STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO

15 March 1989

EXAMINER HEARING

IN THE MATTER OF:

Application of BHP Petroleum, Inc. for special GOR, Eddy County, New Mexico. CASE 9602

BEFORE: Michael E. Stogner, Examiner

TRANSCRIPT OF HEARING

A P P E A R A N C E S

For the Division: Robert G. Stovall
Attorney at Law
Legal Counsel to the Division
State Land Office Bldg.
Santa Fe, New Mexico

For BHP Petroleum, Inc.: W. Thomas Kellahin
Attorney at Law
KELLAHIN, KELLAHIN & AUBREY
P. O. Box 2265
Santa Fe, New Mexico 87504

I N D E X

E X H I B I T S

MR. STOGNER: Okay, call next Case Number 9602.

MR. STOVALL: Application of BHP Petroleum, Inc., for special GOR, Eddy County, New Mexico.

MR. KELLAHIN: Mr. Examiner, I'm Tom Kellahin of the Santa Fe law firm of Kellahin, Kellahin & Aubrey. I'm appearing on behalf of BHP Petroleum, Inc. I have one witness to be sworn.

MR. STOGNER: Are there any other appearances?

Will the witness please stand to be sworn?

(Witness sworn.)

MR. STOGNER: Mr. Kellahin.

MR. KELLAHIN: Thank you.

HAL CRABB,

being called as a witness and being duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. KELLAHIN:

Q Mr. Crabb, for the record would you please state your name and occupation?

A My name is Hal Crabb and I'm a petroleum engineer for BHP Petroleum Company, Inc.

Q Mr. Crabb, on prior occasions have you testified before the Division as a petroleum engineer?

A Yes, I have.

Q Pursuant to your employment as a petroleum engineer for your company have you made a study of the facts surrounding the application to increase the gas/oil ratio in the East Avalon Bone Springs Pool of Eddy County, New Mexico?

A Yes, I have.

MR. KELLAHIN: We tender Mr. Crabb as an expert petroleum engineer.

MR. STOGNER: Mr. Crabb is so qualified.

Q Mr. Crabb, will you take the exhibit package that you have prepared and turn to Exhibit Number One and first of all help orient us to the location of the East Avalon Bone Springs Field?

A Yes. The Exhibit Number One is a land map showing the location of wells in the field. The field

itself is located about five miles northeast of Carlsbad in Eddy County, New Mexico.

Q When we look at Exhibit Number One I notice you have colored certain well locations in different colors. What's the purpose of doing that?

A The purpose is to show which wells are located in the main reservoir or the reservoir proper, as I will refer to it this morning.

I've color coded some wells in blue and others in yellow. The focus of our discussion this morning is going to center around the wells in Sections 1 and 2 in Township 21 South, Range 27 East, kind of in the center of the exhibit there, and these wells -- there's 26 wells and they are all in pressure communication and they make up the -- what I will refer to as the East Avalon Bone Springs Reservoir.

Now we have some wells to the north in Township 20 South, Range 28 East, six wells which are colored in blue, which technically are classified in this same field but they're not in pressure communication with the wells to the south.

We have one well to the south there in Section 11 in 21, 27, which is also technically classified as being in the field but is not in the reservoir proper.

And these, these wells that are colored

in blue, the production is generally low and many of these wells have been either TA'd or P & A'd, so they really have no material effect on the reservoir that we're going to be talking about.

Q Let's look now more specifically, Mr. Crabb, at the area around the central portion of the reservoir in which you've identified a number of these wells in the pool.

Let me direct your attention to Exhibit Number Two. What are we looking at with Exhibit Number Two?

A Exhibit Number Two is a lease ownership map showing who owns what leases in the field. There are six operators in the field, that being LNT Oil, Monsanto, and the remaining four operators are the, what I'll call the major players, the operators i;n the reservoir proper. That would be BHP, Petrus Oil Company, Presidio and Exxon, and just moving from the west to the east or from the left to the right of the exhibit, BHP operates the wells there in Section 2. This is the Burton Flat lease. And moving farther to the east, Exxon operates wells in the Burton Flat B Federal, the Scott Federal, and the Renfro lease.

Moving on, Presidio has two wells on that, on the Scott Federal lease, and to the far east there in Section 1 Petrus operates wells in the Burton Flat and

the Government D Lease.

So there are six operators in this field.

Q Have you discussed your request to increase the gas/oil ratio in the field up to a rate of 5000-to-1 with all the current operators of wells in the field?

A Yes, I have.

Q Have you received any objection from any of those operators?

A No, I have not.

Q Let's turn now, sir, to Exhibit Number Three. Would you identify the information shown on that exhibit?

A Exhibit Number Three is a well count of the East Avalon Field showing how many wells are operated by each oil company.

First of all, I'll just briefly go over this, there are 30 producing wells in the field. There are 26 active wells. There are 4 wells which are currently shut in or TA'd, and there have been 3 wells in the field P & A'd.

Now, BHP operates 9 wells in the field. Exxon operates 9 wells. Petrus Oil, which was formerly Mobil, operates 8 wells. Presidio, which was formerly

Liberty, operates 3 wells, and Monsanto operates 1 well.

Q Can you summarize for us what has been the history of the production and development of the field?

A Yes. The field was discovered by Exxon in October of 1983 with the drilling of the Burton Flat B Federal No. 1, and at that time development took place in 1984 through the middle of 1986 and although the initial GOR's were in the 2-to-4000 range, at this point in time the field GOR is in excess of 60,000, so at this point many wells are shut in due to extensive overproduction. The operators are losing money due to wells being shut in because of overproduction, and that's why I'm here this morning, to seek a reasonable amount of GOR relief so that we can restore these wells to economic status and efficiently recover the remaining oil and gas reserves in the reservoir.

Q Approximately where are we in the productive life of the reservoir?

A This reservoir is in its final stages of depletions, of depletion, excuse me, which I'll show later with subsequent exhibits, and when I undertook this study to evaluated the feasibility of GOR relief, I looked at it as to whether or not it would affect ultimate recovery and whether or not it would violate correlative rights and be of benefit to all the operators in the field.

I've come to the conclusion that this increased GOR is necessary and proper to -- in order to practically produce the remaining reserves of the field and the other operators are in agreement.

Q Give us an approximation so we have some sense of what the range of average is for current oil production in the reservoir on a well basis.

A Well, the field is currently producing, which I'll show later, around 50 barrels of oil a day out of the 30 wells; around 3-million cubic feet per day; and what this boils down to or what this averages out to on a per well basis is less than 2 barrels of oil a day per well.

Q Let's go on with the specifics of your study, Mr. Crabb. In doing so let me have you refer to Exhibit Number Four. Would you identify that for us?

A Yes. Exhibit Number Four is a tabulation of reservoir parameters in the East Avalon Bone Springs Field.

Just very quickly I'll touch on the highlights. This pay zone is occurs at an average depth of 5500 feet. It is a sandstone with shale laminations. The gross pay thickness is 25 feet and it is consistent throughout the reservoir. It doesn't really vary in -- in pay thickness.

The porosity is 12 percent and that's determined from core analysis. The permeability is an average of 1 millidarcy so it's a very tight reservoir and the wells must be fracture treated before they can produce commercially.

The oil gravity is relatively high averaging from 44 to 46 degree API and we would classify this as a volatile oil.

Now moving down to the latter portion of this exhibit, I'd like to make some major points here.

We found the initial reservoir pressure to be 2500 psi and the bubble point from -- taken from PVT data was shown to be somewhat higher than that at 2515 psi.

So we feel that because of this data and other exhibits that I'll show later, there was an initial gas cap, so I would classify this particular reservoir as a combination drive of gas cap and solution gas drive originally, and going on to the final point here, the estimated reservoir size is 980 acres and we feel that we have a good handle on the areal extent because it has been -- the limits have been -- have been found in every direction, as far as drilling dry holes.

Q Turn now, sir, to Exhibit Number Five. Would you describe that for us?

A Yes. Exhibit Number Five is the exist-

ing field rules. As I said previously, we are currently under statewide rules, which are 40-acre spacing and a depth bracket oil allowable of 107 barrels per day and the most important point are the GOR limitation of 2000 and we feel that for this particular reservoir this is inappropriate because the characteristics of the reservoir have now changed to the point where an increase in this GOR is necessary and practical in order for us to be able to produce the reservoir economically and efficiently, and I'll expand on this a little later.

Q Have you prepared a decline curve for field production in the Avalon Bone Springs Field?

A Yes, I have.

Q And is that shown on Exhibit Number Six?

A Yes, it is.

Q Would you describe for us the conclusions you've reached from an examination of the information on Exhibit Six?

A Exhibit Six shows me -- well, first of all, I'd like to point out some of the characteristics of this decline curve, and I'd ask Mr. Examiner to follow along with me.

First of all, just on how to read this thing, the -- the curve with the X's is the gas production in MCF per month and that is to be read on a scale to the

left.

The oil production is the open circles, the curve with the open circles, and that is to be read using the scale to the right.

And the other important curve is the GOR curve in MCF per barrel and that is a closed circle and that is also to be read from the scale on the left.

And some major points I'd like to make here, first of all, a tabulation is attached there on the second page for you to look at, and it shows that the field through January of 1989 has produced a total of 507, approximately, 507,000 barrels of oil; 6.842 BCF, which is a substantial amount of gas; and around 30,000 barrels of water.

And currently, if you'll look at the monthly production in December of 1988, it made approximately 1600 barrels of oil for that month; approximately 92-million cubic feet of gas, and what this translates to, as I said earlier, is about 50 barrels a day for the field, or less than 2 barrels per day per well, showing that the field is in the latter stage of the depletion and there's very little remaining oil to be recovered.

Going back to the decline curve, there are a couple of things I'd like to point out.

First of all, if you'd look at the oil

production curve, the open circles there, initially, when the field was developed through 1984 through the first half of 1986, it looks like the oil production is pretty well stabilized at a certain rate. This is in a way misleading because wells were being drilled all through this time period. For example, in 1984 at least 12 wells were drilled and in 1985 another 8 wells were drilled, so if you'll also note that in July or August of 1986, when the well -- when the field was fully developed, the oil production began to decline drastically, 70 or 80 percent I've got there, and it has continued on a very sharp decline, and the reason we feel like it is declining so rapidly is that this is a volatile oil reservoir and we have, as the pressure had decreased in the reservoir, gas, the oil is flashing into the gas phase and we are recovering gas, we are recovering the hydrocarbon in the gas phase.

The other point I'd like to make is the -- the steady increase in the GOR, as you can see from the GOR curve.

It started out in the 2000 to 4000 range and it's currently above 60,000 for the field.

Q Have you turn now, sir, to Exhibit Number Seven. What's the purpose of this exhibit?

A Exhibit Number Seven is a reservoir fluid classifications taken from a reservoir engineering

book and this is for the purpose of classifying the various reservoirs based on their GOR and what I'd like to show here is that we initially started off in the reservoir, I believe, with a volatile oil due to the fact of the GOR being above 4000 in many of the wells and currently, with the GOR in excess of 60,000, this shows us that according to this classification this reservoir would qualify for a wet gas reservoir. So this is not a typical oil -- oil zone.

Q Let's go to Exhibit Number Eight, now. Would you, before we look at the conclusions about Exhibit Number Eight, identify for us how to read the display?

A Exhibit Number Eight is a tabulation of the initial potentials and the GOR and the date of completion for each well, and you'll notice the three lines by each well.

The top line is the initial potential in barrels of oil per day, MCF of gas per day and barrels of water per day.

The second line is the initial GOR based on those producing rates and the third line is the date that the well was potentialed, and this is also a -- the map this is presented on is a contour map based on the top of the Bone Springs pay zone and these are 20 foot contour intervals and are approximately 240 foot -- 240 feet of

relief in this reservoir from the structurally highest well, which is the Burton Flat Deep Unit No. 2 operated by us, it will be your well farthest to the left there, or to the west, and the structurally lowest well, which is in the south -- no, it's the northeast corner of Section 12, there toward the bottom of the exhibit, approximately 240 foot of relief there.

Q What does an examination of this information tell you, Mr. Crabb?

A An examination of this information tells me that you initially had a gas cap in the formation and I would direct the Examiner's attention to Well No. -- Well No. 2, which is the well to the farthest to the left there. It's initial GOR was 12,857 and when we move to the right one and down one location to Well No. 28, its initial GOR was 25,900, and if we move up from that well to Well No. 27, the initial GOR was 8750.

And there's another point I'd like to make from this exhibit. There's an interesting, interesting feature here. I direct your attention to the southeast corner or southeast quarter of Section 1 and note Petrus Well No. 3, which was potentialed in August of 1986 and had an initial GOR of 25,538, when the well right before it was potentialed three months earlier and had a GOR of only 1909. So in that short period of time you could see a

dramatic increase in the GOR in the down dip wells, which is indicative of the -- the oil going into the gas phase and along with a gas cap expanding down dip and this will be shown later also.

Q All right, sir. Let's turn to Exhibit Number Nine. That's a series of exhibits marked Exhibit Nine-1 through Exhibit Nine-5. What's the purpose of these exhibits?

A Okay, the purpose of these exhibits are to show the movement of the gas in the reservoir and the increasing GOR with time.

There are five pages to this exhibit. We'll just kind of tab through it briefly and I'll show what -- what happens here.

The -- each map represents one year's passing of time and the first map shown here is in January of 1985. You can see that the wells up dip had the highest GOR's, on an average over 10,000, and your GOR's toward the center of the field were more moderate, in the 3-to-4000 range, and the wells to the southeast there in Section 1 had not been developed at this time in January of '85.

And if we'll move to page number 2, this is the gas cap in January of 1986, and you can see that the GOR's have increased on the up dip wells to in the 20-to-30,000 range and your wells in mid-structure have

also increased in GOR and more of the down structure wells have -- have been drilled.

Moving on to the situation in January of 1987, you'll note that by this time the field was fully developed, the wells in the structure -- highest portion of the reservoir or in the 30-to-50,000 GOR range, and if you'll turn to page four, showing the situation in January of 1988, one year later, the wells in the top are over the 100,000 GOR mark and your down dip wells are beginning to show a very high GOR, also. If you'll notice, in the structurally lowest wells you have GOR's of 25,000, 19,000.

And, finally, turning to page number 5, which is the latest production information that I have for the -- for the field as a whole, in August the 1st of 1988 you can see the up dip wells are 3-to-400,000 GOR and the down dip wells, I direct your attention to a well in the southeast corner of Section 1 with a GOR of 35,900, and the structurally lowest well in the field, which is the Petrus Government No. 10-D, it's there in the northeast corner of Section 12, that has a GOR of about 20,000. I don't know if that's shown on that.

Q Other than the expanding gas cap that you have documented over the history of production, as shown on Exhibit Number Nine, is there a direct relationship to the gas/oil ratios and the structural position of

the well?

A Yes, there is. The structurally higher wells initially had the highest GOR's but we're in a situation now where even the wells in the lowest part of the structure are shut in due to overproduction because of the -- the gas cap expanding and essentially gassing out the entire reservoir.

Q Does there continue to be any necessity or need to control the gas/oil ratio so the gas production stays within the 2000-to-1 statewide rules?

A Would you repeat that, please?

Q Yes, sir. Is there -- in the current life of the reservoir does there continue to be a need to maintain the gas/oil ratio at 2000-to-1 as a maximum in order to conserve reservoir energy to assist in the oil production from the down structure wells?

A No, we feel that this is not necessary any longer, nor is it appropriate. The reservoir is in its final stage of depletion with very little remaining oil and an increase, a reasonable increase in the GOR would not materially affect your ultimate oil production.

Q Let me have you turn to the package of decline curves shown as Exhibit Number Ten, and each of the pages, then, in Exhibit Number Ten are numbered from page 1 through page 32.

A Yes.

Q What have you done with this information, Mr. Crabb?

A Okay, these are decline curves. This is a list of decline curves for every well in the field and Mr. Examiner can look at these at a later date. We won't go over all of them but I would like to -- to show some typical wells which are operated by each -- each party in the field, just to give you an idea of what has happened and how the oil production has declined whether you're up dip or down dip.

Q Before you -- we pick out some example wells, can you give us the trends or the typical characteristics you see when you look at the decline curves?

A Yes. What we typically see is a sharp decrease in oil regardless of your -- your production rate and regardless of your structural position. We'll see it on the structurally highest wells and the structurally lowest wells, once again telling us that the -- we're losing oil reserves to the gas phase and producing it as -- producing these reserves as gas, and before we go any further, I'd like to show that on each curve I've shown two, two horizontal lines across each curve. The lower line is colored blue and that is the existing limit on gas production in the field and then the yellow curve up above it is

the proposed increase in gas production, which we hope to get.

Q Can you give us a sample decline curve for various portions of the reservoir?

A Yes, I can.

Q All right.

A And on this, Mr. Examiner, just -- if you'll turn to the pages which I recommend here. First of all let's turn to page 5 and this is going to give you an example of what our wells are doing in the top of the structure. This is the Burton Flat Deep Unit No. 25. You can see just by taking a look at the oil production curve that the production decrease is very dramatic, around 50 percent or better, whereas your gas rates remain essentially constant.

And if you'll turn to page 8 we'll look at the Burton Flat Unit No. 32, which is also operated by BHP and you see -- you see the same trend, the rapidly declining oil production.

Q Where are we with the Burton Flat No. 32 Well in terms of its structural relationship?

A The Burton Flat 32 is on the far eastern part of our lease line, so we're just to the -- just to the west of Exxon. So we're just barely up dip of the Exxon wells.

And if you will turn with me to page 10, I'll show you some of the characteristics of Exxon's wells. This is the Burton Flat -- Burton Flat D Federal No. 1, which is just on the other side, one location to the east of the well we just looked at, and we see the same trend, sharply declining oil production.

Moving on to page 14, this is the Burton Flat E Federal No. 1. It's farther down dip and we see the same, the same thing.

And moving on to the lowest wells structurally in the field, operated by Petrus, let's turn to page 25 and this is the Government D No. 7. You'll note the same, the same trend.

And finally let's turn to the next page, which is the lowest well structurally in the field, the Government D No. 10, and we see the same thing, and this well, being the structurally lowest well in the field, is producing at a rate of 3 barrels a day of oil, and this is as of, I think, September of 1988.

Q All right, sir, let me have you direct your attention to the information contained in Exhibit Number Eleven. What is this package of information labeled Exhibit Eleven, page 1 through 22?

A Okay, this is a 22-page exhibit. This is once again another way of showing how the GOR has in-

creased. This graphically shows the increase in GOR with respect to cumulative oil production, and it's really just showing the movement of the gas cap and once again we won't go through all these wells but we'll look at a couple of representative wells.

If you'll turn to page 2 here and we'll look at Burton Flat Unit No. 23, which is in the top of the structure. You can see that by the time it had produced a little over 5000 barrels the GOR just shot up well above 200,000; I believe that's around 300,000.

If you'll move on to page 9 and we'll look at the Exxon well that we looked at previously on the decline curve, the Burton Flat B Federal No. 1, you'll notice the dramatic increase in the GOR of this well to the current level of about 55,000.

And moving on to further down structure, let's look at Petrus' Burton Flat Unit No. 2, that will be (unclear) No. 16, and once again we see the same trend, the GOR of around 100,000 on this well.

And, finally, if we turn to curve No. 20, we'll look at the structurally lowest well in the field, the structurally lowest point. This is the Petrus' Government D No. 10, which we've also looked at the decline curve, and it's GOR is well over 40,000. So we're talking about a very high GOR throughout the field.

Q All right, sir, let me have you direct your attention to Exhibit Number Twelve. Would you identify and describe Exhibit Number Twelve for us?

A Yes. Exhibit Number Twelve is a reserve calculation. It's an engineering work that I did in order to determine whether or not the GOR (unclear) would be a feasible measure. I'll just go through some of the high points of this exhibit.

First of all I calculated the original oil in place. There are two separate calculations. The volumetric calculation gave me 6.74-million barrels in place and a material balance calculation gave me 5.87-million barrels in place, and an average of these two methods yields 6.31-million barrels in place and this agrees very closely with independent studies of original oil in place made by Exxon and Mobil, who are also operators in the field.

And moving to the next point, the solution GOR from PVT data was shown to be 900. Now, if we multiply this by the original oil in place figure, we get the maximum gas in solution at original conditions to be 5.68 BCF and taking an 85 percent recovery factor we get that we could only have recovered 4.82 BCF, and so this is anomalous in the sense that the gas -- that the field has already produced 6.84 BCF as of January of 1989. So the

only way to account for this tremendous production of gas is with the presence of an original gas cap, and through graphical techniques we've determined that the original gas in place was 5.19 BCF or 17 percent of the original oil in place. So when we add the recoverable reserves from the gas cap to the recoverable solution gas, we get a total recoverable gas figure of 8.8 BCF.

Moving on down to the next item, our gas production to date, as I already said, is 6.84 BCF. This gives us remaining recoverable gas of 1.96 BCF. That's remaining reservoir -- I mean remaining gas to be produced from the reservoir.

Our oil production to January 1st of '89 is 507,000 barrels of oil and the remaining recoverable oil from the decline curve is about 22,000 barrels, or less than 1000 barrels per well, which we will recover with this increase in -- increased GOR.

Q Would you identify for us Exhibit Number Thirteen, I believe it is?

A Yes. Exhibit Thirteen are letters of support from LNT Oil Company and Monsanto. I have more support letters on the way, which I'll submit as soon as they come in. We have excellent support for this measure from the operators in the field and we have not received any opposition at all.

So there are more support letters coming in and we will submit those as soon as possible.

Q Turn to Exhibit Number Fourteen, Mr. Crabb, and identify that for us.

A Exhibit Number Fourteen is a letter from Phillips Natural Gas Company showing that they have the capacity to -- at their booster facilities for an additional 2-million cubic feet of gas per day and that they, in my conservation with John Hawkins over the phone, he is Phillips' representative, he said that they would not have any problem accommodating any additional gas volume which -- which we could deliver from the field because they have an excellent demand for the gas.

MR. KELLAHIN: That concludes my examination of Mr. Crabb, Mr. Stogner.

We would move the introduction of his Exhibits One through Fourteen.

MR. STOGNER: Exhibits One through Fourteen will be admitted into evidence.

CROSS EXAMINATION

BY MR. STOGNER:

Q Mr. Crabb, in a nutshell, what kind of a reservoir do you have here? What's the driving mechanism?

A I believe original -- under original

conditions we had a gas cap and solution gas drive mechanism, and at this point the reservoir is pretty well gassed out and we have a lot of wells shut in due to this high -- due to this GOR limitation and we're losing money on it and we -- we just, as a practical measure we want the relief.

Q And now you mentioned volatile oil. That was on --

A Yes.

Q -- on -- where did you mention that?

A 7, on the Exhibit 7.

Q Yeah, Exhibit Number 7. What do you mean by volatile oil?

A Well, we mean an oil of a relatively high API gravity, which can easily go into the gas phase, more -- more readily so than, say, a lower gravity -- lower gravity crude. In fact, in my -- in my dealings in Texas, where I've practiced my engineering, there have been some reservoirs with gravities of oil of this nature that have been actually reclassified as gas, which we don't -- we don't -- we don't want this for this reservoir, but it has been done.

Q What was the original gravity of this oil in virgin conditions?

A I would say from 44 to 46 API.

Q And now it is what?

A I don't have an existing API gravity of the crude but it's probably substantially lower.

MR. STOGNER: I have no further questions of this witness. Is there anything else, Mr. Kellahin?

MR. KELLAHIN: Mr. Stogner, we'd like to submit to you after the hearing the certificate of mailing.

For your information we have taken the application that was dated January 25th and mailed it to all of the interested parties we could find that had working interest owners in the entire field. There is an exhibit attached to the application that is some 4 pages long (not clearly understood) to all those parties.

If you'll allow me, I'll provide you with a certificate after the hearing to that effect.

MR. STOGNER: Thank you, Mr. Kellahin. Is there anything further?

MR. KELLAHIN: That's all we have, sir.

MR. STOGNER: If there is nothing further, Case 9602 will be taken under advisement.

(Hearing concluded.)

C E R T I F I C A T E

I, SALLY W. BOYD, C. S. R. DO HEREBY CERTIFY that the foregoing Transcript of Hearing before the Oil Conservation Division (Commission) was reported by me; that the said transcript is a full, true and correct record of the hearing, prepared by me to the best of my ability.

Sally W. Boyd CSR

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 9602, heard by me on 15 March 1989.

Michael E. Stogner, Examiner
Oil Conservation Division