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

3 April 1987

COMMISSION HEARING

VOLUME 5 of 5 VOLUMES

IN THE MATTER OF:

Case 7980 being reopened pursuant to the provisions of Commission Order No. R-7407. . . Rio Arriba County.	CASE 7980
and	
Case 8946 being reopened pursuant to the provisions of Commission Order No. R-7407-D. . . Rio Arriba County.	CASE 8946
and	
Case 8950 being reopened pursuant to the provisions of Commission Order No. R-2565-E (R-6469-C) and No. R-3401-A. . . Rio Arriba County.	CASE 8950
and	
Case 9113, application of Benson-Montin-Greer Drilling Corporation, Jerome P. McHugh & Associates, and Sun Exploration and Production Company to abolish the Gavilan-Mancos Oil Pool, to extend the West Puerto Chiquito -Mancos Oil Pool, and to amend the special rules and regulations for the West Puerto Chiquito-Mancos Oil Pool, Rio Arriba County, New Mexico.	CASE 9113
and	
Application of Mesa Grande Resources, Inc. for the extension of the Gavilan-Mancos Oil Pool and the contraction of the West Puerto Chiquito-Mancos Oil Pool, Rio Arriba County, New Mexico.	CASE 9114

BEFORE: William J. LeMay, Chairman
Erling A. Brostuen, Commissioner
William R. Humphries, Commissioner

TRANSCRIPT OF HEARING

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I N D E X

I N D E X CONT'D

E X H I B I T S

(Thereupon at the hour of 8:15 o'clock a.m. on the 3rd day of April 1987 the hearing was again reconvened.)

MR. LEMAY: We shall reconvene at this time.

Before we start with side one's rebuttal witnesses or witness, is there anything that needs to be brought up.

MR. KELLAHIN: In concluding our review of Mr. Hueni's presentation last night it became apparent to us that there are certain specifc points that are uniquely within the scopy of Mr. Greer's expertise, and we will take out of our portion of rebuttal time, reserving, perhaps, twenty minutes, or so, for the possibility that Mr. Greer may have some final points.

We, our best estimate of the time, though, is that two rebuttal witnesses together would occupy approximately two hours. We will do our very best to reduce that further.

Our major rebuttal witness this morning is Dr. John Lee.

MR. LEMAY: Thank you, Mr. Kellahin.

Mr. Lopez, Mr. Pearce, do you plan to put on a rebuttal witness or do you know at this time?

MR. PEARCE: We, Mr. Chairman, we certainly need to reserve that right and until we hear the rebuttal we don't know whether we will come back with anybody or just cross examine.

MR. LOPEZ: But I think you should expect that we will.

MR. LEMAY: We shall reserve the time.

At this time, Mr. Kellahin, would you care to put on your witness?

MR. KELLAHIN: Thank you, Mr. Chairman.

We call at this time Dr. W. John Lee.

Mr. Chairman, while the gentlemen are passing out Dr. Lee's exhibit book, there are a couple of comments I'd like to make with regards to the presentation.

In reviewing the summary of conclusions we distributed to the hearing late yesterday, I note number 7 on that conclusion sheet is not a true rebuttal question.

Number 7, in fact, is Sun's position in the case, or at least one of the conclusions that the Sun witness testified to. I do not believe it is one of Mr. Hueni's principal conclusions; therefore we have deleted it from Dr. Lee's presentation because we don't think it's a rebuttal issue.

In doing so you'll notice that Dr. Lee's exhibit book is sequential, starting from 1 through 5, but then we skip 6 and go to 7. The reason for the change is that we have dropped the Sun position, which is number 7 on the original sheet. It's now been deleted and if you'll simply take 7 in the exhibit book and make that a 6, then everything flows.

In addition, because we have lost track of the exact exhibit numbers for the proponents, with your permission we will simply refer to this package of rebuttal exhibits as Lee Exhibit One. I think it might be an easy way to find the book, and with your permission, we'd like to do so, although Dr. Lee, obviously, is not a party or an applicant. He is an expert witness, but for sake of convenience, we'd like to simply refer to it as Lee Exhibit One.

MR. LEMAY: It will be so noted.

MR. KELLAHIN: Also, Mr. Chairman, Dr. Lee was not sworn originally on Monday and

we'd like to do so now.

(Dr. Lee sworn.)

DR. W. JOHN LEE,

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

DIRECT EXAMINATION

BY MR. KELLAHIN:

Q Will you please state your name?

A My name is William John Lee.

Q What is your occupation?

A I have two occupations. The occupation of note today is that I am Senior Vice President in Charge of Engineering for the consulting firm of S. A. Holditch & Associates in College Station, Texas.

The other occupation, though, is that I am Professor of Petroleum Engineering at Texas A & M University and hold the Noble Chair in Petroleum Engineering at A & M.

Q What, if any, professional degrees do you hold, Dr. Lee?

A I have a Bachelor's, Master's, and PhD degrees in chemical engineering from Georgia Tech, with the

Phd being in 1962.

Q Dr. Lee, have you published any articles within your profession as an engineer?

A Yes. I've published a number of papers, which were summarized in the biographical data sheet that we handed out yesterday, perhaps numbering over twenty or thirty.

Q Have you been the recipient of honors or recognition within your field of expertise as an engineer?

A Well, there -- there are a few that I'm particularly proud of. Probably the one that I'm most proud of was the SPE Resevoir Engineering Award in 1986, and others that I'm really, really proud of include serving as an SPE Distinguished Lecturer in pressure transient testing in earlier years, and also an SPE Distinguished Faculty Award.

Q Have you published any textbooks or publications within your profession?

A Yes. I have written a textbook also under the guise of SPE, a Peer-Reviewed textbook on well testing.

Q Would you summarize and describe for us your experience as petroleum engineer?

A Well, after graduation from Georgia Tech in 1962, I went to work for Exxon Production and Research

Company and I worked there some four to five years, and during that early experience I worked in well test analysis and also in reservoir engineering and technical service work, which included performing resevoir simulation studies on Exxon's major reservoirs around the world.

Following that work at the research center in technical service, I worked in Exxon's Kingsville District in South Texas for a year and a half, in which I designed some major waterfloods in that district.

For three years I then served as Associate Professor of Petroleum Engineering at Mississippi State University and in 1971 I returned to Exxon and my final position there at the time I left in 1977 was as Technical Advisor in charge of Exxon's Major Fields Study Group, in which I supervised teams of geologists and engineers who examined reservoir performance and and developed optimal depletion plans for Exxon's large East Texas reservoirs.

And then in 1977 I joined the faculty at Texas A & M University in petroleum engineering, and two years later I also joined the consulting firm of S. A. Holditch and Associates on a part time basis.

Q Have you been retained as a consultant by Dugan, McHugh, and Sun?

A Yes, I have.

Q And what were you requested to do, Dr.

Lee?

A I was requested to formulate an opinion on the drive mechanisms and the important recovery processes in the Mancos Pool's reservoir under consideration in this hearing, and also to develop an opinion on the proper reservoir description of this reservoir.

Q In making that study, Dr. Lee, have you reviewed the prior transcripts and testimony, including the testimony of Mr. Greg Hueni in the August, 1986 hearings concerning the Gavilan Mancos Pool and the West Puerto Chiquito Mancos Pool?

A Yes, I have.

Q And were you present throughout the entire testimony conducted before the Commission, commencing on Monday morning of this week through yesterday evening?

A Yes, I was.

Q And have you had an opportunity to review Mr. Hueni's analysis and presentation of his reservoir conclusions with regards to the Mancos reservoir?

A Yes, I have.

Q Based upon that review and that testimony and your study, Dr. Lee, do you have certain opinions and conclusions about the Mancos reservoir?

A Yes, I have reached certain conclusions.

MR. KELLAHIN: At this time,

Mr. Chairman, we would tender Dr. John Lee as an expert petroleum engineer.

MR. LEMAY: Dr. Lee is so qualified.

Q Dr. Lee, let me direct your attention to what we have marked as Lee Exhibit One. Directing your attention to the first page after the cover sheet, would you take a moment, sir, and identify for us and describe the principal conclusions you have reached in determining your rebuttal to Mr. Hueni's presentation yesterday and the day before before this Commission?

A Yes. My major conclusions are summarized immediately following the title page of this exhibit, and to summarize those conclusions briefly, the first, and this is the first in an area of conclusions which affect basic rock and fluid properties, the first of these is that I've concluded that the reservoir oil was under-saturated at discovery and that the bubble point pressure was approximately 1534 psig, at least in the Canada Ojitos Unit area, with its elevation and pressure difference compared to Gavilan.

The second conclusion is, I've concluded after reviewing the evidence, that the matrix will not contribute to reservoir oil reserves.

The third conclusion that I've reached is that interference tests are a valid source of reservoir des-

cription data. This is because petroleum engineers routinely analyze interference test data, using a particular mathematical technique, which I note here, and the applications of that technique in the petroleum literature to naturally fractured reservoirs.

And I would also note, and have concluded that properties determined from these interference tests actually characterize and provide an estimate of Kh in an area much larger than just a line immediately between the tested wells.

The fourth conclusion is that permeability thickness values equal or exceed 10 Darcy feet in much of this reservoir.

The next two conclusions deal with the area of reservoir performance.

Conclusion five is that the application of the material balance equation in Mr. Hueni's testimony did not, in my opinion, lead to a realiable estimate of original oil in place.

And the sixth conclusion, which should be renumbered 6, sixth and last, is that the effects of multiphase flow on the potential of the matrix to produce oil have been ignored in the application of the dual porosity reservoir simulator which we heard described yesterday, and especially important in this multi-phase flow is the need to

consider what we call the capillary end effect, which is caused by large differences in permeabilities within a matrix system and within a fracture system, and this, this effect tends to prevent the flow of oil from the matrix to the fracture system and instead to collect at the fracture face, and I feel that neglecting this effect is a fatal flaw in the simulation.

Q And when you talk about the fatal flaw in the simulator, you're referring to Sun's work or Mr. Hueni's work?

A Mr. Hueni's work.

Q Let's turn now, sir, to the presentation you have developed with regards to the first issue or conclusion under the basic rock and fluid properties, and that was the consideration of the bubble point pressure.

A All right. I have presented information on the bubble point pressure in the next section of my exhibit, and you'll note the way this exhibit is organized, on each of the six issues which I'll address, I will restate the conclusion that I've presented in summary form in my overview. I will state to you the implications of that conclusion and then I will go through the evidence which led me to reach that conclusion.

On the issue of bubble point pressure my conclusion is that the fluid sample from the Canada Ojitos

Unit No. 6, or L-11, is representative of the Gavilan Mancos reservoir fluid and the bubble point pressure for that sample of 1534 psig is in close agreement to that of samples taken very early and very late in the life of the reservoir.

Now, the implications of this conclusion are, first, that this reservoir was under-saturated at discovery and remained under-saturated for many years.

The second implication I would note is that fluid properties for use in pressure transient test analysis and for reservoir performance analysis, can be developed based on this sample analysis. We routinely correct fluid properties to separator conditions that are used in a field. This is standard practice; however, in this field there's no single set of separator conditions which were used and so, although I've corrected to separator conditions, any application of the corrected properties to separator conditions, need to be used cautiously when applied to actual wells in the field, and one could argue that perhaps no correction to separator conditions is even necessary because of the wide variation in separator conditions.

The third implication which I've identified here is that an attempt to analyze the reservoir using material balance equations will be unsuccessful during those times in which large parts of the reservoir are above the bubble point pressure and other large parts of the reservoir

are below the bubble point pressure. That is during those times in which we have some fluid above and some fluid below bubble point pressure we're going to have difficulty with material balance equations.

Material balance calculations require the reservoir oil to be essentially totally above the bubble point or totally below the bubble point.

I think, in fact, there's little disagreement between the two parties on what I've said here, because Mr. Hueni has concluded many of these same facts and so mainly I'm establishing a basis for fluid properties that I use in my pressure transient test analysis. I would say the major difference is the conclusion that we have reached regarding what the bubble point pressure in the field was.

Q Let me, before you leave that page, let me have you look at the third line of that summary page. It says 1534 psig; in fact, it's psia, is that --

A That -- you're correct, that's a typographical error. It is 1534 psia.

Q Let's turn to the factual basis upon which you have reached your conclusions about the bubble point.

A All right. The next page following my conclusions is simply a statement of fluid properties corrected to a specific separator pressure which was typical of

many of the wells in which we analyzed pressure transient test build-up and interference tests.

But more importantly, following that is the -- is a summary of the facts which led to the conclusions.

Q And that's on a page that's captioned Summary of Sample Results.

A That's correct. The essence of the argument is this: For the three wells noted here, Canada Ojitos Unit No. 2, No. 6, and the Loddy No. 1, there were samples taken from 1962, then in '65, and 1986. There were samples taken over a period of 24 years.

The bubble point pressure of those samples is noted on this page. For COU No. 2 the laboratory determined bubble point pressure was 1539 psia. That sample was taken very early in the life of the field before there was any significant production from the field and therefore had potentialed to really represent an undisturbed reservoir fluid sample.

The sample from COU No. 6, taken three years later, was a sample in which the well was especially carefully conditioned and it was a real effort to secure a quality sample. And a noteworthy point is that the bubble point pressure in that sample taken approximately three years later was about the same as the first sample.

And then in the sample from the Loddy No. 1, taken twenty-four years after the first sample, the laboratory determined bubble point pressure was again about the same as the other two.

Now, some observations on these numbers. First we notice, when we also note the elevation of these wells, that the bubble point pressure of these three samples increases with increasing elevation and that is as expected in reservoirs with long oil columns, so even though there's a difference in the bubble point pressures, that's consistent with what our expectations would be in reservoirs with long oil columns.

Secondly, and really the most important point, is that the bubble point pressures taken over this period have similar values and to me this is strong evidence that the bubble point pressure is approximately 1534, the one determined in the well in which there were especially careful conditions taken to assure proper sampling properties.

This indicates to me, then, that because we have this consistent saturation pressure, that the reservoir was highly under-saturated at discovery.

The final point really doesn't affect the analysis of these samples and conclusions that I draw, but I think we do want to note that because of this long oil

column and significant differences in elevation points in the reservoir, that there is a higher reservoir temperature in the Gavilan area than in the Canada Ojitos Unit area, and if we corrected the bubble point pressure from the L-11 sample to the higher temperature in the Gavilan area, assuming that the composition of that fluid remained the same, the corrected bubble point pressure for that sample, plus other sample information available, would indicate that the bubble point pressure in the Gavilan area would be about 1572 pounds.

The remaining two pages simply summarize the conditions under which these samples were taken. I'm not going to comment on those. I simply provide this as back-up information to -- to show the quality of the samples and the sampling conditions.

Following those two pages summarizing the sompling conditions, I have placed in the exhibit pages from the Core Laboratory analyses of these samples.

The first page in each case is -- well, the first one is for Bolack No. 2, which is our first sample that is -- that was the name at the time for Canada Ojitos Unit No. 2. We note that Core Labs on the second of these two pages for that well determined a bubble point pressure of 1524.

Similarly we give the actual laboratory

report for the Canada Ojitos Unit No. 12-11 and the reported saturation pressure on the second of two pages there of 1519 psig, which would be approximately 1534 pounds per square inch absolute.

And finally we give two similar pages for the Loddy No. 1 and noteworthy is the saturation pressure for that sample of 1482 psig.

Q One of Mr. Hueni's fundamental conclusions and one of the benchmarks upon which they have placed their analysis of the reservoir is the fact that the matrix will in fact contribute to the reservoir oil reserves.

Do you agree or disagree with that?

A I agree that that's a major factor.

Q What is your opinion with regards to whether or not the matrix will or will not contribute to reserve oil -- to reservoir oil reserves?

A My opinion is that the matrix will contribute very little, if any, to the reservoir oil reserves.

Q Turning to that question, the next principal conclusion you've reached is identified by a page that is captioned and begins, Matrix Contribution - Explanation of Attachments.

A Yes, it is. Here I provide the back-up information for the conclusion that I earlier stated in my overview or summary of conclusions that I've reached in my

study.

Q Would you describe for us what your opinion is and what your conclusions are and how you've reached that opinion and those conclusions?

A My opinion is that the permeability of the matrix at reservoir conditions, in situ, is so low that the matrix cannot contribute significantly to oil reserves, and the method by which I arrived at that conclusion is outlined on this page.

It's based on taking the permeability that Mr. Hueni reported in his written notebook and exhibit that he went over with us yesterday, and a copy of the page on which these numbers are mentioned is found two pages after this page Explanation of Attachments, if you wish to refer to that.

That's entitled Excerpt from Hueni Exhibit Book, Mallon-Mobil-Mesa Grande Exhibit Number 10.

Q And this is page 3.5 out of --

A Right.

Q -- that exhibit book.

A That's correct.

Q All right, sir. On that page Mr. Hueni reported an average permeability of .018 millidarcy from core analysis, and that value was based on dry, unconfined core permeability measurements.

Now Mr. Hueni corrected this core permeability for confining pressure. He reported a value, which, when confining pressure would be applied, of .0003 millidarcy. That's been rounded to ne significant digit and I'm not arguing with that, but in the calculations I'm going to present I've stated more digits, and I've verified his calculation and have come to a number of .000268 millidarcys.

But notice, again referring to Mr. Hueni's testimony that he states that in the simulation model, even though this permeability, when corrected for confining pressure, as it would have in the reservoir, was used .002 millidarcys, the matrix permeability has been increased by almost a factor of 10 with no physical measurement basis for that stated.

Now, I've gone beyond these stated facts to take into account one more important adjustment, which needs to be made to these permeability values before they truly reflect the permeability that a rock would have at reservoir conditions, and that correction is for the effect of connate water saturation.

I've attached a paper which provides the technical background for the further adjustment that I've made following the page from Mr. Hueni's testimony. I by no means am going to go extensively through that paper. Those

who wish to study the background can do so.

I'm simply going to use two of the results from the paper in the work that I'm going to present now.

This paper is entitled Laboratory Study, and it should be "of" rather than "or", of Low Permeability Gas Sands.

What this paper does is present a correlating equation based on the extensive number of laboratory measurements through which we can correct core permeabilities determined without confining pressure and with the liquids removed and correct these dry core gas permeabilities to permeabilities that we would have in the reservoir under in situ condtions with connate water saturation.

Please note another typographical error here in the fourth line under this section SPE Paper, I say, "... net confining pressure and connate water pressure" and that should be connate water saturation.

Now, that correlating equation was developed for use with tight gas reservoirs and that's obviously the major application, since rarely does an operator attempt to develop an oil reservoir with the kinds of permeabilities that are addressed here, but that correlation is nevertheless strictly applicable and can be applied to oil reservoirs. There's just no difference in principal.

And that equation when applied to oil reservoirs with tight rock, I've stated at the top of the next page of my exhibit, and I need to make sure that this equation is clear in form and I'll refer you to the section of the paper to assure this, but my restatement of the correlating equations for oil reservoirs is that the oil permeability corrected to reservoir conditions can be found by taking the permeability from routine latoratory analysis, which we denote by the symbol K. K should be raised to the 1.9 power.

That result, then, should be divided by 7.5

That equation can be found in the reference paper, it's (9) in the paper and notice that there are page numbers in the paper, that's found on page 1639 of the paper.

The equation there, in terms of gas, is gas permeability is equal to a constant a times permeability, which is dry gas permeability raised to a power c. That equation is applicable for air permeabilities or gas permeabilities in the range of .02 millidarcies to .55 millidarcies, which is the range that we're talking about here, and constants a and c are given for various conditions, depending on whether the effects of stress and water are minimum, moderate, great, or very great.

The authors say that when you are unsure you should choose the moderate case and that's what I've chosen here.

In reviewing this formation with geologists, though, I've found that in the formations that are mentioned here below that equation, the rock type that's most comparable to the Mancos formation is probably the Frontier sands, which actually, according to the authors of the paper, experienced large effects due to stress and connate water saturation, but nevertheless, I've chose the average value to use in this equation, a value of a of 1/7.5, a value of c of 1.9.

Now, when I apply those factors to the average permeability, .018 milidarcy, the result is a corrected permeability of .0000646 millidarcies. We've now corrected for both confining pressure and connate water saturation, and I immediately, when I see a number like that, I conclude that that is too low to be of practical importance in the reservoir.

Now, --

Q What is the significance of the difference in the average matrix permeability you have calculated for the reservoir and what Mr. Hueni has calculated?

A Well, the significance is that I have corrected for connate water saturation, whereas he has not,

and the adjustment is that the permeability that he has corrected for confining pressure has gone from .000268 millidarcies to .0000646 millidarcies, about a factor of 5, or so, lower permeability to correct properly for the effect of connate water saturation in this matrix.

Now, there's an alternative way to make this adjustment for water saturation. It will lead to the same conclusion.

The reference paper that I've presented here cites a study by Thomas and Ward, who were with the Department of Energy, and they found that the effect of connate water saturation alone reduces the non-wetting phase permeability, which is oil in this case, to 10 to 20 percent of the dry core vale.

So if we conservatively apply the 20 percent factor to Mr. Hueni's permeability estimate, our adjusted permeability, we take his reported number of .000268 millidarcies and multiply it by .2 and the result is

Now because we're working with correlations, I won't argue that there's any practical difference between these two results. The -- as a practical matter, the result is the same, even before adjusting for relative permeability to oil in the presence of gas, which is another factor that needs to be taken into account in looking at the permeability in the matrix.

The average matrix permeability is too small to be of practical importance.

That's my major conclusion. I must note, though, that I am disturbed by the reported adjustment of permeability upward to .002 millidarcies in Mr. Hueni's notebook and the data entry into his reservoir simulator of an even higher number, .00253 millidarcies.

Q What does that cause, if a higher permeability is applied to the matrix in the simulation?

A If a higher permeability is applied to the matrix, that makes the matrix much more productive in the model than it would be if a lower permeability were used in the simulator.

Q Let me direct your attention now, Dr. Lee, to the third conclusion you have identified on the first page under the Basic Block and Fluid Properties, and have you discuss for us your analysis of the interference tests, whether or not those interference tests are a valid source of reservoir description data.

A My conclusion in interference test analysis is that, first, petroleum engineers do routinely analyze interference tests using the EI-function, which is sometimes called the line source solution, and I'll present evidence that they do.

These applications are reported in the

petroleum literature.

The second part of my conclusion is that properties determined from these interference tests characterize an area much larger than just a narrow line in between the two wells involved in the test.

Q Would you take a moment, Dr. Lee, and crystallize for us what the difference is between what Mr Hueni has said and what you have now concluded?

A Well, Mr. Hueni has said, and this was specifically in the August hearing, that interference tests are not to be trusted, and I'm paraphrasing, but he placed little confidence in the results of an interference test because they reflected properties essentially on a line or in the immediate area between two wells, and I propose that they sample reservoir properties over a much larger area, just as do individual well pressure build-up tests.

Q Show us the basis upon which you've reached your conclusion on that question.

A Well, the basis on which I've reached my conclusion is based on some attachments which I've provided in this section of my exhibit, and this conclusion about the area covered by the build-up test might seem to be circular logic because I have provided first here a quote from a textbook which I wrote, which I guess arguably might be said to prove nothing, but I'd like to refer to that, anyhow, be-

caue I've stated the argument there about as well as I can, and I'll actually say that the point has been made in the literature, not in my textbook.

Immediately following this page of Description of Attachments I have the title page from the book to show you where it came from, and then two pages from the chapter of this book which deal with interference test analysis.

I would focus your attention particularly to the second of these two pages from the chapter of this book which deals with interference test analysis.

I would focus your attention particularly to the second of these two pages and to Figure 6.2, which is a schematic diagram of the region investigated in an interference test, and what we see here, based on a citation from the petroleum (not clearly understood), that the region in which we have determined essentially an average set of formation properties and interference tests, can be modeled schematically as a rectangle, and that rectangle has a length which is equal to twice the radius of investigation which has been reached during the, say, production or injection from, say, one of the wells in this interference test, how far out that -- that well has drawn down reservoir pressure, it's equal to twice that radius plus the distance between the two wells. Of course those radii of influence

will overlap but still the fact remains that the region investigated will be a rectangle which has a length twice the radius of investigation achieved by what has been done at the active well which we're producing or injecting into in an interference test, and the width of that rectangle will be twice that radius of investigation.

The properties we report from the interference test will be some sort of average from that rectangle.

The other item that I would cite form this first attachment is that engineers do frequently use the exponental integral, or EI-function solution, or line source solution, to analyze interference tests. I have simply stated on the first page of the copy of material from my textbook equation 6.1, which is that line source solution.

To apply that solution in practice to test analysis, it's convenient to use what we call type curves and an example type curve is shown in Figure 6.3, which is on the second page of my handout.

When we -- the way we use a type curve, what I mean is we take actual data from a test, the pressure change in a responding well in an interference test, and we plot that pressure change versus time elapsed since we changed the production pattern in an active well, such as, for example, beginning to produce a well which was shut in.

We make that plot of pressure change versus time. A particularly convenient method of test analysis is to compare that plot of pressure change versus time to a so-called type curve on which we basically just plotted this line source solution, and we slide the data around until we find the best fit of our data on the type curve, and from that position of best fit we deduce what the formation properties were which led to this kind of response as observed in this interference test.

All right, that's basic background and the basis for my statement that we do sample a significant area of size and shape that I've described in an interference test.

The second attachment is back up for the fact that petroleum engineers do apply this sort of technology in practice and in fact have applied this sort of technology in practice to a reservoir which has a number of similarities to the pools under consideration in this hearing.

The second attachment is a paper entitled Reservoir Performance and Well Spacing, Spraberry Trend Area Field of West Texas, and I won't go into detail in this paper but to summarize the major point to be drawn from that paper at this point, this illustrates the successful application of EI-function solutions to treat interference type data from this important field in West Texas.

Now in the paper, to assure that I've properly represented what it says there, I would note that in the paper on page 184 of the paper, and in the reproduction the page numbers may have been cut off, but equation 1 in that paper, which is some several pages into the paper, equation 1 is simply the exponential integral or line source solution.

It's on the same page on which Figure 8 occurs.

This particular reservoir is a dual porosity reservoir without question. It has a matrix which does contribute. It is a naturally fractured reservoir. I raise this point because another of Mr. Hueni's opinions is that in dual porosity reservoirs the line source solution is not applicable. I would agree with Mr. Hueni that there is a study reported in the literature which states that if you apply the line source solution to a dual porosity reservoir, that will lead to an over estimate of permeability thickness product. That is true; however, the amount of error is relatively small and becomes smaller as the contribution by the matrix becomes less important.

Now, let me tie that back to the paper that we're reviewing here.

In which this paper in which the line source solution was applied to this clearly dual porosity,

natural fractured reservoir, formation properties were determined and these properties were compared to results in pressure build-up tests and also from productivity tests or productivity index tests. From those we can determine permeability thickness in properties. Mr. Greer has done that in his testimony earlier.

The conclusion in this paper, and this is also, this is found on page 186, where our equation 1 was found. I've underlined on page 186 in this paper a few sentences from a very important paragraph.

The underlined words in this paper are, "Average effective permeability in this area was approximately 16 millidarcies for the 31-foot gross section as determined by this analysis..." and this analysis means this analysis of -- of well interference data using the EI-function solution.

That corresponds to a productivity index of .48 barrels per day per psi and to an initial individual well potential of 520 barrels per day. Actual productivity indices range from about .1 to 2.5 initially and initial potentials range from 31 to 960 barrels per day in this area.

This effective permeability in millidarcy feet is also of the same order of magnitude as that determined by build-up curve analysis in an adjacent area.

The implication is that the author of

this paper, who is a very prominent petroleum engineer, has concluded that you can get reliable properties, or reliable reservoir description, by applying an EI-function solution to analysis of interference test data even in this naturally fractured dual porosity reservoir.

The third attachment, which I allude to back on my page Description of attachments, is a more recent paper. This paper is entitled Interference Test Analysis for Anistropic Reservoirs -- A Case History.

This paper is authored by Dr. H. J. Ramey, Jr., of Stanford University, whom many people consider to be the -- the intellectual leader in the area of pressure transient test analysis in the world.

In this paper Dr. Ramey illustrates the application of the EI-Function solution to interference test analysis in a complex reservoir and he's presented a more sophisticated analysis in this case.

He suggested a possible way to apply the EI-Function solution to a reservoir which has different permeabilities in different directions. That we term an anisotropic reservoir.

Even though he's done that in a reservoir in which there are different permeabilities in different directions, he has -- he has found that individual well tests which can't sense difference in direction permeabil-

ity, the average permeabilities in all directions, those individual well tests and the interference test still come up with comparable permeability thickness values.

On the page that I refer to which documents that, the quality of the reproduction is very poor and should anyone wish, I've made a copy of another page of analyses of the same data on which Ramey's results have been summarized and I will make this available to anyone who wishes, but the statement is made in the paper and the inference in Dr. Ramey's paper is clear that even in this anisotropic reservoir the values of the permeability in -- from the individual well build-up test and from the interference test, looking at data in different directions, lead to comparable values of permeability thickness product.

Now the implication of that is once again basically that the EI-Function solution is a valid way of analyzing interference tests in reservoirs.

In fact, in this paper on page 123, Dr. Ramey concludes that his -- his method is likely applicable to naturally fractured reservoirs, even in the extreme case in which there are fractures only in one direction, where there's a vast difference in permeability in one direction, which would reflect fracture permeability and in the perpendicular direction, which would reflect largely matrix permeability.

The implication is the EI-Function solution when properly modified to account for anistropic permeabilities would be applicable even in that extreme case, and Dr. Ramey so states on page 128 of this paper.

Q Let's turn now, Dr. Lee, to the next basic conclusion you have under the Basic Rock and Fluid Properties, which I believe is number 4 on the summary. It talks about the permeability thickness product values.

Would you first of all refresh our recollection of your understanding of Mr. Hueni's position on this question and tell us whether or not you agree or disagree?

A My recollection of Mr. Hueni's position is that we can characterize the reservoir with a permeability thickness product in the range of, let's say, 400 millidarcy feet, something of that order, 200 to 400 millidarcy feet.

Q Do you agree or disagree with that conclusion?

A I disagree in part but the thrust of my conclusion is disagreement significantly as it affects the performance of this reservoir.

What I found is, first, that permeability thickness products vary significantly from area to area in the reservoir, and I think we're all agreed on that.

Importantly, I've determined that values of permeability thickness exceed 10,000 millidarcy feet, or 10 Darcy feet, and we frequently referred to it in this hearing, they exceed that number in many areas of the reservoir, and further, these values can be determined from interference tests as well as individual well pressure build-up tests, and the implication of this is that permeability thickness values of 10,000 millidarcy feet can be used to analyze the gravity drainage potential in much, not all, but in much of this reservoir.

Q Would you identify and describe for us the basis upon which you have reached your conclusions on this question?

A Yes, I will. The information on which I've based this conclusion is summarized on a sequence of pages, which begins on the page immediately following the conclusion page, and on this first page I've summarized well test analysis results, and here I've summarized the results of interference test analysis, pressure build-up test analysis, for the wells noted on this page, and particularly noteworthy, I think, is the effective permeability thickness value that I have determined from these various test analyses.

Now I want to make some observations.

One, you will note that there are data

from only two wells in the Gavilan Mancos Pool on this table, and those wells are the Native Son No. 1, on which we have two different pressure build-up tests, and the Rucker Lake No. 2, on which we've reported one build-up test. That bias towards data, or that apparent bias, really reflects the general lack of test data in the Gavilan area.

Al Greer, in this testimony on Monday, in Section S tried to fill this gap of test data in the Gavilan area by determining permeability thickness product from productivity tests, and that's all we can do in absence of test data, but I would note that in the Spraberry paper which I've just cited, the author, Mr. Lincoln Elkins, showed that the results from produtivity test analysis and build-up test analysis and interference test analysis should be expected to be comparable.

So we have to fill the gap somehow in the Gavilan area.

The second point that I would like to note is that we examined every build-up test analysis and interference test run in both Gavilan and West Puerto Chiquito. I have not presented results here from all those tests but as we will see in a moment, for the tests to which we do not refer on this table we concluded that the test data were uninterpretable because the test, for the most part, was run incorrectly and no conclusion at all should be at-

tempted from those test data from those other tests, and we'll -- we'll look at those specific tests later.

All right, following this summary page, you should have in your exhibit booklet a map inserted on which we have plotted the position of the permeability thickness values determined from the interference tests and individual well pressure build-up tests, and this shows the areal distribution and, as I've already noted, we have permeability thickness values from only two wells or two tests clearly in the Gavilan area. There is an interference test between the Gavilan and West Puerto Chiquito, which could be inferred to have some properties getting into the Gavilan area, but there are just two build-up tests completely in the Gavilan area.

All right, on the next few pages I present graphs in which we plot the data from these tests and show the basis for the conclusions that we've reached from the permeability thickness products.

Q I notice in the exhibit book there is a loose page that came out of Mr. Greer's exhibit book that you've inserted at about this point. May we use this as simply an index to keep track of where you are with regards to well locations --

A Yes.

Q -- in the tests?

A Yes, and in particular this summarizes the results from the analyses of the various tests, and I think it's even more valuable for that purpose.

Q I notice in looking on this map there are certain numbers written on the display. What are those numbers?

A Those numbers written on the display are the permeability thickness product values which have been determined for wells or areas between wells from all the tests that I've summarized in tabular form on the page that we've just been discussing.

Q When we look at the Kh values in the Gavilan, they appear to be higher than those Kh values -- I'm sorry, they're lower, in fact, than the Kh values in the West Puerto Chiquito Mancos Pool. Is that not true?

A That's true.

Q Would you care to comment on that difference?

A Well, again, as I've -- as I've said earlier in other words, that reflects lack of information as much as anything else. We only have data from two individual build-up tests in the Gavilan area, and that's where the gap, where Mr. Greer has attempted to fill the gap from lack of data in the Gavilan area by analyzing productivity tests.

Q Let's go through those interference test results and have you comment on them.

A All right. We have now a sequence of diagrams starting with the interference tests in which we've shown observed pressure change at individual wells in the interference test plotted as a function of time and we've shown the type curve, the EI-Function type curve which best fit those data and from which we derived our estimate of formation properties for the area in the general area of the tested wells.

I have no particular comment but I wish each one to look at these and observe the quality of fit.

The first is the response at A-14 due to production at L-11 and P-11, two wells production affected the response at one observation well.

The second of these pages is response at Well A-23 due to production at L-11 and P-11, and those fitted curves led to our estimates of formation properties.

The third of these graphs, the response at A-23 due to gas injection at K-13.

The next one is different, notably different, and I need to explain this.

This is the analysis of a 1986 interference test in the Canada Ojitos Unit in which there were a number of wells produced with the response being observed at

Well E-6. Now, that situation where there are a large number of wells being produced and the response observed in only one well can't be matched or can't be modeled simply by an EI-Function solution for one active, one responding well.

What we had to do here is do some -- some modeling or computer history matching of these test data, and what we have on this graph on the vertical scale is the observed pressure drop at well E-6 expressed in psi plotted as a function to time in hours, and the solid line is the calculated response; that is, what the response should have been with a particular set of formation properties and notably important here is the permeability thickness product and the storage or porosity compressibility thickness product.

The solid dotted lines here are the actual observed test data, and notice that the observations begin long after production was started in this area. At the time this test started the reservoir pressure was uniform. There had been a general lack of production and then as wells began to produce they began to affect the overall pressure in this area, and finally, long after individual wells began to produce observations began to be made and the comparison of actual and observed pressures are noted on this graph, and particularly noteworthy is the overall pressure level and general trend in the curve.

As one varies the permeability thickness product, the factor that's particularly changed is the predicted pressure drop at the observation well and with the permeability thickness product which, as I recall, was 10,300 millidarcy feet in this particular area, we found the best match that we could find in this area, which is the match shown here.

For larger permeability thickness products this generally predicts too little pressure change; for smaller permeability thickness product it predicts, again, a pressure change which does not agree as well with the calculated trend.

All right, following this graph we move into a sequence of graphs for pressure build-up tests.

Before we begin to look at these individual tests, I want to make the comment that what we want to look for here is any apparent dual porosity behavior in these tests.

Mr. Hueni presented to us a pressure build-up test yesterday which he suggested might have a shape characteristic of dual porosity reservoirs and if you might recall that testimony, he indicated that that characteristic shape was that a build-up test might have a characteristic straight line and then a deviation from that straight line followed by another straight line with slope

parallel to the first. Please keep that shape in mind as we go through this tab. I think we'll find in fact that -- that that was a unique curve shape and I'll have further comments on that particular test when we look at it later.

All right, the first of these tests in this section is a semi-log plot, or so-called Horner graph of pressure versus a Horner time ratio.

What we're looking for on the Horner graph is a straight line whose slope we infer to be related to the permeability thickness product for the tested well.

It's not a straigtforward matter to identify the most probable straight line. To assist in that and what was done in the case of this first well, was to use in addition a so-called type curve plot of test data.

A type curve plot is log-log graph of pressure change during a test versus what we call effective time in that test. That's shut-in time but modified to take into account the influence of production period prior to shut-in.

That log-log graph is compared to a type curve and on the type curve we're able to deduce when the most probable start of that straight line, whose slope reflects formation property begins.

The next graph is a little bit busy, but it does show the type curve which best fit the actual

pressure data or actual pressure change. That's shown with the square line and the best fitting type curve is shown with the top curve here.

In addition it has become very popular in the industry in recent years to also look at a so-called derivative curve plot and I'm not going to elaborate that any further except to say that that can help us even further to determine when we have found the correct straight line on a semi-log graph, and the characteristic that we're looking for in the so-called derivative flat curve plot is that which is shown with the X's in this particular case. When that curve goes through a peak and then comes back and flattens out. As we note at later times in this particular test, toward the right the X's fall on essentially a flat line and that gives us a pretty good assurance that in that time region we found the correct straight line on the semi-log graph.

So we always put together the semi-log graph and the log-log graph, which includes the derivative factor. But what we're hunting for is that correct semi-log straight line. That's what the thrust of the effort is about.

Well, we've seen that on Native Son No. 1. The next -- that was for 7-84 test.

The next pair of graphs is for a build-up

test on Native Son No. 1, an 11-84 test, and again note that we have identified a semi-log straight line and have found that we're aided by the type curves in being assured that that is the correct semi-log straight line.

We will also note an absence of this test shape indicative of dual porosity reservoir behavior. It appears to be behaving as a single porosity system.

The next semi-log plot indicated is for COU B-29, a test run in August of 1986, and I need to comment on this test in a little bit special way.

This Horner graph that's shown here basically plots observed data in the test going from small days of build-up time on the right towards large days of build-up time on the left. In other words, time is increasing as we go from right to left.

We've identified a fitting straight line through these data but we note that at late times there's a deviation from this fitting straight line. That is without doubt interference effects in this particular test. Mr. Lyon mentioned the problem of wells interfering with each other in these tests and -- and noted that it's wise to -- to watch for this and try to take it into account when it occurs. This well is being interfered with, so there is some drawdown in pressure in the area of this well caused by offset production. This complicates test analysis.

What we've done to take this into account is note the rate at which pressure is changing early in this test and the rate at which the deviation from the early trend is occurring at late times and from this we can -- we can deduce an apparent affect of interference from offset wells, and we've tried to do that here and basically we found that the straight line that we've drawn, we believe gives a valid estimate of formation permeability thickness, interference affects and all, but we're -- we're particularly fortunate in the case of this particular build-up test that this was followed by an interference test between this well and an offset well and the permeability thickness values determined from that interference test confirm the permeability thickness values determined from the build-up test.

I realize that this is beginning to be a rather complicated argument but the long and short of it is that interference effects and all, we believe we can still determine a valid estimate of permeability thickness product from this build-up test and that permeability thickness value can be confirmed with interference test data from the same well.

The next plot, and note that there's an absence of a log-log plot for Well B-29 and the reason is simply that no value of bottom hole pressure at the time a

shut-in was reported and that is required to make a valid log-log plot, so we don't have a log-log plot for that well, so we haven't hidden anything, it 's just that the data required to make that plot are not available.

The next plot is a semi-log plot form COU B-32, and again remembering that the data from long shut-in times are found on the left, we'll note a deviation due to interference effects. In fact this is even clearer because the pressure after reaching a maximum actually begins to climb.

But once again we have confirming interference test analysis which says that using the semi-log straight line is placed where we have and analyzing the rate at which pressure was changing due to interference effects here, we -- we believe that this straight line again leads to a reasonably valid estimate of permeability thickness product (unclear.)

We notice on the log-log graph on the next page that the derivative type curve which I would remind you is shown by the big X's, reaches a flat value indicative of a proper semi-log straight line, and then that derivative, those X's, begin to go lower and lower, indicating a deviation from the fitting trend and, of course, that's reflecting the interference effects from the offset well.

The next graph is a semi-log plot from Rucker Lake No. 2. This is the well which Mr. Hueni identified as having a possible interpretation of dual porosity reservoir behavior.

I've presented an alternative interpretation here. I would agree that -- that different interpretations are possible for a given set of build-up test data, but I want to explain the reason why I have developed the interpretation that I have here.

You'll note a semi-log straight line has been identified here and on the type curve graph on the next page you'll note that those later time data, which reflect the data through which the semi-log straight line has been drawn, also are fitting a type curve, and in that area there's a lot of scatter and this derivative type curve is, these X's, they generally trend around a flat area there.

Data before that semi-log straight line, although they do show a minimum in this derivative, they -- we find that they simply do not fit dual porosity reservoir type curves and certainly data on semi-log straight line, if we were to try to draw two parallel semi-log straight lines through those test data, they simply cannot, those -- those data, those times simply cannot be confirmed by a type curve analysis of data at those identical times.

And again I realize that this is becoming

a complex argument. The long and the short of it is that we cannot reconcile semi-log analysis and type curve analyze for the same data in the same time region on this test, we simply cannot reconcile a dual porosity reservoir characterization for these particular test data.

But in any event, even if that were possible, this is the only one of the tests of all that we've reviewed which have this particular shape which could by a competent analyst, such as Mr. Hueni, be considered to possibly reflect dual porosity behavior.

The other well tests simply don't have that characteristic.

Next graph, and proceeding faster, hopefully, the build-up test data from COU E-6, the semi-log straight line is shown. The log-log graph match is shown there.

Now, I indicated earlier that we had attempted to review every build-up test, every interference test, which have been run in the field and that in some cases we were not able to do so. We felt that the test data could not and should not be interpreted. We should not infer permeability thickness products from those test data.

On the next page we have summarized the other tests for which data was available to us and I would like to identify for these wells what the problem was.

The Gavilan Howard No. 1, which had a build-up test run in August of 1986, this well was in communication with the Dakota prior to the test. It was worked over and produced for only one day in the Mancos prior to shut-in. We do not know and have not been able to determine the rate history or cumulative production for the Mancos but in any event, a build-up test following one day or less of production is likely, in fact with high probability, will be an uninterpretable build-up test. We must produce a well prior to the build-up test for long enough to get out of what we call wellbore storage during production period, and stated simply that means you've got to produce the well long enough so that the rate of oil from the surface is equal to the rate at which oil is flowing into the well from downhole. At early times you unload the wellbore. There's oil in that wellbore, you unload it, and the downhole rate is less than the surface rate, and if you shut-in a well which is still in that condition for a build-up test, you get an improper test interpretation and that would be what would happen if one attempted to analyze these particular test data with less than one day of production time.

The Hawk Federal No. 2, this had a very inconsistent rate history prior to shut-in. Our review of the test behavior indicated the well kept dying. Continued flow, shut-in, flow, shut-in, one should not attempt a

build-up test analysis, certainly using this Horner type approach, which assumes a constant production period prior to shut in, for a well with such data.

Bearcat Federal No. 1, this well was already shut-in when the testers arrived on location. Further, the exact rate history prior to shut-in is not known.

The Invader Federal No. 1, this well produced for only 21-1/2 hours and here we had this problem with wellbore storage. We checked the required duration of production prior to shut-in to get out of this wellbore unloading problem and found that we still had a wellbore unloading problem at the time the build-up test began, and therefore we conclude that one should not attempt to analyze these test data.

And finally, the Loddy No. 1, this well produced for only two days. The duration of wellbore storage was not exceeded during the production period; didn't produce long enough to get out of wellbore storage.

The next page in this section of the exhibit is a copy or an excerpt from Mr. Hueni's exhibit book, Figure 33, and here he has summarized his test interpretations. I didn't superimpose on this our test interpretations. I think you'll find if you check that you'll find generally that Mr. Hueni and I basically agreed on those test which we felt to be interpretable. There -- there are

differences in detail but not significant differences in principal in most cases.

But I do want to point out that of the test interpretations reporteds here in my opinion four of these are interpretations of bad test data for reasons that I"ve just cited, and the bad tests are those in the Hawk Federal No. 2, the Bearcat Federal 1, Gavilan Howard No. 1, and the Invader Federal No. 1.

The next page in this section of the exhibit is also a reproduction of a plot from Mr. Hueni's Exhibit 10, and this is the test in which he has drawn two parallel straight lines; these lines have different position form the straight line that I drew from these same test data, obviously, since we do have these two parallel straight lines, but I've show the curve that he had.

The point I want to make is that the position of the straight lines on the semi-log graph, the early and late straight lines, are not consistent with Mr. Hueni's type curve analysis and I've given a copy on the next page of the type curve analysis which he has performed of his test data, and this type curve analysis he didn't present in his Exhibit Ten in this hearing but he did present the type curve analysis of these same test data in the August, 1986, hearing on this case.

Now, here's the point. The first straight

line should reflect the contribution of the fracture system alone, the high porosity feature in the type curve, and notice that that spans a very considerable time period.

On the type curve on the next page that fracture contribution is reflected in that first matching type curve, which is indicated there, the solid line drawn through the observed data points, and notice that a -- that data from a totally different time range had been matched with the early type curve than those matched with a straight line on the Horner plot.

And that's an inconsistent analysis. Those are not the same data.

And then the late data, which reflects the combined contribution of fracture and matrix system in this sort of analysis, notice that that matching type curve begins at an intermediate value of time and begins to match the data, counting squares here, shortly after the beginning of the second square, continuing through much of the data but then beginning to move above the late data, and notice the reproduction quality here is not as good as we might wish, but the fitting solid line begins above the data in the middle of the second square from the right.

Now going back to the semi-log graph that second straight line has been drawn basically through all the final data on the semi-log graph and by no means could

be argued to begin so early in time as illustrated on the type curve analysis.

My point is this. I don't believe that the type curve analysis that Mr. Hueni performed and the semi-log analysis for these test data are consistent.

Q Having completed your presentation on the interference information, would you refer back to the plat we've looked at earlier.

On the E-6 Well there is handwritten and as the top entry that says 10,300, and then there's a 12,860 below that.

A That's correct.

Q Why is there a difference in those two numbers? What is it?

A The top number is the result of interference test analysis between the E-6 and the offset well indicated in the diagram. That Kh value characterizes the rectangular shaped area in the vicinity of the test well and the offset well.

The pressure build-up test analysis was the source of the 13,860 millidarcy foot estimate and that value characterizes a circular shaped area centered at that wellbore. In other words, we're looking at slightly different areas characterized by interference test on one hand and build-up test in the other. Even so, those values are real-

ly rather comparable.

Q Let me direct your attention now, Dr. Lee, to the summary on reservoir performance and have you first of all identify for us the point in issue that is described in Item Number Five, and contrast your recollection of Mr. Hueni's conclusion on that point with what you have concluded.

A All right. In summary, Mr. Hueni concluded from an application of the material balance equation that the original oil in place in this reservoir was approximately 55-million stock tank barrels.

My conclusion is that the solution gas -- the solution gas drive material balance model, which Mr. Hueni applied to analyze these test data did not provide a reasonable match of observed data and therefore did not and could not lead to a reliable estimate of original oil in place.

And the implication is that the proposed original oil in place estimate of 55-million stock tank barrels is not reliable.

Q Let's turn to that section of your exhibit book that is captioned Application of Material Balance Equation and have you go through with us your conclusion, the implication, and the basis upon which you've reached that conclusion.

A Well, the conclusion and implication I've just stated, so let's look at the -- the reasoning behind this conclusion.

First, I'd like to look with you. and this is summarized on the next page, at the general requirements for application of a material balance equation.

To apply the material balance equation, first we must have identified the proper drive mechaism for the field. There are different forms of the material balance equation depending on what the drive mechanism is.

As an example, if we wish to use a solution gas drive material balance equation, then the field must be behaving in a solution gas drive fashion. We've got to apply the right equation to the right kind of field behavior.

Secondly, all production and injection into the reservoir, and by reservoir in this case I want to be sure we understand I mean all the pore space that's in pressure communication. That needs to be taken into account.

The third requirement for material balance, which is just basically a tank type approach, it assumes that the reservoir is one big tank with all the fluids in it at constant pressure or at least reasonably uniform pressure, or at least it can be characterized with a

single pressure number throughout.

A material balance equation is a model of the reservoir, just as a reservoir simulator is a model of the reservoir, except the material balance equation is what we call a zero dimensional model. It assumes everything is the same throughout the reservoir.

So it assumes uniform pressure. It assumes uniform saturations in the oil zone and if we have a solutong as drive model, it would assume uniformity in the gas cap, and particularly important in this uniformity is an absence of saturation gradients.

And finally, application of the solution gas drive material balance equation specifically assumes that the oil is either totally above the bubble point or totally below the bubble point.

Well, the special requirements to apply the material balance equation to determine original oil in place are that to validate a particular tank type material balance model, solution gas drive as an example, a good technique is to calculate original oil in place from the material balance equation at several different times, which Mr. Hueni has done. That's a good approach to the problem.

The inference is, then, if with that assumed matrial balance equation, which assumes a reservoir drive mechanism, if the original oil in place is constant,

then the model may be considered to be verified. That's history matching with a material balance equation, just as with a simulator. We history match by trying to reproduce observed pressure or gas/oil ratio performance. Our history match here is do we continue to reproduce the same original oil in place estimate.

Now, when we take that approach we also have to be willing to accept the fact that if our calculated original oil in place varies with time, if it is not the same calculated from time to time and time, then either our assumed drive mechanism is incorrect, we've got the wrong model, or that other conditions which are required for the material balance equation to apply, have not been satisfied.

For example, we might have the correct drive mechanism identified but we might have significant non-uniformities and pressure in the drainage area of a well, or we might have significant saturation drainage within the reservoir, but even then the tank type material balance model is not applicable with these large and important (not understood.)

Now, in this particular application of the material balance equation, the Gavilan Mancos Pool, I've noted some significant inconsistencies.

I need to refer to a reproduction of Mr. Hueni's Figure 50, which is found two pages in the exhibit

from the point that I'm discussing now, and here Mr. Hueni shows his apparent original oil in place calculated at each different observation point and plotted as a function of time.

Mr. Hueni drew a straight line through those data with a value of 55,000,000 stock tank barrels and he concluded that the observations, the calculated original oil in place points continued to reproduce this 55,000,000 stock tank barrel number observation after observation after observation.

I don't agree with this. In fact, I have fit the test data in that time frame in which we ought to be attempting the material balance equation and I've agreed with Mr. Hueni that we certainly ought to exclude that time period during which part of the reservoir is above the bubble point and part below, and that's indicated with the area I've separated by the line with arrows. Excluding that, I would still conclude that a better fit of the calculated oil in place is shown with the schematic curve that I've indicated there in darker line than the other type on that page.

The essential point is this. The calculated original oil in place number is changing from observation to observation to observation and there therefore either we have the wrong model or there are significant pressure or saturation gradients in that reservoir which

make the solution gas drive model inapplicable for that reason alone.

The second pont is that notably absent from Mr. Hueni's model was the Niobrara C in Gavilan and most of the West Puerto Chiquito production.

Now, given the demonstrated pressure communication of these parts of the Mancos Pool, however limited that communication might be perceived to be, it still, it has been demonstrated that there is at least some communication, and because there's at least some communication, the complete reservoir model should include the other parts of this reservoir and the model has not.

The third inconsistency that I've noted is that material balance equations led to the claim that 55,000,000 barrels of stock tank oil was identified. Now the claim is also made later in Mr. Hueni's testimony that of this 55,000,000 stock tank barrels, 90 percent is in the matrix.

Now, that's really difficult for me to believe. A tight matrix would feed oil very slowly to a well's drainage area and would have a minor impact only on the pressure that we would observe from that well in a pressure survey, and so really what a material balance equation approach, or material balance analysis of a reservoir would -- would really look at, would be predominantly the oil in

place in the fracture system. The effect of the matrix would be very minor, particularly early in the life of a reservoir, and so what I'm -- what I'm getting to is this: Application of a material balance equation in a presumed dual porosity reservoir in which specifically the -- the low permeability part of the system is a very tight matrix, to me that, attempting to model that kind of reservoir with a material balance equation would simply lead to an estimate which would reflect approximately the oil in place in the fracture. And yet Mr. Hueni has characterized his result from the material balance equation as reflecting the oil in place in the fracture plus the matrix with in fact 90 percent of the oil being in place in the matrix.

Now, my major point is that the conditions required for applicability of a tank type material balance, they're just not satisfied in a dual porosity system with the tight matrix blocks because that sort of system necessarily has large, significant pressure and saturation gradients within the system. There are large differences between pressure in the matrix and pressure in the fracture system in a dual porosity reservoir, and Mr. Hueni has testified to those large pressure differences. He has projected performance which shows those large pressure differences and saturation differences in parts of that system.

The fourth point really is sort of a sum-

mary conclusion and that is that the solution gas drive material balance equation has been misapplied in this application and thus the original oil in place estimate of 55,000,000 stock tank barrels is not reliable.

Q In examining Mr. Hueni's reservoir analysis to determine reservoir performance, have you made an investigation and studied the information by which he has demonstrated the effects of multiphase flow?

A Yes, I have.

Q Do you have a separate tab or a portion of the exhibit book that reflects the effect of multiphase flow on a matrix contribution?

A Yes, I do.

Q Would you again summarize your understanding of Mr. Hueni's position on that point, then describe for us your conclusion and the implication of your conclusion?

A Yes, I will. My conclusion, its implications, and the basis for those, are summarized on the page entitled Effect of Multiphase Flow on Matrix Contribution.

The conclusion is in my analysis of two-phase flows in matrices that two-phase, in this case gas-/oil, flwo effects, they -- they dramatically reduce the ability of a low permeability matrix to produce oil into a high permeability fracture system.

And there are two major reasons for this. One is the permeability of the oil and the presence of gas in the matrix is reduced significantly because of gas saturation increases within that matrix. That's handled with relative permeability curves.

But secondly, and really much more importantly, capillary forces, this is the so-called capillary end effect, this tends to retain the oil in the matrix at the fracture face and causes gas to be produced selectively from a matrix block in which both oil and gas are present, and it's this latter effect that wasn't taken into account in the simulation that was performed by Mr. Hueni. In fact, the simulator itself that he used does not model capillary end effects, and to compound the problem he put zero capillary pressure into the matrix. He said there's no difference between the pressure in the gas and oil phases in this very tight matrix blocks, and in general the lower the permeability in the system, the greater the capillary pressure; that is, the greater the difference in pressure between the oil and the gas phases.

The implication of this is that the probability of a significant matrix contribution to reservoir reserves is reduced virtually to zero in this specific case if we take into account properly the effects of two-phase flow, and further, the dual porosity simulator which was

used in this study is an inappropriate means for reaching any conclusions about the possible contribution of tight blocks which deplete by solution gas drive because it does not properly model and makes no attempt to model capillary end effects.

Now, I've provided some attachments which provide the basis for some of the conclusions that I've reached, and I'd like to identify for you the attachments and the important statements in those attachments.

The first, following three typed pages which summarize some of my arguments, the first attachment is a paper entitled Determination of Fracture Orientation from Pressure Interference, and that might seem far removed from the issue under discussion here. This is another analysis of the performance of the Spraberry trend field by Mr. Linc Elkins, who was the author of an earlier paper that we noted on the Spraberry Field, but the reason why I selected this paper here is because it was written several years after the paper that we reviewed earlier, and after that period of time, and incidentally, in this paper Mr. Elkins continued to imply that the EI-Function solution, although now modified to take into account differences in directional permeabiity, he implied that's still a good way to analyze formation properties. But the point in this discussion is this: He states very clearly in his introduction, and I've

underlined four or five lines in that introduction, he states very clearly this: "The Spraberry Field covering 400,000 acres is a tight sand of less than one millidarcy permeability..." that's the matrix, "...cut by an extensive system of vertical fractures. Primary recovery dominated by capillary retention of oil in the fractured sand matrix blocks is less than 10 percent of the oil in place."

He's singling out the vast importance of these capillary retention forces which tend to keep the oil within the matrix.

In general, the lower the permeability reservoir rock the stronger the capillary retention forces, and in the Gavilan Mancos with its extremely low matrix permeability, as demonstrated from core analysis in that formation, capillary retention will -- should be even more dominant than it is in Spraberry, which has matrix permeabilities which even approach the one millidarcy level.

Now, the second attachment that I have is a paper entitled Laboratory Determination of Relative Permeability.

In that second paper we're not really interested here in how one determines relative permeabilities in the lab, but this is the best discussion in the literature of the capillary end effect in fundamental form as opposed to application to specific fields, and I would like to

refer you in that paper to -- on page 189 to Figures 4, 5, and 6, and my reason for doing this is to give insight into the capillary retention phenomenon.

Let's look at Figure 6, for example, it's at the bottom of the page and it's a little easier to follow, we'll all know what we're talking about here.

Page 189, Figure 6, in the bottom right-hand corner of the page.

What's plotted here is oil saturation in a core as a function of distance from the outflow face of that core. The outflow face is zero on the horizontal axis and in this laboratory experiment what's being studied is the displacement of oil from a core by gas. And what we note is that as we approach the outflow face of this core, that the oil saturation builds up to a high value. This is the so-called capillary end effect and the application of that to the field under consideration here today is that this capillary end effect occurs in tight blocks such as the matrix blocks within this particular field. There are differences in pressure in the oil and gas phases in the fracture system just outside the matrix and within the matrix itself, and this difference in capillary pressures and pressures within the two phases causes the pressure -- causes the saturation of oil to build up on the face of the matrix and tends to let the core or the matrix produce gas selec-

tively.

Now, taking that as insight into what this end effect phenomenon is all about, as I've noted, this same capillary pressure discontinuity as studied in the core analysis here, that exists at the point of matrix/fracture intersection in the Gavilan Mancos and therefore, the oil saturation in a typical matrix block will appear, as I've indicated back on my next page of typed testimony, in which I plotted oil saturation in the matrix versus distance from the face of the fracture. Any time we have intersection between a matrix block and a fracture part of the system, be it a microfracture, be it a huge fracture there's going to be discontinuity. The oil is basically in the matrix. The smaller fractures, the larger fractures, all serve as conduits for that oil but the oil must get from the matrix to these fractures in order to contribute to production, and yet this capillary end effect, as observed in field performance in the Spraberry, tends to keep the oil trapped within the matrix.

Now, in Mr. Hueni's model, because of the way that the matrix flow equations are formulated, that model assumes a uniform oil phase saturation and a uniform gas phase saturation throughout an entire matrix block. So in the diagram that I've illustrated here, I've shown the saturation profile which is used within that particular

reservoir simulator model.

There is no opportunity in that model to have saturation varying with position within the model. The model assumes a single saturation throughout the entire model. So there's no way within that model that the capillary retention forces could be modeled.

Now that modeling technique is used particularly for computational efficiency. It leads to more efficient simulator to characterize a matrix block as having a single pressure throughout the block and have a single saturation within that block at a given period of time.

That method of modeling naturally fractured reservoirs has been proposed in the petroleum literature by Warren and Rupe (sic) and basically that approach said that to model flow rate from the matrix the flow rate from the matrix, which we'll call Qm in an equation that I've cited here in the testimony is proportional to the matrix permeability, the relative permeability to oil for that matrix rock, reducing for the effect of gas saturation, times the difference in that single pressure characterizing the entire matrix and the pressure in the fracture system just outside that matrix.

That model is also called the psuedo steady state model for modeling dual porosity systems. It leads to computational simplicity but the correct way to

model flow from a matrix to a fracture in a dual porosity system, and the only correct way in cases such as this in which we have the possibility of capillary retention forces because the permeability of the matrix is so low, the only correct way to model that is to use the so-called unsteady state matrix flow model and in brief that method of modeling behavior allows for saturation gradients and pressure gradients within the matrix itself, so that we can model unsteady state flow within the matrix. That takes a lot more computer time to do. It's a lot more complex model but in cases in which those saturation pressure gradients are important, that's the only proper way to model a reservoir, and that method of modeling was not used in Mr. Hueni's model. In fact, not only was that not used, Mr. Hueni set capillary pressure forces equal to zero both in the fracture and in the matrix.

In the fracture that's correct. There's very little difference in pressure in the oil and gas phases.

In the matrix, that's incorrect. There will be substantial differences in oil and gas phases, phase pressures.

Well, based on this analysis I've concluded that the reservoir simulator model used by Mr. Hueni does not properly model the mechanics of the Gavilan Mancos

Pool. The input of zero capillary pressure in the matrix, that alone invalidates the model.

Even had capillary pressure been input, the use of the psuedo steady state model for matrix performance would still have invalidated the model in my judgment.

As another point on the model, although not related to capillary end effects, I would note also that that model included no dip, even though it had been demonstrated that in the Gavilan area the dip averages approximately 100 feet per mile, and that dip is required to assess the importance or lack of importance of up-structure gravity drainage.

Q Dr. Lee, would you turn now to the summary page, which is the last page of your exhibit book, and summarize for us your two principal conclusions?

A My two principal conclusions are stated on the summary page, and when we cut through all the work that I've done, I think there are two essential points to be made and the first is that conclusions based on the results derived using the dual porosity model are at best risky because the foundation on which that model is based is highly questionable in my opinion.

The second conclusion is that any conclusions that we as engineers reach based on the oil in place estimate of 55,000,000 stock tank barrels derived from the

material balance equation and its application to this reservoir, those conclusions are also risky.

Q Based upon your study, Dr. Lee, do you have an opinion as to whether or not the Commission can rely with confidence on Mr. Hueni's analysis of the reservoir to set production rates for the Gavilan Mancos and West Puerto Chiquito Mancos Pools?

A Yes, I do have an opinion.

Q And what is that opinion?

A And my opinion is that it can place very little confidence in conclusions derived from that analysis.

Q Let me ask you a hypothetical, Dr. Lee. Let's assume that the Mancos reservoir, and by Mancos reservoir I mean both the Gavilan area and the West Puerto Chiquito Mancos area, if we produce the Mancos reservoir at top allowable for this pool, which is the 702 barrels a day, 320-acre spacing, 2000-to-1 gas/oil ratio, which is the request of the opposition, and over a period of time, assume two or three years from now, actual reservoir performance and data proves that that producing rate was wrong, can we still obtain a comparable ultimate recovery for the pool equivalent to the amount we would have ultimately recovered if production had been restricted originally?

A No, in my opinion we can't. You take advantage of gravity drainage from an early time or you're not

able to take advantage of it later, or perhaps saying it more simply, in more simple terms, it's like Humpty Dumpty, once he's fallen apart you can't put him back together again.

MR. KELLAHIN: That concludes my examination of Dr. Lee.

We move the introduction of his Exhibit Number One.

MR. LEMAY: Without objection Exhibit One will be entered into evidence.

I think before the cross examination we might take a little break now.

MR. PEARCE: Mr. Chairman, we may want to off the record, but I think --

MR. LEMAY: Sure, let's go off the record.

(Thereupon a discussion was had off the record.)

(Thereafter a seven minute break was taken.)

MR. LEMAY: We're going to convene and then go off the record for a time schedule so that we can have an extended break, a two-hour lunch break, which will prepare the MMM group, give them time for preparation for their rebuttal witness. There again our time schedule,

which we hope might take a couple hours, we're talking about maybe 3:30, at that time we have that concluding cross examination, hopefully, but if it extends on further, we want to hear it all, at that time we'll have statements and closing arguments which I have been told will be brief, but we are going to stay around this afternoon till we finish this up. We're not going to take a break and come back Saturday or Monday.

So if that's agreeable, we'll continue with that, with that schedule.

MR. LOPEZ: Even if we have to go to 6:00, Mr. Chairman?

MR. LEMAY: Even if we have to go to 6:00 or 7:00.

MR. LOPEZ: Okay.

MR. LEMAY: We're not going to take any break so we can wind this thing up today.

We'll take breaks, we're not going to break permanently.

I understand that Mr. Mark Adams of Phelps Dodge wants to make a -- or Phelps Dodge wants to make a statement.

I understand Mr. Robert Mock would like to say something because he has to catch a plane this afternnon.

MR. MOCK: Mr. Chairman, Commissioners and Staff, Phelps Dodge appreciates the opportunity to speak here today and we -- I particularly appreciate the consideration on allowing me to make this presentation out of time.

My name is Robert Mock. I'm Director of Materials Management for Phelps Dodge Corporation. Among my responsibilities is the management of the acquisition function of our acquisition of energy for Phelps Dodge Corporation.

As an aside, I'm a graduate of, or attended a New Mexico high school and graduated from New Mexico State University, so I am a New Mexican.

Phelps Dodge is the largest domestic producer of copper. In 1986 we produced about one-third of the copper mined in this country. Nearly all of our production is either mined or processed in New Mexico.

Phelps Dodge has invested approximately One and a Quarter Billion Dollars in equivalent facilities and resources in New Mexico. We are proud to be a part of New Mexico's business community. We have been a part of this state for a long time and we will continue to be a part of this state in the future.

In New Mexico Phelps Dodge is number one among users and expenditures of utilities,

$50,000,000 a year; number two among employers in total payroll, over $70,000,000 a year. We're number three among taxpayers in this -- in the state, paying over $10,000,000 a year, and we are number four among customers of New Mexico businesses, spending approximately $20,000,000 a year. Our average annual expenditure for new construction in this state over the past three years is nearly $70,000,000.

As you can clearly see, Phelps Dodge is in New Mexico for the long haul.

Today Phelps Dodge is a healthy, growing company in what has been a relatively anemic industry. We reported net income of $61.4 million in 1986, remarkedly improved from 1984's record loss of $268,000,000.

This recovery occurred at a time when copper prices remained near all time low levels.

We pursue a competitive strategy of being the lowest cost domestic copper producer and among the lowest cost producers in the world. This is not in-stage condition; it's a goal that we pursue constantly.

In 1986 our unit production costs per pound of copper produced were a third lower than in 1981, before adjustment for inflation. After inflation adjustment our '86 costs were 40 percent lower than they were in '81. These cost reductions are achieved through a

combination of efforts. Directed by the vision of our senior management dramatic improvements were made in effectiveness and efficiency of our labor, equipment and facilities utilization, and the effectiveness of our expenditures for materials and service.

Also very significant in our efforts to lower our costs is our willingness to invest money in new technology. We are by no means experts in the oil and gas industry. I'm here as a representative of Phelps Dodge, a New Mexico taxpayer, a New Mexico employer, and a New Mexico consumer of fuels and natural gas.

With the emergence of open access to interstate pipelines for the transportation of third party natural gas in 1985, we began to develop an understanding of the natural gas and pipeline business. We believe there's a significant value to be derived by the producers and by the end users by moving up-stream of our traditional pipeline supplies for natural gas. Our gas consumption in the southwest, principally New Mexico, is approximately 25,000,000 cubic feet per day and our largest uses for natural gas are in our smelters located in Hidalgo County and Grant County, New Mexico, also a significant use for natural gas is in our electrolytic refining facility in El Paso, Texas. All of these facilities are positioned to be a logical market for New Mexico's gas resource.

Phelps Dodge is interested in obtaining at least a portion of its natural gas requirements from within the State of New Mexico. In late 1986 we purchased a small 4,000,000 cubic feet per day gas processing plant in the San Juan Basin located in Rio Arriba County. Today the plant is fed by seven wells owned by Mallon Oil Company associated with the Gavilan Mancos Pool. The plant currently is operating at between 30 and 40 percent of its capacity. Residue gas from the plant is delivered to Gas Company of New Mexico at their Cedar Mountain delivery point and then on to market. We are presently seeking connections with the El Paso Natural Gas Company's gathering system and the gathering system of Northwest Pipeline.

Our ability to realize our expectations from this processing plant will be significantly affected by the outcome of this proceeding. Phelps Dodge is not in a position to present technical evidence which might be helpful to the Commission in deliberating the issues. I'm sure there will be adequate supplies of technical data presented, that's already been presented and will continue to be presented today.

I would, however, like to present a businessman's point of view. I'm sure this Commission will be guided by what is in the best interest of the state, its industry, and its people. We believe that any-

thing this Commission can do to enhance the attractiveness of the business environment in New Mexico will in the long run serve the public interest. Actions which make the oil and gas business environment in New Mexico more attractive for investment will translate into an improved availability of New Mexico produced oil and gas and larger sales revenues for the producers and tax revenues for the state.

We believe that a policy of encouraging well production at as high a level as possible consistent with responsible (not clearly understood) of the resource, will help to encourage investors to further explore and develop New Mexico's resources.

Ultimately this philosophy will translate into enhanced state revenues by encouraging new markets to look to New Mexico for reliable long-term solutions to their energy needs. Markets that traditionally looked elsewhere for their energy needs can now access through interstate and intrastate pipelines gas supplies in New Mexico. Making this state's energy resource available and accessible will benefit all New Mexicans.

In general, I would like to say that in order to enhance the business environment in New Mexico in this industry, there has to be, as in any industry, there has to be predictability if an investor, Phelps Dodge, or any investor, invests money under a certain

set of beliefs and understandings finds that the assumptions that they made in that investment are changed, there's been enough uncertainty exists in that business environment and along with it an unwillingness to -- to make that investment or to make further investments. I think it is the responsibility of every state regulatory body to communicate consistency and predictability in their rulings so that potential investors will view the state as an opportunity and not an inordinate risk.

That concludes my remarks.

MR. LEMAY: Thank you very much, Mr. Mock. I appreciate your comments.

We shall recall back Dr. Lee to the stand for cross examination.

DR. JOHN D. LEE,

being recalled and remaining under oath, testified as follows, to-wit:

CROSS EXAMINATION

BY MR. PEARCE:

Q Before I begin asking questions I think I need to warn you and everybody else in the room, although they may already know, in listening to my questions and answering them, I think you need to think of me as freshman

engineering student who, when he was in high school liked English and football. That puts you at a severe disadvantage but I hope that we are early enough in the course so that your object will not be to flunk me out but to bring me olong. I'd appreciate that consideration, I really mean it.

You spent a good deal of your time this morning discussing the modeling effort which Greg Hueni and Bergeson and Associates had done.

Have you done, I gather from your credentials, extensive modeling yourself?

A Most of my modeling has been supervising modeling done by others in my company, but early in my career I have done extensive modeling myself and I have developed very simple simulators as part of my teaching activities in school.

Q Have you ever used the model that Mr. Hueni used the Ellipse model?

A No, I haven't.

Q Would it be fair to state that a model is intended to reflect and predict reality? Is that what we're trying to do? We're trying to take historical data, find a model that it will fit, and use that to predict what's going to going to work in the future?

A That's a perfect definition in my opinion.

Q In your preparation for this case have you discussed the modeling of this reservoir that Mr. Dillon did with him?

A I asked him to consider modeling the reservoir using appropriate reservoir properties. That is the extent of my input.

Q When you say you asked him to consider modeling the reservoir using appropriate reservoir characteristics, did you have any input into what those characteristics should be?

A No, I didn't.

Q Did you have any input into which model he should use?

A No, I didn't.

Q Could you give me an indication of whether or not you have verified the parameters that Mr. Dillon did use in his modeling effort?

A No, I haven't.

Q Thank you, sir. When did you first begin to study this area?

A In late January of 1987.

Q And you indicated that you had reviewed previous records, exhibits, and testimony, I assume, in cases before the Division. What other information did you review?

A It's difficult to be complete and accurate so please excuse me if I ramble.

On the individual wells for which we analyzed pressure build-up tests, I have asked for those data which were required to analyze the build-up and the interference test. These would include fluid property data, production data from the wells, test and production data from offset wells. Generally the information required to analyze those tests.

I've asked for core data from which I could deduce at least approximate values of reservoir properties. That sort of thing.

Q If we look at the second page of your exhibit, Item Number 4, you conclude that permeability thickness values equal or exceed 10 Darcy feet in much of the reservoir. Can you give me an indication of -- well, what do you mean by reservoir? What area are we talking about?

A I'm talking about the area in which data are available.

Q Okay, is that the West Puerto Chiquito Mancos Pool and the Gavilan Mancos Pool?

A Most of the data that are available are in West Puerto Chiquito.

Q All right, and that leads to my question,

when you say that your conclusion relates to much of the reservoir, I'm interested in the relationship of your conclusion as between West Puerto Chiquito and the Gavilan Mancos Pool.

A Well, I can only state as a fact a characterization in the area in which I have reviewed data. We must infer from geological reasoning, from analysis of production tests, that there are similarities between some parts of the two different areas.

Q And the interference tests on which you relied were reflected in your exhibit. The one is the four well test in, I suppose, central Puerto Chiauito Pool and the other that northern test between the L-6 and the Gav Howard Well, are those the two interference tests on which you relied?

A There were three interference tests, one 1965 test, one 1968 test, and the 1986 test.

Q Okay.

A To characterize those tests more completely, the 1965 test involved the P-11, the L-11, and interference was observed in A-23 and A-14.

In the 1968 interference test, that was the test that involved production from a number of wells. We included production from O-33, A-16, A-11, L-11, C-11, B-10, and observed production in an observation well there.

And then the '86 test, that was -- that was the one where there was deliberate control or where we observed production from six wells offsetting the observation well.

Q In order to properly analyze the results of an interference test is it necessary to know total compressibility in order to analyze the results?

A It is not necessary to know total compressibility in order to be able to determine Kh. It is absolutely independent of total compressibility.

Q I'm asked to ask you about Phi H. I'll say those words --

A No, only if I try to interpret a so-called time match point in the test do I need to know Phi H. I can determine Kh without making any commitment as to Phi H.

Q All right, sir, let's look, if we can, at the structure map which was included loose in your exhibit, and I want to look at the lower lefthand portion of that. I find the handwritten number 241. Would you tell me what that number represents again, please?

A That number represents Kh from a build-up test for the well there and I'll need to refer to my tabulation of build-up test results to identify the well unless you wish to have me confirm a certain well name.

Q All right, I think that is the Rucker Lake Well.

A Yes. Okay.

Q And as I understand it, you did use that value in your exhibit and in your consideration of this matter, did you not?

A Unless there's a typographical error, I did.

Q Similarly to the southeast of that location at another well I find a handwritten annotation, 203/ -- and mine got blurred out and I can't read it.

A Looks 268 on the original. We could confirm that with the tabulation of final results.

Yes, that's 268 from the Native Son No. 1.

Q Do you have any information available to you about the productivity of those two wells?

A Yes. The Native Son No. 1, a representative test on that well, according to records available to me, is 435 barrels of oil per day at a producing gas/oil ratio of 462 cubic feet per barrel. Current status is that that well is producing.

Let's see, the other well was Rucker Lake, is that correct? My information indicates that a representative test on that well is 193 barrels per day at a

producing gas/oil ratio of 667 cubic feet per barrel and the current status of that well is that it is producing and has produced to 1/1/87, 148,000 barrels of oil.

Q Okay. You indicated, I believe, that your information indicated that the Native Son No. 1 Well, a representative test would be about 435 barrels. Do you know at what level that well is producing now?

A No, I don't.

Q Now, as I understand it from what is on the exhbiit and what you've just told me, you find 203 millidarcy feet in the Native Son No. 1 Well and 435 barrels, is that what --

A Yes.

Q -- what I just found out?

A Yes.

Q Do you have information about the productivity of the wells surrounding that Native Son Well?

A Not -- not here now.

Q Do you know if generally they are -- is the Native Son Well one of the better wells in the Gavilan Pool? Or do you know?

A I don't know.

Q Similarly, do you have information about the wells in the general vicinity of the Rucker Lake Well and the productivity of those wells?

A Again, no.

Q Let's turn, if you would, please, sir, to that section of your exhibit headed bubble point pressure, and I'm looking at the second, the page right behind that, the tabular display of information.

A Yes, sir.

Q You've corrected to a separator pressure of 160 psia.

A That's correct.

Q How did you select that number?

A By checking with the operators and trying to identify a number which might have characterized a significant fraction of the wells whose pressure test data we were trying to analyze in this study.

Q Could you indicate to me which operators you checked with?

A Specifically with Mr. John Roe with Dugan to give an opinion as to what might be typical of the area.

Q Do you know if a significant portion of the operators in the Gavilan Mancos Pool have separator pressures of between 25 and 50 pounds?

A I don't know. The purpose of these data is simply to have fluid properties with which to analyze a transient test analysis and the analysis varies only slightly depending upon these values. It really makes no differ-

ence.

Q Let's look, if we could, to the next page after the tabular summary. At the top it's headed Summary of Sample Results.

Is it fair for me to summarize your testimony to be that you believe the properties found in the L-11 Well are generally applicable to the combined Gavilan Mancos - West Puerto Chiquito Pools?

A No, I am not implying that. In fact that's not true, because the Gavilan Mancos Pool is at a lower elevation and I have made no such application.

Q Have you made the conversion? I mean isn't it possible to do a mathematical conversion and see whether or not those properties, if they were at similar elevations?

A One can adjust fluid property data for differences in elevation.

Q And have you done that?

A No, I haven't.

Q Reflected on that is a test for the Loddy No. 1 Well. Do you know what sampling procedure was used in taking the Loddy sample?

A A not very good one. Specifically it's outlined in the page Detail of Fluid Sample Analyses. That sample is viewed as -- that sampling is generally viewed by

the operators or their representatives, specifically Mr. John Roe and Mr. Al Greer, as being a well in which the well was not properly conditioned prior to sampling; therefore we have less confidence in that sample analysis than in the others.

Q Do you have any information -- I notice that the indication here on your exhibit shows shut-in since September 10th of 1985 and the test date was February 26 of '86.

When you mention conditioning, do you know what was done to that well before they went out and tried to sample it?

A No, I don't.

Q Are you aware of fields or areas of oil production where fluid properties vary areally or vertically within a pool?

A Yes, I am.

Q If you will turn, please, sir, to a section headed Matrix Contribution, Explanation of Attachments, how do you define matrix as you use it in your exhibit?

A The lower permeability system part of our system which is -- whose permeability is characterized by the .018 millidarcy permeability average that Mr. Hueni reported to us.

Q And I believe you testified in response to one of Mr. Kellahin's questions that you had been in attendance throughout the hearing of this matter the last several days?

A That's correct.

Q And I assume -- well, I won't assume. Have you reviewed Mr. Greer's exhibits in this matter?

A Not closely enough to say that I have fingertip familiarity with them.

Q Are you aware of a term which he uses, I believe, of tight fracture blocks?

A Yes.

Q In your understanding, how is a tight fracture block related to the matrix?

A Well, with the term tight fracture block, what Mr. Greer perceives as a model of the reservoir is that there -- there may be blocks of significant size surrounded by natural fractures, and by significant size I mean 20, 40, 60 acres.

And then when one drills a well, the odds are it will not encounter a large major fracture, but instead be some distance from it and therefore to get in pressure communication with that natural fracture system which dominates the production performance of the well, we have to hydraulically fracture the wells. In fact, I'm told that of

all the wells in the field, the only natural or prestimulation -- there's only one prestimulation producer, which -- which supports this idea. In other words, we have to hydraulically fracture the well and establish communication with a major fracture system.

Now I'm being responsive, to get back to your question.

Mr. Greer -- Mr. Greer's model of the reservoir is that these tight blocks are this block into which a well is drilled and through which we must fracture to intersect with a natural fracture system.

Q And -- and this conceptual model, as I understand it, with major fractures over that -- an area that large in acreage is defined as a highly fractured reservoir?

A That's -- that's a matter of semantics. You know, it's a fractured reservoir from which from reservoir analysis Mr. Greer feels that he can deduce a certain amount of oil in place within the fracture system.

Q Did you agree with Mr. Greer in his conception of at least the West Puerto Chiquito Pool?

A I've -- I've not reviewed any direct evidence but it certainly sounds like a plausible idea to me, based on well performance, this idea of having to hydraulically fracture the well to communicate with a fracture sys-

tem.

Q If that conceptual model were accurate, is everything between those major fractures defined as matrix under your model, your conception here that we're talking about?

A Oh, I think that's conceivable.

Q Is there a third type in your analysis in which we have major fractures, a less major fracture system and matrix?

A In my analysis. What do you mean by in my analysis? I --

Q Well, I'm -- you indicated that it was conceivable that major fractures, one to every 60 or 80 acres, and matrix, it was conceivable that that's all you had.

A Yeah, yes.

Q Is it also conceivable that there is a third type of operative mechanism which might be called microfractures?

A There are microfractures. We have seen evidence of microfractures. I don't know about the term operative mechanism, but certainly we have seen evidence that there are microfractures in cores when they've gotten to the surface.

Q I would ask you now, sir, to please turn toward the end of your report where you discuss the material

balance equation.

Have you calculated original oil in place in this reservoir?

A No, sir, I haven't.

Q Have you attempted to do that?

A No.

Q If you had attempted that do you believe you have the information available to you which would have allowed you to perform that calculation?

A The information may be available but I'm afraid this reservoir is so complex that, A, a simple material balance is not an adequate model for reasons that I stated in my testimony, and therefore, I'm required to turn to some alternative method and the method that first comes to mind is a total field reservoir simulation, and that would be prohibitively expensive.

Q Outside of that prohibitively expensive tool, is there, in your opinion, no reliable way to estimate original oil in place?

A Well, at least in areas. There are reliable ways to characterize areas, one -- one of which Mr. Greer has used extensively and that is to interpret interference tests which can lead to values of the product of porosity, total compressibility, and thickness, and from that interpretation of the test, one can infer the oil in

place within the tested area, and in that way, at least, there's potential for characterizing individual areas and their oil in place.

Q And in order to make that calculation dependent upon the interference test applicable to the pool as a whole, you need to feel some confidence that the interference tests reflect the pool as a whole, do you not?

A I -- I confined my comments to individual areas and I wouldn't extrapolate to the field as a whole.

Q But -- thank you. If you said that, I missed (not clearly understood) awhile ago.

Okay, in the materials you've looked at, the interference tests, what Phi H number was used in making those calculations?

A I made no calculations like that so I used no number.

Q If I may, Doctor, I'm going to hand you a copy of the exhibit which Mr. Greer testified to, if you don't have a copy with you.

A I don't have a copy.

Q I would ask you initially, sir, to please turn to the first orange sheet behind Tab S, as in Susan. That is a tab -- that's a sheet headed Semi-log Plot and apparently refers to the E-29 Well.

I'd ask you to --

MR. KELLAHIN: Excuse me, I don't mean to interrupt counsel, but may we ascertain that we are intending to stay within the scope of the rebuttal testimony of Dr. Lee? I assume that's where we're headed.

MR. LEMAY: I think we're in that scope right now.

Q I would ask you first of all, sir, if this exhibit is based upon the same data that you relied on in constructing your Horner plot that you discussed this morning?

A It appears to be at a quick glance.

Q And I would prefer to use this one because it does not have the Horner scale, which I have difficulty explaining to the witness.

Have you studied and performed a complete analysis of this well test?

A Yes.

Q Would you have some confidence in the results of that test and the way it was performed?

A Yes.

Q And the results of that test, as calculated?

A The results that I calculated, which may or may not be the same as Mr. Greer's. I don't know what he's calculated.

Q All right. I notice on this exhibit that Mr. Greer has calculated 49 Darcy feet transmissibility for this well. Did you calculate transmissibility?

A Yes. Do you want to know what number I got?

Q Yes, sir, I would, please.

A Yes, I got about the same answer.

Q Okay, do you know, sir, what zones this well is completed in ?

A No, I don't.

Q If this zone was -- if this well were completed of zones of differing pressure would that have an effect on the results of the test?

A It might.

Q Can you tell me what pressure range was used in determining this transmissibility?

MR. KELLAHIN: Excuse me, on which exhibit? On Mr. Greer's exhibit?

MR. PEARCE: Yeah, I'm still referring to Mr. Greer's exhibit.

A It appears that the pressure's in the range 1373 psia to about 1375 psia were used in his determination.

Q Okay, it appears to me looking at that that the data represented by the set of dots begins at the

lower center of the page and comes up almost vertically to a point of 374.

A That's correct.

Q So there's about a one psi pressure change in analyzing this data.

A That's correct.

Q And that occurred -- can you tell me over what period of time that one pound pressure change occurred?

A You'll have to refresh me as to the time scale Mr. Greer said he used.

Q It's in hours.

A Hours. That occurred within about the first 20 hours of the test.

Q And ovr what period of the test?

A The first 20 hours, sir, as I understand the question.

Q Well, I -- it -- it seems to me that the data on this test doesn't begin until after more than 10 hours. Perhaps I don't understand this scale, either, but I mean it -- I find the first data point reflected on my exhibit to be beyond the center of the log Delta T scale.

A That's correct.

Q And how many hours is represented at one log Delta T?

A I assume that's 10 hours.

Q What I thought.

A Yes, and therefore my conclusion that the data coming up almost vertically was at a log Delta T of 2. I think it's about 20 hours.

Q Okay, and what was the time interval from zero to 20 hour time period that was used in constructing (not clearly understood.)

A I'm sorry, sir, I don't understand the question.

Q And what time interval was used in constructing the line on the -- the straight line is an interpolation from a set of data points, it appears.

THE REPORTER: I'm sorry, I didn't hear all of your question, Mr. Pearce.

Q The straight line appears to be an interpolation from a set of data points on part of that scale.

A Yes, sir, that 's correct.

Q Do you know, sir, what the gauge measurement depth was in this test?

A I have that in my notes. I don't have it here.

Q Okay, I notice on Mr. Greer's exhibit an annotation 6200 GL. Is that reflective of the gauge depth?

A Apparently. I'm not familiar with all his abbreviations, so I don't know.

Q Have you -- what pressure did you use in the reservoir if the gauge was at 6200? Did you make a conversion?

A Yes, we -- in my analysis I attempted to correct in every test from where the gauge was to the midpoint of perfs as a datum for the individual well.

Q Do you -- what pressure did you use in regard to this test after conversion?

A I really don't understand what you mean by what pressure.

Q How did you make the conversion to adjust for depth of gauge versus depth to the midpoint of the perforations in a well?

A Taking into account the substances in the wellbore, hopefully, and in most cases there was liquid in the wellbore in which case we could use a liquid gradient form the gauge to the midpoint of the perfs for that pressure correction. In some cases, perhaps this is one, there may be gas in the wellbore at the location of the gauge, in which case one must use a gas gradient down to a proceived fluid level to make a correction and then in a fluid level down to the midpoint of the perfs.

Q And do you know where the fluid level was perceived to be in this well when this test was tested?

A If this is that well in which that sort

of correction was made, I had to inquire of Mr. Greer and accepted his opinion as to where that fluid level was.

Q When you received the information from Mr. Greer, there was a fluid column or only a partial fluid column -- I'm not -- let me try again -- a gas-oil interface in the tubing, how did you know whether or not you needed to inquire of Mr. Greer for that information?

A We always want to have the pressures at midpoint of the perfs to make sense.

Q Yes, sir.

A And, and if you have -- if you have gas in the wellbore and assume it's liquid, you may extrapolate up to a pressure level that makes no sense at all, in which case you inquire, was there -- is there a possibility of gas in the wellbore in this case.

Q If there was a gas/oil interface in the well, did you measure that with time?

A Did I measure that with time? I don't know whether Mr. Greer measured that with time or not. I didn't.

Q Okay. Can you indicate to me, sir, if an interface moved by 20 feet during the test, what impact would that have on the results shown?

A That's a wellbore storage phenomenon which affects early time data and transient tests.

Fluid gas/liquid interfaces move much more than that in tests and they are perfectly interpretable.

Q Would that not affect the reported bottom hole pressure during the test?

A It -- the position of the gas/oil contact affects the bottom hole pressure. If you're saying is there shift in gradient during the test would that affect the bottom hole pressure, yes.

Q And 20 feet of movement times the .3 psi gradient is about 6 pounds of pressure difference?

A It seems correct.

Q That is substantially greater than the one psi test gradient, is it not?

A Yes.

Q If I may, sir, let me try to ask a hypothetical question.

If a pressure test is taken on a well completed in two zones, the upper zone has a pressure of about 1700 pounds and is a low producing zone, the lower zone has a pressure of about 1300 pounds, and is a highly productive zone, what impact will that have on a pressure test of that well if those zones are not segregated during the pressure test?

A Well, that's a layered reservoir system and the response in a pressure build-up test in such a sys

tem that the early data, after funny things in the wellbore are over, reflects the total permeability thickness product of both layers together, and if the higher permeability system is at lower pressure, it will dominate the test response and the lower permeability part of the system will have very little impact early. It's impact will be felt later, in which case it will cross flow, because it's at higher pressure, into the higher peremability part of the system, but in the range of data such as we have here, the higher permeability part of the system, regardless of its pressure, predominates the test behavior.

Q Can you give me some idea of how long that cross flow, given the 1700 and 1300 pound pressure differences might be expected to last?

A I can't even speculate. I'd need to look at a specific situation, sit down and make calculations on it.

Q Could that have affected the test on the B-29 Well?

A It's not inconceivable, but as I say, if there's a high permeability layer, that's going to dominate the test behavior during the time in which we get that -- that stright line on the semi-log graph which tells us formation characteristics, in my opinion.

MR. PEARCE: Nothing else.

Thank you, sir.

MR. LEMAY: Are there additional questions of Dr. Lee?

Mr. Chavez.

QUESTIONS BY MR. CHAVEZ:

Q Dr. Lee, at a reservoir permeability of an average of 10 millidarcy feet, would you expect there to be a pressure differential that would exist at around 400 psi when the wells are about four miles apart?

A I think you meant to ask me 10 Darcy feet and I'm going to respond to that.

Q Yes, that's right. Yes.

A Not if there is continuous communication at that transmissibility level, but we need to -- we need to compare permeabilities within communicating strata, and I need to qualify my answer to that extent.

Specifically, we don't want to compare a pressure measurement in the C to a pressure measurement in the A some distance away, if we believe that the A and C are basically in very poor communication.

Q In that sense, then, also would the bubble points between the C and the A and B Zones, would those be expected to be different, also?

A Conceivably they could be. I mean, be

expected to be, you know, I can't say that they would be expected to be. I'd simply say that it's possible.

Q So in your experience have you come across stratified reservoirs where they were very similar or very different, or what has your experience been?

A I've run into both types. I've run into situations in which the fluid characteristics seem to be the same throughout a reservoir.

I've run into cases in which there was noticeable variation of fluid properties from, say, high on structure in a reservoir with large closure, down to lower on the structure.

Q Then in making an analysis of the fluid properties of the reservoir characteristics, when you have a stratified reservoir wouldn't it be more appropriate to take the fluid properties from each of the zones?

A If it could be established that those properties varied that -- that would be appropriate, but as to whether it's appropriate to spend a lot of time with that, that depends on what you want to do with those properties, and if you're just looking, probably, say to analyze a transient test, there's rarely enough variation for that to affect a test analysis.

Q In your -- oh, I'm sorry. In your Exhibit One of your well test analysis results --

A Yes, sir.

Q Okay, you'd made a comment that with only three tests in the Gavilan Mancos area you didn't feel that the peremabilities were reliable or --

A No.

Q -- maybe I misunderstood.

A No, no. I'm saying we have not sampled that area thoroughly if we only have three tests and really only two wells.

Q Okay, even though there's only three tests, one well having two tests which are similar, doesn't that kind of reinforce that that's a good measurement of permeaibility?

A Oh, I don't question the measurement of permeability in the testing of the tested well. I'm simply saying we have not characterized that entire reservoir by just looking at the properties of two wells, and so to characterize the rest of the reservoir we need to go to other kinds of calculations and use the data available to us, and that's why Mr. Greer has chosen to characterize the rest with productivity tests.

Q Okay. Well, Mr. Lee, aren't you trying to characterize the West Puerto Chiquito Mancos with only, let's see, one, two, three, three build-up tests and interpretations from interference tests?

A Yes, I am, because that's a much more representative sample. You know, again we have no absolute assurance that the properties outside those tested areas are comparable to those inside but at least we have much wider sampling procedure; much higher probability that that's a good characterization.

Q Are you basing that on, say, the areal extent of the reservoir versus how many wells within it were tested?

A Yes, sir, I am.

Q When you're talking about matrix permeability calculations in the West Puerto Chiquito Mancos Field, are you talking mostly about matrix within the C zone as you talk about no matrix contribution or very little?

A I have to -- I have to preface my answer with this: Mr. Hueni has -- has chosen to characterize the matrix with some core data and I'm simply commenting on those core data, you know, if -- if that's characteristic, then this is the sort of permeability level that we have. So I really can't go beyond saying I've used Mr. Hueni's data for characterization.

Q You made a comment in your analysis of Mr. Hueni's Figure 34, which is the build-up test in the Rucker Lake No. 2.

A Yes, sir.

Q That the second portion of the build-up test could be interpreted as matrix contribution to pressure, is that correct?

A What do you mean by second portion of the test, sir?

Q Excuse me. We have -- Mr. Hueni interpreted one straight line portion, then a pressure anomaly, then a second line portion towards the upper part of the graph.

A Yes, sir.

Q He said that the upper portion could be a contribution of the pressure by the matrix. Is that correct?

A The upper portion would be the combined contribution of the matrix plus fracture in a dual porosity system.

The lower portion would be the contribution just from the fracture itself, which would dominate early behavior, just as I illustrated earlier in the layered reservoir situation.

The higher permeabilty part of the system dominates early response and then the lower part comes into play later and you see that total combined effect later in the life of the test.

Q Dr. Lee, in your analyses and calcula-

tions of material balance equations, is it not common engineering practice to take a graph or a chart or figures and average them, deleting those portions which are -- you feel are not representative?

A Sure it is, but that -- but when you say you're going to average them, what you're -- what you're really trying to do is validate a model. You're trying to say, let's suppose this is the kind of reservoir. Let's suppose it's a solution gas drive reservoir and that from pressures and production at different observation points I can calculate an oil in place.

Then I plot that calculated oil in place versus, say, cumulative production or time or whatever I chose to plot, and if I see random variations around a mean value, then I'm justified in finding that mean value or finding a reasonable straight line fit. Okay, I'm saying that's the oil in place determined from that method, but if I see a systematic trend which is not fit by a straight line with points scattered on either side, I say I have selected the wrong model and therefore I shouldn't attempt to deduct any -- deduce any reservoir properties from that model.

Q In your comments on his -- Mr. Hueni's oil in place calculation, you said he'd left out the Niobrara C and most of the West Puerto Chiquito production and injection.

If an engineer felt that an offsetting pool had very little to do with their reservoir, could he in his interpretation leave out what he considered might be an insignificant contribution of factors?

A The term "very little" is a fuzzy term. If it has no effect, certainly he would be justified . It it had, you know, tiny, again which is another qualitative term, he would be justified, but, you know, how little is little? We must consider the possible impact of this in our model. If there's some pressure communication, we need to consider that possibility and see if we need to include that in our model.

Q In an interpretation of the Greer interference test you said that it wouldn't be appropriate to extrapolate oil in place from those tests to the entire reservoir, is that correct?

A That's correct.

Q Is it improper to extrapolate permeability of those tests to the entire reservoir?

A It is. It is equally improper, you know, until we have sampled enough wells to see that we really have a representative average.

Q Thank you, that's all I have.

MR. LEMAY: Thank you, Mr. Chavez.

Additional questions of the witness?

QUESTIONS BY MR. HUMPHRIES:

Q I apologize, Dr. Lee, this morning I wasn't able to completely clear my calendar, but I have one question in your -- what would be the third page of your report.

To quote from it, it says, "Especially important is the need to consider the so-called capillary end effect caused by large differences in matrix and fracture permeability. This effect tends to prevent the flow of oil from the matrix to the fracture and instead to collect at the fracture face."

We've heard a lot of testimony about two different concepts as to whether we have a tight matrix or a tight block. If this collection builds up on the fracture face, what, in your experience, is the best method to remove that collected fluid or collected oil from the fracture face?

A The technique that's been applied most successfully in practice is to consider waterflooding a reservoir like that, because capillary forces can work for a waterflood. Water will tend to go into those tight matrix blocks because of capillary forces and displace the oil out,

so that's the way to deal with that problem.

It's not effective unless there's enough permeability in the matrix for that imbibition to occur at a reasonable rate and for the oil in imbibe back out at a reasonable rate, and that's why in addition to worrying about capillary to oil, I need to worry about what is the permeability of that matrix.

MR. HUMPHRIES: Mr. Chairman, may I ask some questions about sort of generalized things that have to do with his educational background?

MR. LEMAY: Please do.

Q I served on the Board of Regents of a State University for about thirteen years so I have some concept of what it takes to be a person who's received a chair nomination. I assume the Noble Chair is the chair that's been in existence at A & M for awhile, is that correct?

A It's a fairly new chair. It's been in existence for only two or three years.

Q And do you do research associated with the chair or was all your research done, I didn't have a chance to look document by document through the research and publications --

A Yes, I did.

Q -- you did. Would it be fair to say that

when you do a publication you've done some research prior to that?

A That's correct, sir.

Q When -- when you do research I assume that one of the things you look for is repeatability of predictions --

A Yes, it is.

Q -- you determine that?

A Yes.

Q We've been asked to give a great deal of credibility to two models that seem to be very diverse. They don't necessarily conclude the same things. I think they conclude some similarities.

Do you subject your results and your research to further scrutiny after your first hypothesis?

A Yes, I think that's proper research practice and I try to follow that practice.

Q Do results change?

A Yes.

Q Would they change as a function of perhaps more information about some fo the variable inputs into the model?

A They do indeed.

Q We've asked a lot of questions of expert witnesses back and forth about the variables that were input

into this model, and we have two separate models. How do you increase repeatability?

A Try to match -- try to match more observations.

Q And to match observations to actual results?

A To actual results, right, remembering, though, that one must abide by the physical measurements in hand. In other words, let's don't try to match a model for which we just don't have any basis to observe data, because in the modeling process where there are a large number of variables to play with, you can probably match a given set of data with the wrong model.

Q I'm not asking you to draw a conclusion from either model at this point. I'm just saying that how would you -- if these two models in fact are different, how would you determine which model is most accurate?

A By -- by trying to see which model has basic characteristics which fit with the observations that we've made and then -- then, if we include those characteristics which fit our observed basic characteristics, then trying to see which could most faithfully reproduce what's going on in the field, all different kinds of observations.

Q So both models are a prediction of the future if you subject both models to what's actually hap-

pened for real results. It's going to take a little bit of time and then ultimately one model or the other will prove to be most correct or the two may in fact find something in the middle.

A I think that's a good analysis.

Q Thank you.

MR. LEMAY: Thank you, Commissioner.

QUESTIONS BY MR. LEMAY:

Q Dr. Lee, I have maybe one question. In terms of your study I assume you could say that you did study the reservoir, would you consider this reservoir with your assumptions to be rate sensitive?

A Yes, I do.

MR. LEMAY: Any additional questions of Dr. Lee?

If not, he may be excused. Thank you.

MR. LEMAY: Off the record for a minute.

(Thereupon a discussion was had off the record.)

(Thereupon the noon recess was taken.)

MR. LEMAY: The hearing will come to order.

Mr. Dillon, are you in the audience?

MR. DILLON: Right here.

MR. LEMAY: Oh, yes. Could we recall you just for a short period of time? We'd appreciate that it's within our policy of just asking a couple questions.

Thank you, Mr. Dillon, we've previously sworn you in. Mr. Brostuen would just like to ask you a couple questions, if you don't mind.

MR. DILLON: Okay.

RICHARD G. DILLON,

being recalled as a witness and remaining under oath, testified as follows, to-wit:

QUESTIONS BY MR. BROSTUEN:

Q Mr. Dillon, this is your study, is it not?

A Yes.

Q I asked you some questions the other day and I made some notes here and it appears that maybe I wrote

down the wrong thing or misunderstood you.

Do you have a copy of your --

A Yes, I do.

Q -- exhibit before you? Okay, from the Exhibit Two, your assumptions, and I asked you how you arrived at the one percent porosity figure.

A Yes.

Q And I believe you said you worked -- you derived that from the original oil in place calculation backing out of the equation, is that correct, or am I assuming that?

A That's correct.

Q And so what then is the source of the 3000 barrels per acre original oil in place?

A That number has been calculated and it's been presented in previous testimony or a number similar to that, numbers that -- within which this number is in that range of; principally calculations done by BMG.

I myself didn't make calculations to come up with this. This is a number that appears to be a valid assumption for the area we're looking at.

Q I've (not understood) problems finding the source of that number. I've reviewed or attempted to review in a very brief fashion the exhibits presented by Mr. Greer and I've been unable to find that calculation in

there. If it's in there, can you tell me where to find it, if it is?

A I don't believe he presented that in this hearing. It was in a previous hearing.

Q So that has not been presented at this hearing.

A Not at this hearing.

Q Do you know if the 3000 stock tank barrels per acre, what -- how many acres are we talking about? Are we talking about the entire approximately 2-1/2 or it appears to be 2-1/2 townships in the East Puerto Chiquito Pool?

A The East Puerto Chiquito?

Q Pardon me, west, pardon me.

A This is a number that we felt was representative of the pool that we're looking at. The number, I don't think, can be construed to represent any particular area or is necessarily indicative of perhaps the entire boundary of the pools as they exist.

It's a number that has been arrived at from analysis of producing area, from a test thereof.

Q So you don't know whether it was derived by material balance equation or by --

A No.

Q -- (not understood clearly).

A It was primarily from pressure work.

Q Pressure work?

A Yes.

Q Would I be correct then in multiplying that 3000 stock tank barrels by the acreage that's presented on the -- on the exhibit here for -- for the West Puerto Chiquito Pool or are we talking about the entire area, the entire area that's under consideration today? Do you have any idea about that?

A This is a representative number for the entire area. I think you'd be misled if you were to take the number of sections we're looking at and multiply it by that number. Again the reservoir is somewhat heterogeneous; it will change from point to point.

I would be hesitant to apply this number pool-wide.

Q Do you -- I guess I perhaps -- I'm probably asking the wrong person, but then you have no -- no knowledge as to how the 3000 stock tank barrels per acre was derived.

A No. The 3000 stock tank barrels has come from principally results of interference tests and which, as testified before, one of the results of that test is a Phi H number or a capacity of the rock, if you will, and from that making assumptions of the area that was investigated, you can calculate a (not understood) and again, you know, this number is not a direct measurement but it's a result of an-

other test of actual field data.

Q Do you know if we're talking about -- we've talked about original oil in place and we've talked about 3000 stock tank barrels per acre, I hate to keep on repeating myself, but are we talking about that as representative for the entire area?

That's an average, you might say, for the entire area?

A That is representative of the area that has been tested by interference tests. I think we can make that assumption.

Q So we're talking about just this limited area here in the central portion of -- of the West Puerto Chiquito Field?

A That's -- that is one conclusion. Any further, I guess, any more detailed questions as far as where that number exactly came from might be better directed to someone else who actually had done the calculations, but that's probably a fair assessment, I think that -- that it's a direct measurement from those specific areas.

Q And so they extrapolated that to represent the entire field. That's the number upon which you -- one of the numbers upon which you based your calculations.

A That's correct.

Q Thank you, that's all I have.

MR. LEMAY: Thank you, Mr. Dillon. We appreciate that.

Mr. Lopez, are you ready with your rebuttal rebuttal witness?

MR. LOPEZ: We hope we are. If you'll give us just a second to get organized.

GREGORY D. HUENI,

being recalled as a witness and remaining under oath, testified as follows, to-wit:

REDIRECT EXAMINATION

BY MR. LOPEZ:

Q Okay, Mr. Hueni, I think the first thing that Dr. Lee testified to this morning was that the reservoir oil was under saturated at discovery and that the bubble point pressure was 1534 psia.

Would you please comment and in this connection I'll give you what's been marked Exhibit Eleven?

A Yes, I would like to comment on that.

The fluid properties that have been assigned to the Canada Ojitos Unit, we do not necessarily disagree with. That really wasn't part of the review that we did.

The review that we did concerned the Gavilan Mancos Pool and in performing that study we wanted to be sure that we had properties that were consistent with the

performance of the Gavilan Mancos Pool.

So we realize from the prior hearing the difficulties we have with respect to -- to the bubble point pressure and so we had determined in our study several things, and we've noted this on Exhibit Eleven, and I might just review very quickly a couple of the conclusions.

Conclusion 1 that we recognized, which is down in the middle of the page, we recognize that the bubble point pressure in the Gavilan Mancos Pool was 1660. That pressure was required to obtain a reasonable duplication of gas/oil ratio versus peressure peformance for the total field, as well as for individual wells, and we testified to that earlier.

We have studied that result extensively and that conclusion is true regardless of whether we're dealing with a fracture system or a dual porosity system. It is not dependent on either of those two.

One comment that sometimes -- that has been made previously is that higher gas production observed early in the life of the field is a result of near wellbore pressure drawdowns. We studied using a voidage model the amount of voidage associated with near wellbore pressure drawdowns the amount of free gas that would come out of solution. We concluded the amount of gas that was produced in the early years of Gavilan could not have come out of oil

that was drawn down below the bubble point pressure in the vicinity of the well, were the bubble point pressure a value of only 1500 psi.

So by necessity we arrived at the conclusion that in the Gavilan Mancos Pool the bubble point pressure had to be greater than that.

We recognize that that may be different than in the Canada Ojitos Unit and we would like to state that that's not unusual. We have worked many different areas where we have areal and vertical variations with fluid properties, and we cite an example in the Denver Julesberg Basin of the Codell formation and the Niobrara formation, where we have significantly different gas/oil ratios on wells located within just a few miles of each other. That's shown in Figure 2.

Now one of the statements was that if the fluid composition varies a bit, then the -- then the bubble point pressure would be expected to vary, and on page two we've shown you the Mole Percent of both the methane content and the heptanes content for the Loddy Well as well as for the Canada Ojitos Unit 12-11.

The component that has the greatest effect on the bubble point pressure is the heptanes + fraction and what we note is that the Loddy sample recorded a heptanes + mole percent of 44 percent compared to Canada Ojitos

Unit 12-11, which recorded 46 percent.

The lower amount of heptanes + tends to make the Loddy sample a bit more volatile and that is one of the reasons we associate the higher bubble point pressure with -- with the Loddy sample. So we believe that there is a difference in the actual composition of the two oils, and that is one of the reasonable explanations for why the samples are different.

We also noted that this -- at the time the Loddy sample was taken, the reservoir pressure was noted to be 1648 psi. That would be a pressure very close, in fact a little bit below the 1660 value that we're noting, so any kind of flow into the wellbore by necessity would have had to drop the oil to a pressure below the 1660 number, liberating gas out of the oil, and resulting in a sample that is not characteristic of the Gavilan Mancos Pool.

We note under Item 3 that it's not unusual for wells to be improperly conditioned or for the oil to be so close to the initial bubble point pressure that a representative sample is not obtained and the result of that is an understated bubble point pressure.

In support of that we have some, I think, green pages attached, which we won't go through. They are just taken from a Core Laboratories report. It's actually from a course covering phase behavior, and it just discusses

this problem to let you know that it is not an unusual problem in the field of reservoir engineering.

That's really all I'd like to say about the fluid properties.

Q Okay. I think the second point which Dr. Lee made this morning was that the matrix will not contribute to reservoir oil reserves. I'd like you to comment on this point and in that connection refer to what's been marked Exhibit Twelve.

A I'm not sure Exhibit Twelve goes with that, Mr. Lopez.

Q No, I think you're right. I just will ask you to comment.

A Okay. Yes, I would like to comment on that. The -- I think the real problem here is that once again we started this hearing in our initial testimony by stating what our conception of the dual porosity system was and what the matrix was, and we said the matrix consisted of low capacity fractures, microfractures, and then some sort of intergranular porosity. We have never claimed that it was strictly intergranular porosity.

We recognize that we're dealing with low permeabilities. We've recognized that from the very beginning, and we think that once again the focus may have been taken off of the way we've really defined the matrix in our

analysis. The values that we used for permeability were low values. That was the point that we made. They were not as low as necessarily the core data would suggest because we believe we have other components to what we're terming as the low capacity matrix system than simply intergranular porosity.

Now one of the things I might state with respect to the -- even the lowest permeability portion that Dr. Lee described, is that in -- when we do these, these studies and attempt to match actual historical performance, the important -- the relationship of the matrix to the fracture is described not only by the permeability of the matrix but it's also described by another factor that is multiplied by the permeability that relates to the dimensionality of the -- of the matrix blocks that we're dealing with.

In this case we used a permeability that he claims is too high, or is too -- yes, is too high. If we were to look at the numbers, we could actually revise our interpretation of the matrix block size and use a lower permeability and end with the same number.

In other words, if you have a large matrix block size, then you have to -- and this is all relative, too -- large matrix block size, then you have to have -- you can have -- you need a high relative permeability because the oil has to move a distance, a certain distance.

On the other hand, if you want to associate it with a very low, very low permeability, then you need a small value of this dimensionality parameter in order to produce successfully from the matrix, and we believe that we also have that because we have a very tight fracture spacing.

So once again we believe it was mischaracterization of what we're calling matrix and second off, that the matrix in and of itself has to be considered in conjunction with the path that is required for the oil to move from the matrix into the fracture itself, and that is also a factor that unfortunately we can't go down in the reservoir and necessarily look at. It's not a factor that is going to be constant throughout the reservoir. There is going to be an awful lot of matrix oil that's going to be extremely close to fractures that isn't going to have to move very far.

So we are not offended by the low permeability numbers that are in the model. We would be able to use a lower permeability number adjusting our dimensionality number, as well, and we once again do not feel, none of our group feels that that is unreasonable in terms of the engineering, engineering approach.

Q Okay, now I think we're going to get to Exhibit Twelve.

Dr. Lee's third comment this morning was that interference tests are a valid source of reservoir data and that you don't feel that way.

Would you comment with respect ot that statement and in this connection I would now like you to -- I would like you to comment on his point that the permeability thickness values equal or exceed 10 Darcy feet in the reservoir, and in this connection I'm going to refer you to Exhibits Twelve and Thirteen.

Mr. Chairman, we also have an Exhibit Thirteen-A that goes with this set but it's not quite ready, but I think we could start talking about Twelve and Thirteen and by the time we're done with that we will (not clearly audible.)

A Exhibit Twelve has several comments that we made related to this calculation of transmissibility for the Gavilan Mancos Pool, and I don't know why, I guess maybe in my own mind I feel like I occasionally get misstated, but maybe it's I just don't speak clearly enough on the subject that we're talking about.

I -- my statements with respect to interference testing has never been that it's not been valid but it's valid only when the proper conditions are met durign the analysis phase of that interference test.

And we've always had great concern that

just because of the difficulties in interference test analysis that it would very easily -- it would be very easy for it to be misinterpreted.

As a consequence of that we have looked toward actual well productivities as a demonstration of transmissibility as well as the pressure build-up surveys and I believe, hopefully not misstating Dr. Lee, that you would like to see some agreement between the interference tests and the pressure build-up or drawdown derived from this transmissibility value, so that is something that you -- you always look for, so you try and make maximum information out of the different types of tests that you have available to you.

The points that we would like to make with respect to the transmissibility value are made in this -- in this document that's included as Exhibit Twelve.

On the second page, Page 2, Item 1, we've noted first that it's been our opinion that Gavilan Mancos Pool is producing from a dual porosity system. There are some consequences from that that would seem to us that would need to be -- be honored if a valid analysis is to be performed on -- on the individual well tests that are -- are obtained in the pool.

If we move to the Page 3, Item 3, we would like to point out that the demonstrated well flow

capacity values at Gavilan. we're not talking about Canada Ojitos, we're talking about Gavilan, that range from 10 to upwards of 700+ barrels of oil per day, that the values that are necessary to obtain those kinds of flow rates from wells are in the range of 10 to 400 millidarcy feet.

I'd like to note that that is consistent with the Native Son No. 1 analysis which turned out a value in the order of 200 millidarcy feet to obtain a 400-barrel a day -- 400-barrel a day rate.

Once again we believe the variability of wells in the Gavilan Mancos Pool, a 400-barrel a day well is one of the better wells out there, so we think that the 200 millidarcy feet is certainly the value that's more representative of Gavilan Mancos area.

We'd like to turn to Item 4 on Page 4, we are referencing one of the well testing books, it's a book by Earlougher title Advances in Well Test Analysis, published by the Society of Petroleum Engineers, which we've -- to which we've attached a couple sections out of that report, titled Interference Test Analysis and also Naturally Fractured Reservoirs.

And a couple of the points that are made in the analysis, at least in one type of analysis, which we think -- which oftentimes is done in an interference test, is that in determining -- in using a homogeneous system, to

analyze that -- that type of system you arrive at a value for the porosity compressibility product. In other words, you don't arrive immediately at porosity. You arrive at a product and then you take your compressibility values and you use that to come back to the porosity number.

Now I would call your attention to the fact that traditionally in the -- in this area of the San Juan Basin, we've heard a number of operators testify that the types of compressibilities they are using for a rock compressibility are in the order of 10, and I think you will recall our testimony was that the rock compressibility from laboratory measurements was more on the order of 50 to 100.

The effect of that is if we have 5 times the compressibility in the system that we're analyzing, is that the porosity that we would calculate should really be a fifth of what we would calculate if we were using the wrong compressibility values.

In other words, it's very important to know the right compressibility if you want to determine from an interference test the magnitude of oil in place per acre and unless we know accurately the compressibility we may have some difficulties with that calculation.

One of the other points that we make Item 4, it's on the very last paragraph, is that significantly different answers can be obtained in an interference test

analysis if we use a fractured i.e., dual porosity model and a homogeneous i.e, well, just a homogeneous type model for short time periods, where they define short time periods by some dimensionless times and radiuses.

And what we've done is we've put down that equation 9.6 for the period of time that needs to elapse, at least in a dual porosity system, if that's what we have, before the resulting -- resulting homomgeneous analysis would be applicable to that particular system.

And what we've done is we've put down values that we think then are reasonable for the area that we're dealing with, 40 millidarcy feet, although I think we need to preface this with the fact that we think in the Canada Ojitos Unit area there are wells that have considerably higher than 400 millidarcy feet transmissibility.

We don't agree with 49 Darcy feet but certainly we can see 2, 3, 4, 5 Darcy feet in some wells in the Canada Ojitos Unit area, but 400 millidarcy feet would be typical for perhaps the Gavilan Mancos area.

We've put in these parameters. We've calculated out this rato and we've calculated out a value of a valid analysis to occur that that time should be greater than a value of 5, and it's not.

So we have difficulties just accepting on blind faith a 10 Darcy foot transmissibility value resulting

from an analysis unless we know the conditions of the -- the application of that analysis have been properly honored.

We have attached some other papers that describe the difficulties of obtaining good tests in fractured or dual porosity reservoirs, one by Kazemi and the other by Streitsova, and we have some points related to that which we won't go through.

What we would like to state is again in Item 8, that as we see it, the purpose of pressure build-up tests is generally to determine the average permeabilty thickness product in the region of the reservoir from which the well is draining fluid.

We see interference testing, not that it measures just the properties between the wells, but as Dr. Lee points out, it does measure additional reservoir volume, but normally the purpose of that is to identify anisotropies or directional properties between selected wells, and certainly it is a useful tool in that -- in that sense, and it's also a useful tool in determining the permeability thickness between wells and -- and the storage capacities between wells.

So we see -- but we see that both of those analyses should yield us similar results, particularly if we're dealing in a homogeneous system.

Now if we're dealing in an anisotropic

system when we calculate 10 Darcy feet of transmissibility in one direction, then we must have a very small transmissibility in the other direction to yield, then, as an overall result the average transmissibility resulting from radial flow. That's what we state in Item 8.

So we don't, we wouldn't really wouldn't have any problem with saying 10 Darcy feet could occur if it was anisotropic, but it would have to imply, then, that there was very low permeability in a different direction, in a direction normal to that, such that the transmissibilities would agree with the build-up transmissibilities, which we see as being much lower than that, values that are in the neighborhood of 200 + or - for the Gavilan area.

And then we attached the figure also on here that we used in our -- in our previous presentation.

That is all I wanted to say about Figure 12.

Figure 13, we've collected several test analyses. Different people have analyzed these tests and I think it becomes apparent that the different investigators analyzed tests a little bit differently, that they picked different portions of the pressure build-up curves to analyze, and the first, first figure is the result -- is one of the figures we had in our study that shows the analysis that we arrived at for several wells in the Gavilan Mancos Pool,

which, some of which Dr. Lee agreed with and some of which he felt were not valid tests.

Following that I'd like to include an exhibit taken from Benson-Montin-Greer Case Number 3455, December 17th, 1969, which had as an appendix individual well transmissibilities.

And we show for several of the Canada Ojitos Unit wells, L-11, showing the tests that Mr. Greer carried out and the resulting analyses that -- that he arrived at for these individual wells.

For well number one, the Canada Ojitos Unit L-11, the transmissibility was .45 Darcy feet.

For the Canada Ojitos Unit A-23 the value was -- the transmissibility, well, he has first transmissibility of .025 Darcy feet and a second transmissibility of .206 Darcy feet.

And then the Canada Ojitos Unit K-13 Well, talks about a .025 Darcy feet transmissibility, and then we could continue on through that, but Mr. Greer several years ago, at least, in certain wells was not necessarily seeing as high a transmissibilities as he obtained in some of his -- his interference tests.

I think on the second page there is a well, the Unit K-10, where he has a transmissibility of 1.5 Darcy feet. Certainly 1.5 Darcy feet is enough to make a

very, very good well, and I guess the next well, the P-11, has a transmissibility of 1 Darcy.

Following that are several pressure build-up analyses prepared by various members of the Gavilan Technical Study Committee. The name of the individual performing the analysis is contained in the upper righthand corner.

Included in these analyses are analyses by Mesa Grande, by Mr. Blanford; by Meridian by Mr. Fraley; by Koch by Mr. Pomeroy; by Mallon, Mr. McCord; by Dugan, Mr. Roe; and I believe that's all of the individual investigators that did these -- no, I'm sorry, there's also Mr. Sweet participated in this, Mesa Grande.

And if we would look on these analyses, and certainly several of them may not be valid, but if we were to look at the individual analyses, under Part I there is calculation of Kh or transissibility, and the Kh equals value down along the page, and then we have a sheet for each of the individual wells, and we see what other authors have come up with as well for transmissibility values.

For example, the first well, the Bearcat, 292 millidarcy feet; the Invader, 13 millidarcy feet; the Gavilan No. 1 I believe is 70, et cetera, and we have then additional authors that have investigated this problem coming up with similar low, lower than some operators have

reported, transmissibility values.

The final comment that I would have with respect to Exhibit Number Thirteen is contained in the last page. We were told that we -- we represented the dual porosity behavior as we presented it in our testimony, we showed the dual porosity behavior occurring at the wrong time interval.

What I'd like to -- what I wanted to include was out of our report that was done in conjunction with these tests, the actual write-up that was included.

This is the final page of that exhibit. It deals with the Rucker Lake No. 2, and in this case we show that we very well recognizes that there was nonhomogeneous behavior occurring, that really, instead of a double straight line that we really had three -- we had three breaks in the build-up curve and -- and what they're representing is that we didn't put the dual porosity point at the right point in time, is not really what we did.

Q Okay, I think we're ready to have that Exhibit Thirteen-A now.

A Exhibit Thirteen-A is an analysis we prepared or that we looked at, one of the analyses that was presented in this hearing, to try and detail out for you some of the problems we see in pressure transient testing analysis in this particular area. The net result of this

analysis, I think, it that we don't believe in general that wells are 10 Darcy feet. We don't believe the area is 10 Darcy feet.

We believe that it's more on the order of 400 millidarcy feet, but this is an example of how well test analysis can be not consistently interpreted, resulting in a misinterpretation.

We have a write-up here ad to go through the figures, what we try and do in a properly evaluated well test is to be sure that all of the aspects of the test analysis are consistent and we try and look at early time responses, middle, and later pressure responses as well and make sure that that's consistent with the rest of the reservoir information that we have on the well.

The example that we'd like to use is an analysis presented by Mr. Greer and supported by the test analysis presented by Dr. Lee. This particular well is the Canada Ojitos Unit Well E No. 6, and on this particular well, which we've shown the pressure plot for, pressure versus time plot as Figure 1, we show then the build-up curve. You see all those little dots going very close together, and they're plotted versus the log of Delta T where T is measured in hours, and you see then the analysis that was done on this scrap took calculated Kh and it used the slope as measured by lines A or B, and we notice that slope is

over very short period of time. We note on the pressure scale that we're dealing with these pressure increments in terms of 2 psi per increment.

And once again, there are lots of things that can affect that small a pressure measurement, but at any rate, Line A results in a calculated 17.3 Darcy feet. Line B results in a calculated 13 Darcy feet, and then we also, one of the reasons we selected this well is that Mr. Greer told us what the well flowing pressure is. The well flowing pressure was 1063 psi when it was flowing 680 barrels a day, resulting in a productivity index of 1.53.

Now the 1063 psi value you can see is far, far below the lefthand Y axis, which ends at 1490 psi.

The data that was used to analyze the -- or the slope that was used, is based on, it looks like, times from about, oh, maybe 30 hours out beyond that point.

Now what we'd like to do is the homogeneous solution is based on sort of an infinite, well it's an infinitely acting system, and so we would like to show you on the second page what the pressure profile looks like for one well producing in an infinite homogeneous reservoir with a specified value of 13 Darcy feet transmissibility.

Now what we would expect if we shut in this well, that in the times that we show along the bottom axis we would see the pressure build-up and we have it

building up from about 1488 psi up to on the righthand side of the scale, up to about 1500 psi, and it forms a straight line on the semi-log plot.

Now, if we're truly dealing with a homogeneous reservoir with extremely high transmissibilities, as we've had represented to us, then interference from these other wells -- other wells in the area, are going to be felt relatively quickly and what we can do is we can take this -- this infinite reservoir model and include by superposition a well one mile away from our example well to see what kind of pressure response occurs at our well as a result of producing the second well.

Now, we have in Figure 3 the response, the pressure measured at well one if well two starts producing when well one shuts in. Well, we can imagine all variety of different circumstances coming up, but basically what we're trying to show is interference and what we see is that in one hour through about 10 hours the pressure curve is very similar to what we have in the preceding figure and then in subsequent hours, 10 to 100 hours, the pressure is not rising as quickly as it was in the -- in the subsequent curve.

Now, what we'd like to do is go to Figure 4, I guess that's the next one. Figure 4 is the overlay of those two curves.

Now, the straight line segment from the lefthand side to the righthad side is indicative of 13 Darcy permeability rock, so we should, if we had, well, if we had 13 Darcy rock, we would -- and no wells around us, we would have had the upper curve, but if we have a second well in the vicinity of our well, we would have the lower curve, and what we tried to show here is a cross-hatched area that shows the effects of interference of the second well.

Now if you'll look and see where the interference effects are most severe, is in the time frame of 10 hours to 100 hours. The interference effects are not so severe in the time frame of one hour to 10 hours. We're not as likely to not pick the right straight line to use in our evaluation if we use the early time data as opposed to the late time data.

Of course this assumes there are no early time effects that obscured that straight line, such as wellbore storage or skin effects.

Now the other thing we've done is we put -- in this case we've put in three wells and this is on Figure 5, and what we've shown is that the response in Figure 1 when we shut it in, when there's just that one well out there, there was a straight line that went up from the lefthand side to the righthand side, and it was a constant slope, but now we see the effect of interference not of just

one well but two wells. We see that as the well, the first well shut-in, its pressure begins to build-up, but then because of interference effects it starts dropping off quite rapidly.

Now what we're suggesting and what we're certainly convinced of is that interference effects are obscuring many things in this field. They're causing slopes to be calculated that are way, way too shallow, and the resulting effect is that we're calculating permeabilities that are way, way too too high.

Now one of the things that we've done is we have gone to the early time analysis in Figure 6, we've gone back to the plot that Mr. Greer presented, and we've looked at this early time region that's, hopefully, less obscured by wellbore storage and skin effects, and what we've done is we've drawn a line through the first, I believe it's four hours of data, or so, and you can see it's a very steeply increasing curve.

Now, it maybe looks like it's so steeply increasing that it's unreasonable, but when we extend it, we see it's really only 48 psi per cycle, and so if we use that 48 psi per cycle value, we would calculate instead of a transmissibility of 13 Darcy feet, we would calculate a transmissibility of 1520 millidarcy feet. This is a good well. We think that's -- that's representative of the

transmissibility of a good well.

Now we can do a check against that because we know what the productivity index of this well was. Mr. Greer provided us with the well flowing pressure from which we calculated a value of 1.5. We can use that 1.5 value and we can plug it into a psuedo-steady state flow equation, as we do in Figure 7, and you can see first the build-up value for Kh as we have on Figure 7, it turns out to be, I guess, really 1610 millidarcy feet, and then we went through the productivity comparison and we calculated, we substituted in all the values we knew and then we calculated transmissibility. Instead of calculating 13 Darcy feet we calculated out about 2500 millidarcy feet.

Now these are kinds of numbers that you're going to see. You're going to see ranges between, well, in this case 1600 and 2600, but these are the types of numbers that we believe are representative for this particular well.

We think also if we look back at the individual well performance, we just don't see Darcy -- 10 Darcy feet wells out there in most cases.

Q I think you've also arrived at a different interpretation of the pressure test analysis presented by Dr. Lee, on one well. The results you've presented are substantiall lower, but in line with actual

well productivity.

Could you comment on the effect this over-estimation of permeabilty has on results presented by Mr. Greer and Sun? In this connection would you refer to Mr. Greer's pink sheet I think under Exhibit 5?

A One of the results of overstating the transmissibility and the value of Kh, then the problem is compounded by coming in and using the Kh value and the PI value, as Mr. Greer has done, to calculate some term he calls relative permeability, a relative permeabilty ratio, and he comes up with a value -- on the upper righthand side of that value he calculates KROR over KROW and he comes up with an average of 10, and then he substitutes that into his equation that relates productivity index to Kh and then the next thing we do is we go in and, as I understand his exhibit, he uses assumed productivity index values for several wells and in some cases he adds actual data, but he, I don't think, has actual factual data on the Howard 1-11, but he uses those PI values and takes his equation, which has this relative permeability factor in it that's a value of 10, and calculates Kh based on productivity information values and he calculates out permeability thickness values that are uniformly 2.5 to I don't know, it looks like the highest number is about 18 Darcy feet, and once again, these are higher than we obtained from the analysis. The real problem is the

fact that we come up with this relative permeability ratio that is based on transmissibility measurements that are not -- not accurate.

So what we've done, or what's been done here is to overstate the transmissibility, not ony in the Canada Ojitos Unit area but then extending it over into the Gavilan Mancos Pool, as well.

Q In connection with the pressure analysis performed on the B-29 and the B-32 Wells, which are Canada Ojitos Unit wells, would you please comment on the results of that analysis as it pertains to reservoir performance, and in this connection I'll refer you to what's been marked as Exhibit Fourteen.

A Okay. The analysis that Dr. Lee referred to indicated that there was a great deal of transmissibility in the vicinity of the Canada Ojitos Unit Wells, I believe B-32 and B-29, and I believe there has been testimony that these wells are interconnected and in pressure communication with wells on the other -- in the other, other A-B wells in the Gavilan Mancos Pool, and one of the exhibits that Mr. Roe presented was this plot of pressure versus time for various wells in the pool.

What I'd like to do is to show you the pressures for the B-32 Well and for the B-29 Well when they were first discovered. You can see the pressure for the B-

32 is about 1720 psi; for the B-29 Well I believe it's probably around 1660 psi.

The data we have on the B-32 Well is attached, that leads us to the conclusion that it's -- why it was 1704 psi, is attached to this -- this large graph.

What we'd like to draw the Commission's attention to is the fact that the gas injection area pressure, we have previously observed the decline in pressure that occurred in the gas injection area. We knew that by 1970 it had been drawn down by, I believe, 340 psi, and then Mr. Roe testified that it had continued to decline perhaps on the order of 11 psi per year.

Now if that's true, the CU gas injection area pressure is down at the bottom of the page about something under 1400 psi, as shown by the heavy line in the period 1985, 1984/1985 when these two wells were discovered.

Dr. Lee testified earlier that if we have wells in a -- in a reservoir that has more than one productive interval open in it and the higher productivity interval is at lower pressure, then that would be the pressure that the -- that the well pressure would tend to fall toward, the measured pressure. Well, the measured pressure isn't toward the C Zone interval. The measured pressure is up at the AB interval as the Gavilan Mancos Pool.

And what we feel that this proves and

feel it proves quite conclusively, is that those two wells are not C Zone wells; that they are producing A and B oil out of the Gavilan Mancos Pool and that they bear very little relationship to the C Zone gas injection area project.

Q So it is your conclusion -- yeah, I think it might be helpful to have Kevin point out where those two wells are.

A Right. Okay, yes. That would be -- I would appreciate that.

The Well B-32 and the Well B-29 are just on the east side of the trough area, what we've referred to as the syncline area.

Q And so as I understand it, it is your conclusion now that communication across the syncline is only in the A and B Zones and not in the C Zone, as represented by Mr. Greer under his Exhibit O and yellow sheets following, as well as a white sheet following.

A That is correct. I'd like to look at -- at Exhibit O, the first two yellow sheets. The second yellow sheet is a map of the area.

The area shown by the green -- by the green highlighted areas, I believe these are areas that Mr. Greer indicated communication was indicated by his interference testing or, yes, by his interference testing. I believe he also indicated proof of communication along the

orange areas, which are connected to his C Zone gas injection program.

The problem we have is that little pink dot that's dashed in between the green and the gas injection area, and from this exhibit we do not believe that that exists.

Further down the page or further down in the exhibit, there is a sheet, there are two white sheets. The two white sheets indicate they have on them a blue colored area, a brown colored area, and a green colored area, and I believe it's the minimum area being drained by wells B-32 and B-29.

The area that we show here, it shows drainage occurring from the West Puerto Chiquito area toward the B-32 and the B-29. We would like to take exception to that. We do not believe that those wells are draining from that area. We believe they're in pressure communication with the Gavilan Mancos AB area, and that the actual direction of drainage is -- is in association with the Gavilan Mancos Pool.

Q Are you sure everyone was with you?

A Possibly not.

Q This was the exhibit? Okay.

This morning Dr. Lee, I think, under his sixth point, stated that the -- your application of the

material balance equation could not lead to a reliable estimate of original oil in place.

I'd like you to comment and in this connection refer to what's been marked Exhibit Fifteen.

A Exhibit Number --

Q Fifteen.

A -- Fifteen is taken from Dr. Lee's testimony, Exhibit Number 10, which is taken in turn from our report Figure Number 50, and this was our plot of the material balance calculated oil in place plotted versus time, and we had drawn the conclusion that the oil in place was 55,000,000 barrels and Dr. Lee drew the conclusion that we couldn't apply a material balance analysis to the reservoir for several reasons.

He indicated the general requirements were that a proper drive mechanism identified. I think we have identified that drive mechanism. It was under-saturated reservoir performance before the bubble point was reached. There was solution gas performance after the reservoir finished being a partially under-saturated reservoir. So we, I believe, have met that requirement.

All production and injection into the reservoir taken into account, I'll talk about that in a second.

Uniform pressure throughout the reser-

voir. Well, I think our pressure versus cumulative production plot shows a fairly uniform pressure through there.

Uniform saturations in the oil zone and in the gas cap, well, what's most important is to be able to identify the relative volume of oil and free gas in the reservoir, and initially we had no free gas in the reservoir. Because we're dealing with the Mancos A-B Pool, we're dealing with a strictly oil system, so the oil in place we calculate is a calculated oil in place. We don't have to try and simultaneously calculate an oil zone volume and a gas zone volume, so that is not really a problem in this particular case.

Oil either totally above the bubble point or totally below the bubble point. Well, we recognize that problem. We identified the region where that would not be likely to occur.

Dr. Lee decided that it was perhaps more appropriate to describe our trends and points by drawing a concave downward line through all of our points. I think most reservoir engineers commonly recognize that material balance equations can be most inaccurate in the early life of a field because material balance depends on a measured pressure drawdown and in the early life of a field measured pressure drawdown is -- is the smallest and you can have the greatest error in calculation at that point in time, so when

I presented this figure it certainly didn't disturb me that the early calculated apprent oil in place values were not as high as subsequent ones. What really encouraged me was the fact that they leveled off.

I have to admit, and I related to the Commission, I was disturbed by the fact that the pressures had been declining in 1986, the end of 1986, more than I would have expected, and I said that in part, that I thought this was due to perhaps dual porosity system behavior.

What we now know is that the B-29 and the B-32 are not part of the Canada Ojitos Unit gas injection area. They are part of the Mancos AB Pool, and it is necessary, as Dr. Lee points out in Item 2 that all production and injection into the reservoir be taken into account.

We have taken those additional -- the production from B-29 and B-32 into account and I think from the dots you can see that what that does is it moves the calculated oil in place up more in the direction of the 55,000,000 barrels.

Once again, it's not an exact number. I think it would be very foolish for anyone to expect that it would be an exact number. I think it's a very reasonable number. It's based on a number of factors determined in the laboratory and tested in the field, and we believe that the material balance calculation is correct. We believe it's

55,000,000 barrels and we believe the B-29 and B-32 are part of the Gavilan Mancos AB Pool.

Q Dr. Lee has indicated taht you should have included capillary pressure characteristics in the model. Would you comment on that and indicate why you didn't?

A We didn't include capillary pressure characteristics in the model for a variety of different reasons. One, we didn't have any available. We have a 3-phase system here that we're dealing with. There is probably interstitial water to some extent in the system, as well as oil and gas.

Second, once again we didn't want to -- and we don't want anybody to misstate what our matrix is. We are once again convinced that the matrix cannot be simply described and if somebody wants to simply describe it, then everybody's got a problem.

Q Can we take just a second?

A We didn't want it to be confused with the matrix that -- that we are describing. We believe that the matrix that we have is a more permeable system. It's a very complex flow geometry comprised of fractures, microfractures, and true matrix.

We didn't include that because part of our effort is really a matching effort. There are certain

things that introduce an additional variable into the model, whcih we would then have to -- to adjust and we'd just have more parameters to adjust. We feel that we have enough parameters to adjust, we matched performace very accurately, and we came up with a, we believe, a reasonable representation of actual field performance.

Finally, with respect to the comments that the -- that we did not include capillary pressure into -- in the model, and we were suffering considerably from end effects, we've also discussed that matter with Mobil Research and Development Corporation, their Dallas Research Laboratory. I have from them a reference to oil production from tight matrix fractured reservoirs, as represented by the Gallup B -- Lindrith B-38 Well core, stating, one, "Oil production from this type reservoir is characterized by oil feeding from the fracture system due to the change in the formation..." "... feeding the fracture system due to the change in the formation volume factor because of pressure decline. The fractured Asmari resrvoirs in Iran are an example of this mechanism.

2. Capillary pressure, end effects, and three-phase flow information generated from viscous displacement tests should not be confused with this type displacement.

3. Normally, in excess of 70 percent of the oil in place is found in the tight matrix part of this type of

reservoir and can support efficient recovery."

Which is signed by P. M. Wilson and B. F. Marek of Mobil Research and Development Corporation.

Q Dr. Lee ended up with the conclusion that the reservoir is rate sensitive, presumably on the basis of his work and that of Sun.

Would you comment about this and I ask you now to refer to what's been marked as Exhibit Sixteen.

MR. LOPEZ: Mr. Chairman, with respect to the letter from Mobil Research that Mr. Hueni just read, it just arrived and I'd like to introduce it as an exhibit. We haven't marked it but let's call it Exhibit Sixteen-A, and we'll hand it out.

Now I'll hand Sixteen. They will be out of sequence as a result but we've run out of numbers.

A Would you like me to comment on rate sensitivity now?

Q Yeah, would you, please?

A Yes. We are still of the opinion that this is a system that is not going to be particularly rate sensitive. We had been accused, I guess, of running our model at zero degree dip and I think Dr. Lee referred to the fact that there is up to 100 feet, or 100 feet per mile is the average dip in the Gavilan Mancos Pool. That's actually

a one degree dip in the Gavilan Mancos Pool and a half a degree dip, and so we -- we have run other cases. We've run cases with -- with dip included in our model and we've referred to those as run names Gav 7 and Gav 8. They do have transmissibilities. The first one is 400 millidarcy feet. The second one is 10,000 millidarcy feet. The dip in degrees is one degree. The maximum oil rate we're taking oil out of the pool is 200 barrels a day, which correspondes to 7,200 barrels a day.

And we have for comparison purposes a similar evaluation run at zero degree dip, which we note as Gav 3. That's one of the ones we've previously presented.

If we look at oil recovery at specified average pressures, and look at the very last of the pressures, 300 psi, we see that under the 400 millidarcy case for this particular situation, we arrive at a 15.4 percent recovery; the same recovery whether we have zero dip or one degree dip in the model.

Second, when we put 10,000 millidarcy feet in the model and run it, we arrive at a slightly higher value, 15.8 percent, so we wouldn't consider that terribly significant.

We believe our analysis of the model is valid, that our rate sensitivity conclusions can be relied upon. We've shown on Figures B and C our model run under a

single porosity system mode, simulating a fracture system.

We've plotted gas/oil ratio versus pressure on Figure B as output from the model compared to actual Gavilan, and what we have in the computed run is a model using a Kh of 10,000 millidarcy feet, one degree dip, 400 barrels of oil per day, a gas/oil -- or a bubble point pressure of around 1500 psi, in fact I'm not sure but I think that -- well, it's reasonably close representation of the model that Mobil or that Sun has -- has indicated, or the characteristics that Sun has used in their model.

And I think we can see that actual Gavilan performance on the GOR versus pressure plot is a bit different than what is computed. We have higher GOR's earlier than in actuality in what occurred.

If we turn to -- to the next figure, Figure C, we have the results presented as a pressure and gas/oil ratio versus fraction oil in place produced. You can see the computed model results and what we report for actual Gavilan is shown off on the left and I should note here that when we got to a 1500 psi bubble point pressure, one of the effects that has is that has the impact of increasing the calculated oil in place to a value of about 110,000,000 barrels.

So that's one of the reasons we say you can't divorce the characteristics from field performance.

You've got to use the field characteristics and be sure that they give you reasonable values in light of what you've actually observed in the field. You've got to use that in your model, or you're going to end up with models that give you answers that don't represent what's -- what's actually transpired.

Q Does this conclude your direct, your rebuttal testimony?

A Yes, it does.

MR. LOPEZ: At this point we've concluded our rebuttal testimony.

MR. LEMAY: Would you like to move the exhibits be --

MR. LOPEZ: Oh, yeah, sorry.

Q Were Exhibits Eleven through Sixteen-A prepared by you or under your supervision?

A Yes they were.

MR. LOPEZ: I'd like to offer Exhibits Eleven through Sixteen-A.

MR. LEMAY: Without objection those exhibits will be entered into the record.

Mr. Kellahin.

MR. KELLAHIN: Mr. Chairman, all good things must someday come to an end.

In an effort to do that, and

because we as the proponents have the burden of going forward under the rules of procedure, we also have the privilege of having the last "me too" or "no, we don't agree".

Rather than engage Mr. Hueni in cross examination at this point, I think I can complete an examination of what we want to do and finish in just a few minutes if you'll allow me to call Dr. Lee and ask him five questions, and then we will be done.

MR LEMAY: Is that acceptable, Mr. Lopez?

MR. LOPEZ: Well, Mr. Chairman, it's highly unusual but I've never heard a sur-surrebuttal, but in the spirit of the proceedings and knowing that we all want to ascertain the truth, we'll be more than willing to go along with this suggestion.

MR. LEMAY: Would you like a little break before you did that or are you ready to slip right into it?

MR. KELLAHIN: Not necessary, let's do it.

MR. LEMAY: Okay, let's do it.

MR. KELLAHIN: I would recall Dr. John Lee.

MR. LEMAY: Please continue, Mr. Kellahin.

MR. KELLAHIN: Thank you, Mr. Chairman.

DR. JOHN D. LEE,

being recalled and remaining under oath, testified as follows, to-wit:

REDIRECT EXAMINATION

BY MR. KELLAHIN:

Q Dr. Lee, has Mr. Hueni satisfied your disagreements with his analysis with any of his explanations to you this afternoon in his surrebuttal testimony?

A No, sir, he hasn't.

Q Has anything Mr. Hueni has commented on explained, clarified, or contained in any of his exhibits, caused you to change any of your opinions?

A No, sir.

Q Did Mr. Hueni's explanations and comments cause you to change any of your conclusions?

A No, sir.

Q Has any of Mr. Hueni's explanations, exhibits, comments, or conclusions caused you to want to alter or correct any of your answers or opinions that you expressed earlier?

A No, sir.

Q In your opinion, Mr. Lee, is it still fair to characterize Mr. Hueni as having used the wrong model to model this reservoir?

A That's still my opinion, sir.

MR. KELLAHIN: Nothing further.

MR. LEMAY: Are there any questions and rebuttal?

I have none, Dr. Lee. If there are no questions, you may be excused.

At this point I think we possibly should call Mr. Hueni back so that there can be additional questions. If that's acceptable, from the audience, I mean.

MR. LOPEZ: As I understand the proponents have waived cross examination. We certainly want to open Mr. Hueni to cross examination by any other interested party.

MR. LEMAY It was my impression that Dr. Lee's quick testimony was in the place of cross examination, but after that we usually, it's customary to have the witness submit their testimony to open questions.

Are there any questions from the audience of Mr. Hueni?

That was a quick one. I think we'll excuse him.

Mr. Lopez.

MR. LOPEZ: I guess we should break or maybe we should have a little informal discussion

about where we go from here.

MR. LEMAY: I think so. Let's go off the record just for a few minutes.

(Thereupon a discussion was had off the record.)

MR. LEMAY; This is the beginning of the end and with that in mind are there any statements at this time from anyone in the audience you'd like to get into the record?

Yes, sir, Mr. Jordan.

MR. JORDAN: I'm William O. "Oscar" Jordan, and my address is 28 Old Arroyo Chamisa, Santa Fe, New Mexico, 87505, phone number 505-982-5689.

Originally I, when I appeared the other day I appeared for one client which was a landowner in the Gavilan Mancos area. This morning I -- and I figured there might be some more and this morning, why we turned up with 57 people who are royalty owners in Townships 24, 25, 26 North, and Range 1 and 2 West.

As I said, they're the original owners of this land and the natural resources under there and they leased those with the expectation of receiving renumeration for their fair share of the oil and gas underneath the lands. They want to make sure that maximum

production is had and therefore their revenues will be as high as possible.

I was only called into this case last week, possibly from the -- because of the lack of formal notice to my clients. Naturally I was unable to prepare cases or prepare for cross examination or to get witnesses together to testify, so I elected here to go ahead and monitor these hearings and with the understanding that we might make a statement and participate, but I'll get into that a little bit further here to the extent that also we weren't furnished copies of any of the exhibits.

I point that out in this connection, lack of formal individual notice to royalty owners has bothered me for the past some thirty years, or better than thirty years. I was attorney for the Land Commissioner for many years and the Land Commissioner was on this board. I don't think there was a -- this Commission. I don't think there is a conflict there because he was an elected official and if it's so, then the governor is in conflict every day because he has different interests. He can have the trust on one hand and the conservation on the other, but I don't think those are problems, and we got notice so I didn't think about it, so I didn't think about it, but I always wondered about the private people that would come in. Some say, well, they should have their wor-

king interest would represent them, but that's not always so. Sometimes that is not true.

I realize there's no OCD rule requiring formal notice to royalty owners and that there is publication of the notice, but in the usual course of law, these type of people, royalty owners, would be indispensible parties and the court would jurisdicition -- the court would not have jurisdiction unless they were before the court with proper notice.

To point this out here, you probably, some of you were here the other day when Mr. Kellahin complained, and rightfully so, that he had not seen a certain exhibit, so in order to discuss it with his petroleum engineers, geologists, et cetera, his expert witnesses, and therefore he couldn't cross examine properly.

Well to show you the position that we're in, we have had no copies of any of the exhibits and had no opportunity to consult with anybody and that's probably because of lack of notice.

So I think this is something -- that I mentioned this becausae I think it's something the Commission should be thinking about. I realize it's a real problem determining who all these owners are. Royalty owners can be very diverse, overrides, and so forth. You might have many people to cover but it might set some limit on in-

terest there.

For this reason I have to preserve the point that they have not had due process and opportunity. Now that's not to say that I could get up here after getting hold of a witness, expert witness, and cross examine and change this case around, but the possibility is there and unless you have that opportunity you never know.

In monitoring this case I tried to get enough information here to discuss with my people this morning at very short notice as to what position would be in their best interest and some of them have heard the -- some of the testimony here, and they are primarily interested in maximumizing the production and resulting income to themselves.

In this regard, as I sat back and listened, and I've had some experience, not a lot of experience, but I've appeared before this Commission on behalf of the Commissioner on numerous occasions. I sat in on here on a few occasions. Through the years there's a lot of them, but there was many years, so it was very sporadic that I came here. Also, representing the Land Office as a royalty owner, we were all kind of lawsuits regarding production and offset wells and et cetera. But listening to the testimony here this morning and some of it is pretty deep and I think probably only geologists and petroleum engineers

can fully understand that, we -- I was quite amused at complaints that you're leading the expert witness up here. It's been my experience through the years the expert witness gives the lawyer the questions in the first place.

So you can hardly help lead him when he's given them those questions.

In this regard I feel that the -- it's my understanding that the burden of proof in such a proceeding to vary the standed statewide pool rules, the burden of proof is on the proponent here, and as I sat here and listened to this, I do not think that that has been met, that burden has been met.

It is our position that very much in line with the people over in the Gavilan Mancos area that the spacing of -- going back to the statewide spacing of 320 acres with an allowable of 702, and the oil/gas ratio as set by the statewide rules would be the proper way to do it, and I don't think that that would prejudice or reduce the ultimate recovery or prejudice the prejudice the people over in the West Puerco (sic) Chiquito area.

I heard the testimony, there is some communication between the two pools but that with proper well alignment, and so forth, there wouldn't be any prejudice in that case and it also took in account that there was testimony that there was somewhat of a barrier in be-

tween, but not an absolute barrier like a (not understood) fault.

So our people would take that position. Now, assuming, however, that there is, that the West Puerco (sic) Chiquito people were correct and that this is all one pool, and that there is communication between the two and that wells on one side will drain the others, I'd point out here from our people's standpoint, the way they look at it, they're ranchers and farmers primarily and some of them have been around the oilfield for some time, but they're ranchers and they feel that this -- the testimony was that there was, I believe one witness said 8,000,000 and another one said 10,000,000 produced out of the West Puerco (sic) whereas there's been 3 -- over 23 years, and there's 3,000,000 produced on the other and that there's approximatelyu 55,000,000 there. If that be the case, and that the drainage would occur both ways there, it would appear to our people that the people over in the West Puerco (sic) have already taken a larger bite of the pie than they should have and they should be allowed to catch up at least. They shouldn't share their part now, that same part with these other people.

We also paid attention to the 7 sections there and the testimony from the Gavilan Mancos Pool people are correct. There were seven sections in the

shaded area there between the two. Possibly they should be put over into the Gavilan Mancos -- Mancos Pool from our standpoint.

As I pointed out here, this due process question, I'm kind of in a bind here because the first day I was unable to specify just exactly what our position would be, but as it developed here we could see that I cannot recommend to my people in good conscience that they waive any objection to that.

I also would point out one funny instance here, the -- as far as economic waste, if you go to 640 the well drilled -- wells on the Gavilan area are already on 320 generally and those wells some of them don't produce a full allowable and it wouldn't affect it, but where those strong wells are, if you've got two strong wells together you're going to shut one of them in, you have wasted the drilling, the expense of drilling that well.

So we ask that they go back to the statewide standard rule, that the burden has not been met to show that we should go to a 640, and should just stay in the same position we were.

I realize here when you get up here first to lead off you're subject to being shot at, but I notice that this Commission here is very liberal in granting people a response and rebuttal and surrebuttal, and I

do thank you for your attention.

MR. LEMAY; Thank you, Mr. Jordan.

Are there any other statements? Mr. Padilla?

MR. PADILLA: Mr. Chairman, Members of the Committee, I represent Floyd and Emma Edwards. My comments will be directed to the testimony and evidence that has been presented here.

Mr. Gentry will also speak for the Edwards regarding questions of notice.

First of all, in advising royalty owners in a caseof this nature, it's far different from advising working interest owners who regularly appear in these hearings.

When I was first approached in this case, about two, two weeks prior to the hearing, my initial reaction was to advise them to do absolutely nothing and stay away from here simply because they could not compete with the testimony and with the working interest owners on either side of this proceeding. The kind of technical evidence and the nature of the testimony is far too complex for a royalty owner, not to understand, but from the standpoint to prepare for a hearing of this nature in the time allotted.

The Edwards did hire expert testimony to advise them as to whether or not to get invol-

ved in this hearing and to present a case here. Upon investigation and contact to some of the parties involved in the Mesa Grande-Mallon side, it was decided that they could not do anything at that point. A lot of their material had already been covered and was going to be covered in this hearing, or had already been prepared.

To the extent that we have to side with someone, we obviously have to side with the Mallon-Mesa Grande group. The greatest fear that royalty owners in this area have is that we perceive that this area would be eventually unitized or at least that is what appears to be coming despite any decision that is made regarding this hearing.

To say that we fear a unit is an understatement. Potentially we would found in a participating area that would not be -- come into participation until sometime in the 21st century. I think that a lot of the wells currently producing out of the Gavilan Mancos area would have to be shut-in and for that reason royalty owners would not receive any kind of a participation from the unit depending on how the unit is eventually formed.

The Commission cannot in this case ignore the development historically that has occurred in both of these pools.

Mr. Greer has developed his

side of the fence in a far different manner and unquestionably in a very prudent way. On the Gavilan side it has -- development has occurred on a competitive basis and is completely different than Mr. Greer's side.

To change the spacing, to change allocation formulas as this point it would create inequities not only to working interest owners that have invested a considerable amount of money in there, but it would also adversely compare and affect royalty owners.

In Rio Arriba County alone there are a number of Gallup Pools that are side by side and if not continuous, they have been allowed to operate and have operated successfully without interference from one side to the next. Between these two pools the current rules allow for protection in -- to protect Mr. Greer's unit.

With respect to the so-called permeability barrier that has -- that supposedly divides the two areas, you must keep in mind that this permeability barrier was first invented by Mr. Greer. As time and as development occurred in the Gavilan Mancos Pool, opinions then started changing.

Yesterday Commissioner Humphries asked some questions concerning the geology of this area. He used, in attempting to illustrate his questions, his rules handbood. Now, if you take that same example and you use a brittle type of formation that has been described here, I think the bottom half if you bend a formation in

that way over geological time the C Zone would become severed from the rest of the formation. In fact, sitting here yesterday it appears to me that depending on the amount of the -- of the bend, that you would have something as illustrated in this painting behind us here, is that you might have that kind of separation in the middle with the kind of upheaval because of the upward push in the upper part of where you have the strain on structural dip.

I characterized Mr. Greer's concern as a man who has developed a considerable engineering project here and he is downstream collecting oil with an insufficient amount of wells to protect the unit. You could say that he just doesn't have enough buckets in his bucket brigade to catch all the oil. His concern is that some of that oil is going to get by.

With respect to the matrix contribution, I cannot conceive from the testimony presented here that the matrix does not contribute to production. This is a very hotly contested issue and there has not been any agreement between both sides here but it's certainly difficult to conceive or to believe that there is no matrix contribution.

In a type of this -- in a case of this type, I believe that the Continental Oil Company versus Oil Conservation Commission case, which is a landmark

case in oil and gas conservation, is applicable here, especially in view of the fact that the proponents, or the Benson-Montin group, are attempting to change allowables.

The Continental case requires the Commission to make findings and to make findings that -- as to total reserves in the reservoir, and the proportion of those reserves and attribute total reserves to each individual tract. I don't think there's any disagreement that the various wells, or all the wells that have been discussed here, have different production capabilities. I think it's important that the wells that have high capacity are allowed to produce more than the wells that have lower, lower capacity, and if you're to mix and throw everything into one pool, this thing has to be taken into consideration as to who can -- what wells have a higher capacility of production and those that do not.

Finally, with respect to the burden of proof in this case I was involved in the August, 1986, hearings. I had represented in that case Koch Exploration, which has now basically decided ot give up and not spend any more money in the State of New Mexico, as I understand it, but in that case the members of the previous Commission decided the case on the basis that if they were going to err, they were going to err on the side of conservation. I don't think that this is the standard. If that

is the standard and that is the conclusion that is reached by the Commission, then I think that the proponents of the -- in -- on the Benson-Montin-Greer side have not met the burden of proof.

Thank you very much.

MR. LEMAY: Thank you, Mr. Padilla.

Are there additional statements?

Mr. Gentry.

MR. GENTRY: May it please the Commission, I am Nicholas R. Gentry, also representing Floyd and Emma Edwards.

Mr. Padilla has addressed some of the substantive and more technical aspects of the evidence that has been heard by the Commission. I want to address only some legal issues on behalf of my clients.

We have already submitted a brief to this Commission on those issues, therefore I will be relatively brief but I think those issued are significant, significant enough importance that they need to be addressed.

Now, first of all, we filed a motion with this Commission to continue or vacate these hearings on two grounds.

Number one, simply that we were only recently retained by the Edwards because of a conflict of interest that developed with their previous counsel and therefore there was a problem of time and preparation for this hearing; and secondly, our motion was based on our concerns about the lack of notice or the inadequate notice being provided for these hearings and for previous hearings to royalty interest owners, such as the Edwards.

Now the Commission chose to deny our motion and has obviously proceeded with these hearings. In that regard I did receive a phone call and a letter from Mr. Lemay, I believe it was last week, stating among other things that to vacate the hearing at this late date would cause undue hardship on all the parties.

This reference to undue hardship brings me to our main, or one of my -- our main concerns that I want to address, and that is the question of inadequacy of notice that is provided to royalty interest owners. I think that is where the real undue hardship is lying.

In regard to that question of notice, let me briefly state that the Edwards are royalty interest owners in regard to land in the Gavilan Mancos Pool. They have leases with Mr. McHugh and the increase in the spacing unit from -- that was previously ordered by the

Commssion from 40 to 320 acres has a signficant adverse affect on the Edwards.

Now the Edwards are currently, as I'm sure the Commission is aware, involved in litigation with several parties, including Mr. McHugh and including this Commission.

One of the main points in dispute in that litigation regards the question of notice that was provided or was not provided to the Edwards in Case Number 7980, previously heard by this Commission, and that case culminated in Order R-7407, which ordered the increase of the spacing from 40 to 320 acres.

In connection with this lawsuit the Edwards filed a Motion for Summary Judgment, for partial summary judgment, which was heard, I believe, on Tuesday by Judge Serna, and Mr. Taylor, the Commission's counsel was there and I'm sure he's discussed this with the Commissioners, but in ruling on that Motion for Summary Judgment the judge essentially ruled that sufficient notice was not provided to the Edwards or royalty interest owners in that case of 7980, and I've got a portion of the transcript from that hearing and I'd like to quote from it briefly.

Judge Serna stated that "I find that the Edwards' mineral rights are property rights which are protected by the State and Federal constitutions. I

find that the proceedings in Case No. 7980 matreially and adversely affected the propery rights and that they were entitled to reasonable notice of that case." The judge further stated that "I find that notice by publication was unreasonable and I am specifically finding that in this case in view of such a significant dilution of property rights, that actual notice should have been given."

Now unless the Commission thinks that this is some aberrant ruling by Judge Serna, I would point out, as I did in my brief, that there -- that this ruling is in agreement with numerous other cases and other jurisdictions, which have essentially held that a royalty intererst is a property right; that an administrative act, such as increasing the spacing units from 40 to 320 acres deprives the owners of their property through State action, and that in such a situation the owner is entitled to due process and notice by mere publication in the paper does not constitute due process.

Now our brief details some of these legal authorities and I won't go into it at this point.

I would also state that in regard to Judge Serna's action, he further ordered that the matter be remanded back to this Commission for further proceedings. I think Mr. Taylor would agree with me that there

was some question as to exactly what he did order and how that was to be implemented and our reading of that portion of it, of his order, we disagree with that portion of his order, and that's something that may be challenged later on down the road, but nevertheless the crux of his order is that notice by publication is unconstitutional.

Now this decision puts in question the validity and applicability of Order No. R-7407, at least as it applies to the Edwards, and in my opinion this decision also puts in question these particular proceedings and any order that may result from these proceedings as it would apply to royalty interest owners or other people with property rights that may be affected by this order resulting from these particular proceedings.

Now it's my understanding that the Commission sometime subsequent to Case Number 7980 amended its rules and regulations regarding notice and in my reading of those amended rules it appears, although I'm not quite certain, but it appears that there is now a provision for personal or actual notice to be provided to royalty interest owners, at least in some situations and some hearings, types of hearings before this Commission.

But nevertheless, it appears to me from the information that I've made available to me, that royalty interest owners in regard to this particular pro-

ceeding, royalty interest owners have not been given actual or personal notice. The only notice that has been given, it's my understanding, has been notice by publication, and if that in fact is the case, then it appears that there is a violation not only of the Commission's own rules and regulations, but more importantly a constitutional violation as Judge Serna has already ruled in connection with the Edwards.

Therefore, what has transpired during the past several days and what this Commission may order based on the testimony that they have heard over these past several days, may be in jeopardy, at least as that order applies to the Edwards or people similarly situated that did not get constitutionally adequate notice, and it's our position based on the research that we have done and what we have argued on behalf of the Edwards in District Court in that situation, an order issued by this Commission based on what has been received in this hearing, for which the royalty interest owners did not get adequate notice, those orders are vague, excuse me, not vague, they are void as to those particular individuals.

Now the second point that we also briefed and provided to the Commission, and which I'll touch on briefly, is a question of retroactivity of Commission orders.

Order No. R-7407, it's our opinion, expired by reason of its own terms and language, on March 1st of this year, and even if this order were at one time valid and binding on the Edwards, which we do not concede, but even if it was, that order is now by its own language no longer effective and binding on the Edwards or anybody.

That order provided for temporary 320-acre spacing effective March 1st of 1984 and to last for a 3-year period.

In addiition Order No. 7745 provied for temporary 320-acre spacing for a period ending on March 1st of 1987.

Those orders are clearly no longer in effect and by their own language and I think that the spacing units have reverted back to 40 acres and should remain at 40 acres until further order of this Commission.

The Commission and the various applicants to these proceedings were aware, well aware of the language of these orders and these particular dates, yet as far as I'm aware, neither the Commission nor any applicant has requested any relief for new order that would have retroactive effect back to March 1st of this year, and even if the applicants are requesting such relief or that type of order from the Commission, in our opinion such a retroactive

or nunc pro tunc order would be contrary to the Commission's authority and contrary to the Commission's practice.

In our opinion a retroactive order of that effect would not be necessary to prevent waste or to protect correlative rights.

Secondly, administrative rules and regulations cannot be made retroactive if te equities do not favor the party requesting such relief and we do not believe that's the situation at this point. I think all the equities are in favor of the Edwards and other individuals similarly situated.

Thirdly, the law will not grant retroactive relief to a party where the relief sought became necessary due to that party's own delay or lack of due diligence. Again, that seems to be the situation in this case.

In short, our position is that the retroactive order attempting to bridge this time gap from March 1 of '87 to whatever subsequent order the Commission should issue, especially as that applies to the Edwards, since those original orders were void as to the Edwards because of lack of notice, any type of retroactive order would be ineffective and inappropriate and contrary to the law.

It's our position that the orders of the Commission must be prospective in nature only.

Thank you very much.

MR. LEMAY: Thank you, Mr. Gentry.

Are there additional statements at this time?

Yes, sir.

MR. FRALEY: My name is Richard Fraley and I'm a Senior Reservoir Engineer with Meridian Oil and I'd like to offer a statement concerning Meridian's position in these hearings.

I think you've had your fill o technical arguments and I will not make you sit through any more. I'll also be as brief as I can.

Meridian, as an operator in the Gavilan Pool and a working interest owner in the Canada Ojitos Unit, has been involved in the study of this reservoir since the early stages. I've personally been involved since June of 1986 and as a result of that I was named a co-chairman to the engineering subcommittee last September.

I must say that originally Meridian was skeptical about the reservoir as described by BMG, et al, and we remained open-minded as to other possibilities. I must say that our reasons for the skepticism were first, we thought that the reservoir characteristics were unusual and the performance of the reservoir seemed unusual also.

I'll also say that it's human nature to lean on your past experience and to analyze problems based on a given background with more conventional type reservoirs.

In analyzing this reservoir Meridian soon realized this reservoir was unique and could not be analyzed or expected to perform like those normally encountered; however, through careful study, research, field testing and observations of performance, Meridian became convinced that this reservoir was not being developed in the most efficient manner to maximize recovery and economics, and in that I'm referring to the Gavilan portion of the Mancos Pool.

Further study showed that these ideas presented by BMG, et al, had a great deal of merit regardless of how adverse they seemed when compared to typical reservoirs.

As I mentioned, Meridian tried to remain objective in their analysis. Prior to the August hearing Meridian attended meetings and was invited to join in commissioning a study by the opponents to the McHugh application.

We declined for two reasons. First, not all of the operators in the area were invited to do one and secondly, we were very concerned about the objec-

tivity of any study commissioned specifically for hearing.

Therefore, in order to address Meridian's future in this area, to proprietary in-house studies have been done in the last six months.

First we analyzed the past and future performance of Canada Ojitos Unit, of which we are a working interest owner. Likewise, we analyzed Gavilan. Briefly the results are as follows.

We saw a very efficient gravity drainage gas injection project in the Canada Ojitos Unit currently developed in the Niobrara C Zone and to a limited extent in the Niobrara A and B Zones, with near term plans to develop the A and B before severe drainage could occur into Gavilan. We feel that this project will maximize ultimate recoveries from that portion of the reservoir.

We saw in Gavilan a highly competitive drilling situation in what we considered the same reservoir as Canada Ojitos Unit, with little thought or concern for preventing waste or increasing ultimate recoveries.

I present to you that that is a sharp contrast.

I do not need to remind anyone in this room that these are difficult times for the oil and gas industry. In addition, we are finding and developing more reservoirs that are considered unconventional when com-

pared with those developed in the past.

Meridian submits that this is one of those reservoirs and we can not be afraid to develop this and other reservoirs with practices that are unorthodox and unusual as compared to past practices in order to maximize recoveries and economics.

In this hearing and the hearings that have been held this week, representatives for BMG Drilling Corp., Sun, Dugan Production, and Jerome P. McHugh and Associates, have shown in their testimony the following:

First, this is a fractured reservoir with little or no matrix contribution, regardless of how you define the matrix.

Second, through definitive interference testing it has been shown there is pressure communication between Canada Ojitos Unit and Gavilan.

Third, that gravity drainage production is significant and that the ultimate recovery of this gravity drainage is rate sensitive.

From these conclusions, in order to optimize recoveries from the Mancos Pool, Meridian supports the application of BMG, et al, in the cases under consideration today.

This week we've heard more technical arguments about reservoir engineering than most of

us assimilate in four years of college. Obviously, two very capable and intelligent groups have defined this reservoir in completely different ways.

If in your mind you are still uncertain of how this reservoir performs, I'll disagree with Mr. Padilla and I'll paraphrase a position Amoco took in the August hearing, and that is, if you are to err, it must be on the side of conservation. This, in Meridian's opinion, would at least afford the opportunity for maximum oil recovery for the producers, the royalty owners, and the state of New Mexico.

Thank you.

MR. LEMAY: Thank you, Mr. Fraley.

Are there additional statements from people in the audience?

I don't see any hands. At this time, then, we'll begin our closing arguments. Do you plan to have one person on each side close or are you going to have two over there and two over here?

Okay. Mr. Pearce.

MR. PEARCE: May it please the Commission, it is now my privilege and, I suppose, responsibility to make a closing argument on behalf of Mallon, Mobil Producing Texas and New Mexico, Inc., and Amoco, although

Amoco has chosen to reserve the right to make a separate statement at the close of arguments, if they decide that's appropriate.

Each of these companies owns an interest in the Gavilan Mancos Pool. Each of these companies has invested heavily in the Gavilan Mancos Oil Pool and the point of these investments has been to most efficiently produce without waste the parties' just and equitable share of oil or gas or both within that pool.

As I hope is obvious, these companies are engaged in the business of producing and selling oil and gas. These companies are not in the business of wasting their asset base. They are not in the business of damaging that asset base, represented by the property interests, nor are they in the business of investing more capital to utilize that asset base than is necessary.

Conversely, they are also not in the business of delaying or reducing return on their investment if that's not necessary to protect that asset base.

The whole basis of this dispute is threefold. I believe it is will the producing reservoir under statewide allowables and spacing lead to a loss of recoverable reserves, and I believe we've demonstrated to you the answer to that question is no.

Is there an economical way to

increase recovery from the reservoir at this time? I think the answer to that question is no.

And will statewide allowables and spacing cause an inequity in correlative rights between the interest owners in the Gavilan Mancos Pool and the interest owners in the West Puerto Chiquito Pool? I suggest to you that it's been demonstrated to you that the answer to that question is no.

In order to make the decisions necessary, these parties who compete with each other in the business world have cooperated in an extensive reservoir analysis. This study has involved geological data, well performance data, reservoir modeling results, and economic data. The results of that analysis, the analysis has been presented to you by Mr. Emmendorfer, Mr. Faulhaber, and Mr. Hueni.

Because the operators who I'm speaking for have such a large commitment at risk in this proceeding, I've been asked to highlight some of the more significant items of evidence in this record.

Now let's look at that evidence for just a few minutes.

We began our presentation with Mr. Emmendorfer. He presented a structure map. That may be the only structure map you've seen in this case which is on

a consistent scale throughout.

And let's look at it for a minute.

The West Puerto Chiquito Pool, the contour lines show you how steeply that pool slopes. It shows you that that pool flattens and the evidence in this case has shown you that the West Puerto Chiquito Pool can best be characterized by an anticline with good wells at the bottom and wells below those that are not as good, and we cross the boundary line and everything goes haywire because the symmetry that you have achieved in the West Puerto Chiquito disappears. There are good wells in the Gavilan. There are bad wells in the Gavilan, and it is not possible to operate that pool with the sort of low capital intense symmetry that is apparently achieved in the West Puerto Chiquito.

The operators who I represent wish that was possible because as I said to you, they're not in the business of investing money that they don't have to to make a return, and if they thought that the Gavilan Pool could be produced at one well on 6000 acres and recover all those reserves, and give them their fair share of return, that's how they'd operate.

That can't be done. The evidence in this case has shown you that that pool, because of

the way it varies all over the map, has got to be developed on 320's, and that 320 development is the only way to protect the varying interests of all those parties.

We've presented the second derivative map by Mr. Emmendorfer. That map is a clear indication of the variability of one of the mechanisms at work underground that makes that reservoir productive. It turns red and it turned green and it turned dark green, and it turned dark red, and it turned no color at all. That's what the Gavilan does and if you recall what that second derivative map of the West Puerto Chiquito shows, it's got a solid band of red up here where that formation flexes and it's got gravity drainage, and those few wells down there at the bottom, and there are very few wells, can sit there and drain that reservoir. You just can't do that, you've got to (inaudible). My clients don't want to spend hundreds of thousands of dollars that it costs to (inaudible) in there, but they don't want to waste their asset either and they don't want to waste the resource. They don't want to leave it in the ground and walk away from it.

We had testimony from Mr. Faulhaber. Mr. Faulhaber had some televiewer logs which showed you the downhole fracture pattern in the area around the Gavilan Pool. Mr. Faulhaber had photographs of core samples out of the Gavilan Pool, and those photographs show a dual

porosity or permeability system which would accept fluid and it will give up fluid and it does give up fluid.

Finally, we presented Mr. Hueni who is retained by a very large group of operators and who's conducted the most extensive study of the Gavilan reservoir that we've seen.

Mr. Hueni was retained to find out how the Gavilan Pool should be operated to protect the interest of owners in that pool and he was asked to consider ultimate recovery, well density, production levels, GOR levels, and correlative rights.

In conducting his study Mr. Hueni reviewed all of the historical production and pressure data and completion data he could find. He then came up with a reservoir description which set forth the basic elements of that reservoir and these included a dual porosity permeability system containing a major fracture system and a second porosity permeability system.

Mr. Hueni's description sets forth a producing regime in which oil is released from this secondary system, is transported to the wellbore by the fracture system, and is produced, and Mr. Hueni based his description of this reservoir on log data and core data and production data and televiewer data and literature surveys and compressibility data and pressure build-up data and he

achieved a close match with the history of production in the Gavilan Pool.

He looked at everything he could find and he used the best scientific skills available to predict. The analysis was based on Gavilan Mancos Pool data. It was not, as Sun's model was, based upon data collected from another pool with another structure and entirely different producing characteristics.

After Mr. Hueni had described this particular reservoir as carefully as possible, he modeled the reservoir using parameters that most closely reflected the reality in the Gavilan Pool. He modeled the Gavilan with Gavilan characteristics.

Using these parameters Mr. Hueni's modeling showed that in the future the Gavilan Mancos Oil Pool should be allowed to produce at statewide 320-acre oil unit levels as the wells in the Gavilan Pool will produce if those rules are in effect.

Allowing these production levels will not reduce ultimate recovery. Allowing these production levels will allow the future injection for additional recovery after primary recovery has been completed.

Mr. Hueni has also shown that producing the Gavilan Pool in this manner will not affect the West Puerto Chiquito Mancos Pool.

This is shown by the failure of those two wells to communicate very much at all of a 450 pound pressure differential over twenty years. Twenty years the West Puerto Chiquito Pool was 450 pounds lower in pressure than the Gavilan. The Gavilan pressure reduction, if it was attributable to the West Puerto Chiquito pressure, the pressure drop in the Gavilan was only 70 pounds. I suggest to you that that is very poor communication.

The conclusion that producing the Gavilan Pool will not affect the West Puerto Chiquito Pool is also supported by Mr. Hueni's analysis of the initial pressure gradients just after lunch on the B-32 Well. Those wells came on at pressures which were Gavilan pressures, although they are held out to be producing in the West Puerto Chiquito Pool.

Mr. Hueni has shown that gas injection in the Gavilan Mancos Pool at this time will in fact actually cause waste. Now that's important because I had a little bit of an uncomfortable go-round in my cross examination of Mr. Greer. I was asking Mr. Greer some questions about statutory unitization and I was having a little trouble and finally, once Mr. Kellahin had risen and said that Mr. Greer had told me that he would attempt to statutorily unitize all of this area if it was all one pool, if he couldn't get everybody to agree with him, Mr. Greer

agreed that that's what he'd do. He indicated it would make him unhappy but he said that's what he was going to do.

Well, almost all of the West Puerto Chiquito Pool right now is in a pressure maintenance project and Mr. Hueni had shown you that if you pressurize the Gavilan Pool at this time you reduce ultimate recoveries. That is waste.

Generally the study and the evidence in this hearing lead to several conclusions.

First, the Gavilan Mancos Pool produces primarily from the A and B Zones and it is very weakly connected to the West Puerto Chiquito, in which the primary producing zone is the Niobrara C.

Second, the Gavilan Mancos Pool is a reservoir that has a two porosity or permeability system and you may recall that Dr. Lee this morning said certainly there's no question this is a dual porosity system. This system consists of a high flow capacity fracture system and a low flow capacity component composed of storage and production capacity from microfractures and intergranular spaces.

Thirdly, ultimate recovery in the Gavilan Mancos Oil Pool is not rate sensitive if statewide oil production rules for 320-acre spacing are applied to the Gavilan Mancos Oil Pool and Gavilan wells produce at

the rate at which they're able to produce if those wells are in place.

By that, Mr. Chairman, waste will not occur and by waste I refer to what the statute refers to. I mean that reservoir energy will not be inefficiently or excessively used or dissipated. The total quantity of ultimately recovered oil will not be reduced and in addition, it will not cause the drilling of unnecessary wells.

Fourth, Mr. Chairman, if the operators in the Gavilan Mancos Oil Pool are allowed to operate under historically adopted statewide rules for 320-acre oil spacing units, the West Puerto Chiquito Pool will not be adversely affected and the operators in that pool will be allowed the opportunity to produce their just and equitable share of the reserves underlying that pool.

Fifth, the best wells in the West Puerto Chiquito Pool, along the western boundary of that pool are in communication with wells in the Gavilan Mancos Pool and have Gavilan Mancos Pool pressures.

Sixth, Mr. Chairman, the Gavilan Mancos Oil Pool, it has been demonstrated, is a heterogeneous, very, very complex reservoir of widely varying characteristics as has been shown by the evidence in this case.

And seventh, 320-acre spacing will result in significantly higher recovery than will be attained from 640-acre spacing. You get more oil with two wells and that's why the people whom I represent are interested in drilling two wells, because they're assessing that resource base and they're assessing theirs asset, and they think that's necessary to protect that investment.

In conclusion, Mr. Chairman, the applicants in this case have the burden. They've taken it upon themselves of proving to you that the West Puerto Chiquito Pool and the Gavilan Pool are in fact one pool. In order to accomplish this they took West Puerto Chiquito data, they took data on the reservoir; they took data on the pressures; they took data on the fluids; and they applied those parameters to the Gavilan Pool and ran it through a model and they now tell you that since the model works, the Gavilan must be part of the West Puerto Chiquito.

I suggest to you that that is putting a real cart before an imaginary horse. They want you to assume that they are correct and then decide they are correct. They don't have data which applies to Gavilan. They've fed in lots of numbers from the West Puerto Chiquito, come up with solutions and said, see, I told you, it's all one pool.

That's not like what Mr. Hueni

did. He looked at the Gavilan Pool, and that's what we're talking about.

So far as I know, my client had no complaint about the way Mr. Greer operates his unit. They do have a complaint when Mr. Greer argues that if you apply the parameters from his unit to their reservoir, you have to conclude that it's all one pool. My client has serious trouble with that and I suggest to you that it really doesn't make sense.

Mr. Chairman, there are two distinct pools in this area. Allowing the Gavilan Mancos Oil Pool to produce at statewide 320-acre oil unit rules will prevent waste. It will protect correlative rights, and it will be in the best interest of all of the interest owners with property right in that pool and as the evidence has shown, it will not interfere with the Canada Ojitos.

We therefore ask the Commission to deny the applications filed by our opponents in this matter.

Thank you.

MR. LEMAY: Thank you, Mr. Pearce.

Mr. Lopez.

MR. LOPEZ: Thank you, Mr. Chairman, Members of the Commission. This is indeed an

historic occasion, mainly because in the seventeen years that I've been appearing before the Commission, and if I don't miss my bet, in the collective experience of all my fellow oil and gas counsel in the room, this is the first time we've had three fully participating commission members on any case that we've been involved in, and I think, and my hat's off to you, Mr. Humphries, the State Land Commissioner historically has not taken an interest in these hearings, I think that it's commendable that the three commissioners have stayed with us this week with their staffs and on behalf of the companies which I'm representing I want to express their sincere appreciation and thanks.

The companies I am speaking for are Mesa Grande, Mallon, Hooper, Kimball & Williams, Reading and Bates Petroleum Company, Kodiak Petroleum Company, and American Penn Energy, and on their behalf we would adopt Mr. Perry's closing remarks as our own; however, we would point out that in addition to the technical issues before the Commission here today, we are confronting serious business manipulation issues underlying these proceedings which we would characterize as a raw, naked confiscation of property through the abuse of the administrative process.

This story began about mid last year when the Oil Conservation Division requested a meeting of the operators because Mr. Greer had represented that an

emergency existed in the Gavilan area.

These meetings were held and Mr. Greer immediately set the tone for the discussions by emphatically indicating the need for unit operation.

While the Technical Committee meetings were in progress, Mr. McHugh and Mr. Greer filed an application to restrict allowables without receiving a consensus from the other operators and working interest owners except those obviously aligned in his camp.

We, and by that I mean those aligned on our side of the table viewed this blind-sided attack as no less than a blatant attempt to intimidate and again force unitization.

The initial hearings in these cases were held in August, the result of which was that production was restricted contrary to the advice of the best geologists and reservoir engineers that could be assembled from the wide array of companies again assembled on our side of the aisle.

Among this talented group of peers the weight of the evidence clearly favored our interpretation of the reservoir performance, principally because Mr. Greer's view, as usual, was myopic since it was limited to his Canada Ojito operation and so clearly self-serving.

Nevertheless the Commission was

apparently persuaded that an emergency existed. This emergency was intended to prevent the drilling of additional wells and to preserve reservoir pressures. It is indeed bitterly ironic that, with the exception of the three wells drilled in the West Lindrith Unit outside the southern boundary of the Gavilan Mancos Pool, the only wells, eight wells, that have been staked and drilled since the August hearing are those owned and operated by the proponents, Mr. McHugh, Mr. Dugan, and Benson-Montin-Greer.

It should also be observed that Mr. Greer's approximate 69,000-acre Canada Ojitos Unit has only produced 8.4-million barrels of oil since its first discovery in 1962 and that the A and B Zones within the western Puerto Chiquito Mancos Pool have not been developed by it.

Compare this with the Gavilan Mancos Pool discovered in 1982 and only developed in the last three years which has produced well over 3,000,000 barrels of oil, 35 percent of that produced by Mr. Greer in his 25-year period. It is not even necessary to comment regarding the comparable economics of the two operations and the resulting benefits to the State of New Mexico.

If we were to follow Mr. Greer's logic to its conclusion, it is obvious that the best way to conserve reserves is to essentially shut in the

reservoir.

After the entry of the temporary special order restricting allowables in the Gavilan Mancos Pool, an order, by the way, that neither side of the dispute requested, nobody wanted it, nobody even asked for it, McHugh having requested 200 barrels of oil per day with a 1000 GOR; Mobil arguing for no change at all in the statewide allowable; and for lack of a better term, as this chairman has characterized us, the Triple M team having requested 702 barrels of oil per day and a 500 GOR, proposing what we thought would be a reasonable compromise until these hearings this week could be held and knowing in August that we would again be before the Commission discussing spacing and other issues.

The Commission nevertheless entered the current order indicating that it thought it to be in the spirit of compromise; however, again, as has been typical of our experience, the resultant order had greater adverse effect on our companies and associated operators than that even requested by Mr. McHugh and Mr. Greer.

We can only speculate as to whether such administrative action was ignorant or deliberate. After the hearing an engineering subcommittee was formed at the request of Mr. Stamets to objectively analyze the reservoir. This committee became a format for Messrs.

McHugh, Dugan, and Greer to continue to press the unitization efforts. There was no willingness whatsoever to objectively study the reservoir data. Their minds were made up.

They did, however, propose to employ Mr. Hueni as an expert to analyze the reservoir information thereby indicating a high degree of confidence in his abilities but only on the condition that he would be barred as a result from testifying in these hearings today.

The committee was dissolved in November because it became increasingly clear that it provided no more than a forum for the opposition to continue their intimidation and coercion. Mallon was first to withdraw out of sheer frustration and I would refer to the Commission to the minutes of the committee meetings and to the extent of interchange of correspondence between the parties in order to obtain the flavor of the meetings.

When Mr. Greer could not force a voluntary unit, he then made application to combine the two pools with one set of rules. On the surface this may look innocent enough but again, as Mr. Pearce explained, it's a simple business maneuver whereby combining the two pools would then give Mr. Greer sufficient votes for a statutory unitization, which again indicates what this hearing is all about.

It is also important for the

Commission to know that during the course of these past months Mr. McHugh and Mr. Greer have been negotiating to sell some if not all their production to Sun Oil Company and that such sales have or are about to transpire.

We also understand from reliable sources that Mr. Dugan is negotiating to sell his interest is Sun, as well.

It should also be noted that Sun has offered to buy other interest in the reservoir. In point of fact, Sun made an offer to buy George Mallon's interest at very significantly reduced prices based on the restrictive production rates now in effect, restricted to operate -- put into operation at the instigation of, again, Messrs McHugh, Dugan, and Greer.

MR. KELLAHIN: Mr. Chairman, it is with great reluctance that I interrupt counsel. I've never done it before but I will do it now.

Closing arguments are to be confined to the evidence and to fair comments on the evidence before you. This is far beyond anything that's before you. If he wants to bring in these kind of matters, we'll see him in District Court, but there's not before you here and it's inappropriate and totally unfair.

MR. LOPEZ: Mr. Chairman, I think this is the appropriate forum for the parties repre-

sented on our side of the table to put before you the problems that we feel deeply in our heart are underlying the course of these proceedings.

This is closing argument. We have a sophisticated Commission. The Commission can give these comments as much weight as it deems necessary. The Commission further can go through its own regulatory procedures to examine the weight or the truth of these allegations. Mr. Carr and Mr. Kellahin will have an opportunity to respond and if it were of any benefit, I would be glad to be put under oath so long as that was the condition of Mr. Kellahin's remarks, as well.

And I don't appreciate being interrupted.

MR. LEMAY: Mr. Lopez, I think it's been Commission policy to allow quite a bit in hearings; however, if you want to -- what you say to have weight with Commission, we aren't investigating some of the issues you're bringing up, so you're welcome to bring them up but I just -- I caution you that these aren't the issues at hand, so they won't have any impact on us.

If you can deal with what we heard testimony on, and I think your comments will be -- carry more weight.

MR. LOPEZ: I'm just to con-

clude, Mr. Chairman. I will take up no further time.

As I mentioned in my opening remarks, there exists a sharp difference of opinion as to what the reservoir mechanics are in the Gavilan Mancos Pool and the West Puerto Chiquito Mancos Pool.

We are again quite confident, as we were last August, that our interpretation of how the reservoir should be developed for the reasons summarized by Mr. Pearce in his closing remarks as the most reasonable and most correct.

We are also convinced that there exists sinister business motivation to essentially confiscate our property that forms the basis for the opposition's unpersuasive but elaborately concocted story.

Thank you.

MR. LEMAY: Thank you, Mr. Lopez.

Mr. Carr.

MR. CARR: May it please the Commission, for the last five days you've been subjected to extensive, perhaps exhaustive, information on the character of the Mancos formation underlying the Gavilan Mancos Pool and the West Puerto Chiquito Mancos Pool in the San Juan Basin.

We're here today because per-

haps as evidenced by the tone of Mr. Lopez' comments, agreement between the individual operators in this pool is virtually impossible.

So we're here asking for your assistance.

We've come before you, Greer, Dugan, McHugh, and Sun, asking for an order from the Commission that will treat what we believe clearly is one, single reservoir, as the one pool that it is.

We're asking you to promulgate rules which will limit producing rates from the pool, rates which we now consider to be excessive, and thereby increasing the ultimate recovery of the oil from that pool.

Nothing in what we have proposed will preclude any operator in the pool from developing on 320 acres. That is an option within our proposal. Any comments that have been directed to that in closing argument by our opponents are simply reflective of a misunderstanding of what we are seeking here today.

We submit that what we propose makes sense. We submit what we request is consistent with the evidence presented in this case, and I would note that Mr. Greer at the conclusion of his direct case requested that any order resulting from this hearing carry an effective date of March 1, 1987.

As I told you at the beginning of the case, this is an engineering case and we have basically two proposals or cases before you.

The first one is that presented by Mr. Greer, Mr. Lee, and Mr. Dillon; the other is that of Mr. Hueni.

Mr. Greer, although obviously vilified by some of the people here, is a man who has spent much of his working life studying and developing this reservoir. The data that he has presented, I submit to you, is accurate. It's accurate for one particular reason. It wasn't developed for the purposes of a hearing before the Oil Conservation Commission. He has worked over twenty-five years; he has developed the information, and the benchmark against which his decisions have been measured and tested over the years has been actual field experience. He's the one witness who can stand before you in that position, and I submit that for twenty-five years his work in this area has been tested and proven to be right.

Mr. Lee also has appeared before you on our behalf. We were delighted when he agreed to join our effort, not only because of his obvious credentials, his experience, his skill, but also because of his integrity. We submit he's one of the premier experts in the field of petroleum engineering. He reviewed the work of Mr.

Greer, Mr. Hueni, and Mr. Dillon, and today he has confirmed Mr. Greer's work, that of Mr. Dillon, and he has raised some questions about the work product presented to you by Mr. Hueni.

Mr. Lee showed you the matrix is not capable of contributing much or any production in this reservoir and simply because it cannot flow. He did say -- state there was dual porosity system but he stated the matrix could not contribute. It cannot flow. He pointed out this was because of a capillary or capillary retention forces in the reservoir.

This afternoon Mr. Hueni for Mallon, Mesa Grande, and Mobil responded and the way they responded was they had someone at Mobil write themselves a letter and say this isn't true. That's a response but the fact is and it stands that because of capillary retention forces the matrix cannot and does not contribute.

Now Mr. Hueni is a petroleum engineer who was retained last fall to attack Mr. Greer's conclusions. We submit that anyone with Mr. Hueni's training can take the model and match actual reservoir performance if he adjusts the parameters long enough, and we submit that's what has been done here, and although his work ahs been held out as complying or being consistent with Gavilan characteristics, we submit that's really not true.

He's arbitrarily increased permeability, for example, and he has not taken into account reservoir dip (not understood) and what he did was he made the shoe fit. Perhaps that's why it took 80 to 100 runs to get a fit, but we submit what he did is what anyone with his credentials could do.

Dr. Lee looked at the model and he concluded that it simply does not properly monitor the mechanics of the Gavilan reservoir.

Now I'm not going to review with you the evidence in the detail that Mr. Pearce reviewed it, but I would like to summarize what we believe the evidence shows because I think it clearly establishes that we have met our burden of proof.

First of all, we're not talking about two pools that happen to be side by side. We're talking about one common source of supply, one reservoir. We submit that the evidence establishes or fails to establish any horizontal boundary or barrier running through this reservoir. Where everyone has postulated the existence of a permeability barrier, that falls squarely -- squarely within the interference data Mr. Greer presented.

We submit that there is communication in the A and B Zones. The last exhibit presented today by Mr. Hueni, I don't have the number, it was his Gavilan Mancos Material Balance Oil in Place information, and

on this exhibit he has pointed -- plotted two dots that are indicative of production from the B-29 and the B-32 Wells in the West Puerto Chiquito Pool in the Canada Ojitos Unit, and he noted that it was because of production from these -- that production from these two wells in the West Puerto Chiquito Pool was restrictive flow from West Puerto Chiquito to Gavilan. We submit to you that is clear evidence that there is communication in the A and B Zones.

As to the C Zone, I think it's important to examine the evidence presented, actual test data on production from the Unit well, Canada Ojitos Unit Well F No. 30, and this well is located squarely within the tier of sections that our opponents are proposing be carved out of West Puerto Chiquito and added to Gavilan, and the test data on this well shows that this well is producing 300 barrels a day from the C Zone.

Now, if you put that in the context of their case, their case is the unit, the West Puerto Chiquito produces from the C, Gavilan from the A and B, and yet for some reason they want to carve out a tier of sections and put a well that's producing 300 barrels a day from the C over in Gavilan, that produces from the A and B.

It makes no sense. We can show you with the data from that well that in this tier of sections they would like to move to the Gavilan, that there are

substantial volumes of oil being produced from the C Zone.

If you go over to Mr. Mallon's Fisher Federal Well, you will see that that well, and it has been tested again and that is in the -- the test results are in the record, produced 50 barrels a day from the C Zone. This is one-third of the average production for a Gavilan well. We submit that there's production from the C Zone throughout the area we're talking about, and that this is one reservoir, it is one common source of supply, and it should be produced as one pool.

We see no reason to impose an artificial boundary across it where the boundary exists today or where Mr. Pearce and Mr. Lopez are proposing that the boundary be located. If you look at just the wells on either side of the new proposed boundary, you can clearly see from the interference data, that there is drainage and interference across their proposed boundary and across the existing boundary.

We submit we have one pool which should be produced under one set of rules.

Now we've talked about Mr. Emmendorfer's cross section. We've been patting ourselves on the back because of the scale but remember, we're talking about a formation maybe 300 feet thick and it extends maybe twelve miles across the reservoir, and even though this

shows a dramatic dip in the formation, if you think about the cross sections that were provided by Mr. Ellis, they more correctly depict the actual reservoir as it is spread out across the San Juan Basin.

But we do have dip in the reservoir and even Mr. Emmendorfer's figures indicated that in the Gavilan area, when he took the crest of the dome, which is the flattest area, he took the bottom of the trough between the two, which is the other flattest area in the pool, and he added those and he averaged them somehow that you still had a dip in that reservoir of an average of 55 feet per mile. That is more than the base case that we use showing you how gravity drainage could and would work.

We submit to you what we have shown, Mr. Greer's experience and kinds of results he's obtained in the pool demonstrate to you gravity drainage can work and does work, but as Mr. Lee testified, we have a rate sensitive reservoir and if we withdraw oil from this pool at an excessive rate, the benefits of gravity drainage will be lost; they will be lost once and for all.

We have a stratified reservoir. When we were before the Commission in August the question was whether or not we had any stratification. Today there seems to be no question about the stratification between the C on the one hand, and the A and the B on the other. There

are very definite reasons to believe that the interval between the A and B is plastic and it is effectively sealing off those two individual stringers so that even in the A and B alone gravity drainage can work.

We're here because we're concerned about soaring gas/oil ratios; about pressure drops; and about trying to do something about it to stop it, and we're asking you for reasonable production limits.

If adopted, we submit -- our proposal if adopted we submit we'll benefit, not Mr. Greer, Mr. Greer on one hand is cast as trying to take over the area and on the other being a sales -- trying to sell his interest to Sun. It's not here to benefit Mr. Greer, but will benefit every interest owner in the pool, every royalty interest owner, including the State of New Mexico's interest, will be increased if more oil is ultimately produced from the reservoir, and detailed economic calculations were presented on this very point at the end of the hearing last August. Those are in your record and if you decide you may take administrative of those.

I hadn't intended to comment on sinister business motives and things of that nature, but I think a couple of points in that regard need to be addressed.

We could speculate about what

Phelps Dodge role is coming into the hearing today, or what Mr. Mallon's plans are. Perhaps Phelps Dodge is a common purchaser in that area and perhaps if allowables are increased they will take more from certain wells and perhaps the pricing problems will be aggravated.

But the problem we have with this is you're here, you're an agency that's created by statute. Your powers are expressly defined and limited by the Oil and Gas Act, and you are not directed to protect business decisions but correlative rights. You're direct to protect correlative rights and prevent waste. And when you depart from that and when you start trying to do something to protect someone's business decision, instead of focusing on the conservation issues, when you help one person you harm another, and when you do that, you create uncertainty and the one thing that will kill investment in New Mexico is uncertainty and an unpredictable regulatory climate in which to base your decisions on where you're going to invest your money.

We submit that those are false issues. Economics is a false issue and who has invested in the area is a false issue. The only way that you can do anything for the business community is to follow your statutory directive and base your decisions on waste prevention and the protection of correlative rights.

I told you at the begining of the week that I did not think it would be that difficult a case to decide. I submit we have met our burden of proof and we are entitled to an order granting our application.

But I think it is also important to recognize that if you rule for the Three M's, they will get their big bang for the buck that Mr. Lopez talked about when he opened on Monday.

If you rule for them and they are wrong we're in the situation that Dr. Lee described as Humpty Dumpty falling off the wall. You will never have an opportunity as new development -- as new information develops and one model is seen to be preferable to another, you will never have an opportunity to take the action that you can take now to assure that the recovery from this pool is maximized, so if you rule for them, and they are wrong, we submit there will be reservoir damage; there will be reduced recovery of oil, which is underground waste; there will be excessive drilling perhaps, which would be surface waste; and correlative rights will be impaired. As that term is defined, correlative rights means affording to each interest owner in a pool the opportunity to produce without waste his just and fair share of the reserves, and if you grant their application and they are wrong, we submit you are authorizing waste.

If you hold for us, and we are right, I am convinced that you will have met your statutory directive; you will have protected correlative rights, and will have prevented waste.

If, on the other hand, according to Mr. Hueni's calculations of ultimate recovery and according to ours, if you rule for us and we are wrong, they may not get their big bang for the buck right now, but they will get that oil and in time they will get their return on their investment.

You have an opportunity to grant the application of Benson-Montin-Greer and others, to assure that this pool is operated in accordance with sound conservation principals.

We submit we have met our burden of proof, we're entitled to an order, and if you grant our application you will carry out your statutory duties to prevent waste and protect correlative rights.

MR. LEMAY: Thank you, Mr. Carr.

Mr. Kellahin.

MR. KELLAHIN: Gentlemen, as you can see, there's chaos in the barnyard. This barnyard started off twenty-five years ago and there was only the golden goose and Mr. Al Greer.

I started practicing before the Commission some sixteen years ago this week. It's with some reservation that I commenced on April Fool's Day back in 1972 and we have been through that day this week and perhaps we are continuing with some of that, but we need your help. the barnyard's in trouble and everybody's fighting over the golden goose.

When the barnyard started Mr. Greer was there to watch and take care of the golden goose and it was laying eggs in an orderly and meaningful fashion. I've known Mr. Greer for a large number of years. I have great respect and admiration for his ability, for his integrity, and I hope he won't mind if I charactize him as the wise old owl in the barnyard, because I truly believe that he meets that characterization.

As more critters came into the barnyard the owl kept telling them not to kill the golden goose and he has effectively protected that Mancos reservoir for twenty-five years until last year when the squabble over the goose became so intense that we are ready to shoot the goose.

We're going to turn this goose into a turkey that we will never recover from, Mr. Chairman.

We've characterized this case as a matter of style. We have some of that in this case.

The opposition has played some games with this case and there's been some gamesmanship going on. We've played hide the ball, spin the wheel and find the theory, but this is not a game and this is not a little barnyard. This is a very serious problem.

We have royalty owners coming forth saying we didn't know about this case. The Edwards had to change counsel. They had the Hinkle firm representing them for two years in District Court litigation against my client over the prior order, and attached to their Complaint is the order that's in question now. They were here earlier this week. I submit to you that Mr. Jordan, Mr. Padilla, and Mr. Gentry are farther apart from (not clearly understood) in studying their legal theories on that notice case than Mr. Greer and Mr. Hueni are on their analysis of this reservoir.

I am comfortable and confident that the notice requirements of this Commission have been properly met. For instance, let's understand the role of a royalty owner before a conservation commission in a spacing case. There are no cases in New Mexico on that point. Your notice rules are properly written. The notice requirements are that the working interest owners and the operators determine what is the appropriate spacing and special rules for a reservoir. Why do they do that? Because the royalty

owners contracted with the working interest owners and gave the lessees and the operators that obligation. Royalty owners have the right to the income; they assigned the operating rights to the Mallons, the Greers, and the McHughs and the Dugans of the world, and we are here representing their interests.

You see their position. They want more wells. They want their income now. As Mr. Carr said, there are a lot of issues in this case that are not important issues. The fundamental concept that you need to apply to this case is the one Mr. Pearce quoted to you out of the statute concerning waste. What action can you take that will conserve this irreplaceable resource to maximize the benefits for everyone.

The prior commission recognized that. They said, and they heard most of this same stuff, Mr. Hueni's book from the last hearing is around here somewhere, and it almost weighs the same. Mr. Hueni came forward last August and told us, gentlemen, I have studied the reservoir, it is rate sensitive.

He tells us today it's not. He's the only engineer we have heard all week that has told us it's not rate sensitive.

If it is not rate sensitive and you can produce the reservoir at the maximum allowable,

then we ought to do that, but what if Mr. Hueni is wrong? You can't undrill unnecessary wells and you can't put the reservoir energy back in this reservoir.

What if you reduce the rates as we requested, and were wrong? Have you made an irrevocable decision that you cannot change? Certainly not. The very last questions asked Dr. Lee, if the reservoir rates are reduced now and that decision turns out to be wrong, you can increase those rates later after we have the factual data upon which the experts can then agree, and you can increase the rates if that proves correct. You've not wasted the reservoir energy. If it's not rate sensitive, then it doesn't matter how long it takes you to get it out of the ground. You can increase the rates later and still get the same ultimate recovery.

What is you make a mistake and keep the rates high and Mr. Hueni is wrong? You can't fix it. It's Dr. Lee's example of Humpty Dumpty falling off the wall. You just can't put Humpty Dumpty back together again.

You certainly don't have to understand a lot about geology, I certainly don't, but in understanding and hearing the testimony of the geologists, I deduced one key exhibit. That was Mr. Ellis' exhibit where he took and scaled both vertically and horizontally the structure map across, perpendicular to the nose of the Gavi-

lan from east to west. I defy you to find that dip.

It's like Commissioner Humphries phrases earlier in the hearing, it's like a blanket with a small roll in it. This is not a geologic case.

The A Zone, the B Zone, and the C Zone are geologically continuous. This is one reservoir when we look at it from a geological perspective.

This is an engineering case. What do the engineers tell us?

Mr. Greer tells us that the A and the B Zone and the C Zone are stratified. Mr. Greer ought to know; he named those zones. He developed this reservoir and his theories have been tested. His theories haven't changed. For years he's been telling us about this reservoir. In August he put on a detailed presentation, subject to test at that hearing. The prior commission adopted those positions. It's been under test and study for the last seven months. His theories are the same. He continues to be correct on this order.

Mr. Greer has said that -- in past hearings, that there was a hope, a belief, that there was a permeability barrier between the two areas. Later it was characterized as permeability restriction. His hope was that all the work and effort he had put forth in the Gavilan Mancos area, particularly in the West Puerto Chiquito Unit,

would not be undermined by the unruled competition going on in the Gavilan area, or his work would be deleted, depleted, and undermined.

I'm sure he wakes up at night worrying about how much of the oil that he's tried to save is now going to be produced out of the Gavilan. That barrier leaks, gentlemen. Just sure as you put a pipeline on the surface between the wells in the interference test and tried to pump oil on the surface between the wells, it communicates on pressure pulses and interference tests just as quickly. That's the kind of fracture communication you have in this reservoir and it's unusual. It's unique.

We ask you that you help us save it.

Mr. Lopez makes much of some kind of manipulative scheme to have unitization but I will ask you to ask any engineer that testified before you today, ask your own engineers, ask any engineer on the street, what is the ultimate objective in a reservoir in terms of its operation, and that is to take the reservoir and operate it as a single unit. That's accomplished normally by voluntary agreement and sometimes by statutory action.

But it's no surprise to any party here that the ultimate objective would be to operate it as a single functioning unit. There's nothing inappro-

priate about that.

The parties being unable to agree on how to operate the pool gave rise to the last hearing and I believe it was the hope of the last commission that by reducing the rates it would bring the parties together to work and give you a consensus on a reservoir study. It did not occur. We, however, independently went out and conducted for you a reservoir study. That study has been presented to you in detail.

We would request of you that in your deliberations, that you review certain of the engineering documents. Mr. Greer has fully annotated his exhibits and certainly none of us have had an opportunity to look through those and refresh our recollection of them. We expect you to do so.

We think it would be important to re-read Mr. Hueni's summaries as well as finally looking at Dr. Lee's comments upon Mr. Hueni's work.

I think it comes down to the final choice, you will agree with me that perhaps in my own simple way in understanding this reservoir, and in a matter that is so complex and unusual as this case, the only error that can be made is one in which you have an opportunity to fix it later, and in this case the only position and where you have a chance to correct that change and not adversely

affect ultimate recovery, is to adopt a decision for the proponents.

Thank you for the opportunity to appear before you.

MR. LEMAY: Thank you, Mr. Kellahin.

At this time are there any additional statements from the audience?

Yes, sir.

MR. BUETTNER: Mr. Chairman, no more than three minutes.

Mr. Chairman, Members of the Comission, Ladies and Gentlemen.

My name is Robert Buettner. I am General Counsel and Secretary of Koch Exploration Company. Koch Exploration Company is a wholly owned subsidiary of Koch Industries, Incorporated, which is headquartered in Wichita, Kansas.

Koch Industries is the largest privately owned oil company in the United States. If publicly owned we would rank between 15 and 18 on the Fortune 500 with revenues in the range of $17,000,000,000 annually.

Koch Exploration thus has available to it huge capital resources. Since 1981 we have invested those resources in the Beaufort Sea off shore Cali-

fornia, the Gulf Coast, and the Willison Basin. We have not invested them in New Mexico.

Unfortunately that has been no accident. Mr. Carr has alluded to the regulatory inconsistency, which in his words, will kill investment in New Mexico. Koch was forced to adopt what has essentially been a company policy that regulatory bias in New Mexico against out-of-state investors has made investment in exploration in New Mexico unacceptably risky.

That policy resulted from a series of regulatory actions instigated by Mr. Greer since 1980 but which Koch was prevented from drilling acreage which it bought at competitive sales in the West Puerto Chiquito Gavilan boundary area. Koch was thus forced to yield all but about three percent of its interest in orde to protect Mr. Greer's pressure maintenance unit.

It is significant that Koch's acreage, which was only about 3000 acres, has since then yielded the wells that I've marked in yellow on the maximum oil rate map with the green circles on it on the -- on the far wall.

As you can see, as I can see, even, from across the room if I look closely, the best wells in the Gavilan and West Puerto Chiquito area are among those four wells that -- that I've marked on Koch acreage, and in

addition there is a fifth well on Koch acreage which Mr. Carr yesterday identified as the best well in the State of New Mexico.

Several of those wells were drilled by Mallon on farmout since Koch had essentially, as we said, pulled out of investing in New Mexico.

In other words, gentlemen, we had the fresh, correct, geologic ideas. We made the investments and we were ready to take the risk, and New Mexico gave it all to Al Greer.

This afternoon's disclosure that the acreage which was denied to us to protect the C Zone injection project, produces from the unconnected A and B Zones, is particularly ironic but typical of our bitter experience in New Mexico. Today we observed that Mallon has suffered the same penalty for coming to New Mexico, taking risks, and creating wealth.

Koch believes that past regulatory action resulted from a well motivated but disproportionate reliance on improbable claims of increased recovery and unfounded alarms about waste. Frankly, others have assumed that the action was more darkly motivated; however, that, I think, is enough about the mistakes of the past as Koch perceives them.

My purpose here is to urge this

new commission to be open to new ideas, to encourage explorers, and to recognize that the future of New Mexico's oil and gas industry lies in encouraging enterprise and energy, not in chasing away investment by confiscating and redistributing the fruits of hard and imaginative work.

We urge you to recognize that statewide rule changes and megapools must be proved necessary by their advocates. It should no longer be enough to simply claim that Mr. Hueni may be wrong or if Al Greer happens to be right. The burden to prove the need for these changes is on those who seek them.

To honor the paramount duty to prevent waste does not require you to honor quick sketch criticism or to swallow incredible plan just because they're made. You can better assure the harvest of the resources of the State of New Mexico by encouraging someone to come in and do the work and to recognize work which is of depth and quality.

If you affirm the statewide rules and geologically based pool boundaries which Mallon, Mobil, and others relied on in making their investments, you encourage them that the playing field in New Mexico is level. The result will be an improved investment climate in New Mexico as well as the best development for the Gavilan Mancos area.

That's my -- that concludes my statement except I would like to say that I have this kind of a job and I sit in on these kinds of things around the country, and I have for years, and having sat through all of this, I'll say one thing. Greg Hueni can engineer my oilfield any time.

Thank you.

MR. LEMAY: Thank you, Mr. Buettner.

Additional coments?

MR. WOOD: Yes, sir, if I may.

Mr. Chairman, Members of the Commission, thank you.

My name is Alan Wood. I'm the Proration Unitization Manager for Amoco Production Company, Denver Region.

Amoco's statement of position was reflected quite adequately by Mr. Pearce. I would, however, like to add some additional comments.

The initial hearing in this matter was in August of 1986. Following extensive testimony the Commission issued an order which restricted production in the Gavilan Mancos Pool to a level which would protect the reservoir from potential damage until additional reservoir tests and technical studies could be accomplished.

Amoco participated in that hearing and in fact made a recomendation that you err on the side of the prevention of waste.

What we need to do is to reflect on what has happened since that August hearing. The operators have responded by undertaking joint and separate reservoir testing and evaluation, a process which has cost thousands of dollars and has involved hundreds of manhours.

Amoco Production Company as an operator in the field has participated in this technical effort. Unfortunately, as indicated in the last four days, the various operators have not been able to reconcile their technical differences.

In our letter of March 20th, 1987, we stated our position on the substantive issues which are now before you. For the sake of brevity I do not wish to reiterate the contents of that letter but would request it be made part of the record.

These positions reflected our technical opinions on the Gavilan Mancos Pool at that time.

With regard to Case Number 4946 and 4950, our letter of March 20th, 1987, stated that as of that date the available data was inconclusive as to whether the reservoir is rate sensitive and as to whether there is secondary potential.

Subsequent to that letter we have had the opportunity to review the completed Bergeson and Associates report, as well as listening to the testimony presented during this hearing.

It is our opinion that the Gavilan Mancos Pool is not rate sensitive at the rates which are achievable under the application of the 320-acre statewide allowable, nor at this time is there any immediate need to implement secondary recovery operations.

It is therefore our position that the production restrictions be vacated and the field be returned to primary operations.

Unfortunately, we may never know the correct answer for the Gavilan Mancos Pool. I would point out a statement that Dr. Lee made, that in order to fully understand this reservoir a field-wide reservoir stimulation would have to be developed -- excuse me, simulation, a project that would be prohibitively expensive.

Thank you.

MR. LEMAY: Thank you, Mr. Wood.

Any additional comments or statements?

Well, I think my fellow -- Mr. Kellahin.

MR. KELLAHIN: May parties participating have an opportunity to submit proposed orders to the Commission?

MR. LEMAY: We talked about that. I think the testimony that we've heard is going to take some time to look at and to go through. I think we have some competent staff and ourselves are competent enough to produce the findings and the orders and we will do that on the basis of the record.

I know it's been a policy in the past at times that counsel was requested to submit proposed orders. At this particular hearing we're not requesting it.

I just want to say I think my fellow Commissioners share my view that we've heard very professional testimony over the last five days from all parties involved. The issues aren't simple and it's going to take some time to review them and come up with some conclusions.

We hope to do this in a thirty day timeframe. I can say that during this period of time the staffs of the Land Department and Energy and Minerals, who have been here throughout the hearing, will be working on what Mr. Kellahin referred to as draft orders, draft findings, mainly. These findings will come from various

sources and reflect various viewpoints of uninterested parties. We plan to look at this and the record and after quite a bit of deliberation come up with an order for these fields.

I want to thank everyone that's been involved in the hearing and if there's nothing -- Mr. Carr.

MR. CARR: May it please the Commission, at this time I'd request that the next two cases on the docket be continued and readvertised and scheduled at a later date. They're applications for Benson-Montin-Greer, and we would request that they be rescheduled following the entry of an order in this matter.

MR. LEMAY: Thank you. Is there any objection to that request?

If none, then that request is noted and it will be followed.

At this point I'll see if there is anything else my fellow Commissioners would like to say in regard to the last five days.

Well, we've enjoyed it. Thank you. This case 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 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 this portion of the hearing, prepared by me to the best of my ability.

Sally W. Boyd CSR