STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION
STATE LAND OFFICE BLDG.
SANTA FE, NEW MEXICO
25 June 1980

EXAMINER HEARING

IN THE MATTER OF:

Application of Benson-Montin-Greer Drilling Corporation for a unit agreement, Rio Arriba County, New Mexico.) CASE 6943

BEFORE: Richard L. Stamets

TRANSCRIPT OF HEARING

A P P E A R A N C E S

For the Oil Conservation Division: Ernest L. Padilla, Esq.
Legal Counsel to the Division
State Land Office Bldg.
Santa Fe, New Mexico 87501

MR. STAMETS: Call next Case 6943.

MR. PADILLA: Application of Benson-Montin-Greer Drilling Corporation for a unit agreement, Rio Arriba County, New Mexico.

MR. STAMETS: At the request of the applicant this case will be continued to the July 9th Examiner Hearing.

(Hearing concluded.)

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

CERTIFICATE

I, SALLY W. BOYD, C.S.R., DO HEREBY CERTIFY that the foregoing Transcript of Hearing before the Oil Conservation Division 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. 6943 heard by me on 6-25 1980.
Richard L. Stamets, Examiner
Oil Conservation Division

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION
STATE LAND OFFICE BLDG.
SANTA FE, NEW MEXICO
9 July 1980

EXAMINER HEARING

IN THE MATTER OF:

Application of Benson-Montin-Greer Drilling Corporation for a unit agreement, Rio Arriba County, New Mexico. — CASE 6943

and

Application of Benson-Montin-Greer Drilling Corporation for a pressure maintenance project, Rio Arriba County, New Mexico. — CASE 6944

BEFORE: Daniel S. Nutter

TRANSCRIPT OF HEARING

A P P E A R A N C E S

For the Oil Conservation Division: Ernest L. Padilla, Esq.
Legal Counsel to the Division
State Land Office Bldg.
Santa Fe, New Mexico 87501

For the Applicant: W. Thomas Kellahin, Esq.
KELLAHIN & KELLAHIN
500 Don Gaspar
Santa Fe, New Mexico 87501

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

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EXHIBITS

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

MR. NUTTER: We'll call next Case Number 6943.

MR. PADILLA: Application of Benson-Montin-Greer Drilling Corporation for a unit agreement, Rio Arriba County, New Mexico.

MR. NUTTER: We'll also at this time call Case Number 6944.

MR. PADILLA: Application of Benson-Montin-Greer Drilling Corporation for a pressure maintenance project, Rio Arriba County, New Mexico.

MR. KELLAHIN: I'm Tom Kellahin, of Santa Fe, New Mexico, appearing on behalf of the applicant in Cases 6943 and 6944, and I have one witness to be sworn.

MR. NUTTER: For purpose of testimony, Cases 6943 and 6944 will be consolidated.

(Witness sworn.)

ALBERT R. GREER

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

DIRECT EXAMINATION

BY MR. KELLAHIN:

Q. Would you please state your name and occu-

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

pation?

A. Albert R. Greer, G-R-E-E-R. I'm an officer and petroleum engineer for Benson-Montin-Greer Drilling Corp.

Q. Mr. Greer, have you previously testified before the Division as a petroleum engineer and had your qualifications accepted and made a matter of record?

A. Yes, sir.

Q. And as a petroleum engineer have you made a study of and are you familiar with the facts surrounding these two applications?

A. Yes, sir.

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

MR. NUTTER: Mr. Greer is an expert petroleum engineer.

Q. Mr. Greer, I have taken the packet of exhibits that you have presented today and marked it as Exhibit One, and I would like for you to commence your testimony by referring to each of the parts within Exhibit Number One and if we could start with what is labeled the location plat, and have you first identify for me your proposed unit area.

A. Well, the unit area is shown on this location plat outlined in red. It's within the East Puerto

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

Chiquito Mancos Pool, which is outlined in green on this plat.

Q. Could you describe generally for us what types of acreages are involved in the unit?

A. Yes, sir, there are Indian lands, Federal lands, and fee lands.

Q. The advertisement indicates that there is some 9769 acres, more or less, to be dedicated to the unit.

A. Yes, sir.

Q. What is to be the unitized formation?

A. The Mancos formation.

Q. Is this unit being organized for purposes of primary recovery, secondary recovery, or tertiary recovery?

A. It's principally for secondary and tertiary recovery.

Q. Have the working interests agreed as to a form of unit agreement for this particular unit?

A. Yes, sir, 99.7 percent of the working interest owners of leased lands have agreed to it.

Q. Does the proposed -- has the proposed unit agreement been submitted to the USGS and to the State Land Commission, State of New Mexico?

A. The agreement about as it appears here was submitted to the USGS two years ago. There are some changes in it that they have not yet reviewed.

We have not submitted it to the Land

Commissioner.

Q. Would you summarize generally what has been the history of this particular formation and your efforts to bring about a voluntary unit for secondary recovery?

A. Yes, sir. It's a fractured shale formation. Produced initially oil, under saturated oil, and is under, to the best of our ability, we make it operate with gravity drainage completion, which means that we produce the down dip wells and as the up dip wells reach high gas/oil ratios we shut them in. And this is a procedure that we can carry out only to a certain limit, and that limit is when the down dip producers commence making gas, then we're forced either to produce high gas/oil ratio wells or shut the properties in.

Accordingly, we commenced some fifteen years ago trying to get the area unitized. The Indian tribe, the Jicarilla Tribe, was reluctant to unitize and we put off unitization as long as we could then, because of the Indians, until we reached a point which we now have, that we can delay no longer. We're either going to have to shut the wells in or produce high gas/oil ratio wells, and when we do, we'll dissipate the energy from the secondary gas cap that's formed and the net of it is that -- that we just must unitize soon or we are going to lose a substantial -- otherwise recoverable reserves.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

So in our efforts to unitize, we managed finally a year ago to bring to the attention of the Indians the amount of royalty that they would lose if we did not unitize, and it's a substantial difference, and when we finally got their attorneys to recognize it, then they agreed to unitize, and after considerable negotiation we reached trade terms, an increase in their royalty, net profits, and one thing and another, and we now have an agreement whereby we can unitize.

Q. In your opinion, Mr. Greer, does the proposed unit area constitute a logical configuration by which the unit and the unit operator will have substantial and effective control of the unitized formation?

A. Yes.

Q. In addition to the preparation of a proposed unit agreement, have you proposed a unit operating agreement?

A. Yes.

Q. If you'll commence with the unit agreement and simply go through and indicate for us some of the important points in summary to familiarize the Examiner with that agreement, perhaps commencing with an explanation of why you've indicated in the unit agreement the green shading at various pages.

A. Well, we've indicated in green shading

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

the words where the Oil Conservation Division is given authority in the unit agreement.

I thought two years ago that we had furnished a copy to the Division for review, but in checking my files, I find that we did not. So we've made this agreement conform to one we have recently submitted on another area to the department, or to the Division, and I believe that we have the same authorities here as in the one recently approved.

On page one of the unit agreement we set out where the Oil Conservation Division has the authority to take part in these agreements.

On page two the Division is defined as we use in the agreement here.

Page four the Division is given authority in expansion of the unit agreement -- in expansion of the unit area.

Carried over onto page five it shows again.

On page six the Division is given authority under approval of the plan of operations, which carries over to page seven.

On page ten regarding allocation of unitized substances, which carries over to page eleven.

Also, on page eleven under Section 15, authority regarding what gas might be royalty-free if outside gas is brought in for injection.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

On page fourteen the approval of the unit agreement, the effective date, and the term of the agreement.

On page fifteen perhaps one of the more important sections, Section 23, regarding rate of prospecting, development, and production, the Division is given equal authority with the USGS regarding approvals of rate of prospecting and development; in addition, what both the USGS and the Division determine must be within the limits fixed by the Division regarding the quantity and the rate of production.

On page seventeen authority regarding subsequent joinder of additional parties who might want to come in at a later time.

Those are the authorities granted to the Division. Then there are a few particular items that we should call to the attention now.

One is on page seven regarding tract participations. The participation formula is 10 percent acreage; 22-1/2 percent structural position weighting factor, and that we'll go into in detail a little bit later; 67-1/2 percent production.

Q. Do you have subsequent exhibits to indicate how those numbers were derived?

A. Right. They're explained here in the language of this particular section, but later on it's easier

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

to understand from the exhibits.

Q. On page eight there is indicated a special agreement with the Jicarilla Tribe. Would you identify that for us?

A. Yes, sir. About the center of the page eight is spelled out briefly one of the terms that we agreed to with the Jicarilla Tribe, and that is after we have determined the Tribe's equity as to the various leases, I think there's five or six of them, the Tribe wanted the equity reallocated on a different basis than the basic formula. We agreed to do this. This affects only the Indians and the working interest owners.

Q. Will that have an adverse effect in any way upon any of the other working interest or royalty owners in the unit?

A. No, sir, it doesn't affect their equity at all.

MR. NUTTER: Well now, it would the other working interest owners, wouldn't it?

A. The other working interest owners who are parties and own interest over these leases are affected, and they have all agreed to this trade.

MR. NUTTER: So in other words, this is changing the participation for the Indians probably to a higher rate, but it's carved out of working interest and not out of any other royalty owners?

A. That is exactly right.

MR. NUTTER: Okay.

Q. I believe on page nine there is a need for an explanation on some of these undrilled acreage. Do you have any open acreage involved here?

A. Yes, sir, there's some unleased Federal acreage and a little bit of unleased fee acreage. The bottom paragraph on page nine sets out how the unleased Federal acreage will be handled, which essentially is that when it's put up for sale the successful bidder will be obligated to join the unit agreement, unless there's some reason of the equities that it should not.

Q. Back on page six under plan of operation, you've set forth a number of different substances that might be used for secondary and tertiary recovery.

You might summarize for us, if you would, the anticipated substances that could be used.

A. Yes, sir. We are thinking about not only water flooding and gas injection, but tertiary methods, which can include caustics, polymers, and chemicals, which we identify in the first paragraph of Section 10.

Q. I believe that covers most of the significant points in the unit agreement, Mr. Greer.

MR. NUTTER: Mr. Greer, before you get

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

too far off on that, now that portion, wherever that section was, I lost it --

A. It's page six.

MR. NUTTER: No, the part about the lands that would be leased after the effective date of the unit.

Now how are you going to bind those parties that pick up these leases after the effective date? Will the government put the clause in the lease that they must join the unit?

A. This will be part of the -- when the leases are advertised for sale --

MR. NUTTER: That they're subject to this binder?

A. -- they'll be subject to that, yes, sir.

MR. NUTTER: And they take the leases under that binder?

A. Right, uh-huh.

MR. NUTTER: I see. Okay.

A. The same as is in an exploratory unit. The main difference here, of course, is that this is unusual for a secondary unit because ordinarily you already have --

MR. NUTTER: You already have the lands leased.

A. -- the lands leased, right. So we do have that unusual provision here.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

MR. NUTTER: Okay.

Q. If you'll turn to the unit operating agreement now, Mr. Greer.

A. I think the only unusual thing here is on page eight, commences on page eight, the investment adjustment of intangible drilling and non-removable downhole equipment. Here again, for the problem of bringing in parties who have not paid for wells now and do not have any investment, if they buy a new lease, as for instance the Federal leases, then they'll be required to pay a share of the cost of the previously drilled wells. We have an investment adjustment for the surface equipment, which is more or less standard in any unitization, but the problem of the intangible drilling costs, which often is taken care of in a unitization by each man drilling his own well, you have here a situation where there will be leases with no wells on them, and so that these outside parties, then, would be required to pay a share of the intangible drilling costs.

We've estimated that as the cost -- what it would cost to drill wells at this time, but the well costs are depreciated at the rate of 1/2 percent a month for 50 months, which means we'll take 75 percent of the estimated cost of the wells at this point, and that's the figure that will be used for the investment adjustment of the intangible drilling costs.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

Then for the costs of chemicals, we've added those in, and the reason for that is that depending on the plan of -- that we use for our tertiary recovery process, we could inject a substantial amount of the chemicals the first few months, or perhaps the first year. If, for instance, we spend $1,000,000 on chemicals the first year, and then the lands come up for sale, the parties who come in at that time will get the benefit of the chemicals, which may take some 20 years to do their work through the reservoir, so they again are obligated, or we feel they're obligated, to pay their share of the chemical cost. We depreciate the chemical cost over a 25-year period, assuming that in 25 years that we dissipate them.

Q. Now in your discussion on page seven of the unit agreement you indicated a formula for the determination of tract participation.

A. Yes.

Q. I'd like you to go to those lettered attachments to the exhibit, which will explain to us how you determined the tract participation.

A. All right, sir. I might say in passing, if you looked at the different exhibits, A, B, C, D, and E, they are simply exhibits A to the unit agreement, B to the unit agreement, C to the unit agreement, D to the unit agreement, and E is Exhibit E to the unit operating agreement.

They have to do primarily with the statistics of what we'll be talking about here now.

Under Section E -- no, Section F, Section F, we have a discussion of the parameters that we used for determining the participation factors.

The first parameter is acreage, which is quite simple, just the acreage to each tract is given its share of a 10 percent weighting.

Structure position weighted acreage factor is a new concept, which the USGS geologists and engineers felt we should include, and that's for the reason that the area so far has been produced by a gravity drainage process with the primary production being taken out down dip; the up dip wells now covering the secondary gas cap, the value of the gas for a given volume of reservoir is less than the value of oil, and we have the problem of otherwise determining equity, which you ordinarily do from reservoir volume and estimated reserves. This being a fractured shale reservoir, there's no way to do that under ordinary methods.

So we had to devise some other equitable approach to it. The way we wound up is giving a factor of zero in the structural position weighting factor for the uppermost contour, the 6000-foot contour interval, and increasing that down dip until we're just above the water/oil contact, at which point we start decreasing the weighting factor, and --

Q. It might be helpful, Mr. Greer, if you could identify for us one of the plats of the area, and so you could summarize how you took into consideration the structural position of weighted acreage factor.

A. Under Section L, there is first a plat which shows the zones that are producing in the two areas, East Puerto Chiquito and West Puerto Chiquito. We call them Zones A, B, and C.

In this particular area only Zones A and B produce, the yellow and green colored ones on the plat.

The next map after that is a structural contour map that shows my interpretation of the fluid content of the reservoir now and also identifies the wells we plan as producing wells, injection wells, and both gas injection wells and water injection wells.

The area colored in yellow is area which is pretty much gas saturated now because of depletion or drainage down dip from these wells.

The area colored in red is essentially gas-free oil saturated.

And the area colored in green is principally water.

The water/oil contact is shown halfway between the 3800 and 4000 foot contour interval, where the

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

red meets the green.

The 6000 foot interval which we give zero weighting on the structure position rating factor is over on the righthand side of the map.

And I think perhaps we should go right straight to the structural position weighting factor map. I believe that map is listed under -- in the index under H, but I think under most of these exhibits it's under G. It's a foldout plat similar to your structure contour map that we just looked at.

MR. KELLAHIN: It's under H.

A. If you look at the upper righthand part of the map, Section 9, the structural contours are given a rating factor, starting there with 3, moving southwest you can follow them up, 4, 5, 6, 7, 8, 9, 10, at which point we drop from there to the next contour down to the oil/water contact, we give that a weighting factor of 5, and then zero on the next contour, the 3600 foot contour interval.

And the weight --

MR. NUTTER: Anything below that gets zero because it's in the water.

A. Then the way we get those back to tract factors, we probably ought to take just a minute to look at that. If you can find the yellow, green, and blue sheets that are either in that same section or the section just

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

ahead of it. They're identified as Exhibit C, Part III, Schedules I, II, and III. The gold colored one is the first one.

For instance, there the first line, the northeast quarter of Section 4, if you look at Section 4, which is about the center of the map on the righthand side, go to the northeast corner of that quarter section is given a rating of 0.7; the northwest quarter, 1.2; the southwest quarter,0.7; the southeast quarter, zero; the arithmetic 4-point average is .65.

So that gives the structure position weighting factor for that northeast quarter.

Then we go to Schedule II, which is the green colored sheets --

MR. NUTTER: Now you -- in other words, you've taken the northeast quarter of Section 4 and divided that into the four 40-acre tracts, and given each of those 40's a value, is that it?

A. Well, we give the corner a value.

MR. NUTTER: You base this on the corner points?

A. Corner point, uh-huh.

MR. NUTTER: I see.

A. It's not quite as accurate, of course, as if we had planimetered, but it's a lot easier for somebody

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

else checking the thing to come up with the same numbers.

MR. NUTTER: But every quarter section has four points that you've taken measurements on.

A. Right. And then we just take the arithmetic average. That's shown on the gold colored sheets.

Then on the green sheets we come again to the northeast quarter of 4, that's the first one that's listed. Under Column (4) is that weighting factor we just talked about. Under Column (3) is the number of acres in each tract. For instance in the northeast of 4 there are three tracts, 3, 14, and 26. We take the acreage in each one of them, multiple it by the weighting factor, and in Column (5) we have then the structural position weighting factor for that tract in that quarter section

As you can see down on line about 6 and 8, Tract 3 appears again and then again further down.

Then we summarize all those on the blue sheets, the Schedule III.

We go to each tract, find each one of its parts in each quarter section, sum them up, and then that is the structure position weighting factor for each tract.

Then we go with that and perhaps we should now look under Section C to see how it's all put together.

If you'll look at the last sheet of Section C, page five, you can see, for instance, for Tract 25, it's

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

160 acres; its structural position weighting factor of 762.25; and its 1976-77 production, which is the year we used for production, 160 barrels. If you take weighting factors for each one and come up with a total and -- and that's the total participation for each such tract.

Then we should take a quick look at the redistribution to the reallocation to the Indian tracts. That starts on page three, Tract 17, on the righthand side the equity factor for Tract 17 would be .163783. By our special allocation it's given a rating factor about five times, or an equity factor about five times what it otherwise would have.

The next tract is reduced from 64 to 44 percent.

MR. NUTTER: How did you get them to take a reduction on that?

A. Well, it had to come from somewhere. They didn't mind giving up 25 percent royalty for 50 percent net profits.

Then we might look quickly at the -- at the acreage -- the distribution of production to the tracts is fairly simple, based on the communitized acreage within each tract.

Under Section J there are some notes regarding surveying, which we don't need to go into detail,

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

but need to be a part of the record.

The first two pages explain some of the guidelines we used for allocating acreage to tracts.

The third sheet is a plat, which shows the problem we have of the homestead entry surveys right down the middle of the unit. That particular tract you can see where we had the little survey problems to work with.

Following that are some survey notes, the balancing of the angles, the calculating of the areas, and the plats themselves.

Now, under Section K we show a plat, or we have a plat which shows the lands and the wells within two mile arcs of the proposed injection wells. The color coding here, the triangular wells marked in red are those planned for gas injection; those in blue, the two center ones will be converted wells to water injection; the north and south blue triangles would be new water injection wells.

All of the land within those arcs that has no color means that it's leased by Benson-Montin-Greer Drilling Corp., or SNB Drilling Company, both of whom are parties to the unit agreement.

Lands colored are lands either unleased or owned by other parties.

Those in yellow are Federal lands that are not leased.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

Those in blue are fee lands that are not leased.

Those in orange are owned by operators who have not yet committed to the unit agreement.

MR. NUTTER: In other words, what was that last?

A. The two little tracts colored in orange.

MR. NUTTER: Yeah, those are the only lands that are leased that are not committed?

A. Yes.

MR. NUTTER: By the working interest.

A. By the working interest, and we're negotiating on those and I feel that we probably will get them. It represents about 3/10ths of 1 percent of the working interest.

MR. NUTTER: How about all this open government land? Will it be put up for lease within the near future?

A. Well, we presume, and the discussions we've had with the USGS representative, is that once the unit is effective, then depending on their paper process, why, they will have the lands put up for sale, and how long that will take, we don't know, but by virtue of the way we have our operating agreement structured, we feel we do not have to wait on the sale in order to proceed. We can go ahead and

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

get to work and of course the quicker they have the sale, why, the better, but we can move ahead and when the parties come in they can pay their share. If we're still drilling, well, they can pay their share then; if not, they'll just have to reimburse those who have paid.

MR. NUTTER: Well now, to put it bluntly, Mr. Greer, by the time you have placed a value on all these wells and all these improvements that you've got in here,and you're making those people buy these prospective leases, pay for those improvements, this puts them in a pretty bad dis-advantage trying to buy into the unit, doesn't it?

A. Oh, I don't know. It's -- I'd say it's not like finding a bird's nest on the ground, but --

MR. NUTTER: But doesn't it put you in a better position to bid on the leases if they're put up for competitive bidding?

A. Oh, I presume that's true in any instance where one already has an investment in a property and a new man comes in and wants to buy into it, and he hasn't paid anything, why, yeah.

MR NUTTER: Well, you've already had a certain amount of use out of some of those wells.

A. Yes, we've had some use out of them, no question about that. But also we feel that it's not fair to us just to give them an interest. In round numbers we're

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

talking about $4-1/2 million worth of wells and we're talking about $50 million worth of oil.

So they're certainly obligated to pay some.

MR. NUTTER: What's the total amount of acreage that's not leased today?

A. I don't have the acreage amount. The equity amount of about 5 percent.

MR. NUTTER: About 5 percent of the total unit.

A. Right.

MR. NUTTER: Go ahead, I'm sorry.

Q. In your opinion, Mr. Greer, is the proposed method of participation fair and equitable for all the parties?

A. I believe so. The -- we tried a number of different formulas, and in the end we come up with just about the same.

Oh, one thing before we leave this plat, we've outlined one little tract in green in the southwest quarter of Section 9. The ownership there is just a little indefinite. We think we have some leases on part of the interest but that's a fee tract. Three or four estates are involved; a number of people.

MR. NUTTER: Is that that old T. D. Burns estate?

A. Right. So there is a question there as to what -- just what the status of that is.

Q. Would you identify for us now, Mr. Greer, those exhibits and information that establishes the -- your anticipated recovery from the institution of the secondary and tertiary projects?

A. Yes, sir. We might take a quick look at the laboratory analysis we've had on the tertiary work. That's under Section M.

The significant information is on Table 4. The pages are not numbered; it's Table 4, in which three runs were made with different kinds of chemical injectants.

The first column is with straight sodium hydroxide, 3 percent solution. The second and third ones were with the same sodium hydroxide but with polymers added.

I've underlined the waterflood recovery in red under the oil recovery section, and the tertiary oil recovery underlined in red.

For instance, under column 1 --

MR. NUTTER: You don't have any underlining on mine, Mr. Greer. Where do we underline?

A. The one I might call attention to, the first red underline under Column 1 shows 48 cc recovered from this particular core, which incidentally, these are radial

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

floods, a special type of core analysis, I think really is pretty representative of what might be expected. The problem is, of course, we had to use Berea cores. We didn't have a formation core to use.

Recovered 48 cc by waterflood. Now that's both primary and a waterflood recovery.

Then the tertiary recovery is 30 cc in addition to that, which in terms of percent of the initial recovery is about 62 percent.

There's a little higher recovery in runs two and three with the polymers added, but that increases the viscosity of the water and it's my feeling that we would be better with a low viscosity water than a high viscosity where we're trying to float the oil on top of the water, and so we're thinking about straight -- straight caustic.

Now although this shows a 62 percent increase, I've assumed maybe a 3/4ths efficiency factor and the number I've used is about 46 percent that we might hopefully expect to pick up of tertiary recovery in addition to the waterflood recovery.

The graphs of the laboratory tests, which we might look at the first one, shows how -- how the oil cut drops off as the core is flooded, to about 2 or 3 tenths of a percent of pore volume, the water cut drops real low.

Then on the second graph you can see how,

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

again after 2 or 3 tenths of pore volume is injected, the oil cut picks up.

Then there are some photographs at the end of that section where they took pictures of the test tubes whick they gathered at every 5-hundredths of a pore volume that was flooded.

The upper lefthand photo, the dark color you can see is the oil that's recovered, and where it's light, that's water, and you can see that after six or eight test tubes, or about 3-tenths of a pore volume, that the oil cut drops to a very small amount.

Then they start the tertiary chemicals in and on the lower lefthand photograph you can see how initially the oil cut is small but it increases with -- with the flood.

We were surprised that this oil would respond as well as it did to caustic, but it appears to be that it could be quite helpful.

That's the basic information that we deal with for the expected increase through tertiary methods.

Now, by unitizing the -- perhaps the most important thing we can do is save dissipating the gas. By picking up the produced gas and re-injecting it, we can maintain the reservoir pressure, keep the viscosity low, and we think we can do two things: We can let the gravity drainage process continue through the high capacity fracture system.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

We found that we ran tests in the West Puerto Chiquito Pool, just a few miles away, the same formation. We concluded that the reservoir is made up of blocks, kind of like a jigsaw puzzle, tight blocks with high capacity fracture system in between.

Initially we drained the high capacity fracture system, the gas and -- nearest to the well bores, and we produce high volumes of gas. There still, we think, is oil left in the tight blocks, and one of the questions is how do we best recover that. If we go ahead and blow the pressure down that, as soon as the gas in the high capacity system reaches the down dip producers, we're looking only at solution gas drive recovery in the tight blocks; whereas, if we can continue to maintain the pressure for a long time, we think we can get part of the oil out of those tight blocks by gravity drainage and sweep them with the gas on down the high capacity system to the producers.

Now this is just a theory but we think it has a little bit of substance to it through one of the tests we have run in West Puerto Chiquito Pool, and that's shown in this yellow graph under Section O.

In West Puerto Chiquito the same as in East Puerto Chiquito, as soon as wells reach a high gas/oil ratio, and by high we mean like, oh, four or five times their solution ratio, in West Puerto Chiquito when the ratio reached

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

about 2000-to-1 we shut the wells in. With the exception of this particular well, the C-34, when the gas in the high capacity system reached this well we went ahead and produced it to see what would happen if the gas/oil ratio would just go out of sight or if it would level off somewhere if we might pick up producer oil, and it appears, in this well, at least, when the ratio reached about 10,000-to-1 it leveled off.

In 1974 this particular well had produced about 300,000 barrels of oil and in six years since then even that high gas/oil ratio, it's produced another 150,000 barrels of oil. I think a good part of that could have come from drainage of tight rocks in support of this theory that we think the reservoir is made up of these tight rocks and high capacity system.

If, for instance, this well would continue on as it's indicated here for 20 years, it's already gone 6, why it would produce another 400,000 barrels of oil beyond the time at which it produced 300,000. That would be over half as much would come out of perhaps the tight rocks as compared to the high capacity system.

And just from some of the theoretical analyses we made earlier we felt like that could be as much as half of the oil in the tight rocks, half in the high capacity fracture system.

MR. NUTTER: Now, Mr. Greer, are you

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

talking about the oil that's in the matrix itself or are you talking about in tiny fractures?

A. I'm really talking about -- by blocks I mean substantial areal segments of the reservoir. If you can think of it as a jigsaw puzzle and a block being like 30 to 70 acres big. That's about the size that we measured through our interference tests and pressure tests in West Chiquito, and the behavior of the wells is such that -- that you've drilled a well that's in, say, a 40-acre tight block, and if it's surrounded by high capacity system, just like the ocean around it, then this is how the reservoir has behaved, and I believe that's the way it actually is.

And so when I speak of a tight block, I'm speaking of a large segment of the reservoir, 30, 40, 50 acres. It drains, and oil seeps out slowly into the high capacity system. If we're cycling gas, we've got a chance of picking that up, if we don't let the pressure drop. Presumably, when the oil drains through the high capacity system it left a thin film of oil on the sides. Additional oil could fall and flow along those -- that same film, if we haven't destroyed the film. Now, if you let the pressure deplete, gas will come cut of solution, that oil on the -- that thin film of oil will no longer be a film. It will be dried up and there is nothing left to get the oil out of the tight blocks and it just stops right there.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

So by holding the pressure up and sweeping gas through it, we feel we can pick up additional oil. The amount could be all the way up to as much as 100 percent of what we've already produced. The estimate that I've made here is that realistically we might hope for 10 percent, and that's what I put in my estimate. I hope I'm conservative.

I feel that we'll get maybe 10 percent more from the high capacity system that still is above the lowest producing wells.

Then below the lowest producing wells we have oil that I call basement oil, that exists from that structure position down to the water/oil contact. That oil we hope to get by injecting water down dip in the water zone with tertiary chemicals in it, and float the oil above that. I've estimated maybe 15 percent of what we've already produced can be recovered that way.

And then I feel that the tertiary chemicals should work on a minimum of the oil that's left in the high capacity system and where we move the water up through the basement oil now.

So when you add all those together, they are itemized here on the first white sheet under Section O, 300,000 barrels -- the wells have produced about 3,000,000 so far. 10 percent would be 300,000 barrels from the high capacity system; another 10 percent from the tight rocks,

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

totalling 600,000 we can get from reserving the pressure and gas injection; pick up 400,000 from waterflood, and another 400,000 by tertiary, and we figure 300,000 the tertiary, a direct result of the chemicals and then another 100,000 barrels because of drilling additional wells. We'll drill additional wells because of the front end tertiary incentive program that the Department of Energy has introduced, which lets us release this $6.00 oil to $40.00 if we take the increase in income and put it into a tertiary project.

Then we -- the analysis in terms of cost to institute the secondary and tertiary methods is shown on page two, summarized at the bottom.

For gas injection we estimate it will cost us $400,000 to institute that system. We'll pick up, hopefully, 535,000 barrels at .34 cents a barrel.

And we might take a look at the graph at the end of this section to see how we've estimated -- or how these look.

You can see that the present rate of decline is 25 percent a year, the way the wells have been produced now. We've had to shut wells in in order to preserve the gas and I've shown here for the middle of 1980 that if we put all wells on production now, the ones that have been shut in, we would increase the rate from roughly 40,000 barrels a year to 80,000 barrels a year, but I would expect a very high rate of decline from there, like 75 percent a year. That's shown on the lefthand side of the yellow colored area.

If, however, we save that gas through a gas gathering, gas injection system, then we can stretch out to the righthand side of the yellow colored area, about 12 percent a year, and pick up that additional volume of oil.

The green shaded area shows what I think we'll get from waterflooding, and then the pink is the increase by the tertiary chemicals.

Then those costs shown on page two at the center of the page amounts to about $1.30 a barrel for gas injection for the additional oil recovery, $1.60 a barrel for waterflooding, and about $10.00 a barrel for the extra oil that I expect to get from tertiary.

Under Section P we just show the plan of operation, which we will submit when we present the agreement for approval, which simply is just what we've discussed.

Perhaps we should mention, there's a formation water analysis under the section where the -- regarding the tertiary chemical laboratory data.

As to injected water, we're not sure what we'll use. We have the right to use one of the wells shown on the plat in Section 13 to get Dakota water for injection. We've still not run enough tests to know if that's what we want to inject or not, primarily because of how it reacts

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

with the tertiary chemicals.

So that's one of the points not yet definitely decided.

As to wells within a half mile radius of the injection wells, there are none within a half mile radius of the water injection wells, and the gas injection wells, we're not certain yet which ones we'll use. We have a little bit of a problem there in that we want to inject gas into one zone and one well and the second zone in another well. In order to know which wells we can do that, we're going to have to go in and work on them and then come back and submit the details of the completion of those wells and the wells that are within a half mile radius of them.

Q. Mr. Greer, are you familiar with Division Memo 3-77, with regards to limitation on injection pressure into injection wells?

A. Yes, sir.

Q. And will any of your proposed wells exceed that pressure limitation factor, 0.2 psi per foot of depth?

A. No, sir, in fact we think the water will probably go in on vacuum. I'm estimating 400 pounds surface pressure for the -- the gas injection wells. The existing pressure in the secondary gas cap now is about 150 to 175 pounds.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

Q. Was Exhibit One and all its attachments prepared by you or compiled under your direction and supervision?

A. Yes, sir.

Q. In your opinion will approval of these applications be in the best interests of conservation, the prevention of waste, and the protection of correlative rights?

A. Yes, sir.

MR. KELLAHIN: That concludes our examination. We move the introduction of Exhibit One.

MR. NUTTER: Exhibit One will be admitted in evidence.

CROSS EXAMINATION

BY MR. NUTTER:

Q. Mr. Greer, now to consolidate all of your testimony, first of all, you're seeking approval of the East Puerto Chiquito Mancos Unit Area, and that's in Case Number 6943.

A. Yes, sir.

Q. And then second, in Case Number 6944, you're asking for approval for a pressure maintenance project in that unit area?

A. Yes, sir.

Q. Okay. Now, the project would be by the injection of what?

A. We'll inject gas in the up dip gas injection wells, and we'll inject water with some alkali metal as a tertiary recovery process. The alkali metal we're thinking of now is either sodium hydroxide or sodium carbonate. The test runs so far have indicated the oil responds better to sodium hydroxide than to sodium carbonate.

Q. Now would this tertiary process be begun at the beginning of the injection program or would you have a straight water injection program down dip and a gas injection program up dip carried out first and later on the chemical injections?

A. We're thinking about starting the chemicals right away for the reason that -- let's see, if you'll refer to the colored plat, contoured plat, under Section L, the water/oil contact is not -- not absolutely -- we don't know exactly where it is. We think it's approximately between the 3800 and 4000 foot contour interval, but wherever it is there, there's going to be a substantial amount of water move up ahead of anything we inject in the injection wells, the water injection wells, so that in a sense we are going to have a waterflood first, followed by a chemical flood, even if we start the chemicals immediately, because we don't plan on starting water in any of the oil saturated area. We just plan on putting water and the chemicals only in the

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

water zone below the oil.

Q. Well now, what has been going out here up to date? Have you been injecting gas?

A. No, sir. No, all we've done is shut in -- just shut in high ratio wells?

A. -- high ratio wells, yes.

Q. So, actually, we're going from a primary production into a tertiary production, and then where's the secondary? That's what --

A. Actually, the secondary will come ahead of the -- the secondary waterflood will come ahead of the tertiary, just because we've got that fresh water band, and there's probably -- there may a half a million remaining barrels of water there that's going to move up to the oil zone before the tertiary chemicals hit.

But if we inject water first and flood it out completely and then go to tertiary chemicals, I'm afraid then that economics might not justify it, because we might have to wait then for this half a million barrels of water to move through before we see any response.

Q. Before the chemicals would get to it.

A. Right, and that could take several years. We feel that we have to inject the water real slow. We've had very good luck in West Puerto Chiquito with gravity segregation in this fractured formation by the difference in

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

gravity -- or the density of the gas and the oil.

Q. I see.

A. We think we'll have the same thing working in our favor here, the difference in the density of the water and the oil, but we know that we must move it real slow.

Q. Would it be fair and would it upset your cost estimates or your profit estimates if we called it a combination secondary-tertiary recovery program?

A. Oh, no problem at all, because in a sense it's just all going to be going on concurrently.

Q. But that doesn't affect you as far as DOE prices and incentives on tertiary recovery?

A. No, sir, we --

Q. If we call it a combination secondary-tertiary recovery pressure maintenance project.

A. Right. There are so many questions with the Department of Energy regulations, you know, all we can do is make an educated guess as --

Q. Just hope you come out right.

A. --to what it's going to be, and five years from now when the auditing is all done, we'll find out whether we guessed right or not.

Incidentally, we've asked for an exception to their rules on determining of base production control level under unitization. Their rules are such now, which is just

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

as hard to understand, but then a lot of their rules are hard to understand, we suffer a -- having a higher BPCL by unitizing than if you take the properties individually.

When we asked for our exception we found that there had been one other exception asked for. That was by Shell and for the Hobbs Pool for the same thing. So we're hoping, of course, they're going to rule favorably on Shell's application and so they probably will on ours.

Q. Okay, now, Mr. Kellahin in filing his application stated that you propose to convert the following existing wells to injection wells, and then he listed five wells, and he also proposed to drill new injection wells at the following locations, and gave us two.

Now, could you be specific and tell us which of those are gas injection wells and which are water injection wells?

A. Yes, sir. If you'd look again under Section L at that plat, and we'll identify them.

Q. Is that same colored plat?

A. Yes, sir, the same colored plat.

On the lefthand side is a row of blue colored wells. The two center ones, marked H-25 and S-6 are existing wells that we will convert to water injection wells.

The new two wells we want to drill --

Q. You're going too fast for me, Mr. Greer.

A. Oh, okay.

Q. 25 and --

A. H-25, that's at Unit H in Section 25.

Q. All right.

A. And then the F-6 is Unit F in Section 6.

Q. Oh, you call that S-6 on this.

A. Oh.

Q. It's F-6, Section 6.

A. Right, uh-huh.

Q. That's a water injection well.

A. Yes.

Q. Okay, and then?

A. Then Section 19, up in the lefthand corner, somewhere in that northwest quarter we want to drill an water injection well.

Q. Do you have the 40-acre tract picked out yet for that?

A. No, no, sir, we do not. We do not.

Q. Could you make that determination and let me know a 40-acre tract for it?

A. Okay.

Q. And I can just specify a Unit D, or E, or F, or whatever it is, if you'll just give me a 40.

A. Okay. One of our problems there, you know, is the Indian land. It's pretty country up there and

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

we have to be careful just where we locate it.

Q. Yes.

A. Okay, the same thing would be true in Section 7, the northeast quarter there.

Q. Section 7, right.

A. Then the proposed gas injection wells are those colored in red.

Q. And those three are already drilled. That's G-29, C-2, and G-4, is that correct?

A. Right, uh-huh, and our plan there is to go in and test these wells. First we need to pressure test the casing and then we need to see if we can get the bottom and which are the ones -- I think one of them only goes to the first zone, and we need to -- I hope to have them in shape that we can inject in one zone in one well and another zone in the other well.

If we can't get enough gas in that at 400 pounds pressure, we may need to convert some additional wells, which we presume we can come back to ask for that if need be.

Q. I think the project rules would probably specify additional wells be drilled and converted to injection.

A. I see.

Q. Now, did you have any special rules for the operation of the project that you were proposing?

A. Well --

Q. As far as production limitations or allowable transfers, or credits on high GOR's, anything like that?

A. Nothing special. We will, of course, want to produce the most efficient wells with the higher rates, and --

Q. Will you be continuing to shut in high GOR wells?

A. My plan is to operate within the limits of our compressor, and what we disgned -- what we designed it for is on the assumption that we'll be producing from 100 to 300 barrels a day, and we can handle up to about 3,000,000 feet of gas with the compressor, which means we could go to a gas/oil ratio average of 10,000-to-1 at 300 barrels a day, or 30,000-to-1 when we get down to 100 barrels a day, and depending on how much of that gas we have to use either for gas lift or if we have to operate a little bit higher pressure than I'm estimating, then we have those limitations, but within those limitations, we just produce all the wells all the time.

Q. It won't be so critical to shut them in now if you're re-injecting gas.

A. No, as long as we re-inject gas, then I think the cycling can't do anything but help.

Q. Will you be stiffening this gas or running

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

it through any kind of a plant?

A. Well, we thought about it. It's really a small volume and I'm sure as time goes on we're going to want to be thinking about it.

The issues, of course, are that we're dealing with a high capacity fracture system, the gas is, although it will be work going through that system, whether it would get exposed to a big enough area of the reservoir to pick up additional hydrocarbons, liquid hydrocarbons, we don't know, but the odds are we'll be thinking about it.

In round numbers I think we'll be cycling a core volume every six or eight months in the gas zone, whereas it will probably take 20 years to cycle a core volume of water.

Q. Okay, now what about the configuration or the construction of the injection wells? You said you plan to test these injection wells before you ever use them to be sure that the casing and cementing programs are intact.

A. Right.

Q. Then what will you be doing, going down tubing?

A. Yes. Our plan will be to -- we'll have the casing cemented into the Mancos and then we'll set tubing on a packer with the packer fluid in the annulus, and of course we'd like oil for that packer fluid, and dealing with

$6.00 oil we might just as well use it as packer fluid, except of course, a little bit of additional energy we give the country, why, we probably should go to a water with treated water and give the government that oil.

But that would be the plan.

Q. Now, how about the -- how about these two wells that have already been drilled, are they drilled down into the Mancos and cemented through the Mancos?

A. The --

Q. Or will you have to recement them?

A. The 6 has a liner set -- it's just about where we want it, and it is drilled -- has been drilled into an open hole with cable tools into the Zone A, and it has a good capacity, like 10 or 20 barrels an hour. It will be a -- I think we have a dandy injection well in that zone.

The H-25 just north of it has been -- has been drilled to both zones; has 7-inch casing set into the Mancos. We will clean it out and run a 5-inch liner through both zones and probably inject in only the lower zone, if we can get satisfactory injection rate in it.

Q. Then how about the two injection wells you propose to drill?

A. The other two, I have hopes that we can run liners, cement liners, to both zones and figure out a way that we can inject, either control injection into each zone,

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

or at least be in shape where we can alternate injection in one zone and the other, depending on what it looks like we should do.

Q. Now, you're going to using some rather toxic chemicals here, Mr. Greer. Have you made investigation as to methods and means of handling this so that it won't be contaminating any fresh water supplies, and so forth?

A. Yes, sir, we have. In fact, we visited one of Gulf's operations in the North ___________ Field here two or three weeks ago, and by the way, they were most kind to take us out and show us everything, and I was impressed, of course, by the problem of handling these caustics, and we'll be taking every precaution to -- to protect not only the fresh water zones but our people in handling them. They are dangerous.

Q. And all injection would be through tubing and the annulus would be loaded.

A. Right, yes, sir.

Q. With the oil.

Would the injection into those three gas injection wells be through tubing, too?

A. Yes, sir. Yes, sir, it would.

MR NUTTER: Are there any further questions of Mr. Greer? He may be excused.

Do you have anything further, Mr. Kellahin?

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

MR. KELLAHIN: No, sir.

MR. NUTTER: Does anyone have anything they wish to offer in Cases 6944 and 6943?

We'll take the cases under advisement.

(Hearing concluded.)

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

CERTIFICATE

I, SALLY W. BOYD, C.S.R., DO HEREBY CERTIFY that the foregoing Transcript of Hearing before the Oil Conservation Division 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 C.S.R.

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 6943-6944 heard by me on 7/9 1980.

_______________, Examiner
Oil Conservation Division

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409