. And lastly, a calculation of secondary performance utilizing generic relative permeability data, since this type core data is not available from any of the field wells, will be examined.

The Queen has been successfully flooded for years in the Permian Basin and, as mentioned, there is a nearby analogy in the West Pearl Queen Unit approximately 2.5 to 3 miles to the southeast. In addition, the floodability of the Queen in the Quail field was demonstrated during the late nineties and early 2000's, when the Quail State No. 1 was converted to salt water disposal in the field's producing interval. Approximately 207,000 barrels of produced water, according to IHS records, was disposed of from 1997 to 2004 and oil increases as well as drastic GOR decreases were observed in several of the offset producing wells. Attachment No. 9 is a montage of the production plots for the four producers in the proposed eighty acre five spot pattern in this area. The field production curve as well as the individual plots on the State BG 3, Quail State 2, 3Y, 4 and 6 in Appendix B show clear evidence of moderate secondary response during the time of disposal into Quail State SWD #1. Approximately 22 percent, of the reservoir pore volume for this eighty acre five-spot pattern was injected into the center SWD well over a seven year period. During this time it is estimated that approximately 11,400 barrels of secondary oil was produced from five offset wells. The resulting positive response in five of the six direct producing offsets is an encouraging result that provides strong support to the waterflood program planned for this area. A waterflood analysis of the eighty acre five-spot pattern centered around the Quail State SWD #1 is included as Attachment No. 10. The disposal of produced water in the Quail State SWD #1 and subsequent results provide, in effect, a successful eighty acre five spot waterflood pilot for the field. Hence, there is a strong case for the secondary waterflood reserves developed for the proposed Quail Queen Unit (QQU) as being proven undeveloped when the unit order is received from the NMOCD.

The West Pearl Queen Unit (WPQU) was unitized in the summer of 1964. The proposed unitized interval in Quail Queen is correlative to the unitized interval in the WPQU and the reservoir parameters are similar. However, the upper part of the Queen is productive in West Pearl whereas it is wet or tight in the Quail area. The WPQU is located approximately 3 miles to the southeast of the Quail Field as shown in Attachment No. 11. It is approximately three times the size, at 2,520 acres, of the proposed Quail Queen Unit. The ultimate primary recovery in the WPQU was 2,686,000 STB which was 80 percent depleted upon unitization. In the 49 years since discovery, the WPQU has produced over 5 million barrels of oil. The secondary to primary (S:P) ratio is 0.88. The WPQU was developed on 40 acre spacing and the waterflood pattern for the WPQU was eighty acre five-spots which is also the proposed pattern for the QQU. If the QQU has a similar S:P ratio as the WPQU then the secondary reserves will be 763 MBO. Attachment No. 12 is a comparison of the proposed QQU to the analogous WPQU.

The last method used to estimate secondary recovery in the QQU is to calculate the recovery based on relative permeability data compiled by the 1984 National Petroleum Council. There is not any relative permeability data obtained from any of the core retrieved in the Quail Field area. Therefore it is necessary to use the default relative permeability relationships and parameters similar to those presented by Molina on page 2-23 to 2-24 of Smith & Cobb's "Waterflooding" text. These default relationships and parameters are based on the 1984 National Petroleum Council's Technical Committee recommendations. The waterflood calculations are presented in detail in Appendix No. C. The relative permeability curve, Attachment No. 13, was used to create the fractional flow curve which is shown in Attachment No. 14.

The volumetric sweep efficiency is a function of the mobility ratio and the permeability variation. The mobility ratio is 0.57 which is very favorable. The permeability variation, based on several of the cores taken in the Quail Field, is 0.828 and its calculation is shown in Attachment No. 15. The mobility ratio and permeability variation indicates a secondary recovery of 15.6 percent. The waterflood recovery is estimated to be 697,156 STB yielding a S:P ratio of 0.805 which is in reasonable agreement to the analogous WPQU S:P ratio of 0.88.

The injection rate per well, based on analogy, will be 200 – 300 BPD with initial injection pressures in the 1,500 to 2,000 psi range. As fillup is approached the injection pressures will increase so the injection system should be designed for 3,000 psi. Fillup volume is 1,423,862 BBLS with a current gas saturation of 14%. If an average injection rate of 200 BPD per injection well can be maintained then fillup will occur in less than three years.

## UNIT PARTICIPATION

Attachment No. 16 is a tract map with the proposed 840 acre unit area shown. Noticeably missing from the proposed unit area is the 120 acre tract in the southeast quarter of Section 14. This 120 acre tract is a Federal tract that is unleased and cannot be nominated due to an ongoing sand dune lizard study scheduled for completion by 2009. Once this study is completed and if the results allow for the leasing of this tract, Chesapeake will make every effort to include this tract in the unit. Section 4 in the Unit Agreement stipulates the method for expansion of the unit and any future expansion of this unit will follow these guidelines.

There are nine tracts included in the unit with 100 percent of the minerals owned by the state of New Mexico. Participation in the unit by working interest and royalty owners is determined by prorating each tract's contribution to the unit in four categories including: useable wellbores, average rate of production, ultimate primary recovery and reservoir pore volume. The proposed weight factor for each category is as follows:

Useable Wellbores ..........................................................40%
Average Monthly Rate (April - June, 2007)..........................40%
Ultimate Primary Recovery as of July 1, 2007.....................10%
Reservoir Pore Volume.......................................................10%

The tract participation factors (TPF) for each of the nine tracts are shown in Attachment No. 17. A list of the working interest owners with their proposed unit participation, based on these tract participation factors, is shown in Attachment No. 18.

## WATER SUPPLY

The maximum daily volume of injection water required is approximately 300 BPD for each of the six injection wells or 1,800 BPD. Two different sources of water have been determined. The first and most economical will come from the Chesapeake 100 % operated Hornet State No. 1 located approximately one mile to the northwest in section 3 of T-19S R-34E. This well, drilled in 2003 to a depth of 13,796 feet, is awaiting a recompletion to the 3rd Bone Spring(BS), 10,559-69 feet. It is currently shut-in after making an original completion in the Wolfcamp in early 2004. The 3rd BS is a 44 feet thick dolomitic zone with about ten feet on top of water. The water will be tested for compatibility with the Queen and an idea of what the water producing capacity of this dolomite is, will be determined. If compatible, the rest of the zone will be perforated upon such time as the water is needed for injection in the QQU. Hopefully, this zone will provide the needed water for the unit. However, if it proves to lack the ability to produce the volumes required, then the second source of supply will be pursued. The West/East and South Pearl Queen Units, 2 to 3 miles to the southeast are all operated by Xeric Oil and Gas Corporation. Chesapeake has contacted Xeric and they are agreeable to provide additional water as needed up to the 2,100 BPD needed. This option will cost more than the Hornet State option due to having to install a longer distance pipeline and involves a major road crossing.

## CAPITAL REQUIREMENTS

The capital expenditures listed below are estimates by the Enhanced Oil Recovery Group based on industry experience and knowledge of the current market. The actual costs may be different depending on the market conditions at the time of expenditure. The operations group is currently reviewing these costs for accuracy. The capital costs are based on a two phase implementation process over 1.5 to 2 years. Due to the current state of useable wellbores in the proposed unit area no additional drill wells are proposed to be drilled in Phase one. Six producers will be converted to injection in Phase I. Attachments 19 and 20 are maps that show the proposed development plans, Phase I & II, respectively. Restoring the casing integrity of the Quail State SWD 1 in Phase I and the cost to install injection facilities and production facility upgrades are included for both phases. A two mile pipeline from the Hornet State No. 1 facility to the centralized QQU battery is included for delivery of 1,800 to 2,500 BWPD source water. Other costs in Phase II include drill cost for two wells and re-entry of the Mobil #1 as an injector

Initial Phase (Phase I) Capital Requirement:

| | |
|---|---|
| Convert six wells to injection ($100k, each) | $ 600,000 |
| Re-Enter and Restore Csg Integrity, Quail State SWD 1 | $ 125,000 |
| Injection Lines 10,030 feet x $12/ft | $ 120,360 |
| Water Supply, Hornet St 1 Workover/Pipeline | $ 250,000 |
| Battery Upgrades/Centralization | $ 500,000 |
| Injection Facility | $ 500,000 |
| **Sub-Total** | **$ 2,095,360** |

Second Phase (Phase II) Capital Requirement:

| | |
|---|---|
| Drill 1 Injector ($1MM) & One Producer($1.2MM) | $ 2,200,000 |
| Re-Enter Mobil 1 as injection well | $ 200,000 |
| Battery Upgrades/Centralization | $ 500,000 |
| **Sub Total** | **$ 2,900,000** |
| **Grand Total** | **$ 4,995,360** |

## ECONOMIC ANALYSIS

The project evaluation has been based on future net cash flow, defined as that amount of future net income estimated to accrue to the 100% working interest and 79% net revenue interest by operating the project to the estimated limit of profitability.

The product prices, operating costs and capital requirements were estimated by Chesapeake Energy

Corporation. An initial oil price of $70 per barrel was held constant throughout the life of the project. Initial operating expenses started at current levels and were escalated in proportion to the escalating fluid volumes. Severance taxes appropriate for the state of New Mexico were applied to the oil and gas revenue. No provision was made for depreciation, depletion or State and Federal income taxes. No consideration was given to possible surplus and/or salvage values or to the cost of properly plugging and abandoning the wells at the conclusion of secondary operations. Attachment No. 21 includes a total unit plot including the estimated secondary performance. Attachment No. 22 are the total project economics including both phase I and phase II to the 100 percent unit working interest.

Economic data and parameters associated with the secondary operations are:

Revenue and Expense Forecast

Gross revenue less severance/ad valorem tax ------------- $36,321,230
Operating expense------------------------------------------- $ 4,255,307
Net operating income --------------------------------------- $32,065,923

Present Worth

Discounted at 10% ------------------------------------------ $9,094,7480
Discounted at 25% ------------------------------------------ $2,878,1220

Rate of Return ------------------------------------------------------ 78.09%

Discounted Return on Investment ------------------------------ 3.28

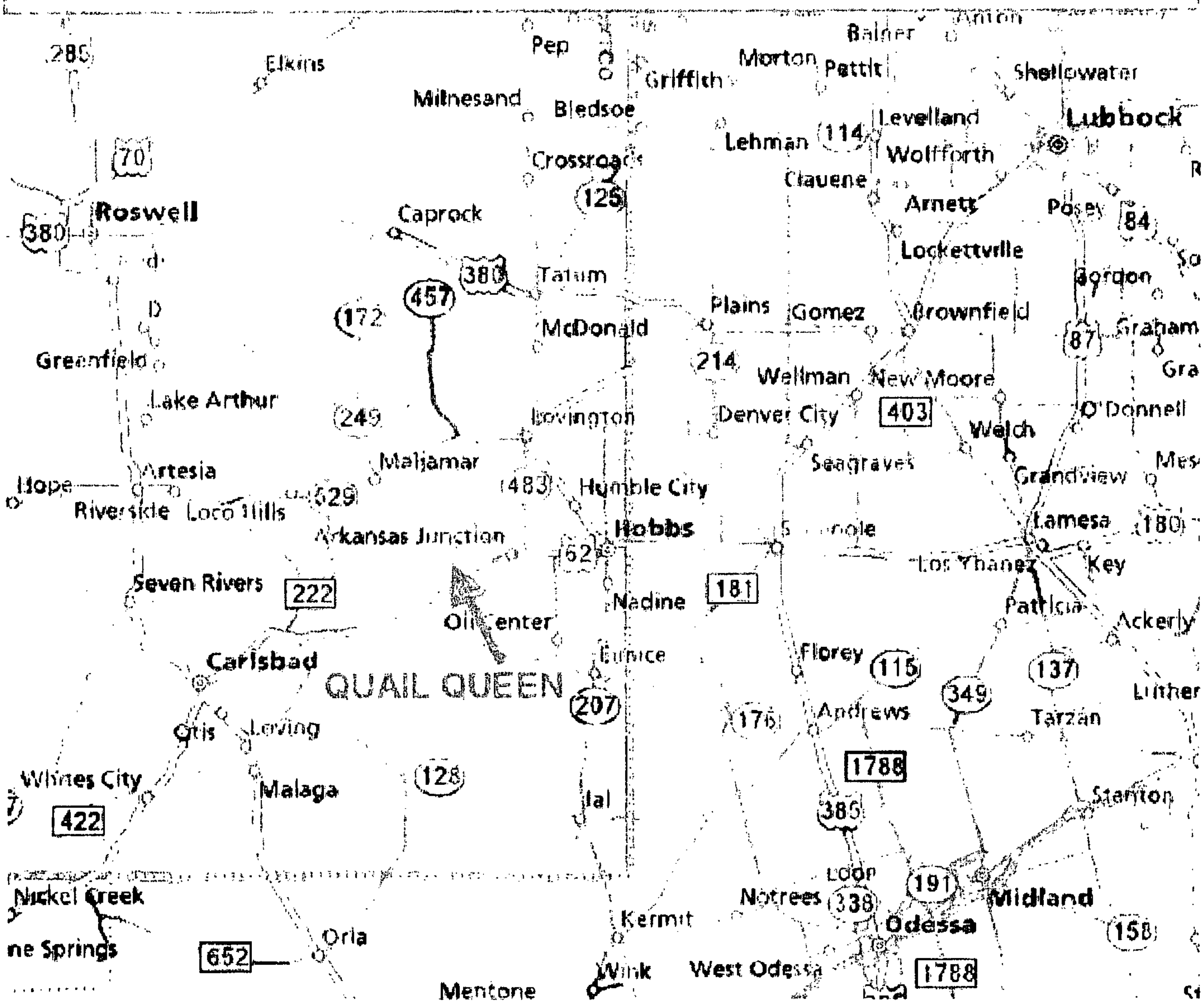
## CONCLUSIONS

1. The field is a strong flood candidate
2. Waste will occur and up to 763 MBO in secondary reserves will be lost, if not flooded.
3. The fields primary reserves are 91 percent depleted.
4. There has been a case example in the field of response to water injection.
5. There is strong economic incentive to flood the field now.

## RECOMMENDATIONS

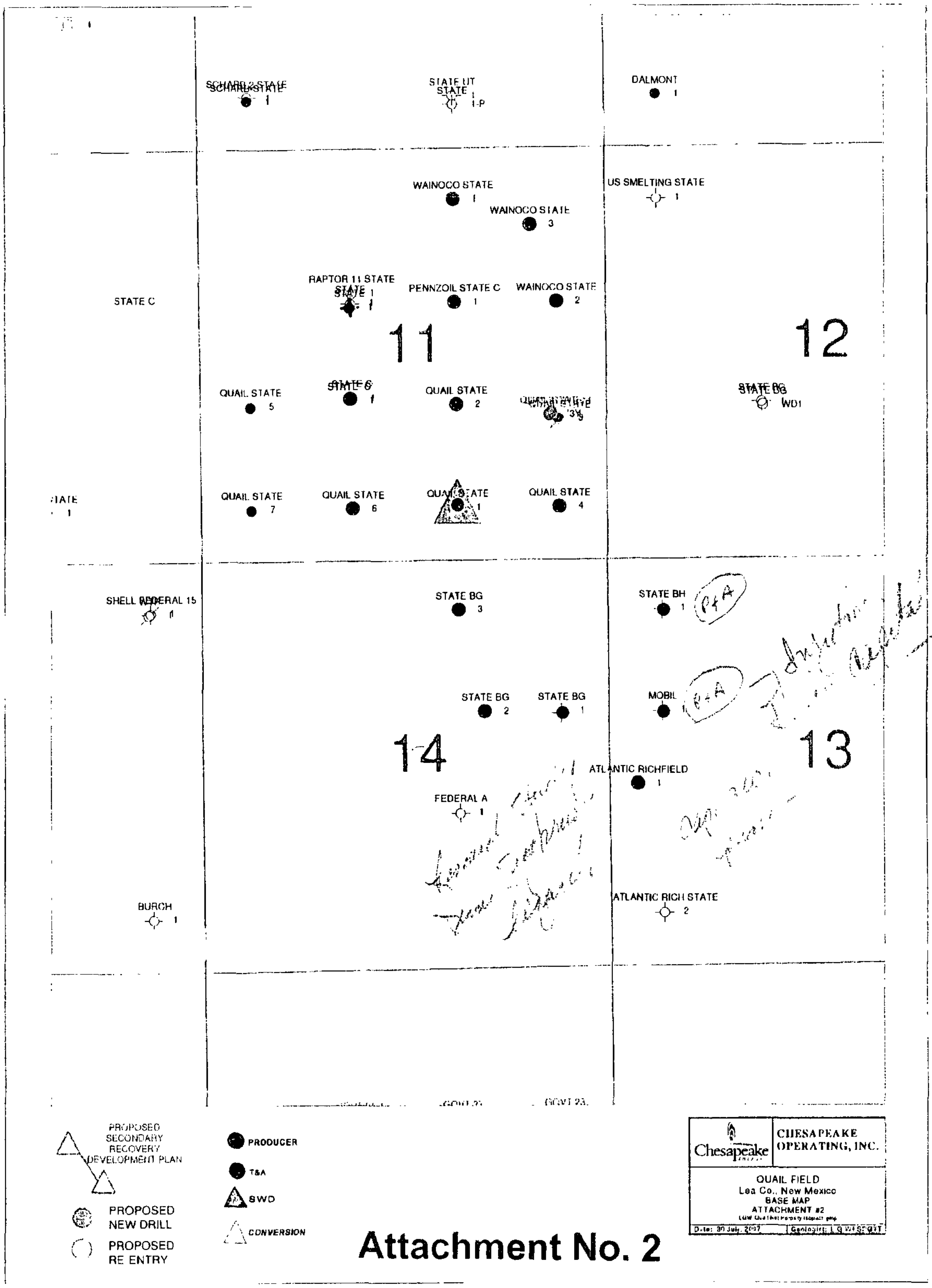
1. Form a unit as soon as possible.
2. Implement Phase I of the flood plan.
3. Observe and analyze the initial flood behavior
4. Perform additional drilling and conversions as needed.

# QUAIL QUEEN LOCATOR MAP




ATTACHMENT #1

**Attachment No. 1**

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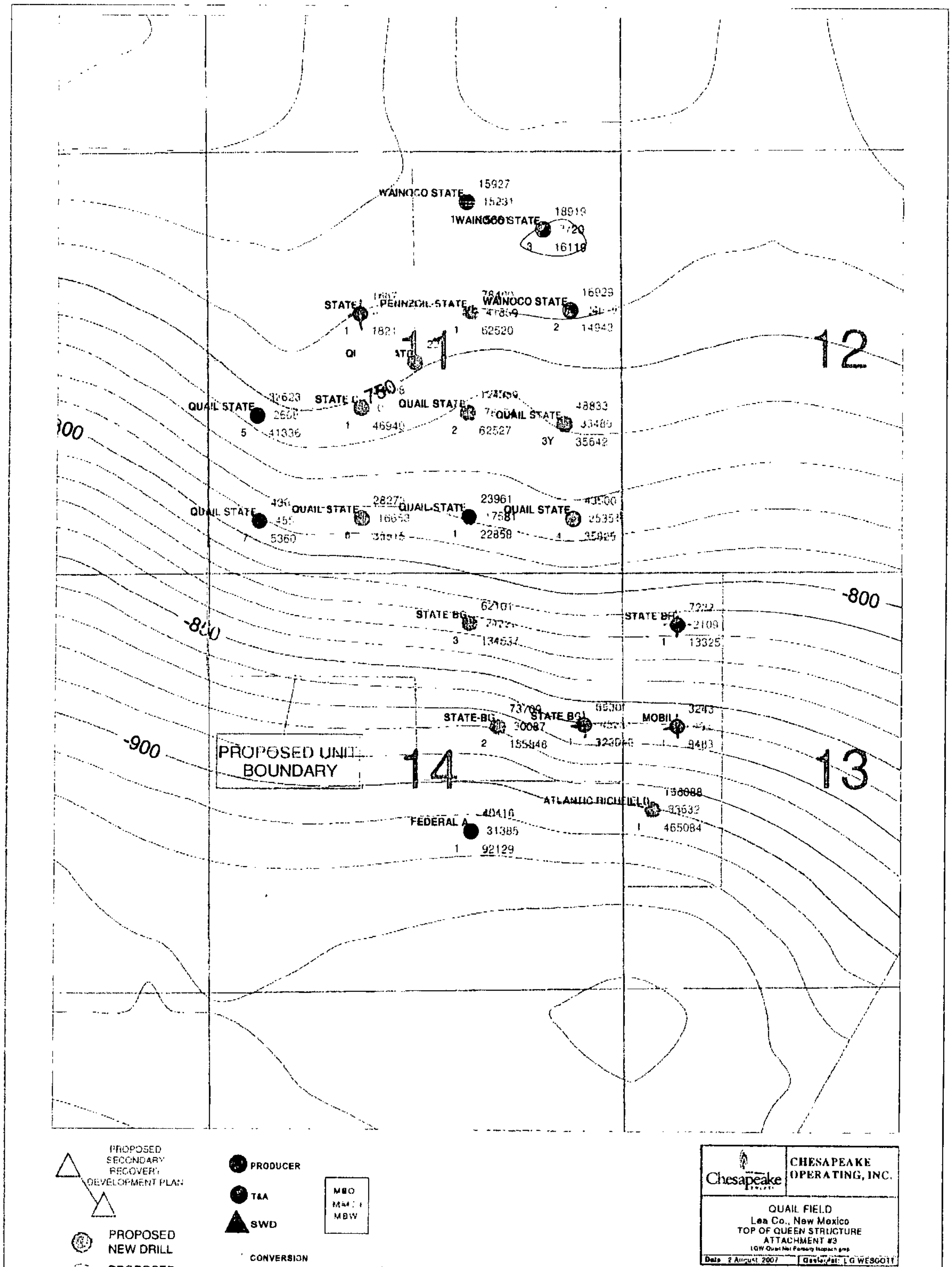


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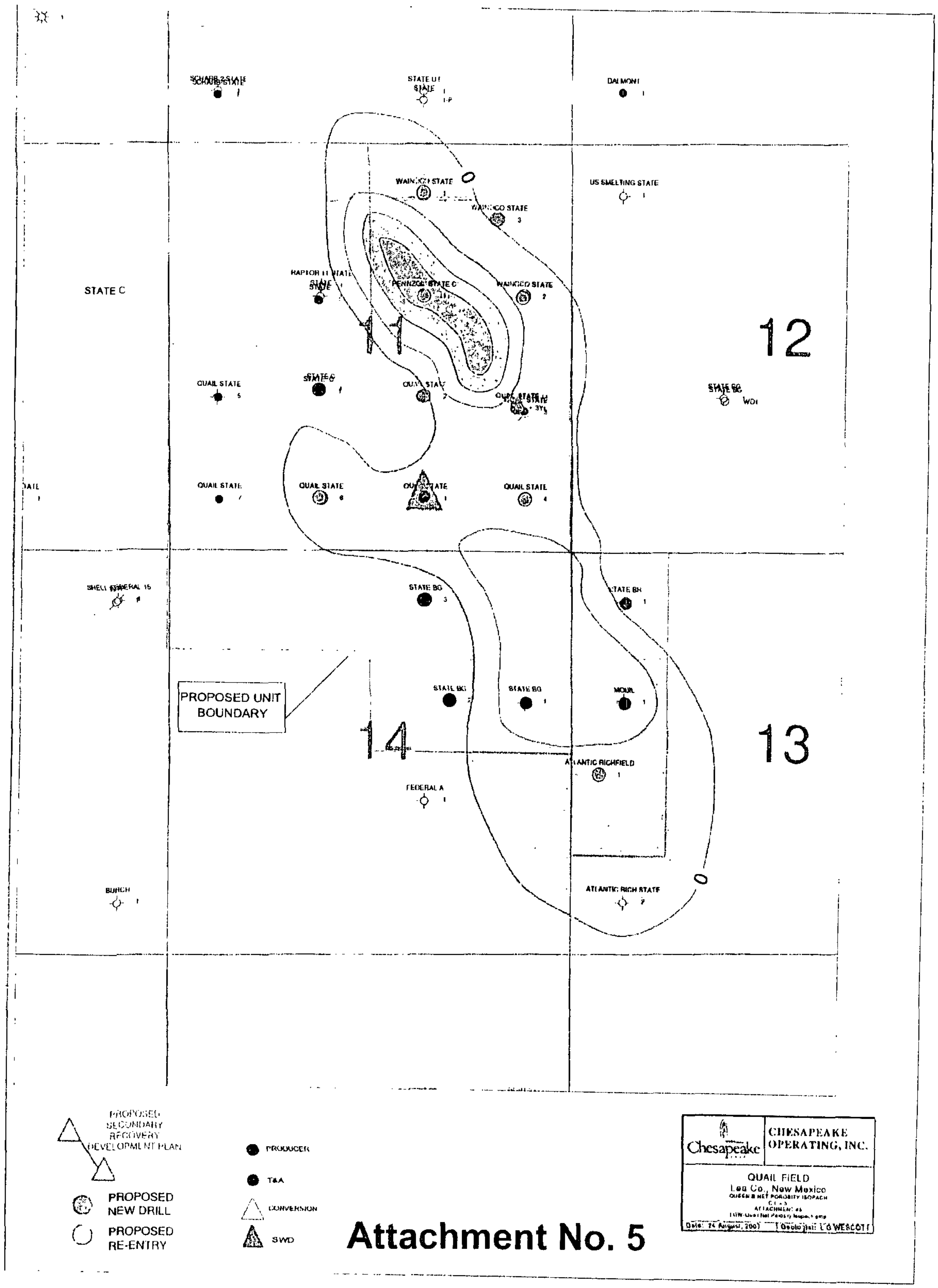


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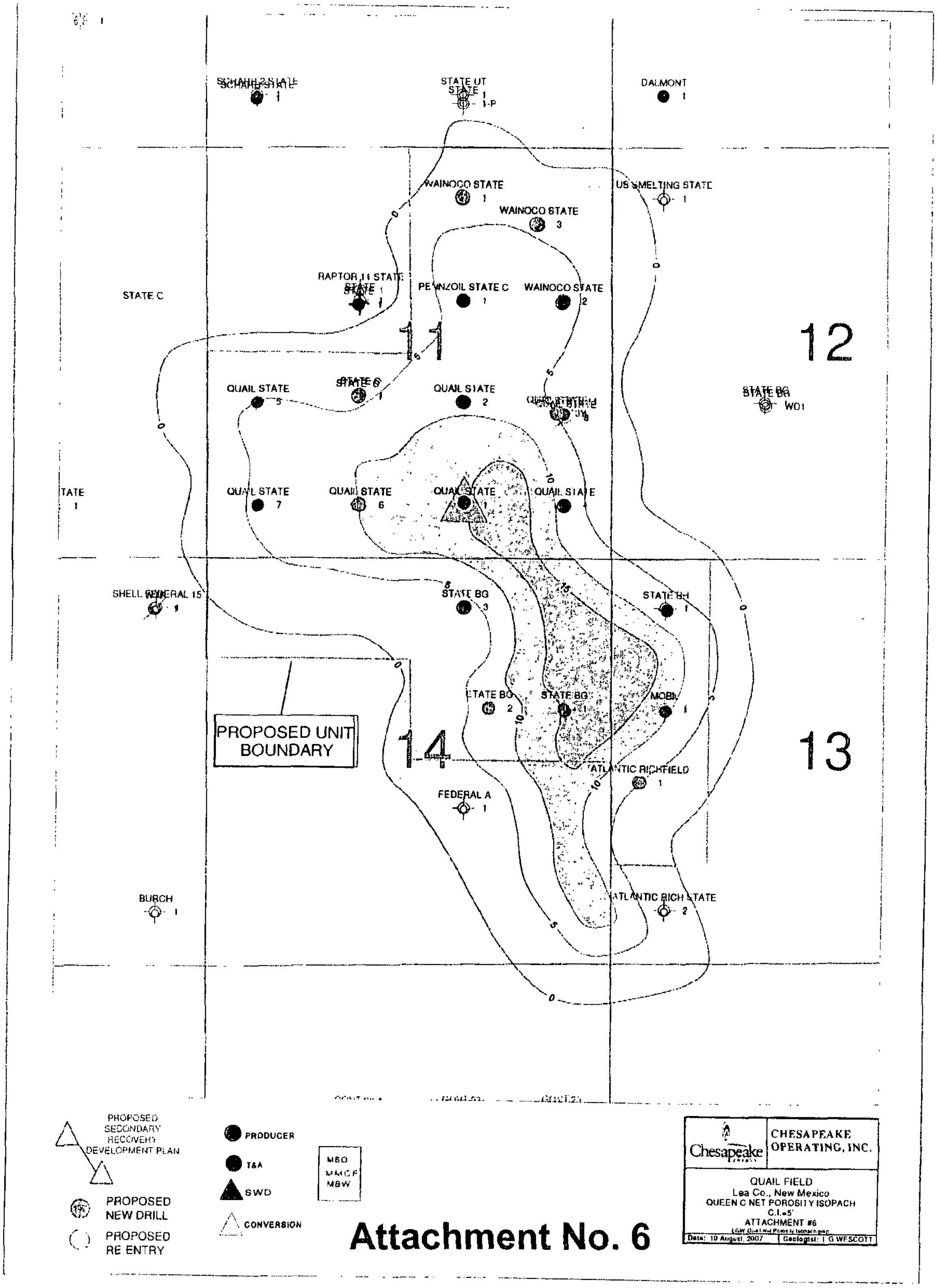
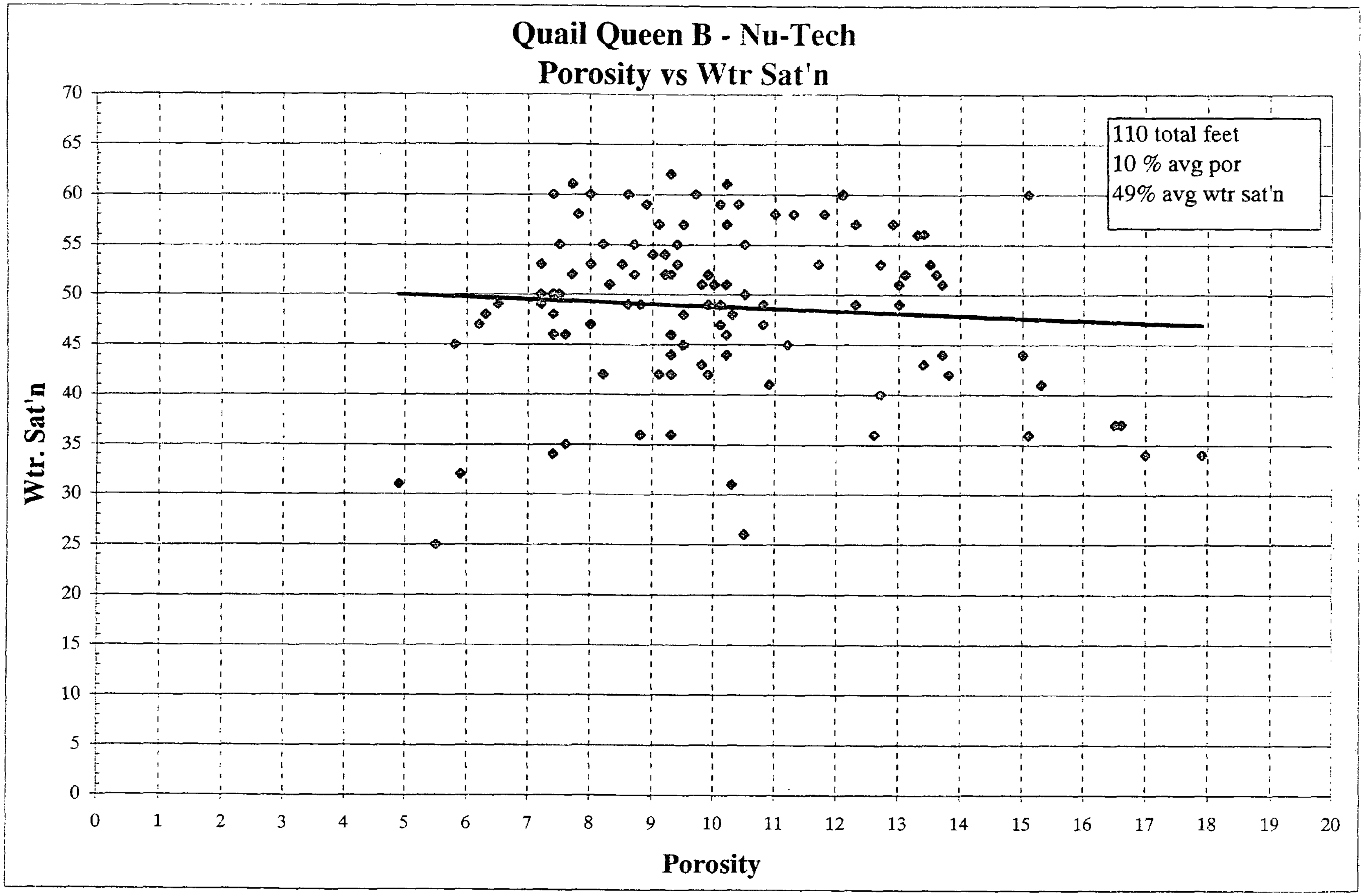


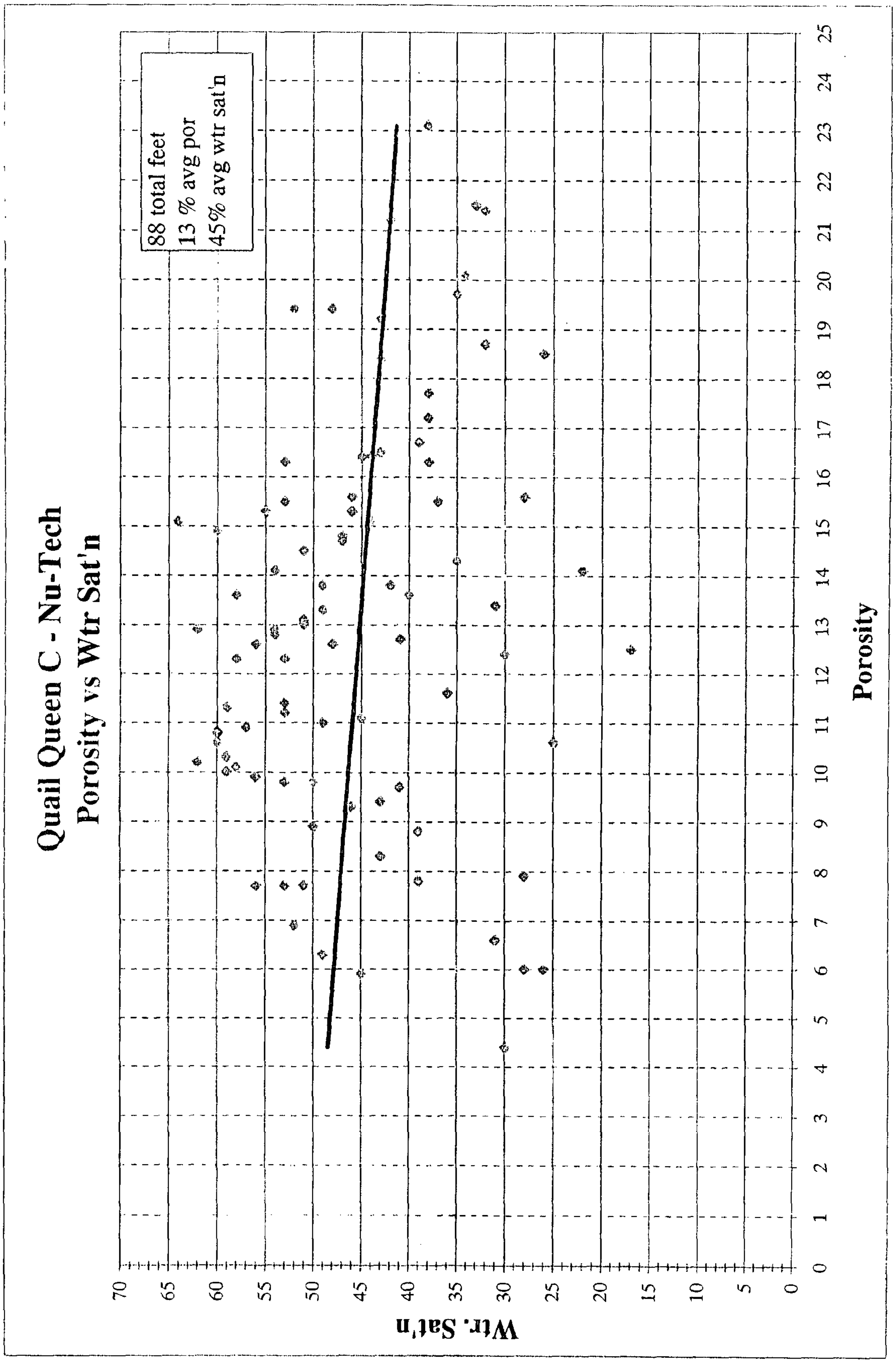

# Attachment No. 6

Attachment No. 7



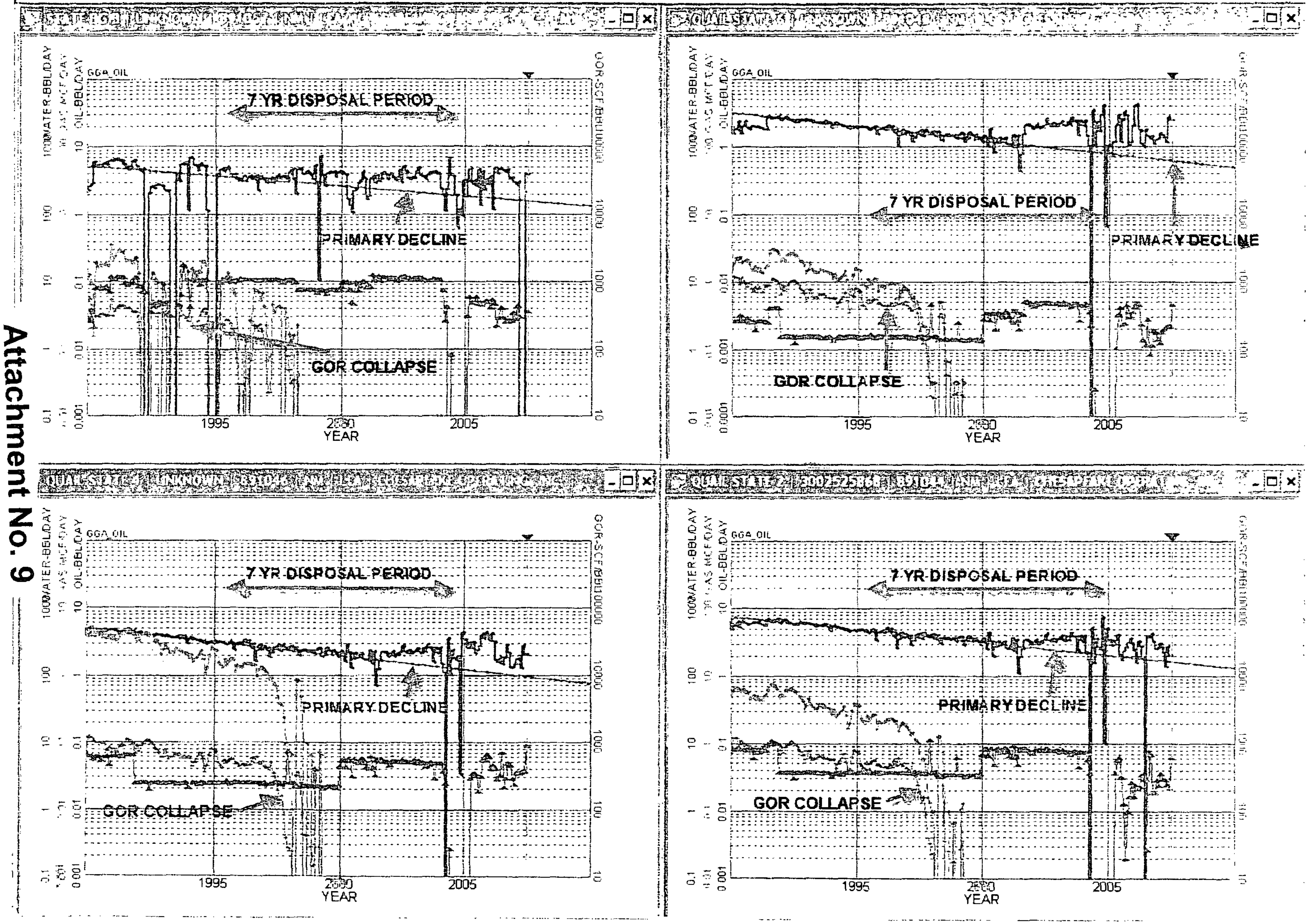

Attachment No. 7

Attachment No. 8




Attachment No. 8

# 4 WELL MONTAGE CENTERED AROUND QUAIL STATE SWD #1




ATTACHMENT #9

Attachment No. 9

# Quail Queen Waterflood Analysis of the Eighty Acre Five-Spot Pattern Centered Around Quail State #1

| | Primary to 7/1/2007 | | | Secondary to 7/1/2007 | | | Total |
|---|---|---|---|---|---|---|---|
| Well | Oil,BBLS | Pattern Fraction | Pattern Oil,BBLS | Oil,BBLS | Pattern Fraction | Pattern Oil,BBLS | Pattern Oil,BBLS |
| Quail State 2 | 105,378 | 0.25 | 26,345 | 1,764 | 1.00 | 1,764 | 28,109 |
| Quail State 4 | 37,307 | 0.25 | 9,327 | 2,061 | 1.00 | 2,061 | 11,388 |
| State BG 3 | 40,894 | 0.25 | 10,224 | 3,227 | 1.00 | 3,227 | 13,451 |
| Quail State 6 | 23,878 | 0.25 | 5,970 | 2,230 | 1.00 | 2,230 | 8,200 |
| Quail State 1 | 23,961 | 1.00 | 23,961 | - | 1.00 | - | 23,961 |
| | 231,418 | | 75,825 | 9,282 | | 9,282 | 85,107 |

**OOIP reservoir parameters for the 80 acre pattern:**

Acres = 80
Avg height = 12.5 feet

Average porosity = 12%
Average water sat'n = 45%

**Pore Volume (PV) = 7758*A*h*Φ**
= 7758*80*12.5*0.12
= 930,960 BBLS

**OOIP = (PV*(1-Sw) ) / $\beta_{oi}$**
= (930,960*(1-0.45)) / 1.15
= 445,242 STB

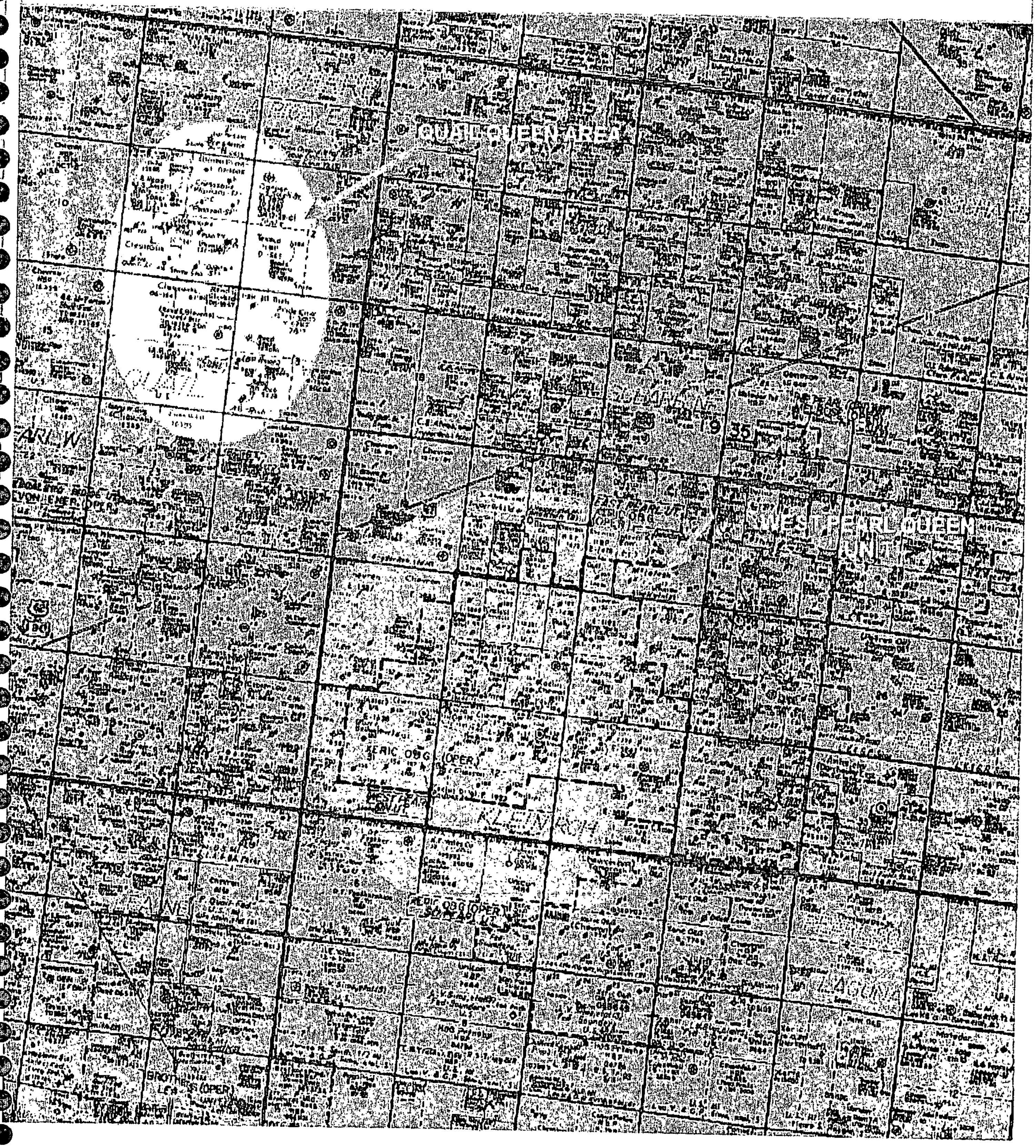
**SWD/Injection to Date:**

206,908 BBLS water injected over seven years
0.22 pore volumes injected

**As of 7/1/2007:**

| | | |
|---|---|---|
| **Primary Recovery Efficiency** | **17.03%** | |
| **Secondary Recovery Efficiency** | **2.08%** | with 22% of PV injected |
| **Total** | **19.11%** | |

# WEST PEARL QUEEN LOCATOR MAP



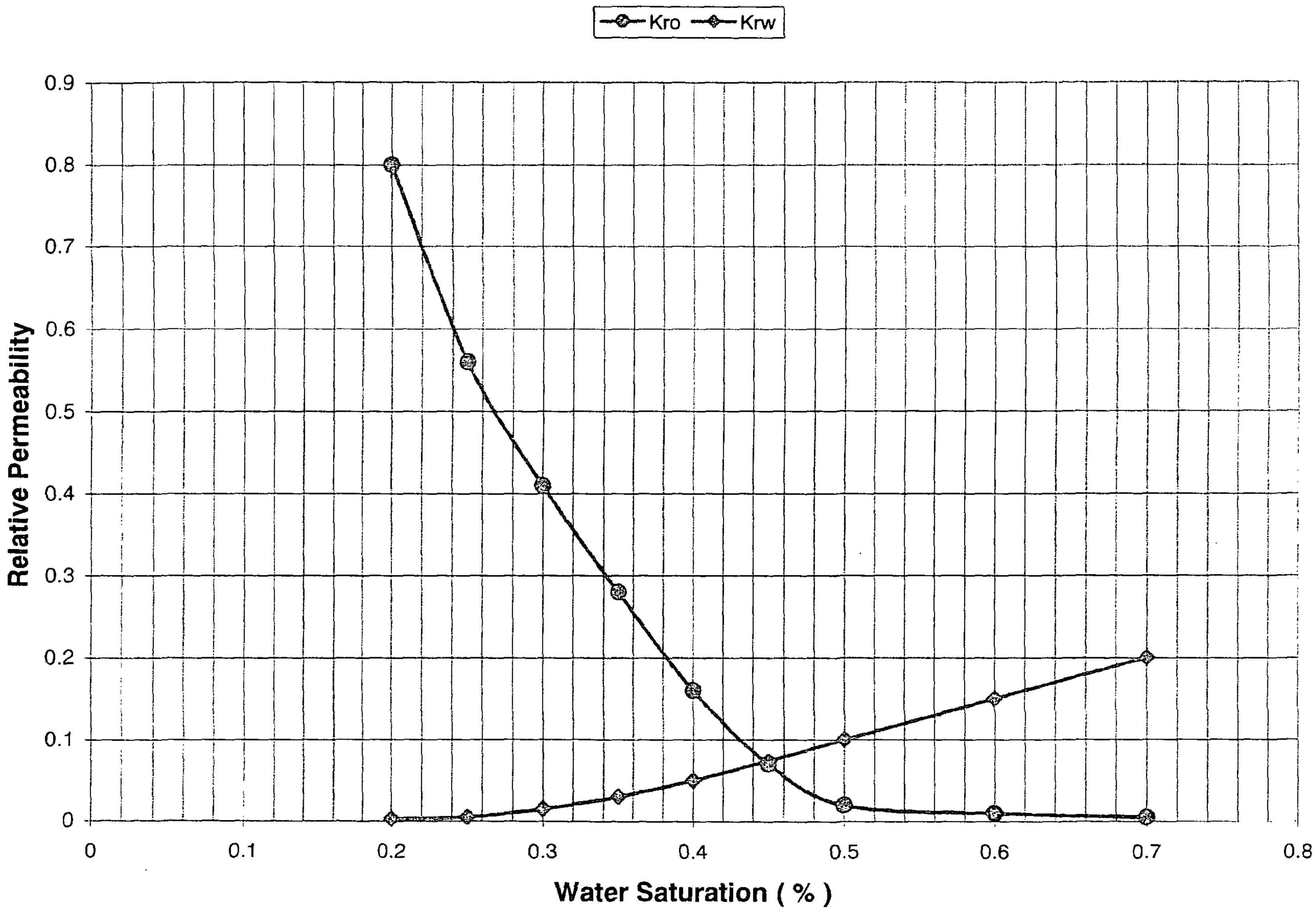

ATTACHMENT #11

# QQU vs WPQU
# Waterflood Analogy

| Item of Comparison | Proposed QQU | Existing WPQU |
|---|---|---|
| Net Area (acres) | 840 | 2,520 |
| Thickness (feet) | 12.5 | 18 |
| Depth (feet) | 5,100 | 4,900 |
| Line Pressure (psia) | 1,848 | 1,776 |
| Bubble Point (psia) | 1,255 | 1,400 |
| $B_{oi}$ | 1.15 | 1.18 |
| Porosity (%) | 13 | 16.7 |
| Φh | 1.625 | 3.0 |
| Volume (ΦAcft) | 1,365 | 7,560 |
| $S_w$ (%) | 45 | 54 |
| OOIP (MBO) | 4,467 | 22,763 |
| Primary (MBO) | 867 | 2,686 |
| % Primary | 19.4 | 11.8 |
| Secondary (MBO) | 725 | 2,374 |
| % Secondary | 16 | 10 |
| Sec: Pri | 0.83 | 0.88 |
| **Total (MBO)** | 1,592 | 5,060 |
| **% Total** | 0.36 | 0.22 |

**Attachment No. 12**

## Generic Sandstone Relative Permeability Curves

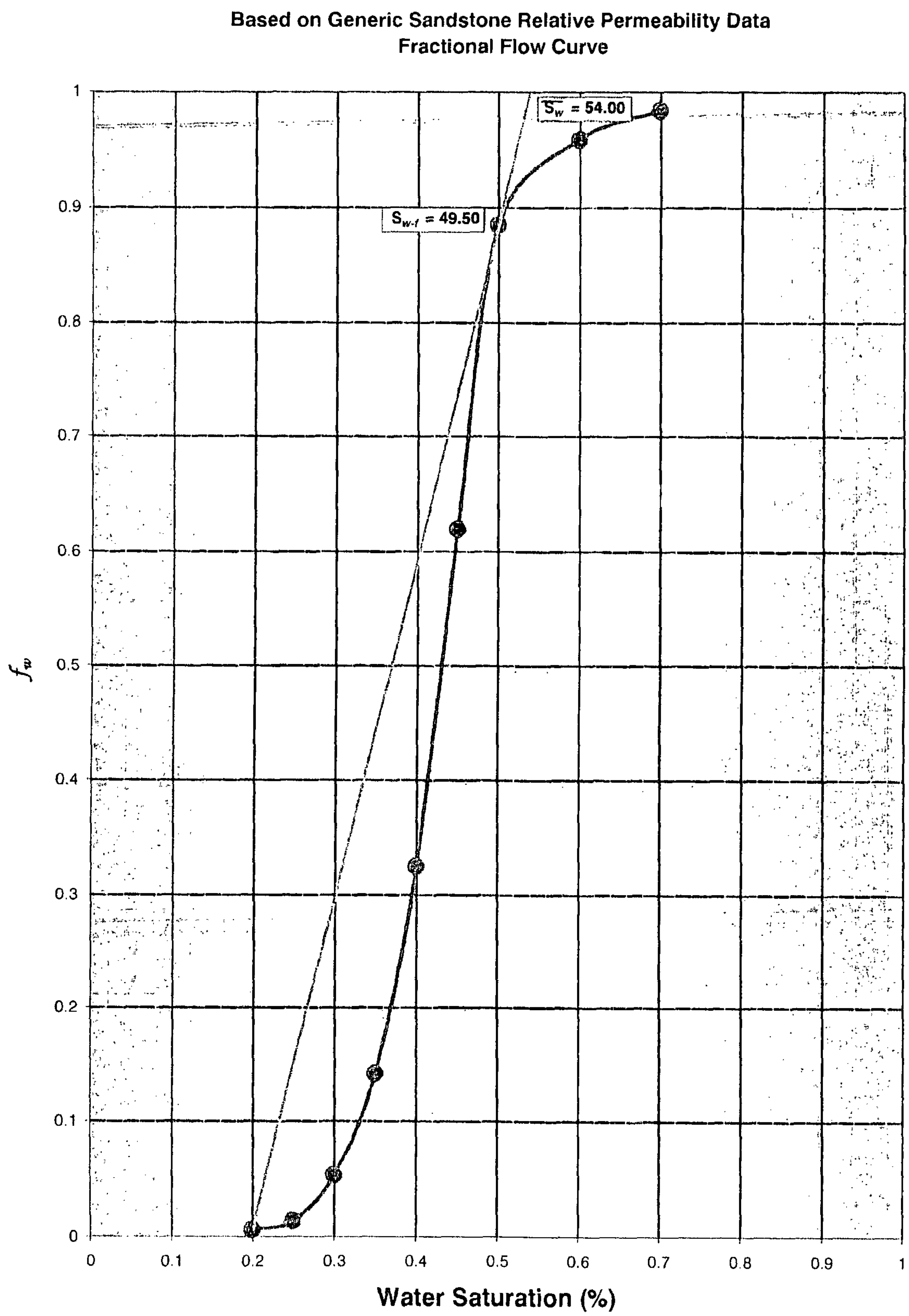



Generic Sandstone Rel Perm.xls
Re. Perm Curves

**Attachment No. 13**

Attachment No. 13

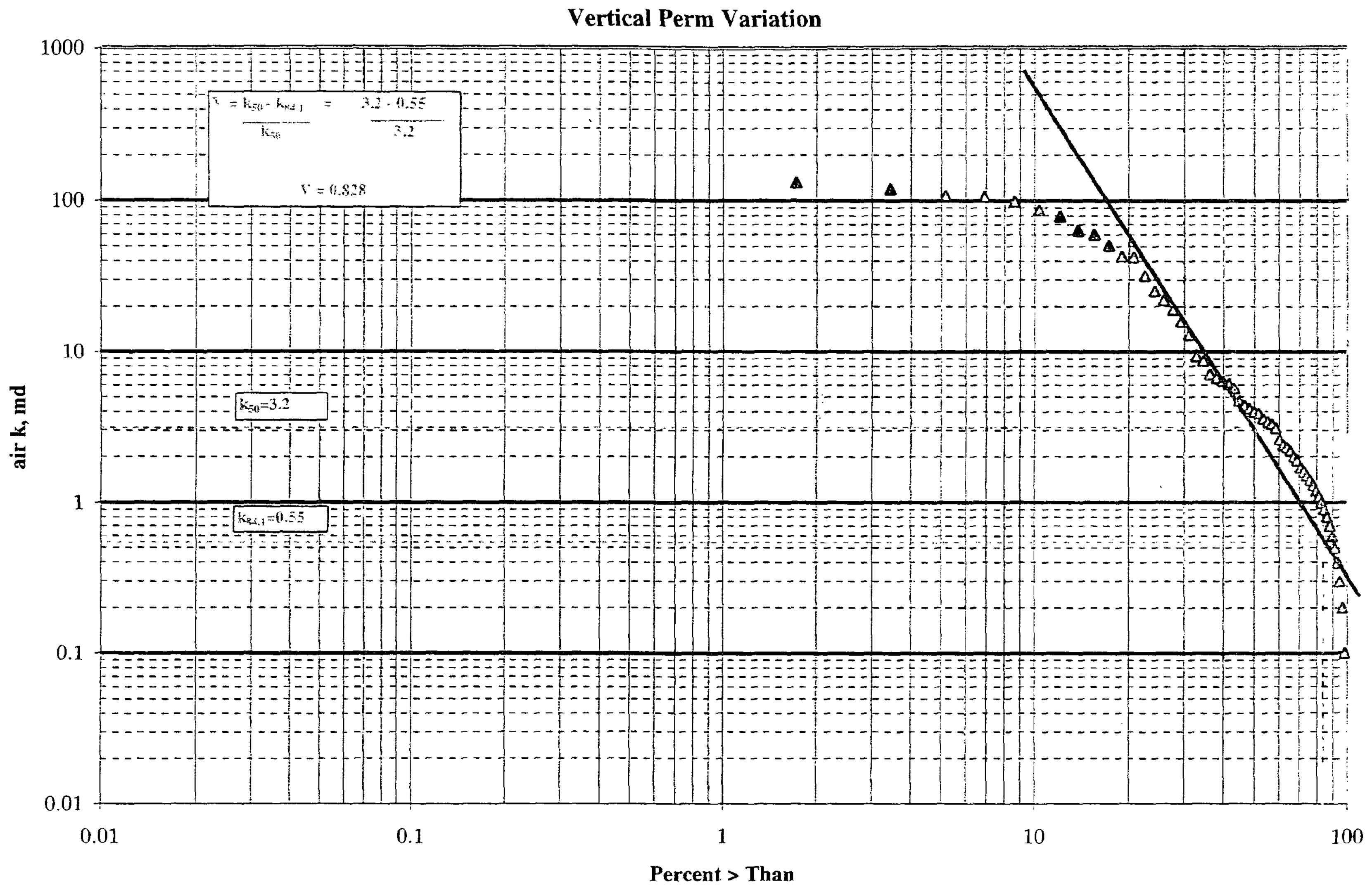
# Fractional Flow Curve




Generic Sandstone Rel Perm.xls
fw curve

**Attachment No. 14**

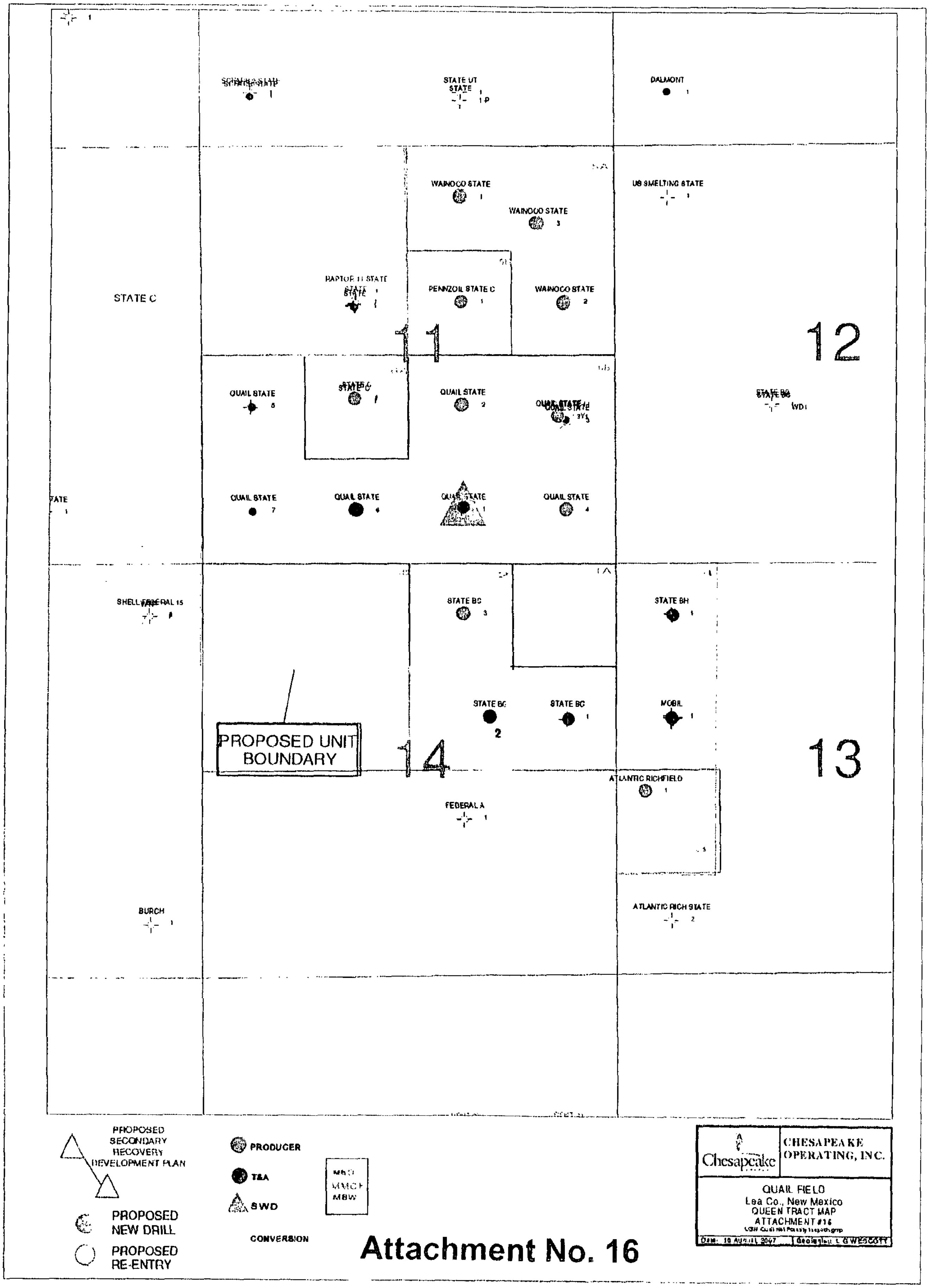
# Quail Queen Field




U:\WATERFLOODS\Quail\Perm Variation_Quail.xls Vert K Variation chart B&C

**Attachment No. 15**

Attachment No. 15




**Attachment No. 16**

# Proposed Quail Queen Unit
# Tract Participation Factors

| Tract | Usable Wells | | Well | Avg. Rate (BOE/D) | | | Est. Ultimate Primary Oil | | | | | Res Pore Vol, Queen B,C | | Tract Participation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Ac-Feet | | |
| No. | No. | Tract % | Name | Well | Tract | Tract % | MBO | MMcf | MBOE | Tract | Tract % | Volume | Tract % | Factor (%) |
| 1A | | | | | | | | | | | | 767.30 | 10.091 | 1.00907417 |
| 1B | | | | | | | | | | | | 201.70 | 2.653 | 0.26525513 |
| 2 | 2 | 16.67 | State BG 2 | | | | | | | | | 994.70 | 13.081 | 26.18674939 |
| | | | State Bg 3 | | | | | | | | | | | |
| | | | | 9 | 9 | 39.57 | 202.111 | 99.545 | 218.702 | 218.702 | 23.825 | | | |
| 3 | 1 | 8.33 | Atlantic Richfield 1 | 3 | 3 | [illegible] | 166.088 | 83.682 | 180.035 | 180.035 | 19.612 | 174.80 | 2.299 | 10.28275250 |
| 4 | | | | | | | 10.475 | 2.601 | 10.909 | 10.909 | 1.188 | 994.10 | 13.073 | 1.42617110 |
| 5A | 3 | 25.00 | Wainoco St 1 | | | | | | | | | 694.60 | 9.135 | 14.20432449 |
| | | | Wainoco St 2 | | | | | | | | | | | |
| | | | Wainoco St 3 | | | | | | | | | | | |
| | | | | 1 | 1 | 6.52 | 51.775 | 66.515 | 62.861 | 62.861 | 6.848 | | | |
| 5B | 1 | 8.33 | Pennzoil St 1 | 1 | 1 | [illegible] | 78.460 | 41.859 | 85.437 | 85.437 | 9.307 | 680.70 | 8.952 | 6.46420024 |
| 6A | 1 | 8.33 | State C 1 | 1 | 1 | [illegible] | 24.898 | 0.000 | 24.898 | 24.898 | 2.712 | 214.40 | 2.820 | 5.21832097 |
| 6B | 4 | 33.33 | Quail St 2 | | | | | | | | | 2,881.70 | 37.897 | 34.94315200 |
| | | | Quail St 3Y | | | | | | | | | | | |
| | | | Quail St 4 | | | | | | | | | | | |
| | | | Quail St 6 | | | | | | | | | | | |
| | | | | 8 | 8 | 35.42 | 301.988 | 198.848 | 335.129 | 335.129 | 36.508 | | | |
| | 12 | 100.00 | | 23 | 23 | 100.00 | 835.795 | 493.050 | 917.970 | 917.970 | 100.000 | [illegible],604.000 | 100.000 | 100.00000000 |

| | |
|---|---|
| Wells | 0.40000000 |
| Rate | 0.40000000 |
| Ult | 0.10000000 |
| Ac-ft | 0.10000000 |

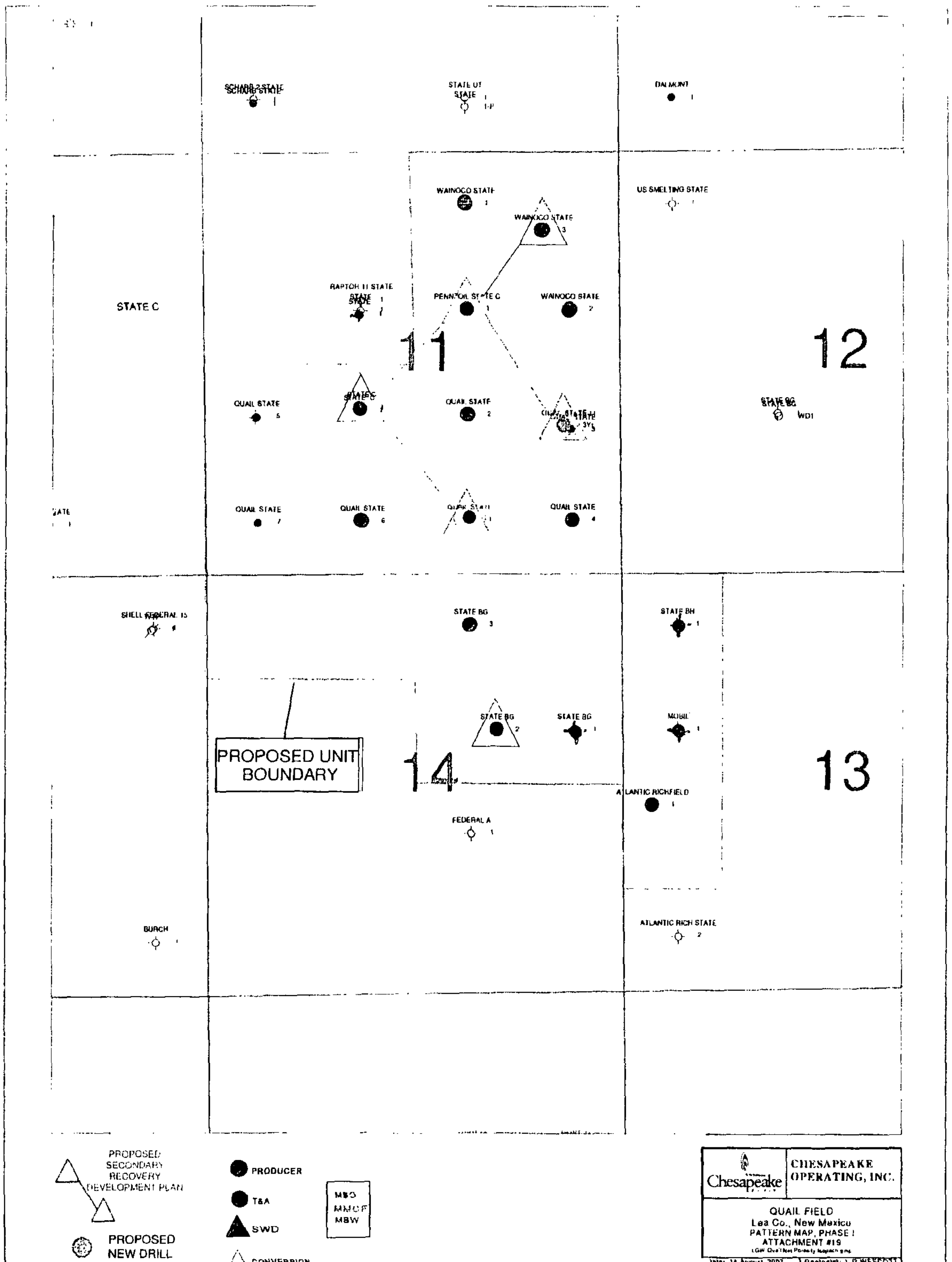
**Attachment No. 17**

TPF Att17.xls
TPF

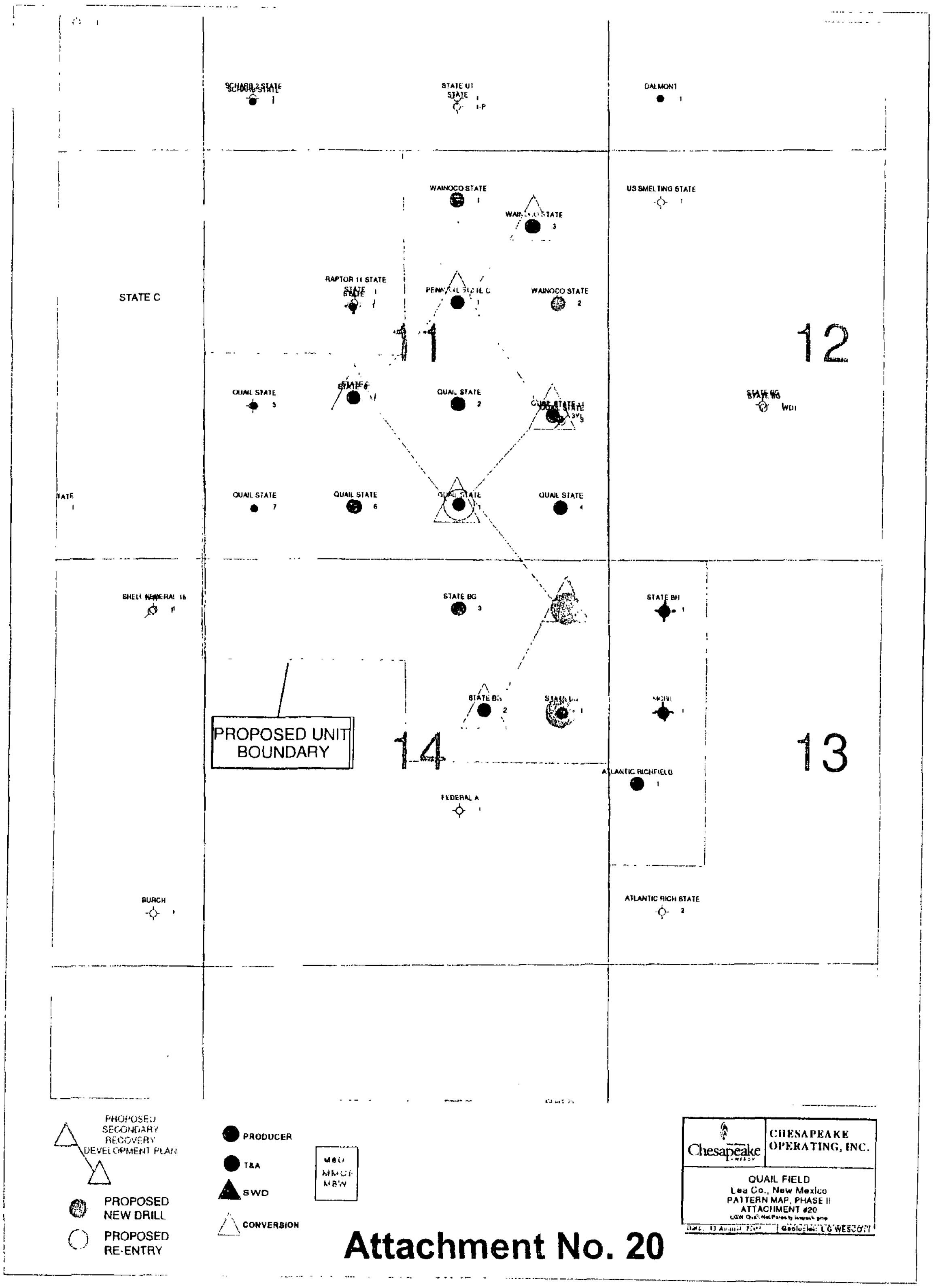
**Attachment No. 17**

# QUAIL QUEEN UNIT
# WIO Unit Participation BASED ON TPF'S

| | Total of | |
|---|---|---|
| | All Tract's TPF | |
| Tracts Unit Participation Fraction | 1.0000 | |
| Working Interest Owner | UNIT WI | UNIT NRI |
| Chesapeake Exploration LP | 0.88926063 | 0.70642158 |
| Roy G. & Opal Barton Revocable Trust, Roy G. Barton Jr., aka George Barton Trust | 0.00321336 | 0.00250642 |
| Pintail Production Company, Inc. | 0.02570688 | 0.02005137 |
| New Mexico Western Mineral, Inc. | 0.00642672 | 0.00501284 |
| Read & Stevens, Inc. | 0.00671780 | 0.00524708 |
| Joe M. & Nancy Wigley | 0.00022952 | 0.00017903 |
| MRT Ltd | 0.00022952 | 0.00017903 |
| William D. Bradshaw | 0.00022952 | 0.00017903 |
| CLM Production Company | 0.00022952 | 0.00017903 |
| Patricia L. Pruitt | 0.00022952 | 0.00017903 |
| Laura K. Read | 0.00022952 | 0.00017903 |
| Marion P. Riley | 0.00022952 | 0.00017903 |
| Pride Energy Company | 0.01426171 | 0.01188476 |
| First Century Oil Inc. | 0.00365079 | 0.00285275 |
| Fisco Inc. | 0.00365079 | 0.00285275 |
| Gene A. Snow Operating | 0.00182572 | 0.00142683 |
| All Tex Royalty Ltd | 0.04367894 | 0.03275921 |
| | | |
| | 1.00000000 | 0.79226879 |




**Attachment No. 19**




**Attachment No. 20**


| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Qual= | GGA0306 | Ref= | 11/2008 | Ref= | 11/2008 | Ref= | 11/2008 |
| Ref= | 11/2008 | Cum= | 0 | Cum= | 0 | Cum= | 0 |
| Cum= | 1 | | | | | | |
| Rem= | 725061 | | | | | | |
| EUR= | 725062 | | | | | | |
| Yrs= | 28.164 | | | | | | |
| Qref= | 0.0 | | | | | | |
| De= | 0.000000 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 0.000000 | | | | | | |
| Qab= | 23.1 | | | | | | |

**Attachment No. 21**

Lease: QUAIL QUEEN UNIT WATERFLO
Field: QUAIL
Operator: CHESAPEAKE OPERATING,
County: LEA State: NM
Oil Differential: 0.000000 $/BBL
Gas Differential: 1.080663 $/MCF

DATE : 08/14/2007
TIME : 16:34:58
DBS : CHK0101
SETTINGS : CHK0707M
SCENARIO : GGA0707

# RESERVES AND ECONOMICS

AS OF DATE: 07/2007

| --END-- MO-YEAR | GROSS OIL PRODUCTION ----MBBLS---- | GROSS GAS PRODUCTION ----MMCF---- | NET OIL PRODUCTION ---MBBLS--- | NET GAS PRODUCTION ----MMCF--- | NET OIL PRICE ---$/BBL--- | NET GAS PRICE ---$/MCF--- | NET OIL SALES -----M$---- | NET GAS SALES -----M$---- | TOTAL NET SALES -----M$---- |
|---|---|---|---|---|---|---|---|---|---|
| 07-2007 | 0.000 | 0.000 | 0.000 | 0.000 | 70.000 | 0.000 | 0.002 | 0.000 | 0.002 |
| 12-2007 | 0.000 | 0.000 | 0.000 | 0.000 | 70.000 | 0.000 | 0.008 | 0.000 | 0.008 |
| 12-2008 | 0.723 | 0.000 | 0.573 | 0.000 | 70.000 | 0.000 | 40.108 | 0.000 | 40.108 |
| 12-2009 | 42.989 | 0.000 | 34.056 | 0.000 | 70.000 | 0.000 | 2383.930 | 0.000 | 2383.930 |
| 12-2010 | 54.104 | 0.000 | 42.861 | 0.000 | 70.000 | 0.000 | 3000.277 | 0.000 | 3000.277 |
| 12-2011 | 50.745 | 0.000 | 40.200 | 0.000 | 70.000 | 0.000 | 2814.001 | 0.000 | 2814.001 |
| 12-2012 | 47.299 | 0.000 | 37.470 | 0.000 | 70.000 | 0.000 | 2622.930 | 0.000 | 2622.930 |
| 12-2013 | 44.088 | 0.000 | 34.926 | 0.000 | 70.000 | 0.000 | 2444.833 | 0.000 | 2444.833 |
| 12-2014 | 41.094 | 0.000 | 32.555 | 0.000 | 70.000 | 0.000 | 2278.830 | 0.000 | 2278.830 |
| 12-2015 | 38.304 | 0.000 | 30.344 | 0.000 | 70.000 | 0.000 | 2124.097 | 0.000 | 2124.097 |
| 12-2016 | 35.703 | 0.000 | 28.284 | 0.000 | 70.000 | 0.000 | 1979.871 | 0.000 | 1979.871 |
| 12-2017 | 33.279 | 0.000 | 26.363 | 0.000 | 70.000 | 0.000 | 1845.437 | 0.000 | 1845.437 |
| 12-2018 | 31.019 | 0.000 | 24.573 | 0.000 | 70.000 | 0.000 | 1720.132 | 0.000 | 1720.132 |
| 12-2019 | 28.913 | 0.000 | 22.905 | 0.000 | 70.000 | 0.000 | 1603.335 | 0.000 | 1603.335 |
| 12-2020 | 26.950 | 0.000 | 21.350 | 0.000 | 70.000 | 0.000 | 1494.469 | 0.000 | 1494.469 |
| S TOT | 475.209 | 0.000 | 376.461 | 0.000 | 70.000 | 0.000 | 26352.260 | 0.000 | 26352.260 |
| AFTER | 249.852 | 0.000 | 197.933 | 0.000 | 70.000 | 0.000 | 13855.293 | 0.000 | 13855.293 |
| TOTAL | 725.061 | 0.000 | 574.394 | 0.000 | 70.000 | 0.000 | 40207.551 | 0.000 | 40207.551 |

| --END-- MO-YEAR | AD VALOREM TAX -----M$---- | PRODUCTION TAX -----M$---- | DIRECT OPER EXPENSE -----M$---- | INTEREST PAID -----M$---- | CAPITAL REPAYMENT -----M$---- | EQUITY INVESTMENT -----M$---- | FUTURE NET CASHFLOW -----M$---- | CUMULATIVE CASHFLOW -----M$---- | CUM. DISC. CASHFLOW -----M$---- |
|---|---|---|---|---|---|---|---|---|---|
| 07-2007 | 0.000 | 0.000 | 5.000 | 0.000 | 0.000 | 0.000 | -4.999 | -4.999 | -4.979 |
| 12-2007 | 0.000 | 0.001 | 25.001 | 0.000 | 0.000 | 0.000 | -24.993 | -29.992 | -29.288 |
| 12-2008 | 0.552 | 3.325 | 63.616 | 0.000 | 0.000 | 0.000 | -27.385 | -57.376 | -55.471 |
| 12-2009 | 32.795 | 197.628 | 274.947 | 0.000 | 0.000 | 2095.360 | -216.799 | -274.175 | -332.955 |
| 12-2010 | 41.273 | 248.723 | 450.519 | 0.000 | 0.000 | 2900.000 | -640.239 | -914.414 | -810.559 |
| 12-2011 | 38.711 | 233.281 | 553.724 | 0.000 | 0.000 | 0.000 | 1986.286 | 1073.872 | 548.844 |
| 12-2012 | 36.082 | 217.441 | 236.496 | 0.000 | 0.000 | 0.000 | 2132.911 | 3206.783 | 1874.447 |
| 12-2013 | 33.632 | 202.677 | 220.438 | 0.000 | 0.000 | 0.000 | 1988.087 | 5194.870 | 2997.714 |
| 12-2014 | 31.349 | 188.915 | 205.470 | 0.000 | 0.000 | 0.000 | 1853.096 | 7047.965 | 3949.530 |
| 12-2015 | 29.220 | 176.088 | 191.519 | 0.000 | 0.000 | 0.000 | 1727.271 | 8775.236 | 4756.064 |
| 12-2016 | 27.236 | 164.131 | 178.515 | 0.000 | 0.000 | 0.000 | 1609.989 | 10385.225 | 5439.492 |
| 12-2017 | 25.387 | 152.987 | 166.394 | 0.000 | 0.000 | 0.000 | 1500.670 | 11885.895 | 6018.603 |
| 12-2018 | 23.663 | 142.599 | 155.095 | 0.000 | 0.000 | 0.000 | 1398.775 | 13284.670 | 6509.321 |
| 12-2019 | 22.056 | 132.916 | 144.564 | 0.000 | 0.000 | 0.000 | 1303.798 | 14588.468 | 6925.138 |
| 12-2020 | 20.559 | 123.891 | 134.749 | 0.000 | 0.000 | 0.000 | 1215.270 | 15803.738 | 7277.485 |
| S TOT | 362.515 | 2184.602 | 3006.047 | 0.000 | 0.000 | 4995.360 | 15803.738 | 15803.738 | 7277.485 |
| AFTER | 190.600 | 1148.604 | 1249.260 | 0.000 | 0.000 | 10.000 | 11256.827 | 27060.566 | 9094.750 |
| TOTAL | 553.115 | 3333.206 | 4255.307 | 0.000 | 0.000 | 5005.360 | 27060.564 | 27060.566 | 9094.750 |

| | OIL | GAS |
|---|---|---|
| GROSS WELLS | 1.0 | 0.0 |
| GROSS ULT., MB & MMF | 725.062 | 0.000 |
| GROSS CUM., MB & MMF | 0.000 | 0.000 |
| GROSS RES., MB & MMF | 725.061 | 0.000 |
| NET RES., MB & MMF | 574.394 | 0.000 |
| NET REVENUE, M$ | 40207.555 | 0.000 |
| INITIAL PRICE, $ | 70.000 | 0.000 |
| INITIAL N.I., PCT. | 79.220 | 0.000 |

| | |
|---|---|
| LIFE, YRS. | 29.50 |
| DISCOUNT % | 10.00 |
| UNDISCOUNTED PAYOUT, YRS. | 3.96 |
| DISCOUNTED PAYOUT, YRS. | 4.10 |
| UNDISCOUNTED NET/INVEST. | 6.41 |
| DISCOUNTED NET/INVEST. | 3.28 |
| RATE-OF-RETURN, PCT. | 78.09 |
| INITIAL W.I., PCT. | 100.000 |

| P.W. % | P.W., M$ |
|---|---|
| 5.00 | 14906.022 |
| 8.00 | 10972.667 |
| 10.00 | 9094.748 |
| 12.00 | 7621.411 |
| 14.00 | 6446.749 |
| 16.00 | 5496.724 |
| 25.00 | 2878.122 |
| 40.00 | 1106.350 |
| 60.00 | 276.008 |
| 100.00 | -154.909 |

**Attachment No. 22**

# APPENDIX A

## FIELD PRODUCTION PLOT WITH PRIMARY FORECAST

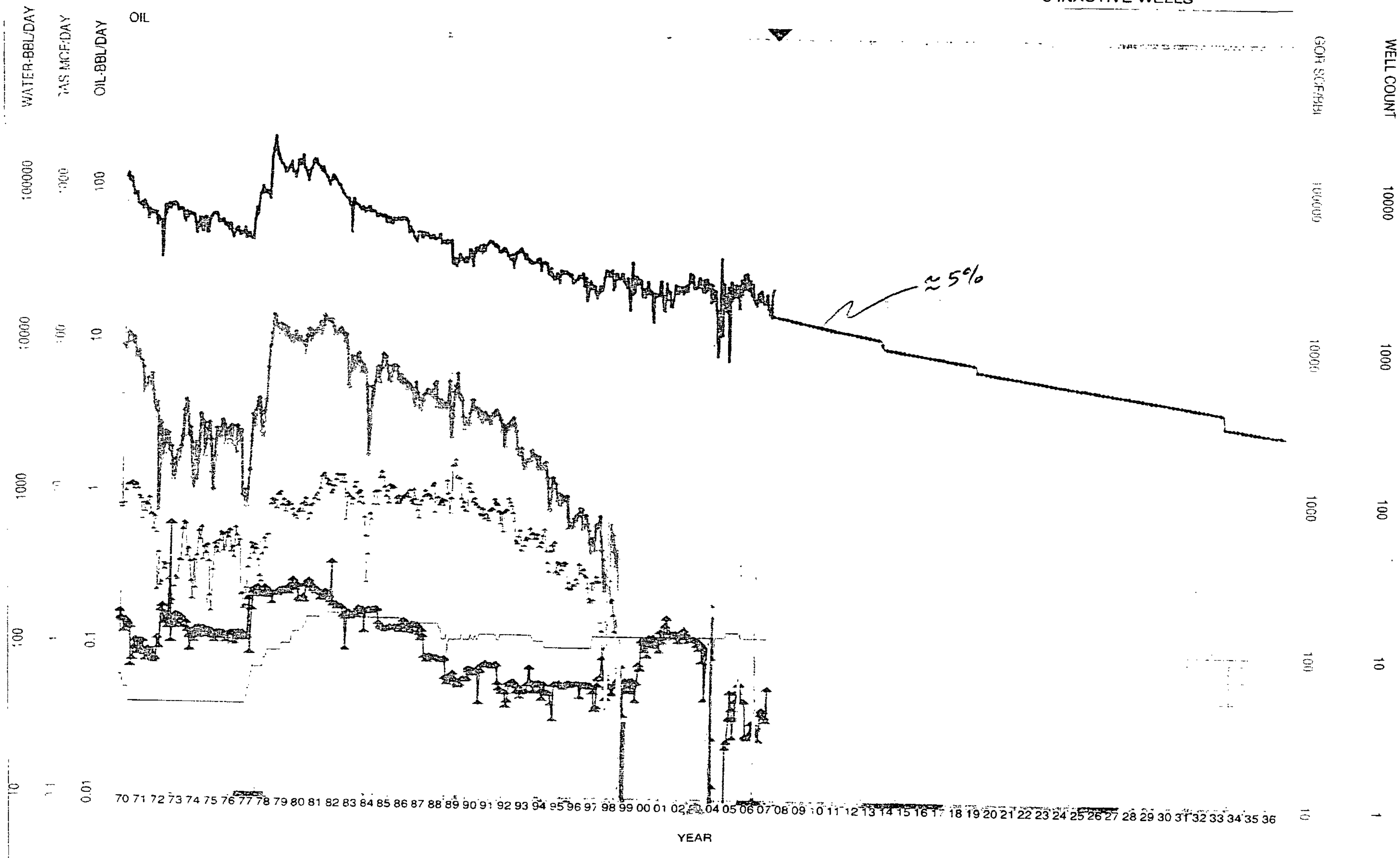
## INDIVIDUAL WELL PRODUCTION PLOTS WITH PRIMARY FORECAST

## PROPOSED QUAIL QUEEN UNIT

## WATERFLOOD FEASIBILITY STUDY

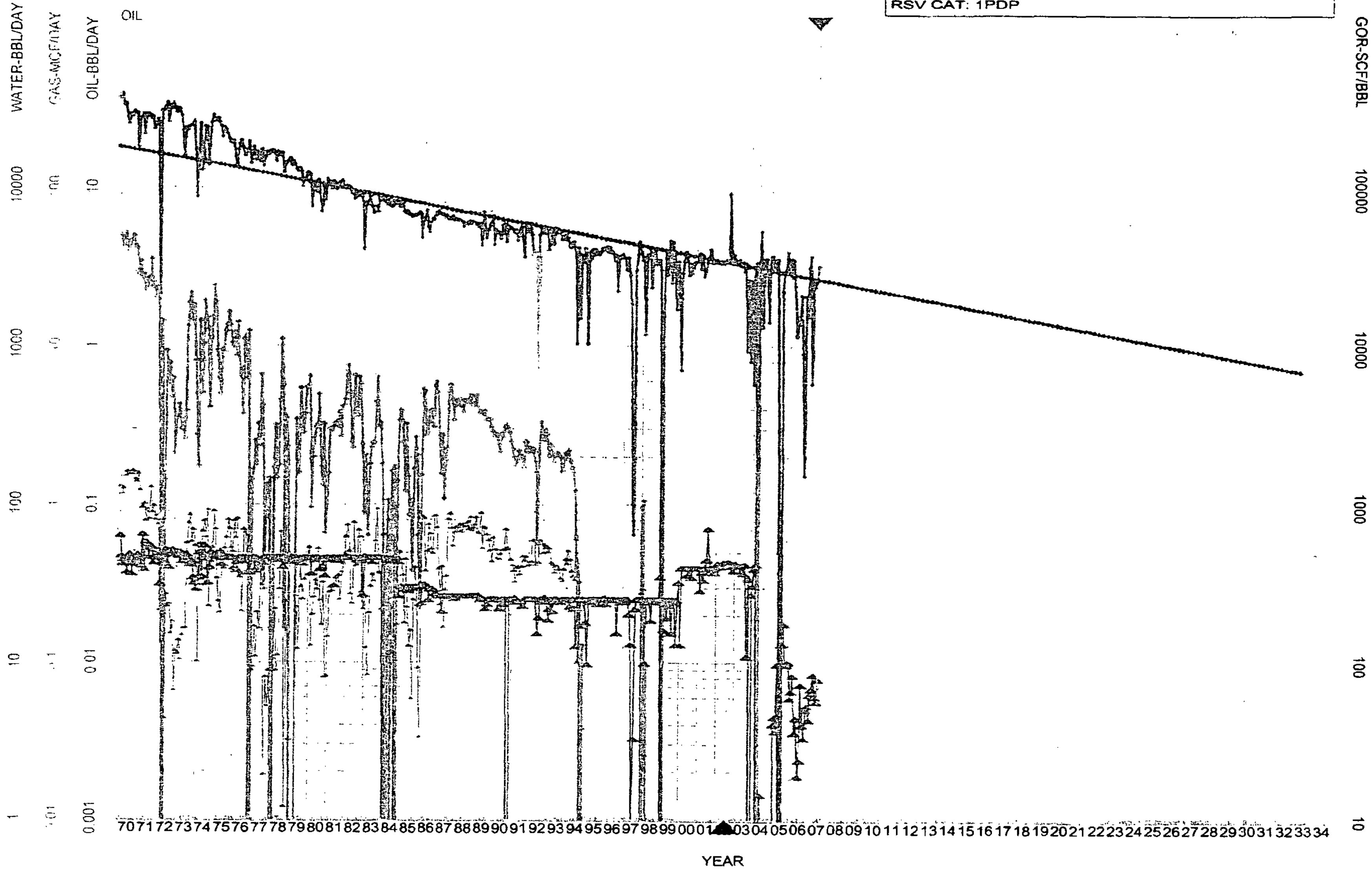
## AUGUST, 2007

# QUAIL TOTAL FIELD
12 ACTIVE WELLS PLUS
8 INACTIVE WELLS



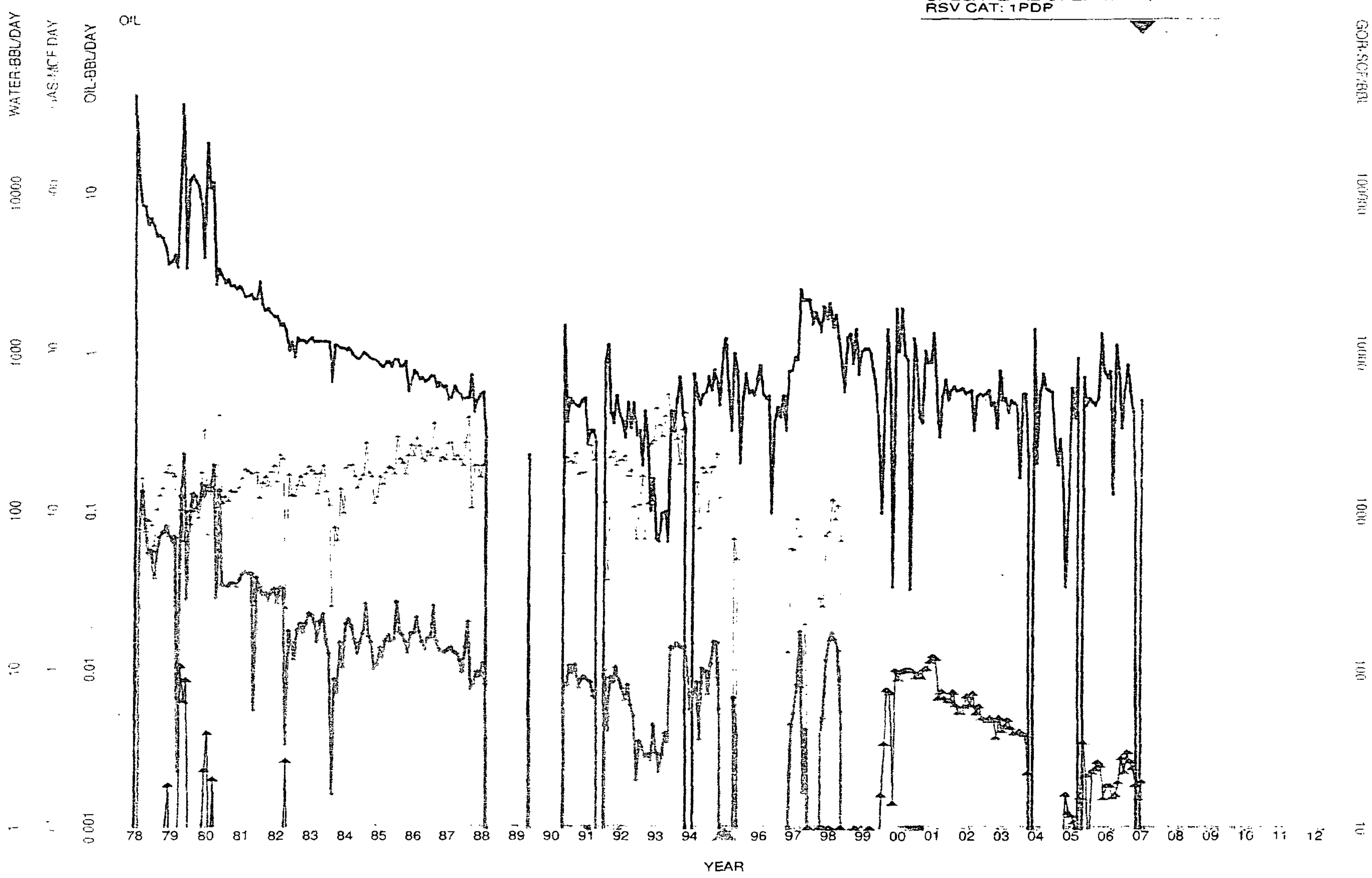

| | OIL-BBL/DAY | GAS-MCF/DAY | WATER-BBL/DA | GOR-SCF/BBL | WATER_INJ-BB | WELL COUNT |
|---|---|---|---|---|---|---|
| Qual= | GGA0707 | GAS - 1 | WATER - 1 | GOR - 1 | WATER_INJ - 1 | WELL_COUNT - 1 |
| Ref= | 7/2007 | 7/2007 | 7/2007 | 7/2007 | 7/2007 | 7/2007 |
| Cum= | 799248 | 0 | 0 | 0 | 0 | 0 |
| Rem= | 78720 | 0 | 0 | 0 | 0 | 0 |
| EUR= | 877968 | 0 | 0 | 0 | 0 | 0 |
| Yrs= | 31.663 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Qref= | 15.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| De= | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| Dmin= | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| b= | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| Qab= | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

SEQ #:814 ATLANTIC RICHFIELD 1
QUAIL
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
| Qual= | GGA0707 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 83682 | Cum= | 465004 | Cum= | 24326 |
| Cum= | 152273 | | | | | | |
| Rem= | 13815 | | | | | | |
| EUR= | 166088 | | | | | | |
| Yrs= | 25.997 | | | | | | |
| Qref= | 2.6 | | | | | | |
| De= | 5.000000 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 0.000000 | | | | | | |
| Qab= | 0.7 | | | | | | |

SEQ #:1363 WAINOCO STATE 1
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP




| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Cum= | 15927 | Cum= | 15231 | Cum= | 15898 | Cum= | 0 |

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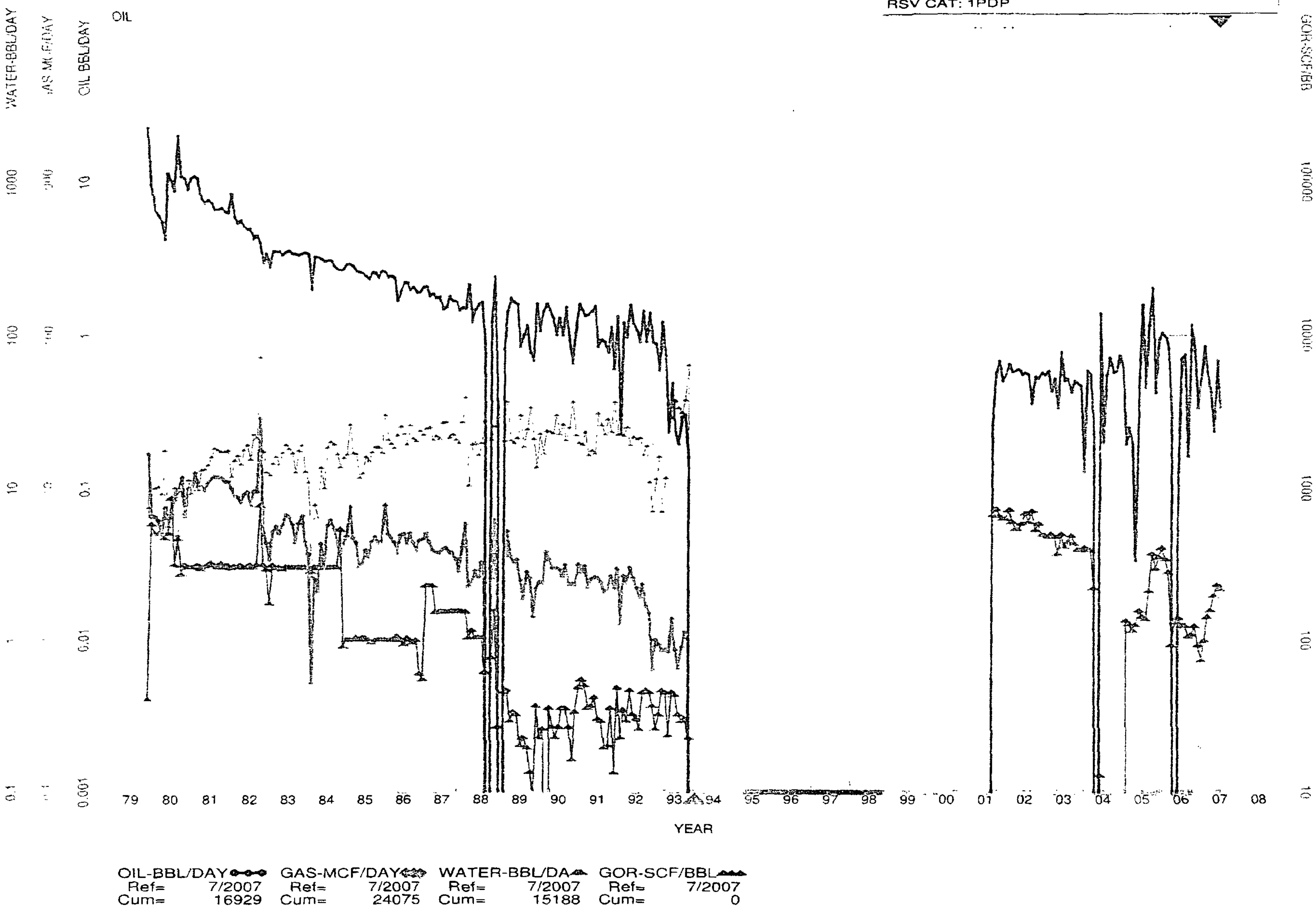
QUAIL , QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP



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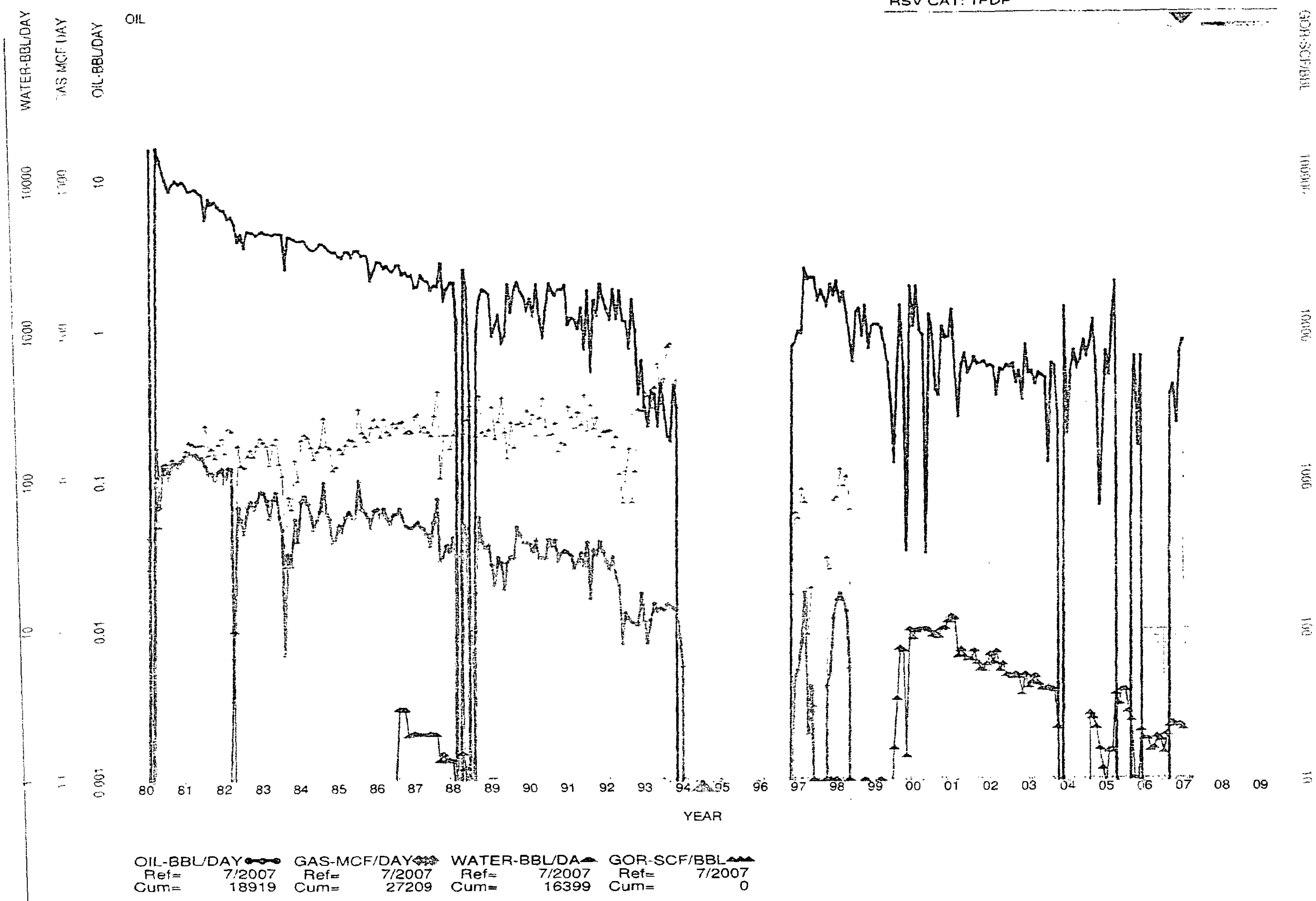
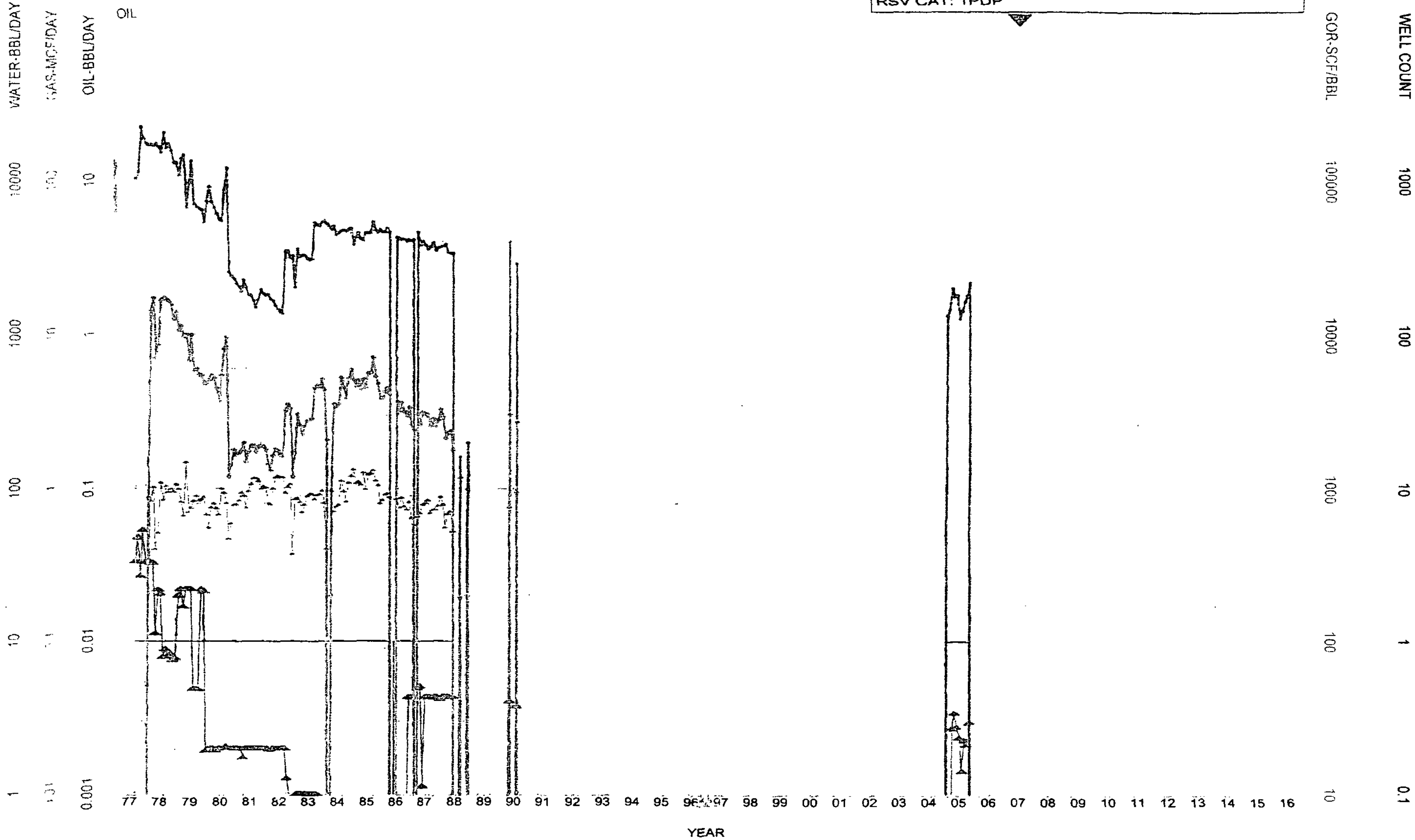
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP



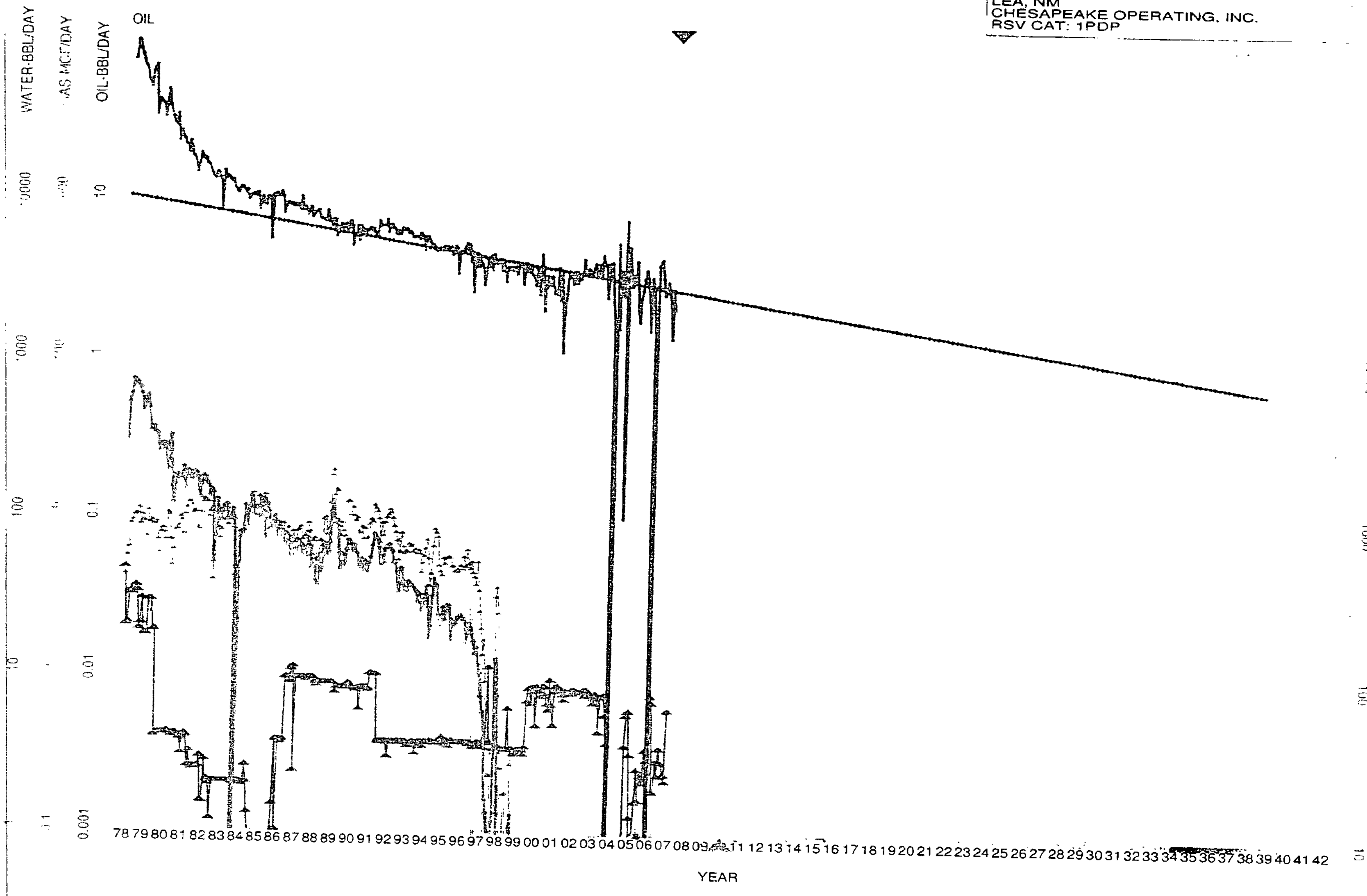
**SEQ #:1370 QUAIL STATE 1 SI INJ**

QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP



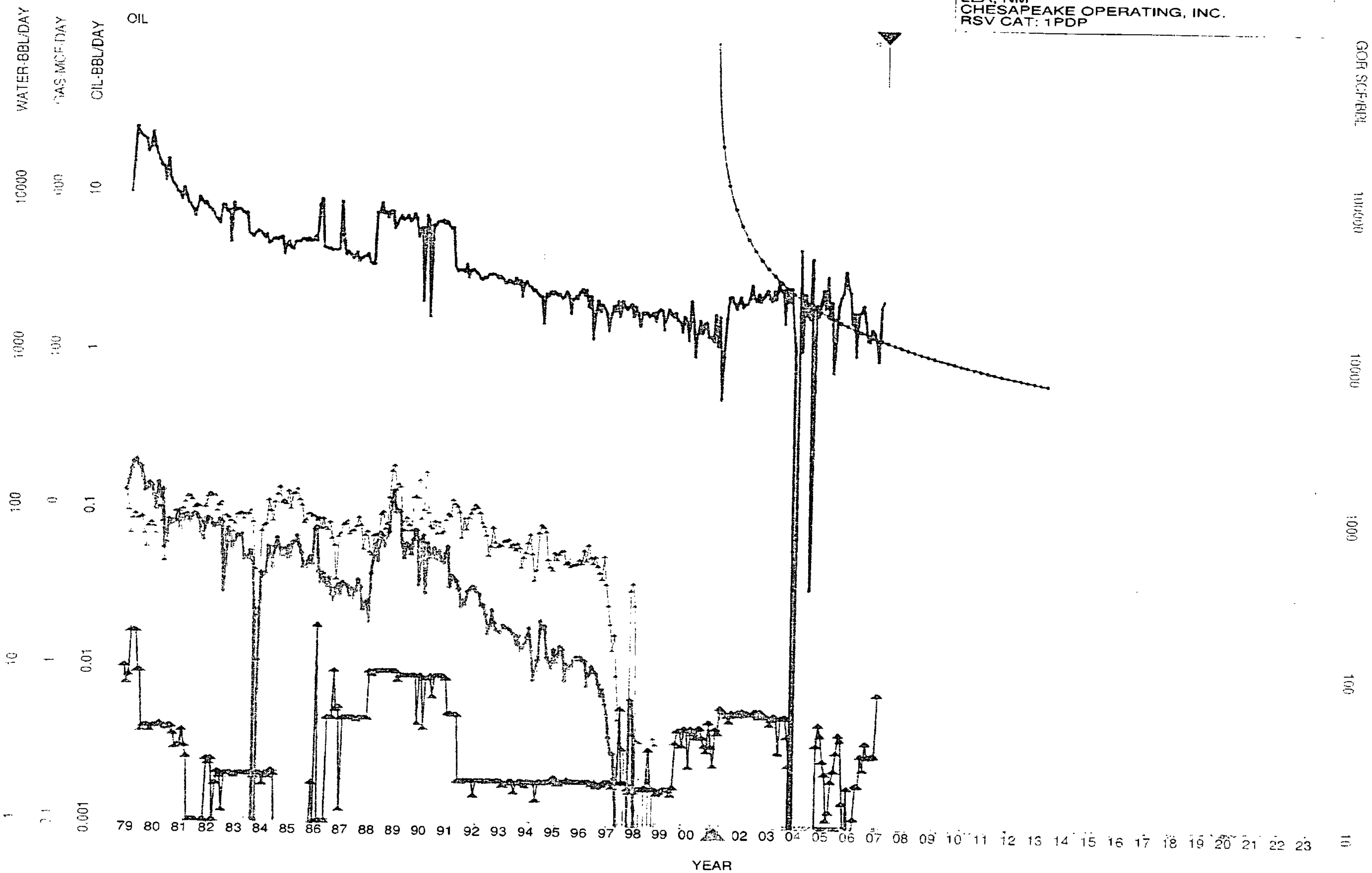

| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | | WATER_INJ-BB | | WELL COUNT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Qual= | CEC0407 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 17581 | Cum= | 23472 | Cum= | 0 | Cum= | 206908 | Cum= | 142 |
| Cum= | 23961 | | | | | | | | | | |
| Rem= | 0 | | | | | | | | | | |
| EUR= | 23961 | | | | | | | | | | |
| Yrs= | 0.419 | | | | | | | | | | |
| Qref= | 0.0 | | | | | | | | | | |
| De= | 0.000000 | | | | | | | | | | |
| Dmin= | 0.000 | | | | | | | | | | |
| b= | 0.000000 | | | | | | | | | | |
| Qab= | 0.0 | | | | | | | | | | |

SEQ #:1369 QUAIL STATE 2
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP



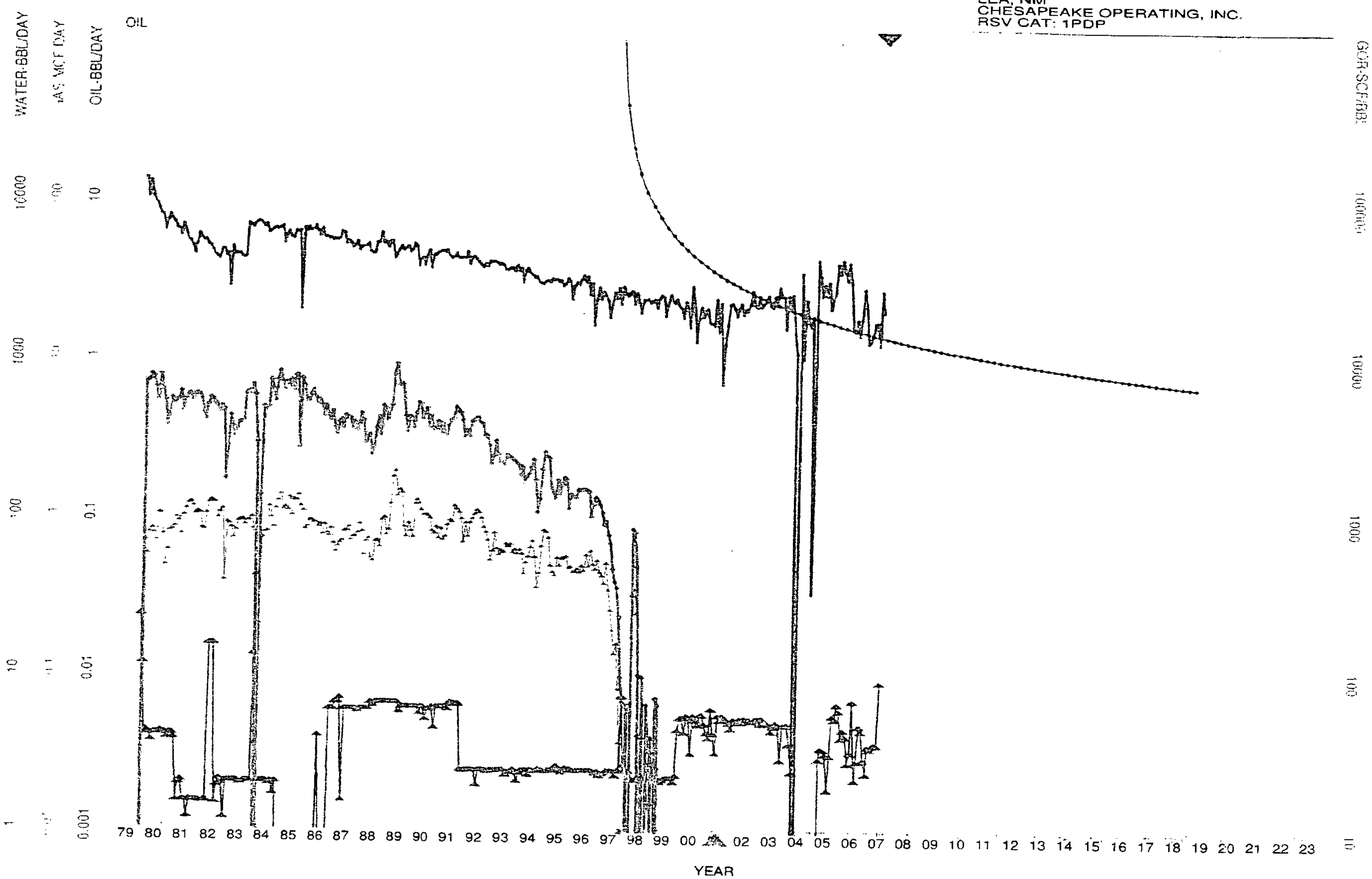

| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Qual= | GGA0707 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 78634 | Cum= | 62942 | Cum= | 0 |
| Cum= | 107142 | | | | | | |
| Rem= | 17227 | | | | | | |
| EUR= | 124369 | | | | | | |
| Yrs= | 31.663 | | | | | | |
| Qref= | 2.7 | | | | | | |
| De= | 4.239793 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 0.000000 | | | | | | |
| Qab= | 0.7 | | | | | | |

SEQ #:1368 QUAIL STATE 3Y
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP



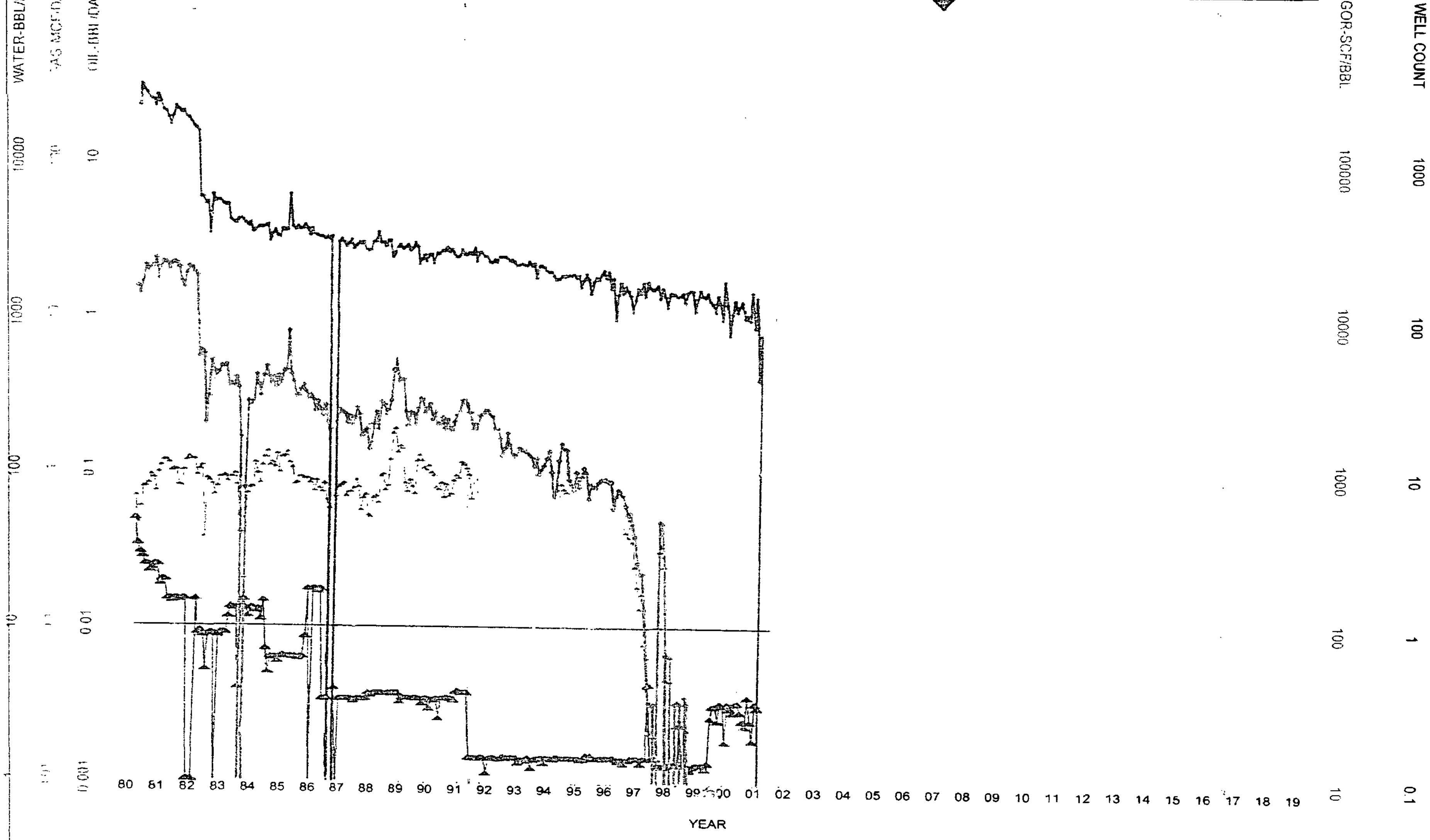

| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Qual= | GGA0707 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 33480 | Cum= | 36129 | Cum= | 0 |
| Cum= | 46709 | | | | | | |
| Rem= | 2124 | | | | | | |
| EUR= | 48833 | | | | | | |
| Yrs= | 6.249 | | | | | | |
| Qref= | 1.3 | | | | | | |
| De= | 12.408345 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 1.100000 | | | | | | |
| Qab= | 0.7 | | | | | | |

SEQ #:1367 QUAIL STATE 4
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP



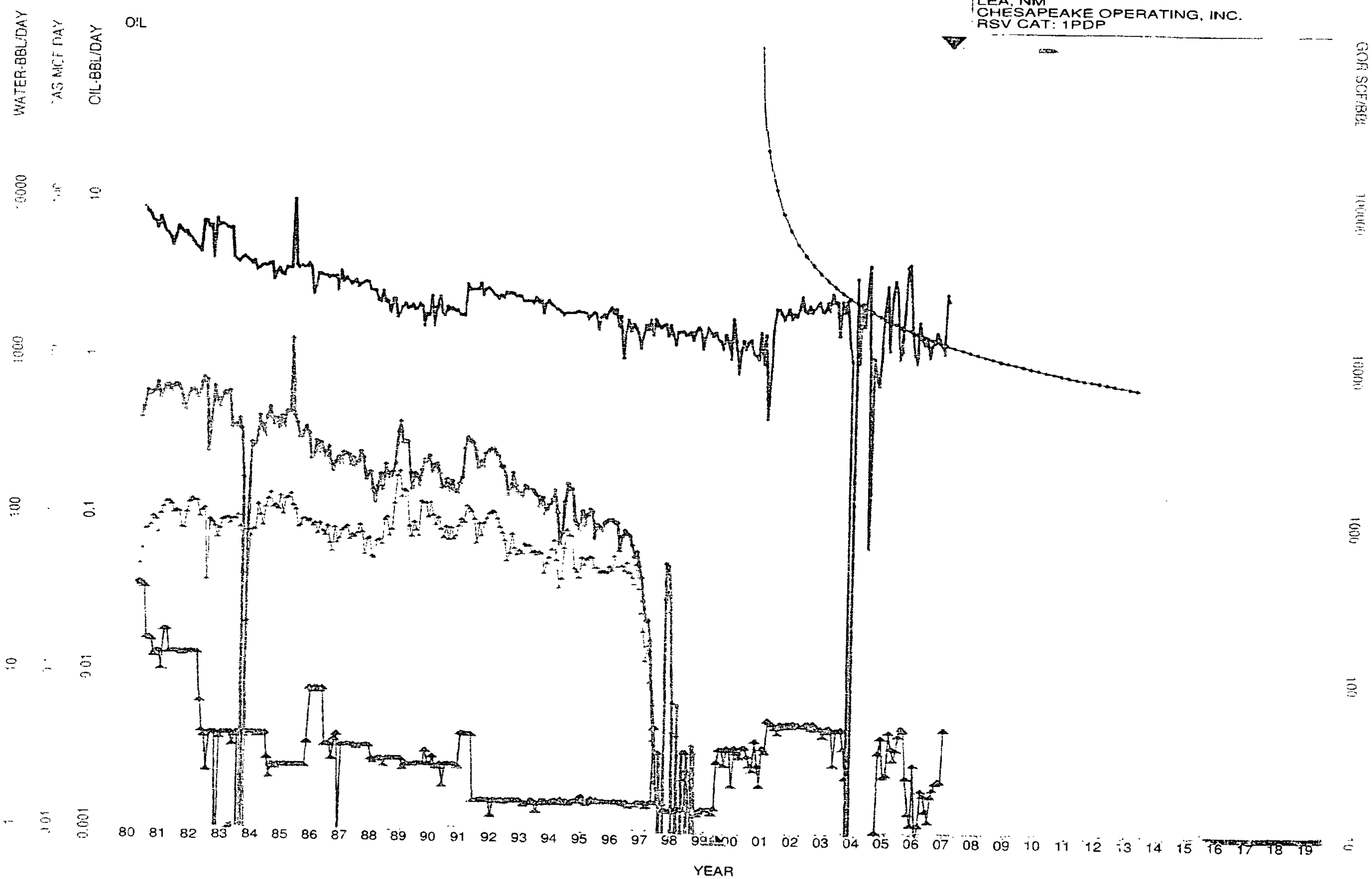

| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Qual= | GGA0707 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 25358 | Cum= | 36434 | Cum= | 0 |
| Cum= | 39368 | | | | | | |
| Rem= | 4132 | | | | | | |
| EUR= | 43500 | | | | | | |
| Yrs= | 11.748 | | | | | | |
| Qref= | 1.4 | | | | | | |
| De= | 8.362479 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 1.100000 | | | | | | |
| Qab= | 0.7 | | | | | | |

**SEQ #:1366 QUAIL STATE 5 SI**
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 2PDSI



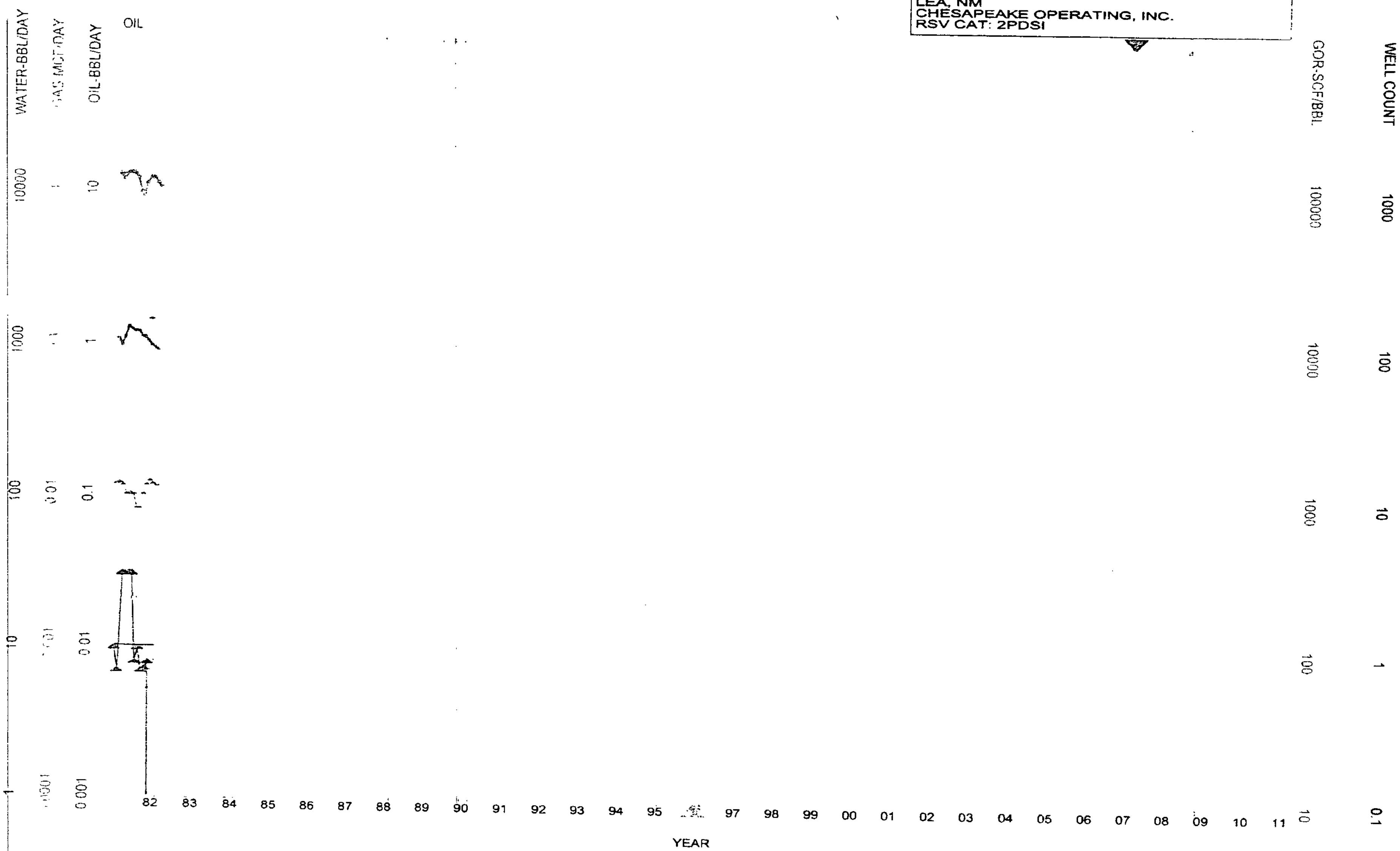

| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | | WATER_INJ-BB | | WELL COUNT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Qual= | CEC0407 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 26687 | Cum= | 41336 | Cum= | 0 | Cum= | 0 | Cum= | 257 |
| Cum= | 32623 | | | | | | | | | | |
| Rem= | 0 | | | | | | | | | | |
| EUR= | 32623 | | | | | | | | | | |
| Yrs= | 0.419 | | | | | | | | | | |
| Qref= | 0.0 | | | | | | | | | | |
| De= | 0.000000 | | | | | | | | | | |
| Dmin= | 0.000 | | | | | | | | | | |
| b= | 0.000000 | | | | | | | | | | |
| Qab= | 0.0 | | | | | | | | | | |

SEQ #:1365 QUAIL STATE 6
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP



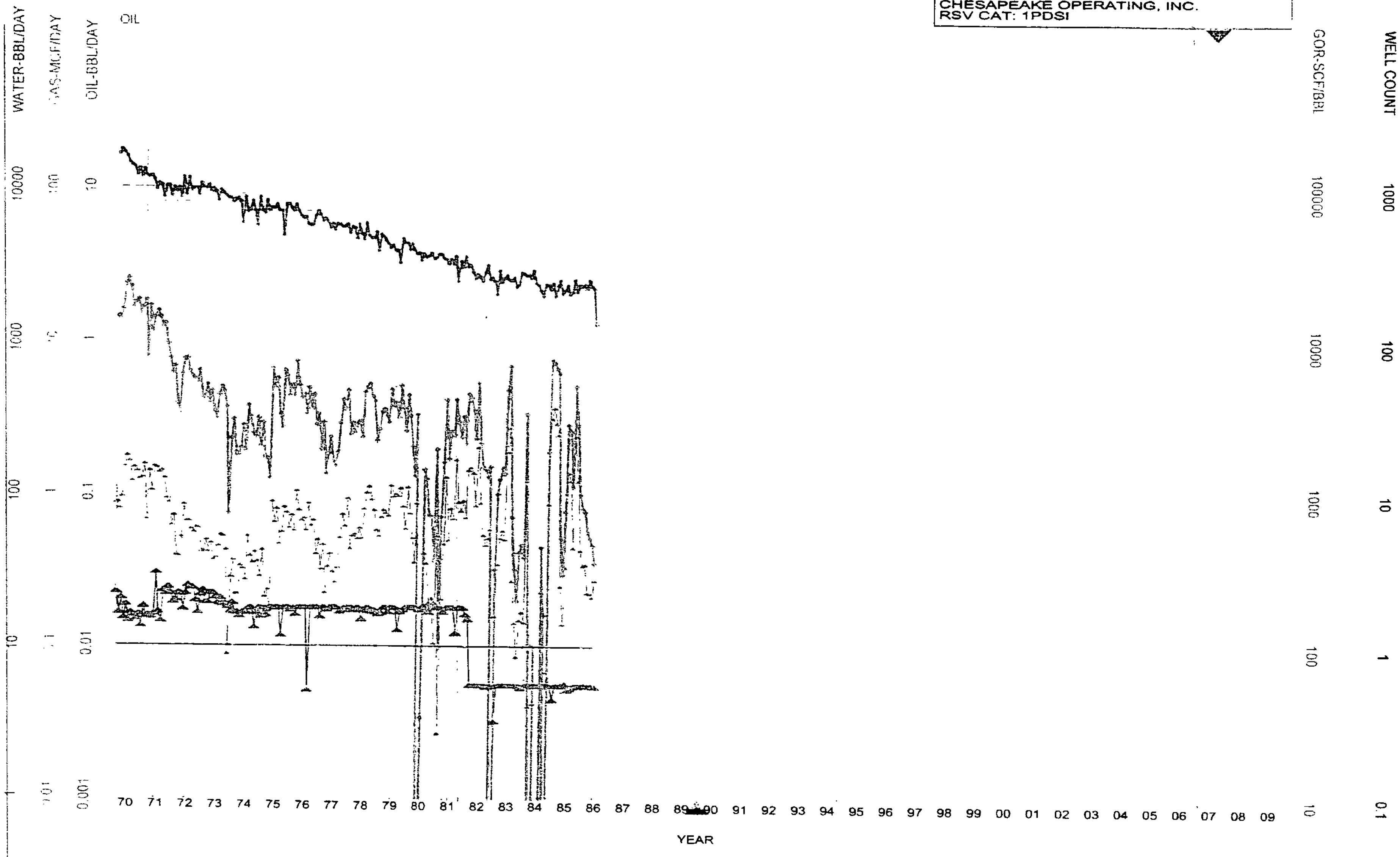

| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Qual= | GGA0707 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 16653 | Cum= | 36260 | Cum= | 0 |
| Cum= | 26108 | | | | | | |
| Rem= | 2165 | | | | | | |
| EUR= | 28273 | | | | | | |
| Yrs= | 6.334 | | | | | | |
| Qref= | 1.3 | | | | | | |
| De= | 12.408345 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 1.100000 | | | | | | |
| Qab= | 0.7 | | | | | | |

**SEQ #:1364 QUAIL STATE 7 SI**
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 2PDSI




| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | | WATER_INJ-BB | | WELL COUNT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Qual= | CEC0407 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 455 | Cum= | 5360 | Cum= | 0 | Cum= | 0 | Cum= | 13 |
| Cum= | 429 | | | | | | | | | | |
| Rem= | 0 | | | | | | | | | | |
| EUR= | 429 | | | | | | | | | | |
| Yrs= | 1.419 | | | | | | | | | | |
| Qref= | 0.0 | | | | | | | | | | |
| De= | 0.000000 | | | | | | | | | | |
| Dmin= | 0.000 | | | | | | | | | | |
| b= | 0.000000 | | | | | | | | | | |
| Qab= | 0.0 | | | | | | | | | | |

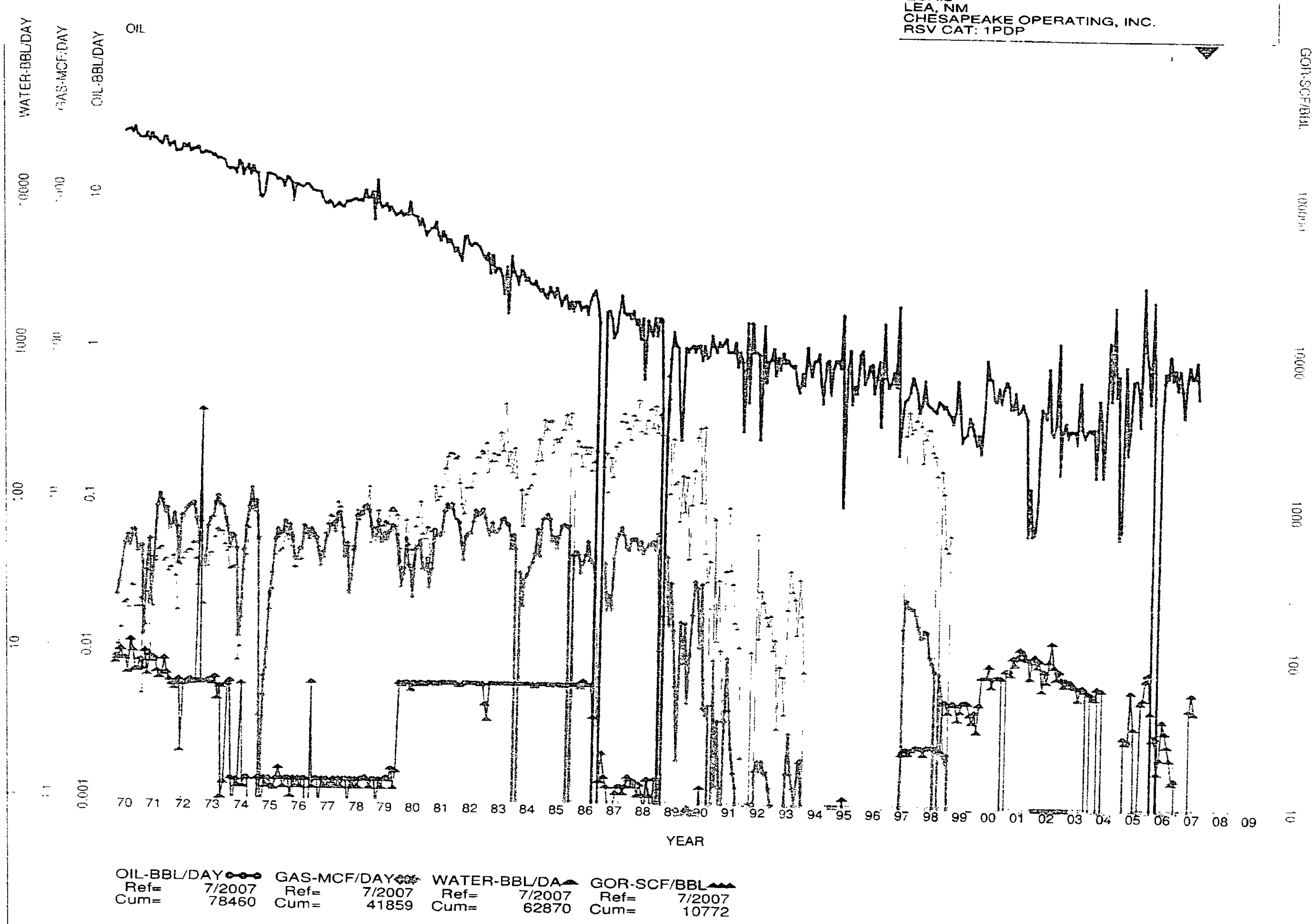
SEQ #:1376 FEDERAL A 1 SI
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDSI

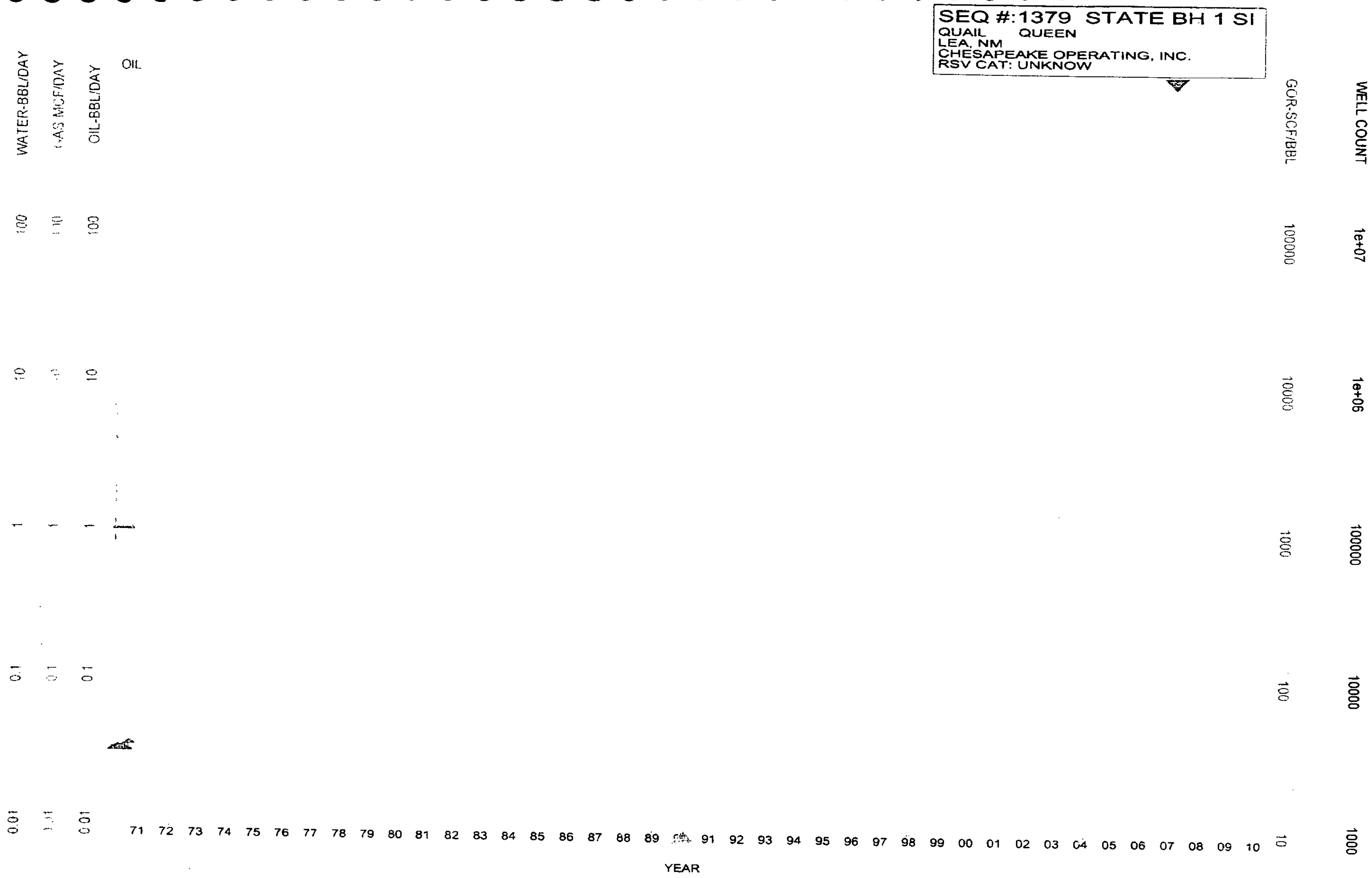



| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | | WATER_INJ-BB | | WELL COUNT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Qual= | CEC0407 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 31385 | Cum= | 92129 | Cum= | 5088 | Cum= | 4462 | Cum= | 197 |
| Cum= | 40416 | | | | | | | | | | |
| Rem= | 0 | | | | | | | | | | |
| EUR= | 40416 | | | | | | | | | | |
| Yrs= | 0.419 | | | | | | | | | | |
| Qref= | 0.0 | | | | | | | | | | |
| De= | 0.000000 | | | | | | | | | | |
| Dmin= | 0.000 | | | | | | | | | | |
| b= | 0.000000 | | | | | | | | | | |
| Qab= | 0.0 | | | | | | | | | | |

## SEQ #:901 PENNZOIL STATE 1

QUAIL
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP






OIL-BBL/DAY
Qual= CEC0407
Ref= 7/2007
Cum= 7232
Rem= 0
EUR= 7232
Yrs= 0.419
Qref= 0.0
De= 0.000000
Dmin= 0.000
b= 0.000000
Qab= 0.0

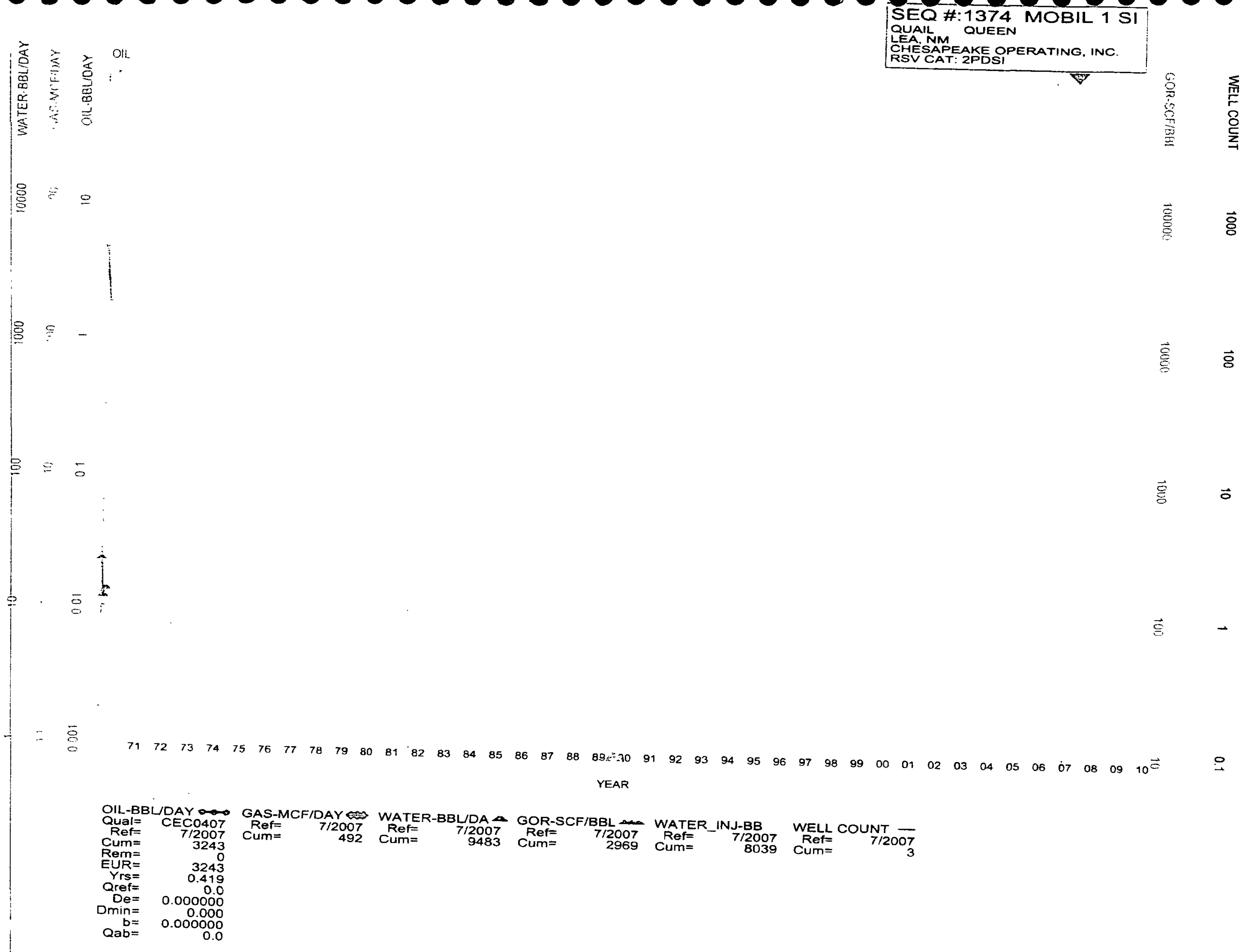
GAS-MCF/DAY
Ref= 7/2007
Cum= 2109

WATER-BBL/DA
Ref= 7/2007
Cum= 13333

GOR-SCF/BBL
Ref= 7/2007
Cum= 7232

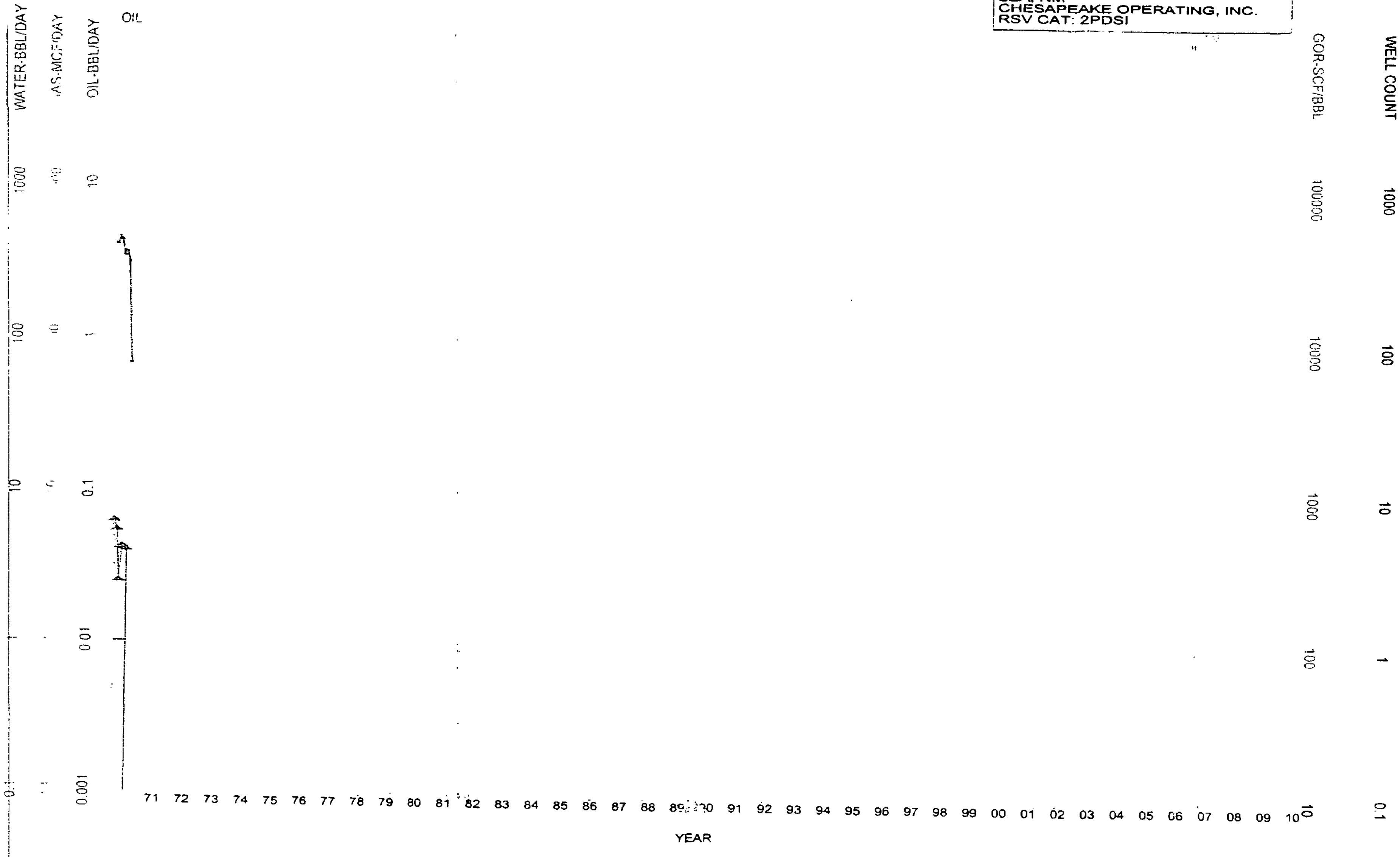
WATER_INJ-BB
Ref= 7/2007
Cum= 13325

WELL COUNT
Ref= 7/2007
Cum= 0



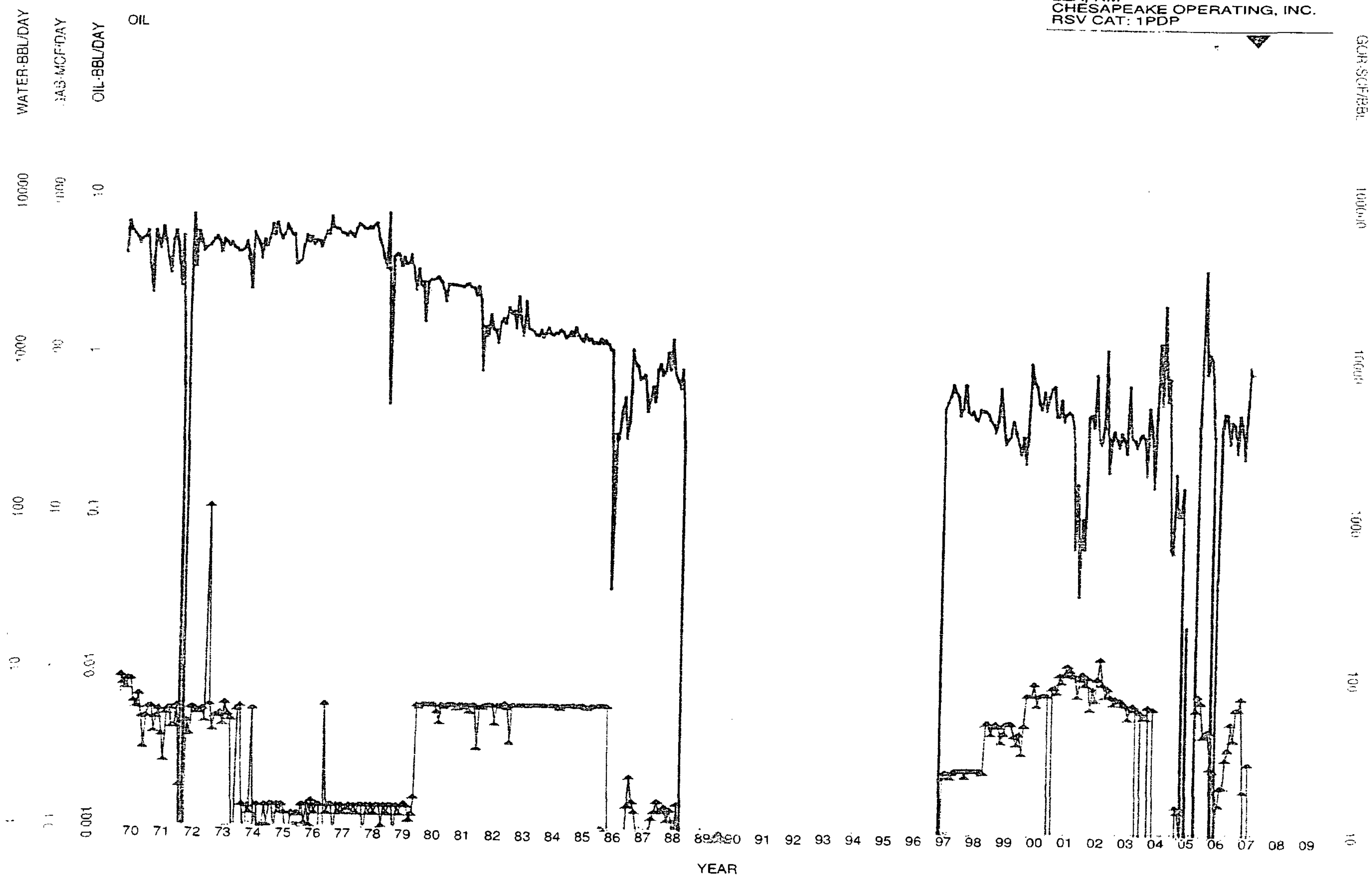
SEQ #:1374 MOBIL 1 SI
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 2PDSI
WATER-BBL/DAY
OIL-BBL/DAY
OIL
10000
1000
100
10
1
10
1
0.1
0.01
0.001
GOR-SCF/BBL
100000
10000
1000
100
10
WELL COUNT
1000
100
10
1
0.1
71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
YEAR
OIL-BBL/DAY
Qual= CEC0407
Ref= 7/2007
Cum= 3243
Rem= 0
EUR= 3243
Yrs= 0.419
Qref= 0.0
De= 0.000000
Dmin= 0.000
b= 0.000000
Qab= 0.0
GAS-MCF/DAY
Ref= 7/2007
Cum= 492
WATER-BBL/DA
Ref= 7/2007
Cum= 9483
GOR-SCF/BBL
Ref= 7/2007
Cum= 2969
WATER_INJ-BB
Ref= 7/2007
Cum= 8039
WELL COUNT
Ref= 7/2007
Cum= 3

SEQ #:1377 STATE 1 SI
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 2PDSI



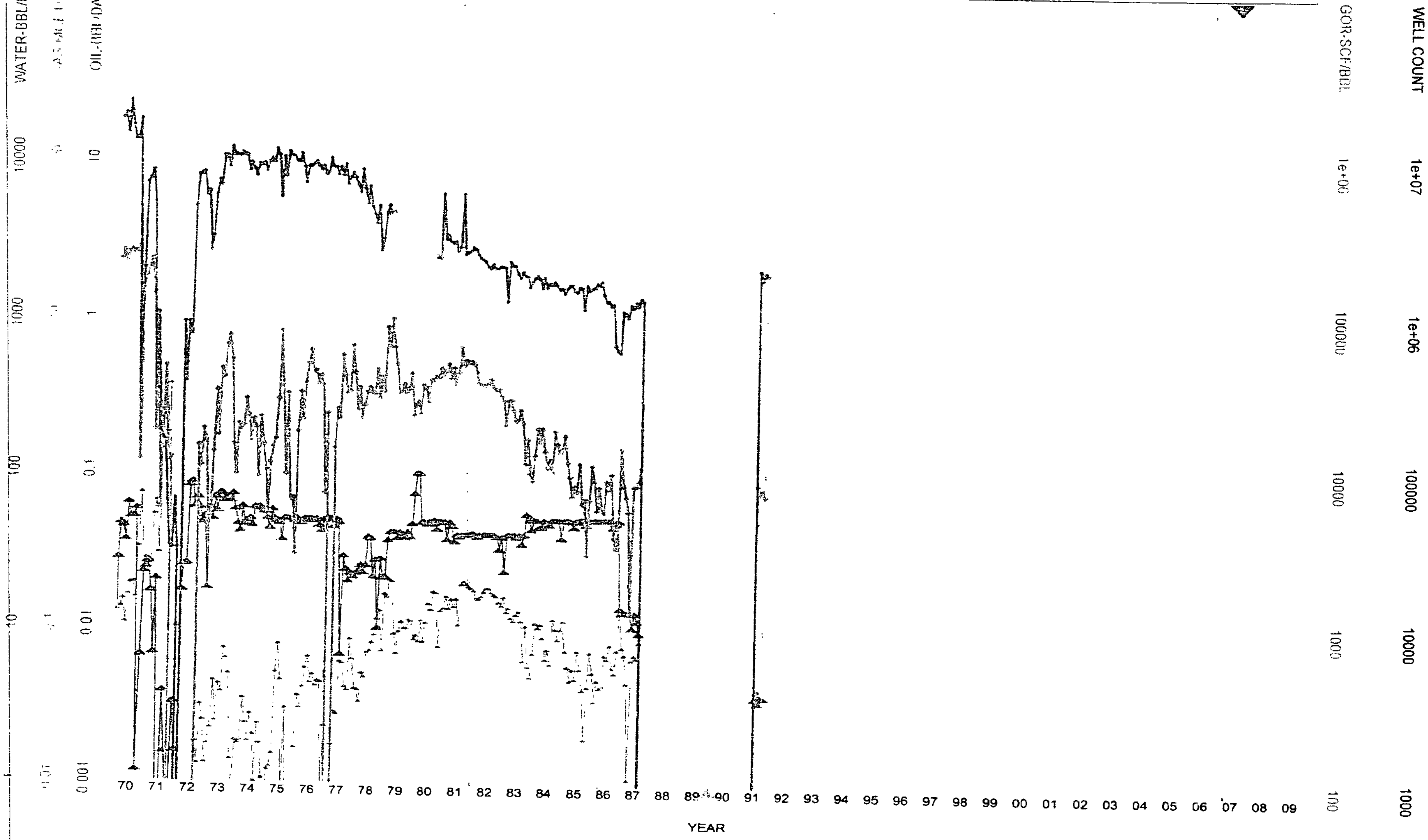

| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | | WATER_INJ-BB | | WELL COUNT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Qual= | CEC0407 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 0 | Cum= | 1821 | Cum= | 962 | Cum= | 1020 | Cum= | 7 |
| Cum= | 1667 | | | | | | | | | | |
| Rem= | 0 | | | | | | | | | | |
| EUR= | 1667 | | | | | | | | | | |
| Yrs= | 0.419 | | | | | | | | | | |
| Qref= | 0.0 | | | | | | | | | | |
| De= | 0.000000 | | | | | | | | | | |
| Dmin= | 0.000 | | | | | | | | | | |
| b= | 0.000000 | | | | | | | | | | |
| Qab= | 0.0 | | | | | | | | | | |

SEQ #:922 STATE C 1
QUAIL
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP




| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Cum= | 24898 | Cum= | 0 | Cum= | 47219 | Cum= | 866 |

**SEQ #:1378 STATE BG 1 SI**
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: UNKNOW




OIL-BBL/DAY
Qual= CEC0407
Ref= 7/2007
Cum= 66301
Rem= 0
EUR= 66301
Yrs= 0.419
Qref= 0.0
De= 0.000000
Dmin= 0.000
b= 0.000000
Qab= 0.0

GAS-MCF/DAY
Ref= 7/2007
Cum= 45236

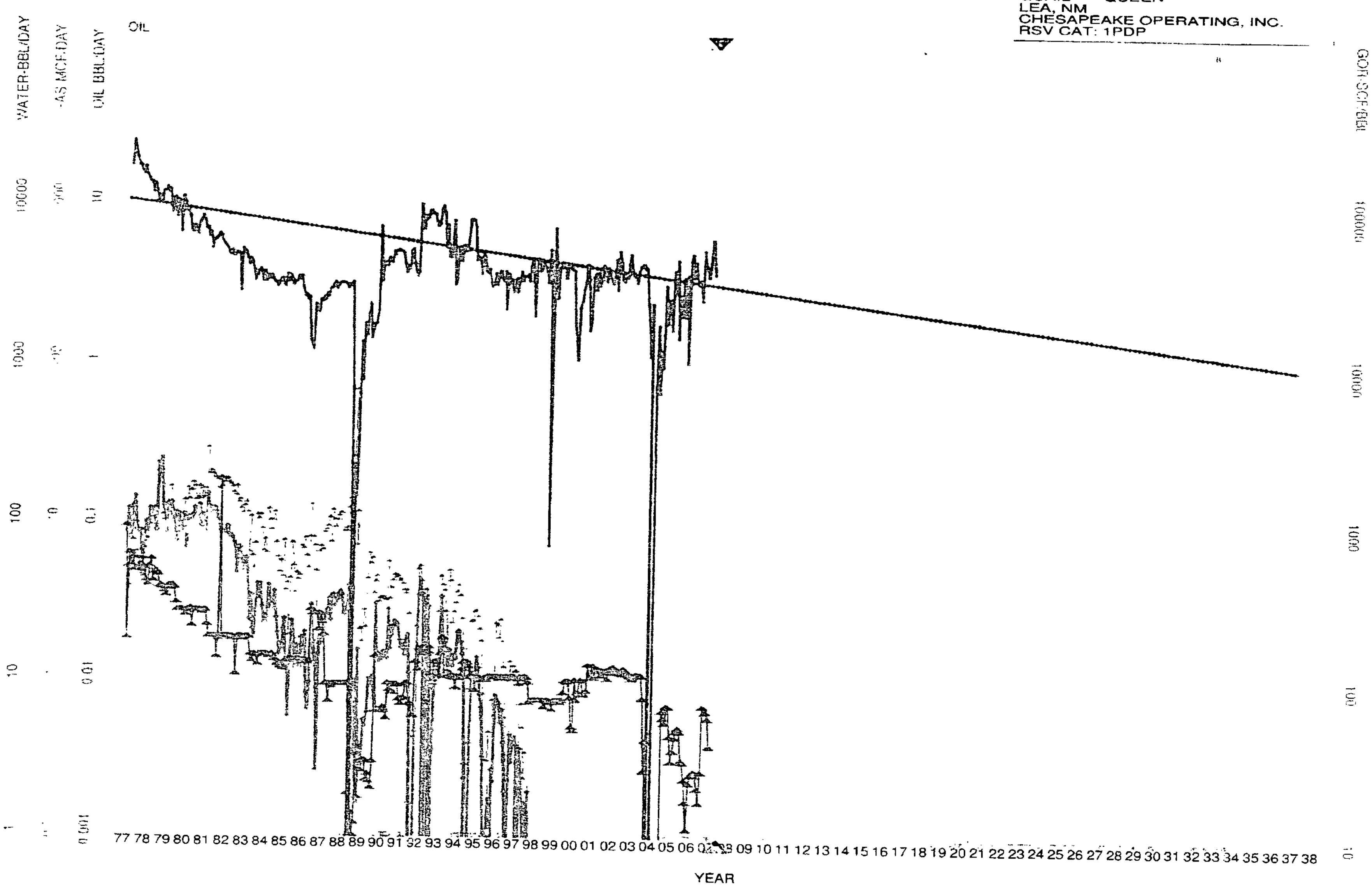
WATER-BBL/DA
Ref= 7/2007
Cum= 321428

GOR-SCF/BBL
Ref= 7/2007
Cum= 33805

WATER_INJ-BB
Ref= 7/2007
Cum= 57047

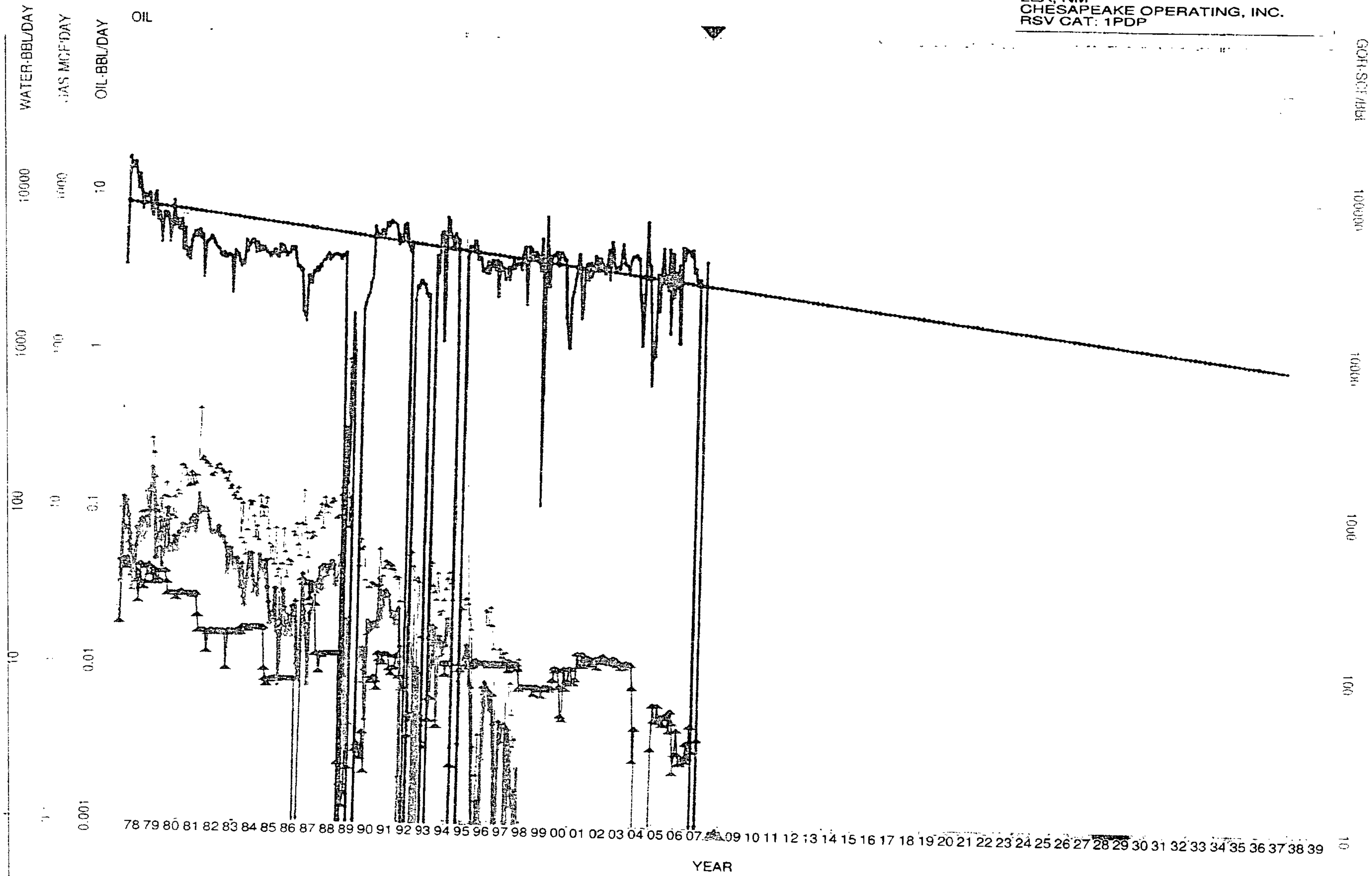
WELL COUNT
Ref= 7/2007
Cum= 0

SEQ #:1372 STATE BG 2
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP




| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Qual= | CEC0407 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 30087 | Cum= | 156536 | Cum= | 0 |
| Cum= | 52522 | | | | | | |
| Rem= | 21187 | | | | | | |
| EUR= | 73709 | | | | | | |
| Yrs= | 30.082 | | | | | | |
| Qref= | 3.2 | | | | | | |
| De= | 3.700000 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 0.000000 | | | | | | |
| Qab= | 1.0 | | | | | | |

SEQ #:1371 STATE BG 3
QUAIL QUEEN
LEA, NM
CHESAPEAKE OPERATING, INC.
RSV CAT: 1PDP




| OIL-BBL/DAY | | GAS-MCF/DAY | | WATER-BBL/DA | | GOR-SCF/BBL | |
|---|---|---|---|---|---|---|---|
| Qual= | GGA0707 | Ref= | 7/2007 | Ref= | 7/2007 | Ref= | 7/2007 |
| Ref= | 7/2007 | Cum= | 24222 | Cum= | 135030 | Cum= | 0 |
| Cum= | 44121 | | | | | | |
| Rem= | 17980 | | | | | | |
| EUR= | 62101 | | | | | | |
| Yrs= | 30.082 | | | | | | |
| Qref= | 2.7 | | | | | | |
| De= | 3.678537 | | | | | | |
| Dmin= | 0.000 | | | | | | |
| b= | 0.000000 | | | | | | |
| Qab= | 0.9 | | | | | | |

# Quail Queen Field
# OOIP Calculation

## Appendix B

**Reservoir Parameters:**

| | | |
|---|---|---|
| BHT = 113$^\circ$F | $p_i$ = 1,848 psi | $P_{sp}$ (est.) = 100 psi |
| $p_b$ = 1,255 psi | $T_{sp}$ (est.) = 90$^\circ$F | $R_{si}$ = 300 cf/bbl |
| Gas G = 0.9 | $\beta_{oi}$ = 1.15 | Oil G = 33$^\circ$ API |
| $\beta_{ob}$ = 1.15 | $p_{ab}$ = 250 psi | $\beta_{oab}$ = 1.04 |
| $p_{cur}$ = 450 psi | $\beta_{ocur}$ = 1.06 | |

**OOIP Calculation:**

Queen B

$$OOIP = \frac{7758 * Ah * \Phi * (1-S_w)}{\beta_{oi}} = \frac{7758 * 2874 * 0.10 * (1-0.49)}{1.15}$$

$$= 988{,}800 \text{ STB}$$

Queen C

$$OOIP = \frac{7758 * Ah * \Phi * (1-S_w)}{\beta_{oi}} = \frac{7758 * 7212 * 0.13 * (1-0.45)}{1.15}$$

$$= 3{,}478{,}673 \text{ STB}$$

Queen B and Queen C

$$OOIP = 988{,}800 + 3{,}478{,}673 = \boxed{4{,}467{,}473 \text{ STB}}$$

# Appendix C

# Proposed Quail Queen Unit Waterflood Calculations

**Reservoir Parameters:**

| | | |
|---|---|---|
| BHT = 113°F | $p_i$ = 1,848 psi | $P_{sp}$ (est.) = 100 psi |
| $p_b$ = 1,255 psi | $T_{sp}$ (est.) = 90°F | $R_{si}$ = 300 cf/bbl |
| Gas G = 0.9 | $\beta_{oi}$ = 1.15 | Oil G = 33° API |
| $\beta_{ob}$ = 1.15 | $p_{ab}$ = 250 psi | $\beta_{oab}$ = 1.04 |
| $p_{cur}$ = 450 psi | $\beta_{ocur}$ = 1.06 | $\mu_{ocur}$ = 4.21cp |
| $\mu_{wcur}$ = 0.915 | | |

1. As previously calculated in Appendix B

   $\boxed{\text{OOIP} = N = 4{,}467{,}473 \text{ STB}}$

2. Oil Saturation at primary abandonment pressure of 250 psi

   $S_{or\text{-}pri} = (1 - \Delta N_p/N)\,(\beta_{oab}/\,\beta_{oi})\,(1 - S_w)$

   $= [1 - (866{,}568/4{,}467{,}473)]\,(1.04/1.15)\,(1 - 0.45)$

   $= (0.8060)\,(0.9043)\,(0.55)$

   $= \boxed{0.4009}$

   Estimating water injection to start by July 1, 2008 then oil saturation at start of flood is calculated with current pressure and another 8,390 bbls of oil produced.

   $S_{ocur} = [1 - (874{,}958/4{,}467{,}473)]\,(1.06/1.15)\,(1 - 0.45)$

   $= (0.8041)\,(0.9217)\,(0.55)$

   $= \boxed{0.4077}$

3. Mobility Ratio = $\lambda_w/\lambda_o = (k_{rw}/\mu_w) / (k_{ro}/\mu_o)$

Mobility of the water in the water bank

The fractional flow curve shows the average water saturation in the water bank is 54 percent. At this water saturation the relative permeability curve shows the $k_{rw}$ to be 0.12. The viscosity of the water at 450 psi is 0.915.

$$\lambda_w = k_{rw}/\mu_w = 0.12/0.915 = 0.13$$

Mobility of the oil in the oil bank

In the oil bank the relative permeability to oil is 100 percent.

$$\lambda_o = k_{ro}/\mu_o = 1.0/4.21 = 0.23$$

Mobility Ratio = M = 0.13/0.23 = $\boxed{0.57}$

M is less than 1 which is favorable for waterflooding because it is easier for water to displace oil in the reservoir.

4. Permeability Variation (See Attachment No. 15)

$$V = \frac{k_{50} - k_{84}}{K_{50}} = \frac{3.2 - 0.55}{3.2} = \frac{2.65}{3.2} = \boxed{0.828}$$

V less than 0.75 is good, so this value indicates a fairly high level of variation.

5. Volumetric Sweep Efficiency

Empirical correlation with 100 layer Higgins-Leighton streamtube model show WOR = 25, $E_v$ = 70% and at a WOR = 50, $E_v$ = $\boxed{72\%}$

Refer to Fig.'s 6.22 and 6.23, Page 206, Wilhite's SPE Text Vol. 3.

6. Waterflood Recovery

Secondary Reserves = $7758 \text{ Ah } \Phi \text{ } (S_{or\text{-}pri} - S_{or}) \text{ } E_v / \beta_{ocur}$

$= [7758 * 10{,}086 * 0.13 \text{ } (0.4009 - 0.30) \text{ } 0.72] / 1.06$

$= \boxed{697{,}156 \text{ STB}}$

Secondary Recovery Factor = 697,156/4,467,473 = $\boxed{0.156}$

Secondary : Primary Ratio = 697,156/866,568 = $\boxed{0.805}$

7. Gas Saturation estimated at start of flood

   Assume injection begins July 1, 2008

   $S_{oc} = (1 - \Delta N_p / N)\ (\beta_{ocur} / \beta_{oi})\ (1 - S_w)$

   $= (1 - (866{,}568/4{,}467{,}473))\ (1.06 / 1.15)\ (1\text{-}0.45)$

   $= 0.806 * 0.9217 * 0.55$

   $= \boxed{0.4085}$

   $S_{gc} = 1 - S_{oc} - S_w$

   $= 1 - 0.4085 - 0.45$

   $= \boxed{0.14}$

8. Water Injection at Fillup

   $W_{if} = 7758\ A\Phi h S_{gc}$

   $= 7758\ (1788)\ (0.13)\ (5.64)\ (0.14)$

   $= \boxed{1{,}423{,}862 \text{ BBLS}}$