BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

December 19, 1957

TRANSCRIPT OF HEARING

Case 1308

I N D E X

INDEX

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IN THE MATTER OF: (Rehearing) In the matter of the rehearing requested by Sunray Mid-Continent Oil Company, et al, for reconsideration by the Commission of certain portions of the application in Case 1308 for the temporary establishment of uniform 80-acre well spacing and promulgating Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.	Case 1308

BEFORE:

Mr. Murray Morgan
Mr. A. L. Porter

TRANSCRIPT OF HEARING

MR. PORTER: The meeting will come to order, please. The Commission will consider this morning Case 1308.

MR. COOLEY: Case 1308. (Rehearing.) In the matter of the rehearing requested by Sunray Mid-Continent Oil Company, et al, for reconsideration by the Commission of certain portions of the application in Case 1308 for the temporary establishment of uniform 80-acre well spacing and promulgating Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.

With your permission, Mr. Commissioner, I would like to outline the conditions under which this hearing will be heard.

MR. PORTER: You may proceed.

MR. COOLEY: In Order 1069-A wherein this rehearing was granted, it was ordered, one, that the above-styled cause be reopened and a rehearing be held at nine o'clock A. M. on December 18, 1957, Mabry Hall, Santa Fe, New Mexico, at which time and place all interested parties may appear. That order goes on to say, "It is further ordered that testimony on rehearing shall be limited to, one, new evidence on the issues raised in the petition for rehearing." It is the intention of the Commission to strictly enforce the provisions of this order in this hearing today. With that understanding, you may proceed unless there is some misunderstanding.

MR. PORTER: Any questions of Mr. Cooley's statement? Mr. Errebo.

MR. ERREBO: If it please the Commission, Burns Errebo from Tulsa appearing for Sunray Mid-Continent Oil Company, in addition L. C. White for Sunray Mid-Continent from Santa Fe, and Mr. Jack Campbell, Campbell and Russell of Roswell. We will have two witnesses.

(Witnesses sworn.)

MR. ERREBO: The first witness I would like to call, Mr. L. J. Finfrock.

L. J. FINFROCK

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. ERREBO:

Q You are Mr. L. J. Finfrock?

A That is correct.

Q And you are located in Tulsa, Oklahoma as a staff geologist for the Sunray Mid-Continent Oil Company?

A I am.

Q You testified as a geologist in the previous hearing in this matter, is that correct? A That is correct.

Q Mr. Finfrock, since the original hearing in this matter in September, have you made or caused to be made additional studies of this area, and as a result do you know of additional information concerning this reservoir and its adaptability to the spacing which Sunray has requested? A Yes, I have.

Q Will you please refer to an aerial map which has been placed on the board and marked Sunray Exhibit 1-R and identify and explain it?

MR. ERREBO: Incidently, at this point I would like to explain that our exhibits have been identified by the letter R after the number to indicate rehearing exhibits.

(Marked Sunray's Exhibit 1-R, for identification.)

A Exhibit 1-R is an aerial map of the Bisti-Lower Gallup Oil Pool situated in portions of Township 23, 24, 25 and 26 North, Ranges 10, 11, 12 and 13 West, in the San Juan County, New Mexico. As can be seen from this exhibit, we have brought it up-to-date as near as possible at the time we left for this hearing. There have been several wells drilled within the area of the Bisti-Lower Gallup Pool since the last hearing. These wells have been posted and added to this field.

You can also see that the boundary indicated in red which we outline as our proposed area for 80 acre spacing has been reduced in area, and this boundary reflects the orders of this Commission outlining the Bisti-Lower Gallup Oil Pool.

We have shown here that the green line, the traces of the micro-log cross sections which will follow as additional exhibits in this rehearing, and these are as follows, A A_1, from the British American No. 1 Marye in Section 1 of 25 North, 13 West, to the Shell 3220 in Section 20, 25 North, 11 West. Section B B_1 starts with the Shell 3220, continues in a southeasterly direction to the Monsanto No. 1 Blanch located in Section 34 of 25 North, Range 10 West.

Microlog section C C_1 through the pilot area extends from the BA No. 5 Marye in Section 1 of 25 North, 13 West in a north-easterly direction, terminating with the Sunray C-7 Federal in Section 31, 26 North, 12 West.

The fourth and final microlog, D D_1 starts, a north-south section, starts with the Shell No. 5 Carson in Section 27, 25 North, 11 West, terminates with the Sunray Mid-Continent No. 1 Platero in Section 15 of 25 North, 11 West.

Q Then as I understand your answer, Mr. Finfrock, the area which Sunray now proposes to space in this application has been reduced since the original hearing in this matter and is now confined to that area which has been heretofore recognized by this Commission as being a part of the Bisti-Lower Gallup Oil Pool, and certain one other 160 acre tracts upon which there have been drilled and completed certain oil wells, is that correct?

A That is correct.

Q Now, Mr. Finfrock, since the original hearing have you obtained micrologs of wells in this field which were not available to you at the time of the original hearing?

A I have.

Q And have those micrologs been used in constructing certain cross sections and have they formed the basis for a new study which you have made in this field? A Yes.

Q Mr. Finfrock, will you please refer to Exhibit 2-R which is a cross section and identify and explain it?

(Marked Sunray's Exhibit 2-R, for identification.)

A Exhibit 2-R is a northwest-southeast microlog cross section along the central part of the section. It is a microlog cross section of the main pay sections in the Bisti-Lower Gallup

Oil Pool. Starting with the British American No. 1 Mayre in Section 1 of 25 North, 13 West, and terminating with the Shell 3220, this section is composed of portions of the micrologs of the wells that compose this cross section. On these micrologs we have defined the positive microlog separation by the dark red shading, which you will see in each of these logs. We have connected this positive separation by the solid lines and have connected between these wells with a lighter shading to indicate the continuity of this porous and permeable sand body. As you will note in the northwestern portion of this cross section, we have only the positive separation on the upper of these two main sand bodies. Whereas in the last four wells of this cross section, namely the Shell 34-13 Carson in Section 13, 25, 12 South, the Shell 34-18 in Section 18, 25, 11, The Shell No. 4 Carson in 20, 25, 11, and the Shell No. 32-20 in Section 20, Township 25, Range 11, both evidenced by positive micro-log separation in the two main pay sands.

Q In the original hearing, Mr. Finfrock reference was made to microlog separation and there were certain exhibits offered showing microlog separation. This Exhibit and some of your subsequent exhibits are exhibits showing microlog separation. Will you please explain what you mean by microlog separation and to what extent it is significant in determining sand continuity and permeability?

A In referring to microlog separation, we are here referring to positive microlog separation as shown by these electrical characteristics which I have just described.

In a bore hole the fluid will leave a thin veil of filtrate on the bore of the hole, and this is common throughout the hole except at those positions in the hole where a porous and permeable body is encountered and at these positions in the bore hole a filter cake will be built up as we have lost fluid into this porous media.

The micrologging tool, the pad that is pressed against the wall of this bore hole, when it is reading the filter cake, it will read a positive separation at that point where the filter cake is built up opposite a porous and permeability formation, and thereby resulting in the positive separation that is shown on micrologs.

Q Mr. Finfrock, how many wells are there in this field, to the best of your knowledge?

A To the best of my knowledge at the time we prepared these exhibits, there were 187 wells.

Q And you have studied micrologs on how many of these wells?

A I have obtained and studied micrologs on a total of 164 of these wells.

Q You have studied micrologs on 164 of 187 wells in this field, is that correct? A That is correct.

Q Now, Mr. Finfrock, will you please refer to Exhibit 3-R and identify and explain it?

(Marked Sunray's Exhibit No. 3-R, for identification.)

A Microlog cross section 3-R is a continuation of 2-R from the 3220 Carson down to the Monsanto No. 1 Blanch in Section 34, 25 North, 10 West. This microlog section as the previous, has been built from portions of the micrologs of the individual wells that have been drilled in the field, and we have shown here by the same symbols that we had on the previous section, the positive microlog separation by the solid red color.

In these sections you can see both the main producing sand bodies have been found in each of these wells, though in varying degrees of thickness. We have found that in this study we have the opportunity to use wells that were not available at the previous hearing, which have given us closer spacing in order to get a better correlation between wells than we had before, and we feel as a result of these studies that our opinion about the continuity of these pay zones in the Bisti-Lower Gallup Oil Pool has not been changed as evidenced by these exhibits.

Q In fact, would you say that your opinion has been strengthened as a result of these new studies?

A Yes, I would.

Q Will you please refer now to Exhibits 4-R and 5-R and identify and explain them?

(Marked Sunray's Exhibits No. 4-R and 5-R, for identification.)

A Exhibit No. 4-R, microlog section C C_1, which is essentially a north-south, I mean a north-south cross section through the microlog section through the Bisti gas injection area. This cross section, as previous, has been built in the same manner as before and we have shown here the positive separation and the continuity of the permeability between these wells.

As can be seen from this exhibit, which is a transverse exhibit to the lengthwise of the field, that we do have a definite thin ning of the porous and permeable zones on the flank with a definite thickening in the central well, indicating that these sands do thin as they approach the flanks of the field, and do lose some of their porosity and permeability.

Section D D_1 is a north-south section in the gas cap area from the Carson No. 5 to the Sunray No. 1 Platero.

Q That is actually down toward the southeast part of the field, is it not?

A Yes, it is. We have shown here by the same symbols we had in the other exhibits, this exhibit shows one thing, two things that we didn't have in the other. It shows the absence of the upper sand in the No. 1 Platero and the absence of the second sand in the Shell No. 5 Carson.

I would also like to point out to you the difference in the stratographic position of these two sands in the wells in which they are present. The upper sand, you'll see the belt of porosity and permeability assumes an arc which I feel represents more or less the relief of the sand bar, while the second sand stratographically climbs the section as we move northward, becoming a little higher in the section as we move northward. Although the dip is to the northeast, the lower sand does not drop in the same relation that the upper sand, because it is structurally higher sand as we move north.

Q Of the 164 micrologs which you studied, how many had microlog separation in the upper sand?

A Of the 164 wells that I studied, I found a total of 138 which showed microlog separation in the upper sand.

Q Then microlog section indicates a continuity of porous and permeable sand, is that correct?

A That is correct.

Q How many, if any, showed no microlog separation?

A I found a total of 26 wells which did not show positive microlog separation.

Q Were the micrologs which you studied well distributed throughout the field, or were they bunched up, leaving large areas or substantial areas which had no micrologs available?

A No, the 164 wells were very well distributed throughout the length and breadth of the field.

Q Did you find any micrologs in the better portion of the field which has been referred to as the fairway, which showed no separation? A No, I did not.

Q In other words then, is it true that the micrologs which showed no separation were taken from wells located on the flanks of the field where the Lower Gallup thins out, is that correct?

A Yes, that is correct.

Q Now, does your testimony and your exhibits which you have presented down to this point, do they further confirm the continuity which was shown by the electric log cross sections offered by Sunray at the first hearing?

A Yes, I feel that they do.

Q One more question with regard to these wells, on the flanks which have no microlog separation, are all or a part of those wells producing even though they have no microlog separation?

A To my knowledge the wells that are on the flanks of the field, they are productive of oil and have been perforated.

Q To be productive of oil, they have to have some permeability in them, don't they?

A They would have to evidence some.

Q Throughout the main portion or the fairway of this field, have you found the main body of the Lower Gallup to be continuous and permeable and porous without interruption?

A Yes, I have.

Q Then is it therefore your conclusion that the main body of the Lower Gallup formation is a sand body of continuous porosity and permeability which may thicken and thin throughout some parts of the fairway, is that correct?

A Yes, I think that is evidenced by our cross section, that it isn't continually the same thickness throughout, it does vary.

Q Is it also your conclusion that the lateral edges of the other subsidiary reservoir do not always line up vertically with each other so that wells drilled on the edge of the sand bar can be expected to find erratic sands of fairly low permeability?

A That is correct.

Q Mr. Finfrock, has Sunray Mid-Continent Oil Company recently drilled and tested a well known as the No. 1 Platero, located in the southwest quarter of Section 15, 25 North, 11 West?

A Yes, it has.

Q Did that well produce gas on its initial test?

A Yes, that well produced dry gas at the rate of 566 MCF per day on an 1864 inch choke with a tubing pressure of 840 pounds.

Q On the first test was that a dry gas?

A Yes, it was.

Q Is there anything unusual which might be considered unusual at first blush in this situation?

A Yes, it was at first appearance.

Q Have you prepared a structural map which explains this situation?

A Yes, I have.

Q That map has been identified as Sunray Exhibit 6-R. Will you please proceed to explain it?

(Marked Sunray's Exhibit 6-R, for identification.)

A Sunray Mid-Continent Exhibit 6-R is a structural map on the top of the second sand member in the Lower Gallup formation of the Bisti-Lower Gallup Oil Pool. This map is contoured on an interval of ten feet. We have shown hereon the various wells in the area, near the Platero well, so that we could reconstruct geologically the reason to explain the dry gas test that we had in our Platero well.

As can be seen from these contours, this structure dips into the north and northeast and across the central portion of this map, we find a very definite nosing, on this nosing in a downdip position we find a structural closure within which structure closure we find two wells, the Sunray Mid-Continent No. 1 Platero in the southwest quarter of Section 15 and the Shell 2122 A in the northwest quarter of Section 22.

As can be seen from this interpretation, it is my opinion that when the hydrocarbons were moving into the Lower Gallup sand in this Bisti Field, that this anomaly, this closed anomaly was filled with gas and oil, but there were more hydrocarbons present than could be accounted for by this small structure and it spilled over from this small structure and moved on updip to the updip limit or shaleout of the sands which afforded the updip trap of this stratographic type field.

We find updip from this Platero area the gas cap area, and we also find updip from the Platero area that there have been completions in these same Lower Gallup sands for oil.

It is our conclusion that with this structural picture that we have here, we can explain the position that although it appears that the Platero well was downdip structurally, that actually it is on a closed high which is higher than many of the producing oil wells in that area.

Q Have you prepared a schematic cross sectional diagram which further explains this situation? A I have.

(Marked Sunray's Exhibit No. 7-R, for identification.)

Q Will you please refer to that schematic diagram which has been marked Sunray Exhibit 7-R, and explain it?

A Sunray Exhibit 7-R is a schematic diagram in the gas cap area of the Bisti-Lower Gallup Oil Pool. Shown hereon in a schematic fashion is an interpretation of the structural map which we have just looked at.

On this diagram we have spotted the Sunray Mid-Continent No. 1 Platero in the small anomaly which is downdip from the major portion of the Bisti Field. In an updip position we have spotted the Sunray Mid-Continent No. 1 Es-Ka-Nel-E-Wood well which was completed as an oil well, which is actually fifteen feet higher structurally than the No. 1 Platero well, but we feel that this interpretation shows why we would find some gas accumulated though in small volumes below updip oil.

Q Then is it your opinion that the gas which is being produced lower on the structure than oil is being produced from a local pimple or bump on this structure as it dips to the northeast?

A Yes, it is my opinion that this gas was trapped in a local anomaly on this large stratographic feature.

Q Is it further your opinion that this gas that has been so entrapped can not move on upstructure to the main gas body?

A Yes, there's a certain amount of gas that was trapped in this structure that was not able to move on updip, although the major portion did.

Q Then, based upon your studies of this area, Mr. Finfrock, is it your opinion that a gas cap exists, a major gas cap, which is in communication with the oil which is found in the other portions of the reservoir? A That is correct.

Q Now, Mr. Finfrock, have you changed your opinion from the previous hearing, or has it been further confirmed by the additional studies based on this new information, the drilling of new wells and the passage of three months' time?

A Well, my original position has not been changed.

MR. ERREBO: I believe that's all we have from this witness.

MR. PORTER: Anyone have a question of Mr. Finfrock?

Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q Mr. Finfrock, I would just like to ask you a couple of questions about your exhibits. On your cross sections there you apparently have no horizontal scale, is that correct? They're just arbitrarily placed?

A No, they are placed at the same intervals throughout the length of the field. The scale is shown, well, here is the scale shown here in these sections, and then up here we have shown where the wells are located across the sections of the field. They vary from quarter of a mile up to about a three-quarters of a mile.

Q But you have not represented on the cross section other than the diagram, is that right?

A Well, we show the scales as such here with a vertical scale of fifty feet to the inch and there's no scale on the horizontal, they are equally spaced.

Q Likewise you have no vertical control of down either, do you?

A Yes, we have hung these from a correlation point at the top for the Lower Gallup Formation here. They are all hung from the same correlation point electrically. It is an electrical location point.

Q The diagrams don't indicate that, do they?

A Well, we have this same chracteristic across here, and we come to the same position above it to the tie.

Q You have done that regardless of the depth below --

A (Interrupting) These aren't hung from a subsea datum. They are hung from the Upper Gallup here. These are not subsea.

Q Then you have not attempted to show the relative positions --

A (Interrupting) Structurally.

Q (Continuing) -- structurally at all?

A No.

Q It's more or less an arbitrary arrangement then of these various long pictures both vertically and horizontally?

A We have picked a correlation point to hang each log from regardless of its structural position.

Q Well, your C C_1 would show quite a dip, would it not?

A Yes, it would show a dip in this direction from south to north if we had hung it from a subsea datum, we would take these lines here and they would assume an angle like that.

Q Then your points of microlog separation would not be opposite each other necessarily, would they?

A Opposite each other?

Q From one well to the next they would not be on the same horizontal line?

A No, because we would be connecting the same porous sand in here. If we hung them from a subsea datum the line would be tilted in this manner with the updip sand in a higher position than the downdip sand, and these correlations would drop as we move northward. It would be the same correlation though.

Q You have arranged them so the lines appear --

A (Interrupting) They are not straight, no, but we have just correlated between the sands as has been shown.

Q Have you shown all the microlog separations in each well? Take for example, on B B_1, Skelly No. 2 Longhart, is there some separation that you haven't shown there, for example?

A Yes, there is. There is separation right at this position here that we have not shown.

Q And the Monsanto No. 1 Frank, is that likewise true?

A I don't believe that I can read from this print whether that is microlog separation or not, but there are, I would say out of the 43 wells that are on these cross sections, I think I counted 6 wells of which we had a position like this in the Skelly Longhart, of which there was a small amount of microlog separation, and we did not attempt to show those microlog separations in these inferior sands.

We are attempting to show that in the main pay sands of the Bisti-Lower Gallup Oil Pool we had this continuity of porosity and permeability.

Q Then there are other productive sands, or at least sands showing microlog separation that you have not attempted to show? You haven't shown them all?

A That is the inferior sands. That is correct.

Q You have testified, I believe, that there was continuous porosity and permeability throughout, but you do not testify on any variations in either one of those factors, do you?

A I believe I stated that we had variable thicknesses of the porous zones within the sands, as can be seen from these sections, that they do vary.

Q You certainly recognize that there is varying porosity and permeability throughout the general sands that you speak of?

A It does vary, yes.

Q The information with reference to the existence of the gas wells, I believe you mentioned that the sands shale out?

A Yes, we have an updip shaleout of the lower sand, I mean of the sands of the Lower Gallup Formation, which afford the updip trap for the sole stratographic feature known in the Lower Gallup Pool.

Q Would you expect to encounter similar shaleout in other portions of the pool?

A It is continuous from one end of the pool to the other. The sands do shale out.

Q Why did you, on 6-R, Mr. Finfrock, why did you prepare that on the top of the second sand member?

A Because that was the sand that was encountered in our No. 1 Platero well, and was the sand that came in for a dry gas test to begin with, and I wanted to find an explanation for it, and I had to map on the productive horizon to do so.

MR. PORTER: Anyone else have a question of Mr. Finfrock? Mr. Malone.

MR. MALONE: Ross Malone, Atwood and Malone of Roswell, New Mexico for Gulf Oil Corporation. I would like to enter the appearance of Booth Kellough of Denver, Colorado for Gulf Oil Corporation.

By MR. MALONE:

Q At the time that you testified in the case previously, Mr. Finfrock, was there any doubt in your mind as to the conclusions to be drawn from the evidence which you presented?

A No, I thought from the evidence, you mean presented geological testimony?

Q Yes, geological evidence.

A As far as I could see from the geologic standpoint, and not taking in the other aspects of the case, I thought that we had shown the continuity of the Lower Gallup Formation through the field.

Q The further study which you have made since that hearing has merely further strengthened your conclusion in that regard?

A It has my personal conclusion, yes.

Q Your conclusions now are actually identical with those to which you testified here on the original hearing, are they not?

A I would say not exactly identical, no.

Q Would you say substantially the same?

A Substantially the same, yes.

Q You have limited your study of the microlog separation shown by these logs to the two principal members as you define them in this Bisti-Lower Gallup Pool, have you not?

A I studied the entire area of the Lower Gallup Formation. We have limited our exhibits to the main productive zones of the Bisti-Lower Gallup.

Q So that for instance on a number of those logs where perforations are shown opposite which you have not indicated microlog separation, there are other areas of permeability and porosity?

A As I mentioned, I think there were six wells out of the forty-three on these sections that we were able to see a positive microlog separation, and in those same zones in the other wells there was no evidence of microlog separation.

Q Your exhibits do not indicate any continuity or communication as between those zones and the members which you have portrayed?

A No, as can be seen from these exhibits, you are not able to show from the positive microlog separation a vertical connection, is that your question?

Q Yes. Are there other areas in the pool in which this condition exists in which oil wells were found apparently upstructure from gas wells in addition to the area to which you testified?

A To my knowledge this area in 25 North, 11 West is the only area that has come to my attention that this does exist.

Q If there are other areas, would you account for them in the same way you have accounted for this one?

A If there are such areas I would want to make a geologic study of them before I would attempt an answer. I had to do that in this case.

Q You wouldn't account for them necessarily in the same way?

A No, but I would say this, that where it exists in one place it's possible that the same situation could exist again.

Q If I may invite your attention for just a minute to Exhibit 5-R and to the Shell No. 21-22 Government A shown on there.

A Yes. That is this well here.

Q In the upper member that is shown there I notice that you show what appears to be a separation of that member into an upper and lower segment by a loss of permeability, I assume?

A That is correct.

Q Now, as you proceed toward D, you show that loss of porosity or permeability? A To the right?

Q No, that is D_1.

A Towards D, I see.

Q As you proceed towards D you show that loss of permeability to terminate and the two segments to again become one, so that the lower segment would have complete communication with the upper members shown in the Magnolia well? A That's right.

Q How do you reach the conclusion that there is a continuous area of porosity and permeability there rather than that there is a pinchout of it between the Shell and Magnolia well?

A I find that in the Shell well, as we have shown, there is about a one and a half feet, it looks like, of known positive microlog separation, and we find in the Magnolia well, we have no such separation, and this point is an arbitrary point, I have picked it halfway between, it could be here, it could be there, we don't know where the point, the juncture is. It is a common geologic practice when you are dealing with an unknown, to put it at a point halfway between the two knowns.

Q Would it be an equally acceptable conclusion, in your opinion, that the lower segment pinched out between those two wells so that there would be no communication between it and the separation in the Magnolia well?

A I would have no information to state what actually did happen to that lower portion of that sand.

Q So that it is --

A (Interrupting) This is my interpretation, my geologic interpretation of the facts as we have them.

Q But you don't have information by which you can actually substantiate the way that is portrayed on your exhibit, do you?

A Well, looking at it in its plain diagram, we do not. Possibly taking other wells in the vicinity and studying the whole picture, it might be able to prove another thing, I don't know.

Q It would also be possible though, would it not, that that, if there is a pinchout in that lower segment, that that would be one of the erratic sands that would not have communication with the rest of the member?

A The sand itself is present electrically all the way through there. We're dealing here with measured positive microlog separation, but the sand itself I have no doubt that it is not present between the well.

Q And you would not be able to say with certainty that communication would exist through that, would you?

A Well, the microlog tool I would say is one of the more accurate electrical tools in the industry, but it does not measure down to zero permeability, and it's possible that though we do show here a zero permeability from reading, not zero permeability, but non permeable streak there, that if we had core analysis through the section we would possibly show low order permeability.

Q So that the conclusion which you have portrayed with reference to the continuous nature of that lower segment, is the conclusion that you draw from it, but one which there would be a difference of opinion on?

A Yes, that is geology.

MR. MALONE: Thank you.

MR. PORTER: Anyone else have a question of the witness?

MR. BUSHNELL: H. D. Bushnell, attorney with Amerada.

By MR. BUSHNELL:

Q Mr. Finfrock, I believe you stated this morning that the hydrocarbons in the Lower Gallup sand migrated into the sand, is that correct?

A Yes. There will be some migration and some inside too, hydrocarbons.

Q If that's true, would it not necessarily follow that this reservoir would be one common source in your opinion?

A I think it is.

MR. BUSHNELL: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Utz.

By MR. UTZ:

Q Mr. Finfrock, I'm not sure that I understood for sure whether or not you interpreted the gas wells in the upstructure from your Platero No. 1 to be a gas cap.

A Yes, it is our opinion it is a gas cap.

Q Then, referring to your Exhibit D D_1 --

A Which exhibit?

Q D D_1. A D D_1, yes.

Q Between the Magnolia No. 1 Ah-Nus-Bah and the Shell No. 21-22 Government A, would you say that there was a low trough in there which separated the Platero and your Shell 21-22 from the Magnolia Ah-Nus-Bah?

A Yes, that is my interpretation.

Q Is it your opinion that some volumetric limitations should be put on those gas wells in the gas cap?

A I'm not sure I understand your question.

Q Well, something --

A (Interrupting) You mean volumetric is --

MR. ERREBO: (Interrupting) If the Commission please, this gentleman is a geologist. We will have an engineer on the stand who will discuss the gas cap and make the recommendation, I believe, you are seeking.

MR. PORTER: Would you refer your question to that witness?

MR. UTZ: Yes, sir, I will. That's all I have.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Finfrock, was the Sunray No. 1 Platero well originally a gas well and is now an oil well?

A Yes. I will be glad to read here a short dissertation on that well. This well was perforated December 5, 1957, in the Lower Gallup sand from 4852 to 4903, on the twenty-four hour test with a 1864 inch choke the well flowed at a rate of 566 MCF gas per day, with a tubing pressure of 840 pounds.

After that test the well was shut in for a period of nine days. On a test of the same perforation on December 14, 1957, the No. 1 Platero flowed oil at a rate of 73.24 barrels in twenty-four hours on a three-quarters inch choke. Tubing pressure had dropped to 280 pounds, casing pressure was 500 pounds, and the gas-oil ratio 34,000 to 1.

Q What has happened there, has the gas in that nose or that little pimple been depleted and the oil is moved upstructure?

A I think that that would answer a major portion of the question, that we have a small gas cap in this area and when we initially tested it we tested the dry gas and when it was, the well was perforated through the entire sand and which was through the gas in the oil column, when the well was opened back up again we got our liquid hydrocarbons.

Q Which had moved up the structure while the well was shut in?

A No, I believe they had been there to begin with, and we had as I might say it, I might be getting into reservoir engineering over my head, as I see it we had a little gas cap above this oil and in our initial test we got the dry gas.

Q You don't think that the perforations penetrated oil that was in place originally?

MR. ERREBO: If I might interrupt you, Mr. Nutter. We will have an engineering witness later on that I think can give you quicker answers.

MR. NUTTER: That is fine. We will defer that line of questioning. No further questions.

MR. PORTER: Anyone else have a question.

MR. McGOWAN: I have one question. James McGowan, Sinclair Oil and Gas Company.

By MR. McGOWAN:

Q Mr. Finfrock, the Definition 46 of the Commission Rules and Regulations reads in part as follows: I quote: "Pool means any underground reservoir containing a common accumulation of crude petroleum oil or natural gas or both". Is it your opinion that the Bisti-Lower Gallup Pool constitutes such a common accumulation as is referred to here in this definition?

A Yes, I do.

MR. McGOWAN: Thank you.

MR. GRENIER: A. S. Grenier, representing Southern Union Gas Company.

By MR. GRENIER:

Q Mr. Finfrock, in response to a question by Mr. Seth, I believe you stated that although this was in your opinion a continuous reservoir, at least as to these two main members there, there were some variations as to porosity and permeability within the pool area?

A Yes.

Q Are you familiar with any producing pool or field which does have completely homogenous porosity and permeability?

A No, I am not.

Q In other words, this variant characteristic of porosity and permeability is typical of any continuous formation, and they're never exactly the same all the way through?

A I would say that would be the natural result, yes.

MR. GRENIER: Thank you.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

MR. ERREBO: I have several questions on redirect examination.

MR. PORTER: Go ahead.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q With regard to the lower zones which you did not show, Mr. Finfrock, on your cross sectional exhibits, those actually from your study, are those not rather negligible insofar as the major part of the oil accumulation in this reservoir is concerned?

A Yes, I think they are.

Q That is the reason you did not show them?

A Yes.

Q With regard to the way in which you ranged the logs for correlation and interpretation, is that not the generally accepted way among geologists of ranging logs on cross sections for interpretation?

A There are two ways, you can range them this way and hanging from subsurface to get a structural picture. I am not trying to define structure here. It is an accepted way of making cross sections.

Q I believe you previously testified, have you not, that the porosity and permeability varies from the center to the edge of the field? A Yes.

Q So that therefore our cross section D to D_1 in going from the Shell No. 21-22 Government A to the Magnolia No. 1 Ah-Nus-Bah, you would not expect the formation to thin or to pinch out, would you?

A I wouldn't normally.

Q That would be contrary to the trend which has been observed throughout the entire field? A That is true.

Q In further regard to that point, have you found any well in the main portion of this field that has not had either, have you found any well in which either the upper or the lower sand pinched out once that sands continuity has been established?

A Would you repeat the question, please?

Q In the northwest portion of the field, the upper sand is shown to be continuous throughout? A That is correct.

Q In that portion of the field have you found any well in which the upper sands pinched out?

A Not except on the flanks.

Q Except on the flanks? A That is correct.

Q And in the southeast part of the field have you found any well in which either the first or the second sand is pinched out?

A I think the situation is the same.

MR. ERREBO: I believe that's all.

MR. PORTER: Anyone else have a question?

MR. ERREBO: If it please the Commission, at this time --

Q Mr. Finfrock, the exhibits were prepared by you, were they not? A Yes, sir, they were.

Q Or under your supervision.

MR. ERREBO: If it please the Commission, we would like to offer in evidence Exhibits 1-R through 7-R.

MR. PORTER: Without objection these exhibits will be admitted to the record. The witness may be excused.

(Witness excused.)

We will take a short recess.

(Recess.)

MR. PORTER: The hearing will come to order, please. Mr. Errebo, will you proceed with your next witness?

MR. ERREBO: If the Commission please, we would like at this time to call Mr. Brinkley as our next witness.

(Witness sworn.)

T. W. BRINKLEY

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. ERREBO:

Q Will you state your name, please?

A My name is T. W. Brinkley.

Q By whom are you employed and where, Mr. Brinkley?

A I'm employed by Sunray Mid-Continent Oil Company in Tulsa.

Q And you are Chief Reservoir Engineer for Sunray?

A That is correct.

Q And you testified as a Reservoir Engineer at the original hearing in this matter, did you not? A That is correct.

Q Since this original hearing have you made additional studies of this pool, taking into consideration new information which you obtained? A Yes, I have.

Q Does this new information that you have obtained consist primarily of bottomhole pressure data in the area surrounding the pilot area of the experimental LPG project in this field?

A Yes. Considerable additional information is now available in the pilot area that was not available at the last hearing.

Q Have you prepared a plat showing this data which has been accumulated since the last hearing? A Yes, I have.

(Marked Sunray's Exhibit 8-R, for identification.)

Q That plat has been identified as Exhibit 8-R. Will you please go to that plat on the wall and explain what is shown on it?

A Exhibit 8-R, which we have a large copy of, I believe you will want to mark your exhibit. Exhibit 8-R is a pilot area map, the pilot area is shown with heavy dashed lines at the intersection of Township 25, 26 North and Range 12 and 13 West. This pilot area, for your convenience, is located in a previous exhibit in the northwest portion of the field where I am pointing. The pilot area consists of four oil wells, Sunray Federal 2-C located in the southwest of Section 31, Phillips Hospah No. 1-A located in the southeast portion of Section 36, British American Marye No. 1 located in the northeast portion of Section 1 and Sunray Federal No. 1 located in the northwest portion of Section 6.

In the center of these four oil wells we have an injection well. We have shown in the four sections, Section 31, 36, 1 and 6, all of the wells that have been drilled in those sections. In addition to showing the wells we have listed measured bottom hole pressures, also the date when the pressures were run and the type of instrument we used to measure the pressure.

As an example, British American Marye No. 1, located in the northeast portion of Section 1, we showed five pressure measurements. The first pressure measurement was taken in October 23, 1956. The B indicates a bomb measurement, the 1252 represents the reservoir pressure at an elevation of plus 1300 feet.

The next pressure was August 15, 1957, S standing for sonolog. That is an echo device which we used to estimate the reservoir pressure and the pressure on that date was 1203 pounds. The next pressure was in September, the 4th, 1957. Again a sonolog pressure and the value at plus 1300 feet was 1298 pounds.

October 1, 1957 is the next pressure, again with a sonolog, and the measured bottom hole pressure was 1292 pounds. On November the 6th, 1957, sonolog method indicated a pressure of 1386 pounds. It is quite significant with this information that all notice between the first and second pressures that there is a decrease in reservoir pressure over the period of roughly ten months. The decrease in pressure is 49 pounds. That means that the natural decline in reservoir pressure for the ten-month period prior to the injection of LPG and gas amounted to 49 pounds.

It is significant too that the third pressure on September 4, 1957 had shown an increase of 95 pounds over the preceding pressure. Further, the October 1, 1957 pressure further substantiates the higher pressure than the reservoir pressure immediately prior to the injection of LPG. Also, the last pressure, November 6, 1957, shows the pressure to be 1386, still greater than the pressure immediately prior to injection of LPG.

This is a pressure reversal from the normal decline experienced by this well as a result of injecting LPG and gas.

Q Mr. Brinkley, could I ask you one question at that point? How long was it between the second and third pressure maintenance, that was roughly three weeks there, was it not?

A Slightly less than three weeks.

Q Was that not a significant increase in such a short period of time? A That is correct.

Q And you also have quite a large increase between the first of October and the sixth of November, do you not?

A That is correct.

Q And was the decrease in pressure that occurred from October the 23rd of 1956 to August the 15th, 1957, a significantly large decrease considering the amount of oil which had been withdrawn from that reservoir and from that well over that period of time?

A That is correct.

Q Thank you.

A Let's consider another well. Sunray Mid-Continent No. 5 Federal which is almost a mile south of the gas injection well. Again we find the same characteristics on October 22, 1957, as you were, 1956 with a bomb measurement, we measured the reservoir pressure of 1446 pounds. On April the 5th, 1957 again with a bomb we measured the reservoir pressure to be 1343. The third pressure taken in October 7, 1957, again with a bomb, we found the pressure to be 1412 pounds.

Again we find the normal decline in pressure during the period prior to LPG and gas injection and the characteristic pressure reversal, after the injection of fluids, that same characteristic is observed in other wells in this area.

Generally we expect a higher pressure reversal or pressure benefit in the wells nearer the injection well, and they occur earlier than outlyingwells. In any event, we can construct possibly a line around the injection well in a radial fashion, indicating that fluids have moved away from the injecting well, and the reason we know the fluids have moved is because of this pressure reversal effect that we have noted.

Now, this fluid movement confirms sand continuity in this immediate area consistent with the previous exhibit presented by Mr. Finfrock. I believe that's all.

Q Will you please refer to your Exhibit No. 9-R, Mr. Brinkley, and identify and explain what it shows?

(Marked Sunray's Exhibit 9-R, for identification.)

A Again I would suggest that you number your exhibit; Exhibit 9-R illustrates the basic information that was presented on Exhibit 8-R, only we show it in a chronological fashion. As an example, the red line as shown on our exhibit according to the date of August 21, 1957 which corresponds to the scale at the bottom, represents the date at which we started the injection of LPG. At that time you will notice that the reservoir pressure in the pilot area based on the factual data presented on Exhibit 8-R was in the range of 1100 pounds to roughly 1350 pounds.

I invite your attention also to the date of October, 1956, when the reservoir pressure was the range of 1200 pounds to 1400 pounds. The trend shown by the data for those two periods indicates the normal decline experienced in the pilot area prior to the injection of LPG. That decline averages approximately a hundred pounds per square inch for the ten-month period. This trend is defined or illustrated by two heavy lines, the extrapolation of that defined trend to periods past the injection of our LPG indicates that at the present time we would have suffered additional pressure decline as substantiated by later pressures in outlying wells.

The portion of the curve to the right of this red line and above the probable extension of the pressure decline indicates the pressure restoration or the pressure reversal that we have experienced in the pilot area by the injection of LPG and gas.

It is significant that the pressure has remained stable since the start of gas injection. Moreover, it has been restored to the value that we observed ten months before the pilot. In addition to that we have withdrawn high oil rates out of the four oil wells.

You will notice Phillips Hospah 1-B and 2-A, 1-B, 2-A on Exhibit 8-R have shown the pressure increase, but at a later date as we would expect.

Further, every well in this area with the exception of No. 9, an outlying well, has experienced a pressure reversal due to the movement of fluids through the sand, supporting continuity.

Finally, the benefit that we have gained in the pilot area by pressure buildup has amounted to approximately 200 pounds, had we not started the project, and that benefit will continue the longer the pilot project is in operation. I believe that pretty well covers the significant items.

Q The results of these tests then show, do they not, that wells almost a mile away from injection well have already shown pressure increases as a result of the injection of LPG and gas into the injection well, is that not correct? A That is correct.

Q Mr. Brinkley, have you calculated the amount of acreage which has been affected by this injection well, and will you state how much it is?

A The circle that we have drawn or indicated in the pilot area as being affected by fluid movement through a continuous sand, taking that radius of 4500 feet, the distance from the injection well to the No. 5 would circumscribe an area approximating 1500 acres.

Q Then is it your opinion, based on this information, that one well will drain some 1500 acres in this field?

A The evidence that we have here indicates that it will drain an area approximating 1500 acres.

Q Your Exhibit 9-R then shows a decrease in pressure which you say is normal for this reservoir up to the point at which injection was commenced in the pilot well, is that right?

A That is correct.

Q You say this is normal. You mean it is normal for a reservoir of this low oil in place originally?

A The pressure decline on withdrawals is normal in a solution drive type mechanism. But the rate of pressure decline with the small volumes that have been removed here is abnormally high.

Q Then actually the second portion of your curve shows a rather sharp increase over a short period of time after the commencement of injection of LPG and gas into this well?

A This shows a rapid increase in pressure occurring shortly after the injection of our LPG, and that same characteristic is repeated and will repeat itself as we go further and further away from the injection well.

Q Would you then say that this LPG injection program would be just as effective on 80 acre spacing as on 40 acre spacing?

A Absolutely.

Q That being the case, are 40 acre wells needless wells insofar as secondary recovery by LPG injection and gas injection into this field are concerned?

A Forty acres are a waste. They are not needed in this process.

Q Now, Mr. Brinkley, in order that we may have a little closer look at this matter of efficient and economical drainage, will you please state what in your opinion is one of the prime requisites for such drainage?

A The first requisite for efficient and economical drainage is pressure interference.

Q What would you say would be a second requisite for an efficient and economical drainage?

A The second requisite would be proper permeability and viscosity of the oil.

Q And what would be another requisite for an efficient and economical drainage?

A Finally, sand continuity.

Q Pressure differentials which you have stated are the first requisite for drainage have been found to exist as far as one mile from the injection well, have they not?

A That is correct.

Q As to your next requisite for efficient and economical drainage, is the ability of fluids to flow, which requires fluids of proper viscosity and reservoir rocks of sufficient permeability to permit such flow important?

A I should like to invite your attention to the fact that Well 2-C is in a thin sand section, it is not shown here, but as previously testified to, also of inferior rock characteristics. The main body of the pool lies in here, and of course, this would represent one of the edge wells where you encounter thin sand and poor permeability, yet we detected pressure interference due to the fluid movement.

Moreover, Well No. 5, a mile away approximately, also represents a south flank well where the rock properties are inferior and thin.

Yet again we detect the pressure reversal due to fluid movement from the injection of our LPG and gas clear through this area and being felt down here.

Q Then, as for your third requisite of sand continuity, that has also been established then by the pressure tests, has it not?

A Obviously since we have detected pressure reversals it has been a result of fluid movement, and that movement has had to move from the injection well past these wells through the intervening space where we had no control or where it was questionable on our cross sections to get to these outlying wells. So we have to accept the fact that the fluid has moved through those areas in order to detect this pressure reversal.

Q Then I believe you state, Mr. Brinkley, that throughout the general pilot area that you have shown, there is some variation of permeability, but that variation of permeability then in your opinion will not prevent adequate drainage and proper and efficient drainage of this area because of the pressure differentials you observed?

A That is correct.

Q And the influence of the other requisites that you stated as being necessary for efficient and economical drainage?

A That is correct.

Q Does this further confirm the position which you took with regard to drainage in the original hearing?

A That is correct.

Q In your work as a reservoir engineer, Mr. Brinkley, do you have frequent occasion to make use of micrologs?

A That is correct.

Q Microlog separation indicates a permeability of rock formation which is capable of allowing the passage of fluids and transmitting pressures? A Yes.

Q You heard Mr. Finfrock testify, did you not, that microlog separation, indicating the presence of permeability, has been found in approximately 164 of 187 wells? A That is correct.

Q That have been drilled? A That is correct.

Q Are you in agreement with previous testimony in these two hearings that this reservoir is similar in its general characteristic throughout the area of this field?

A That is correct.

Q That being the case, is it your opinion that the results obtained in the pilot area could be obtained throughout the rest of this field? A That is correct.

Q Is it your opinion that one well located in any part of this field where sand is developed will drain it in excess of 80 acres efficiently and economically? A That is my opinion.

Q Are you in agreement with Mr. Finfrock's testimony that gas is found in this, found in structurally higher locations?

A That is correct.

Q Are you also in agreement with his explanation of the occurrence of gas at a lower structural level than oil?

A Yes, I am. I might elaborate on that a little bit. I am satisfied that there is no question among we people that gas is found in structurally high positions. Furthermore, the structural configuration forming, if you will, an apex as you go down the flanks, you can encounter irregular highs, you might call secondary highs, which they themselves can trap gas in the high locations.

I have observed this thing in a number of stratographic traps, solution gas drive type reservoirs, and they are secondary gas accumulations along the flanks of a typical gas cap. It is not at all unusual as far as I am concerned.

Q Then is it your opinion that the gas cap in this reservoir is in communication with the down structure of oil?

A It is my opinion.

Q At the last hearing there was some question raised as to the status of the Shell Carson No. 5 located in Section 27 inasmuch as there was a report that this well had produced highly and it is the highest well structurally in the field at least at that time. Have you had opportunity to give some study to this matter and to obtain some additional information on this well which will enable you to explain this situation?

A Yes. The records will reflect that Shell Carson Unit No. 5, located in the southeast quarter of Section 27, 25 North, 11 West, and structurally in the gas cap, is a gas well. The records show that the well was fractured with 80,430 gallons of oil, and the only oil produced has been a part of this fract oil.

Q In other words then, this well has produced no reservoir oil?

A That is correct.

Q Then would you say that any inferences previously drawn with regard to the apparent production of reservoir oil from this well are at this time not valid in view of this information?

A I believe they were presented by misinformation and are not valid.

Q Mr. Brinkley, have you made a study of the Pedigrew-Tocito Pool, located in the State of New Mexico?

A Yes, I have.

Q How do the reservoir conditions and the structure of this pool compare with those found in the Bisti Field?

A Both Bisti and the Pedigrew-Tocito Pool are quite similar. Both are stratographic traps. The core analyses are very similar, the electric logs when layed side by side are very similar, the reservoir fluids are similar with one exception, the Tocito Pool has a little better quality fluid characteristic.

The reservoir pressures at Tocito are only approximately 600 pounds greater than at Bisti, and that is due to an additional 1600 feet of depth. Both reservoirs are solution gas drive type mechanisms, both reservoirs have identified a gas cap. I believe those are the significant points, high lights at this time.

Q Do you know what spacing the Commission has adopted for that field?

A The order as issued, approved 80 acre spacing. However, out of the 18 wells drilled, 16 of them are on 160 acre allocations.

Q This field has been produced for a period of approximately five years since this spacing order was adopted. Do you have any information as to what has been the drainage efficiency which has been observed in this field under this pattern of 80 acre spacing or greater which has been adopted?

A We have two observations regarding drainage. The first observation is that of the first nine wells, as of the first ten wells drilled, the first well completed indicated an initial reservoir pressure of 2197 pounds on the date of July 26, 1951. The following nine completions each identified a completion reservoir pressure lower than the original completion reservoir pressure by 76 to as much as 193 pounds per square inch, bearing in mind that these nine later completions were on spacing considerably greater than 80 acres.

This is the first indication of interference and drainage. The second observation of drainage efficiency is revealed in the ultimate recovery from the reservoir. The estimated primary recovery for the period before the pressure maintenance went into effect permits the conclusion as to the natural depletion recovery on this wide spacing. That recovery is of the order of approximately 100 barrels per acre foot consistent with what was predicted there as well as Bisti. Therefor I concluded that the spacing at Tocito, being considerably greater than 80 acres, permits me to conclude along with the similarity of the two reservoirs and their fluids, that we can efficiently and effectively deplete and drain on 80 acre spacing.

Q It is your statement then, based on the efficiency of drainage that has occurred in the Tocito and the similarity of conditions in this pool, the Bisti, that you can consider that a well on 80 acres can efficiently, economically drain 80 acres in this pool, the Bisti Pool?

A That is correct.

Q Then with the testimony that you have given here this morning, does it or does it not confirm the testimony and opinions which you held at the previous hearing before the additional studies were made?

A This additional work that we have done, using additional reservoir pressures et cetera, confirms my original conclusion, and that conclusion was that we can efficiently and effectively drain the Bisti-Lower Gallup reservoir on 80 acre spacing.

Q Do you believe that waste will occur if this application is not granted?

A Yes.

Q Do you recommend that the rules which you presented at the original hearing be adopted by this Commission?

A My recommendation is consistent with the recommendation presented at the previous hearing, namely that wells will be located in diagonal 40's in 160 acre tracts, forming 80 acre proration units.

Two, wells will be located a minimum of 330 feet from the 40 acre lines. Three, allowable to be based on 80 acre proration unit. Four, limiting gas-oil ratio of 2,000 cubic feet per barrel.

Five, semi-annual survey for gas-oil ratio and reservoir pressures.

Q Were Exhibits 8-R and 9-R which you presented here this morning, prepared by you or under your supervision?

A They were prepared by me or under my supervision.

MR. ERREBO: We would like at this time to offer them in evidence.

MR. PORTER: Any objection to the admission of the Exhibits 8-R and 9-R? They will be admitted. Does anyone have a question of Mr. Brinkley?

MR. SETH: If I may, I would like to ask Mr. Brinkley three or four questions.

CROSS EXAMINATION

By MR. SETH:

Q Referring to 8-R, Mr. Brinkley, doesn't the data on that map show some considerable pressure differentials between adjacent wells, referring to some of the more recent tests, does it or does it not show that? A Yes.

Q It does? A Yes.

Q For example, on the SDX wells 5 and 6, does that show a considerable pressure between those two wells from time to time?

A Yes.

Q Have you prepared any isobaric map showing this situation?

A No, I have not.

Q If one were prepared, it would show a highly irregular picture, would it not? A That is correct.

Q Now, how would you explain that in view of the testimony of this freedom of pressure communication? Why is it different, why is it irregular?

A Well, we expect this sort of thing like you mentioned, irregular pressure among wells, and it's as I say, what we expect due to the variance in sand quality. The quality varies in this well and the fluid, of course, will follow the path of least resistance.

Q Well, we are speaking just about pressure communication?

A Yes.

Q That shows an irregular pattern, does it not?

A That is correct.

Q How did it happen that this particular area was picked for the pilot project in the first instance?

A We were interested in getting our results of evaluation of this new recovery method as soon as possible. We also wanted to share with other operators. We searched around for an area where the wells were clustered so that we could get our results quickly rather than selfishly going to our own lease where we had a pattern on wide spacing, yet sacrifice a year or two's time for the results.

We searched and we found the one area in this part of the field where three operators could cooperatively join, pool, their talent, experience and so forth and drill an input well and share and share alike on this new venture.

We all recognized at that time that the salvation for this poor type field would depend on some type of secondary method.

Q You don't need to sell us on the program. We are for it. I just wondered why you picked this area. You certainly didn't pick one where you expected to find poor communication or poor sands, did you?

A Frankly, we were after the close spacing wells on this pilot test to get our results quickly. We realized at the time that this was an inferior well, and might offer problems, but we didn't know enough about the method to know what kind of problems we would get into. We know much more about it now by having that poor quality sand in our pilot area, and I think it is to our advantage that we have looked into this situation.

Q Well, you have certainly picked an area where you expected to encounter good or better communication in the sands certainly?

A Correct.

Q Because you wanted the quick result?

A That is correct.

Q Your testimony as to the facts and the testimony today has been confined to this particular area, and from that you have expressed your opinions as to the entire field?

A Yes.

Q Do you feel confident that from this localized area in the better part of the field you can extrapolate the results over the entire field?

A Yes, sir.

Q You have no misgivings on that point at all, is that right?

A We have learned a lot in this past four or five months, and we are quite confident that we can apply these results to the other developed portions of the reservoir.

Q And you would testify that one well in any reasonably good part of the field would drain 1500 acres, is that correct?

A No, I didn't mean to infer that at all. I said the evidence we have here indicates that I have testified that one well drilled on 80 acres would efficiently and effectively drain that 80 acre tract.

Q I thought you testified that one well would drain 1500 acres, that is what I understood. If that is not correct, I was mistaken.

A I will erase my statement, I did say that. I think I prefaced that based on this information that one well will drain 1500 acres. I stand corrected.

Q In view of what you have now testified that one well in any reasonably good part of the developed area would drain 1500 acres--

A Yes, sir.

Q You are basing that testimony primarily on the pressure communication which you have found in this area that you have these pressure interference tests, is that correct?

A That is correct.

Q In this area are the pressures above or below the bubble point?

A In the pilot area right now 1350 pounds are above the bubble point.

Q What were the compressibility factors, what did you use or what would you use here? A For the oil?

A Yes.

A I don't recall precisely what the number is, but it is probably one times ten minus five volumes per delta PSI reservoir conditions.

Q The compressibility would be less in these fluids where the pressures, we haven't reached the bubble point in areas where you have, is that correct? A I didn't follow you.

Q Does your compressibility vary whether it is above or below the bubble point? A Yes.

Q Well, then, are there other portions of the field where it is below the bubble point?

A I believe it would be best if I answer this way --

Q (Interrupting) Perhaps you could answer yes or no and then explain the answer.

A Well, I can't give just a one answer because of the variance.

Q Well, go ahead then.

A I will state this, the Bisti-Lower Gallup reservoir contains oil and gas, at the gas-oil interface the reservoir oil is saturated as we proceed down structural elevations lower than gas-oil contact, we get into more and more under saturated oil to the point where the lowest elevation or the lowest structural elevation would be the most undersaturated oil.

Q Your data and your conclusions based on this data would make a difference whether you have taken it in an area that is below or above the bubble point, would it not, Mr. Brinkley?

A What are you referring to?

MR. SETH: Would you read the question to him?

REPORTER: Reading: Your data and your conclusions based on this data would make a difference whether you have taken it in an area that is below or above the bubble point, would it not, Mr. Brinkley?

A I take it that you are referring to the pressure interference?

Q Yes.

A Yes, if you moved toward the gas cap, then the effect of pressure interference will become minimized due to the difference in compressibility of your fluid.

Q That would be true in any area where the pressures are below the bubble point, is that not right, not only gas cap areas, but any other?

A That would be true if you have sufficient gas. The effect on your pressure interference is directly proportional to the amount of gas that you have, hence they would be more felt in a gas cap area than in the undersaturated area.

Q That is what I was wondering. You have wells of your own with pressure on the order of three or four hundred pounds, do you not?

A I don't believe they are that low. We have some 700 pounds.

Q Then there are, certainly are wells that you know of within the area that are below the bubble point?

A Yes. Yes, in fact the pilot area is below the bubble point, or would have been --

Q (Interrupting) It is not now?

A These surrounding areas down here may be.

Q You say may be. Are they or are they not?

A Yes, this well is low.

Q Now, the cumulative withdrawals have not been large from the area that you have discussed here, have they? Do you have the information on that?

A They vary from well to well. I do have the data if you would like to go through them well by well.

Q No, I wouldn't like to do that. Can you characterize them as being either large or small or medium, give us the high and the low? That will give us an idea.

A They vary from possibly the order of 2,000 barrels to possibly the order of 30,000 barrels.

Q That would be an estimate on the spread?

A That would be the spread, yes.

Q Just one more question. We note you don't have any pressures on your 2-C well which is within the pilot flood. Why is that? Recent pressures?

A Original pressures.

Q Recent pressures?

A Yes. We ran one just before we came out here and I got the data just in the last few hours. I have it right here. C-2 on forty-eight hour shutin has a casing pressure of 850 pounds and the reservoir pressure was 1389 pounds. 1389 would put it some place in here.

Q Is that a bomb test?

A No, that is an echometer test.

Q How about the British American Marye No. 1? Do you have a December pressure on that?

A No, the last data I had was December 6.

MR. PORTER: Anyone else have a question of Mr. Brinkley?

Mr. Malone.

MR. MALONE: Ross Malone, with Gulf.

By MR. MALONE:

Q Mr. Brinkley, do you have any recent pressures on the Federal 5 and 6 in Section 6?

A No, sir, that's the last data I have.

Q The October pressures are the last ones that you have?

A Yes, sir, that is the last ones I had, yes.

Q The last two pressures on those two wells indicated that the pressure was going up, did they not?

A That is correct.

Q And on the No. 4 well which is an offset, the pressure is going down in the last two, would it not?

A That is correct.

Q You don't know what the December pressures would show on 5 and 6?

A No, sir. We would have to measure it.

Q Your cross section indicates that the injection of gas is being made into a single sand member in the injection well, does it not? A That is correct.

Q That single sand member condition is not uniform all over the pool, is it?

A No, it is not.

MR. MALONE: That is all.

MR. PORTER: Anyone else have a question of Mr. Brinkley? Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, I believe in answer to Mr. Malone's question you said that the pressure information reflected a single sand member?

A I don't believe he asked that.

Q Well, I'm asking you that then now. Could not this same pressure information, this communication be shown if a single sand member is common to all these wells? A Yes.

Q Then it would not necessarily follow that all of these wells would have every sand member present in the Bisti-Lower Gallup Oil Pool?

A I don't know whether I understand your full statement there.

Q Does the fact that there is communication indicated as a result of your pressures also indicate that the various sand members of the stringer of sands that have been testified to that are contained in the Bisti-Lower Gallup trend would necessarily be present in all the wells shown on your Exhibit 8-R?

A We are injecting into the upper member, and that is the member that is being pressured up, and that is what we have detected in these adjacent wells, and the movement of fluid through the upper member and going over to the adjacent wells, I mean that movement has caused the pressure reversal.

Q This pressure reversal is no indication whatsoever that every stringer in the Lower Bisti Gallup trend is present in every well on your Exhibit 8-R, is it? A No.

Q I believe you testified that it was your opinion, as a result of this information, that one well would adequately and efficiently drain 80 acres? A Yes.

Q Now, tell me, Mr. Brinkley, if a well, any one of the wells on Exhibit 8-R failed to penetrate one of the lesser members, or failed to penetrate any trend or any stringer in the Lower Bisti trend, it would not be possible for that well to drain that particular trend, would it?

A You are speaking of the lower member?

Q Of any member if it failed to penetrate it, it couldn't drain it, could it?

A It is my opinion that the bulk of the reserves is contained in the upper member.

Q Mr. Brinkley, would you please answer my question? If the well --

A (Interrupting) I would like to have it repeated again.

Q If the well does not penetrate a given sand member, it cannot drain that member, can it?

A If the sand member is penetrated?.

Q I say, if it does not penetrate it, it cannot drain it?

A Not that well.

Q Maybe the question is so ridiculous you refuse to answer?

A Not that well. That is correct.

Q Then this information does not conclusively show that a well drilled on 80 acre spacing pattern would drain all of the sand members in the Lower Bisti trend, whether they are important or unimportant, in their opinion it doesn't prove that it would drain all of them?

A That is correct.

Q On primary recovery, Mr. Brinkley, what is the effect on the pressure decline, the normal pressure decline when a well is shut in?

A The pressure decline permits a buildup in gas saturation.

Q I don't believe you understood my question. What is the effect on the pressure decline, the normal pressure decline without any type of secondary recovery measures, what is the effect on the pressure decline when the producing well is shut in?

A I'm sorry, I don't understand you.

Q You get a pressure decline on a well in primary recovery?

A Yes.

Q It is declining at a steady rate?

A Yes.

Q Then the well is shut in, what is the effect on that curve?

A Well, it would continue to decline if the other wells in the field continued to produce.

Q Assume they do not in the area around this well.

A They would maintain the same value.

Q Would there be any possibility of a buildup?

A Not in a solution gas drive reservoir. Once it has built up due to its normal rock properties, then it would remain stable.

Q Are you aware of what production has been taken from the wells shown on Exhibit 8-R other than the four test wells?

A Yes.

Q What production has been taken from those wells during the months of September and October, 1957?

A I don't have it just in that form. I have the accumulated values for the pressure measurements on each well, but I have in my book here the monthly production by each well.

Q Are you aware that none of the wells according to your statistical report on Exhibit 8-R has any production whatsoever for the months of September and October with the exception of the Sunray Federal C-5 in Section 6, Township 25, North, Range 12 West.

A Let me present what I have here on Section 6, 25 North, 12 West.

Q That is the Sunray Federal 5-C?

A Five.

Q C-5? A For what months?

Q September and October. Substantially the period of time since the institution of the LPG injection program that was commenced on August 21, 1957, is that correct?

A September, my book shows for Federal C-5 to have produced no oil. For October I have 689 barrels.

Q Now, do you have any production whatsoever for any other wells shown on Exhibit 8-R with the exception of the four test wells?

A No, sir.

Q What effect do you think the failure to produce these wells would have on these pressures shown on Exhibit 8-R?

A It would reduce the pressures further.

Q Had they been produced?

A Had they been produced, that is correct.

Q In your direct testimony I believe you referred to a comparison between what you called the Pedigrew-Tocito Pool?

A Yes.

Q I believe that is the pool that the Commission designates the South Blanco-Tocito Pool? A Exactly.

Q On primary production prior to injection of water in the South Blanco-Tocito Pool, the records indicate that they were able to produce 3,152 barrels per PSI decline?

A Yes.

Q Will you state whether you think the Bisti-Lower Gallup Oil Pool could produce a similar quantity of oil without injection?

A No, it would produce less.

Q How much less? It doesn't need to be precise. In the order of a thousand less or two thousand less.

A It will be the same order of magnitude as observed in the Tocito Pool.

Q It would produce? A Roughly three thousand.

Q Three thousand barrels per PSI?

A That was what we have observed to date. I believe I had better qualify that statement, however, that is in the undersaturated region where we are operating.

Q What would be the importance of that qualification? What would be the effect in a saturated region?

A In a saturated region the barrels produced per delta PSI would be less than the three thousand.

Q Did you explain in answer to Mr. Seth's cross examination, I believe, the apparent anomaly of undersaturated oil and gas cap?

A I don't know.

Q Isn't it anomalous to have a gas cap in undersaturated oil?

A The oil in contact with the gas cap has to be saturated, but the oil that is downstructure at elevations lower than the gas-oil contact can be undersaturated like we have here at Bisti.

Q This is not an unusual situation?

A This is not unusual, no, sir.

Q You don't feel that this might possibly indicate a lack of communication between the gas cap and the oil?

A No.

Q I believe you testified that if this pool were developed on 40 acre spacing, that waste would occur? Would you please tell me how?

A Waste would occur by the drilling of unnecessary wells requiring investment by the operators.

Q The drilling of unnecessary wells rather than waste as defined by the New Mexico Statutes? A Exactly.

Q The definitions of waste are underground waste and --

A (Interrupting) Yes.

Q (Continuing) -- surface waste through evaporation or burning?

A Yes.

Q Economic waste through production of oil in excess of market demand? A Yes.

Q Waste as related to violation of ratable take. None of these would occur as a result of 40 acre spacing, would it? It would be merely by the drilling of unnecessary wells?

A The drilling of unnecessary wells.

Q Mr. Brinkley, would you direct your attention, please, to Exhibit 8-R please? More specifically to the British American Marye No. 3 well. On October 23, 1956, the pressure reading was taken of 1190 pounds, is that correct?

A That is correct.

Q And on August 15, 1957, the pressure reading was taken showing 1234 pounds? A Yes, sir.

Q This was prior to the injection of any LPG or gas into the Lower Gallup Oil Pool? A That is correct.

Q Would you please explain what in your opinion caused this increase in pressure?

A Let me check my records first.

Q The increase is also indicated on your Exhibit 9?

A Yes. That increase in pressure of 1234 pounds taken August 15, 1957 as compared to October 23, 1956, some 14 pounds.

Q Forty-four pounds, I believe.

A Some 44 pounds. Probably is explainable by the shutin times. The August pressure was shutin quite a few hours longer than the earlier pressure.

Q Are there any other variations in shutin times on the pressures indicated on Exhibit 8-R which might account for some of the variations shown thereon?

A There may be. I didn't try to list all of that information.

Q These tests were not taken under identical conditions for each well? A No, they were not.

Q Can you furnish the Commission with the shutin times for each of the wells for each of the tests?

A Yes.

Q Would you please do so? A Yes.

MR. COOLEY: Thank you very much, Mr. Brinkley. I have no further questions.

MR. PORTER: Mr. Brinkley, I believe you testified that you, in your opinion, this pool could be efficiently drained on an 80 acre spacing pattern? A Yes, sir.

Q Does that mean that you think you would recover as much oil on an 80 acre spacing pattern drilling one well to the 80 acres, as you would two wells to an 80?

A As far as we can be practical about it and honest with ourselves, yes, sir.

Q Then, you would have to assume that these various zones of pay are identical on horizontal limits, wouldn't you?

A We would have to assume that they extended sufficient distance to be penetrated by the wells.

Q All of the wells? A Yes.

MR. PORTER: Anyone else have a question? Mr. Errebo.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q With regard to Sunray Federal No. 4 well, do you have any explanation at this time for the decrease in pressure from the November 6, 1957 pressure of 1314 pounds to the December 4, 1957 pressure of 1294 pounds?

A Both tests were shut in in the same length of time, namely forty-eight hours. However, the likely reason why we have a variance there between those two dates is probably due to the irregular injection rates that we have experienced, and the reservoir had not stabilized in that area.

Q Mr. Brinkley, have you calculated the recoverable reserves in this field? A Yes.

Q What percent of these reserves are found in the two upper main sands?

A I would say essentially 95% of the total producable oil out of this reservoir would be contained in the two uppermost sands.

MR. ERREBO: Thank you. That's all I have.

MR. PORTER: Mr. Grenier.

RE-CROSS EXAMINATION

By MR. GRENIER:

Q Are you familiar with the definition of waste, Mr. Brinkley, as contained in the New Mexico Statute?

A No.

Q Let me then refer you to this portion of Section 65-3-3 of the New Mexico Statutes where it states as used in this Act, "The term waste, in addition to its ordinary meaning, shall include various other things", then it lists underground waste and surface waste. As I understood, in response to your answers given to Mr. Cooley, you indicated that perhaps the waste that you were talking about in the drilling of excess wells here that weren't needed, would not be either underground or surface waste. But when you drill twice as many wells as might be needed, would you mean that would be wasteful in the ordinary meaning of the word?

A In my opinion it would.

Q Approximately how many wells, or Mr. Finfrock indicated had been drilled in this pool?

A I think 187.

Q Have those been drilled to date substantially on 80 acre spacing?

A All with but a few exceptions.

Q Do you have any indication as to how many additional wells it would require to drill this up to 40 acre spacing?

A It would be over 200 wells.

Q What would the approximate range of cost of those wells be, would you have any concept of that? I mean per well.

A What a per well would cost?

Q Yes.

A Someplace in the order of $70,000.

Q So that multiplying seventy thousand by two hundred would indicate additional investment of about how much?

A About a million and a half dollars. Close to fifteen million.

Q So that using waste in the ordinary meaning of the word, you would think then there might be waste approaching fifteen million dollars? A That is correct.

Q If your conclusion is correct that 80 acre spacing will adequately drain all but the inferior flank portion possibly of this pool, is that correct? A That is correct.

Q Now, what is the position of an operator who has drilled his tract on 80 acre spacing and finds that other operators around him have, as permitted by regulation, drilled up to 40, can he adequately protect his position by producing from his 80 acre tracts?

A With the 80 acre unit allowable, I feel that he can.

Q Could he with a 40 acre allowable?

A If he had two wells on the 80 acre unit he could.

Q But if he is only going to drill up his tract to an 80 acre density rather than to a 40 acre density, can he adequately protect himself from drainage in that situation without drilling up his wells also?

A You kind of lost me in there with so many wells.

Q Assuming a situation where 40 acre spacing pattern is permitted by Commission order as at the present moment, assuming an operator has drilled up his tract originally on an 80 acre spacing pattern. His offset acreage around him is now drilled up to 40 acre density by the offsetting operators. Will he be adequately able to protect himself in that situation without drilling his own acreage? A I think so.

Q He will be able to do so even under those circumstances?

A If I understand your question properly, you are wanting to know if you can protect yourself whether you are on 40 acre drilling or on 80 acre drilling, is that correct?

Q No, I'm saying here he sits still. He doesn't drill up his particular tract to 40 acre density. He just stays put with 80 acre spacing in his particular tract of land, but all around him are 40 acre spaced wells. Will he in a 40 acre spacing pattern established by the Commission be able to protect himself without himself drilling up to a 40 acre density also?

A I'm sorry, I must be dense this morning. I just don't follow the entire question that you are asking.

Q Well, I'm assuming that each of these wells is now going to be getting the same allowable that he is going to have, each of these wells that he has drilled, one every 80 acres, but because he is only given 40 acres for prorationing purposes as his producing unit, he is only going to be getting one allowable for each of his wells. Now, under that circumstance, will he be able adequately to protect himself from drainage by these surrounding wells that are drilled to double the density on his tract?

A I'm still not clear. May I get this clear? Are the 80 acres on 40 acre allowable?

Q Yes.

A No, sir, you will not.

Q He will not be able to protect himself?

A No, sir.

Q Without drilling the additional wells necessary to put him too on 40 acre spacing?

A No, sir.

Q So, in effect, once people do start drilling on 40 acres, each operator offsetting that 40 acre drilled area is going to have to drill up to the 40 acre level himself in order to prevent being drained, is that correct? A That is correct.

MR. GRENIER: I think that's all.

By MR. VERITY:

Q Mr. Brinkley, George Verity for Rex Moore. If I understood you, you said there was only approximately five percent of the reservoir in these minor stringers?

A That is correct.

Q That is other than the two that you have graphed?

A That is correct.

Q Or Mr. Finfrock graphed. Assuming for the moment that you wouldn't recover any of it on 80 acres, which we realize is an assumption, and if you recovered all of it on 40 acres, would it pay for the cost of drilling the additional double amount of wells?

A No, sir.

By MR. MALONE:

Q Mr. Brinkley, you were asked a question by counsel for Southern Union as to the effect of developing on 40 as against 80 acre locations. Would you refer to your Exhibit No. 1-R, and in particular to the northwest quarter of Section 10 in Township 25 North, Range 12 West. Tell us how Southern Union developed those locations, drilled those locations, whether it was on 40 or 80 acres?

A You are referring to the northwest quarter of Section 10, Township 25 North, 12 West?

Q Right.

A Those are on 80 acre locations.

Q They are 40 acre offsetting wells, are they not?

A We have 160 acres, and considering 80 acre tracts running vertically, you would have one well on 80 acres. Hence it is consistent with the 80 acre spacing.

Q It does not conform to the pattern which you have recommended to the Commission, however, does it?

A No, sir.

Q Now, with reference to your statement that 95% of the total recoverable oil is in the two uppermost sands, have you computed the recoverable oil in place in this pool?

A Yes.

Q Could you give us that figure, please?

A It would be the same figure you presented in the previous case and it is not new information.

Q I think it relates to some new testimony.

A All right. Will you restate your question, please?

Q I asked you if you had computed the recoverable oil in place in the pool. You said yes, and I asked you what figure you had obtained.

A It would be roughly twenty-two million barrels.

Q Have you allocated that as between the two principal members which are shown on your cross section?

A Yes, sir.

Q Can you give us that allocation?

A You mean split between the two sections?

Q Yes.

A No, I have not done that.

Q Have you allocated it as between those two sections and the lower sections which are perforated in a large number of these wells?

A I don't have that precise number. However, we have arrived at this five percent additional oil out of the lower members by using the rock characteristics and the high water saturation in all of those to show there is very little oil in place and using a small recovery efficiency consistent even with other operators, that the amount of oil recovered is negligible and the five percent is basically an order of magnitude number.

Q Is Mid-Continent perforating in those lower zones in the wells they are drilling?

A We perforate in the lower zones as well as in the upper zones.

Q Would you say then that your figure of 95% was an estimation rather than a computation?

A It is an estimation.

MR. MALONE: Thank you.

By MR. GRENIER:

Q Mr. Brinkley, are you familiar, referring again to this group of Southern Union wells which was just mentioned in Mr. Malone's cross examination? A Yes.

Q Are you familiar with the zones in which those wells are respectively completed?

A No, I would have to refer to cross sections and maps.

MR. GRENIER: If we may make a statement at this time, Mr. Porter.

MR. MALONE: A sworn statement.

MR. GRENIER: I thought it would expedite matters and give you the answer in which you appear to be interested. If you would like to have Mr. Wiedekehr on and sworn, we will be glad to do so.

MR. MALONE: I am willing to accept your statement. I was kidding.

MR. GRENIER: There are, as indicated by Mr. Malone's questions, two wells upon this 160 acre quarter section. There are two completions in the upper zone, there are two completions --

MR. WIEDEKEHR: (Interrupting) If I may make the statement for him. There are two wells completed on 160 offset on 40 acres, one well completed in the upper zone and the other in the 200 feet separating the two; so actually there are the two wells completed on one 160 acre spacing, one well in each zone.

MR. PORTER: Thank you.

MR. SELINGER: May I ask the witness a few questions?

MR. PORTER: Are you going to direct your question to Mr. Brinkley?

MR. SELINGER: Mr. Brinkley.

By MR. SELINGER:

Q Mr. Brinkley, you testified that in your opinion the drilling of more than one well to 80 acres is an unnecessary well, is that correct? A That is correct.

Q You indicated that at the present development that there is some, there would be some 200 wells drilled as unnecessary wells?

A That is correct.

Q Now, every time you drill a well in this reservoir you utilize some of the reservoir energy in drilling that well, is that correct? A That is correct.

Q Now, if the drilling of an unnecessary well utilizes some of the reservoir energy, then that unnecessary well is utilizing reservoir energy unnecessarily, is that correct?

A That is correct.

Q Now, I want to read you the definition of underground waste as being the inefficient, excessive or improper use or dissipation of the reservoir energy, including gas energy. Now, would you have that situation in the drilling of the great many unnecessary wells in this field? A That is correct.

MR. SELINGER: That's all.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, just one more point on this definition of waste, 65-3-3 of the New Mexico Statutes Annotated. It says, Waste-Definitions, This definition is the definition of the waste of hydrocarbon, not the waste of money." Now, under the defined sense of A, B and C, or under the ordinary meaning of the word waste, will there be any wasting of hydrocarbon as the result of drilling on 40 acre spacing?

A Yes, under item A, the dissipation of reservoir energy, gas energy, spacing, drilling, operating, producing.

Q Will there be less hydrocarbon recovered on 40 acre than on 80 acre spacing, Mr. Brinkley? A No.

Q Then there wouldn't be any waste of hydrocarbons?

A There's always a waste in producing.

Q As compared between 80 and 40 acre spacing. You stated that 40 acre spacing would cause waste in this pool. I asked you what you meant by that. I think I know what you meant, you meant the economic loss? A Yes.

Q Of drilling wells? A Yes.

Q But you don't mean you mean to say there is going to be less oil recovered on 40 acre spacing than on 80 acre spacing?

A No.

MR. SELINGER: I believe you were conversing with Mr. Nutter at the time I was interrogating this witness. We are talking about the dissipation of reservoir energy, not the recovery of hydrocarbon, we are talking about the ~~recervoir~~ energy itself in the reservoir. He testified there would be a dissipation, an excessive inefficient dissipation of the reservoir energy in the drilling of unnecessary wells. That is defined as part of underground waste.

MR. COOLEY: I also asked him if there would be more oil recovered on 80 than 40.

A No.

MR. SELINGER: You are talking about a recoverable factor. I'm using the term of underground waste in the use of reservoir energy.

MR. COOLEY: If oil is not recovered it is wasted.

MR. SELINGER: If you drill unnecessary wells and dissipate reservoir energy regardless of your recoverable factor, that is underground waste.

MR. PORTER: Mr. Seth has a question.

MR. SETH: I don't know whether to direct this question to Mr. Selinger or the witness.

By MR. SETH:

Q Mr. Brinkley, you testified in response to Mr. Selinger's question, that there would be reservoir energy lost by the drilling of wells? A That is correct.

Q Now, would you explain how that comes about?

A Well, the fuel that is required in order to drill those wells i fluid that is used to do unnecessary work, and in my opinion that would be waste.

Q Using gas to complete the wells?

A Yes.

Q That is the extent of your point on that particular question?

A That is one example.

Q Well, what else is there, it takes reservoir energy to produce these wells too, is that what you are testifying to?

A Well, now, I'm not an expert on waste and legal matters.

Q I'm not talking to you at all about legal matters. The question was reservoir energy. You are an expert on reservoir energy?

A That's right.

Q How is that expended by drilling these 40 acre wells?

A Because you are using fuel to drill unnecessary wells, and the fuel could be diverted to repressuring operations to further the recovery in this reservoir.

I might carry that a little bit further, that we know that we can get additional oil recovery by the injection of gas, and one of our studies right now considered the injection of gas to improve the recovery, and if the gas is wasted and can't be injected, it would be waste.

Q Your testimony now is that it takes gas to power the equipment to drill the wells and for gas depletion, is that right?

A Yes.

Q What is being done with that gas now if it were not used for that?

A Part of it, I'm sure, is being used for fuel, but right now we are making a study to utilize that gas.

Q Well, then, the extent of your testimony was that you use some fuel to drill wells and the fuel is procured locally?

A Yes.

Q Is that about the extent of it?

A Yes.

MR. GRENIER: May I ask one question?

By MR. GRENIER:

Q In response to Mr. Seth's questioning, I gathered that you were indicating that exclusive of the fuel use, things happening on the surface, that approximately the same amount of reservoir energy would be required to produce the same amount of oil whether on 40 or 80 acre spacing, is that correct?

A I believe it would be the same amount of energy.

Q Now, having used the same amount of energy to produce the same volume of oil on either spacing, which would be the more efficient way of using that reservoir energy, through a program that cost X dollars or through a program through having double the wells, two X dollars?

A The former X dollars.

Q So, it would be the more efficient use of reservoir energy to recover this same amount of oil and make use of this same amount of reservoir energy on an 80 acre spacing pattern than on 40?

A That is correct.

Q So that relatively the 40 acre spacing pattern utilization of reservoir energy would be inefficient, is that correct?

A That is correct.

Q And therefore that would be within the definition as we have it here in this section referred to where it defines underground waste as being a number of things embracing the inefficient use or dissipation of the reservoir energy, which you characterize it, then the use of reservoir energy by 80 acre as being such an inefficient use of reservoir energy?

A That is correct.

Q So that it would be wasteful then to that extent?

A That is correct.

MR. PORTER: Mr. Cooley.

By MR. COOLEY: Mr. Brinkley, are you familiar with the way the two Southern Union wells, which were mentioned in the testimony a few moments ago, were completed?

A Only from what I have heard here.

Q These wells are on offsetting 40 acre tracts, are they not?

A That is correct.

Q And since you do not know of your own information that these wells are completed in different zones, let us assume that these wells are completed in two different zones.

A Yes.

Q One is completed in an upper zone and one completed in the lower zoneʔ A Yes.

Q Then, Mr. Brinkley, my question is this, had the Southern Union wells been drilled in accordance with your recommendations, one of the wells would have been to the northeast corner, I believe was your recommendation? A That is correct.

Q Is there not a good possibility that the zone penetrated by the well in the southeast where it is actually located, might not even have penetrated that zone? A That is correct.

MR. COOLEY: Thank you.

MR. PORTER: I have a question in mind, but I think I will defer it for awhile. Mr. Sullivan.

MR. SULLIVAN: Mr. Sullivan, British American.

By MR. SULLIVAN:

Q There has been a good deal of testimony here, Mr. Brinkley, with regard to the terms of the New Mexico Statute. I would like to read a provision to you and ask you whether or not that this provision existed in the law. You may answer this either yes or no. Are you aware of the fact that Section 65-3-14(b) of the New Mexico Conservation Act reads as follows: "The Commission may establish a proration unit for each pool, such being the area that can be efficiently and economically drained and developed by one well, and in so doing the Commission shall consider the economic loss caused by the drilling of unnecessary wells, the protection of correlative rights, including those of royalty owners, the prevention of waste, the

avoidance of the augmentation of risks arising from the drilling of an excessive number of wells, and the prevention of reduced recovery which might result from the drilling of too few wells."
Are you aware that that was in the statute?

A I have never read this.

Q Just the answer no then?

A But through conversation --

Q Just the answer no then? A No.

MR. PORTER: The hearing will recess until one-thirty.

(Recess.)

AFTERNOON SESSION

MR. PORTER: The meeting will come to order, please. I don't recall who was questioning Mr. Brinkley at the recess. Mr. Grenier, were you questioning the witness?

MR. GRENIER: No, but it has been called to my attention during the recess by one of the other lawyers in the case, that apparently I misstated one question and the witness misheard and we got a rather strange question and answer. This relates to the point where I was inquiring of Mr. Brinkley as to whether 40 or 80 acre development of the field would represent the more efficient utilization of reservoir energy. I think I asked, isn't 80 acre spacing less efficient, and he said yes.

My question, I'm sure, was asking him wouldn't 40 acres be more inefficient, and I would ask him what his answer to that would be.

A Yes, a 40 acre spacing would be less efficient.

MR. GRENIER: Thank you.

MR. PORTER: Anyone else have a question of Mr. Brinkley at this time?

MR. UTZ: I have a question.

MR. PORTER: Mr. Utz, I didn't see you.

By MR. UTZ:

Q Mr. Brinkley, how long do you think that it takes to stabilize the shutin pressure in the Bisti Pool?

A We have observed in some of the wells along the longitudinal axis they would completely build up in pressure in less than forty-eight hours. Also the fringe wells have been, required a longer period of time than forty-eight hours to stabilize.

Q That would be due to lower permeability?

A Due to poor rock characteristics.

Q In taking shutin pressures in the pool, what would you recommend as the shutin pressure time for the period of stabilization?

A For the wells in the fairway I would recommend forty-eight hours, and in the fringe areas I would recommend a minimum of seventy-two hours.

Q It would be a little bit difficult to have two different times?

A Yes, it would.

Q In reference to your Exhibit 9-R, with particular reference to the Sunray C-2, I note over in the first part of April a shutin pressure in the vicinity of 1270, and apparently there was not any more shutin pressures taken until somewhere about the middle of September? A Yes, sir.

Q Do you attribute that increase to your injection of LPG and gas?

A This is an abnormally high pressure, and I cannot explain it. It could be an error in measurement or instrument or something else, but it is obviously too high. I did put it on here because it was a data I received and I did not try to edit the data.

Q It also shows quite a fast decrease in pressure on the pressure taken the latter part of September, does it not?

A Yes, sir, this point here. I first would like to say that I questioned that point, and since I had this point here I drew a line to connect the two data points and the decline carries no significance as far as I'm concerned.

MR. UTZ: That answers my question.

MR. PORTER: Anyone else have a question of the witness? Mr. Nutter.

By MR. NUTTER:

Q Mr. Brinkley, you stated there would be a difference in the efficiency in the use of the reservoir energy in 40 acre against 80 acre spacing? A Yes, sir.

Q How would this be measured, what would be the ultimate outcome of the difference in the efficiency in the use of the reservoir energy?

A For one thing, you would have half as many pressure sinks in the reservoir, which of course, a pressure sink causes increase in gas saturation and it is that that I am referring to.

Q The ultimate answer to the use of reservoir energy is the barrels of oil produced, is it not?

A Yes.

Q And then the question could be resolved as to the matter of time in which the oil is produced?

A Yes.

Q The economic limits of the time that it takes to produce a given amount of oil, that is important?

A That's right.

Q Would it be fair to say that one of the criteria here that the Commission must consider, would be how long it would take to produce a given amount of oil in this reservoir?

A That might be one criteria.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

The Commission has had a request from counsel for Rex Moore, Mr. Verity, for permission to make a short statement in order to leave here to make a plane connection. Is there any objection to Mr. Verity making this statement at this time?

MR. VERITY: Your Honor, in behalf of Rex Moore, we don't have any evidence to produce at this hearing, but I would like for the record to show that Mr. Rex Moore, who owns the 1,040 acres of leases within the area that is here under consideration, finds himself in a very embarrassing position. If the Commission establishes a 40 acre spacing as his lease is at the present time, or in the past when it was being developed under a voluntary 80 acre spacing, he, as an independent operator, could develop his lease. I'm sure this Commission is aware of the fact that the average independent must borrow money in order to develop his lease properties under normal circumstances, and certainly Mr. Moore is in that position, and I believe the bulk of the independents in this Bisti Pool. He is in the position that whereas he can borrow money and develop his thousand and forty acres on 80 acre spacing, he as yet has been unable to find any lending agency that will finance him to develop his pool on 40 acres. That leaves him in the position, if this Commission allows its order to stand that it promulgated recently, establishing the 40 acre, he is going to have to sell his lease or else farm it out on whatever kind of a basis can come around.

He feels that that is inequitable and that is unfair, and therefore he joins in the application for 80 acre spacing. He finds that his engineers and bankers concur with the engineering that recommends the 80 acres to this Commission.

MR. PORTER: Mr. McGowan, did you have testimony to present at this time?

MR. McGOWAN: If the Commission please, we will have three exhibits. I suggest that we continue to number them 10, 11, 12-R so there will be continuity in the record. They are in support of the application for rehearing and in support of the application.

MR. PORTER: We have no objection.

(Marked Applicant's Exhibits 11-R, 10-R and 12-R, for identification.)

C. D. GAINES

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. McGOWAN:

Will you state your name and by whom you are employed and what capacity, please?

A The name is C. D. Gaines. I am Division Production Engineer for Sinclair Oil and Gas Company in their Denver Division.

Q You do have a degree in engineering and have had about nine years' experience as a working engineer for Sinclair?

A That is correct.

Q You have not previously testified in this hearing?

A No, sir, I have not.

Q You have previously, however, testified as an expert before this Commission? A Yes, sir, I have.

MR. McGOWAN: Are his qualifications acceptable?

MR. PORTER: Yes.

Q In your capacity, Mr. Gaines, as Division Engineer for the Denver Division, do you have under your jurisdiction what is being referred to here as Bisti Pool? A Yes.

Q Does Sinclair Oil and Gas Company own interests and leases in wells in that pool? A Yes, we do.

Q Are they more or less concentrated in a particular portion of the pool?

A Yes, they are concentrated in Township 25 North, Range 11 West, approximately in this area in here.

Q Now, Mr. Gaines, have you, although you did not testify in it, have you read and are you aware of the testimony that was given at the previous hearing in this matter?

A Yes, sir, I am.

Q You have the information that was contained then in the testimony given at that time, it has been available to you in your studies, has it not? A Yes, sir, it has.

Q Have you also made an independent study of the pool yourself with particular attention to the area you just made reference to?

A Yes, sir. In fact, the study was concentrated on this hearing.

Q Is that the reason that you had more information in that area than other areas?

A It was partially due to the fact that our interests are in this area of the pool and we were interested in evaluating Sinclair Oil and Gas Company's interest, and also that is the data that we had available to work with.

Q Now, you were aware in your study, were you not, that the Commission had under consideration here the proper sized spacing or proration units to develop this pool on, together with the field rules that would be necessary to prevent waste in this pool, were you not?

A Yes, sir, I was.

Q Did you make a study of this reservoir to enable you to make what in your opinion would be a recommendation to the Commission which would be in your opinion the best method of so doing?

A Yes, sir, the concentrated study, as I said before, was in Township 25 North, Range 11 West, but I did review other data that was presented at the last hearing.

Q In making such study you were aware, were you not, that the Commission is concerned with the prevention of waste as defined in the statutes, and those definitions you were aware of?

A Yes, sir.

Q You were aware that the Commission has a duty of protecting correlative rights, and you were aware of that in your study?

A Yes, sir.

Q May I ask you, in considering the effect upon correlative rights, were you considering the statutory definition of such, which is essentially to give to each operator the opportunity so far as practical, to recover the hydrocarbons under his lands?

A Yes, sir.

Q Now, Mr. Gaines, evaluating a pool and coming to a conclusion concerning the size of spacing of proration units that would be necessary, do you feel that there is a minimum below which you cannot go?

A Yes, sir, certainly.

Q Is that minimum actually based upon economics?

A Yes, sir, it is.

Q In other words, then, any unit that does not contain sufficient recoverable hydrocarbons under it to pay for the cost of drilling and operating a well to depletion plus profit would be uneconomical and therefore below that limit, would it not?

A Yes, sir, it would.

Q Would it be fair to state that you start with that minimum and then see how large an area in your opinion can be drained by one well in order to establish the maximum?

A Yes, sir.

Q Then within those two limits, you decide what you feel is the best proration or spacing unit for that field?

A Yes, sir.

Q Now, in constructing and coming to the recommendation that you are going to make to the Commission, did you consider all these factors and proceed essentially on the matter that has heretofore been outlined?

A Yes, sir.

Q Then on that basis, will you advise what your recommendation is concerning this pool?

A We feel that the greatest ultimate recovery could be obtained from the Bisti-Lower Gallup Field by a fixed 80 acre spacing pattern. However, we feel that the establishing of 80 acre prorationing units would essentially accomplish the purpose with respect to preventing waste. We concur in the recommendation of Sunray Mid-Continent that the limiting gas-oil ratio for oil wells be set at 2,000 cubic feet per barrel.

We would further recommend that for the present at least, that a well which is producing with a gas-oil ratio in excess of 15,000 cubic feet per barrel be classified as a gas well.

We would further recommend for allowable purposes that a gas well be permitted to assign up to four 80 acre units, and that the allowable be based upon the volumetric formula.

Q Now, Mr. Gaines, when you used the word spacing unit, you were thinking in terms, were you not, of prescribed 80 acre units with a prescribed well location thereon and prohibition against drilling additional units on this 80 acre unit?

A Yes, sir.

Q When you mentioned the word proration units, you were talking about a proration unit for allowable purposes without any restriction as to whether one or two wells could be drilled thereon?

A Yes, sir.

Q You mentioned a gas cap, Mr. Gaines. With particular attention to the area in which Sinclair has leases and in which you have, in your opinion, sufficient information to evaluate the reservoir, do you feel that you have come to a valid conclusion concerning the approximate location of the gas cap in this reservoir?

A Yes, sir, as to the approximate location.

Q In discussing the gas cap as you envision it in this field, will you refer to Exhibit 10-R? Would you please advise the Commission what that exhibit shows?

A Exhibit 10-R is a structure map in the area that we were speaking of, which is based upon a marker which is approximately ten feet above the top of the first sand in the Lower Gallup. We have indicated two cross sections, A, A_1 and B, B_1 which are shown on Exhibits 11-R and 12-R. The area that is colored in yellow represents our interpretation of the area in which some free gas could be expected.

Q That would be what would normally be referred to then as the gas cap area?

A Yes, I think so. Certainly you would have to move inside this yellow band to get a gas well without making any oil because there would be marginal areas through there where you would have both oil and gas, and thus high gas-oil ratio wells.

Q Do you feel then that the gas in this area is pretty well concentrated, or the gas in this pool is pretty well concentrated in a gas cap along the southwestern flank except for such free gas as might be found in isolated anomalies as was discussed by a previous witness this morning?

A Sir, we did not go past the town line, rather the range line, between 11 and, Range 11 and 12 West, and our interpretation of the gas area in Sections 19 and 20 in Township 25 North, Range 11 West is based purely on interpretation. We had no gas volumes to use from these wells, but using the same criteria that we did use down in this area where we did have control, we extended this gas cap area across here. We have no proof that it does go there.

Q Do you feel that you have been able at least in that area to define the gas cap to the southwest?

A We have --

Q (Interrupting) Let's say the southwestern edge of the gas cap.

A We have a distance of approximately five miles in lateral extent that we can very definitely define the gas cap.

Q You feel the southwesterly edge of it would be the edge of the pool?

A Yes, sir.

Q The northeasterly edge of it would be the gas-oil contact?

A Yes, sir.

Q And the southeasterly and northwesterly limits of it cannot at this time, in your opinion, be defined or at least on the information that you have?

A Based on the information I have, I cannot define them. It might be possible they could be defined.

Q I gather that you are of the opinion there is a significant gas cap area in this pool?

A We are looking at the gas cap area that certainly represents approximately a fourth of the length of the pool.

Q Will you refer to your Exhibits 11-R and 12-R and advise the Commission what they are and the significance of those exhibits? One moment, Mr. Gaines, before you go to the latter two exhibits. It has been called to my attention that on the map there is an error in one or two lease owner names. Would you like to correct that at this time?

A Yes, sir, on this plat we did not catch this until we had them prepared, but the Sunray Mid-Continent Sinclair lease in the southwest quarter of Section 15, Township 25, all of these are in Township 25 North, Range 11 West, the name of that lease should be the Platero. The lease in the northeast quarter of Section 23 should be Bittony NEZ, and the lease in the northwest quarter of Section 25 should be Es-Ka-By-E.

Q Would you mind spelling those lease names?

A Es-Ka-By-E, E-s-k-a-b-y-e, Platero, and B-i-t-t-o-n-y N-E-Z.

Q Now, will you refer to Exhibits 11-R and 12-R and state what they are and their significance?

A Exhibits 11-R and 12-R are cross sections, as I stated before. No. 11-R being more or less perpendicular to the field with the exception of the red going over to the Shell Carson Well and the other well diagonally across the breadth of the field. We were concerned about the Shell Carson No. 5 due to the past tests, but we had to report that it was a 33 barrel oil well, and we felt like that certainly it should be a gas well.

I don't believe it is proven that it isn't a gas well as yet. In Es-Ka-Nel-E-Wood No. 2, Sunray Mid-Continent Well afforded us some very valuable information with regard to this gas cap, in that the well was tested separately in both the first and second zones and produced gas from both zones, which meant that our gas-oil contact must lie below the bottom perforations in the second zone, but there is no fluid reported.

Then Sunray Mid-Continent Es-Ka-Nel-E-Wood No. 1 was completed with a gas-oil ratio of 1,020 to 1. That would certainly mean that essentially all of the perforations in Es-Ka-Nel-E-Wood No. 1 must be in the oil zone. Therefore I think certainly in this area here we would expect that the gas-oil contacts in the two zones must be slightly different.

I might add, in talking about these gas-oil ratios, that practically all of them are potential tests or completion tests on the wells. After short periods of significant fluid withdrawals, I think the gas-oil ratios could change considerably.

Q They would change to a higher rate, would they not, in your opinion?

A Certainly I think in this gas cap area. Yes. We had the Texas Company No. 1 Navajo also, and then the No. 1 Harvey which was a dry hole. We attempted with our other cross section to apply these same gas-oil contacts to the wells that we have in this cross section.

I might add that we did have core data on the Anderson-Pritchard or Sun Oil's No. 1 H Begay, Sun Oil Heirs of Ko-Sa No. 2, the Heirs of Ko-Sa No. 1, the Sun Oil No. Heirs of Ka-Na-Pah and No. 1 and No. 2.

Using the same gas-oil contacts which were a plus 1550 in the first zone, and I believe plus 1530 in the second, we used this same data to apply to this cross section. This was a gas well in the second zone perforated only in the second zone. Magnolia's No. 1 Ken-Nu-To had a gas-oil ratio I believe of about 11,550 cubic feet per barrel. It produced 45 barrels of oil on a 1664 inch choke. We found that to explain a low gas-oil ratio of, and by low I mean approximately a thousand to one in Sun Oil's No. 1 Heirs of Ko-Sa, that we had to tilt the gas cap approximately ten feet, going down structure.

It could be that with more production we would find a higher gas-oil ratio in this well. Then as we go on down structure, we have ratios of a thousand or less, and then we do have included the No. 1 Platero which was discussed this morning, and we also independently put a little gas cap in this area independently, I would say, of Sunray's approach to the gas that is found down structure in the second zone, and the first zone, or rather the second zone which is the producing zone in the Platero No. 1 is found at plus 1510, while the second zone in Sun Oil's No. 2 Heirs of Ka-Na-Pah is down at a plus 1500. In other words, it is higher structurally.

Q You then agree with the conclusions that were expressed concerning that well this morning?

A Yes, sir, I do.

Q One other question on two exhibits. Those two cross sections, I believe, are constructed to scale both horizontally and vertically, are they not?

A Yes, sir, they are.

Q Now, Mr. Gaines, you recommend to the Commission 80 acre proration units?

A Yes, sir.

Q Did you evaluate this reservoir from an economic standpoint?

A Yes, sir, I did.

Q Is it your opinion, without going into detail very much, the record is full, that 40 acre units in a major portion of this reservoir would be uneconomical?

A Yes, sir.

Q They would not produce enough oil for drilling and operating the well to depletion? A Yes, sir.

Q In making such calculations, and the calculations in the previous testimony are on the same basis, you were assuming a depletion of the wells based upon an allowable at least in line with other allowables in the State of New Mexico?

A We used a ten year life for 40 acre spacing, which I think would be a reasonable life with the allowables in southeastern New Mexico.

Q If that allowable in northwestern New Mexico, and particularly in this pool, remains substantially lower than in southeastern New Mexico as it presently is, that would extend the life of the wells? A Yes.

Q It would also substantially increase the operating costs?

A Yes, sir.

Q It would make wells that might now seem economic, uneconomical? A Yes, sir.

Q You recommended 80 acre proration units, is it your opinion that one well will economically and efficiently drain the recoverable oil from under an area in excess of 80 acres in the oil portion of this reservoir?

A From the data that we have worked with and the data that we have had the opportunity to look at that other people have worked with, I do.

Q Without repeating the testimony to any extent, I gather then that you feel that the permeabilities in this pool are sufficient to allow drainage in excess of 80 acres in the oil zone?

A Yes, sir.

Q And it is your opinion that the interference test and the information in the test that has been given here before conclusively proves that? A Yes, sir.

Q Is it your opinion that one well will economically and efficiently drain in excess of 320 acres in the gas cap area?

A Yes, sir.

Q It is the basis of your recommendation of assigning a maximum of four proration units to a gas well?

A Yes, sir, and also on the basis that a lesser spacing would be very uneconomical and in fact 320 acres would be a slightly less than break even proposition to the gas wells located in that area.

Q Do you feel that the method of controlling this field and setting up proration units that you have recommended to the Commission will result in the greatest ultimate recovery of hydrocarbon from the entire pool?

A Yes, sir, I certainly think there is that possibility.

Q Now, Mr. Gaines, without leaving any inference that you feel that one well on 80 will produce more oil than two wells would, is it nevertheless your opinion that the 80 acre spacing will actually produce more oil from this pool than 40 acre would?

A If we make certain assumptions.

Q And that assumption would be that the fringe areas should not be and would not be developed on 40 acres?

A Together with the assumptions and data that has been previously presented to the Commission.

Q Insofar as each area of this pool could not be economically developed on 40 acres, the oil underlying that land would not be productive except by drainage into the center of the pool?

A Yes, sir.

Q In your study of this reservoir, have you found leases that in your opinion could not be economically developed on 40 acres?

A Yes, sir.

Q Does Sinclair own one? A Yes, sir.

Q Would you recommend to your management that they drill 40 acre wells on that lease if the Commission orders 40 acres?

A No, sir, I would not recommend they drill wells on that lease.

Q It would be to the economic advantage of Sinclair to abandon the lease rather than drill 40 acre wells on it?

A That would be my recommendation.

Q I assume that you feel that in order to prevent waste and protect correlative rights of the parties to the greatest extent possible, 80 acre proration units should be established for the Bisti-Lower Gallup Pool?

A Yes, sir.

Q Do you feel that unnecessary wells would be drilled if such a program is not adopted by the Commission?

A Yes, sir.

MR. McGOWAN: I believe that's all.

MR. PORTER: Anyone have a question of Mr. Gaines?

MR. SETH: I have a few questions.

MR. PORTER: Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q If I understand your testimony, Mr. Gaines, the issue here is if the Commission continues with the 40 acre spacing, you'll either have to drill that lease up on 40 acre tracts or abandon it, is that right?

A That is not the issue with us, no, sir.

Q I mean is that what you think you are faced with? Is that your choice?

A If we are talking about one lease. I think it is broader than one lease, but there will be leases that we feel would be uneconomical to drill.

Q Let's take the one lease that you spoke of. You feel that if they continue the 40 acre spacing, that you'll either have to drill it up or abandon it, is that correct?

A That is correct.

MR. SETH: That's all.

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q Mr. Gaines, as I understood your study was limited entirely to the area east of the range line, which is depicted on your Exhibit 10-R?

A Yes, sir, it was, other than reviewing, also the results of other people's studies, also.

Q Was your study also limited entirely to the two sand members that are shown on the two cross sections which you have introduced?

A Essentially, we looked at some 30, 31 or 32 wells in this area. We found cases where we would have as much as two or three feet of microlog separation below that.

Q And that was perforated in a number of those wells, was it not?

A There was a very few of the wells that it was perforated in. In fact, I think they were in Township 25 North, 11 West, there were four wells which were perforated in zones other than the first and second zone.

Q Did you make any study of that sand member?

A Not independently, no, sir.

Q So its existence is not taken into consideration in the recommendations that you made to the Commission?

A Other than we feel it will contain very small reserves.

Q You feel that it can be disregarded and you have disregarded it?

A Yes, sir.

MR. MALONE: That's all.

MR. DUTTON: Granville Dutton, Sun Oil in Dallas.

MR. PORTER: Mr. Dutton.

By MR. DUTTON:

Q I have heard two references to I believe it's Shell Carson 5. Am I correct in understanding that this well was represented at the last hearing as being an oil well?

A I believe that's the conclusion that I drew from reading the testimony.

Q And it is your testimony now, and I believe if I understood Mr. Brinkley this morning, that the well has produced only 33 barrels of oil?

A No, sir, I believe it has recovered, I believe he used 80,000 gallons as a fract treatment, and it has yet not recovered the 80,000 gallons of oil.

Q Is it your testimony now that in your opinion this well is a gas well?

A No, sir, we do not have any data as to whether that well tested a gas well or whether it didn't.

Q Well, it is your testimony that a gas cap does currently exist in the southeastern portion of the Bisti-Lower Gallup Oil Pool?

A Yes, sir, I think very definitely.

Q You testified that you have made an economic evaluation of the leased portions of this field?

A Yes, sir.

Q In so doing did you arrive at an average figure for a cost of a well in this area?

A Yes, sir, we did.

Q Would you give us that figure?

A The average figure for an oil well, including the averaging out, the lease equipment and the artificial lift equipment, we used a figure of $70,000. For the well itself we had a figure of $54,800.

Q Mr. Gaines, would it be your opinion that it would be economically feasible to drill a $54,800 development well if the reasonable expectation was to receive a producing allowable of only ten barrels per day?

A Certainly not.

MR. DUTTON: Thank you.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Gaines, in making your study of this pool, did you attempt to determine how much of the oil was in the various independent pays that comprised the Gallup formation?

A No, sir. We did not split them up by zones. However, it would be purely an estimate on my part. I would say that probably in excess of 95% would be in the first and second zones in the areas that we have looked at.

Q In these two main zones that you have shown us?

A Yes, sir.

Q Mr. Gaines, in drilling a pool up on 80 acre spacing, on a northeast-southwest basis in each 160 acres or northwest-southeast, does it not follow that the wells would of necessity, to be on a perfectly uniform pattern, have to be 660, 1980 locations?

A Yes, sir. To be perfect.

Q And if a pool is drilled up on 40 acre spacing with completely uniform spacing throughout the pool, it follows that the locations must of necessity be 660, 660 locations, is that correct?

A Well, I believe it would be 1320, if they were in the center of the 40.

Q I mean 660, 660 out of each 40 acre tract in the center of each 40. A Yes, sir.

Q If you drill wells on ten acre spacing, the normal spacing pattern would be 330 feet out of each ten acre tract in order to be in the center, would it not? A That is correct.

Q How many wells does Sinclair have in this area that you have depicted in your exhibit?

A We have a half interest in nine wells that are completed, and I believe at the present time there are two drilling.

Q How many of those wells have been located in such a manner that the minimum distance from the lease line, or minimum distance from the 40 acre tract in which the wells are located, is at least 660 feet?

A It would be an estimate on my part since I don't think right here I have the exact location of the individual wells.

Q These wells are located on your map with respect to the actual distance from the lines, aren't they?

A That's correct.

Q The Platero No. 1, how far does it appear to be from the section line?

A I would guess that to be a 330 location.

Q Sinclair Sunray's Es-Ka-Nel-E-Wood No. 2 is what type of location?

A Could I correct myself on that last statement there, it would be, do you want the distance to the closest lease line?

A That's right.

A Then it would be, it appears to be approximately 330.

Q How about Sinclair Sunray Es-Ka-Nel-E-Wood No. 2 in Section 22 there?

A It looks like it is 660.

Q It is a 660, 660 location?

A Yes, sir, No. 2 is also.

Q The No. 1 and No. 2 on that lease?

A Yes.

Q How about up here, Sunray Sinclair A-Se-Des-Pah?

A Yes, that was the Bittony NEZ and that would be 660 also, I believe.

Q How about Sinclair Sunray's, about this well over here in Section 24?

A I believe that is a 330 location.

Q Sinclair's Margalita No. 1 is a 660, isn't it?

A Yes, sir.

Q How about down here in Section 25, the Es-Ka-By-E No. 2?

A Well, that looks like it could be between 330 and 660 from my plat here.

Q It doesn't appear to be a 660?

A No, it appears to be between 330 and 660.

Q How about the Kas-Na-Des-Pah in Section 25?

A That appears to be 330 from the north line.

Q How about in Section 30, SDX 9 Eton No. 2?

A The No. 2 appears to be 330 from the north line of the lease. The No. 1 appears to be 660 from the east line and greater distance from the south line.

Q So that probably would be close to 330 from the north line of that tract, would it not?

A The No. 2 would, the No. 1 --

Q (Interrupting) The No. 1 from the 40 acre tract?

A From the 40 acre tract, yes, sir.

Q Is there any significance in this location of these wells, Mr. Gaines? I count six wells that are 330 locations from the 40 acre tracts and four wells that are 660. Is there any significance in the location of those wells?

A I think there might be one significance in the area in that high-gas-oil ratios have been experienced down in this area and it's recognized that there is a gas cap here, and I think certainly that any operator would try to stay away from the gas cap.

Q In a field where it becomes necessary to drill more than half the wells on 330 locations, is that any reflection on the ability of the wells to produce an 80 acre tract?

A I don't think it is. As to the reason for it becoming necessary to drill on 330 from the edge of 40 acre tracts, it certainly would have some bearing upon the drainage. However, in the core analysis that we did examine in this area, we found very good permeabilities in the first and second zone. I think certainly I would concur with the opinion that one well could drain in excess of 80 acres.

Q In other words, the location on 330 feet from a line was not necessitated by any lack of permeability whatsoever?

A Having part interest in this property, the recommendations for drilling are submitted to Sinclair and approved by us. As to the exact reasons, we don't know, we do approve them if we agree with them.

MR. NUTTER: Thank you.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Gaines, I believe you stated that you felt that something in excess of 95% of the reserves in the Bisti-Lower Gallup Oil Pool are in the first two zones?

A Yes, sir, based upon the area that we have looked at here.

Q And then limiting yourself to the area that you have studied, to what degree are these first two zones coextensive through this area?

A The first two zones?

Q Yes.

A I think that you can trace them completely through the area, as indicated by the two cross sections we have there, until you do get out on the flanks of the field, and then it appears that in this area, as you get to the north edge of the field, that the first zone shales out before the second zone does. To the south it appears that the first zone, the second zone possibly shales out a little before the first does.

Q Could you give a rough estimate in percentage as to what percent of this area you feel these two zones are coextensive, 75% or better or 50% or better?

A Well, what we would have to do to come up with that volume I think is to plot the limits of where the zones would shale out along the flanks of the field and then perimeter that area under that and apply it to the number of feet that we would think would be an average.

I think when we talk about total reservoir volume, that we are speaking about, probably a significant percent due to the perimeter of the field. Assuming that these conditions do exist all the way around the field, I think that there is a possibility that it would be a significant volume.

Q A significant area over which they are not coextensive?

A By coextensive --

Q (Interrupting) One well drilled at any given point would not penetrate both zones?

A Yes, sir, I think it would be a significant area because of the perimeter of this field. I think you are looking at quite an area if you just drew a circle around the field if it were only one location wide.

Q Of course, this perimeter, I believe, as all the testimony indicates, all the way around are the poorer locations?

A Yes, sir.

Q Mr. Gaines, I am not sure I understand all of your recommendations concerning the proration of the gas wells completed within the gas cap in the Bisti. Would these wells be assigned 320 acres as a standard unit, I believe you testified you are up to four proration units?

A Yes, sir.

Q Would a standard, would there be such a thing as a standard unit and would that unit be 320 acres?

A No, sir, I believe that would be the maximum unit size.

Q What would determine whether a 160 or 320 or any figure would be assigned to a given well?

A I think it would be determined by the area that would be productive of gas, and by that I do mean gas cap gas.

Q Would this area dedicated to a gas well, would it be the possibility under your proposed plan of dedicating certain of that acreage to an oil well also? A No, sir.

Q There would be no simultaneous, it would either be dedicated to a gas well or oil well? A Yes, sir.

Q Did you include a volumetric withdrawal computation into this?

A I mentioned one.

Q I thought you just mentioned, and in passing I wondered if you would expand on that just a little.

A Well, there are several ways that you could approach it, it would be a matter of how exact you wanted to get, and of course, the more exact that you get I think the more data that it would require to regulate these gas allowables. The simplest would be to apply the solution, the limiting gas-oil ratio for oil wells, times the number of 80 acre units assigned to a gas well to come up with a limiting gas volume.

Q If an 80 acre oil well got X, the amount of gas that an 80 acre unit could produce along with its oil would be X?

A That's correct.

Q Then a 320 would produce 4X?

A That is correct, that would be the simplest and then you could go to more or other formulas that would be more complicated and require bottom hole pressure data in that.

Q Do you think there is a danger in the possibility that gas might be withdrawn from this gas cap at higher rates than the corresponding oil production and cause a wetting of sands?

A If it isn't regulated I do.

Q But would this gas-oil ratio type of formula be any insurance whatsoever against that sort of occurrence? Your system would seem to give everyone a fair share of reservoir energy.

A Yes, sir.

Q But would it prevent the wetting of sands?

A It has been my experience that if a gas cap is produced, or if high gas-oil ratio wells themselves were causing some wetting of the gas sand by oil, and likewise the gas will move down structure and you will have oil wells going to high gas-oil ratio wells. About the only way that if you are going to produce from this area of high gas saturation that you can prevent some wetting would be from some type of secondary recovery, gas cap injection to hold that injection above the pressures that would exist in the oil section.

Q I don't believe I understand you. You would advocate the injection of gas and the production of gas in the same area?

A I am not advocating.

Q Is that the essence of what you just stated?

A I think there will be some wetting of the gas cap sand by oil, if wells in the area of high gas saturation are produced.

Q Theoretically it is possible to produce them at a balanced state, is it not, where there would be no wetting if you can determine what that rate would be?

A Theoretically it is; practically, it is very hard to do.

Q And to be on the safe side, you could underproduce the gas and be assured of avoiding the wetting of sands?

A Well, of course, I don't think that you would necessarily be giving the people in the gas cap area --

Q (Interrupting) I mean discounting the possible violation of correlative rights.

A Yes, sir, it would improve, a gas expansion drive would certainly give you a higher recovery.

Q Mr. Gaines, I believe you said that you had certain leases, that Sinclair has certain leases, which you would advise your company not to develop in the event this Commission decides upon 40 acre spacing for the Bisti? A Yes, sir.

Q Do you likewise have some leases that you would advise them not to develop on 80? A Yes, sir.

Q Now, can you tell me what the difference is?

A Yes, sir.

Q I mean in terms of percentage or numbers, how much of the pool are we talking about that wouldn't get developed at all if we go to 40 as compared to 80, obviously some of it wouldn't warrant development at any type of spacing?

A Yes, sir. Well, for instance, let's take one lease where we happen, well, let's just take the northeast quarter of Section 23, the Bittony NEZ lease there. One well had 16 feet of pay in it. This well that was over in the northwest quarter of Section 24 had six feet of pay in it. I don't think that we would be too pessimistic to say that the average pay over that 160 acre tract, that quarter section, would not exceed ten feet.

We did have control by the dry hole up in the southeast quarter of Section 14 on 80 acre spacing, you could drill a well that probably the well itself would never pay out, it might, you would be taking a risk on that, but at least if you average up the volume of recoverable oil that you could estimate under that tract with two wells I think we could make a reasonable profit. If we drill four wells, I don't think that we would recover our drilling costs.

Q Now, would you advise your company to drill a well anywhere in the north half of the northeast quarter of Section 23?

A Section 23?

Q It is the same area that we have been talking about, could you drill a well in the north half of that section at all under either type spacing?

A Well, I believe, are you speaking of the north half of the southeast?

Q The north half of the northeast quarter of the section. You have one well in the southwest quarter of the northeast quarter?

A Well, that is the tract that I was speaking of.

Q Yes. Now, would you advise your company to drill a well in the north half of that northeast quarter of Section 23?

A Yes, sir, I would advise them to drill a well there if 80 acre proration units were established for the field.

Q How about the north half of the northwest quarter of Section 23, moving on to the east?

A No, sir, I would not on 80 or 40 acre spacing.

Q Now, would you drill a well in the southeast quarter of the northwest quarter of Section 24? An immediate offset to your, I guess that's a drilling well, isn't it, in the southwest quarter of the northwest quarter?

A Yes, sir. You did say the southeast quarter of the northeast quarter?

Q Yes, it would be an immediate east offset.

A No, sir, I wouldn't recommend a location to be drilled there.

Q Then there wouldn't be too much difference as to the un-drillable leases as far as Sinclair is concerned, whether 40 or 80 go into effect?

A In one instance there was and in the other one there wasn't a difference.

Q I missed the one where you were going to drill, that is the northeast quarter of 23? A Yes, sir.

Q You would drill it in the northeast quarter of the northeast quarter?

A Yes, sir, if we knew that we were going to be committed to two wells for that quarter section, I think we could justify drilling a well there.

Q Couldn't you expect a great deal more recovery drilling a well in the southeast quarter of the northeast quarter?

A From that particular well, yes, sir, comparing the two wells I think you would expect a greater recovery.

Q The point I'm trying to make here, Mr. Gaines, is that it seems to me in a practical operation that all of these fringe wells would be drilled as near the better part of the field as you can and dedicate the acreage on out in the poorer sections away from the trend to the west unless a complete strict type of spacing is enforced there. You could expect, as I believe you testified, considerably more recovery if you drilled your second well in the northeast quarter of 23 in the southeast quarter of the northeast quarter rather than the northeast quarter of the northeast quarter.

A That is considering only the comparison of the two wells that we are considering there.

Q What you can expect by comparison, it would be a better well?

A Yes.

Q You would have every expectation it would be a better well?

A Yes, sir.

MR. COOLEY: That's all the questions I have. Thank you.

MR. PORTER: Anyone else have a question?

MR. McGOWAN: I would like to ask a few on re-direct examination.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q In discussing the two well locations with Mr. Cooley in the northeast quarter of 23, you stated that a well on the south 40 acres would be a better well than a well on the north?

A That is correct.

Q Would you expect to recover any more oil from under that 160?

A I would think that the recoverable oil from beneath the 160 would be less than it would be, would be less if both wells were drilled in the 80 to the south than if one well was drilled in the south half of the northeast quarter and the other well were drilled in the north half of the northeast quarter, yes, sir.

Q In evaluating the lease, you are looking at how you can get the most oil out of it with the least number of wells?

A That is correct.

Q When you talk about recommending wells or well locations to your management, you are talking about it from the purely economic standpoint as calculated by you as an engineer? In other words, will it make a profit or not?

A Yes, sir.

Q Now, then, looking at the fringe areas again, obviously some of it, whatever portion it might be, would be developed on 80 that could not be developed on 40 from an economic standpoint, is that correct?

A I think that is correct.

Q Would you not also be justified in taking a gamble if you could hope to get all the oil out from under 80 acres on a well that you wouldn't be justified in taking if you had it restricted to 40 acres?

A Yes, sir, I think you would.

Q So what might not be a worthwhile gamble on 40 would be on 80? A Yes, sir.

Q Now, in talking about the wells that Sunray and Sinclair have drilled that they jointly own, all of those wells were at least 330 feet from the lease lines, were they not?

A Yes, sir.

Q That is what is presently and at that time were the requirements of the Commission? A Yes, sir.

Q I believe you stated that at least one of the reasons for so locating them was to avoid the gas cap area?

A I would imagine that that was one reason.

Q That is good conservation practice, is it not?

A Yes, sir.

Q Had the rules that you have advocated here today been in effect allowing us to attribute additional acreage to a gas well, it would not have been so important to do so, would it?

A No, it wouldn't. Assuming that the gas cap were being produced, however, there is very little gas being taken from the gas cap.

Now, just high ratio wells are the only ones that are producing the gas.

Q As to your recommendation for proration units in particular attention to the gas cap area, as I understood your recommendation, it was that the Commission establish 80 acre proration units for the entire Bisti-Lower Gallup Pool? A Yes, sir.

Q And that where a well produced at a gas-oil ratio of higher than 15,000 to 1, it be classified as a gas well?

A Yes, sir.

Q And that to such gas well there may be attributed up to four proration units, assuming those units were underlain by gas for allowable purposes? A Yes.

Q And that the allowable for the gas well would be calculated on the volumetric formula with a 2,000 to 1 limit gas-oil ratio?

A That is correct.

Q These three exhibits were prepared by you or under your supervision, were they not? A Yes, sir.

Q To reemphasize, the two cross sections are to scale both vertically and horizontally? A Yes, sir, they are.

Q So they show the true dip and variation within the reservoir itself?

A Yes, sir, the horizontal and vertical scales are different, however they are scaled. They are both to scale, both horizontally and vertically.

MR. McGOWAN: I offer these three exhibits in evidence.

MR. PORTER: Without objection to the admission of the three exhibits, they will be admitted.

MR. McGOWAN: That's all.

MR. PORTER: Does anyone else have a question?

MR. SETH: I have a question that was brought up by reason of the re-direct examination.

RE-CROSS EXAMINATION

By MR. SETH:

Q I don't follow you, Mr. Gaines, on the reason why you would get more oil out of the northeast quarter of Section 23 by a well located in the northeast of the northeast?

A Yes.

Q Why do you say that, if you would maintain at the same time that one well will drain 80 acres?

A Well, I maintain that as you get to the flanks, towards the flanks of this structure, you are going to get into tight sand and that certainly as you get into lower permeabilities your drainage radius is going to become less, and with two wells located on the south half of this 160 acre tract, your drainage radius would be considerably greater than it would be on 80 acre spacing actually to drain the whole 160 acre tract.

Q Your drainage area for your northernmost well would be less than the southern well, is that right? You say they are in tighter sands?

A Yes, sir, it would. It would have less drainage radius.

Q But you feel it would be a better well because it would have more acreage, is that right? Does that improve the well, Mr. Gaines, to have more acreage?

A I said the recovery.

Q Assigned to it.

A I believe I stated that the recovery from that 160 acre tract, and that is disregarding any drainage into that tract, any drainage situation that might occur, but the recovery would be greater with the location of a well in the northeast quarter of the northeast quarter.

Q Well, assuming, as you apparently did, that would be a mediocre well -- A Yes, sir.

Q -- you don't testify it becomes any better because it is on an 80 acre than on 40, or that it is more profitable on 80 than 40?

A I testified that a recovery would be greater if two wells, only two wells were drilled on the south half of the quarter section.

Q You would still, although it is in an obviously poor area, you would still attribute 80 acres to this well, is that right? You would assign 80 acres to it? A Yes, sir.

MR. SETH: That's all.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q Mr. Gaines, I think it's obvious that the assigning of more acres to a well will not make it any better well?

A No, sir, it will not.

Q If through one well you are allowed to recover the oil out from 80 acres, it is going to be more economical than if you can only recover the oil out from under it under 40 acres, would it not? A That is correct.

MR. PORTER: Mr. Cooley.

RE-CROSS EXAMINATION

By MR. COOLEY:

Q I'm confused, Mr. Gaines, I believe in answer to my question awhile ago you said a well drilled in the southeast quarter of the northeast quarter would be a better well than one drilled in the northeast, northeast quarter?

A Yes, sir, if you put the well on the pump or started producing it, it would be a higher capacity well, then certainly, assuming that something unusual doesn't occur, than your well in the northeast quarter would.

Q Is the reason that your total production from the two wells would be, I think you testified that the total production from the two wells if they were located both in the south half of the northeast quarter, would be less than the total production from the two wells if one is located in the northeast quarter of the northeast quarter, is that your testimony? If one well is located in the northeast of the northeast quarter, will the combined production of the existing well and this new well we are talking about, northeast quarter of the northeast quarter be greater than the combined production from the two wells located in the south half of the northeast quarter?

A Yes, sir, it should be. We are not talking about rates. We are talking about ultimate recovery.

Q When I said better well, I was really referring to ultimate recovery. I possibly should have qualified my question.

A The ultimate recovery of the 160 acre tract should be greater if one well were located in the southwest quarter of the northeast quarter, another well located in the northeast quarter of the northeast quarter, than it would be if one well were located in the southwest quarter of the northeast quarter and the other well in the southeast quarter of the northeast quarter.

Q Is the reason for that that your well in the southeast quarter of the northeast quarter will interfere or will drain some oil that the well in the southwest, northeast quarter would not have drained?

A Would not have drained you mean?

Q Would the well in the southeast quarter of the northeast quarter cut down the production that you could expect from the well in the southwest quarter of the northeast quarter?

A No.

Q It wouldn't, I don't understand that.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q If you drilled two wells on the extreme southern edge of the 160, they would produce more oil than two wells drilled anywhere else on the 160, disregarding where the oil might come from, is that correct? A That is correct.

Q If you are attempting to recover the oil in place from under that 160 acres, then a well in the southwest 40 acres and the northeast 40 acres would come more nearly doing it?

A That is correct.

RE-CROSS EXAMINATION

By MR. COOLEY:

Q Did you mean anybody kicking back any oil that came from his well bore because it came from anybody else?

MR. VERITY: I take exception to that. We are trying to establish a formula that will establish the greatest ultimate recovery from that pool.

A It would recover possibly more, less uneconomically.

MR. NUTTER: It is a matter of economics?

A Yes, sir.

MR. NUTTER: I think that four wells would probably drain more oil in that quarter section. However, we must take the matter of the economics of the thing into consideration.

MR. COOLEY: That concludes my questions.

MR. PORTER: Anyone else have a question? Mr. Utz.

By MR. UTZ:

Q Mr. Gaines, I believe you recommended a gas well over 15,000 GOR and up to 320 acres be dedicated to a well?

A Yes, sir.

Q Did you make any recommendation as to how the units would be dedicated to the well? In other words, by hearing of the Commission or by just purely a request of the operators as to whether you wanted to dedicate 80 or 320?

MR. McGOWAN: I think that is getting into a procedural question that our engineers should not attempt to answer. We feel that is a matter for the Commission's discretion as to whether they are going to have a hearing on each well or whether they want to do it administratively.

MR. UTZ: I will ask him another question to satisfy me.

Q Do you think, Mr. Gaines, it would be good practice to dedicate oil acreage to a gas well? A No, sir, I do not.

Q Then the dedication of acreage to the gas well should be controlled quite closely? A Yes, sir.

Q Did you make any recommendation in your fixed spacing as to what part of the 160 acres the wells should be drilled in?

A No, sir.

Q Would you want to?

A Yes, sir. I think it would be certainly to the best advantage if each well were located in diagonal 40's within the 160 acre tract, it wouldn't make an awful lot of difference which way they ran.

Q The pattern is pretty well set up now, is it not?

A Yes, sir, I think so.

Q And to follow that pattern would be in accordance with your thinking? A I think so.

Q And did you make any recommendation, Mr. Gaines, as to what part of the 160 acres would be dedicated to each well, that is, the north-south, or east or west half?

A I have given that some thought. I don't know that I'm prepared to make a recommendation in that respect. However, I think certainly one thing that should be considered in the assigning of this acreage is the condition, or better, I might say the composition of the field, which is rather a long, thin field as far as the length and breadth goes. Also the gas cap possibly should have some influence on that too.

Q Do you agree that it would not be good practice to dedicate dry acreage to an oil well? A Yes, sir.

Q Then the field being more east and west than it is north and south, would you say that there would be less danger of that if you dedicated the units to the south and north half?

A I think that that would certainly be a point in that dedication.

Q But you wouldn't recommend it?

A I think personally, I'm not speaking for my company, I can say personally that I would recommend it.

MR. UTZ: That's all.

MR. PORTER: Anyone else have a question of Mr. Gaines?

MR. McGOWAN: I might correct one statement for Mr. Gaines. He was speaking for the company.

MR. PORTER: Were you, Mr. Gaines?

A Yes, sir, I am.

MR. PORTER: I believe this is all the witnesses you have. The witness may be excused. We'll take a fifteen minute recess.

(Witness excused.)

MR. SULLIVAN: This is just in the matter of information. I don't think it needs to go in the record.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Sullivan, I believe you have one witness for British American. Would you have the witness stand and be sworn?

(Witness sworn.)

JOHN STEIN

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. SULLIVAN:

Q Would you state your name, please?

A I am John Stein.

Q Are you a petroleum engineer?

A Yes, I am.

Q Have you previously appeared before this Commission in this cause?

A Yes, I have.

Q Was that at the hearing held on the application of Sunray Mid-Continent on September 18, 1957?

A Yes, it was.

MR. SULLIVAN: May this man's qualifications be accepted as an expert witness?

MR. PORTER: Yes.

Q Mr. Stein, since the hearing held in this matter in September, has the British American Producing Company conducted any tests and studies to determine whether or not 80 acre spacing is the proper spacing for the Bisti-Gallup Pool?

A Yes, we have.

Q Will you describe the nature of those tests and your conclusions? A Yes, I will.

I have here on Exhibit No. 1 the results of some bottomhole pressure drawdown tests run by the British American Oil Company of two of our wells in the Bisti-Gallup Field, namely the Douthit B No. 5, located in the southwest of the northeast of Section 28, 26, I believe that is 12, 26 North, 13 West, and on the Douthit B No. 8, which is located in the northeast of the southwest of Section 27, 26 North, 13 West.

At the time we started these drawdown tests, all the wells had been shut in from seven to ten days prior to commencement of the drawdown tests. In particular, the Douthit B No. 5 had been shut in ten and a half days prior to commencing the drawdown tests, the Douthit B-8 had been shut in seven and a half days prior to the drawdown test.

We then initially took a bottomhole pressure on each of the wells, and approximately a day and a half later started producing the wells surrounding the Douthit B-5 and Douthit B-8 wells. Of course the Douthit 5 and 8 wells were left shut in during this time, and twice a day a pressure survey was taken on each of the wells.

The results of these pressures are shown graphically on Exhibit 1. The Douthit B-5 commencement of the test, the bottomhole pressure was 1078 PSI. Approximately a day, roughly two days later it was 1139½, a day later 1150, about four o'clock on the 12th, 1192, and it reached a stable peak at midnight and was 1195, then dropped rather rapidly, at noon the next day, it was 1061, stayed fairly stable until the next day and a half and then dropped to 1031 PSI on noon of December 15 at which time we ran out of tank room.

The Douthit B-8 at the commencement of the test, the bottomhole pressure was 1036, then over two days it had built up to 1193, and then started a gradual drop 1173, slight build up 1178, very slight drop 1177, a fairly good drop to 1153, and then fairly stable pressure at 1162 to the end of the test at which time we ran out of tank and were unable to produce the wells any longer.

These drawdown tests, as I stated before, were conducted with these two wells shut in and the other wells producing.

Q Mr. Stein, have you indicated on this exhibit, this aerial exhibit on the right here, the wells to which you are referring in the exhibit to which we'll refer as British American No. 1. Have you indicated these wells on this aerial map?

A Yes, I have a circle drawn around them. I also described them in the testimony.

Q Thank you. Proceed, please.

A Now, as a result of these drawdown tests we can certainly see that interference exists between these wells, between the wells shut down and producing wells, otherwise there would have been no pressure drawdown in these two particular wells. That certainly indicates to me that one well can drain substantially more than 80 acres.

Q In your opinion, Mr. Stein, what is the area, the demonstrative area of interference as indicated by these tests that you have just described?

A Well, I would take the minimum area which would be between the nearest offset wells, these wells being about 1980 feet from the center of each of the shutdown wells, would calculate out something about 280 drainage as the minimum.

Q What do you mean by minimum?

A Of course, there are other wells out here producing. I can't definitely say that the drawdown was caused in B-5, say, from B-13, it was a combining of all the wells, but let's take the very minimum conditions which is the direct offsetting of the wells. That would indicate 280 acres.

Q Then the minimum area of demonstrable interference is, as you have just indicated, at least in the immediate offset well?

A That is true. Of course, the maximum could be this large area here.

Q You need not volunteer that. Let's just confine ourselves to the minimum that we have shown. Mr. Stein, you have across the top of the room a long series of cross sections. Incidentally, let us refer to Mr. Stein's Exhibit there, the first one he used as British American Exhibit No. 1. I believe it is the first exhibit we have introduced in this cause. Let us refer to your next exhibit then as Exhibit No. 2, and will you describe to the Commission what it is, please?

A Exhibit No. 2 is a cross section of certain wells across the field that were cored or on which core analysis were available to me, and of course --

Q (Interrupting) At what time now, you say were available to you, when do you mean?

A Well, during the time I was making this study.

Q Is that since the hearing held in September on this matter?

A Yes, it is.

Q Thank you.

A This cross section was prepared to illustrate the continuity of the sand clear across the field, and this is done by plotting actual measured values of permeability from core analysis opposite each of these wells. It extends from the British American Douthit 11, which is in the northeast, northeast of 29 on across the field and ends up about at the extreme southern edge of the field in the Lion No. 1 Atlas, I believe it is called.

As you can see, we can trace permeability, measured permeability, through core analysis clear across this reservoir on every well that was cored, and at the first bench some measurable amount of permeability was found. To me this indicates that the permeability distribution across this reservoir is continuous.

Q To anticipate a question which I'm certain Mr. Seth will ask, these are all hung from some common marker and do not, on the cores, and do not represent any tilt or angle to the strata, do they?

A No, these do not attempt to show structure.

Q I do that in the interest of time.

A It's an accepted method of determining or illustrating the continuity of sands across the reservoir.

Q Were you present when Mr. Brinkley testified this morning?

A Yes, I was.

Q Do you recall his Exhibit 8-R?

A Yes, I do.

Q Do you remember what the substance of that exhibit was, Mr. Stein, what did it represent?

A It represented that the pressures in the vicinity of the pilot project had built up considerably and thereby indicated a maximum area of drainage, I believe, in the neighborhood of 1500 acres.

Q Are you a member of the Engineering Committee which was formed to supervise and study the pilot injection program?

A Yes, I am.

Q Do you agree with the conclusions that Mr. Brinkley drew, based upon his Exhibit 8-R this morning?

A Yes, I do agree with him.

Q Do you recall generally, and would you so state if you do recall what the conclusions were? Be as brief as possible.

A He concluded that the gas injection here had caused the pressures to build up in all the wells in the vicinity here and that a maximum drainage area around this particular injection well could be in the neighborhood of 1500 acres.

Q And those are the conclusions with which you agree?

A Yes, I agree.

Q You testified, I believe, at the earlier hearing, that you were in concurrence with the recommendations made by Sunray Mid-Continent in support of their application for 80 acre spacing in this field, is that correct? A Yes, that is correct.

Q Have you changed your opinion with regard to that concurrence since the last hearing? A No, I have not.

MR. SULLIVAN: That's all, Mr. Chairman.

MR. PORTER: Anyone have a question of Mr. Stein? Mr. Cooley.

CROSS EXAMINATION

By MR. COOLEY:

Q Mr. Stein, how many pounds pressure buildup did you get from shutin in the two wells shown on your exhibit, what is the number? A Exhibit No. 1.

Q Exhibit No. 1.

A Yes. Well, it built during the time that the pressure survey was being conducted, pressure in the No. B-5 well had built up from 1078 to a maximum of 1192, and then leveled off at 1195, 1195 was the maximum.

Q And what was it, something over a hundred pounds, I didn't catch the figures.

A Yes, from 1078 to 1195 would be 113 pounds.

Q What did you get on your other well?

A It built up from 1036 to 1193 maximum.

Q What is the difference there?

A About 167.

Q Now, are these wells affected in any manner, in your opinion, by LPG injection project?

A No, they would not be affected, I don't believe, they are too far away.

Q I believe you stated you were present when Mr. Brinkley was testifying this morning? A Yes.

Q And in response to my question, I had asked him when a well was shut in, what happened to the pressure on that well.

A Yes.

Q He said it would stabilize. I asked him if it would build up and his answer was, I believe, in the negative. Have you found that to be true in your experiments in this field?

A Well, if a well has been produced for any length of time, of course it has a bottomhole operating pressure which is somewhat lower than the static pressure would be. Certainly when you shut that well in that well will try to reach its static pressure.

Q Then do you think --

A (Interrupting) It will be something higher than the bottom-hole operating pressure, of course.

Q Do you think that there might be a possibility that the shut in of the wells around the LPG project might account for the appearance of the pressure buildup?

A I do not, I don't think so in that case.

Q Why?

A It has been a long time since those wells were shut in, oh, 120 days at least, and any additional pressure they have gained has been due to the pressure built up in the pilot project. Perhaps in the first three or four days that they were shut in they probably got some pressure buildup and reached a static, and then from there on any pressure that was added in those wells had to come from the pilot injection project.

MR. COOLEY: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Malone.

By MR. MALONE:

Q Mr. Stein, referring to your cross section up there, did I understand you to say those were all based on core analyses?

A Yes, sir.

Q Not electrical logs?

A No, the electric logs were merely put on there so we could show the sands themselves. It would be rather difficult to show sands in relation to each other just from a permeability profile.

Q You had how many core analyses to work from?

A Oh, I would have to count them across there. Well, there is nineteen represented here.

Q They extended the entire length of the Bisti-Lower Gallup Pool, did they?

A Well, I would say fairly well over the entire length, yes.

Q So far as I can tell from this distance, as you have colored that area of permeability that you have traced through there, you have found it to be a single area that is coextensive throughout, is that correct?

A I have only attempted to show the permeability continuity in the No. 1 bench of the sand. I did not attempt to show it in the other benches.

Q This is then a single bench?

A Yes, sir, that is correct.

Q You do recognize the existence of other benches that are not portrayed by this exhibit?

A Yes, that is true. There are other benches, you can spot them on here as you go along.

Q The continuity that you found to exist in this bench doesn't necessarily exist in the other, does it?

A It wouldn't be so indicated by this.

Q So your testimony with reference to the communication that would result, is limited to the single bench as to which this exhibit is prepared?

A Yes, sir, that is correct.

MR. MALONE: That's all.

MR. PORTER: Anyone else have a question? Did you wish to offer your exhibits in evidence?

MR. SULLIVAN: Yes, sir, if everybody is through. I submit British American Exhibits 1, 2 and 3 in evidence in this cause.

MR. PORTER: Without objection the exhibits will be admitted. The witness may be excused.

(Witness excused.)

Is there anyone else wishes to present testimony?

MR. KELLAHIN: If the Commission please.

MR. PORTER: Mr. Kellahin.

MR. KELLAHIN: If the Commission please, Jason Kellahin of Kellahin and Fox, appearing on behalf of Phillips Petroleum Company. We will have one witness, Mr. Lewis.

(Witness sworn.)

E. F. LEWIS

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. KELLAHIN:

Q Would you state your name, please?

A My name is E. F. Lewis.

Q By whom are you employed and in what position?

A I'm employed by Phillips Petroleum Company as a supervising area petroleum engineer.

Q How do you spell the last name?

A L-e-w-i-s.

Q Mr. Lewis, does the area under your supervision include the pool under consideration here, the Bisti-Lower Gallup Oil Pool? A Yes, sir, it does.

Q Have you previously testified before this Commission and had your qualifications as an expert accepted by the Commission?

A Yes, sir.

MR. KELLAHIN: If the Commission, please, Mr. Lewis has appeared in examiner hearings. If it is the desire of the Commission we will go through them.

MR. PORTER: If he has previously qualified before an examiner it wouldn't be necessary.

Q In connection with your duties, Mr. Lewis, as supervising area petroleum engineer, have you made a study of the Bisti-Lower Gallup Pool? A Yes, sir, I have.

Q What was the nature of that study?

A Well, the nature of the study was to examine the economics of 40 acre spacing versus 80 acre spacing in an entirely new approach and specifically to apply to the question raised by the Commission Staff with regard to saturation gradients and pressure gradients as to the recovery under the two types of spacing.

Q In making this study, would you describe the methods which you used?

A Well, in very brief, the method is an application of a material balance method presented by Luper and Calhoun in their technical papers 25, 92 as published in the Volume 186 of the AIME transactions. This study further was modified by the use of Bisti crude properties.

Q Now, in connection with the use of these Bisti crude properties, have you prepared an exhibit showing what those are?

A Yes, sir, I have.

(Marked Phillips' Exhibit 1-R, for identification.)

Q Referring to the exhibit which has been marked as Phillips' Exhibit 1-R, would you state what that is?

A These properties shown in Exhibit No. 1-R are simply the variation in formation of volume factors, solubility, oil and gas viscosity and gas conversion factor as taken, being the average of two bottomhole samples, one taken on Sunray Mid-Continent Federal C-21 and the other was British American Marye B No. 1 well.

Q Now, Mr. Lewis, in making your calculations, what results did you find in applying this method to the Bisti Pool?

A I found that, essentially, that the result of this calculation was that there was no effective difference between the ability of the well to drain 40 acres as compared to 160 acres, which was the spacing that I used for a particular purpose in this examination.

Q Now, referring to Phillips' Exhibit 2-R, would you state what that is?

(Marked Phillips' Exhibit 2-R, for identification.)

A Exhibit No. 2-R is a graphical portrayal of the saturation distribution as it would be in various stages of depletion in a 40 acre developed area as compared to 160 acre developed area.

I might, if I may, refer to the larger scale copy of that exhibit and briefly explain that this represents the saturation distribution, the heavy line represents the saturation distribution as it would be around a well drilled here, and the second well drilled at this position.

Q You say at this position, what do you mean by the two relative positions, Mr. Lewis?

A Where the two wells would appear they would be on 40 acre spacing. The dashed line represents the saturation distribution around the well bore on a single well drilled on 160 acre spacing at this common location here.

These three curves represent the saturation distribution at three separate stages of depletion. The bottommost one being the distribution in effect at the abandonment pressure.

Q Which you show as 137 pounds per square inch, is that correct?

A Yes, sir, that is correct.

Q Is that exhibit in proportion, Mr. Lewis, in regard to its size?

A No, sir, of course the significant element in this saturation distribution in the exhibit is the shaded area here which represents the saturation sink which occurs by the drilling of this additional well as against a single well at this point, and of course at this final stage of depletion this relatively pressure sink or saturation sink represents then the difference in recovery which would occur as between the 160 acre well drilled at this point and the infill well drilled at this point.

Q The infill well being on a 40 acre pattern?

A The infill well being drilled on 40 acre pattern. This roughly two feet in height here represents something on the order of 27½% of the total pore space in the reservoir. If we were to represent all of the pore space occupied by oil in this reservoir by a graph, it would be approximately eight feet in height, which is a little bit impractical, it is easy to string them out, but you can't get them up quite that high.

Then with an exhibit eight feet in height, this shaded area represents the difference in recovery that you would achieve with an infill well on 40 acre spacing.

Q Now, what percentage of the oil in place does the shaded area represent then, Mr. Lewis?

A According to my calculation it represents four hundredths of one percent of the total stock tank oil originally in place.

Q In making this calculation, did you take into consideration any pressure maintenance or secondary recovery process that might be effected?

A No, sir. To have considered that would result in, rather secondary recovery operation or pressure maintenance operation would nullify even that difference in ultimate recovery.

Q Now, have you made a calculation on a material balance method, Mr. Lewis?

A Yes, sir. I have made the calculation material balance performance on this field by the specialized method which I originally referred to, and that method, by its nature, permits one to compare the relative performance on 160 acre spacing versus 40 acre spacing or any other interval that one might wish to do.

In other words, this special adaptation of the material balance equation of Luper and Calhoun considers a bounded area and therefore you can evaluate the performance of whatever area you chose or, in fact, whatever rate of pressure drawdown that you might wish to impose on the reservoir.

Q Now, is that information reflected on Exhibit No. 3-R?

(Marked Phillips' Exhibit No. 3-R, for identification.)

A Yes, sir, Exhibit No. 3-R is a plot of the gas-oil ratio and pressure performance,using the Bisti crude as applied to this Luper and Calhoun method, the gas-oil ratio is demonstrated by the curve beginning in the lower left-hand portion of the exhibit, and the pressure performance is that curve which begins in the upper left-hand portion of the exhibit.

Now, the several points, the different methods of indicating points at essentially the same spots on this thing represents the performance with the open circle on 160 spacing and the cross on 40 acre spacing. I think that the significant element here is that these points are in effect superimposed on one another and it would be impossible to draw or indicate a separate performance characteristic which would be attributed to the 160 as compared to 40 acre spacing.

Q Are we to understand this is a modified application of the material balance method? A Yes, it is.

Q Have you tested this calculation against the conventional method of arriving at a material balance curve?

A No, sir, I didn't personally make that comparison, but the authors in their paper made a comparison and I have taken a material balance calculation which was made in a completely independent manner, and which predates both of these hearings and incorporated that as our Exhibit No. 3-R-A I believe. That is a transparent overlay which when superimposed on this curve will show the agreement in the two methods.

Q Now, does this support then the validity, in your opinion, of your calculations?

A Yes, sir, it is my belief that it does.

Q Do you have anything you want to add to that, Mr. Lewis?

A No, sir.

(Marked Phillips' Exhibit 4-R, for identification.)

Q Now, referring to Exhibit 4-R, would you state what that is?

A That is a tabulation of the same data which is on this Exhibit 3-A on which the 3-R is based.

Q What are the significant factors that appear on that exhibit?

A Here again is the only point or the only manner in which we can see really the difference between 160 acre and 40 acre spacing and that is in the final point here at pressure decrèment No. 7 we find the difference in recovery of four hundredths of one percent of the oil in place.

Q Have you calculated what that would represent in terms of barrels of oil?

A Yes, based on an oil in place figure of 220,000 barrels, this would represent approximately 300 barrels.

Q Would that represent an increase in the cost of recovery as against the spacing on the 40 acres as against 160?

A Well, to express it in terms of development cost, this would require that we spend approximately $180.00 per barrel to develop this additional oil. That cost figure is based on a well cost of $54,000 conservative estimate of well cost, incidently.

Q Were you present at the previous hearing in this case?

A Yes, sir.

Q Was that approximately the well cost represented by the testimony of Shell's witnesses?

A As I recall, that was their estimate of the well cost including pumping equipment and a share of the lease facilities I believe they referred to.

Q Again, Mr. Lewis, does this calculation that you have made as to the amount of oil to be recovered, and the other testimony you have given on these exhibits, take into consideration the effect of pressure maintenance or secondary recovery?

A No, sir, it does not.

Q Does the calculation take into consideration the economic limits of oil production?

A No, it does not consider the effect of economic limits on oil recovery.

Q Now, what effect would a pressure maintenance program have on this?

A It would tend to further minimize the difference in recovery between the 40 acre and 160 acre spacing patterns.

Q In your testimony so far you have referred to wells spaced on 160 acre spacing as opposed to 40 acre spacing. For what reason did you do this?

A Well, the purpose was to emphasize the lack of difference between recovery on the 40 acre spacing as opposed to some wider spacing, and also to highlight the fact that the distance that oil must travel from the limit of a drainage radius to a well bore is immaterial as to the amount of recovery that may be attained at a well, and also it follows that no matter how tortuous the path, the oil must follow in a low spacing to get to the well bore it will get there with no loss of ultimate recovery, or certainly very little loss.

Q Your answer to that question then, and the calculations which you have made, assume a continuous reservoir, do they not?

A Yes, sir. This material balance method, as in all other methods of evaluation in which gross reservoir properties are used, does require the assumption of continuity within the reservoir.

Q Now, have you made a study and have you had experience with sands of similar characteristics to the sands found in the Bisti Field in that connection?

A Yes, sir. In my personal experience I have observed a number of reservoirs in which sands are of generally similar characteristic.

Q Now, you have heard the testimony in this case. In your opinion is it a practical thing to attempt to correlate sand continuity on the basis of the presence or absence of the showing of continuity on core data and electric logs?

A No, sir. In my opinion unless you have pressure interference data or some similar type of data, it is extremely hazardous to assume that you have either continuity or lack of continuity.

Q In other words, you would have to have some performance information to consider in connection with that?

A Yes, sir, with the one exception in considering that historically these fields in which we have variation in permeability and variation in an apparent lack of continuity that the reservoirs do perform as a homogeneous mass.

Q Now, what experience have you had that shows that?

A Well, the best example of that arose in the evaluation of a secondary recovery project in which Phillips was the operator in the North Burbank Unit of northeastern Oklahoma.

Now, this reservoir, as in Bisti, is a solution gas drive reservoir. The reservoir is an offshore bar deposit having generally similar sand and fluid characteristics to the Bisti Field.

In that study a series of injectivity profiles were run in injection or input wells and compared with permeability profiles in the same wells, and in the course of these studies it was observed that there was little or no correlation between the injectivity profile and the permeability profile within the same well.

Q Is that shown on Exhibit No. 5-R?

(Marked Phillips' Exhibit 5-R, for identification.)

A Yes, it is. This is one of the number of permeability profiles that were run on wells in which there was core data available. This illustrates the lack of continuity of injection and the lack of correlation between input rate in a given foot of sand as compared to the permeability in that foot.

Q Well, did you have any experience in connection with this particular pool which supported your contention that it was a homogeneous reservoir?

A Yes, sir, I was employed as a reservoir engineer in this North Burbank District of Phillips for a period of a year and a half. I did not, however, participate in the actual running of these injectivity profiles.

Q What facts, then, supported your contention in that pool that it was the homogeneous reservoir, Mr. Lewis?

A Well, I would like to back off here just a minute, if I may, and further explain something about this peculiar performance that was observed here in this lack of correlation between injectivity profile and the permeability profile and state that in view of this peculiar performance, our research department took a sample of a core from this well and drilled horizontally through this four and a half inch core sample and divided that cylinder into three separate permeability plugs and tested the permeability on those three small pieces and found that within that four and a half inch section that the permeability varied in the order of 300%, so that naturally disturbed them very much and led to a further investigation to see if this was a peculiarity of that particular four inch sample that they ran or whether it was more nearly characteristic of the nature of permeability itself. And they took then six inch by four and a half inch core section and divided that into forty-eight separate permeability plugs and tested the permeability on each of those forty-eight samples. The results of that detailed, more or less detailed, examination of this one small core sample is shown, I believe, in Exhibit 6-R.

(Marked Phillips' Exhibit 6-R, for identification.)

Q What is the significance of the figures shown on Exhibit 6-R, Mr. Lewis?

A Well, this exhibit, as I see it, illustrates that to take a single core sample from a foot of formation is rather grossly misleading and here we have within six inches a variation in permeability from nine-tenths of a millidarcy to twenty-eight millidarcies, I believe is the highest one shown in this series of forty-eight samples.

The conclusion then, from this, is that it's somewhat presumptuous to assign permeability value to not simply the one foot vertical distance that is commonly done, but to also assign that same value to a length of 600 or 1300 feet or however far the distance may be between several wells.

So that a fallacy can arise from the use of the very small sample that is given a reservoir by the one sample per foot method.

Q Yet in spite of this wide variation in permeability, you found in this particular reservoir, did you find that it operated as a homogeneous reservoir?

A Yes, sir, this reservoir was a remarkable example of homogeneity despite the lack of continuity in this projectivity profile.

High permeability, the fact that it did behave as a homogeneous unit, was illustrated by the fact that in the area of which these wells are a part, approximately ninety-nine and three-tenths percent of the calculated fillup volume was required to be injected before any increase in oil was observed in the offset oil producing wells.

Now, that fillup volume, incidently, was calculated on the basis of all of the measureable permeable sand in the core sample.

Q Now, in your opinion is this situation similar to the situation that you have found in the Bisti Pool?

A Yes, sir. It is.

Q Are we to infer from what you have said that you do not agree that there is a continuous sand body across the reservoir?

A That I do not agree there is a continuous sand body.

Q The fact that you have shown there may be a discontinuity of permeability, are we to infer it is not a continuous reservoir then?

A No, sir, I would not infer it is not a continuous reservoir because of the lack of continuity of permeability illustrated in the several core samples or core information that has been presented here and because of the fact that you can't correlate specific elements within the gross sand interval, it's my belief that as a result of this work that it is all you have to prove to establish that the reservoir will behave in a homogeneous manner, is that you do have continuity of the gross interval.

I think I might add that the gross, the existence of a gross interval of continuity has been proven here, and certainly it was our intention to prove that and further that continuity has been indicated by the interference tests introduced in evidence here despite this apparent lack of homogeneity and despite the fact that you can't take individual elements of the sand and correlate them from well to well.

Q Now, on the basis of your study of the Bisti and on your experience in other areas, what are your conclusions then, Mr. Lewis?

A Well, it is my conclusion that the effective continuity does exist within this reservoir and that one well therefore will economically and efficiently drain 80 acres.

Q And is that your recommendation to the Commission then?

A Yes, sir, it is.

Q Do you have anything further you want to add to this?

A Well, I believe that my thoughts in the matter are rather well summed up by a report on well spacing by the Research and Coordinating Committee of the Interstate Oil Compact Commission, made September 10, 1951 at a meeting of the Commission. I would like to, if I may, quote several of the conclusions of that Committee which I believe fairly represents my thoughts on the matter.

The first of these is that, and I quote, "While porosity and permeability in most fields are known to be irregular and to lack apparent continuity, fluid flow performances are much the same as if discontinuities did not exist. In either solution gas-water drive or combination drive reservoirs, the production of oil is independent within reasonable limits of well density. Where land lease controls permit, new oil fields could be first developed on wide spacing patterns, final well density and other development and production practices could then be determined in the light of geologic engineering and economic information development."

Q Mr. Lewis, to go back in your testimony a ways to a point I think we overlooked, you stated I believe that you did not take into consideration the economic time element in connection with your calculations, is that correct?

A The original statement as to the amount or the difference in recoverable oil as between 40 and 160 acre spacing did not consider the economic time of depletion. I did, however, for the purpose of illustration, assume that we might be forced in consideration of economic rates of production, to abandon the reservoir at somewhat higher pressure than we would under 40 acre development, and in that example I used a depletion pressure of 175 pounds.

From Exhibit 3-R. The recovery at that point, as I remember, would have been 19.6% of the original oil in place, and the difference then in recoverable oil would have been 1800 barrels on 80 acre spacing versus 40 acres spacing under those conditions and the development cost of that oil, using the same well cost value would be approximately $30.00 per barrel.

MR. KELLAHIN: That's all the questions we have. Thank you, Mr. Lewis.

MR. PORTER: Anyone else have a question of Mr. Lewis? Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q Mr. Lewis, in your calculations, they were of course made on the assumption that it was a homogeneous reservoir?

A Yes, sir.

Q I conclude from your subsequent statements that it doesn't make any difference in these calculations whether it is homogeneous or not?

A No, sir, I don't believe, it certainly wasn't my intention to convey that.

Q I thought you testified that the performance would be, you would expect the same performance where it was homogeneous or heterogeneous.

A No, sir, my intention was to make it clear that reservoirs behave as a homogeneous unit whether they appear to be heterogeneous or discontinuous or not.

Q Then you speak of the performance then as the same whether it is heterogeneous or homogeneous?

A In that sense, yes, sir.

Q Then you would in this particular case, I had a little difficulty in following when you were testifying about the Oklahoma field, and in this field, in this particular field you would ignore the facts if they be established that there are isolated areas in the pool that would be productive of oil, in arriving at these calculations?

A Well, sir, I don't know that we have gotten into the question of isolated areas within the pool as yet.

Q Well, that was part of the heterogeneous nature of it, perhaps I am mistaken in my terms, if there are wide variations in permeability which result in isolated sand members, would you ignore that situation in these calculations that you have made?

A Well, it is my contention that the wide permeability variations do not result in isolated --

Q (Interrupting) Then you haven't considered that, is that your answer?

A (Continuing) -- areas.

Q So I understand since you do not believe they occur, you have not considered them?

A My experience leads me to ignore them, yes.

Q Then you have ignored them, have you or haven't you?

A Well, fundamentally this method -- this method dictates that you must ignore isolated elements in the reservoir if these isolated elements, in fact, exist. My experience, however, dictates that there are no such things, generally there are no isolated elements in the reservoir.

Q Your answer is that you have ignored them as far as the Bisti Pool is concerned?

MR. KELLAHIN: I submit he has answered the question.

A I don't believe, if I understand all this thing correctly, I don't believe that I want to say that.

Q I'm not trying to lead you into anything. You said your experiences lead you to ignore it, but you would never answer my question. If your experience would lead you to ignore it, did you or didn't you ignore it?

A Might I say that I don't recognize there are separate elements in this field.

Q They don't make any difference as far as the calculations are concerned? A No, sir.

Q You have also ignored the time factor too, is that correct? I believe in response to Mr. Kellahin's question that the time of recovery does not enter into this picture as far as your calculations are concerned.

A No, sir, it does not. However, the last question that Mr. Kellahin asked brought out that we did make a separate calculation considering to some extent the difference in recovery that would result from economic timing.

Q Yes. Are you in the economics department of Shell Oil Company? A No, sir.

Q I didn't get your qualifications.

A I am not with Shell. I might listen to an offer. I am in the production department.

Q You are in the production department?

A Yes.

Q You would precede your statement that you made an approach to the economics of it, what is the new approach, is that the proposition whether it is heterogeneous or homogeneous doesn't make any difference?

A No, the approach is something that I don't believe was brought forth in the last hearing, that I have attempted to show mathematically that there is no practical difference between the recovery on whatever spacing you might choose to institute here.

Q And your study data took you into the core analysis and that type of data? A I didn't hear you.

Q Did your study of the field take you into the matter of core analysis, core data, or wasn't that necessary for, did you ignore that also?

A It is not necessary to the method that I go into detailed examination of the core data, no, sir.

Q You didn't do it then, is that right, if it is not necessary?

A I didn't do it in respect to this particular calculation I made.

Q It doesn't enter into the material you presented to the Commission today?

A It doesn't enter into the material balance method of calculating oil in place.

Q Does Phillips follow a method of sampling cores every foot or every two feet, what is the practice?

A Every foot. One sample per foot generally.

Q Do you still follow that practice although you are inclined to cast some doubt on it, is that correct?

A Yes, sir.

MR. SETH: That's all. Thank you.

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q Mr. Lewis, with reference to this North Burbank Pool in Oklahoma, I understand that you find a marked similarity between that pool and the pool under consideration here?

A A general similarity, yes.

Q On what spacing pattern is that pool developed?

A Ten acre.

Q With reference to the experiments that were conducted by your company on the core samples, that resulted from your having encountered quite an unusual condition, did it not?

A Yes, sir.

Q And because that condition was so unusual, you performed a number of experiments which you would not normally have performed in the course of the operation you were conducting?

A Yes, sir.

Q You concluded from those experiments, conducted in this unusual situation, that to all intents and purposes the Commission in this case would be justified in disregarding permeability entirely in the treatment of this reservoir, is that a correct conclusion?

A Well, I wouldn't want to go quite that far, not entirely certainly, since we must have some permeability in order to be able to produce oil.

Q And in determining the characteristics of the reservoir and the manner in which the greatest ultimate recovery can be obtained, it will be appropriate for the Commission to give some consideration to the permeability situation found to exist, will it not?

A Yes, sir.

Q In suggesting that a wide variation in permeability and a great reduction in permeability may be ignored, is there any limit to that? In other words, if we have a, let's say a fifty foot section of extremely low permeabilities, do you mean that its effect on the performance of the reservoir would be different than if it was only ten feet?

A I don't know that I understand exactly what the meaning of your question is. Certainly a well with fifty feet of permeability one-tenth millidarcy is going to have some difference in flow characteristics than one having ten feet of permeability of the same permeability in forty feet as some other permeability.

Q It is true that we spent quite a bit of money fracting wells to improve the permeability even though it may be disregarded, isn't it?

A I don't know whether I want to go all the way along with you or not. We did spend a lot of money fracting wells, that is true.

MR. MALONE: Thank you.

MR. PORTER: Anyone else have a question of the witness?
Mr. Nutter.

By MR. NUTTER:

Q Mr. Lewis, this Exhibit 5-R, is this a portrayal of the input rate and the permeability of this North Burbank Unit Well No. 127W8 or it is a North Burbank Unit Well, isn't it?

A These wells are in the same, they may not be the same well. I failed to check that particular point when I got these exhibits together. They are in the same, I believe 90 to 120 acre area, however.

Q Well, whether it is the same well or not, it is immaterial. This is the North Burbank Unit Well?

A Yes, sir.

Q First of all, how did you determine the input rate per foot in this well?

A We used a device, an instrument that has been developed by Phillips Research Department. I don't know whether I can explain exactly how that works or not or whether my research people would want me to explain how it works, since I think that some features of it are patentable, but it was, part of this study was intended to give this injectivity profile instrument a marketable quality and that's part of what generated our interest in why the injectivity profile didn't agree with the permeability profile.

Q Did you ever solve the reason why the bulk of the water that finds its way in the reservoir is opposite the zones of low permeability?

A We believe we found the answer to it in the detailed core study which is Exhibit 6-A which indicates that you don't have the same permeability across four inch increment, that you can't presuppose that because the sample that you have at hand has a permeability that it's applicable to the next inch or the next foot or the next 600 feet of formation away from this thing.

Q But a zone of measureable permeability such as from 2980 feet to 2985 which has reasonably high permeability and yet a low injectivity, does this detailed analysis of small cores account for something like that?

A It's our thought that it does, yes, sir.

Q Did you attempt to measure the permeability in a well before you perforate that well?

A Do we attempt to?

Q Yes, sir. By logs or any such means.

A I don't believe we do ordinarily, no, sir. The permeability data is not available until after the fact, so to speak.

Q Well, isn't a microlog an indication of permeability in some cases?

A In a general sort of way.

Q You attempt to determine permeability where you have one according to the law? A Yes.

Q So if where you can have high permeability or high injectivity and conversely a high rate of output on a producing well in a zone with low permeability, you probably attempt to perforate where high permeability is indicated, don't you?

A We're just delighted to get any permeability, and we perforate anything, generally anything that looks good either on these micrologs or the other log characteristics which are not quite as definitive as the microlog is.

Q I see. Was any section of this well on this exhibit stimulated in any way to affect the injectivity?

A No, the only treatment that was given the well, to the best of my knowledge, was a small slack period with perhaps a small acid treatment to relieve any mud effects on the well bore itself.

Q None of this stimulation could have affected the reservoir opposite the well bore?

A Not to a material degree, no, sir.

Q What was that last document that you read from which summarized your thoughts on the subject?

A The report by the Research and Coordinating Committee of the IOC Commission, made at their meeting of September 10th, 1951.

Q The first paragraph that you read, would you read that again, please?

A "While porosity and permeability in most fields are known to be irregular and to lack apparent continuity fluid flow performances are much the same as if discontinuities did not exist."

Q Did the Research and Coordinating Committee attempt to explain that phenomena?

A I don't know. I believe that there are several references throughout this thing to experiences in which heterogeneous reservoirshave performed as though they were homogeneous.

Q On your Exhibit 2-R where you show a very small difference in the production of oil from a hundred sixty acre spaced well to a forty acre spaced well, does that take into any account the time that these infill wells may be drilled or Exhibit 3-R, is the time in which the infilled wells are drilled considered at all?

A No, sir, I believe it would be immaterial.

Q It would be immaterial? A Yes, sir.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question of the witness?

MR. KELLAHIN: If nobody else does, I do.

RE-DIRECT EXAMINATION

By MR. KELLAHIN:

Q In response to the question by Mr. Malone as to whether you disregarded permeability in your calculation, actual performance as demonstrated by interference is of more importance in your opinion, is that correct?

A Yes, sir, I think that is the critical evaluation of that.

Q We are not to infer from your testimony that you would greatly disregard the factor of permeability in connection with your testimony, are we?

A I don't believe that we can completely disregard it.

Q Would it be correct to say that your testimony goes to the effort to correlate permeability as between wells and across the field rather than a recommendation that permeability be ignored?

A Certainly I wouldn't recommend that permeability be ignored. I think it's my intention that it was to set forth that specific intervals of permeability need not be correlatable from well to well in order to show continuity from well to well.

Q Were the exhibits which you have used in this testimony prepared by you or under your directions and supervision?

A Yes, sir, they were.

MR. KELLAHIN: At this time we offer in evidence Phillips Petroleum Company's Exhibits 1-R through 6-R inclusive.

MR. PORTER: Without objection these exhibits will be admitted. Does anyone else have a question of the witness?

RE-CROSS EXAMINATION

By MR. COOLEY:

Q Your material balance calculations assume throughout that one well will drain 160 acres, do they not?

A They don't assume, they are intended to prove that they will develop or rather drain 160 acres.

Q They are intended to prove it? A Yes, sir.

Q By what manner? A Well --

Q Can you sit down with a pencil and prove it will drain 160 acres?

A That is what I have done, mathematically proved that one well will drain 160 acres.

Q I don't understand from your figures how you can assume that one well will drain 160 acres.

A It isn't an assumption any longer. As far as I'm concerned, it becomes a fact that according to the mathematics and the mechanical and physical principles involved, that one well will drain 160 acres.

MR. COOLEY: That's all.

MR. PORTER: Does anyone else have a question of Mr. Lewis? The witness may be excused.

(Witness excused.)

MR. KELLAHIN: That's all we have, Mr. Porter. Thank you.

MR. PORTER: Is there any other Applicant in this case that has testimony to present?

MR. BUSHNELL: H. D. Bushnell, attorney, representing Amerada, co-Applicant. We have one witness and four exhibits which we don't have enough copies to pass out to all those who might like a copy, and therefore, we would like to take a couple of minutes to post them on the bulletin board.

MR. PORTER: Take a couple of minutes, we will take a five minute recess.

(Recess)

MR. PORTER: The meeting will come to order, please. Mr. Bushnell, will you proceed.

MR. BUSHNELL: Amerada has one witness to be sworn in.

(Witness sworn)

R. S. CHRISTIE,

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. BUSHNELL:

Q Would you state your name and the company by whom you are employed?

A R. S. Christie, Amerada Petroleum Corporation.

Q And in what capacity are you employed?

A Petroleum engineer.

Q And you have testified before this Commission on prior hearings, is that right? A Yes, I have.

Q Mr. Christie, will you go up to the blackboard and point out Amerada's Exhibit 1-R and state what it purports to show.

A Exhibit 1-R is drawn to represent the development of a 640-acre section based on the statewide field rule, or statewide rules. To be specific, that is 104-C. The dots represent the wells 330 feet from the corner of each quarter quarter section, if we assumed that one well will drain only 40 acres. The stippled area represents that area which will not be drained by this sort of development.

Q Now, how many acres is represented by the stippled area showing undistributed area or acreage area?

A The undistributed area, assuming that one well will drain only 40 acres, represent 280 acres.

Q So that means that 280 acres would be undeveloped or undisturbed? A Yes, sir.

Q Now, this plat, or Exhibit No. 1-R, does not purport to represent the development of any particular field, is that right?

A No, sir.

Q Now, refer, Mr. Christie, to Amerada's Exhibit 2-R. Would you state what that represents?

A Exhibit 2-R indicates the same thing except that the wells indicate that they are draining ratably as we would expect, of course, in any well, so that in this case, we also have a stippled area that represents essentially the same thing as in Exhibit 1-R. I think actually it is about nine acres less.

Q Approximately nine acres less of the undisturbed area than that represented in Exhibit 1, is that correct?

A Yes, sir.

Q Now, Mr. Christie, do you conclude from these two exhibits that any well pattern that locates the wells as close as 330 feet from the outside boundary line prevents the full development of the pool unless each well drains in excess of 40 acres?

A Yes, sir, I do.

Q Now, would you refer to Amerada's Exhibit 3-R and state what that purports to show?

A Exhibit 3-R is intended to show the drainage area of uniformly spaced wells on 80 acre spacing.

Q And that is on the assumption that those wells are located on the center of each alternate 40-acre tract, is that correct?

A Yes, sir.

Q Now, how many acres is represented in the stippled area which purports to be the undisturbed area?

A The total undisturbed area? On Exhibit 3-R it is 57.9 acres.

Q And how does the size of that undisturbed area of 57.9 acres, as shown on Amerada's exhibit, compare with the size of the undisturbed area assuming a 40-acre well development pattern, and that such 40-acre wells were located in the center of each 40-acre drilling unit?

A It would be exactly the same. In other words, if you drilled the section up on a 40-acre basis with the wells located in the center of the 40's, you would have an undisturbed area of 57.9 acres.

Q Now, Mr. Christie, refer to Amerada's Exhibit 4-R and point it out and explain what that purports to show.

A Exhibit 4-R simply shows the development of a section with the wells located similiarly as in Exhibit 3-R and showing the units running north and south.

Q And such wells are located in the center of the alternate 40-acre tract?

A Yes, sir. And in this case we would have no undisturbed area.

Q Now, is it your conclusion from these four exhibits that if a well will drain 80 acres, the infill wells are unnecessary to develop such a pool?

A It is my conclusion, yes, sir.

Q Were these four exhibits prepared by you or by some one under your supervision? A Yes, sir.

Q Now, Mr. Christie, if you will return to your chair, please. Are you acquainted with the provisions of this Commission's Order R 106, dated October 9, 1957?

A Yes, sir.

Q Is it your understanding that the effect of this order is to authorize the location of wells in the Bisti Pool as close as 330 feet from the boundary line of each 40-acre drilling unit?

A The order would permit that, yes, sir.

Q Is there any findings in this particular order that a well completed in this Pool will effectively and efficiently drain any number of acres? A No, I believe not.

Q Assuming that a well completed in this Pool will effectively and efficiently and economically drain 80 acres or more, in your opinion, will development on an 80-acre well spacing pattern drain this pool just as adequately as development on the basis of a 40-acre well pattern development?

A Yes, I do.

Q You have heard the testimony and reviewed the exhibits presented at this hearing by the applicant today, is that correct?

A Yes, sir.

Q Based on that evidence and testimony, in your opinion, can the Bisti Pool be adequately developed on the basis of an 80-acre well pattern? A Yes, sir.

Q Do you wish to state anything else or make any other conclusions, Mr. Christie?

A Well, it is not my intention to suggest that the statewide rules be changed. I think they are perfectly adequate to develop any oil field we have, and I think the spacing is probably immaterial since one well will drain, as has been testified, as much as 160 acres, so that the spacing is not material, and the advantage of having the flexibility of a 330, I think is proper also. What I probably intend to show here is that the Commission itself apparently realizes or recognizes the fact that, by their own order, one well will drain more than 40 acres in this field,or any other field for that matter.

Q Now, is it your opinion that one well will drain a minimum of 80 acres in the Bisti Pool? A Yes.

Q And is that the opinion upon which you have now reached the conclusion that this Bisti Pool can be adequately developed on the basis of an 80-acre pattern development?

A Yes, sir. There has been quite a bit, if I may add -- There has been quite a bit of discussion on how much one well, or what area one well will drain, and I have a report here that I would like to submit to the Commission, if they would like to have it. I would like to read from that report the following exerpt which is very short. This is a report by W. O. Keller and F. H. Calloway. It is titled, "Critical Analysis of the Effect of Well Density on the Recovery Efficiency," and they have found by their experiments and by their work that a hundred and sixty acre spacing, the recovery based on the percent of original oil removed would be only 16.2 percent or would be only 16.2 percent. Now, on an 80-acre basis, the recovery of the percent of the original oil in place would be 16.3 percent. In other words, they found that there is only one-tenth of a percent difference between recovery on an 80-acre and 160-acre tract, and they have continued that on to two and a half acres where they get only 16.93 percent recovery on a two and a half acre basis, and if the Commission would like to have a copy of that, I will submit it for the record.

MR. BUSHNELL: I suppose that should be shown as Amerada's Exhibit 5-R, then. I believe that is all I have.

MR. PORTER: Does anyone have a question of Mr. Christie?

MR. SETH: On your Exhibit 2, if the Commission should require that the well be drilled in the center of a 40-acre tract, would you have any estimate as to --

A I gave that, Mr. Seth, I believe. It would be exactly the same as an 80-acre basis or 57.9 acres.

MR. PORTER: Does anyone else have a question? The witness may be excused.

(Witness excused.)

MR. PORTER: Mr. Bushnell, would you like to move the admission of your exhibits?

MR. BUSHNELL: Yes, I move that Amerada's Exhibits 1-R through 5-R be a part of this record.

MR. PORTER: Is there objection to Amerada's Exhibits? They will be admitted.

Are there any other of the applicants in the case that would like to present testimony?

MR. WHITE: At this time Sunray would like to incorporate by reference the statement made by John Woodward in the consideration of the oil allowable for the Month of December as the statement was given November 14, 1957.

MR. CAMPBELL: Would you mind restating that, Mr. White, incorporate by reference the statement of John Woodward in consideration of the oil allowable for the month of December?

MR. MALONE: Was he under oath?

MR. WHITE: He was under oath.

MR. COOLEY: What is the significance?

MR. MALONE: I object to it, if the Commission please.

I don't know what the statute says, but apparently it has no relation to this hearing. I am sure there are parties who are interested in this hearing who were not present at the time he testified. If there is anything Mr. Woodward could testify to that would be pertinent to this case, he should be presented as a witness so that he would be cross examined by the interested parties.

MR. WHITE: If the Commission please, we think it is very significant as to the economics involved in this hearing, the question of a person being required to go through the cost and expense of drilling on a 40-acre tract in consideration of the probable market demand that might be available to him. Mr. Woodward brought out very clearly that the filling of the pipeline will take until about the middle of February. It is an artificial false market, and also he further stated that it would take more than a crystal ball to even estimate what the market demand on the West Coast might be for New Mexico crude oil. He also brought out that --

MR. SETH: If the Commission please, I believe counsel is virtually stating the contents of the statement, and I think it should be in or out.

MR. WHITE: Mr. Cooley asked what the significance was. I would like to state what material parts of the statement might be --

MR. PORTER: Just one moment, Mr. White.

MR. WHITE: And I might state that as far as Mr. Malone's objection is concerned, there were some twelve representatives of Shell and about four or five representatives of Gulf present at this hearing. It certainly has material bearing on economics in this case. Mr. Malone was present and also Mr. Seth.

MR. MALONE: Can you assure me that I was in the room when the testimony occurred?

MR. PORTER: The Commission rules that the counsel's motion for the incorporation of Mr. Woodward's testimony and statement into the record is overruled or denied.

MR. CAMPBELL: May I inquire the basis for that? Is it because it is immaterial?

MR. MURRAY: Mr. Campbell, I think we have considered some of the testimony Mr. Woodward gave as pertinent to this case, but his entire statement is not to be considered in this case, and if counsel wants to develop similar information insofar as being pertinent in this case, that's his opinion.

MR. WHITE: Can I renew my request to incorporate the record as it appears on Page 39 through 42.

MR. SETH: If the Commission please, we know it is clearly hearsay, because he is not here to be cross examined, but it is simply that, instead of incorporating these statements in other cases, where some of the parties were present and some weren't, and considering them as part of the record in this case as if given under oath here, there is no opportunity for cross examination, and it is hearsay.

MR. WHITE: Mr. Seth representing Gulf and Ross Malone representing Shell or vice versa are in a position to raise the point, but it is inadequate, that they weren't present, but they were in fact present at the hearing, and I believe the rules permit the admission of statements. They have been read all the time in these hearings, telegrams, and otherwise.

MR. MALONE: We would renew our objection to this further offer, and we would like to point out in connection with it, that counsel says that he wants to put in Mr. Woodward's evaluations of the California market situation. Now, if we had had any idea that that was going to become pertinent in this case, we certainly would have cross examined Mr. Woodward to see if he is an expert and able to testify in the California market situation. We were sitting out in the audience waiting for another hearing to come up, and having no interest on his testimony at that time, we, of course, did not cross examine him at that time.

To permit testimony to be introduced when the witness is not available for cross examination is contrary to any principal of either administrative or judicial hearings that I know of.

MR. PORTER: The Commission's ruling denying your motion extends to all of his statement.

MR. WHITE: In view of the Commission's ruling, I will request that the Commission take administrative notice of its records and particularly the statement made by Mr. Woodward on Page 39 through 42. That's the testimony in consideration of allowables for December, 1957.

MR. PORTER: The Commission will do so.

MR. WHITE: Thank you.

MR. MALONE: What was the ruling, please?

MR. PORTER: The Commission will take notice --

MR. COOLEY: Take administrative notice of its own records.

MR. MALONE: I don't want to labor this point, but the Supreme Court of New Mexico has held that for a Commission to take into consideration, in deciding a case, material which was not presented in the hearing and to which no opportunity was afforded for cross examination, is reversible error, and I hate to see the Commission put in the record the fact that it is going to do something that the Supreme Court of New Mexico has held improper.

MR. SETH: If the Commission please, this might simplify the question. We have no objection if Mr. Woodward would like to write the Commission a statement, a letter, and the Commission give the letter consideration and give consideration to the statement given in this matter. Our objection is considering it as part of the testimony. The Commission as you all know received statements, and we have no objection to that. If Mr. Woodward wants to write a statement with the same material, that's all right with us.

MR. MURRAY: That is the light in which we were going to consider it.

MR. SETH: Mr. White is asking it be included as part of the testimony and as part of the sworn testimony.

MR. WHITE: As a mere statement of Mr. Woodward, that's all we care about it.

MR. SETH: I don't think there is any probability it can, as far as I can see. We don't know whether Mr. Woodward wants this in or not. Maybe he doesn't, but if he is prepared to write a letter on it, we have no objection.

MR. McGOWAN: If the Commission please, in taking administrative notice of your records, and you are not making it a part of the record in this case, the only way there is any objection, or any objection can be made, is if you made a decision on taking administrative notice on facts clearly outside the case. You have to take administrative notice of your own regulations and records, and that's all it amounts to.

MR. PORTER: The Commission will stand on the ruling. I believe that I requested the other applicants in this case to come forward with testimony, if they had some to present at this hearing, and nobody took advantage of it.

If there is nothing else at this time, the hearing will recess until nine o'clock tomorrow.

MORNING SESSION

Friday, December 20, 1957

MR. PORTER: The meeting will come to order, please. At this time we will continue with Case 1308.

MR. WHITE: May the record show that I'm also appearing on behalf of The Texas Company at this time?

MR. PORTER: Mr. L. C. White, appearing on behalf of The Texas Company.

MR. COOLEY: Mr. Commissioner, at this time I would like to move the Commission to reconsider its ruling of yesterday on the question of whether the Commission will take administrative notice or judicial notice of previous separate cases heard by this Commission. I believe I found the rule of law to be that the Commission can not take judicial notice of records in another and different case.

MR. PORTER: Mr. Cooley, you refer to the Commission's action of yesterday in taking administrative notice of Mr. Woodward's statement in the previous case?

MR. COOLEY: Yes, sir.

MR. PORTER: The Commission hereby reverses that ruling. We will not take administrative notice of Mr. Woodward's statement. Mr. Seth.

MR. SETH: If the Commission please, we would like to start Shell's case in opposition to Sunray's application for the change in the statewide rules. I would like to enter the appearance of Mr. Leslie Kell with Shell Oil Company, and Oliver Seth as attorneys. We would like to call as our two witnesses Mr. Methven and Mr. Lindsay who have both previously testified before the Commission.

MR. PORTER: Will the witnesses stand, please, to be sworn.

(Witnesses sworn.)

MR. SETH: Would you take the stand, Mr. Lindsay?

DONALD R. LINDSAY

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Lindsay, and your position with Shell Oil Company?

A Donald R. Lindsay, I'm an exploitation engineer with the Shell Oil Company. I would like to mention that my specialty in that classification has been production geology. I think I failed to say that at the first hearing.

Q You are the same Mr. Lindsay who testified at the original hearing in this case? A I am.

Q Would you please go to Shell's Exhibit 1-R and make your preliminary observations?

(Marked Shell's Exhibit 1-R, for identification.)

A Shell's Exhibit 1-R is a structure contour map of the Bisti Field, and it is a different one than we presented at the first hearing in that it covers the entire field instead of just a portion of it, and it has been contoured on Marker GC which is the highest producing oil productive sand in the field rather than on Marker GA as the previous map.

On this map we have in red lines section lines for new sections which we have constructed for this hearing. In the northwest part of the field are sections GH and IJ, in the central portion of the field are sections KL, MN, and OP. Farther to the southeast is Section QR and in the southeastern portion of the field are sections ST and UV.

We have left on this map, or have shown on this map, section lines AB, CD and EF, which were presented at the first hearing, and we have left them on this map so their locations can be noted. As in the previous case we still maintain that this is a stratigraphic type trap and that structure is not the most critical factor as far as oil accumulation goes, but it does seem to be a factor in the southeastern part of the field in the upstructure portion of the field where there is gas produced.

We have not changed our views on the fact that there have been gas wells completed downstructure from oil wells with no structural explanation for this. I refer to Shell Government 21-22A in Section 22, 25 North, 11 West which was completed as a gas well at a structural elevation at Marker GC of 1565 feet above sea level.

There are a number of oil wells to the west and upstructure from this well which are completed in the same zone and which are oil wells. I won't take the time now to enumerate all of them, but will do so if requested. I refer also to Shell Carson 32-20 in Section 20, 25 North, 11 West which has also been completed downstructure in the same sands and with no structural reason for this well to be down structure from oil wells. To summarize our views on this, we think these wells which have been completed since the last hearing tend to strengthen our belief that this field does not contain one simple gas cap but a number of gas producing sands which are isolated from upstructure oil-bearing sands.

Q Have you constructed a petrophysical chart based on additional data?

(Marked Shell's Exhibit 2-R, for identification.)

A Yes, Shell Exhibit 2-R is a petrophysical chart of data from Shell Government 24-16A located in Section 26, 25 North, 11 West.

Q Would you point that out on the map, please?

A On the map I have circled that location in red.

This well has been drilled and cored since the last hearing, and I present here data from this well. On it we have traced the electric log, the SP and resistivity curves, we show the well depths every fifty feet, and we show again with a solid bar the interval I have interpreted as supposing positive microlog separation.

As in the other charts prepared for the last hearing, we have traced on this chart a porosity profile with all values greater than ten percent porosity shaded in green and a permeability profile with all values greater than one millidarcy shaded in red. We also show on this chart several well depths indicated which will point out the positions of core samples which will be presented forthcoming.

The permeability scale, as on the previous charts, is a logarithmic scale and has no zero point, and as on the other chart, the point one or one-tenth millidarcy column includes all values which were one-tenth millidarcy or less. A number of these measured zero permeability core analysis in the lap, and to indicate those which do I have written a zero beside each value in the oh point one column which is actually a zero value.

Q Why is this chart significant? Would you summarzie, please?

A It is significant, in the first place it confirms our previous evidence that there is good correlation between microlog separation and core analysis values.

Q Would you point out that correlation between the permeability and the microlog separation in several examples?

A There are several intervals of microlog separation in the

GC sands, and opposite those are generally concentrated the highest values of permeability and porosity. The GC has the best reservoir characteristics, in this particular well it has permeables up to forty-four millidarcies and porosities up to sixteen percent.

The GC has a short microlog pay interval, GD corrected, and that shows high porosity, but the permeabilities here are all less than one millidarcy, but they are higher than intervening intervals.

I want to mention, in addition to these intervening intervals, that approximately sixty percent of the gross interval core here measured zero permeability. In this well, the GE sands in the lowest part of the section are not productive at this location, but they are elsewhere in the field.

Q Are there areas of zero permeability lying between sections showing microlog separation there?

A Yes, there are. There are several intervals of zero permeability between the two microlog pay intervals in the GC sand, and I think particularly significant is the fact that they are a couple of feet within the GC microlog interval showing zero permeability. In other words, we have an interval which shows microlog separation and does not show correspondingly high permeability.

But this occurs in each case opposite a deflection in the SP curve on the electric log, and I think that these deflections are significant in their correlation with core analysis, and I believe that from this chart and from cores which we will see in a moment, that they represent interbedded shales and silt stones that are nonproductive and are nonpermeable and are effective barriers to intercommunication between the underlying and overlying sands.

Q And you have an effective horizontal separation between these microlog areas there, is that right?

A I believe so.

Q Are there any further comments on Exhibit 2-R?

A I think those are the main points I wish to mention.

Q Do you have photos of the core from this well?

A Yes, Shell's Exhibit 3-R is a set of photographs of the cores from Government 24-16-A.

(Marked Shell's Exhibit 3-R, for identification.)

MR. CAMPBELL: What was that well again, the same well?

A The same well.

Q Would you describe the preparation of these cores, how these cores were handled?

A Yes, the photographs of the cores from 24-16-A were prepared in the same manner as the core graph of an interval from 33-24-A which we presented in the first hearing. The core was cut down the middle through its entire length, and one-half of that core was mounted and photographed and the other half was sampled every foot for core analysis and for exhibits for this hearing. So that the exhibits which we will have will not actually be the photographed piece, but its other half, its better half. In this photograph the top of the photograph down to a depth of 4943.

Q Which way does it run on the photographs?

A Well, the top is in the upper left, the well was commenced coring at 4914 to total depth and the upper left of the first photograph is the top of the core and it runs down and then across each page as this comes in order in this exhibit.

The uppermost portion of the core from the top to a depth of 4943 which is near the bottom of the second photograph, includes the interval in the GC to GD group of interbedded sand stones, silt stones and shales.

Q Can you refer to Exhibit 2-R and show us where that is, please?

A From the top to the portion of the petrophysical chart labeled GD. The GD group extends from 4943 to a depth of 4992, and the GE.

Q Show us the top of that again.

A (Witness complies.)

Q From that point to --

A (Indicating.)

Q Thank you.

A Below that are the GE and lower sands and shales, they are not very sandy in this well. Mostly shales and silt stone. This well is located about two and a half miles east and slightly north of Shell Carson Unit No. 1 which is the nearest cored well by the Shell Oil Company for which evidence was presented at the last hearing.

It lies about a mile north of the depositional trend of the Gallup sands from Carson Unit 1. So it therefore represents a more northerly sampling of the field than the previous two cores presented as exhibits.

Q Would you point out any significant portions of this exhibit?

A Well, viewing as a whole, it appears to be, to have the same, the same general characteristics of sedimentation as the previous examples. It has extremely irregular bedding, the sands in this core are very intricately bedded with shales and silt stones, and you can see countless discontinuities on a very small scale, generally for a sand reservoir I would say it is remarkably heterogeneous. The porosity and permeability on the petrophysical chart were samples measured every foot, but I think that if you measure them every fraction of an inch you would get great differences, so these can only be used as general average values throughout a particular interval.

I think that this set of photographs tends to confirm that the cores which we presented at the last hearing from Carson Unit 1 in 33-24 were representative and characteristic of this formation.

On these photographs there are red arrows which indicate the core samples or the intervals of core samples which will be presented as exhibits.

Q Anything further on those photos?

A I think not at the moment.

Q Do you have the core samples? A Yes.

Q Mr. Lindsay, you have presented the core samples which are Exhibits 4-R A through H? A Yes.

(Marked Shell's Exhibits 4-R A through H, for identification.)

Q Would you proceed with these and indicate their significance and their general location and depth? What well are these from?

A These cores are from Shell Government 24-16A, the same well for which the petrophysical characteristics are shown on Exhibit 2-R. I would like to refer to this chart as I describe just briefly the appearance of each of the cores.

The uppermost core sample is from a depth of 4917 feet, I will give these to the nearest foot. That is in the uppermost microlog interval of the GC sands. It's a fine grain calcareous silty sand stone and this foot of core measured 1.3 millidarcies, but again I think you would have wide variation within that foot.

Referring both to the core sample and the photograph, we again have these little irregular streaks, pods of more friable sand, which I think were caused by marine organism, some of a burrowing nature which probably left burrows and borings in the sediments and which were later filled with other sand. These generally are of a more permeable nature than the surrounding rock, but I don't think they are very effective as far as communication because generally the walls of each of these little borings are lined with silt, probably deposited during, while the organisms were in action. The second core at a depth of 4925 is from --

Q (Interrupting) That is Exhibit 4-R-B?

A 4-R-B is from an interval between, two intervals of micro-log pay in the GC sand group. This is a silt stone of zero permeability, and it also shows extensive reworking by marine organism and contains many isolated little sand streaks which are apparently not effective to communication because of the fact that we were not able to obtain any permeability in this core in lab measurements at all.

The next sample, 4-R-C, from the depth of 4933 feet, and that is in the longest microlog pay interval in this well in the GC sands, and this consists of very closely interbedded sands, silt stones and shales. This sample measured 10.7 millidarcies, but I think that if you were to get an independent core analysis permeability measurement of a streak of sand by itself, if you could do so, you would probably get a much higher permeability. The permeabilities are in this interval extended up to 44 millidarcies.

The next sample, 4-R-D from a depth of 4939 isn't this same microlog interval, but from a lower sand which is separated from the previous one by a number of shale breaks, this is from a six inch sand body from which particularly on the photographs the evidence of these borings by marine organisms is particularly in evidence. This particular sample measured 6.2 millidarcies, but it is adjacent to more permeable sands.

The fifth sample, 4-R-E from a depth of 4952 is from a very irregularly bedded shale and silt stone interval which lies between the microlog permeability intervals in the GC and the GD sand groups, and this also measured zero permeability, and I think that this is from an extensive section that separates and isolates the GC and GD sands in this well.

The next sample, 4-R-F, from a depth of 4974 is from the microlog pay interval in the lower part of the GD interval. It is very fine-grined silty calcareous sand which showed a permeability in this foot of 0.3 millidarcies, and again if evidence of reworking is present and on the top of the core where the core was broken is a fossil.

Q Will you point it out, please?

A Yes. Which is a fragment of some mollusk which I think might very well be a bottom dwelling organism and may possibly have been one of the organisms which caused, of the species which caused all this reworking.

The next sample, 4-R-G, the depth of 4991 occurs just above

Marker GE in this well and is a shale with streaks of silt stone and non-interconnecting very fine grain sand streaks of zero permeability, and the lowest sample 4-R-H from a depth of five thousand and three is a slightly more sandy sample, but it is also a predominantly silt stone and shale, and also measured zero permeability.

Q Do you have any comments now on any relationship of the chart to these cores? Before that, I believe you testified that location of these particular samples is shown on the core photographs by some red markers, is that correct?

A Correct.

Q So we can relate the other half of these particular samples to particular points in the photograph?

A Yes, the arrows in each case point to the top of the interval from which the sample is taken. I would summarize from this that inasmuch as we have cored a well some distance away from previously cored wells and found the same nature of sedimentation, that this core has not changed our ideas regarding the nature of the Gallup sands in the Bisti Field, that it is very heterogeneous reservoir, and that I don't think that any further development will modify our ideas regarding the reservoir.

Q Have you prepared some cross sections as indicated on Exhibit 1-R? Would you go to those, please?

A Quite a few. I have already indicated the locations of these sections. In the previous hearing we didn't have any sections through the southeastern portion of the field, and so I have prepared two cross sections in that area, cross section ST which is Shell Exhibit 5-R, which is along the trend of the sands.

(Marked Shell's Exhibit 5-R, for identification.)

Q Would you point it out to its full extent, please?

A It starts in Section 24, of 25 North, 11 West and extends southeast to Section 34 in 25 North, 10 West. In Section UV which is Shell Exhibit 6-R, is constructed across that section in a southwest-northeast direction. That is entirely within Sections 33 and 34 of 25 North, 10 West.

(Marked Shell's Exhibit 6-R, for identification.)

Q Would you discuss those two sections and point them out, please? ST is Exhibit 5-R and UV is 6-R?

A That is correct. ST is this long section which goes through a number of wells, to save time I won't name them all, but the most northwesterly well is Gulf Carson 4 and at the southeastern end is Monsanto Blanch 1. I have used a similar approach in interpreting pay intervals in these wells and in interpreting their communication or lack of communication.

I have shown on each well a black bar which represents the interval of positive microlog separation. Now, as I pointed out on the petrophysical chart, there may be areas of positive microlog separation which include very thin interbedded shales of zero permeability and break these intervals into thinly interbedded sands and shales, so I have used the SP curve in conjunction with the microlog in interpreting the position of the pay sands.

As before, we don't maintain that all production comes from only these pay intervals as indicated sections, but these are the best sands, the sands of considerably higher permeability than any of the sands which do not show microlog separation. I have indicated these best sands with this stippled pattern on each cross section. In this Section ST there is pay in both the GC and upper GE sand intervals almost all the way along the section. This, of course, would show the most continuity inasmuch as it is constructed along the depositional grain of the sands.

This does not necessarily mean, though, that where two wells are shown as connected with pay that there is actually effective communication between these wells. I mention that now, but I will show more evidence for it a little later. The most striking situation on this well I think is the Skelly Lockhart No. 2 which is the third from the right on the section. This well was drilled or completed in September, 1957, it is a 40 acre lease line offset to Monsanto Frank 1 which was completed in July, '57.

The well to the northwest of Lockhart 3 is Skelly Lockhart 2 which was completed in October, '57, and I want to point out the greatly increased pay interval picked up in this well, Lockhart 2, of which three sands do not reach either of the other wells.

This, to me, is a very surprising thing, particularly for a longitudinal section. There are two sand intervals in the GC and one in the GD which do not show microlog pay in either of the adjacent wells on this section.

This Skelly Lockhart 2 is the tiein well for our southwest-northeast cross section UV. The wells on this section are Skelly Lockhart 1, Skelly Lockhart 2 and Monsanto Atlas 2. In the middle well, Lockhart 2 again penetrates a much greater pay interval than either of the adjacent wells. I guess Skelly has real good geologists because I would not have been able to predict from the adjacent wells what we would find in this well, and I think it is very surprising that we find a much thicker pay interval than in either of the adjacent wells.

On this section you have, we can see that the uppermost micro-log pay sand interval in Lockhart 2.

Q Would you point it out, 2?

A Which was not penetrated by Skelly Lockhart 3 or Monsanto Frank 1 was penetrated by Skelly Lockhart 1 and Monsanto Atlas 2, but the lowest pay interval in the GC group is not penetrated by an adjacent well on either section, including one 40 acre offset.

To me this is strong evidence that that sand would not have been drained had not this well been drilled in this particular location. Again, the lowest GD sand for which there is microlog separation in Skelly Lockhart 2 does not show microlog separation in either of the surrounding four wells. I reach the same conclusion for that sand.

I would like to show next, in conjunction with these sections, Shell Exhibit 7-R, which is a true scale section of a portion of cross section ST. The wells on this true scale section are from left to right, Skelly Lockhart 3 and Skelly Lockhart 2 and Monsanto Frank 1. The first sections that I referred to, Exhibits 5-R and 6-R are constructed with a ten-fold vertical exaggeration, in order to show the data it is necessary to show, and not have the section unduly large. The scale on the full-sized exhibit is to a horizontal scale of one inch to two hundred feet and a vertical scale of one inch to twenty feet.

(Marked Shell's Exhibit 7-R, for identification.)

Exhibit 7-R, the portion of cross section ST is to both a horizontal and vertical scale of one inch to twenty feet. I constructed this merely to point out that these other sections give a rather distorted view as far as distance between wells go. They look like they are real close together, but this Exhibit 7-R shows their true relationship in distance. So you can see on this section the distance between a 40 acre location from its offsetting well, Skelly Lockhart 2 and Monsanto Frank 1, and the distance between Lockhart 3 and Lockhart 2 represents the distance between two diagonal 80 acre wells.

I think this gives us a better idea of the distances over which we are correlating these very thin stringers of sand.

Q You have an additional cross section, Mr. Lindsay?

(Marked Shell's Exhibit 8-R, for identification.)

A Yes, cross section QR is Shell Exhibit 8-R. Section QR is the next cross section to the north we have of Sections ST and UV, and it runs in a southwest-northeast direction through this portion of the field.

In this section we can again see evidence of very rapid sedimentary variations in all intervals, the uppermost GC sands, GD sands, and also down in the lower sand group, the GF sands on this section.

This section extends from Shell Carson Unit 34-19 on the left to Shell Government 23-16 A on the right. Shell Carson Unit 32-20 picked up the best sand development in the GC sand group. And of these, the uppermost three pinches out before it reaches either adjacent well, and the lowermost, well, all the interval thins out before it gets to either adjacent well, and even more striking is the upper GD sand which shows no microlog separation in either of the adjacent wells.

Between Shell Carson Unit 41-20 and Shell Government 24-16 A there are very rapid sedimentary changes. It may appear that the wells are not in communication with each other at all.

I would like to amend this section at this time to indicate that the lowest portion of the upper GC sand in Shell Carson Unit

41-20 may connect with the uppermost portion of the upper GC sand in Government 24-16 A. That may be a more preferable interpretation. But even if they do, they are not in exactly the same stratigraphic interval, and it is my opinion there might be very poor communication between those sands.

Q Is there a gas well on this section?

A Yes. Shell Carson Unit 32-20, the third from the left, was completed as a gas well, the initial production on October, '57 was three barrels of load oil and 1250 MCF per day gas. Production since then has indicated that it is a dry gas well. This well is situated downstructure from Shell Carson Unit 23-20 and Shell Carson Unit 34-19. These are oil wells, I believe, that 23-20 has a higher than average gas-oil ratio. I don't believe that 34-19 does. These are in communication as shown on this section through the GC sand.

Now, that's an enigma that we would have oil wells upstructure in communication with gas wells, and this is very significant to me in that even where I can show communication there may be discontinuities between those wells that we know nothing about until we drill there. I think this is a genuine anomaly and I can't explain it structurally.

One final thing, I would like to point out, is the lowest GD sand in Shell Government 24-16 A which was not penetrated by the, I believe in the adjacent 40 acre well, Shell Government 26-13 A.

Giving additional evidence there is discontinuities between 40 acre wells. I show pay in the lower GD sands, they should not be considered as pay inasmuch as they are water bearing.

Q Would you go to KL, Exhibit 9, and point out where KL is on the structure map?

(Marked Shell's Exhibit 9-R, for identification.)

A I would like to refer next to Section KL, MN and OP which are situated close to each other and near our previous Section AB and CD. Section KL, which is a Shell Exhibit 9-R, is a west to east section extending from Section 7 to Section 10, 25 North, 12 West. Section MN is a south to north section within Sections 15 and 10 in the same township and range, and Section OP is another east-west section, cross section, extending from Section 9 to 11 in the same township and range.

On Section KL, the west-east section, there are three Sunray Mid-Continent wells on the left side, Federal C-18, C-16 and C-14 which are spaced at 80 acre locations, and on the right side are five Shell wells extending from Shell Government 12-9, sorry, correction, four Shell wells and a Southern Union well which are at 40 acre locations in the line of the section.

The best sand development is found in the GC sand group, fortunately, on the right side of the section. In Shell Government 32-9 and 42-9 there appear to be as many as five separate inter-bedded sands which pinch out in both directions, thinning down to the west to three sands, two and then one, which is getting quite thin. The GC sands on the left side of the section there appear to be at least two separate sand stringers which are not at the same stratigraphic position, and therefore, in my opinion they are not in communication with each other, and the GE and GF sands on this section, the lowermost sands are present in most of these wells, showing microlog separation.

They have very erratic distribution up and down the section as well as exhibiting very rapid lateral variations. Probably the thickest GE sand was penetrated in Shell Government 32-9 that pinches out completely to the left in Shell Government 22-9, and thins down to practically the vanishing point in Shell Government 42-9. The lower portion of Shell 42-9, there are two GC sand stringers that doesn't show any microlog pay interval in the adjacent well.

The Shell 22-9 is a GE sand. That does not. Shell Government 12-9 are three GE sands in which neither the upper or the lowest appear to reach either of the adjacent wells, and Sunray picked up one in Federal C-18 which appears to not reach 16 in that it appears there is no microlog separation.

Some of the sands are perforated and do not produce oil, particularly after having been fracted even. Again, I believe that the best developed sands are where they do exhibit microlog separation and where they don't I believe the sands to be very tight and to not communicate over any considerable horizontal distance.

Q Exhibit 9-R, you have instances where there are sand members showing microlog separation that don't even extend from one 40 acre location to another, is that correct?

A That is correct. Several of these wells were drilled since the last hearing as 40 acre location wells, and several of them have picked up new sands.

(Marked Shell's Exhibits 9-R and 10-R, for identification.)

Q Now, Exhibit 10-R. A Excuse me.

Q Well, proceed.

A I have a few more things on this one. I want to point out another drafting error in Sunray Mid-Continent Federal C-14, the lowest GF sand or the GF sand which shows microlog separation was located ten feet too low on this exhibit and should be ten feet higher.

The interval should be 4858 to 60 and that would place it opposite the interval which Sunray wisely perforated, it would probably then communicate with the upper GF sand in Government Shell 12-9 rather than the middle one.

I have one further thing that Southern Union made a very good well out of this Ka-Gee-Tah 1. They perforated it only down to the GE sand as I believe was explained yesterday, and the initial rate, according to our records, was 480 barrels a day from the lower sands alone, even where they don't exhibit microlog separation.

This would appear to me to indicate that it's possible to make a fairly good well out of just the lower sands, and they have been referred to as inferior sands and they aren't the best sands in the field, but I think here is evidence that they are very important in the development of this field.

Now, Section MN is Shell Exhibit 10-R. This is the north-south section in the central portion of the field.

MR. SETH: Mr. Nestor, would you point that out again, please?

MR. NESTOR: Yes.

A I would like to refer to this section in conjunction with Section OP since these two sections cross MN, being the vertical and OP I should say, the north-south and this, the OP, the west to east section. The tiein well on these two sections is Shell Government 34-10. In other words, both sections pass through Shell Government 34-10, and show the same pay intervals.

This well was also shown on Section AB at the previous hearing. If you'll compare them, which I'm sure you will, you will notice that in this section we show four separate sand intervals in the GC, whereas in the previous one we showed only one continuous sand interval. I have reexamined many of these logs and I found a slight streak in the microlog pay in the upper portion in the GE sand in this well which I think actually is not continuous microlog separation, and the reexamination of the SP curve shows there are many shale breaks which we have seen from the petrophysical chart, and the core samples and photographs do represent interbedded shales which are not pay and which separate the sands into interbedded layers.

I think the explanation for this microlog pay, where we don't really think it is, is that where there is a gross sand interval with many interbedded shale beds, that undoubtedly the microlog zone dragged some mud cake across the face of the shale, gives you a reading where there really isn't enough permeability to really be indicated by the microlog.

I have taken that into account in constructing my section, and that's my explanation for this reinterpretation in 34-10. On other of these sections the GC sands are very well developed. They occur in most wells as many layers of sand rather than one continuous one. The thickest GC interval was penetrated in Shell Carson Unit 11, the far right well on Section OP. There appear to be eight separate sands, and the uppermost and the lowest GC sands in Carson Unit 11 have pinched out by the time, pinched out in Shell Government 44-10 and do not show microlog pay intervals.

Again I think this is evidence of the pinch of permeable sands between two 40 acre wells and that if 14-11 had not been drilled we might not have penetrated these sands in any well. Their easterly extension is undetermined because development hasn't continued that way to date.

On Section OP, the second well from the left, Phillips I-Tah-Nip 2 penetrated three intervals of GD sand as indicated by the microlog. This well was also on Shell's cross section CD in the previous hearing. If you check this against that you'll find that the upper two GD sands were penetrated by El Paso Kelly State 1, but the lower one was not. So there are wells on three sides of I-Tah-Nip 2 which do not penetrate a GD sand which was penetrated by I-Tah-Nip 2. On Section MN, Shell Exhibit 10-R, the well second from the right penetrated several sands in the GE and GF group, and on this section they have all pinched out in Shell Government 31-10, that is they don't extend that far.

The middle one of these three sands pinches out before it reaches Shell Government 34-10 with microlog separation, and the top and bottom sands have thinned down to a very small interval.

I think those are the points I want to make on these sections.

Q Do you have any general observations to make to the Commission as a result of this study?

A There are two more sections. These are the last two.

Q All right.

A Sections GH and IJ were located in the northwesternmost extremity of the field. GH is a section northwest-southeast section longitudinal with the sand trend. It extends from Section 29 to Section 34, in 26 North, 13 West, it extends from British American Douthit B-11 to British American Salge B-3. Section IJ is a southwest, northeast section which crosses GH at Douthit B-14, it extends from Section 33 to Section 22, the same township and range. It extends from British American Salge B-2 to Benson, Montin, Greer Foster 2.

On Section GH, which is the section longitudinal through the deposition, grain appears to have fairly good, relatively good continuity as indicated by the micrelog. But there are again reasons to believe that this does not necessarily mean completely good communication.

The GC interval shows good sand development in British American Salge B-1, and in Salge B-3 there were two microlog intervals in the same sand, and I would have interpreted these as pay except that British American ran a drillstem test including both of these intervals in one test and they recovered 65 feet of drill mud on a one-hour test, so it would appear to me that these sands are quite tight and perhaps just porous enough and barely just permeable enough to exhibit microlog pay.

They are not productive, the well was abandoned. British American Salge B-1, according to our records, was completed for an initial production of 743 barrels a day, and the next well to the northwest, Douthit B-14 which shows even more GC pay but no GD pay although it was perforated there, had an initial production of 185 barrels a day. This, to me, reflects the changes in the quality of this reservoir rock which you cannot pick up merely by plotting the microlog and suggests to me that the most prolific portions of this field are not very predictable and that many of them may be missed or just grazed if spacing is carried on too wide a pattern in this field.

I have to explain another drafting mistake. It is not important to the discussion, British American Douthit B-15 is mislocated laterally between Douthit B-11 and B-14. The correct distance should be from Douthit B-11 to B-15, the horizontal distance is 1880 feet and from 15 to Salge B-1 the distance should be 47, 10, 1. That would move B-14 farther left on this section, but there do not seem to be significant discontinuities which I will dwell on which this change would affect in any way.

Section IJ, which crosses GH at British American Douthit B-14, shows much more evidently rapid sedimentary variations. British American Douthit B-5 penetrated a fairly thick sand in the GC interval. That is the most, lowermost one which's not penetrated, Douthit B-14, and has practically thinned down to nothing in B-16. In a situation like this, if B-5 were here and B-6 were here, this sand would not be adequately drained, and therefore in the similar situations between 40 acre wells where there is a thick section penetrated in one well and thinned down to a very thin interval in another well, I think the drainage would not be adequate even though it was penetrated in this thin interval, that the drainage of the greater portion of the sand would not be adequate unless it is penetrated in its thickest, best value portion.

Of course, I say we are more likely to do that on 40 acre spacing than on 80 acre spacing. Other discontinuities on this section are found, British American Douthit B-13 is the lowermost GC sand, I see appears to pinch out before it reaches either of the adjacent wells.

Q Do you believe that these lower sand members are a matter that should be considered and perhaps a significant part of the reservoir after all, based on your study and the presentation of these cross sections and also the completion by Southern Union of a well in the lower pay?

A Yes, I think they have proven to be a significant portion of this reservoir.

Q Do they show a greater or lesser discontinuity, could you generalize on that?

A Yes, the lowermost sands, the ones, the GE and lower are much more irregularly distributed in this reservoir. They don't occur in every place that the overlying sands do, and if you drill, my opinion for only the overlying sands, you may miss many portions of the lower sands. They are generally thinner as a group, but they seem to occur in discontinuous intervals, and they don't seem to extent over as wide areasas the individual stringers, streaks of sand in the upper sands.

Q Is it also the case where you have production from sections where there is no microlog separation too?

A Yes, it is.

Q Do you have any further comments, Mr. Lindsay?

A I think that is all I have to say with reference to the exhibit.

Q Do you have any general conclusions you would like to draw?

A I don't think my conclusions would be different from what they were after the first hearing.

Q Would you restate them just briefly?

A Just very briefly, that my geologic investigation of the Bisti Field has shown it to be an extremely heterogeneous sand reservoir, that it shows frequent numerous discontinuities from well to well, and that examined both on a large scale with maps and sections and also on a very, very small scale with core samples, that I would not expect this sand to have characteristics which would permit it to drain over wide areas, and that I think therefore a spacing as wide as 80 acres is certainly going to miss many sand intervals which would be penetrated by 40 acre wells. I think that that now has been proven.

MR. SETH: I believe that's all the direct we have, if the Commission please.

MR. PORTER: We are going to take a fifteen minute recess.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Seth, you were through with your direct examination?

MR. SETH: Yes.

MR. PORTER: Would you take the stand, Mr. Lindsay? I'm reasonably sure that somebody has a question.

Anyone have a question of Mr. Lindsay? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Lindsay, first I want to assure you that if you hadn't confessed I wouldn't have found those errors.

A I thought Mr. Selinger would be here this morning.

Q You may have stated at the last hearing, but I'm not sure, would you please tell me the extent of your experience in sand reservoirs of this nature in the Mid-Continent or Rocky Mountain area?

A My experience with sand reservoirs of this nature in the Mid-Continent or Rocky Mountain area consists exclusively of the Bisti Field. I became familiar with the development at Bisti during the latter part of 1956, and since last July I have been Shell's production geologist responsible for the production geology of the Bisti Field.

Q Have you had experience in other areas with fields that you considered to be comparable with regard to the deposition and so forth as the Bisti Field?

A I have not had experience in other fields which are quite like the Bisti Field.

Q How can you then state as a conclusion that this field is, as I understood you, more heterogeneous than other fields of similar nature?

A By other fields of a similar nature, I was referring to sand reservoirs in general. I have never seen so heterogeneous a sand reservoir.

Q It's quite true, is it not, that the Bisti Field, based upon your study, is considerably different in a great many respects than in the sand reservoirs, say on the West Coast?

A Yes, it is.

Q That is true with regard to the characteristics of the rock as well as the pay thickness and so on?

A That is correct.

Q Would you say that this Bisti Field, considering the general pay thickness, is of an inferior quality to many of the sand reservoirs on the West Coast?

A There are many on the West Coast that are much better and there are some I would say of generally comparable quality as a reservoir.

Q Are there reservoirs that you have studied that you have as in this reservoir, various stringers of possible productive sand such as you have described here this morning?

A There are reservoirs of that type, but I have not thoroughly studied this type of reservoir before.

Q Do you believe that it is feasible to drill a sufficient number of wells in this reservoir to penetrate each and every one of the possible productive sand stringers to which you have referred?

A You mean economically feasible?

Q Yes. A No, I don't.

Q So that it is a matter of degree as to the feasibility or advisability of drilling additional wells in this reservoir?

A I think that's a sound basis to go on.

Q Our basic difference then lies in what that degree may be, as I understand, whether it's necessary or feasible to do it on 40 acres or 80 acres?

A That seems to be the controversy.

Q This may be an engineering question, if it is, of course you should defer it to the engineering witness. I would like to refer you to your Exhibit 9-R which I believe is the long exhibit at the top of the main board there. A Yes.

Q As I understand that, you have three wells of Sunray on the left spaced at 80 acres, correct?

A I believe that's correct.

Q Are those wells essentially toward the flank of this sand bar?

A They are near the southernmost extremity of the Bisti-Lower Gallup sands.

Q Would you expect at that point the GC and the GD and all the rest of the sands there would probably thin out due to the nature of the deposition?

A Thin out in which direction?

Q Thin out towards the flanks. A I believe that they do.

Q Now, then, referring to the four wells of Shell's there, I would like for you to tell me how much additional oil sand you penetrated by the drilling of those inside wells there that you did not penetrate with the 80 acre location. Considering those two that you just pointed to as your normal 80 acres, it appears to me that you got more sand with those than you got with the 40 acre ones.

A It appears that we got the most in the normal 80 acre well 32-9 and we have just about as much of the 42-9, including two sands in the GE and GF groups that were not present in 32-9, and we appear to have encountered a GE sand in 22-9 which is not at the same stratigraphic position as the GE sand in 32-9.

Q Now, assuming that you have approximately the same amount of sand in your upper zones which I believe is your GC and possibly part of the GD there, in all four of those wells do you consider that you obtained enough additional oil sand or potential production from the lower zones of the infill wells to justify the cost of their drilling?

A You talking about additional oil?

Q Yes. A From the new wells?

Q Yes. That you would not have recovered from the 80 acre wells.

A The mechanics of production and volumes of recovery do merge on the present of our engineering site and I have not made a cost estimate or a volumetric estimate of the type you mentioned. But apparently this is considered by Shell's Engineering Department as a profitable enterprise, so that's the way we are conducting it.

Q I'm sure that is true. Could that be a matter of the rate at which you are able to obtain the oil rather than whether you obtain the oil?

A No. Of course, we'll obtain it faster, now we are getting into supply and demand and I don't want to go into rate and all that, but I conclude that there is a significant amount of additional oil which you would not get at all on 80 acre spacing.

Q Well, now, are you concluding that as a geologist, or do you want me to ask the engineer about the amount of oil?

A Well, from a geological standpoint.

Q Explain that to me, that is what I want to find out.

A Not only on these particular wells.

Q I want you to talk about these particular wells. Those are the ones that are demonstrated there as indicative of the conditions in this field.

MR. SETH: I think the witness can answer the question and explain it further by referring to other exhibits.

A I will explain it here. I will refer to Shell Government 22-9 and 42-9, those wells penetrated sands in the GE and GF groups which were not penetrated by the other wells, and I believe that that is new oil which will be produced that would not have been produced on the 80 acre wells.

There appears to be a pretty fair correlation of pay zones up in the more prolific pay. Now I mentioned earlier the qualification I placed on these correlations I make. That I am convinced by now that merely because you can correlate a microlog pay from one well to another does not mean that they are necessarily in complete communication. I have attempted to stress the lateral variations in porosity and permeability development in these wells, and their apparent lateral variations in productivity as shown particularly on GH where you can correlate microlog pay zones in one well it is very productive and in this well it is dry.

Q Let's talk about the lateral variations in, or the vertical variation in permeability, do you consider there are inpenetrable barriers between the zones that you have classified in your geophysical chart and as you showed them on your cross sections?

A I lost you.

Q Do you consider there are inpenetrable barriers between your GD and GC or GE there?

A I think that at the location of this well we have direct evidence that there are layers of inpenetrable rock through which oil will not migrate in any practical time.

Q Do you consider that exists throughout this reservoir?

A It is my opinion that it does.

Q Do you think there is more than one oil reservoir involved here?

A It's difficult to define, I would say, an individual reservoir in a field like this. We look at the whole thing as one oil field, but it's my belief that it really consists of many isolated sands which are completely separated from each other, I mean a great many and each of those I think if you wish to cut it very finely you might call a separate reservoir.

Q Would you recommend that any of these particular sands be produced separately? A No, I don't.

Q Do you consider that that situation at this stage of development creates some uncertainty with regard to the nature of this particular reservoir?

A I think that at this date we have an even greater sampling of the reservoir and a portion of it on closer spacing than we had at the previous hearing. At that time I had drawn certain conclusions regarding the nature of the reservoir, and I think that the development since then has only strengthened those and has not really changed them.

Q Let's go to another point which appeared to me to be a matter of considerable uncertainty in your mind. You have referred to a number of what you classify as gas wells being downstructure from oil wells in this reservoir, is that correct?

A Yes.

Q You say that you are unable to find any geological or structural explanation for that situation?

A For the ones that I mentioned, yes.

Q Doesn't that create some degree of uncertainty about the nature of the reservoir and the manner by which it should be developed and produced?

A I draw the conclusion, what sort of explanation was I unable to find?

Q Well, I understood you, you said it was an anomaly and that's it. It's one of those things apparently you are indicating it was another indication of heterogenity in this reservoir.

A What I think I said, and what I meant to say, I find anomalies which I cannot explain on these structural bases, and therefore I conclude it is a stratigraphic reason, the stratigraphic reason being the discontinuity of the sands.

Q Well, as long as that situation exists, an unexplainable situation so far as you are concerned, do you not feel that it creates some degree of uncertainty as to the manner of development and production from this particular reservoir?

A I believe I just explained it.

Q How do you produce your gas wells, do you know?

A No.

Q Do you know how you produce your high gas-oil ratio wells?

MR. SETH: What do you mean how?

Q In what manner. Are you producing them as gas wells or oil wells?

A Some wells we, you mean our wells which produce both oil and gas?

Q Yes.

A I had better not qualify myself as an expert to answer that question.

Q One other question, again, with regard to your Exhibit 9-R. I believe you indicated that in your wells there were some areas that were perforated across that microlog separation which actually didn't produce in one well, it might produce in another. Are those distances sufficiently small that communication could be established by fracturing?

A You mean horizontal distances?

Q Vertical distances.

A Vertical distances.

Q In the upper zone there?

A Oh, (indicating).

Q Yes.

A Of course the purpose of fracturing is to increase the permeability of the reservoir immediately adjacent to the well bore and as to how far those fractures extend in the reservoir and as to whether they form effective vertical communication I think is something that certainly I don't know, and I don't believe that we could rely on fractures to do anything further than increasing the permeability of the pay, and we hope of the tighter pay right adjacent to the well bore, but as to establishing an effective vertical system of communication between the various pay zones any distance away from the well bore, I don't think that we can rely on them to do that.

Q One general question. Are you acquainted with the number of wells that have been drilled by Shell, since the original hearing, on a 40 acre spacing pattern?

A I don't have a figure with me, no.

MR. CAMPBELL: That's all.

MR. PORTER: Anyone else have a question of Mr. Lindsay? Mr. Grenier.

MR. GRENIER: I have never been a real good geological lawyer and I'm afraid much of this testimony is just completely beyond my individual depth. With the Commission's permission, I would like to have them permit Mr. Wiedekehr, our reservoir engineer and head of the Production Department, to conduct a portion of our company's cross examination.

MR. PORTER: Yes.

MR. GRENIER: Thank you.

By MR. WIEDEKEHR:

I would like to start back with Southern Union Gas Company's Ka-Gee-Tah, please. I think we will do better if I can go with you so we can see what we are talking about. Referring to your Exhibit 9-R, Southern Union Ka-Gee-Tah No. 1, would you state first approximately where the perforations on that well are?

A They seem to extend from about 4845 to 4865.

Q 4845 to 70 be all right? A Yes.

Q How much microlog separation did you find on that particular well? A I didn't find any.

Q No microlog separation?

A No positive microlog separation.

Q Did you have available to you core analysis from that well by any chance?

A I did not prepare that with core analysis available.

Q In your cross sections that you have used this morning you have been correlating, I believe, potential pay zones using micro-log separation, right? In other words, you have shown that these sands pinch out, disappear, come back in, and the basis that you used for that has been microlog separation?

A Not entirely. I have used the data available to me, and as far as drawing my sections, I have used both microlog and SP development.

Now, I do want to make it clear that I did not consider a sand interval as shown by the electrolog without microlog separation as not being a pay zone, but as being very tight.

Q You have, I believe, on your Exhibit 9-R the reported high pay from that well?

A My records show 480 barrels a day.

Q 480 barrels a day flowing? A Yes.

Q Let me assure you that is correct. Then I wish you would explain to me, with no microlog separation, I happen to have the core analysis available, only two feet of it had any permeability, how a well of that category could produce that much oil. I mean geologically how can you get 480 barrels flowing out of a well with no apparent permeability? That's what your microlog is supposed to show.

A It is supposed to show the better permeability. There is permeability there or we would be unable to produce the oil.

Q Right. Wouldn't it require relatively good permeability somewhere adjacent to the well bore to have produced that volume of oil?

A That rate is certainly more than I would expect from the appearance of that well.

Q Well, assuming that we are correct then that that particular zone, no microlog separation, no apparent permeability, matter of fact very poor SP, wouldn't you say?

A Mediocre.

Q Mediocre. All right. Assuming that it produced oil from that type of formation, would it not be possible that say Shell's Government 44-10 in Exhibit 11-R in an interval from 4830 to 4840 or so, showing no microlog separation but having equivalent or better SP, might be productive?

A We have perforated that interval. We have not yet completed the well at least to my latest knowledge. We have perforated that interval without microlog separation for the purpose we believe it will produce some oil down there.

Q In other words then, we might say that since Shell has perforated in their Carson Unit 14-11 zone with no microlog separation, and this one, the 44-10 and the Government 24-10 and the Phillips 1 I-Tah-Nip, apparently they have perforated that same zone, it is apparently the feeling of both Shell and other companies that these zones will produce, at least if they didn't they wasted a lot of money on perforation even though there is no microlog separation, isn't it considerable that all these zones could be tied together even though you can't correlate them with microlog separation?

A Where there is no microlog separation I infer from that information that the permeabilities are very low. Therefore, I would say that sands of that character would have a much smaller drainage radius than sands of higher permeability.

Q We just got through discussing a well with no permeability made 480 barrels a day flowing.

A It had permeability.

Q But what type of permeability would it have to have, as a geologist would you say it had to have good or poor or fair, or how would you describe the type of permeability required for that kind of a volume?

A From a rate alone, if I had no other information, it would sound to me like you had some pretty fair permeability.

Q Let me ask you, were you in the hearing room yesterday when Mr. Lewis testified for Phillips? A Yes, I was.

Q You heard his testimony about the variation in permeability even within an inch of core?

A Yes, sir, I agree with him on that.

Q You agree with him. Then you would also agree that if we took any one of these wells and moved out three inches further from the well bore that there might be a good change in permeability and there might be good permeability there?

A In the sands in this interval which I have examined in cores are of heterogeneous nature and you certainly will get rapid changes good to bad, good to bad permeability in that very irregular distribution, and you may move out three inches and get better permeability, but in sands of this type, from the appearance of them from cores and from their log characteristics, I wouldn't expect you would go out three inches and encounter a real permeable bed that would go on and on.

Q You wouldn't expect that, yet apparently something on that order happened in this particular well?

A It may have happened in this particular well.

Q Let's look at Exhibit 12-R. I believe you discussed the capacity of a couple of wells. The British American Douthit B-12, B-1 produced at one rate.

A Our records show 743 barrels a day initial.

Q How about the B-14?

A Pumping 185 barrels a day.

Q You based, I believe now on direct examination you based that on the fact that the sands were, you said that even though sand in the B-14 appeared much better, that the Salge B-1 was the better well. Would it not be entirely possible that that was strictly a matter of completion? In other words, does the method of completion have a lot to do with the IP of these wells in the Bisti Field?

A I think the method of completion does have a lot to do with it. I had better admit right now that I don't know exactly the method of completion in these wells beyond perforating the sands.

Q I believe on direct you did infer that it was a difference in sand that caused it rather than completion practice. I just want to point out and ask you as a geologist if you didn't think that the completion practice might have had a lot to do with it?

A Yes, I am sure it would. I also referred to Salge B-3 which also has sand and microlog development, but which is tight.

Q Was pipe set on that well?

A I can't say for sure, but apparently not.

Q In other words, apparently British American relied on a drill stem test in that area to decide not to set pipe?

A Apparently they did.

Q Is it not true that there have been a number of wells in the San Juan Basin on which pipe was not set because of poor drill stem test and yet future development has proved that area to be productive?

A I'm not familiar with development away from the Bisti Field itself, but the statement that you make as regards in general is true.

Q I was referring particularly to another Gallup field, the Verde Gallup. You are not familiar with it at all?

A No, I am not.

Q For your information, two wells were drilled and plugged and abandoned as dry holes due to poor drill stem test before the first producer was found. What I am trying to point out, that with that well with pipe set on it might have made a little oil well.

A Yes, it might.

Q I'm sure you are familiar with other fields other than Bisti. Do you know of any field in which the sand condition, both the type of sand and the thickness of the sand, does not vary from one portion of the field to another? Let me reverse that. Do you know of any field in which the sand is constant throughout in thickness and characteristics?

A Constant is a relative word.

Q I said thickness. A Oh, in thickness.

Q Yes.

A The constancy of the thickness of the sand certainly depends on the manner in which the sand was laid down, on all manner of geologic events which would govern the thickness of that sand and the extents laterally.

Q You would expect sands in any field to vary in thickness for two miles away or three miles away? It is not unusual for sands to vary just as they do in Bisti?

A No. Sands may vary in constancy over a long area, but others will do it much more rapidly.

Q I was never quite satisfied with the answer you gave Mr. Campbell about the additional oil that you expected to recover by the drilling of the Shell 22-9 and the 42-9. Would you tell me roughly how many feet, assuming microlog is correct entirely, how many feet of microlog difference you have from the Shell 42-9 to the 32-9 in the bottom sands only on Exhibit 9-R?

A You referring to the individual sands or the whole group?

Q The bottom sands, that is from your GD down.

A They are approximately the same in total thickness.

Q How about in 42-9, how many feet of sand do you show on microlog below the GD sand? A About four feet.

Q As a geologist, are you familiar with the estimated recovery per acre foot from the Bisti Field?

A I used to know the figure, but I can't recall it.

Q As a geologist, would you recommend that your company drill a well in the Bisti Field for four feet of pay?

A Four feet only, no.

Q But if we assume, and let's make an assumption right now, if we assume that the GC sand could be drained across an 80 acre spacing, then in an appreciable period of time then actually the drilling of the Government 42-9 was drilled for only four feet of sand, was it not?

A If we make your assumption I can't say yes to that because we didn't know how much GC sand we would find. We drilled it for the productive sand that we would find in that location.

Q But you drilled it for four feet now in the lower members. In the lower members now.

A We found an additional four feet of microlog pay.

Q So as I said before, I believe then assuming the upper member could have been drained on 80 acre spacing, you actually then did drill that well and would expect the economics to show that the four feet of pay there would pay for the drilling of the well?

A Based on your assumption that the 32-9 would drain completely and efficiently, that we would get no additional oil from here. Actually I have to subtract about a foot from that four, three feet.

MR. WIEDEKEHR: Thank you. That's all.

MR. GRENIER: Just one or two more questions, Mr. Lindsay, on behalf of Southern Union.

Q How many wells of the, I believe it was the 187 it was testified yesterday, have been drilled to date, have you examined logs on or informed yourself about, substantially all or just a small percentage?

A I should count these before I come in here because I always get asked this.

Q Would it be about half?

A Well, I would say that it is somewhat less than half.

Q Approximately 80 to 90 then would be something in the range that you looked at in some degree of detail?

A Yes.

Q Were most of those wells along the so-called fairway or were they along the flanks or were they spread in a fairly representative fashion?

A The greater part of them would be in the, would be along the fairway, it's been called Route 66, although there is a fair scattering across the entire trend.

Q What proportion of those wells which you have examined logs on exhibited sand, pay sand in the upper member? I believe that's the one you referred to here generally as the GC sand, is that correct?

A That is correct. A good majority of them exhibited pay in the GC interval.

Q In the fairway area would it be correct to state that substantially all exhibited this?

A Not entirely. Many of them even in the fairway were better developed in the lower, what we call the GD sand group than in the GC, but certainly most of them along the central part of the trend did exhibit better GC qualities than GD.

Q Approximately what proportion or percentage, if you can give it to us that way, of these wells that you have examined did exhibit some microlog separation in the lower sands?

A By lower, do you mean --

Q I'm referring to the GD on down.

A It would be a horseback guess, roughly three-quarters, possibly a little more.

Q Would you have any figure that you can give us as to approximately what the development was there? Was it about the same, three or four feet, that we were discussing in your just preceding cross examination by Mr. Wiedekehr, would that be fairly typical?

A It varies from several feet of sand, perhaps ten or more, to nothing.

Q So that any given well which was drilled here and taken on down to these lower sands would have approximately 75% chance then I gather, based on the wells that you have seen, of hitting something which might vary from zero to ten, is that correct?

A You're referring to sands exhibiting microlog separation?

Q Yes.

A That would depend on which part of the field you are in, in some portions of the field you might have a greater percentage than in the other, but if you are including the GD sand, I probably should have raised my estimate to more than 75, but that might be a fair figure.

Q Now, then, going below the GD, what would the percentage of wells be that exhibited anything below the GD level?

A Well, if the sands exhibit microlog separation they're less than 50%.

Q So that whenever a well was taken down below that either on 80 or 40 acre spacing, you would have somewhat less than a 50% chance of hitting anything there, is that correct?

A I think you would. Well, anything, you may hit sands which might produce a considerable amount of oil on being fractured, but for hitting sands which you would run a microlog and find separation down there, I would say you would have less than a 50% chance.

Q You would have a less than 50% chance if you based it only on microlog separation, but you might have more than that if you based it on what actual production history is shown in the absence of microlog separation,as for example in the Southern Union well which you were discussing a few moments ago?

A Yes, I think that is correct.

Q So that whenever you go down below the GD level, you are having about a 50% chance of hitting anything at all, if I understand your testimony.

A I think you would have more than 50% chance of hitting sands which are capable of production but less than 50% chance of finding sands which show microlog separation.

Q In your opinion would the additional sands that you would find down there, disregarding the upper strata, be of sufficient likely productivity to justify the drilling of a well?

A I think that the lower sands by themselves probably in most parts of the field would not justify drilling a well just for that alone.

Q Would you have any estimate that you could give us, or have you formed any opinion about this as to what portion of the total reserves in the field are to be found in the area below the GD level?

A I have not formulated an opinion to the point where I could give you any figure.

MR. GRENIER: That's all. Thank you.

MR. PORTER: Mr. White.

MR. WHITE: Mr. Wade has one question. All of mine have been pretty well covered.

MR. PORTER: Mr. Wade.

By MR. WADE:

Q I would like to discuss nomenclature with you a little bit.

I believe on one exhibit, I believe it was your cross section OP, you referred to eight sands I believe, is that right?

A Yes.

Q Actually you were referring to eight indications of micro-log separation, were you not?

A Well, the microlog is in fair agreement with the SP, and I would say that both the microlog and the SP suggest that there are eight sands.

Q Eight separate sands?

A By that I mean that eight sand layers showing microlog pay were penetrated in that well which are separated by interbedded shales, silt stone.

Q You referred to your black bars which are an indication of microlog separation almost uniformly in your testimony as sands. Do you consider that those, each of those black bars is an indication of a separate sand on each of these exhibits?

A Actually my black bars tend to generalize on the real number of discrete sand layers within any microlog separation interval. I have attempted to stress that I consider them to be very thinly interbedded sands for the most part as seen on the cores and as evidenced by the SP in many wells and as evidenced by the very, very irregular permeability profile.

Q Well, in your references to sands and the black bars, again using that nomenclature in this Southern Union well that has been discussed here, there are no sands in that portion that were opened, is that right?

A The SP shows there are sands.

Q Well, then, the nomenclature that you were using as regards microlog separation does not necessarily mean that when you call them sands that they are sands as such?

A I was perhaps abbreviating somewhat when I referred to them as sands.

Q I didn't want to leave any confusion with the Commission that you were indicating that all of these cross sections and the lack of continuity shown thereon was the basis of sands, but rather that they were drawn to show that there was lack of continuity between microlog correlations only?

A Yes, the sands I referred to in my discussion of my sections, I meant to refer to the portions of the interval which show the stippled pattern as being the sands which do show microlog separation.

Now, there are other sands over sections which do not show microlog separation, and they are sands and I say they are very low permeability.

Q If you eliminated this nomenclature calling the bar sands and correlated on actual sands, the SP curves, this discontinuity or apparent discontinuity that is shown by correlation of micrologs would disappear to a certain extent?

A I have seen quite a few exhibits at this hearing which did show that is true.

Q Showing a continuity of sand, but a discontinuity apparently of microlog separation?

A A discontinuity of the very permeable sands.

MR. WADE: Thank you.

MR. PORTER: Anyone else have a question?

MR. DUTTON: Granville Dutton, Sun Oil, Dallas.

By MR. DUTTON:

Q Mr. Lindsay, to return for a minute to the heterogeneous variations of permeability in sands, would you say that your examination reveals any systematic distribution of those heterogeneous?

A Examination of cores?

Q Of all information available to you.

A A systematic distribution?

Q Systematic distribution.

A Yes, there are in this field certain trends that can be seen if you add up in each well the sum total of all the various microlog pay intervals and plot them as isopacks; as a matter of fact I presented one at the last hearing which do show areas of this field which have more net pay than other areas, and if you can draw isopacks on it and get a trend, the trend does follow generally the trend of the field itself. But I also wish to make clear at that time, and say again, that merely because you can draw isopacks showing a trend does not mean that all those separate thin layers are all connected.

Q Then within a given core sample, those that you have introduced in evidence here, would you say there is any systematic variation in the heterogenity in those cores?

A In these cores alone?

Q Yes.

A I would say it is quite irregular, some of these sands in this core are massive for perhaps a few inches up and down and others are very small streaks of sand completely encased in shale material, and in these very irregularly distributed, finely interbedded sands in many of those intervals why we were unable to establish communication in our core analysis. That is core analysis showing zero probability, or permeability, showed that they were not interconnected and showing they are radically distributed.

Q The systematic distribution that you have described is primarily one of weighing the permeability in one and the porosity in one and lumping that together and then you find with that weighted average some systematic distribution, is that correct?

A I think that there is some systematic, well systematic, there are trends of more pay in this field, yes.

Q But within the individual core would it be correct to describe the parameter as being randomly distributed?

A Not entirely randomly since this is a bedded formation it is certainly, certain qualities of sand follow very specific bedding planes, are contained within specific stratigraphic intervals, and perhaps within a certain stratigraphic interval you will find a particular type of sand interbedded a particular way and above and below you may find a dense shale and above that a massive sand, so above that you may say there is some systematic distribution within a core.

Q With respect to Shell Carson No. 5, could you tell me if that is an oil well or a gas well in your estimation?

A I have been informed that is a gas well and that the oil production that I think was referred to in the last hearing was load oil. We have no indication it was an oil well.

Q Would that explain one of these anomalies that you thought was present in the original hearing where you had oil production above gas production or thought you had?

A The anomaly that I referred to and attempted to stress was the anomaly between Gulf To-Nah-Bah Navajo 1, which is a gas well according to my information, and Shell Carson Unit 33-24 and Shell Carson Unit 2, both of which are oil wells and upstructure from that Gulf well.

Q And Carson No. 5 does not indicate any anomaly at this time, is that correct?

A No, there is no anomaly there.

Q You have testified that in your opinion, or perhaps I should ask this as a question. Is it your opinion that it is economically feasible to develop on 40 acre spacing at this time?

A Well, I have not made those calculations myself, but I'm informed by fellow workers at Shell that it is their opinion that is profitable development.

Q Are these fellow workers under your supervision?

A No.

Q Or do they just give you the advice?

A We give each other advice. They are not workers under my supervision.

Q Your classification is exploitation engineer, do you ever indulge in economic analysis?

A I have from time to time at Shell, but generally the economics are in the province of the Reservoir Engineering Department, and, let me clear something up. Shell's Production Department, there is the Mechanical Engineering Department and the Exploitation Engineering Department. Within Exploitation Engineering there are three specialties, being Reservoir Engineering, Petrophysics and Production Geology, and we all try to familiarize ourselves pretty much with all three fields, but we have one specialty and mine is production geology, so it is therefore not my responsibility to make economic calculations.

Q Then your testimony relative to the desirability of 40 acre spacing is based entirely on the geology of the field and not upon economics.

A I try to limit my opinions to what the geology alone shows. I don't try to calculate in terms of dollars what we are going to get here or there or even in barrels of oil. But merely I try to the best of my efforts to determine the nature of the geology of this field and then as for the economics, that is a matter of the company policy.

Q In answer to one of Mr. Campbell's questions, I believe you indicated that you did not consider it economically feasible to drill on less than 40 acre spacing, was I correct in your statement?

A You are referring to the first hearing?

Q No, I'm talking about the cross examination by Mr. Campbell today.

A I cannot recall that question.

Q Then I will ask it. Is it your opinion that if this field were developed on 20 acres it would recover more oil than if developed on 40?

A It is my opinion that you would recover more oil.

Q Then would it be your recommendation to develop it on 20?

A Not until our reservoir engineers had made an economic analysis of that situation.

MR. DUTTON: Thank you.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q I have just a couple of questions here. Mr. Lindsay, has any analysis been made of any cores or in any other manner to determine whether any vertical communication exists between these various sand bodies, or within these various sand bodies, for that matter?

A Our core analysis has been limited to one sample per foot, and we have not, to my knowledge, in the lab made any effort to establish vertical communication between individual sands as far as permeability measurements go.

Q Well, now, have you made laboratory analysis, or has a laboratory analysis been made, I should say, of these silt stones and shales to determine whether they are permeable either horizontally or vertically?

A The analyses, for example, in Shell 24-16 A are shown on the petrophysical chart and we have therefore made numerous measurements of the silt stones and shales which do show zero permeability.

Q Laterally? A Laterally.

Q But no analysis has been made on vertical permeability?

A Not to my knowledge.

Q Mr. Lindsay, I can understand why a company might perforate where no microlog separation was evident. These cross sections indicate a lot of perforations in many wells, but I can't understand why a company wouldn't perforate where the separation did exist. What's the reason for that? I note that it has occurred in several instances.

A Were it my job to recommend perforations in any particular well that we might drill, I would recommend perforating all of the microlog pay intervals, all of them including and in addition the better developed sands from the SP that didn't show microlog. Right off-hand I can't think of a reason why one would not want to perforate microlog pay zones, assuming that those sands were not water bearing.

Q I note on your Exhibit OP, Carson Unit 14-11 has some microlog separation which hasn't been perforated. I just wonder about that.

A I don't know the reason for that. I would have recommended that we perforate the whole thing, I mean the whole microlog pay. There may be a discrepancy in depth measurement which was not corrected when this section was drawn, but I don't know if there is.

Q Mr. Lindsay, you corrected several of the exhibits while you were testifying. Are there any other errors in these exhibits or have they been checked to see if there are errors?

A They have been checked. I have corrected those errors that I have been able to find.

Q This process of checking, have you determined in your own mind that you feel that these exhibits are correct as they are now with the corrections that you made on them?

A They are to the best of my knowledge correct now.

MR. NUTTER: That's all.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Lindsay, are the GC sands and the GD sands, as you identify them, the same sands which the Applicants refer to as the top two and most prolific sands?

A I think that they are. They have a different nomenclature.

Q You were present at the hearing yesterday, of course?

A Yes.

Q You heard continuous reference to the top two sands which were referred to as the most prolific sands?

A Yes.

Q From which two witnesses testified that they felt either 95% or something in excess of 95% of all the oil in the Bisti-Lower Gallup oil pool lies? A Yes.

Q Now I would like to know if you agree with this estimate as to the distribution of the reserves through the various sands?

A Well, I believe that this is weighting the upper sands rather heavily. I think that the 95% figure is probably lower than 95%. I would say that there is apparently, in my opinion there is more oil in the lower sands compared to the upper sands than in other opinions.

Q If you were asked to make an estimate to correct this figure, what would you think would make a closer approximation of the distribution of the oil?

A I would be pretty hard pressed to give a figure, but I should think that I believe that our reservoir engineer has made an estimate and I would hate to give one different from his.

Q I would like to know from your geological examination what you feel the distribution is. I understand there are many factors from the engineer standpoint that come to bear upon these and modify them; strictly from the geological standpoint where do you feel this figure would be more properly placed?

A Well, I would say that as an opinion it would be more on the order of 75 to 80%.

Q Thank you, Mr. Lindsay. Yesterday Mr. Lewis testified that he felt that correlation between microlog pay was an extremely hazardous way of attempting to establish either the presence or the absence of communication between wells due to many factors, one of which you core a very, very small area compared to the distance between the two wells and the wide variations of permeability of which you have no knowledge in between. Do you agree with this statement?

A This approach certainly has limitations. It's an interpretive problem, has a lot of geology, it's the best method that I know of doing that of geologically looking for communication or discontinuity, I make every effort to correlate microlog pay though where they lie in the same stratigraphic position.

I think where they lie in different stratigraphic position, where one exists in one well and does not exist in the next well, I think it is a reasonable interpretation that somewhere between those two wells this sand which is confined between certain bedding planes must decrease sufficiently in permeability that it does not reach the other well, and therefore there is not communication, effective communication between those two wells in that sand interval. That's the best way I know how to do it.

Q You would agree that actual communication tests conducted between the wells would be more conclusive proof of the existence or non-existence of communication rather than an interpretive correlation of microlog pays?

A I think really the two approaches in conjunction might give you more of an answer, but I think that you have to, or that it is more informative if you conduct your pressure tests in individual sands rather than as in the entire interval open to the well. I think in many cases some sands may go through and communicate and show you pressure communication where many others do not go through, but the effect of those as I understand from our reservoir experts, is that where there is even a slight amount of communication you would see a pressure drop or a pressure interference between two wells which does not mean that all the sands are communicated between those two wells.

Q I'm not referring now to any communication test or tests that have been conducted with reference to this pool, but in general if they are conducted under ideal conditions and as you say we will assume they are conducted for each interval.

A Yes.

Q This would be considerably more conclusive method of determining communication between the wells than would correlation of microlog pays, wouldn't it? A I think it would be, --

Q (Interrupting) Thank you.

A (Continuing) -- conclusive.

Q If you have further explanation I didn't mean to cut you off.

A That's all right. I think that the two really together would probably give you more information if you do test isolated sands, but of course I have confined my investigation to purely the geological approach.

MR. COOLEY: Thank you.

MR. PORTER: Mr. Utz.

By MR. UTZ:

Q Mr. Lindsay, I'm sure by now that you are aware that there are a number of perforations shown on your cross section exhibits which are borne out by microlog separation. Is my understanding correct that those perforations were made on the basis of the SP curve alone? A They were.

Q Then, let's refer to your cross section OP, Exhibit 11-R, for a minute. The perforations below your GD sands on Government

44-10 which do not show microlog separation, can you state whether or not those perforations are still in that well?

A To the best of my knowledge they are.

Q Let's enlarge it to all of your exhibits. Are all of the perforations shown on your exhibits still open in the well bore as far as you know?

A As far as I know they are unless there are any cases that I am not aware of where it has been indicated that the well has been plugged back above those; otherwise, I would assume they are open.

Q Getting back to your Shell 44-10, can you state whether or not the lower perforations below your GD sands produce oil in that well?

A I can't say conclusively that they do because I don't think they have been tested separately.

Q Can you state that any of these perforations shown on your exhibits, which do not show microlog separations, produce oil?

A On one of my cross sections at the previous hearing we showed Shell Carson Unit 2 which showed perforations in an interval of no microlog separation, and that is an oil well, it is not a very good oil well, but it does produce oil from only perforations opposite no microlog pay, and then this Southern Union well on Section KL appears to have perforations only opposite a sand interval without microlog separation. Apparently the sand intervals which do show microlog separation have not been perforated.

Q That turned out to be a pretty good well then, didn't it?

A Sure.

Q So microlog separation alone is not indicative of whether a well will produce or not, is it?

A No, it is not.

Q I believe that it is your contention that there are quite a number of isolated sand lenses in this reservoir which are completely separated from other sand lenses. Am I correct in your analysis?

A It is again the problem of nomenclature. The sands in, I would say, probably most of these cases do go through to other wells, but those adjacent wells don't show microlog separation and therefore I think that the communication between those wells would be very poor inasmuch as the more permeable sands lose their permeability going between the wells until somewhere between this well and that well the permeability has dropped to so low a figure, probably in the tenth of a millidarcy or less range.

Therefore, I conclude that there is poor communication, if any, between those wells.

Q Have you, or do you know of any pressure tests, gravity tests that have been made as between these individual sand lenses?

A I don't know of any between individual sand lenses.

Q Would that not be a pretty fair way of indicating that they had complete separation?

A I think that would be a good approach.

Q But you don't know that that has ever been done?

A Not to my knowledge.

Q Just one other question. Mainly out of curiosity, if these sand lenses are completely separated, how do you account for the oil being there in the first place?

A Well, we are getting back to this problem of geologic time. I was asked that question at the last hearing and I stated that I thought some part of the oil was indigenous, but that most of it migrated in the Gallup sands from an outside source, and I would say that the vast majority of it has migrated into the Gallup sands.

The Gallup sands, if you look at them in their environment, are a series of relatively thin sands interbedded with and entirely encased in a vast section of shale, the mancous shale, which I believe is considered to be a good reservoir rock. And I would say that in my opinion the mancous shale is probably the source of virtually all the Bisti oil, and of course when these sands were laid down why they were not tightly cemented like they are now. They had streaks of fairly relatively clean sand which had very little clay in them, and other portions which did have a good deal of clay which would account, would be represented by the shaleout of the sands in lateral directions, and the mancous shale at that time as it was laid down before and after these Gallup sands, consisted of mud and clay which was gradually compacted, and in that mud and clay I would say from the large concentration of organic remains, that the oil was generated and more or less squeezed out of the shales into the sands.

In other words, as oil is generated in shales and shales are compacted, they become tighter and the oil tries to escape and we find some escapes into the sands and becomes concentrated into the sands. Then, of course, the sediments are buried rather deeply and at some time, at some geologic time, other changes take place, circulation of ground waters which deposit cementing material, much of it probably a result of the calcareous remains of the various fossils which are right in the sands themselves, and that changes the quality of the sands, it changes the nature of the sand, they become differentially cemented and the oil which remains in these streaks and stringers of permeable sand becomes trapped. That is my concept of how the oil got into these sands and why it can't get out until you penetrate it with a well.

MR. PORTER: Mr. Grenier.

By MR. GRENIER:

Q Just a couple of questions that have come to mind in the course of the cross examination by other parties. Referring to your Exhibit 11-R, I believe it was indicated in your Shell Carson Unit 14-11 well there were some eight different microlog separation intervals there where positive separation was shown, is that correct?

A That's correct.

Q Going over to the next one on the left and the Shell Government 44-10, is that bar correctly shown there as being a continuous positive microlog separation throughout that interval which you have stippled in that well?

A Yes, it is. I can't recall the log itself. I looked at quite a few, but I would assume that the micrlog did indicate a solid interval of separation.

Q Now, running through that solid interval I see that you have some four non-permeable streaks which appear to pass right through it, two of them at least going on a couple of wells on further to the left of the exhibit, isn't that correct?

A Yes.

Q What was your basis for determining that those were still impermeable lenses, or whatever, when you had positive microlog separation throughout the full interval?

A The basis for the shale beds separating the sands was the SP curve of electric log.

Q The microlog separation did not indicate that discontinuity?

A Not in thiswell.

Q I gather that you think that these, taking again the eight separate sands over there in 14-11, that some of them pinch out before they get over to offsetting wells. Wouldn't it be just as likely to assume that some or all of the non-permeable intervals would pinch out before they got over to the next wells?

A A reasonable question, and I think in many cases the non-permeable streaks do pinch out as I show some here which do, Shell Government 14-10, and toward the center of the same section has a solid sand interval, and on the other side of it is a shale which is approaching that, but which pinches out before it gets to it.

The reason why I interpret it that way is because in that particular well that sand appears from the electric log to be fairly continuous sand and the shale is a very thin body and therefore the sand is in the majority. Looking at the field as a whole, the sands are in the minority and I find it easier to visualize thin sands pinching out into shale rather than the shales pinching out into sands.

Q But within these areas, not taking the entire depth of the well, you do have certain intervals which are predominantly sand?

A Yes.

Q With minor stringers within them?

A Yes.

Q With the same line of reasoning, those would be more apt to pinch out?

A Yes, they would.

Q Thank you.

A I wasn't quite through. I attempt to correlate all the sands in the same stratigraphic, but if they are not in the same interval, then I interpret those sands as not being communicated.

MR. PORTER: My watch shows it is noontime.

MR. GRENIER: We are going to have to leave to catch one of the planes. May I say that Southern Union supports the Applicants in this case for 80 acre spacing. It does so primarily on the ground, even after the testimony it is solidly confusing and irreconciliable, the most you can get to from that situation is a condition where we don't know yet, we cannot prove conclusively what the conditions are in this reservoir, that you cannot undrill a well once it is drilled.

It's always easier to drill one that you haven't drilled before, but you can never undrill one, and particularly in the light of the low takes which have been adverted to in the testimony in this case of oil from this pool, at this time this is hardly the time to be pushing people, as it was indicated in Mr. Brinkley's testimony yesterday, into a 40 acre development pattern as opposed to the 80 on which most of the field has been developed to date.

MR. SETH: Is Mr. Wiedekehr going to leave too?

MR. GRENIER: Yes.

MR. SETH: We were going to call Mr. Wiedekehr as a witness since he has given statements from the floor. The only thing we wanted was the cumulative production from the well that is under production. If he would give that.

MR. WIEDEKEHR: I don't have that available. We will be glad to furnish it. It has been very small. It has been 200 barrels a day.

MR. SETH: How did you measure?

MR. WIEDEKEHR: After swab test, after load oil has recovered.

MR. SETH: What about your practice on core samples?

MR. WIEDEKEHR: Yes, every foot, and you can have that too if you would like to have it. If you will drop me a little note I'll send you all the information I can on it.

MR. SETH: I think that will do it.

MR. PORTER: I realize that these plane connections are difficult to make, so if someone else would like to make a statement.

MR. WOOD: A. W. Wood, from Monsanto Chemical Company. Monsanto wants to express concurrence with the proponents of 80 acre spacing and reiterate its requests made at the original hearing, that the Commission grant temporary 80 acre spacing in the Bisti-Lower Gallup Pool.

MR. PORTER: The meeting will recess until one-thirty.

(Recess.)

MR. PORTER: The meeting will come to order, please. Does anyone else have a question of Mr. Lindsay? The witness may be excused.

(Witness excused.)

Mr. Seth, did you offer your exhibits?

MR. SETH: No, I had one redirect, if I may.

MR. PORTER: I see.

RE-DIRECT EXAMINATION

By MR. SETH:

Q Would you expect that the drainage radius in areas that showed no microlog separation would be smaller than in areas that did indicate a microlog separation?

A Yes, I would expect them to be smaller.

MR. SETH: I believe that's all.

Q Now, referring to the exhibits, were these exhibits prepared under your direction or supervision? A They were.

MR. SETH: We would like to offer at this time Shell's Exhibits 1-R through 13-R, including letters A through H under 4-R.

MR. PORTER: Is there any objection to the admission of these exhibits? They will be admitted.

MR. SETH: I call Mr. Methven.

NORBERT METHVEN

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Methven, and your position with Shell Oil Company?

A My name is Norbert E. Methven. I'm a reservoir engineer with Shell Oil Company, stationed in Farmington, New Mexico.

MR. PORTER: Just a minute, Mr. Cooley. Mr. Cooley says that the witness was not sworn.

A I was sworn with Mr. Lindsay.

MR. COOLEY: You were both sworn at the same time?

A Yes, sir.

MR. SETH: He was sworn with Mr. Lindsay.

Q What type of work are you doing in Farmington?

A I am a reservoir engineer, doing engineering work primarily in the Bisti Field.

Q During the course of that work you have become familiar with the reservoir characteristics of the Bisti Field, have you?

A Yes, I have.

Q What reservoir engineering data do you have that relates to the geological information that Mr. Lindsay has presented this morning?

A Well, there is considerable reservoir data which supports this geologic concept of irregularities and discontinuities. One of these is the apparent absence of vertical communication, and I think most, at least Shell uses, for instance in their completions they use a method of fracting --

Q (Interrupting) Well, in your fract methods do you recognize and take into consideration the fact that there is no vertical permeability, there is no effective vertical permeability?

A That's right.

Q If so, how do you do that?

A Well, we take that into account, and in order to assure ourselves of fracting each individual sand, remembering that there are various permeabilities of these sands, or the permeability varies, we use a method wherein you use rubber balls in the fracting process. What you do is commence your fract job and in essence you will then fract the higher permeable zones, and then you use the rubber balls, you float the rubber balls and those go into the holes where the velocity of the fracting fluid is greatest and plug those off and the fluid is diverted to the zone of lesser permeability.

Not only does Shell do it, but I have been informed that other operators do likewise. Now, if you felt that you had vertical permeability, you wouldn't be concerned about something like that. You wouldn't need it.

Q What other reservoir characteristics relate to the discontinuity?

A Well, the presence of gas in a lower zone which is structurally lower than the presence of oil in an upper sand would indicate lack of vertical communication. Now, in view of the fact, as our geologist testified, that the oil was put in there in geologic time, surely this separation or migration would have occurred, but in any event this was depicted in Sinclair's Exhibits 11-R and 12-R as presented yesterday where they showed oil occurring above the gas. Now if they had vertical communication or permeability, surely that gas would have migrated up and the oil down.

Q Now, have you in your reservoir studies, have you made a survey or paid special attention to the pressure picture in the field? Could you give us any over-all analysis or estimate on the pressure picture?

A Yes. There are large differences, large pressure differences, at adjacent well locations. Now, this occurs especially below bubble point.

Q Can you point out or do you have an example?

A Yes, I have some. One of these examples is in the British American properties in Section 28, Township 26 North, Range 13 West. The well that I am going to refer to first is Douthit B-2 in this case. In the month of October, 1956, this well had a static pressure of 760 PSI. Here is a case of a very low pressure, and it is British American Douthit B-4 in Section 27, Township 26 North, Range 13 West had a pressure of 924 during the same month.

Another one in this same area was taken as of a later date, this same British American Douthit B-4 had a value of 601 in April of 1957, while Douthit B-5 had a pressure in the same month of 1326.

Q Does this pressure show a pretty irregular arrangement throughout the field, or is there any sort of pattern to it?

A There is no apparent pattern. I think there's some other examples down here in for instance Amerada No-Des-Pah No. 1 in Section 8 of Township 25 North, Range 12 West.

Now, in April of 1957 that well had a static pressure of 1292, while the well immediately south of that which is in Section 17, Township 25 North, Range 12 West, Sunray Federal B-1 had a pressure of 441 during the same month. Pressure data in general throughout the field exhibits those irregularities. Upon attempting to say make an isobaric map of the field, why you run into those differences, very, very great differences in pressure. Just in general the pressure data is scrambled up and certainly highly indicative of poor communication.

Q That shows irregularity would more or less confirm the geological data that was put in by Mr. Lindsay?

A Yes, sir, it would be.

Q I believe you were here, or did you hear the testimony concerning interference tests conducted in the vicinity of the pilot test area? What does an interference test of that character show?

A Well, an interference test as such shows pressure communication only, and it does not necessarily show the amount, or does not give you a measure of drainage efficiency.

Q Why isn't pressure communication alone a measure of drainage efficiency?

A Well, one thing is where you have isolated sands, why you would not be measuring, for instance if you measured a well here and a well there, and if you had an isolated sand why you wouldn't necessarily measure the pressure or the interference.

Q Does the degree of pressure at the particular time have any significance?

A It has a very definite significance.

Q What is that?

A Well, pressure communication early in the life of a field that is undersaturated, is a function of the time and the compressibility of the fluid at that time. Now, when you are above the bubble point, the compressibility, I mean above the bubble point means you have undersaturated fluids, it means fluid and the compressibility of a fluid is very small. So when you have a certain pressure in say a vessel filled with fluid and you take a drop out, the pressure changes very greatly, but if you have a case where you have this vessel filled with some gas and you take a drop of gas out, then the pressure effect is very slight because the pressure of the fluid, or rather the compressibility of the fluid, is very slight as compared to gas.

Therefore, when you take an interference test when you are above the bubble point in the undersaturated region, then you have a, quite a pressure effect, but not very much or not necessarily very much fluid communication.

Q Well, then, it would be relatively easy to show pressure communication in an area where the pressures are above the bubble point? A Yes, it is.

Q That would hold whether the pressures were obtained artificially or were naturally occurring, is that true?

A Yes. And the difference of say the pressure communication from say above the bubble point to some place below the bubble point can amount to say a hundred times as much as the same amount of, that the time to detect that pressure difference would be say one hundred times.

Q Are there areas in the field that are presently below the bubble point?

A There are, yes. I just cited a few pressure cases that were.

Q I don't believe you told us what the bubble point was, what is it?

A It's in the region of, well, in the original hearing it was stated as 1207 PSI.

Q Now, you have indicated that there can be instances of pressure communication, but that will not show drainage efficiency and will not show the complete drainage picture. Can you refer to any of the exhibits that are presently posted and show us an example where there may be pressure communication through a particular zone while others there is no communication indicated?

A There are, of course, quite a few of them. I think on our

Exhibit 13-R, British American Douthit B-13, you can see that as you check the communication between this well and this well, you could very well have it or you could possibly have it any way through there, but it doesn't tell you what's happening to this sand in here, this separate sand in here.

Q Then if interference tests were conducted, using those two wells, it could possibly show pressure communication and it would be much easier to show it if it were above the bubble point, but still we wouldn't have a very good picture on the drainage situation?

A No, it certainly wouldn't tell you anything about what the drainage situation was of that sand. There's a lot of examples like that. Oh, we can pick say this well right here, this is Government 22-9 as depicted on KL or our Exhibit 9-R, there's a stringer here that you couldn't tell what the effect was by measuring the pressures in here or here as far as drainage is concerned. You could very well have pressure communication there, but you couldn't tell what is happening there.

Q The pressures taken in the well bore generally are not selective of any particular sand, they just measure the total over-all pressure?

A That is the conventional way of measuring pressures, and it is only very occasionally does somebody try to isolate the sand and try to measure the communication.

Q What are the two methods used to try to determine drainage efficiency?

A Of course, interference is good, assuming you have homogeneous sands and you are measuring those sands in particular. However, say a material balance calculation can give you an idea of what the drainage efficiency might be or an extrapolation of pressure and or production decline trends.

Q Considering where we are in the life of the Bisti Field, do you believe that it is, you could apply either one of those two methods?

A Certainly not now. For one thing, say the material balance is based on pressure performance and we have already stated that the pressure performance is very erratic and as a consequence the reliability of any material balance at this stage would be very, very poor.

Q You heard Mr. Lewis testify, and if I understand it correctly, you recognized that method of computation as being a method used generally, is that correct? A Oh, yes. It's --

Q (Interrupting) But you would not feel that it should be applied to the Bisti Pool at the present time, is that right?

A No, his was based on purely a text book example, and a perfect reservoir, and I'm sure this is anything but that, plus the fact that your pressures indicate the same.

Q Would you express an opinion as to when in the life of this field that you think that you could apply the material balance calculation in order to extrapolate from your production data?

A Well, in order to give you any measure of workable accuracy, you should be say a third of the life or later of the reservoir.

Q Now, from what you know about the Bisti Field, do you think that can happen in the next five years, say, or three years or what, do you have any basis for estimating that?

A I think it could happen, certainly not within three years, and possibly not until five years.

Q Then it's going to be down the line a ways before you start using those particular methods for their drainage efficiency?

A Yes, it will.

Q Now, consider just a delay of say a year on the drilling of 40 acre locations, how will that affect completions, assuming that you had to drill on 80 acre locations now and waited a year to drill on 40's, what effect, if any, will they have on the drilling of these infill wells, a year or some such order from now?

A Well, in view of a certain degree of pressure communication, why these sands that may occur from one well to the next would be, at least their pressure would be lower and thus that would be in some of the sands. However, other sands would have initial reservoir pressures, so in the process of drilling wells through partially depleted sands as compared to virgin sands, why you have a lot of completion difficulties. Some of these are say mudding up of the lower pressure sand.

Q Does that complication arise by reason of the fact that there are areas of different pressure within the same well bore? Do you get more mud in some sections than others?

A By all means, yes.

Q Explain.

A Well, during the process of drilling the well, you of course carry a certain mud weight to hold back the formation. In this case you would have to carry enough to hold back the pressure of the higher zones. The lower pressure zones would be highly susceptible to taking the filtrate out of the mud itself.

Q That would complicate the efficiency of your completion, is that correct?

A By all means. Not only mudding up, but the fracturing considerations are quite complicated there that, if assuming then that you didn't have mudding up, then if you were to fract the well, then this same lower pressured sand would be the one that would be most receptive to the fract fluid, then you have the problem of fracting the virgin sands to get the additional recovery.

Q Again, on this proposition of delaying the drilling of the infill wells and assuming, as the proponents do, that there is drainage, what effect will it have on changing the direction and movement of this oil? We assume it starts toward the 80 acre location if the proponents would, and that you drill the 40 acre wells, does the oil have to change its path?

A That's right. You can envision the oil moving toward that well bore and then you drill another well here and it reverses itself.

Q Is that of any significance?

A Well, one thing, based on those assumptions then for one thing, say the gas saturation will be higher and as a result the mobility ratio or the ability of the oil to move back again will be reduced.

Q Does this show that the drilling of these so-called infill wells at a later date would be less attractive to any person to fully develop the field?

A By all means.

Q What other factors are involved, cost factors?

A Well, of course, you will incur higher drilling costs because of say a noncontinuous development program. Your completion costs, as we have already stated, would be higher. The lease facilities that you would have to replan those costs would be higher at a later date.

Q On the pressure aspect of it too, would you expect to encounter in some of the sands at least, lower pressures, and will that affect your payout situation?

A Yes. At a later date some of the pressures will be lower, and the consequent payout of the well will undoubtedly be much longer than they are today.

Q During the course of the hearing there has been a considerable discussion about the importance of the production from the lower members of this sand. Is it your opinion that the expected production from these areas is important, is going to be important in the over-all production from the Bisti Field, or is it of no consequence as the Applicants have indicated?

A No, I think it's quite important that any well you recover there that you should do so, and it is very difficult to calculate how much this will be, but it will be quite a bit, and in the difference of say a 40 to 80 will be even more in view of the discontinuities as indicated in the upper sands too.

Q Well, in drilling the 40 acre locations, you not only get the oil that is in discontinuities that don't extend over the 80 acre distance, but does that have any effect on the efficiency and the drainage in the upper sands?

A I think it will have an appreciable effect on the drainage efficiency of the upper sands.

Q And in these 40 acre wells we have to consider not only the production in the lower areas, but it is a complete well in itself and we should look at the entire well, should we not?

A Certainly.

Q Would you care to express any, or indicate to the Commission any percentage that you would expect, making a division between the upper and lower sands?

A Well, --

Q Just considering oil in place in the first instance.

A Well, in the case of the lower sands, let's refer to what we call the GE, GG, which are the lower members as depicted by the cross sections, there is probably some 20% of the total oil in place in those sands.

Q Now, Shell's testimony shows too that these lower sands you probably wouldn't get the same production efficiency that you would from the upper sands. Is that a fair statement?

A I think it is. They're poorer sands in general.

Q Then that should be considered by the Commission also, should it not? Your figures relate to oil in place?

A Yes, they do.

Q But you would feel that it was important to consider also that the production be less efficient from the lower?

A Yes.

Q Are there some examples of each well in the field that have shown some rather high initial production but have dropped off?

A Yes, there are some wells on the edge that appear, that apparently don't have much pay in them, and as a result their pressures have declined and the wells are approaching the economic limit, and I wouldn't think that they would recover, but say several thousand barrels, and those wells are generally where there's small if no microlog pay in them.

Q Do you have any other comments that you would like to make to the Commission on the reservoir situation?

A Well, I think that one thing, wells completed say in this, in these lower sands that apparently don't show any microlog pay, there has been some brought out today that actually produced oil, produced quite a bit of oil, however I think they'll have rapid declines, especially on a wide spacing program, and I think that's quite applicable to say the sands in the interior where you have poor pay but there's certainly oil there, certainly recoverable and we certainly would like to recover it.

Q This production, you heard testimony about the Southern Union well where there was no microlog pay indicated, and there was production, would you expect the radius of drainage there to be less than in areas where there is a microlog separation?

A Yes. It would be a very logical conclusion, that is a wide-spaced well would not recover a very great percentage of the oil where a closer-spaced well would recover a greater percentage of that oil.

Q This oil that is apparently in the areas where there is no microlog separation, that has a place in the picture, does it not?

A Yes.

Q And our spacing should be geared with that situation in mind, very small drainage radius? A Yes.

Q Is there a considerable development in the field to date on patterns other than any requested by the Applicants? Do you have an exhibit showing that? A Yes.

(Marked Shell's Exhibit 14-R, for identification.)

Q Would you refer to Exhibit 14-R?

A Yes. This is Exhibit 14-R, which is a contour map of the Bisti-Lower Gallup Pool, and what we have done is colored in the Governmental quarter sections, for instance the ones in red are the Governmental quarter sections on which there have been two wells, which there have been more than two wells drilled. There's eight red ones, I believe.

Now, in the case of the green ones, those are Governmental quarter sections on which two non-diagonal wells have been drilled. So you can see these are spaced throughout the field.

Q In this diagram you have not taken into consideration direct 40 acre offsets, have you? A No.

Q You are just considering quarter sections alone?

A Yes, there are a lot of other wells that are misplaced.

Q There are a lot of forty acre direct offsets?

A There are, yes.

Q Is Shell Oil Company prepared to proceed on the 40 acre development as testified at the previous hearing?

A Yes, as far as I know.

MR. SETH: That's all the direct questions we have.

MR. PORTER: Does anyone else have a question of the witness?

Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Methven, will you stand up and refer to this exhibit again, please, your Exhibit 14-R? Do you have the dates on which the wells in this area were completed by Shell since the first hearing?

A The dates of completion?

Q Yes.

A I could probably get some of them. I think I have some of those dates with me.

Q I'm going to point to various of these red marked quarter sections in the approximate center of the exhibit and ask you to tell me who appears to be the owner of the acreage underlying those red marked quarter sections. Let's take this one right here. Is this Shell acreage? A Yes, it is.

Q Is this one?

A That is Shell's acreage.

Q Is this one? A Yes.
Q Is this one? A Yes.
Q Is this one? A No.

Q Who owns this acreage?

A El Paso is the oil company.

Q Out of the six quarter sections marked in red in that area, Shell is the owner of five, is that correct?

A It is.

Q Can you tell me how many of the wells that are shown in those five quarter sections have been drilled by Shell since the last hearing?

A I don't know exactly, but I think most of them were. There are, I believe a few that were drilled prior to the other hearing.

Q Do you know the number of wells that Shell has drilled on a 40 acre pattern since the last hearing, the total number?

A I don't remember the number, no.

Q As a reservoir engineer, would you say that it is a correct statement to say that in a situation of this type with a cluster of wells as these are clustered in what has been testified to as the fairway or Highway 66, might result in a drainage situation to the advantage of the owner of these properties with the clustered well ownership?

A You mean under the present condition wherein the other people do not have 40 acre wells?

Q Yes.

A Well, I think there might be some room for say some drainage out there based on limited amount of apparent interference.

Q Do you have any data with you on the production history of the wells situated in that area to which we have been referring on the Shell acreage? A Yes, I have some.

Q Can you tell me what the production was from those wells during the month of November?

A I don't think I have the November figures. I think the book is only up to October, the October figures.

Q Do you know whether Shell has the November figures here available? A I don't think they are.

MR. SETH: We can get them for you if you want them.

A The November figures, of course, come out in December and we apparently didn't have them available.

MR. CAMPBELL: I would like to request that the production figures on the Shell wells in Township 25 North, Range 12 West be furnished to the Commission together with the dates of the commencement of drilling on each of the wells.

MR. SETH: We will be glad to furnish that.

Q Is there any other acreage shown on that exhibit that is owned by Shell than that to which we have referred, your Exhibit 14-R, that is marked in green or red?

A Which ones did you point to?

Q That group in the center of some eight, are there any others marked that are Shell acreage?

A This is Shell here.

Q Have any wells been drilled on that tract since the first hearing? A Yes, sir.

MR. CAMPBELL: I would also like to have the information on that tract, the commencement date on each of the wells, and the production data.

MR. COOLEY: Mr. Methven, will you identify the last quarter section?

A This last one, Section 16 in Township 25 North, Range 11 West, and this is the southwest quarter of that section.

MR. SETH: We will like the same information on Sunray's offsetting wells.

MR. ERREBO: If you will identify in some general terms, we will know what you want.

MR. PORTER: Is that the November production figures that you have requested?

MR. CAMPBELL: Yes, sir. I understand the October are available to the Commission.

MR. SETH: That is Sunray Mid-Continent C-14 and C-21, those two seem to be the only ones.

MR. PORTER: I believe those reports usually reach the Commission about the 25th of the month.

MR. COOLEY: Will you be willing to furnish the information requested, Mr. Errebo?

MR. ERREBO: Yes, I so stated.

Q During the course of your testimony, you, as I recall it, made the general statement that at the present time because of the inadequate production history, as I understood you, you could not determine the situation in this reservoir by an examination of the production usually and the pressure decline, is that correct?

A I believe I made that statement.

Q And what was your reason that you could not determine the movement of fluids by interference tests?

A Interference tests showing only pressure communication above the bubble point.

Q Do you consider that pressure communication is not any measurement of communication or drainage?

A It's an indication of movement and drainage, but it gives you no qualitative or quantitative amount.

Q And at this stage of development and production or completion of this reservoir, there is no quantitative basis on which you can determine that, is there? A Determine what.

Q The drainage, the movement of fluid, the amount of fluid moving that you referred to. If you can't use interference tests and you can't use material balance method, then there is no basis at the present time upon which you can calculate that, is there?

A You have to base your estimates on the geologic picture.

Q And as you said, the indication of pressure changes, is that correct? A Yes.

Q But you do believe that with additional production history in this reservoir some of the factors necessary to make those calculations will appear, will they not?

A I think they might, given sufficient time. However, say the pressure, the erratic nature of the pressures to date suggest it would be a long time, and matter of years of course.

Q If you are unable to make any of these calculations, are you unable for your company at this time to calculate or estimate ultimate recovery or possible performance of your wells in this reservoir? How would you do that?

A How would I, would you rephrase that?

Q How do you calculate for your company in their economic calculation of drilling, any basis for ultimate recovery from the lease?

A You base that on the geologic picture and the total oil in place.

Q You base it entirely on your geologic picture?

A And your calculation of the total oil in place.

Q How do you calculate that? A By volumes.

Q Do you have enough information in this reservoir to do that?

A I think so. There's quite a few exhibits here that give you a very good means of calculating the oil in place.

Q Is that the method that you used in calculating the 20% of the oil in place in the lower sand zones?

A Yes, volumetric.

Q Do you have your calculations as to the amount of sand you estimate?

A I have some calculations here.

Q Did you consider the reservoir characteristics in the lower sands to be the same as in the upper sands in your calculation?
A No.

Q Did you consider the porosity to be the same, the average porosity?
A No.

Q Did you consider what you stated was the possibility of rapid decline of production in the lower zone?

A Pardon me.

Q Did you consider what you stated during the course of your testimony was your prediction of a rapid decline in production in the lower zones?

A You are asking me about the total oil in place calculations?

Q Recoverable oil, yes.

A I believe I understood you to be talking about total oil in place, at least I was.

Q Well, were you talking about recoverable oil in place when you were referring to 20%?

A Total oil in place?

Q Total oil in place.
A Yes.

Q Do you have any calculations or estimates considering reservoir characteristics and the performance possibilities of the lower sands to indicate recoverable oil as related to the upper sands?

A Well, you have, as you mentioned, the porosities and saturations of those sands.

Q Do you think that the estimates that have been made here by their engineering witness as to the approximately 95% of the recoverable oil being in the upper sands are out of line?

A I think so, yes. I think that would leave only five percent of the recoverable in the lower sands. I think there's more than that.

Q How much more recoverable?

A I couldn't give, you can't calculate it, so I can't give a definite number.

Q In other words, there is no way in which you can calculate it, is there?

A No, not the recovery efficiency.

MR. CAMPBELL: I believe that's all.

MR. PORTER: Anyone else?

MR. WHITE: I have one question.

MR. PORTER: Mr. White.

By MR. WHITE:

Q In your testimony as to the delays and the resultant difficulties that wouldarise by development on 80 acre spacing program such as mudding up due to low pressures, you are wholly disregarding, are you not, the possible success of the LPG program?

A Could you read that back to me.

REPORTER: Reading: In your testimony as to the delays and the resultant difficulties that wouldarise by development on 80 acre spacing program such as mudding up due to low pressures, you are wholly disregarding, are you not, the possible success of the LPG program?

A I think you will have these same troubles a year from now whether you flood or not.

Q To the same degree or lesser degree in view of the LPG, assuming it to be a success?

A In order to answer that, you have to make a lot of assumptions, now, for instance who you would propose to flood.

Q Well, you were here yesterday, were you not?

A I was indeed.

Q Let's assume that the LPG program continues to be successful as it is pointed out to be, what would your conclusions then be on that assumption?

MR. SETH: What area are you referring to?

MR. WHITE: Well, wherever the LPG program initiated, where the results of it would be felt.

Q Well, getting back to the original question, did you or did you not give any consideration to the LPG program?

A Well, we're actively considering it, of course.

Q Do you take that into consideration when you state your conclusions as to what difficulties might be encountered by delay caused by drilling on an 80 acre spacing program?

A Well, let's go on to the next question.

MR. SETH: Maybe if you would make them a little more specific as to areas they would be capable --

MR. WHITE: (Interrupting) I merely asked him if in stating his conclusions he took into consideration the LPG program.

Q You stated that Shell was ready to proceed on a 40 acre spacing program, is that true? A I did, yes.

Q Do you intend to drill the outer edges on a 40 acre spacing program?

A We don't intend to drill any non-economical wells. If a well out there is uneconomical, we have no intention of drilling it. We obviously will drill out as far as a well is economical.

Q Then your statement definitely has limitations to Shell's readiness to proceed on a 40 acre spacing program?

A Well, it would if it was any spacing.

MR. WHITE: That's all.

MR. PORTER: Mr. Wade.

MR. WADE: I have just a couple.

By MR. WADE:

Q Mr. Methven, back to this delay business, what will happen on 80 acres, if you were to have to go back in later? I think your first difficulty that you were discussing in completion was this mudding up of the low pressure sands?

A Yes.

Q Do you think that that mudding up situation would be of such magnitude that the normal fract job wouldn't bring it back in good shape?

A I think there's quite a possibility, yes, that if not mudding up, you could say have some sort of blocking of the formation back into the formation.

Q You are assuming then that the filtrate will penetrate a pretty far distance back from the well bore if a fract job wouldn't eliminate that block, aren't you? A That's right.

Q Has it been your experience, or do you think that that occurs, that you have a filtrate invasion to a considerable degree in this thing?

A We have already experienced some troubles along that line.

Q And a fract job would not bring them back?

A They did in this case, but I suspect that if the sands have been depleted, that the trouble would have been exaggerated over and above what they have been recently, and I think you would encounter considerable difficulty.

Q I think you also indicated that fracturing would be more complicated?

A If not mudding up, then fracturing would be more complicated just, if you didn't have mudding up then you would have the case of the oil going into that depleted sand and possibly not fracting the lower sand.

Q That is just what I was going to get at, what is wrong with your rubber balls that you are using now?

A In this case it's questionable about the effectiveness at that date, that time.

Q What do you mean effectiveness?

A The effectiveness of the rubber ball fract jobs.

Q Well, that rubber ball fract job is just a physical principle of the rubber balls going to the zone of highest permeability, is it not? A Yes, it is.

Q Wouldn't that physical prinicple still hold?

A In general it might be complicated.

Q I think you also said that you would experience a higher drilling cost the second time around for drilling the infill wells, is that right? A That is, yes.

Q What do you base that on?

A That's based on the previous testimony at the previous hearing.

Q Did you testify to that? A I did not.

Q You really don't know then whether or not it would be more expensive the second time around?

A I would expect it to be.

Q You would base it on your experience?

A Well, I'd base it on the previous testimony, the previous accepted testimony.

Q I think you also indicated payout on the second time around would be longer?

A It could very well be.

Q That would be based on your assumption that the drilling cost would be higher the second time around to a great extent, would it not?

A That plus the wells capabilities at that time might not be as they are today.

MR. WADE: That's all.

MR. PORTER: Mr. Dutton.

By MR. DUTTON:

Q Mr. Methven, are you one of the members of Shell Oil Company that gets to deal in dollars, respecting economic evaluation?

A I don't handle many dollars.

Q Do you make economic evaluations?

A I do, yes.

Q Have you made one in this field?

A Yes.

Q In making such an economic evaluation, say with particular reference to the drilling of the development well, do you think that payout time should be considered?

A Payout time should be considered. I think so, I think it always does.

Q Do you have any idea of your own, as a reservoir engineer, as to what might be a reasonable payout period for the development of well costs?

A A reasonable payout time is dependent upon what the company is willing to accept, and I have no, I mean I don't control that.

Q In the original hearing, did you testify that you thought that a 40 acre spacing would pay out in a reasonable length of time?

A I did.

Q At that time were you speaking for Shell Oil Company on your own position as a reservoir engineer and professional man?

A Speaking for Shell Oil, yes.

Q At that time what did Shell consider to be a reasonable payout period?

A I think it's about two years.

Q About two years? A And it varies.

Q Are you familiar with the Bisti Unit allowable that has been recommended for the month of January, 1958, for the standard 40 acre unit? A I believe I heard.

Q What figure do you recall hearing?

A For what period was this?

Q January.

A For the month of January?

Q Yes, expressed in barrels per day.

A I don't think it was definitely decided, but it was something to the effect of ten barrels per day for the month of January.

Q Mr. Methven, what is your idea of the approximate cost of drilling a well in the Bisti area?

A Previously a witness -- could you define the cost now, what does the cost that you are talking about include?

Q First to define it, I would define it as the total cost of drilling, completing and equipping. I would accept any one of the categories that you would define.

A Which one would you prefer?

Q The sum would be fine.

A The testimony at that time was to the effect of $48,000.

Q On the basis of ten barrels of oil per day production, can you give us an estimate of what the payout time would be for the --

A (Interrupting) Ten barrels per day per month. Are you making an assumption that you can produce the well only at ten barrels a day --

Q (Interrupting) I'm assuming --

A -- forever?

Q I'm assuming that the well will produce ten barrels a day, yes, sir, approximately what time would the payout be on that?

A It is certainly a hypothetical question, and I don't have a handy figure, but there is no question about it, it would be a long time.

Q It would exceed two years by a substantial margin of time, would it not?

A Assuming this hypothetical production rate?

Q Assuming this hypothetical type of an example, would you object to stating that the net income would be roughly to the operator two dollars a barrel after all expenses of lifting the oil?

A Would you rephrase that?

Q Considering all expenses involved to the operator, would you say that his net income per barrel of two dollars would be too far out of the ball park just to talk about years?

A No.

Q At ten barrels per day then, the operator would have essentially a twenty dollar a day income?

A That is right.

Q In $48,000 expenditure, how many days would that involve just roughly?

A Forty-eight divided by twenty?

Q Yes.

A That goes in about thousand --

Q (Interrupting) Would twenty-four hundred be all right?

A Yes.

Q Then twenty-four hundred days would be approximately seven years. A I presume.

Q Mr. Methven, do you have any information that you would like to submit to the Commission at this time that would indicate that the allowable situation in the Bisti Pool is likely to change in the immediate future?

MR. SETH: If the Commission please, I don't believe that is within the scope of the direct examination. I don't think it is pertinent. I don't think it is within the scope of the hearing at all.

MR. DUTTON: If the Commission will hear discussion, the purpose of the question was that Mr. Methven's hypothetical term given to this particular example might have left, or did to me insinuate that ten barrels a day would not last very long, and I just wondered if he had any information that would indicate that to be a fact.

A Could I --

MR. SETH: Just a minute.

A Oh.

MR. PORTER: The objection to the question is sustained.

MR. DUTTON: Thank you. That's all I have.

MR. KELLAHIN: Jason Kellahin for Phillips Petroleum Company.

By MR. KELLAHIN:

Q Mr. Methven, you, as a reservoir engineer, recognize the use of the material balance calculation in predicting reservoir performance in terms of oil originally in place, do you not?

A He interrupted my ability to concentrate on the mispronunciation of my name.

Q I apologize. A It's Methven.

Q Shall I repeat the question?

A I wish you would, yes.

Q Mr. Methven. A Thank you.

Q As a reservoir engineer, you do recognize the use of the material balance calculation to predict reservoir performance in terms of oil originally in place, do you not?

A Yes.

Q And do you make that prediction after the pool has been one-third depleted?

A You can make these predictions all along the line, but the accuracy of these predictions on a pool are very poor because the material balance equation is based on a homogeneous reservoir, so they're very poor until you get very, very good data, and that data comes only after a period of years.

Q In that event, then, you wouldn't say that the material balance calculation is useless at the initial stages of reservoir development, would you?

A Well, it gives the reservoir engineer something to do, but I for one couldn't sell it to management in the early stages of development.

Q Have you, yourself, used it for that purpose?

A Like I said -- I have used a material balance equation.

Q In your use of that, did you have the perfect reservoir to which you referred?

A No, I didn't. And my results showed it.

Q Actually the only assumption in that connection is an assumption of continuity, is it not? A Pardon me.

Q I say the only assumption you make in reservoir characteristic on that point is an assumption that it is a continuous reservoir, is that correct?

A Oh, yes, you have to know all of the factors of the reservoir.

Q I mean in regard to a homogeneous reservoir, you have to assume continuity, is that correct, in a material balance formula?

A Oh, surely.

Q Now, you made some reference to difficulty or impossibility of reversing the flow of the fluids in the reservoir by the drilling of later infill wells. Just what was your testimony on that, Mr. Methven?

A I said that you can -- by drilling wide spaced wells you can have oil moving towards that well and then when you drill a well in between and you, say you draw the pressure down here, would prefer to go to this well then, after having moved possibly beyond that point.

Q Actually it would move to the new well, would it not?

A Pardon me.

Q It would tend to move toward the infill well?

A Some of the oil, yes.

Q The relative permeability at that point being less than at the point of the old well?

A The relative permeability being less at this time and therefore the movement of that oil at this time is impaired as compared to drilling the well initially.

Q Then what is the difficulty in the movement of that oil toward the new well? I don't follow your reasoning on that.

A I just said that you have already moved it away from the new well and now you are going to move it back into the well. Why didn't you drill the well, I mean you should drill the well first and take it out there.

Q But the fact is that it will move, is that correct?

A Yes.

Q To the new well? A Oh, yes.

Q Then there's no loss?

A Oh, on the contrary, the ability for it to move it at a later date then is impaired as compared to initially.

Q In connection with your testimony on the drilling of these infill wells, you expressed some concern about the mudding up of low pressure zones. I believe you also had some testimony to the effect that the pressure communication did not necessarily indicate the ability of the fluids to move through the reservoir in regard to drainage. In that connection, how would pressures be reduced at the point of these infill wells if there was no effective drainage at that point?

A I did not say there wasn't any drainage. I said that the drainage efficiency could not be measured by pressure interference tests. I did not deny --

Q (Interrupting) There would be drainage?

A I wouldn't deny that if you have communication. The degree, of course, is very important.

MR. KELLAHIN: Thank you, sir.

MR. PORTER: Anyone else have a question of Mr. Methven? Mr. Cooley.

By MR. COOLEY:

Q Mr. Methven, have you, yourself, made any calculation as to the drainage efficiency of one well or an average well in the Bisti-Lower Gallup Oil Pool?

A The drainage efficiency of one well?

Q I don't mean any particular well, but I mean what you feel the drainage efficiency is in this pool over all.

A In certain sands, yes, certain members, the prime members I believe we testified would be something like 20% at the previous hearing.

Q And have you made any calculation as to the area which one well will drain?

A Well, you can't do that, you can't calculate how much one well will drain. Given enough time, why a well could in this field, could drain over long distances, but I don't think it would drain many of the sands and the efficiency would be very, very poor.

Q Well, I believe you answered that you felt that one well would drain 40 acres, didn't you? A Pardon me.

Q Haven't you testified in this case that one well will drain 40 acres? A Yes.

Q Now, this is what I'm getting at, how did you determine that it would drain 40 acres? What method of calculation did you use?

A Well, you of course use the geologic picture, and from that it appears that you can drain a certain amount of that oil out of that region, and so you estimate what the efficiency would be.

Q It's based primarily on the geologic picture?

A Primarily, plus experience from what you might experience from a field like this.

Q This geologic picture is obtained through the interpretation of micrologs and electric logs and core data?

A All data available, yes.

Q All of this is localized in the area of one well bore and you are interpolating or interpreting what the intervening area will hold? A Oh, sure.

Q You feel that this type of calculation is more reliable than pressure interference information?

A I think it is at this stage, yes. I think that's the method.

I don't mean that pressure interference tests are not applicable, but they don't give you a measure of the degree.

Q Wouldn't the amount of drawdown give you some indication of the qualitative drainage effect? You have stated repeatedly that you can't ascertain the quality of your drainage through communication tests. Wouldn't the degree of drainage pressure variation give you some indication at least of that quality?

A Yes, yes. But you don't have anything to relate that degree to.

Q You are not prepared to state what percentage of recoverable oil you feel lies below the GC and GD sands as you define them?

A Percent of recoverable. I don't know what that would be, but I said that it would probably be less than the upper sands which are better. It's very difficult to estimate what it is. It's something less than that.

Q I believe you also stated that you felt the density of the drilling affects the recovery. Is this only in extremely heterogeneous types of reservoirs? I mean we have had testimony and extractions from papers by various bodies, Interstate Oil Commission Committees andvarious other agencies, to the effect that density of drilling was pretty much, made very little difference in the ultimate.

A They said that it made some difference and that amount of difference was calculated on the basis of purely textbook example of a very homogeneous reservoir, so there is, even they admit to some in the case, I mean a small amount in the case of the homogeneous reservoir, and then when you differ from the homogenity that the figure goes up.

Q It is your feeling that the homogenity increase is due to the increased density?

A Yes, I think as the homogenity increases, then your efficiency increases with the denser spacing.

MR. PORTER: Does anyone else have a question of the witness?

MR. SETH: I have a little re-direct.

MR. PORTER: Let's take a five minute recess.

(Recess.)

MR. PORTER: The hearing will come to order, please. Mr. Seth, I believe you have some re-direct.

MR. SETH: Yes.

RE-DIRECT EXAMINATION

By MR. SETH:

Q Mr. Methven, in your calculations on your reservoir here, did you use the methods that are ordinarily used in the industry?

A Yes, volumetric calculations, those are the general and accepted methods.

Q Generally accepted throughout the industry, are they?

A Yes, they are.

Q Your other calculations likewise?

A Very much so, yes.

Q In those calculations you used established permeability, porosity, water data that had been furnished to you, is that correct? A That's right.

Q And using all of that data you made your calculations as testified to in the original hearing?

A Yes.

Q You were asked about efficiency on 40 and 80 acre tracts. What would your opinion be as a comparative efficiency on the 40 as compared to 80 acre locations, ordinary drainage efficiency?

A Well, related to this pool there would be quite a bit of difference in addition to this lower interval which we've stated has about 20% of the total oil in place. It's difficult to say how much of that you'll get, but you might get, well, half the recovery efficiency there as you would with the upper sand, or say 10% of that, and that plus the additional segregated or discontinuous members that you would get in the upper sands, plus the improved recovery efficiency in general, would amount to a considerable percentage of the oil in place.

Q And you would recommend to the company, as you did before, that they would proceed on such a drilling program?

A Yes, I think so. There's a lot of oil there, and I think they can recover it, and I think the fact is I advise that they do recover it, and in any event these wells are going to be economical.

MR. SETH: I believe that's all. We would like to ask that our Exhibit 14-R be admitted in evidence. That is the map.

MR. PORTER: This completes all your exhibits? Without objection Exhibit 14-R will be admitted.

Anyone else have a question of Mr. Methven? Mr. Utz.

MR. UTZ: Yes, I would like to ask a question or two.

RE-CROSS EXAMINATION

By MR. UTZ:

Q Mr. Methven, it is your contention, I believe, that you can recover more oil on 40 acres than 80 acre spacing?

A In a non-homogeneous reservoir it quite frequently --

Q (Interrupting) Well, with particular reference to Bisti.

A Yes.

Q Can you state how much more oil you can recover by drilling two wells on an 80 than one well?

A Well, as an estimate I should think it would be at least 20% more.

Q Could you put that in barrels?

A Well now, you mean in barrels for an 80 acre tract?

Q Well, in barrels, you said 20% more oil recovered on 40 acre spacing than 80 acre spacing. A Yes.

Q If you can, I would like to know about how much that is in barrels.

A Well, it would probably be in the neighborhood of twenty to thirty thousand barrels.

Q It's my understanding that Shell is drilling their wells, or developing their acreage, on somewhat of a mass production, a production line plan, whatever you would like to call it. How much money do you save per well by drilling them in that manner?

A This manner, it means not so much mass production as continuous production. I guess you can interpret that as mass. The amount of saving is, I don't know what it is, but it is several thousand dollars per well.

Q Do you have any idea what your first, second or third well costs?

A I'm not familiar with the cost, no.

Q Would it be $10,000 a well, $20,000 a well, do you think?

A The question is the second and third costs?

Q Well, what I'm really wanting to know is how much money are you saving per well by drilling on a continuous basis as you call it, rather than drilling and contracting one well at a time.

A Well, the move in costs out there, I think they vary quite a bit, oh, something like five thousand, seven thousand dollars or something like that.

Q You stated that your drilling cost was $48,000?

A Yes, it is.

Q Would you say that a figure of $65,000 would be unreasonable for drilling individual wells?

A Oh, I wouldn't think it would be that high, no.

Q $60,000?

A Somewhere between fifty and sixty.

Q Now, is it your opinion that by drilling on 40 acre spacing that you will recover the oil from your acreage in a lesser time than if you drilled on 80 acre spacing, is that a consideration, I will ask this?

A Oh, yes, yes, you normally would expect that you would recover the oil faster with the denser spacing program, and that is not predicting what allowables would be. I don't know what that would come to.

Q Then in your decision to recommend 40 acre spacing to your company, the length of time to recover the oil was a factor?

A By all means, the rate of return is always a very important factor to a development program in the field.

Q The fact that you could recover, as you just stated, twenty to thirty thousand more barrels per acre tract, was that a factor?

A Yes.

Q And likewise the fact that you can save fifteen, or well, we'll say for the purpose of a figure, $15,000 a well by the fact that you can use your continuous development plan, was that also a factor?

A Yes.

Q Which one of those factors was the most important?

A Well, I think they all make each other important.

Q If your wells cost you $60,000 a well to drill as it would say an independent operator with 80 or 160 acres, would you still recommend 40 acre spacing?

A As long as it's an economical venture why I certainly would.

Q Well, you have made those economic calculations, haven't you?

A Yes.

Q I'm asking you from your standpoint and what you know from your study, would it be an economical venture?

A Well, of course, it depends where it is located in the field, if the oil isn't there, then no spacing would be economical and so here is the case where you would be incurring additional $10,000, it in that case would detract from the profitability, but I don't have a ready figure to say how much it would amount to.

Q You can't say whether it would detract enough to where you would not recommend 40 acre spacing?

A No, I think you would have to make an individual analysis of it in the specific case. I'm sure in some cases it would be quite economical.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

MR. PORTER: Anyone else desire to present testimony in this case? Any statements at this time?

MR. HINKLE: If the Commission please. Clarence Hinkle, representing the Humble Oil, and I have a brief statement on behalf of Humble.

Under our statute authorizing the Oil Conservation Commission to establish proration units, a unit must be established that can be efficiently and economically drained and developed by one well. In establishing proration units, it is mandatory that the Commission consider first the economic loss caused by the drilling of unnecessary wells, two, the protection of correlative rights, three, the prevention of waste, four, the avoidance of risks arising from the drilling of an excessive number of wells, and fifth, reduced recovery which might result from the drilling of too few wells.

We believe that the testimony in this case clearly shows that one well will effectively, efficiently and economically drain more than 80 acres in the Bisti-Gallup area, that economic loss will result in loss on 40 acre spacing, and that substantially the same amount of oil will be recovered by development on 80 acre spacing as by development on 40 acre spacing.

In this case we have a pool which covers a relatively large area, and roughly the operators owning less than 50% of the productive area are seeking development on 40 acre spacing and the other operators want development on 80 acre spacing. The undisputed evidence shows that development on 40 acre spacing will require the drilling of approximately two hundred additional wells, of which the owners of more than half of the acreage in the field would be required to drill more than one hundred additional wells, and to risk in excess of five million dollars in drilling equipment.

The proponents of 80 acre spacing are only requesting a temporary order for one year. As we pointed out in the original hearing, a field which has been developed on an 80 acre pattern can always be further developed on a 40 acre basis, but if an error is made in requiring the field to be developed on 40 acre basis, resulting economic loss can never be recovered. In our opinion it would not, under all the facts and circumstances of this case, be in the interest of good administrative practices under the Oil Conservation Act to require the majority of the operators in this field to develop on 40 acre spacing pattern until it has been demonstrated beyond a reasonable doubt by additional production history that waste will be committed by development on 80 acre spacing.

If there is any doubt about the matter in the minds of the Commission, that doubt should at this time be certainly dissolved in favor of the temporary order. We urge that the Commission grant the temporary 80 acre spacing.

MR. PORTER: Mr. Errebo.

MR. ERREBO: If it please the Commission, Magnolia

Petroleum Company was joined in the application of Sunray and others for rehearing. Its representative H. J. Ramsey appeared at this hearing but has had to leave and has authorized me to make this statement in their behalf. The Magnolia Petroleum Company is an operator within the productive limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, operating six oil wells and one gas well with 800 acres under lease.

At the previous hearing of Case 1308, Magnolia supported Sunray Mid-Continent in their application for 80 acre spacing. Magnolia's position has not changed and we again concur with Sunray Mid-Continent for 80 acre spacing.

It is believed that waste of hydrocarbons will not occur with 80 acre spacing. Infill drilling can be accomplished at a greater rate and the productive limits of the field determined sooner on 80 acre spacing. It should be kept in mind that spacing on 40 acres can be accomplished at any time, while initial 40 acre spacing may result in economic waste with little or no ultimate hydrocarbon recovery being realized.

MR. PORTER: Mr. Kellahin.

MR. KELLAHIN: Jason Kellahin, representing Phillips Petroleum Company. Phillips Petroleum Company feels that the testimony which has been offered in this case clearly demonstrates that one well will adequately and economically drain and develop 80 acres;as it was pointed out by Mr. Hinkle in behalf of Humble, if there is any doubt in the mind of the Commission, certainly that question should on a temporary basis be resolved in favor of a temporary order for 80 acres, and particularly in view of two important factors, one, the present market situation, the other being the pressure maintenance program which is being presently operated on a pilot basis.

Now, the development of this pool on temporary 80 acre proration units, we frequently hear the statement that you can go back and infill. I would rather compare that somewhat to the nature of an exploratory operation as against an autopsy. If we ever are going to find out anything, we can find it out on the basis of 80 acres and then we will know where we are going. If we drill it on 40 acres we have performed an autopsy over a dead body, there is nothing more we can do about it. The development of this field, as has been pointed out, on 40 acre spacing, will result in expenditure of a tremendous sum of money, and if as present indications certainly point out, the fact will be this pressure maintenance program is successful, that money could far more adequately be used in secondary recovery than in development on a 40 acre pattern, and Phillips Petroleum Company urges the Commission to adopt the temporary order.

MR. PORTER: Mr. Malone.

MR. MALONE: May it please the Commission, Ross Malone for Gulf. There are two things that I would like to point out at the outset that it seems to me should be borne in mind in consideration of the problem that here faces the Commission.

The first is that we are here on a rehearing of the order of the Commission which made applicable the statewide 40 acre spacing rules under which substantially all the oil of New Mexico has been developed. Now, this problem of spacing and large spacing units and small spacing units is one that has been troublesome ever since the industry started and will always be troublesome, and some companies are referred to as wide spacers and some as narrow spacers. Gulf has been before this Commission many times urging 80 acre spacing, it has andundoubtedly will be before the Commission again urging it, but the function of the Commission as we view it is to apply the standards to the particular pools under consideration and see whether as regards that pool the most efficient development and the least waste will result from 80 acre or 40 acre spacing.

Now, if we start out with this homogeneous pool that has been discussed here, that has perfect communication, one well for the entire pool as we all know would ultimately drain and would most efficiently and most economically drain that pool. As we move away from that ideal condition, the spacing unit must inevitably get smaller and smaller. It can be assumed then that when the operators come before the Commission as in this pool and say that the spacing unit should be larger than the one on which 95% of the oil in New Mexico has been developed, that they would have a pool in which conditions were much better than average and hence you would be entitled to assume that you would get better performance under a wider spacing pattern, but the evidence that has been presented by both sides shows exactly the contrary to that. It shows a pool which in its rock characteristics, in the heterogeneous character of the sands, in the pinchouts of permeability, all of those things make this a less desirable and not a more desirable pool for wide spacing.

Now, under those circumstances, with 95% of the oil of New Mexico having been developed on 40 acre spacing, it's a little difficult to understand other than on the theory of wide spacing for the sake of wide spacing, a recommendation that the pool be developed on 40 acres.

Gulf has a relatively small amount of acreage in this pool. We don't have and won't have any production line drilling operation going on out there, but our experience and the experience of our engineers fully supports the case which has been presented by Shell, which is that we have here a deposit of oil in sands which if not developed on a pretty dense spacing pattern is going to result in a lot of that oil being left in the ground, and that basically as we understand it, is the question that the Commission has before it, the question of how this reservoir can be developed so that it will be efficiently and economically depleted. We believe that the evidence which has been presented here today, as does the evidence presented in opposition to the Commission order, adds little, if anything, to the testimony that the Commission heard at the outset in this case. It shows again two main sand members in which communication is shown to exist, and nobody has argued about that, there is some communication in the most favorable parts of the sand members.

I don't think anybody would question it. That is not the question that makes the completion of this pool, as we feel indicates that it should be done on a 40 acre and not an 80 acre basis. If the Commission were dealing only with a single sand member such as exists up there in the pilot flood area which has the most favorable communication possible, or the most favorable communication that exists in this pool, it would be one situation. But the evidence shows that is not the situation that exists throughout the pool, and that unquestionably there are going to be not only stringers in these lower producing horizons, but because of the lack of continuous permeability in the upper horizons, there is going to be oil that would not be produced on an 80 acre pattern. We feel that the extent of the pool and the perimeter of it in which these two principal sand members are not coextensive, creates another tremendous area in which oil will be left in the ground on an 80 acre development pattern.

Under those circumstances, Gulf feels that the order of the Commission was proper, that no reason has been shown for it to be vacated, and that the Bisti Pool should be developed on a 40 acre pattern as have been all other comparable pools in New Mexico.

I would like to add only this, that some reference has been made to gas-oil ratio and field rules in this hearing. As we view it, that was not an issue on this rehearing. Certainly it's a matter which when the Commission gets ready to consider it, should be the subject of a special hearing, that it could be gone into, because I don't believe any of the operators intended to go into it at this time. Thank you very much.

MR. HALL: Hall, representing Elliott and Hall. We are operators in the Bisti Field, southeastern part of the field. We wish to go on record as supporting Sunray Mid-Continent's application for temporary 80 acre spacing.

MR. BUSHNELL: Amerada would like to urge the Commission to consider granting of this application in light of the apparently numerous anomalies existing in the minds of the witnesses of the opposition, Shell Oil Company. Amerada feels that if there is any doubt, and there apparently is, as to certain information concerning the Bisti Pool, that the Commission should consider wider spacing until those apparent anomalies have been resolved. Thank you.

MR. PORTER: Mr. Seth.

MR. SETH: I don't think it is necessary to argue this thing, particularly, or rediscuss the evidence that we have all heard in the last several days. There is one point here I would like to mention. It relates to, specifically to testimony of Mr. Gaines of Sinclair, I think it has more or less prevailed here in the thinking of a good many of the Applicants. Mr. Gaines testified that he felt that the company would have to drill every 40 acre location on the lease that was then under discussion, or abandon the lease. Again, in the statements this afternoon there was a figure of two hundred wells. That contemplates the drilling of a location regardless of whether it is economical or not. Nobody under any sort of spacing is going to drill these locations.

That was what the proponents have been arguing, that is what Sinclair argued, that they would have to drill every 40 acre location within their lease, within this pool. That is clearly not so. No one is going to have to drill uneconomical wells regardless of what the spacing is. This figure of two hundred wells multiplied by the cost of drilling each well, that figure is based on the same sort of reasoning. Again, perhaps the opponents in this case do not own a majority of the acreage in the field. I don't think we do. We would probably like to, but we certainly don't, but that again, I don't believe that is the basis for consideration. It is strictly a matter of drainage, a matter of waste that is the only consideration.

In examining the applications for rehearing in this case, I think it was apparent to all of us that there has been some confusion about the burden of proof in a situation like this, and in the original case as far as that's concerned, and again referring to Sinclair, their counsel indicated that there were no rules as I understood him, for this situation, and it was time we got some.

Well, that's not the problem, it wasn't at the original hearing, we have statewide rules. The situation is covered by rules, it is operating properly. Shell has drilled its wells there in accordance with the rules all along, everybody has. We have rules, the situation is that the Applicants want to change the rules. They have the burden of proof.

In the applications for rehearing, the matter of the burden of proof in the original hearing was completely ignored. The applicants have the burden of persuading the Commission to change the statewide rules. Just because there is some doubt created, that doesn't mean the statewide rules should be changed. Several statements just awhile ago said if there is some doubt it should be in the other direction. That is certainly not the burden of proof rule that has always prevailed before this Commission. The Applicant has the burden of making his case. He has to make his case, it is not upon the opponents to.

We feel they have failed to do that in this case. They are trying to offer proof in order to change an existing rule. No reason has been shown to change the spacing. The evidence, we believe, clearly shows that the most efficient development of the field as a whole will be on 40 acre basis. That is the efficient and economic way to drain the field and to prevent waste.

The discussions concerning these lower sand members are very important. Mr. Finfrock testified that there was virtually nothing in the lower sands, it was negligible. We think that that should be considered, the content of the lower sands. We don't consider the oil in the lower sands alone as a factor. It is one, but you have to consider in addition the improved efficiency and drainage by drilling a 40 acre location, the improved efficiency in the upper sands. You add the increased efficiency in the upper sands with the oil in the very discontinuous lower sands and you clearly have efficient operation in the field.

The wells will be commercial, everybody wants to make money in a situation like this and to have commercial wells within the limits of conservation, and prevention of waste, and we think that the 40 acre program will clearly do that. We don't have any production line drilling program. I don't know quite now how that got into the picture. We operate our drilling program just like everybody else does, the other companies, we try to keep the contractors busy over an extended period of time. It is better for him and it is better for us. The independents do that, individuals do it, there is nothing unusual about it. I don't think we have any more rigs going than anybody else, it is just a matter of planning, and we do just like anybody else, there is nothing unique about keeping a drilling contractor busy for an extended period of time.

In that connection we don't have any production line system. We are no different than anybody else. Our costs are lower, but it is just by using ordinary business planning in that connection, and again, on this burden of proof on the temporary order matter, there seems to be the idea that you can get by with a temporary order when you don't have enough proof for a permanent order, that it is somewhere in between. If you can't make a case on a permanent order you ask for a temporary order. That again, I don't believe is the case. You have to make your proof for any change in the rules whether it is temporary or permanent. And to ask for just a temporary because you are not quite sure or you don't think the proof is strong enough, you are asking the Commission to make a change in the existing rules, you have to make a case to do it no matter what change you are asking for, and to fall back on a temporary argument because you don't have a strong case as you would like and don't think you have a strong case for a permanent order, I don't believe that is contemplated in the rules of the Commission or in ordinary or judicial or administrative rules.

We believe that not only that the Applicant has failed to meet the burden of proof, but that the proof is overwhelming that there should be 40 acre spacing for proper development of this pool, and to prevent a very real danger of waste if the spacing is on an any wider pattern. Thank you.

MR. PORTER: Mr. Campbell.

MR. CAMPBELL: If the Commission please, I shall not take the time to discuss with the Commission the question of burden of proof except to say that I do not agree with Mr. Seth's construction of the statewide rules, but I'm satisfied that the Commission here intends and will establish in this pool what it considers to be the most appropriate, most efficient, most economic, the least wasteful program that will adequately develop this field, both in the light of primary production and in the light of possible secondary production.

The Commission's order in the original case stated that there was not proof that one well would drain 80 acres. At this hearing the Applicant has undertaken, and I believe has by additional evidence from additional information, additional studies, additional engineers for different companies, undertaken to substantiate its position and to improve its position with regard to this particular point. At the first hearing it was implied by the witnesses for Shell that only a microlog study could really establish the question involved in this drainage. At this hearing the geologist for Sunray presented a fieldwide study of microlog separation in which he concluded as do these exhibits, that appear on the wall, it seems to me at least in general, that there is communication and continuity at least as to the upper two principal producing zones in this particular field.

That information was further substantiated by the witness for

British American who made the same sort of analysis across the entire length of the field from all the cores that he had available, and he correlated those into the same kind of picture that we believe exists in these principal producing sands.

The witness for British American also indicated by pressure drawdown tests, interference tests, that there was communication. These have been minimized by the witness for Shell today. Nonetheless, in the absence of additional production history which we cannot get without the passage of time, certainly that is the best information to establish this particular point whether you are dealing with 40 acre spacing or 80 acre. The testimony of the Phillips' witness used the application of the material balance formula in which he reached the conclusion that only an infinitesimal amount of additional oil would be recovered by 40 acre spacing than 80 acre spacing.

Finally we had the testimony of Mr. Brinkley in connection with the operation of what we considered to be a very important pressure maintenance LPG injection program, and so we think that the testimony at this rehearing has certainly established that one well will drain 80 acres upon the basis of the information now available.

The Applicants conceded in the original application that there has not been sufficient production history in this field perhaps to justify a permanent order. This rehearing has made it even more apparent, even when you consider it in the light of the evidence offered here by Shell. Let's just look for a moment at some of the uncertainties that exist in this field. These are some of the things that I believe do differentiate this situation from 95% of the pools to which Mr. Malone referred. I agree with him that each pool should be considered on its own. There have been varying estimates in the cost of wells by different companies, different methods of operation. The second place, there has been testimony regarding the lack of production history from these wells, testimony regarding the present limited production from these wells due to market conditions, and finally uncertainty as to what the production might be in the future.

Those things enter into the economic considerations that the statutes require in the establishment of proration units. Then there has been the question of the gas cap, the existence of gas wells at a structurally lower position than oil wells. This is a formation or pool condition which we feel needs to be approached with extreme caution. Then there has been the installation and the development of this pressure maintenance program, which up-to-date appears to be progressing satisfactorily, even on a wide area basis. We believe this should be given an opportunity to work to determine by all of the operators in the pool how they can best invest their money to get the most oil out of this reservoir, and perhaps have a little left over to invest in some other place.

The witness for Shell has testified that they have been unable to make any determination of vertical permeability in this field to date. They have no pressure or gravity tests in the lower sand zones, apparently have not tested them separately. They have been unable to determine fluid movement because there has been a lack of production history.

All of these factors, when considered in the light of this very important economic factor, the possibility of economic loss from the drilling of unnecessary wells, we feel justifies a temporary order in this particular field. I have heard with some interest a remark of the Sinclair witness and the statement recently made by the Sun Oil Company, whether he is an attorney or engineer or both, Mr. Dutton, in any event in connection with the establishment of 80 acre proration units. I think that is a possibility that the Commission must consider, particularly in view, in the light of the fact that Shell has apparently, since the last hearing, and I would assume since there are some twenty wells drilled since the application for rehearing, continued to develop in their own areas upon a 40 acre basis. We believe that there isn't any evidence here which will run contrary to the issuance of a temporary 80 acre proration unit or spacing order in this field, as the Commission should see fit to apply.

MR. PORTER: Mr. Wade.

MR. WADE: The Texas Company is an Applicant in this rehearing. I would like to make a statement for The Texas Company on this matter.

I think that there are two issues involved essentially in this hearing. The first of which, does communication exist in this reservoir in sufficient nature to justify the drilling of one well on 80 acres, and would that one well efficiently drain that 80 acres.

The second point, I think that we need to consider, would that well more economically drain the acreage than would one well on 40. Texas Company believes that the proponents of 80 acres have presented data here that does justify the acceptance of both of these points, and we would urge the Commission to accept and grant the 80 acre spacing for this field.

MR. PORTER: Mr. Dutton.

MR. DUTTON: Sun is in the same position. If I may make a statement, Sun Oil Company, as an 80-acre operator in the Bisti Field, is seriously concerned with the Commission's action in this case. However, we realize that the Commission's action cannot be predicated upon the alleviation of Sun's concerns, but must embody an attempt to realize the dual proration goals of preventing waste and granting each operator a fair opportunity to recover the hydrocarbons under his property. Such an attempt must of course be within the statutory authority of the Commission.

The status upon which Sun bases its recommendation to the Commission is contained within Paragraph (b) of Chapter 65, Article 3, Section 14 of the New Mexico Statutes. It is requested that the Commission take administrative notice of this statute, particularly the language which parenthetically defines a proration unit to be "....the area that can be efficiently and economically drained and developed by one well....". It is significant that the definition does not read "most efficiently". It is also significant that it reads, "can be" and not "might be" or "will be if the market demand improves" economically drained and developed.

Ample testimony has been given that both 40-acre and 80-acre spacing will adequately and efficiently drain the pool. On the other hand testimony to date has been that it is not economically feasible to drill even the cheapest Bisti well for the January indicated allowable of 10 BOPD. As the referenced statute is couched in the present tense, it is submitted that the statutory requirement that a proration unit be an area that can be economically developed by one well would not be met by a present designation of a 40-acre proration unit.

Sun Oil Company is on record as being in support for 80-acre well spacing and we do not now alter this position. However, Sun is not merely interested in maintaining a position -- or for that matter in merely enforcing the absolute letter of the law -- but is vitally interested in not only the prevention of waste, but also in the assurance that each operator has a fair opportunity to recover the hydrocarbons. Therefore, in the alternative, Sun would recommend that if the Commission sees fit to establish 40-acre well spacing, that they also adopt an optional 80-acre proration unit. By so doing, the Commission would be granting to those operators who believe they can eventually profit from a 40-acre development an opportunity to prove their point. At the same time, there would be no statutory violation to force such operator's poor domestic cousins into what is currently a patently uneconomical situation. In addition, such an order would overcome the objection that uniform 80-acre spacing would result in failure to drill certain choice locations. Both sides might well benefit from this feature. As to the possible complaint that such an order would result in irregular surface spacing, the evidence introduced by both sides indicates that the Bisti has hardly been deposited in quarter-quarter sections.

MR. PORTER: Anyone else?

MR. BUELL: Guy Buell for Pan American Petroleum Corporation. In the interest of saving time, may we simply readopt our closing statement that we filed by letter after the September hearing. In that letter we supported 80-acre units. We feel that data are even more conclusive now that the only proper spacing in this field is 80-acre.

MR. PORTER: Anyone else have a statement to make?

MR. SELINGER: If the Commission please, Skelly Oil Company is one of the applicants for the rehearing. We regret that we have no affirmative factual data to present, mainly because we attempted to take some interference tests and unfortunately we are unable to complete them due to the lack of tank room. Likewise, we had no factual data to present as an applicant in view of the lack of production history from our wells, all of which are relatively and comparatively new wells.

At the time of the first hearing we had in the process of completion six producing wells. At this time we have twelve producing wells, and all of the twelve producing wells are on alternate 40-acres or 80-acre spacing as we know it. We have drilled three wells in the gas cap since the last hearing. The first well is 660 feet from the nearest lease lines, and our other two wells are a minimum of 990 feet, these three wells being in the gas cap. We would like to recommend to this Commission to take consideration of the 80-acre spacing.

MR. McGOWAN: I would like to make this one point. There are no rules on this field. It is simply subject to the restrictions of the state general rules against drilling close to lease lines, and it has a proration unit for your proration purposes. It is a very substantial field; it has a number of wells in it, and it certainly is time the Commission took jurisdiction of it and issue such orders as they feel will come nearest to preventing waste possibly, and we feel it should be whatever program will do it, and not whether the 40-acre proration units should be changed, but an affirmative action on the part of the Commission. As stated by our engineer, we do feel that Sinclair would have been, and even now could recover a greater amount of oil, and in an effort to keep this field under control, and in view of the great development on it already, we are recommending 80-acre proration units as a means of controlling this field, at least on a temporary basis. Thank you.

MR. PORTER: Anyone else desire to make a statement at this time?

MR. STEWART: Standard Oil Company of Texas concurs with the application.

MR. PORTER: Are there any more statements? If there are no other statements to be made at this time, the hearing will be adjourned.

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STATE OF NEW MEXICO)
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COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Court Reporter, do hereby certify that the foregoing and attached Transcript of Proceedings before the New Mexico Oil Conservation Commission was reported by me in Stenotype and reduced to typewritten transcript under my personal supervision, and the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal this 17th day of February, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Ada Dearnley
ADA DEARNLEY, COURT REPORTER
NOTARY PUBLIC

My Commission Expires:

June 19, 1959