

Title: **“Improved Miscible Nitrogen Flood Performance Utilizing  
Advanced Reservoir Characterization and Horizontal Laterals  
in a Class I Reservoir – East Binger (Marchand) Unit”**

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## Abstract

Implementation of the East Binger Unit ("EBU") DOE Project continued during this reporting period. EBU 64-3H, the first horizontal well to be drilled in this Budget Period, has been drilled, stimulated, and put on production. Early performance has been consistent with expectations from reservoir characterization work that suggested the well would develop unswept reserves, as both the GOR and produced gas nitrogen content are well below field averages. The next horizontal well, initially planned to be drilled in 2002, will now be drilled in 2003.

The project includes one planned vertical injection well, EBU 74G-2. Initially planned for 2003, this is now planned for late 2002. EBU 74G-2 is near EBU 64-3H and will provide injection support to that well.

No additional planned conversions of production wells to injection service were completed in the period. One has been deferred to 2003 because of the change in drilling order, one is awaiting permit approval, and one is dependent on further technical evaluation using the simulation model.

Data gathering to monitor the impact of the development work on the performance of the nitrogen flood has been initiated. Early data is encouraging, as three wells near a previously drilled horizontal well are cycling less nitrogen. The early data also adds further evidence to the observed dominant east-west flow direction discussed in previous reports.

Final decisions on field work to be completed in 2003 will be guided by continued work with the simulation model, after completing the reconstruction of the history match to better honor observed field behavior. This reconstruction is nearing completion.

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## Quarterly Technical Progress Report – 3<sup>rd</sup> Quarter 2002

### Introduction

Budget Period 2 of the East Binger Unit (“EBU”) DOE Project is the period during which the pilot project will be implemented in the field. Implementation will include drilling three new horizontal producing wells and one new injection well, converting five producers to injection service, and expanding injection capacity for the field. The pilot area is shown in Figure 1 and the planned well work is shown in Figure 2.

This quarterly report covers the Third Quarter of 2002, the second quarter of Budget Period 2. Implementation of the pilot project began in the Second Quarter of 2002 with the drilling of the first of the horizontal wells, EBU 64-3H. This well was completed, stimulated, and put on production in the Third Quarter. The early performance of this well will be discussed in this report. Data gathering aimed at monitoring the impact of the project on reducing gas cycling was also initiated and will be discussed.

### Executive Summary

Implementation of the East Binger Unit (“EBU”) DOE Project continues. EBU 64-3H, the first horizontal well to be drilled in this Budget Period, has been drilled, stimulated, and put on production. Early performance has been consistent with expectations from reservoir characterization work that suggested the well would develop unswept reserves, as both the GOR and produced gas nitrogen content are well below field averages. The next horizontal well, initially planned to be drilled in 2002, will now be drilled in 2003.

The project includes one planned vertical injection well, EBU 74G-2. Initially planned for 2003, this is now planned for late 2002. EBU 74G-2 is near EBU 64-3H and will provide injection support to that well.

No additional planned conversions of production wells to injection service were completed in the period. One has been deferred to 2003 because of the change in drilling order, one is awaiting permit approval, and one is dependent on further technical evaluation using the simulation model.

Data gathering to monitor the impact of the development work on the performance of the nitrogen flood has been initiated. Early data is encouraging, as three wells near a previously drilled horizontal well are cycling less nitrogen. The early data also adds further evidence to the observed dominant east-west flow direction discussed in previous reports.

Final decisions on field work to be completed in 2003 will be guided by continued work with the simulation model, after completing the reconstruction of the history match to better honor observed field behavior. This reconstruction is nearing completion.

## Results and Discussion

The following is a detailed review of the work conducted in this reporting period.

### *Task 1.2.1 – Drill New Horizontal Producing Wells*

Well EBU 64-3H, the first of the planned horizontal producing wells was spud in May and completed in the third quarter. Figure 2 shows the location of the open hole section of this wellbore. Problems encountered during the drilling were reported and discussed in the previous Quarterly Technical Progress Report (15121R09).

Following a gelled diesel breakdown – actually an attempt to stimulate the well with a propped fracture which had to be shut down prior to the proppant stages of the treatment – the well has been on production at well over 100 bopd, as shown in Figure 3. Production has been declining steadily, and plans to re-attempt the fracture treatment are in place. Prior to the breakdown, attempts to flow EBU 64-3H without stimulation were largely unsuccessful. The well produced about 15 bopd for six days before loading up and ceasing to flow.

Initial results from EBU 64-3H have been consistent with expectations from reservoir characterization work that suggested the well would develop unswept reserves. The nitrogen content was a minuscule 1% prior to the breakdown, and increased to about 25% after the treatment. This is still well below the field producing average of 73.5% (prior the opening of this well). The GOR has leveled off at about 3.7 MCF/STB, also well below the field average of about 21 MCF/STB. In the first month with production from EBU 64-3H, the field's average producing GOR dropped from over 21 MCF/STB to under 18 MCF/STB and the average nitrogen content in the produced gas dropped from 73.5% to 70.0%.

The final cost of EBU 64-3H is expected to be about \$2,500,000 – significantly higher than the roughly \$1,600,000 estimated in the Budget Period 2 proposal. Most of the cost overrun can be tied to the problems and resulting sidetrack discussed in the previous report (15121R09).

The next planned horizontal producing well is EBU 45-3H, the location of which is shown in Figure 2. Initially planned for 2002, this is now planned for 2003. With the high production rates from EBU 64-3H, it was determined that an offsetting injection well should be drilled before the next horizontal well. The new injection well will be EBU 74G-2, discussed below (Task 1.2.2).

### *Task 1.2.2 – Drill New Injection Well(s)*

There is one new injection well, EBU 74G-2, planned for Budget Period 2. As shown in Figure 2, it will be located south-southeast of EBU 64-3H. This location should allow the injection to support the production from 64-3H and improve recovery in this area. Drilling was originally planned for 2003, but has been accelerated into the fourth quarter of 2002.

EBU 74G-2 will be drilled and completed as a vertical well. The original Budget Period 2 work plan included this well as a vertical well, but also included plans to evaluate with the simulation model whether it should be drilled horizontally. The model work has not been completed, but it was decided that more information regarding horizontal well development in this reservoir could be gained by drilling and completing this well as a vertical well, due to its proximity to EBU 64-3H. The well will be produced for 60-90 days prior to putting it into injection service. This will provide valuable data for comparing vertical vs. horizontal performance in this reservoir. If future modeling work shows significant advantage to a horizontal injection well, a lateral sidetrack can be drilled from the initial wellbore.

#### *Task 1.2.3 – Convert Producers to Injection*

As shown in Figure 2, the conversion of five wells to injection service is planned for Budget Period 2. Initial plans called for four conversions in 2002 and one (EBU 61-1) in 2003. To date, only one conversion (EBU 57-1) has occurred. This was completed in late June. The conversion of EBU 65-1 should occur in the 4<sup>th</sup> Quarter of 2002; well work was completed in August, but permit approval for the laying of a line to bring gas to the well has been delayed.

The third planned conversion for 2002 was EBU 59-1. This is now planned for 2003 since the drilling of EBU 45-3H (Task 1.2.1) has been put into that year. The final planned conversion for 2002 was either EBU 37-3H or EBU 44-1, as noted in Figure 2. This decision is awaiting modeling results, and could occur in late 2002 or early 2003.

To date, conversion costs have been running below the original estimate of \$95,000/well. The conversion of EBU 57-1 cost approximately \$20,000 and the conversion of EBU 65-1 is expected to cost about \$85,000.

#### *Task 1.2.4 – Construct, Modify, and Upgrade Plant Capacities*

No work has been done on this task. The expansion of plant injection compression capacity was planned for late 2002. With the delay in the conversions to injection, this will be deferred into early 2003.

#### *Task 1.2.5 – Initiate Monitoring of Pilot Area Performance*

A number of gas samples were collected in the pilot area. EBU 37-3H, the horizontal well drilled in Budget Period 1, appears to be having a positive impact on the nitrogen content of the gas produced from nearby wells. Three wells – EBU 36-1, EBU 37-2, and EBU 44-1 – are all producing gas with a lower nitrogen content than they were when EBU 37-3H began significant production. Gas samples from all of these wells were taken in December 2001, approximately one month after EBU 37-3H was fracture stimulated.

Plots of produced gas nitrogen content vs. time for EBU 36-1, EBU 37-2, and EBU 44-1 are shown in Figure 4. The most significant drop was seen at EBU 36-1, from 65% in December 2001 to 50% in August 2002. It appears that EBU 37-3H is “intercepting” gas injected in EBU

38G-1 and headed toward EBU 36-1, further substantiating the dominant east-west flow direction discussed in the Budget Period 2 Project Plan and the Quarterly Technical Progress Report for the 1<sup>st</sup> Quarter of 2002 (15121R08).

Gas samples were taken at six other wells in the pilot area, primarily as baseline samples prior to work being implemented in this budget period. None showed an appreciable change related to project work. Sample data from these six wells plus the three wells discussed above are tabulated in Figure 5.

#### *Task 1.2.6 – Technology Transfer Activities*

Additional technical progress reports have been posted on the project web site, [www.eastbingerunit.com](http://www.eastbingerunit.com).

#### *Task 1.2.9 – Modify and Update Simulation Model, etc.*

The modeling effort to reconstruct the history match with a new understanding of dominant flow mechanisms is underway and nearing completion. The quality of the history match has been improved significantly. A number of problems with individual well matches still exist, but potential solutions have been identified and are being tested.

### **Conclusion**

The implementation of the pilot project of the East Binger Unit DOE Project is progressing. EBU 64-3H, the first of the planned horizontal wells has been drilled and completed. While no additional producer-to-injector conversions were completed during the reporting period, one additional well has been prepared for conversion. Additional development work is planned for 2002 and 2003, and will be discussed in future reports.

Early performance of well EBU 64-3H has been consistent with expectations from reservoir characterization work that suggested the well would develop unswept reserves, as both the GOR and produced gas nitrogen content are well below field averages. Because of the success of this well, the planned order of development drilling was altered. EBU 74G-2, an injection well planned to be drilled to support EBU 64-3H, was initially planned for 2003, but is now planned for late 2002.

Data gathering to monitor the impact of the development work on the performance of the nitrogen flood has been initiated. Early data is encouraging, as three wells near a previously drilled horizontal well are cycling less nitrogen. The early data also adds further confirming evidence to the observed dominant east-west flow direction discussed in previous reports.

Work also continues with the simulation model. This will be used to guide future decisions with respect to pilot wells, such as the optimal location for the final planned horizontal well and the optimum flood configuration on the western end of the pilot area, near well EBU 37-3H.

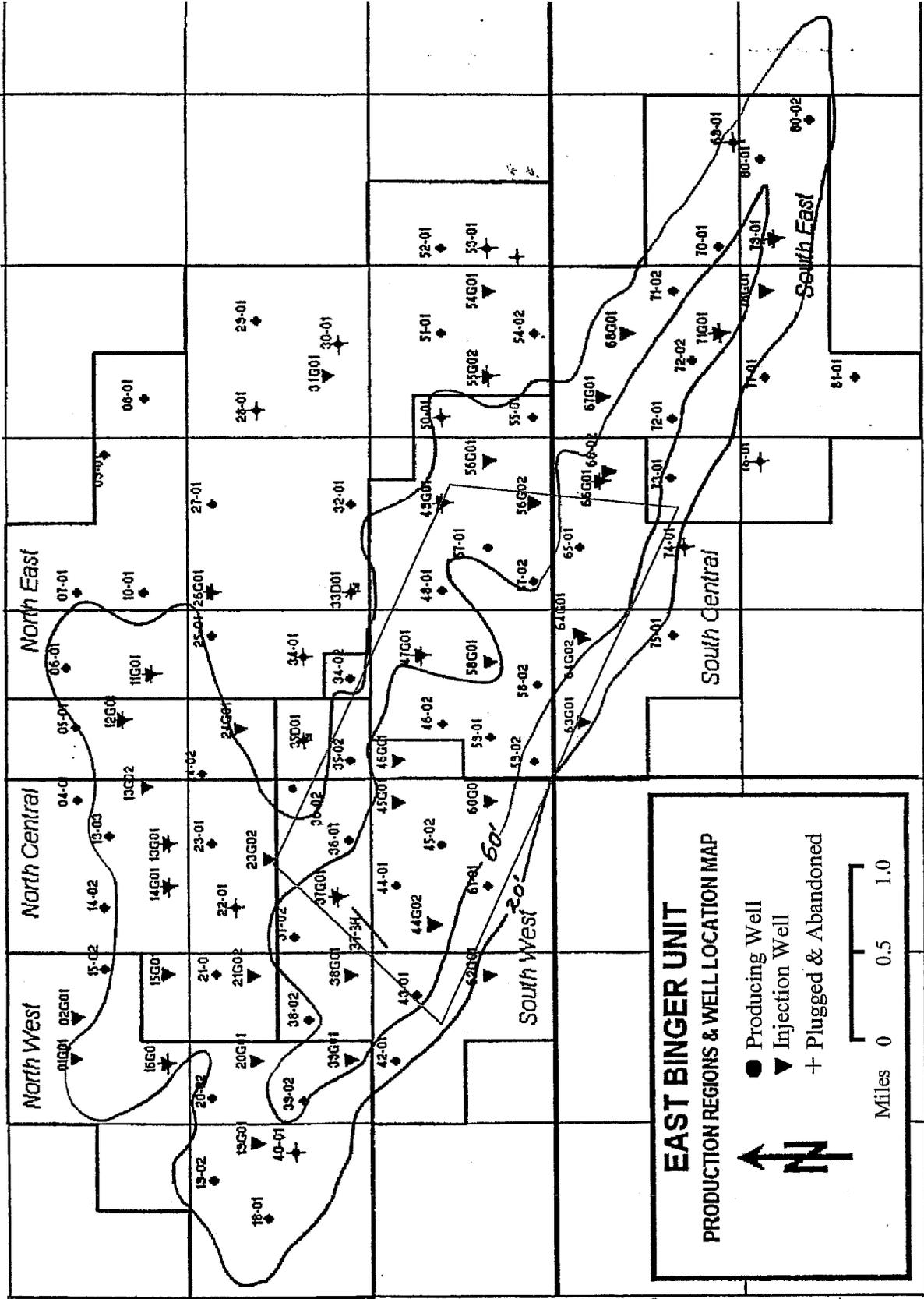


Figure 1. East Binger Unit net pay map. The blue box surrounds the pilot area.

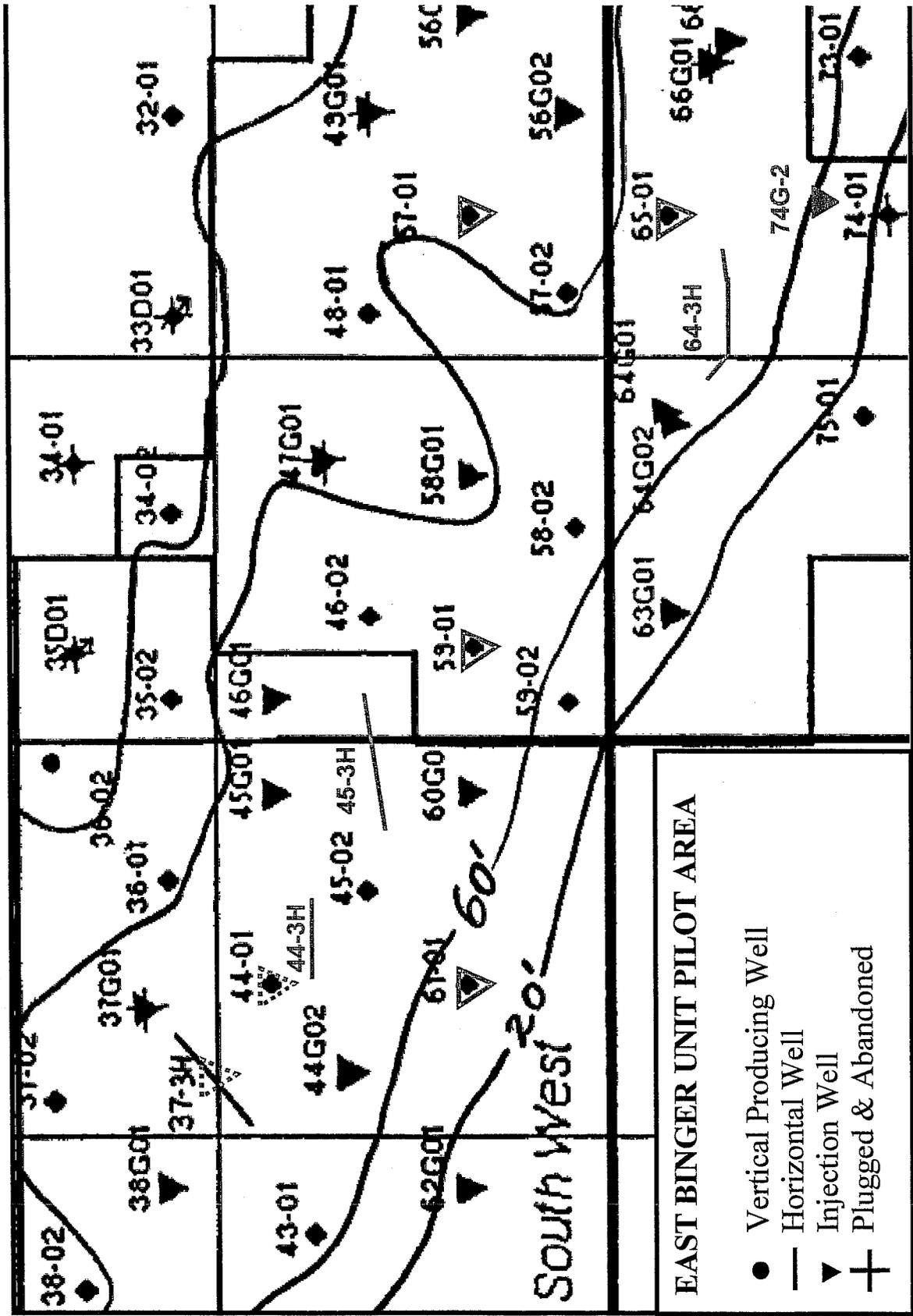


Figure 2. Fieldwork planned for the pilot - shown in red. Either 37-3H or 44-1 will be converted to injection.

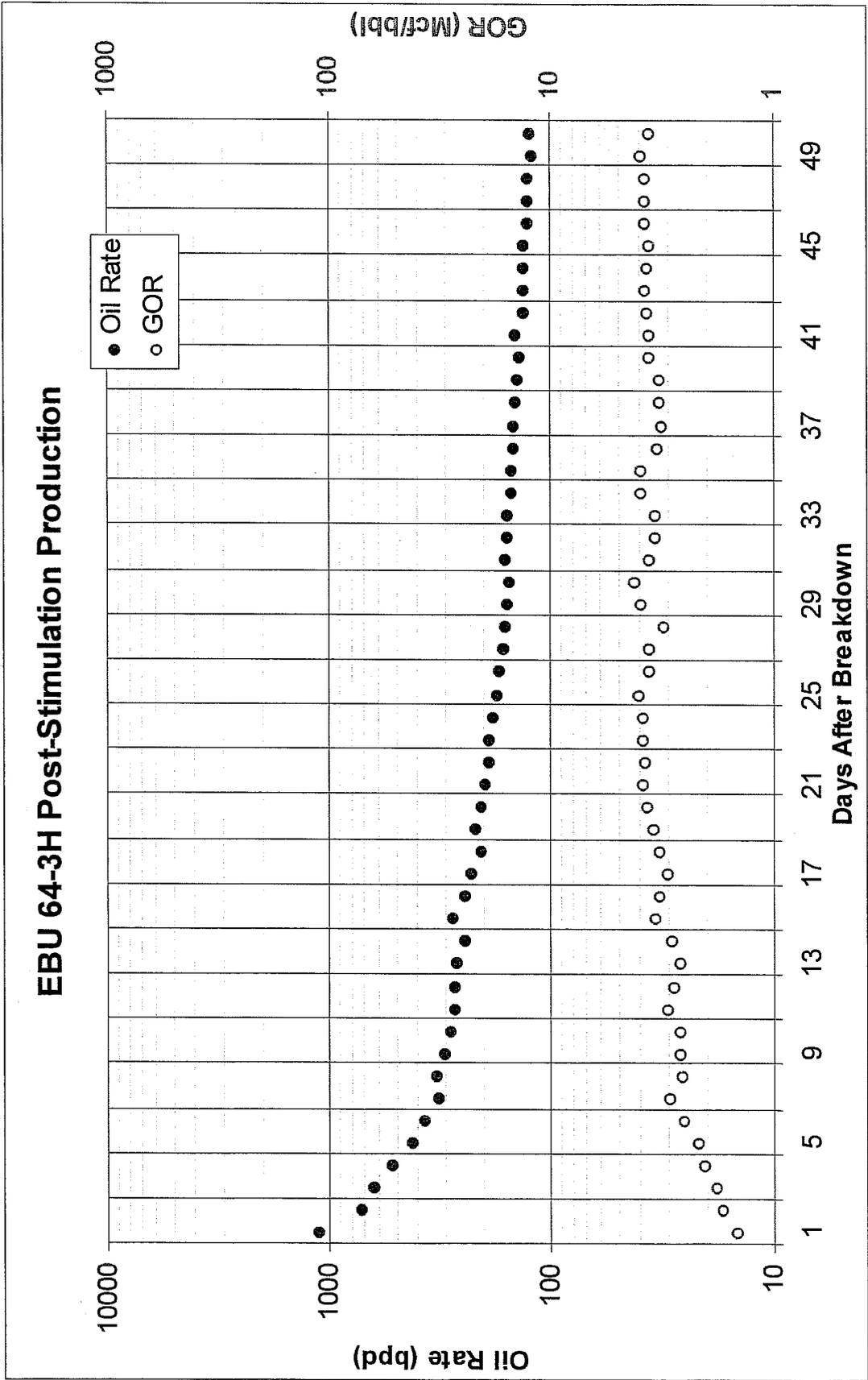
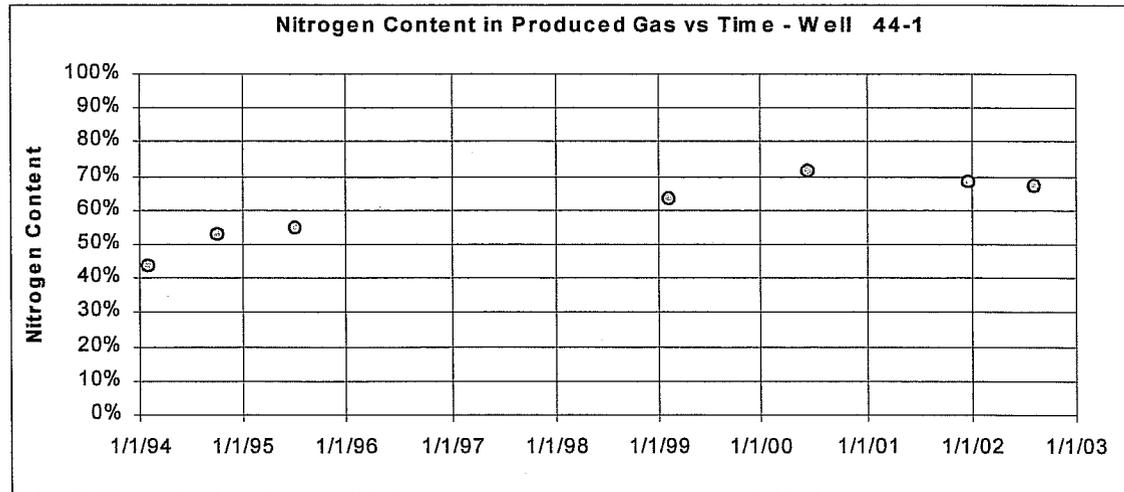
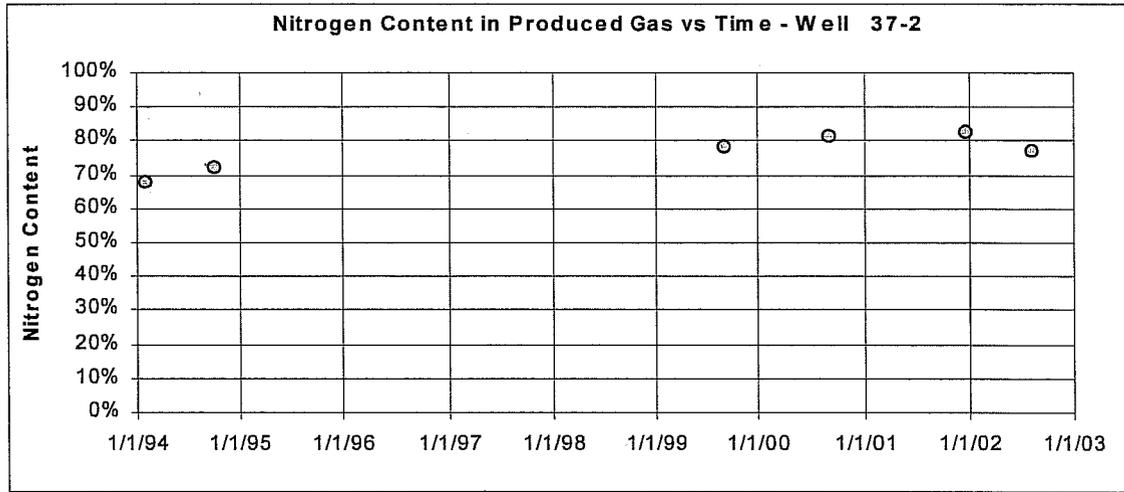
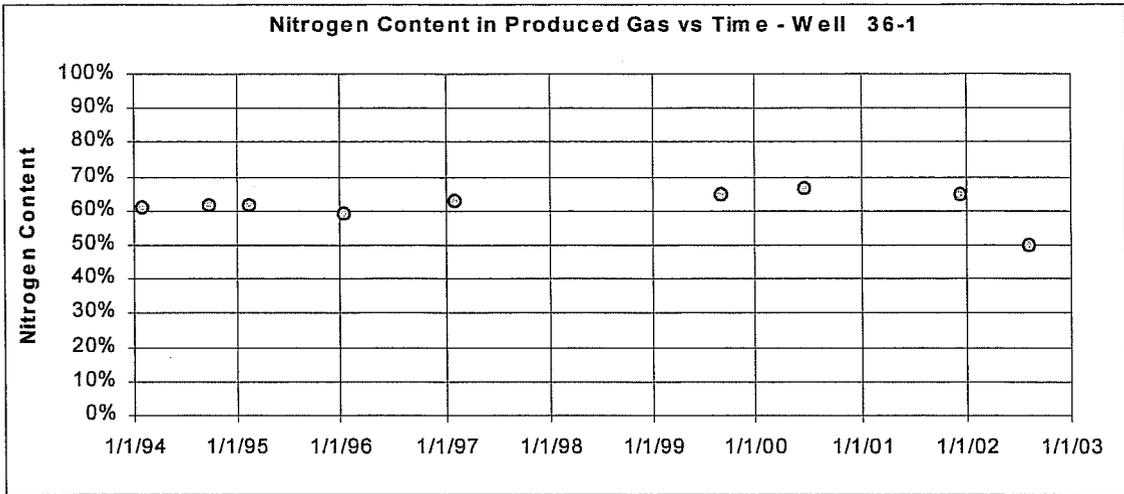


Figure 3. Post-stimulation production data for horizontal well EBU 64-3H. The breakdown treatment was pumped in early September 2002.



**Figure 4. Nitrogen content of produced gas from three producing wells near EBU 37-3H. EBU 37-3H was fracture stimulated in November 2001.**

**East Binger Unit Pilot Area  
Nitrogen Content in Produced Gas  
3rd Quarter 2002 Sample Data**

<u>Well</u>	<u>December 2001 Sample</u>	<u>August 2002 Sample</u>	<u>Change</u>
36-1	65%	50%	- 15%
37-2	83%	77%	- 6%
43-1	9%	10%	+ 1%
44-1	69%	67%	- 2%
45-2	56%	58%	+ 2%
48-1	83%	83%	-
57-2	37%	41%	+ 4%
58-2	8%	5%	- 3%
73-1	13%	21%	+ 8%

**Figure 5. Pilot Area gas sample data.**

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## A. CONTRACTOR ACTION (CONTRACTOR COMPLETES PART A. 1-5)

1. Document Title: Improved Miscible Nitrogen Flood Performance Utilizing Advanced Reservoir Characterization and Horizontal Laterals in a Class I Reservoir – East Binger (Marchand) Unit - 15121R10 – Quarterly Report for the period ending September 30, 2002

2. Type of Document:  Technical Progress Report  Topical Report  Final Technical Report  
 Abstract  Technical Paper  Journal Article  Conference Presentation  
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3. Date clearance needed: NA

◆4. Patent information.

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Is any patentable subject matter disclosed in the report?

If so, has an invention disclosure been submitted to DOE Patent Counsel?

If yes, identify disclosure number or DOE Case Number \_\_\_\_\_

Are there any patent-related objections to the release of this report? If so, state the objections.

◆5. Signed \_\_\_\_\_

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Date 10/31/2002

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## B. DOE PATENT COUNSEL ACTION

Patent clearance for release of the above-identified document is granted.

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