

BEFORE THE  
NEW MEXICO OIL CONSERVATION COMMISSION  
State Land Office Building  
Santa Fe, New Mexico

September 16, 1970

REGULAR HEARING

IN THE MATTER OF: )

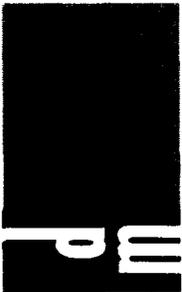
Application of Mobil Oil Corporation, )  
for a waterflood expansion, Lea County, )  
New Mexico. )

Case No.  
4367  
(De Novo)

Application of Mobil Oil Corporation, )  
for a waterflood expansion and amendment )  
of rules governing same, Lea County, )  
New Mexico. )

Case No.  
4368

BEFORE: A. L. Porter, Jr., Secretary-Director  
Alex J. Armijo, Member



MR. PORTER: Now, in Cases 4367 and 4368 the Commission would like to have the appearances.

MR. SPERLING: James E. Sperling of McGrall, Seymour, Sperling, Roehl and Harris of Albuquerque appearing for Mobil Oil Corporation.

MR. MORRIS: Commission please, Richard Morris and Owen Lopez of Montgomery, Federici, Andrews, Hannahs, and Morris of Santa Fe and Mr. Jack McAdams of Houston, Texas, all appearing for Marathon Oil Company.

MR. KELLAHIN: Jason Kellahin of Kellahin and Fox, Santa Fe, appearing for Continental Oil Company.

MR. PORTER: We will recognize Mr. Sperling.

MR. SPERLING: Mr. Porter, we have one witness, Mr. Kelly.

MR. PORTER: Mr. Kelly, would you take the stand at the end of the table, please.

By the way, I think we can have witnesses for all of the parties appearing stand and be sworn at the same time.

PAT KELLY

a Witness, being duly sworn according to law, upon his oath testified as follows:

MR. HATCH: Mr. Sperling, are all these exhibits to be marked?

MR. SPERLING: Yes. They have.

I might state that the stapled exhibits are before Mr. Porter with the exception of Exhibit No. 1 which is the plat on my far left and there are two other exhibits which are rather long and which I didn't have space enough to put them up. Those are Exhibits 10 and 11. Otherwise, Mr. Porter's packet is the complete exhibit.

DIRECT EXAMINATION

BY MR. SPERLING

Q Mr. Kelly, would you please state your full name, the name of your employer, your place of residence and the capacity in which you are employed?

A My name is Pat Kelly. I live in Midland. I am employed there by Mobil Oil Corporation as a Petroleum Engineer.

Q Are you familiar with the Vacuum field in Central Lea County, New Mexico?

A I am very well familiar, I think, with the San Andres reservoir of the Vacuum field in the general vicinity of Mobil's Bridges State lease which comprises almost all of the Northern Nose of the Vacuum field -- approximately one-third of it, maybe a little less.

Q Mr. Kelly, have you, on any previous occasion, testified before the Commission as an expert in the field of petroleum engineering?

A Yes, sir.

Q Your qualifications then are a matter of record?

A Yes, sir.

MR. SPERLING: Are the witness' qualifications acceptable?

MR. PORTER: Yes. They are.

Q Mr. Kelly, you have stated that you are familiar with particularly Mobil's acreage within the Vacuum field in Central Lea County, New Mexico. You, in that capacity, I assume, are aware of the fact that a waterflood project has been previously authorized by the Commission in that area. Would you state generally what the extent of Mobil's participation has been in the waterflood project, both in the past and currently.

A I believe there are currently two waterfloods in the Vacuum field underway. One is operated by Texaco. The last time I looked into it it was what I called an inverted Nine Spot Flood. It is situated on the West San Andres unit, I believe it is called, immediately southwest of the Bridges State lease. The other waterflood in the field that is active now is that on Mobil's Bridges State lease and surrounding leases, the State G and the State J and finally the State II.

Q Would you please now step to the board behind the Commission there and indicate what has been marked as Exhibit 1 in this hearing and explain the purpose and what it represents.

A Exhibit 1 is an area map encompassing, I believe, the entire Vacuum field. It has shown on it all of the wells that have been drilled regardless of what reservoir they were completed in. It shows the acreage operated by Mobil within the area of the map colored in yellow; the Continental State II 35 lease colored in orange and the Marathon State McCallister lease colored in purple. The Bridges State lease is found in this area here. It covers some fifty-five hundred acres or so and blankets almost all of the Northern Nose of the structure. The general outline of the field follows this line here and the crest of the structure is in the vicinity of the Phillips Hale lease in Section 35 and Mobil's 1 lease in Section 36. It falls to the North and the South from that point. There is also structural relief to the East and West in this area where the Northern Nose plunges off the anticline and Mobil's property is, for the most part, situated on that Nose.

Q Well, I take it that that exhibit shows the area of the waterflood presently being operated by Mobil?

A Yes, sir. The map has identified on it the injection wells that Mobil operates according to the legend and currently takes in all of the acreage from the extreme North end of the Bridges State lease in Section 3 down to about the mid-point of Section 26 on the South -- approximately the South half of Section 26 and only the North row of wells in Section 25 are

currently in the waterflood.

Q What is your area of specific responsibility with reference to the waterflood being operated by Mobil?

A I am the Project Engineer on this waterflood. I took it over in 1967 about the time that it was undergoing a major expansion from the old Pilot Flood that started in 1958.

Q Now, would you please refer to what has been marked as Exhibit 2 and explain what it is and its purpose.

A Exhibit 2 is the map shown here. It is intended to identify all of the San Andres wells that have been drilled in and around the Bridges State lease. You might note that Exhibit 2 is just a blown-up, a larger scale map of the Bridges State and surrounding property. It doesn't take in the entire Vacuum field as does Exhibit 1.

I have color coded on Exhibit 2 in red circles the wells that are apparently completed in or producing from the San Andres formation. Color coded in blue are the wells which I have identified in this area as having been formerly completed in the San Andres formation and recompleted at another time in some other zone or in one or two cases I believe the wells have been plugged. I wanted to identify those San Andres wells because there are many reservoirs on the vacuum structure and there are a lot of twin wells shown on the map that are complete in other zones. This will afford some basis for determin-

ing where the San Andres production actually is.

Q Well, the San Andres is the subject of the waterflood operated by Mobil at the present time.

A Yes, sir. The only waterflood we have underway in the Vacuum field now is in the San Andres formation.

Q Would you refer now to what has been marked as Exhibit 3 and explain that exhibit and its purpose.

A Exhibit 3 covers the same area as Exhibit 1. It also has some wells circled and colored, identified according to the legend. This map shows only the water injection wells in Mobil's San Andres waterflood. It shows in red the original six water injection wells that water was started into in December of 1959 in the old Pilot Flood. Adjacent to the Pilot are two wells colored in brown which were injection wells converted in 1963 in an expansion of the Pilot Flood. The next expansion of the Flood took place in 1967 and included all of the wells that are on this map colored in either green or orange. Because it takes some time to install the facilities necessary to waterflood, that is the injection lines, necessary gathering lines, the pumps to pump the water and all, way, it developed that we were able to put some of the wells on injection a little earlier than the others in the 1967 expansion and the wells that we started water into first are identified in green here. We injected into those beginning in May of 1967

and the wells colored in orange we began water into as those facilities were completed in October of 1967. At the end of the 1967 expansion we had all of our developed acreage in Sections 13, 14, 23 and 22 and part of 24 under flood.

In 1968 we drilled another injection well No. 127 here and put it on. In 1968 we bought the Phillips Petroleum Santa Fe 10 from them in 1968 and put it on injection here and about the same time we put our State G No. 3 on injection. We were actually prepared to inject into State G No. 3 at the time of our '67 expansion but we had reason to believe at that time that there was a unit going to go to the East here which was then and is now being expedited by Phillips and we had developed some co-operative plans for injection along the common line between our property and Phillips and we were intending to delay injection into No. 3 until the Phillips unit went into effect. As it developed, Phillips ran into some trouble somewhere and was unable to get the unit formed at that time, so we went ahead and converted and started water into G-3.

The next expansion that we undertook was the one that finally precipitated this hearing today. On June 10, 1970 there was a hearing before the Commission for the purpose of considering Mobil's application to expand waterflooding operations on their Bridges State lease to include the balance

of the acreage on the South end. That would include all of our acreage on Section 25, 26 and 27. Also at that time we asked that our original waterflood order for the Bridges State lease be amended so as to allow further expansion by administrative action. Following the hearing the Commission granted that request along with modified, I'd say, partial approval of the remainder of the application and since then we have converted and started water into these wells colored light blue on the extreme North end of the lease. The wells on the North end are all co-operative injectors with the Yates Brothers that have formed a unit. It is not identified on this map, but in general the acreage North of the Bridges State Lease there is productive in the San Andres, is now within a unit operated by Yates and I understand they are in the process of converting their wells.

The injection wells we wanted to use and ask for permission to use in the June 10th hearing that the Commission denied us authority to use are Bridges State No. 29; a new injection well that we propose to be drilled one hundred feet from our lease line -- that is 560 feet South of the producing well No. 26 to close up that pattern; Bridges State No. 15, No. 25, No. 14 and another well that we propose to drill 330 feet from the lease line in the location of Section 25. Our request at that time was for authority to inject into any

of the oil bearing porosity that we had or might find in the San Andres formation. We encountered substantial opposition to that application by both Continental and Marathon, operators of the orange and purple colored leases here, and I viewed in part or to a major extent because of the ample reserves that Marathon has demonstrated underlies this property in the lower San Andres and the ample reserves that Continental thought it probably had in the lower San Andres. Now, we recognize -- I recognize that there are substantial reserves in the lower San Andres and know that the lower San Andres is much more prolific as you proceed South on the Vacuum structure.

In part, in an effort to avoid some of the controversy with respect to our injection along the South line and also because Mobil's reserves are really in the upper San Andres where we have got almost all the oil we have produced on the Bridges State lease, we have decided to eliminate a portion of the request that we formerly made and at this time ask the authority to inject into the same wells that I just identified with one exception in Unit E of Section 25. We are proposing at this time that these wells be authorized as injector into the upper San Andres pay only, having the lower San Andres plugged off in some acceptable way because I believe that it is necessary for us to inject into the lower San Andres in Unit E of Section 25 if we are to produce enough oil out of

that pattern to justify drilling the extra well which would encompass the lower San Andres and I have decided not to recommend to my management that we drill that well and am relying now on utilizing former San Andres well No. 13, that which is approximately 660 feet from the West line and 660 feet from the South line of the lease; the West line of Section 25 and the South line of the lease that is Marathon's lease North line and recomplete that well in the San Andres at such time as the well bore becomes available.

You will note from the map earlier introduced, Exhibit 2 or 3 -- Exhibit 2 -- that No. 13 has been recompleted from the San Andres into some other zone. It is a Blinbry well now and by my estimate has some three to five years to go before it will deplete its Blinbry reserves.

I would like the Commission to grant authority, as a result of this hearing, for Mobil to inject into well No. 13 into the upper San Andres at such time as the well bore becomes available; that is after the Blinbry reserves are depleted.

Q As I understand you, Mr. Kelly, you are now asking the Commission to grant authority to inject only into the upper San Andres insofar as those injection wells proposed located on the South end, the extreme South end of the Bridges State lease?

A Yes, sir, with respect to the Southern most row of wells only. We have the lower San Andres open in some of the other wells that are already in use for the North lease. I think there are some oil reserves under the Bridges State lease in the lower San Andres, but except on the extreme South end of the lease I think they are somewhat speculative and I am not really sure how much we will get out of there. I do know that almost all of the oil we have made on the property has come from the upper San Andres and I regard it as imperative that we enclose this Flood on the South side and in order to enclose it and get the oil that I really think that we have, that I am sure we have on these properties, I would modify the application, amend the original application and ask authority now to inject into those locations set out on Exhibit 3 in triangles, into the upper San Andres only.

MR. MORRIS: If the Commission please, may I interpose an objection at this point that the witness has stated here that he wishes to amend the application that is pending before the Commission at this hearing which is, of course, an admission that this is not a De Novo hearing from the original application but is in effect a new application to this Commission. We would suggest to the Commission that this De Novo hearing go no further and that the matter be referred to Examiner for an initial hearing in this matter.

MR. SPERLING: Commission please, the relaxation of the original -- if that is a good word -- of the original application certainly is not an expansion of anything that was requested at the initial hearing. We felt that in view of the opposition which has arisen at the time of the other hearing that some points had been made by that opposition and this is an attempt to meet that opposition in a fair way. We do not think that this is a jurisdictional question at all. The Commission has before it the action taken by the original Examiner. It also has before it the statement of the witness at this time concerning the proposal now made which is in recognition of the points made at the previous hearing. We do not believe that this constitutes a new application since it involves identical wells, the identical formation, the identical flood is that which was the subject of the prior Examiner hearing and we think that in view of that, that the Commission is perfectly justified in going ahead and hearing this De Novo as requested.

MR. PORTER: Mr. Kellahin, as counsel for the other party in this case would you care to comment on the motion by Mr. Morris?

MR. KELLAHIN: Commission please, we feel that technically speaking Mr. Morris' objection is well taken. Continental Oil Company, however, feels that the proposed change in the application is at least a step toward improving

the situation to which we had objected and for that reason we have no serious objection to the change.

MR. MORRIS: May I address the Commission again on this point, please?

MR. PORTER: Yes.

MR. MORRIS: Mr. McAdams has pointed out to me that the change that we encounter here in the application is prejudicial to the position of Marathon in this matter in that we have prepared our evidence in this case to meet the thrust of the original application in this case. Now we learn that -- we have had no advance warning of this at all -- we learn that the application in effect is changed and that the evidence that we have prepared here, which you would ordinarily prepare on a De Novo case, does not directly meet the thrust of what we understood the application to be.

Now, this is prejudicial to us because if this matter were to be first considered in an Examiner hearing, then the party adversely affected -- whether it be Mobil or whether it be Marathon -- would have the right to apply later to the Commission for De Novo hearing if that should be necessary and I think that it runs afoul of the procedures that have been established for operating the Examiner hearings before this Commission and the De Novo hearings to permit an applicant to come in at a De Novo hearing and substantially change his application as Mobil has done in this case, so it is not

simply a matter of this case either being heard by the Commission or by an Examiner -- we feel that our rights will be substantially prejudiced unless this matter is assigned to an Examiner and we renew our motion that the matter be referred to an Examiner at this time.

MR. PORTER: Mr. Morris, in other words, you still -- your client still objects to the proposal as made by the applicant, as modified by the applicant?

MR. MORRIS: That is correct. Now, as Mr. Kellahin stated, it is not as onerous as their original application, but we still object to it and we believe that we can demonstrate that waste will occur and that our correlative rights will be impaired by the application in its modified form.

MR. PORTER: So if the Commission should grant your motion and should dismiss this case and it were referred to an Examiner -- called up again -- then we would have to go through the same procedure that we have already. In other words, we'd have another Examiner hearing; we'd have the same objections, maybe not to the same degree and probably -- I don't know what the results might be before an Examiner, of course -- I can't guess what his recommendation would be or what the reaction of the Commission would be --

MR. MORRIS: Well, that is true, Mr. Porter, but the only reason we object to the Commission continuing and

just going ahead and hearing the case is that we are -- the application has been so substantially modified that it is a new application. It is a new application and we should have the two-step procedure available to us in the event that as the result of an Examiner hearing further De Novo hearing should become necessary. As a new application I don't think that Mobil could say that it was being -- that its rights were being impaired by having to follow the normal procedures for new applications of this type.

MR. SPERLING: I can't agree with Mr. Morris that it constitutes a new application. I know of many instances where the relief sought has been reduced in hearings before Examiners and this Commission. If we were seeking relief which went beyond the original application, that would be one thing and I can certainly understand the claim of prejudice in that instance. I cannot understand any claim of prejudice in this instance when the relief sought is less than that which was originally sought, having in mind the position of Marathon, and I can't agree with Mr. Morris that this indicates a new application.

We have exactly the same subject matter, exactly the same waterflood involved and I cannot see, in the presentation of evidence, how the restriction of the limits of the hearing into injection into one portion of the San Andres as distinguished from the two constitutes prejudice.

MR. PORTER: Mr. Morris, the Commission will overrule your motion or deny your motion and continue with the case.

Q Mr. Kelly, I have some difficulty in recalling where we were, but I think we were on Exhibit No. 3. Have you finished your discussion of the information contained on Exhibit No. 3?

A I believe so, sir. I had just completed to point out to the Commission which wells it is that we are asking for authority to inject into; the locations that were not approved as a result of the June 10th hearing and also pointed out that we are restricting our application at this time from down to injection into the lower or the upper San Andres only whereas in the first instance we had asked for permission to inject into both the upper and the lower.

Q Let me ask you this, Mr. Kelly, for the record, do the lower San Andres and the upper San Andres represent separate reservoirs insofar as classification by the Commission is concerned?

A All of the San Andres oil is, according to my understanding, regulated by the Commission as a common field or common source of supply. It is a fact in my opinion -- and I will have some evidence to introduce on it at a later time -- that there is geological separation between what I identify as upper San Andres and lower San Andres pay within the vicinity

of the Bridges State lease in this waterflood in the offset leases and that there is no interchange of fluids between those zones except perhaps in well bores which have both zones open to production.

Q Well, insofar as the flood as it presently exists is concerned and including the most recent expansion granted by or following the June 10th hearing, there is no distinction as between the lower and the upper San Andres, is there?

A If I understood your question correctly, the answer is "No". It is one oil field, one reservoir as prorated by the Commission.

Q Now, would you proceed to a discussion of Exhibit 4 and what it shows.

A Exhibit 4 is a plat which shows the same area as Exhibits 2 and 3. It shows the injection wells, currently active injection wells on it in the same way -- also the Marathon and Continental tracts colored in the same way. On the South end of the Bridges State lease there is an area that is colored red on this map. That area represents the Bridges State acreage which lies beyond the affect of an enclosed pattern flood by virtue of the Commission's decision pursuant to the June 10th hearing. In other words, whereas the acreage to the North will be influenced by a closed pattern Five Spot Flood, the acreage to the South in the red area will

portion of this map?

A Yes, sir. There are approximately 730 acres colored red on the map.

Q Have you computed in barrels the number of reserves

be influenced generally by a one-way push flood. In general, the injection will be taking place to the North and the flood will be pushed toward the South, under the order that we now have.

Q Well, the red area then represents the area of possible recoverable oil reserves by secondary methods assuming a closed Five Spot Flood pattern, is that correct?

A Yes, sir. The red acreage is what in effect could be swept of its recoverable waterflood reserves by Mobil if it were to be assumed that the flood could be expanded onto the South so that the patterns would be enclosed and if it could be further assumed that we could have lease-line co-operation around the South side. Where you have lease-line co-operation in a waterflood there is generally acreage, floodable acreage given up by one operator in favor of the other, but it balances out over the extent of the lease-line such that we would, if we did have co-operation around the South side, we would end up with equivalent of this red acreage floodable in a closed pattern flood.

Q Have you computed the acreage area of the red colored portion of this map?

A Yes, sir. There are approximately 730 acres colored red on the map.

Q Have you computed in barrels the number of reserves

underlying that red area?

A Yes, sir. Using the techniques that I generally use in computing waterflood reserves I have estimated that the red area is underlying by 1,656,000 barrels of recoverable oil by enclosed pattern flooding in the upper San Andres only.

Q Well now, how did you make those calculations -- what information did you use in arriving at that figure?

A I employed some rock and fluid properties that I have carried in my files as the proper test of the San Andres in the vicinity of the Bridges State lease. A great many wells on the extreme North end of the lease have been cored as the most of the other wells were drilled earlier in the late 1930's and 1940's at a time when there wasn't much core and well logging going on. The average values that have been computed from the core analysis of wells that we have cored comes to about eleven percent porosity in the upper zone. Some other work that we have done indicates the water saturation is about thirty-six percent and some information that we have developed on the fluid properties indicates that the oil was initially under-saturated and had a volume factor of 1.26. These are some of the conditions that went into the computation of those reserves.

Q Have you prepared exhibits which reflect those

calculations?

A Yes, sir. Exhibit 4-A is a sheet containing the basic assumptions that I have made in computing waterflood reserves for Mobil all over the Bridges State lease and the equations that I used to develop those reserves.

Stated broadly, the technique employed was to measure or I will say estimate the net pay volume, the reservoir volume of the rock from the Isopachus map which I will introduce later, and calculate the oil saturation remaining in that reservoir rock at such time as the wells had produced whatever accumulative oil they were indicated to produce at the control points -- in this case it is July 1, '70, at the start of the flood -- and to employ simple material balance equations to estimate the recoverable oil, waterflood oil within an enclosed pattern in that acreage, under that acreage, utilizing the beginning oil saturation indicated. I might observe that I have used a volumetric sweep efficiency of seventy percent in the Five Spot Flood that we have here. I think I have seen some information or former performance developed in the more mature parts of the flood to indicate that we are going to recover reserves of a magnitude that would substantiate a seventy percent volumetric efficiency and a twenty-five percent residual oil saturation within the flooded out area and a five percent residual gas saturation

in the flooded out area. These are the basic assumptions that I have made.

The calculations of the reserve for the red area is summarized in Exhibit 4.

Q So Exhibits marked 4-A and 4-B contain the basic assumptions and the calculations which causes you to arrive at the estimate of recoverable reserves under the red area as being 1,656,150 barrels?

A Yes, sir. Exhibit 4-A contains the assumptions and equations. 4-B contains the calculations with specific regard to the red area on Exhibit 4.

Q Well now, I assume that since you have stated that the red area represents the recoverable reserves, based upon a closed pattern, that you have made some investigation of the affect of a closed pattern as against an open flood pattern on the recovery of those reserves, is that correct?

A Yes, sir. I believe that I have a good estimate of closed pattern reserves for the red area because the order that we are operating under now in this flood does not permit the flooding of the red area in the manner that I assume would take place in the calculations in Exhibit 4-B. I felt obliged to find a reasonable basis for determining the waterflood reserves that we are actually going to recover from that area if we are required to operate under the order that we now have. In order to do that I went back to well performance of

wells around the old Pilot Water Flood up in Sections 14 and 23. That Pilot Flood area is shown on Exhibit 5 and I have the producing wells whose performance I analyzed separate, encircled in red on that map, and I have the injection wells that were influencing them circled in blue. There are some red shaded areas on Exhibit 5 which schematically represent what I estimate to be the approximate floodable area between the injection wells and the producing wells whose performance I analyzed.

Those producing wells are Bridges State wells No. 57, No. 10, No. 55 and No. 54. All of those wells during the Pilot Flood were subject to a one-way push and this is substantially what we will have on the South end of the lease, so I reasoned that if I could determine what proportion of floodable area would be effectively flooded in a one-way push, that I could, by analogy, apply those data to the area to the South and come up with a reasonable estimate of the one-way push reserves for the South end of the lease.

Q Well, would you refer now to what has been marked as Exhibit 5-A through 5-D and explain what those analyses and calculations represent with reference to Exhibit 5.

A Exhibits 5-A through D are sheets showing the calculations involved in analyzing the performance of each of the producing wells around the old Pilot that I just enumerated. 5-A is the analysis for Bridges State well No. 10;

5-B for well No. 54; 5-C for 55 and 5-D for No. 57. I will summarize the calculations for well No. 10 and state the calculation is the same for the other three wells. Well No. 10 is found 1,320 feet South of the injector which I believe floods the well No. 31. Previous to the time that well No. 10 experienced response to injection in No. 31 the pattern that it was producing from had produced 297,000 barrels of oil, approximately. I allocated the cumulative oil to the pattern in this manner. What I was attempting to come up with in the first place was a closed pattern waterflood reserve for the pattern that No. 10 produces from to see what maximum we'd get under or what we'd ordinarily get under closed pattern, so I allocated the one-fourth of the cumulative oil from each of the corner injectors; Bridges State well 6, 7, and 31 and the Amerada State V-A No. 3 and added to that the cumulative oil to January 1, 1964, for well No. 10. That came to the 297,000 barrels.

From the Isopach map I determined that there were 2,850 acre feet within that eighty acre pattern described by the four injectors and one producer. Dividing the production by the reservoir volume it is indicated there is a recovery, a primary recovery to January 1, 1964 of 104 barrels per acre foot. When that is compared with the oil initially in place, 433 barrels per acre foot, it can be seen that twenty-four

percent of the oil in place, initially in place in that pattern had been produced to that time. Depletion to that extent will yield an oil saturation at the start of the flood within the pattern of 40.5 percent which will, using the basic assumptions that I have set out in Exhibit 4-A, will give forty-three barrels per acre foot waterflood reserves for that pattern.

I have the production curve for well No. 10 that I will offer in a moment. It shows that No. 10 had, early in 1964, experienced a response to the waterflood that it went through a typical response period, then began a decline and was approaching the economic limit at the time that the 1967 expansion took place. Extrapolation of that observed decline to the economic limit will give No. 10 well actual and projected waterflood oil of 13,112 barrels in a one-way flood situation. That is the equivalent of recovery, closed pattern recovery from 8.6 acres -- in other words, about ten percent of the eighty acre pattern or about forty-three percent of the area that I interpret to have been flooded out by the injection of the well between 31 and 10. It is a little bit difficult in a direct line drive situation as is the case between 31 and producing well 10 to come up with floodable acres. I think it is a little bit elusive because there aren't any side borders on it, but I determined certainly that there are twenty

floodable acres between the injection wells in the staggered line drive configuration that producing wells 57, 55 and 54 were controlled by in the old Pilot Flood because I went on to determine that 54, 55 and 57 had also recovered the water-flood oil from the vicinity of eight to nine acres -- that is most probably well No. 10 had been influenced by twenty floodable acres also. The numbers came out so close that -- we were so consistent that I concluded it must have been about the same magnitude of floodable area.

The effective acreage flooded to well No. 54 is set out on Exhibit 5-B as 8.1 acres; for No. 55, 7.9 acres and according to the reports for No. 57, 17.4 acres. Well, I calculated 57. I had run through the other three wells first and got such close agreement I was surprised when I came up with seventeen acres for No. 57, so I went back and analyzed the well tests that we had accumulated on the well through the response period and I determined that we had reported to the Commission quite a lot more production for well No. 57 during 1965 and '66 than I thought it could possibly have produced. The well tests during that period were quite a lot less than actual production reported so I went back and estimated the production through the same period for well 57 based upon the well tests that we had and we were taking a lot of them at that time and I estimated that the well had actually produced some

27,000 barrels before reaching its economic limit -- 27,575 barrels before reaching its economic limit in the one-way push flood rather than the 53,000 barrels we had reported to the Commission.

The 27,000 barrels is the equivalent recovery from nine acres, so finally I decided that I had very consistent results from all four wells and it is on the basis of this performance that I have, by analogy, estimated the recoverable reserves from the South end of the lease in the one-way flood.

Q Well, your explanation of what you did appears at the bottom of Exhibit 5-D, I take it?

A Five-D -- you are speaking with respect to No. 57?

Q Yes.

A The bottom of Exhibit 5-D, yes, sir.

Q Do you have any further comment on that?

A No, sir.

Q Now, you made earlier mention of production curves in connection with your explanation of Exhibit 5 as well as 5-A through D. Would you now refer to those curves which have been marked 5-E through 5-H, I believe.

A Exhibits 5-E through H are the production curves representing oil produced over the period from 1957 forward by each of the wells that I analyzed around the Pilot. In numerical order, 5-E is for well No. 10; 5-F is for well No. 54;

5-G is for well No. 55 and 5-H is for No. 57. These curves, incidentally, do reflect the oil production that was reported to the Commission and I have pointed out why I think the curve and the production for well No. 57 is in error.

Q All right now, would you refer to Exhibit 6, please, and explain what it shows and its purpose.

A Exhibit 6 shows connected with red lines -- it is a plat -- it shows connected with red lines the injection wells that is the Southern most row of enclosed pattern that we have in the current flood. It shows colored in blue those patterns that will, under the Commission's current order, be influenced by what I describe as a three-way push in further operations in this area. The red area on Exhibit 6 is the area that I interpret will be influenced only by a one-way push and the green area is that which lies outside of the effective productive area of Mobil's last row of producing wells on the South side of the lease in this flood, by this flooding method.

Q Well, Exhibit 6 then represents your calculations of the sweep efficiency of the various colored areas under the existing order, is that correct?

A Yes, sir. The legend shows the estimates that I have made for those various colored areas. For example, the red area which I interpret will be subject to a one-way push flood I have assumed, for purposes of making reserve calculations for it, that one-half of the closed pattern recovery oil will

actually be recovered. I might note that the average data, average performance of the wells around the Pilot Flood that I analyzed indicated some forty-two percent of the recoverable closed pattern recoverable oil from the floodable area would be recovered. For purposes of simplicity in this reserve calculation I have just assumed instead of forty-two percent it would be fifty percent. I have not analyzed any performance on wells with a three-way push, but my logic tells me that a well -- a producing well subject to a three-way push ought to recover more oil than a well that is subject only to a one-way push. Also I don't believe that it will recover as much of the floodable oil as a well that is subject to a four-way push that is enclosed on all sides, so I have made the assumption for the blue areas that will be influenced by injection on three sides that they will recover an amount of oil which is halfway between the closed pattern recovery and the one-way push assumed recovery of fifty percent. In other words, I have assumed that the blue areas would give up to our producing wells three-fourths of the floodable closed pattern reserves in those areas.

Q Having explained your reasoning and logic with reference to the pattern under the existing order, did you make some calculations as to reserves under those conditions as contained within the respective areas?

A Yes, sir. I have made some calculations of those reserves and they are set out on Exhibit 6-A. From the Iso-pachus map I determined the net pay volume beneath each of the areas, the blue area and the red area, and subjected those areas to the percentage recovery factor that I have assumed, seventy-five percent for the blue area -- one-half -- fifty percent for the red area. After having determined the current oil saturation in that area by the same technique that I employed over here originally where I estimated that the closed pattern waterflood reserve was sixty-one barrels per acre foot, I determined that the blue areas should give up 265,000 barrels of waterflood oil.

Q That is the three-way push.

A Yes, sir. The blue area. That will be subject to a three-way push. It will give up 265,000 barrels of waterflood oil. I have all the red area subject to one-way push will give 472 barrels of waterflood oil, giving a total recovery to Mobil, I believe, of 737,490 barrels from the area that is colored red on Exhibit 4 and which is the sum of the red and the blue areas on Exhibit 6. Mobil will not recover any oil short of lease-line co-operation from the area colored green. That oil will be pushed outside the drainage area of those wells as the water invades from the North and I believe quite a lot of it will be pushed across the lease-line to the

South.

Q Have you made a calculation as to the volume of that green area, that is the volume of oil which is unrecoverable by Mobil?

A I have estimated the volume of closed pattern reserves for the red area on Exhibit 4 that would not be recovered by Mobil in pursuing the flood under the current orders and that volume is 918,660 barrels. In other words, of the 1,656,000 barrels I think are recoverable from the South end of the lease outside the closed patterns that we now have, I believe 919,000 barrels -- in round numbers -- will be pushed outside the drainage area of Mobil's wells and we will get a much smaller quantity than we had there to start with -- less than half.

Q Do you have any further comment on Exhibit 6-A?

A I might observe it would be my opinion that short of some sort of co-operative flood being worked out across the South line of the lease a good share of that 918 or 919 barrels will be lost forever. I don't believe anybody will ever get it. If I assume that Mobil's flood is carried to its conclusion in this way as shown on Exhibit 6 and our wells finally water out, I don't know what we will do -- whether we will probably plug them -- that is what we ordinarily do.

There will be a corridor 1,320 feet wide between our last

row of production wells and Continental's North row of production wells and the same thing with respect to Marathon -- there will be a 1,320 foot corridor all around the South end of the lease there. That is short of some sort of co-operative flood being worked out where maybe in fifteen or twenty years they finally want a waterflood in the upper zone where they can use some of Mobil's wells to do it with. I think that oil will be lost forever. I don't believe anybody would have a prayer of getting it.

Q Now, refer please to what has been marked as Exhibit No. 7 and explain that exhibit and its purpose.

A Exhibit 7 shows once again -- it is a plat of the same area as the previous exhibit. It shows once again red lines connecting the Southern most row of currently enclosed waterflood patterns on the lease and it shows green lines connecting the additional proposed injection wells that we now request tied into the pattern. It shows colored in green, shaded in green, the area around the Bridges State lease that would not be effectively flooded of its reserves to Mobil. If this application is granted that is the area outside the effective drainage area of the last row of producing wells under the configuration that we propose short of having lease-line co-operation.

Q Well, have you made a calculation using the same

method of reserve calculations concerning the volume of that green area, that is the volume and barrels underlying it?

A I have not done it just that way. I have made some reserve calculations for the South end of the lease. If I could assume that reapplication we are making here today will be approved and will go on with the flood as I propose, then the addition of the enclosed patterns on the South side of the lease together with the one pattern which will be subject to a three-way push and the one pattern which will be subject to a one-way push, the remaining acreage having been enclosed by the injection wells, that probably will recover a total from the South end of the lease of a 1,362,000 barrels. That is the sum of the recovery from all three areas which would result in only 294,000 barrels being pushed outside the control of our producing wells, some of which I should suppose would make it to the lease-line.

Q Well then, in effect that presents a contrast of a loss of or a leaving of some 295,000 barrels as against 918,000 barrels, is that right?

A Yes, sir. It is the difference between Mobil giving up 294,000 barrels of recoverable oil beneath its lease in the configuration set out in Exhibit 7 and 919,000 barrels in the configuration as set out in Exhibit 6.

Q In other words, Exhibit 6 is representing the present

order and its effect and Exhibit 7 is representing the proposal made by Mobil at this time and its effect?

A Yes, sir.

Q Now, you have made reference in the course of describing your calculations and the basis therefore to an Isopachus map. Refer to Exhibit 8 and describe what that is.

A Exhibit 8 is the Isopachus map that I have used for purposes of estimating waterflood reserves over the Bridges State lease including the South end of the lease. Yes, sir.

Q And that data is based on what -- where did you recover the data for the preparation for the Isopachus map?

A The Isopach is based on several types of data. For the most part it is based on well logs. I pointed out earlier that most of the San Andres wells in this area were drilled a long time ago. Starting in the late -- well, I believe the discovery well was drilled in 1927 and development followed that. They were not logged by the methods that are used today. There was usually a sample log available on the wells, sometimes a drilling time log, something of that nature, but no well surveys. Because production has been found in deeper zones in recent years and there has been a lot of drilling going on the last few years to get that production, why, we have recently come into quite a lot of well log data which covers most of the area concerned here. Those logs were generally

the basis for this Isopachus map. There are a few cases where we had core data which corroborated the log data and confirmed the net pay that was present in the upper San Andres. I might also point out that Exhibit 8 is an Isopachus of the upper San Andres and it doesn't take in the lower San Andres.

MR. SPERLING: Mr. Porter, we have got a couple of rather large exhibits to put up. This might be a proper time to take a recess, if you would be so inclined.

MR. PORTER: We will take a ten minute break.

(Whereupon there was a short recess.)

Q Mr. Kelly, you are the same Mr. Kelly who was testifying prior to the recess?

A Yes, sir.

Q At the time of the June 10th hearing, June 10, 1970, at which the matter which is the subject of this hearing was first considered, there was reference to high water production having been experienced by Mobil in the early stages of its waterflood project in the Northern portion of the Bridges State lease. Do you recall that testimony?

A Yes, sir. I offered some of it and I believe there was another witness or two that commented on it.

Q Now, for the record in this hearing, would you please relate what Mobil's experience was in that regard?

A In and around the Pilot Flood -- you can't see any

of it up here now because they are covered up, but in and around the Pilot Flood in Section 14 and 23 and finally in the expanded area which we took into flood in 1967 a good many wells, producing wells, did experience water response. Almost contemporary with water response, in some wells the oil production showed up first and in a month or two or perhaps six months later the water production showed up. In some wells the initial response was a kick of fifty or seventy barrels of oil and fifty or seventy barrels of water per day.

We have recognized this problem from the early time of the flood. It showed up in the Pilot Flood and when we expanded the flood in 1967 it showed up again. It was of interest to us to find the reason for this early water production that was showing up and so we started to analyzing the various data that we had on the wells and we began to see a correlation between early water production and certain characteristics that we could identify in the wells. We have prepared some geologic cross sections that are intended to illustrate what I believe is taking place in those areas where we do experience high water production at an early time.

Q Lets identify for the record what has been marked as Exhibit 9, which I believe is an indication of the line of cross section which will be covered in the course of the

explanation of Exhibits 10 and 11. I believe there are only three copies of that line of section which has been presented to the Commission.

A Yes, sir. We just have three copies of that plat which has been marked Exhibit 9 and it shows the lines of two sections, two cross sections drawn on it. I believe all three of those maps are in the Commissioner's packet.

Q Well, isn't it true, Mr. Kelly, that on Exhibits 10 and 11, which we will get to in a moment, the line of section is shown on the exhibit itself?

A Yes, sir. In a reduced area quad on each cross section the line of section is shown.

Q Well, we will assume that we have established what the line of section is by Exhibit 9 which will, of course, be a part of the official record, and for the purpose of your explanation now of Exhibit 10 would you please refer first to that line of section as reflected on that exhibit and then go to the exhibit itself and explain what it shows with the relation to your previous explanation concerning the experience of Mobil with early water production at some stage in the flood?

A Exhibit A -- I beg your pardon -- Exhibit 10 is a log cross section, AA prime, which extends in an East-West direction beginning on the East -- I beg your pardon --

beginning on the West in Mobil's Bridges State No. 135 and ending on the East in Mobil's Bridges State No. 88. This cross section utilizes five inch logs so as to more amply illustrate the point that I think is significant. The particular wells selected for this cross section were so chosen because we did have logs on all of them and because we had core analysis data on all but two of them.

Plotted on the cross section on each log where the core analysis information is available is the data summary sheet out of the core report. For example, in well No. 135, the core data is plotted along side the well log as it is in No. 78, in No. 74, in No. 79 and in No. 88. The core analysis in each of these wells show an interval of extremely high permeability as compared with the permeability of the rock above and below. This interval of very high permeability on the core analysis coincides with a zone of very high porosity indicated on the well logs. The permeability and what I call the high permeability zone is very high. It ranges up to about 1,700 millidarcies. The main body of the pay I find frequently has a much lower permeability in the order of a fraction to say 25 millidarcies, so the permeability within the high permeability zone is very much greater than it is within the main body of the pay. The pay is sort of thin up on the North end of the lease too. In this case the logs on AA prime section

show that most of the pay is in the high permeability section.

We have colored in red the interval which is interpreted to comprise the high permeability section and in pale green the upper San Andres interval. That is just ordinary pay above five percent porosity. This shows that throughout the East-West length of the section that some portion of the high permeability interval is present.

I might point out that there is a well, Bridges State No. 134, indicated on cross section A prime with a star above it. This star is indicated to show that this particular well is common to both cross sections AA prime and BB prime.

Q What is the average thickness of this high permeability section in there that you have described -- I think you referred to it as being relatively thin.

A Yes, sir. I haven't computed the average thickness. I can see that the upper interval, the red interval on the West end of the section, looks like it is two or three feet in thickness there. The lower red interval is perhaps four or five feet in thickness and you can see by comparison that it maintains that approximate thickness until you get over into Bridges State No. 134 where the upper high permeability zone increases in thickness to about six feet and the lower zone to seven or eight and that seems to follow on through the rest of the way -- seven to generally nine feet in the lower

of the two high permeability zones.

It might also be worthwhile to note that the zone comes and goes. It is not present everywhere. Whereas, it is indicated to be present on the West of Bridges State No. 79 in the upper zone, by interpretation of the log it goes out as evidenced by the core analysis in the upper zone in wells 79 and 88 on farther East, but the lower zone holds up through there and does extend between the wells, I believe.

Q Now, by your reference to upper and lower zone, you don't mean to imply, do you, that this is what you have classified in your previous testimony as the upper San Andres and the lower San Andres?

A No, Sir. I am speaking of the two high permeability streaks that are evident in the upper San Andres interval on cross section AA prime. Sometimes a well will have one of them, sometimes the other. It may even be that some of them will have three such intervals. Sometimes they have none at all. In this case it is the high permeability interval is present over a good portion of the North end of the lease and this simply illustrates that it goes all the way across from East to West on the extreme North end.

Q Now, having made that investigation and having correlated the data that you have described did you reach any conclusion with reference to the conducting of the water-

flood project concerning the early water production that you experienced?

A Well, on seeing data like this set out on exhibit -- on cross section AA prime, I began to become suspicious that this high permeability, however, would provide an extremely conductive zone for injected water. In other words, I would expect any fluid to move through it much more readily than through the rest of the pay. Further study of the well data in the waterflood area itself indicates that in every case where early water production has been a problem that we have something like this high permeability interval indicated from the data that we have.

Now, our core data is pretty sparse on South of the area covered by Section AA prime, but we do have a good many well logs and, of course, we have the original drilling records on the San Andres wells themselves which afford some basis for deviating between quality of pay -- sample logs and drilling time logs and such as that. In every case where we experience the early water production it was evident in the producing well that made the water and also at least one offset injection well that a very porous soft drilling interval was present. I interpreted that this was in all probability the high permeability interval that we saw in the core analysis farther North.

Q Now, would you refer to what has been marked as Exhibit 11 and explain that line of section.

A Exhibit 11 is cross section BB prime which extends in a North-South direction. On the North end it ends with the -- I believe it is now the Marathon State Bridges No. 3. It goes from there to the Bridges State Mobil Bridges State No. 123 which is common to both cross sections and proceeds on in a Southerly direction from there down through the balance of the Bridges State lease. It crosses on to the Marathon lease at this point on to the Continental State H-35 lease at this point and exits on the South side of the Continental lease to the Phillips Hale No. 7 on the extreme South end. The section also shows, as does cross section AA prime, across the top of it, the section which the wells are located in. As you progress from North to South you go from Section 12 to 14 to Section 13 to Section 24 and so on down to Section 35 on the extreme South end.

Q And, again, the line of section as shown on the extreme right-hand portion of the exhibit.

A It is shown on the right, extreme right of the exhibit, yes, Sir.

Q Now, would you continue with your discussion of Exhibit No. 11?

A You can observe once again on the log which is

common to both sections the interval colored red which I described as the high permeability interval. We think it probably extends on up to the North under the Marathon lease and extends to the South from No. 134 down to our Bridges State No. 40. From there the line of section goes to Bridges State No. 107 in Section 13 where almost all of the porosity of this disappears altogether. You might note on the section that the white area left remaining on each of the logs within the colored interval is representative of the tremendous or the magnitude of deflection of the porosity curve and which correlates generally with porosity -- that is the greater the white area and the farther to the left the porosity curve comes, the greater the porosity, so you can see we are coming from fairly high porosity in the first three wells to very little porosity in No. 107 and I view that high permeability streak is gone altogether there; that the best porosity in that well is not very good. It comes out to Section 24, Bridges State 11 -- I can't tell whether that is 113 or 118 -- where this time, by interpretation of the porosity logs, I concluded that the high permeability interval must have come back. This is a very highly porous zone in here and we have got some water production in that area and so I feel it has come back there; that it is present also in No. 114, the next well on the section -- that it is present also in No. 127, the next

well on the section, but that it disappears as we cross between Sections 24 and 26 proceeding South and I don't find that highly porous and I think highly permeable interval present anywhere else to the South.

The porosity is generally pretty skinny in Mobil's wells along this particular section. It improves quite a lot with respect to thickness and some with respect to quality too in the Continental State H-35 No. 8. It is still pretty good in No. 12 and it is very good quality in the Phillips Hale No. 7.

Q Well now, there is a datum reference on the exhibit there indicated as minus 400. Would you explain what that is and then the vertical designations that appear on the cross section and what they are supposed to indicate?

A Well, this particular section was hung on a subsea datum of minus 400 feet and so it shows structure. It shows that the top of the San Andres is higher with respect to the sea level on the South end than it is on the North end, as I pointed out at the outset, that our property is on the North Nose of the structure and the structure comes up as you go South. The color code on the exhibit identifies what I have defined as the upper San Andres porosity in a pale green color.

The Lovington Sand is identified as a yellow color. The lower San Andres porosity is identified in a dark green color

and is found on the bottom of the section. If one were to look at an Iso-cumulative map it could be readily understood when comparing it with this cross section, why, it is most probable that the wells improve in productivity to the South. The wells on the North end which generally comprise Mobil's property have principally the upper San Andres only. The best part of it is in Section 24 and some part in Section 26.

The lower San Andres porosity, which is shown here in Section 24, has been calculated on the logs to be water barren and so, if memory serves me right, has not been tested in this particular area. We have tested the lower San Andres and Bridges State No. 27 several intervals in the lower of this dark green porosity were perforated in succession, beginning at the bottom and coming up, and in each case ending up with a top interval here. After a big frac job on each one of them we were able to get substantially a hundred percent water. We did get a little bit of oil out of the upper-most layer of the San Andres interval that we opened up in No. 27. I believe that well came in from the lower San Andres with twenty barrels of oil and forty barrels of water, but within forty-five days it had been plugged because the water production had progressed to about ninety-eight or ninety-nine percent. It was making one barrel of oil per day when we plugged it a month and a half later.

Q What is the character of the rock as between the upper San Andres as you have classified it and the lower San Andres and including what you have designated there as the Lovington Sand?

A The Lovington Sand I interpret as being generally impervious. It is the interval colored in yellow here. I haven't looked at every log that we have. All of them I have looked at -- I say, all of them that I have analyzed with respect to the Lovington Sand itself indicate to me that the porosity is generally below ten percent and from the experience that I have had with sand in the Permian Basin, I very rarely find one that will transmit any fluid when the log porosity is below ten percent. I think that is probably because the sand has primary porosity and the Permian Basin is usually a silty sand, has a lot of dirt that has come into it and, of course, it has been formed in part by water moving through the rock and dissolving some of the rocks leaving the holes. The interval that I point to on State H 35 No. 8 below the Lovington Sand, colored dark blue, on down to the first porosity, colored dark green, is what I would characterize as generally impervious dolomite or lime. I don't believe there is any likelihood of oil or water or any fluid moving vertically between the light green porosity and the dark green porosity in any of these locations that is outside the well bores which

have come in communication there.

Q Well, has that, the preparation of that cross section and your study of the data represented by it -- have you reached any conclusion as to whether there is communication other than through the well bores as between the upper San Andres and the lower San Andres?

A Yes, sir. It is my opinion that in the area covered by this section which is generally the North end of the Vacuum field there is no vertical communication outside of well bores between the upper and lower San Andres as identified on this cross section. It is also my opinion, based on this section, that the high permeability streak is not present South of Sections 24 and 23 on the Bridges State lease and therefore I do not expect the water channeling problem that we have experienced on the North end of the lease to prevail on the South. I expect a flood of the upper San Andres interval on Sections 26 and 25 which are from this area South; that the flood front will move right with much more uniformity through the rock and will not tend to move and will not tend to finger ahead of the oil bank and result in premature high water production.

Q Well, have you reached a conclusion or formed an opinion as to the affect of injection in wells as proposed by Mobil on the lower portion of the Bridges State lease upon

offsetting acreage lying to the South and East?

A Yes, Sir, I have. In an effort to understand what the risks probably are with respect to an upper San Andres waterflood on Mobil's property bringing some harm to the property to the South -- which in this case are the Continental H-35 lease and the Marathon State McCallister lease -- I might take one of these down so we can look at the map -- I thought it best, I thought the best way to understand, since I feel pretty well acquainted with our own production in here -- the best way to understand what the risks might be, I tried to in particular to analyze the character and quality of production and production history on the Continental State H-35 lease in Section 35 right here. I plotted out the production, recent production on all of the wells, the San Andres wells on that lease, and determined as best I could from extrapolation of the visible declines of those wells what the remaining primary reserves were. I was able, by this method, to determine, in my opinion at least, what the remaining reserves were for all of the San Andres wells on the State H-35 lease exclusive of Well No. 2. Well No. 2 does not show any observable decline in recent years and so I didn't choose to go through any more completion method of estimating its reserve and have not estimated them. I also wanted to form an opinion as to where the oil was coming from that the Continental wells had produced in the past and, of course, these wells were not logged either now but they have been. They have had twin wells drilled

close by to most of them and the twin wells had porosity logs on them from which I could pick the upper San Andres and the lower San Andres porosity that probably are open in each of the San Andres wells. By comparison of the open hole completion interval in each of the San Andres wells with the log porosities in the twin wells I did form some opinions as to the approximate total feet of upper San Andres and lower San Andres and porosity that is or was probably open in all of Continental's wells during the primary depletion up to the present and I have tabulated those picks on a companion exhibit somewhere.

Q I take it that you are referring to what has been marked as Exhibit 12 and companion exhibits to it, is that correct?

A Yes, Sir. Exhibit 12 is titled "Assessment of Past Primary Performance of State H-35 Lease". It has two or three things showed on it. There is a tabulation on the upper part of the page which shows the reported cumulative oil for each of the San Andres wells in thousands of barrels to May 1, 1970. It shows my estimate of the relative portions of that cumulative recovery that I estimate came from either of the lower or the upper San Andres and it shows the estimated pay thickness that I think is probably open in each of those wells in the upper and lower San Andres. I might say that in each case I just took a straight proportion in allocating the production between the upper and lower zones. I just took a

straight proportion of the cumulative relative to the total thickness as it compared with the thickness of one of the other zones.

Q Let me interrupt at this point, Mr. Kelly, and ask you if on a cross section represented by Exhibit 11 any of the logs of the Continental wells as shown on the exhibit which shows the location of them are present. In other words, are there any --

A Yes, Sir. There are two Continental logs on this cross section State H-35 No. 8 which is a twin to the No. 2 well and the State H-35 No. 12 which is a twin to the No. 1 well.

Q Now, show the location of the No. 1 and 2 San Andres wells on the plat where your pointer is.

A Proceeding South in the same order on the cross section the No. 2 well is in the upper Northeast corner of the lease and the No. 1 well is in the lower Southeast corner of the lease.

Q Alright. If you will continue now.

A These logs show the relative thickness of the upper and lower San Andres in total but, of course, don't illustrate, without knowledge of the complete data on the San Andres wells themselves, what portion of the lower San Andres might be open. For example, in Well No. 2 which is twined by this Well No. 8, I estimated there were thirty four feet of San Andres open and only five feet of lower San Andres. My examination told me

that probably only this upper green interval was open in that wellbore. Although that is an illusive thing, the structure does change and the intervals change laterally so you never really know. That is the best I could come up with with comparison of those logs. In the case of Well No. 1, which has as its twin Well No. 12, I estimated that there were fifty six feet of upper San Andres interval open and fifty six feet of lower San Andres interval open in the well so in that case I allocated the production being equally between the two zones. Of course, fifty six feet of upper San Andres doesn't begin to take in all the San Andres porosity. It is just the amount that I thought was probably open.

Q What do you mean by "twin well"? You have made reference to it. How close is the twin to the original well or to the San Andres well that you are talking about that are open hole completions?

A I think by looking at the map that they will range anywhere from a hundred to two hundred feet apart. Some of them look a little closer than others.

Q Alright. Go ahead.

A The second tabulation on Exhibit 12 in the middle of the page is my computation of the depletion status of the upper San Andres on the State H-35 lease if I can assume that my allocation of cumulative oil to the upper San Andres is realistic. When I compared the reported recoveries for each of the wells with my estimate of upper San Andres oil by this

technique that I have described with the oil in place beneath forty acres around each well I discovered that all of the wells would have had to have produced a high percentage of the oil in place initially beneath that acreage. The only well that I calculated to have recovered anything like a solution gas recovery from the upper San Andres on that lease is Well No. 1 which was indicated to have produced 23.6% of the oil in place. I might say that I have analyzed various portions of our Bridges State production in the San Andres and rarely do I find a well that produced more than 24, 25% of the oil in place before it had approached the economic limit. Of course, in the case of Well No. 1, it is way above the limit and I think it has a good amount of reserve left to it.

As we come on down the tabulation it can be seen one well, the No. 6 Well, which by my interpretation over on the West side of the lease doesn't have any lower San Andres open in it and it has produced all of its oil out of fourteen feet of upper San Andres porosity, the allocation that I gave to it, which was reported production, shows that it must have recovered 142.8% of the oil initially in place. I don't believe any of these things happen with the solution gas mechanism. If they had all come up close to 20 or 25% or less I would probably have concluded that my allocations were realistic. I don't believe they were realistic and I conclude that one of

two things must have happened. If the allocations are correct it must follow that quite a lot of oil has moved into the Continental lease in the upper San Andres zone. If the allocations are incorrect it must be that I have allocated much too much oil to the upper San Andres and much too little to the lower San Andres -- in other words, that the lower San Andres must have actually given up a much greater proportion of the oil than I have allocated to it by this straight proportional technique. I have formed the opinion from further study of the data in and around the H-35 lease that in all probability the upper San Andres is in fact pretty well depleted of its primary oil under that lease. I believe if, for example, these wells could have recovered fifty or a hundred percent of the oil in place beneath their drainage patterns, and oil had migrated into them from adjacent tracts to generate that recovery in the past, that it would still be happening at the present. There are two wells on the lease that are either below or close to the economic limit. The two wells on the West side of the lease. No. 4 has been shut in since, as I recall, the early part of 1969. I have a plot of its production here which would show when it was because it is apparently incapable of production. I noticed that it had been treated with -- it seems like it had been treated with acid before it was finally closed in. Also I believe thirteen hundred and eighty pounds of explosives were set off in the bottom of it

last year or it may have been the last of 68 or early 69 and still no oil came out of it. That well has produced all of its oil, primary oil. It is shut in.

Now, No. 6 is currently producing somewhere in the neighborhood of four to six barrels per day which is not really out of line with the production that I see farther on North in areas where I am certain the upper San Andres is pretty well depleted of its primary oil. I know from the data that I have seen on other wells completed in the lower San Andres around here that the lower San Andres is a very prolific reservoir and will give up its oil pretty readily. I had the opinion that the lower San Andres is the place that the substantial majority of the remaining reserves to the Continental State H-35 are coming from and that the upper San Andres is in all probability pretty well depleted of its primary oil.

Q Well, you mentioned earlier and I don't believe you completed your explanation concerning conclusions reached by you to the effect that oil was not migrating onto the lease.

A I believe if oil were currently migrating onto the lease so as to afford a recovery of 140% of the oil in place or 50% or 60% or whatever, that it would still be doing so at the present. The pressure history of the San Andres Field has been pretty flat. It was a low pressure field to start with. It came in originally slightly more than sixteen hundred pounds bottom hole pressure and I believe that the current reports

that after forty eight hour shut-in wells in the general vicinity of the Continental State #35 and State McCallister, the Marathon State McCallister and the Phillips Hale will show that it is currently in the neighborhood of six to seven hundred pounds and that over the past several years has been declining somewhere between twenty and forty pounds per year and this would compare with a decline in reservoir pressure down to the vicinity of nine hundred pounds over the first seven or eight years of production for the field, so you can see that since 1945 when the average reservoir pressure was somewhere in the vicinity of nine hundred pounds, that there has been very little dropping reservoir pressure without there having been a substantial drop in reservoir pressure from the prolific areas. It seems to me that the differential must still be there, that the differential must substantially be there and if migration in the upper San Andres had taken place in favor of the Continental lease in the past, it really ought to be doing it at the present time and I don't believe -- I am certain it is not doing it on the West side of the lease and the wells on the East two-thirds of the lease I think have both the upper and the lower zones open, so I can't be certain. I just have the opinion that it is probably a similar condition existing over there.

I was going to say that there is such a good interval of upper San Andres indicated on the extreme East side of the

lease in Wells 8 and 12 that I think it is conceivable that since that is offset also by good stuff to the east and south, that there may be some replacement in there. I don't think there is any oil coming in the lease on the west two-thirds of it in the upper San Andres. I think all the oil that is coming in, if it is, is in the lower San Andres.

Q Well, I take it then from what you have said that your conclusion has been that most of the production being experienced currently from the Continental lease at least is from the lower San Andres, is that right?

A That is my opinion. Yes, Sir.

Q Now, you made reference to production plots in the earlier portion of your testimony while in the course of discussing Exhibit 12. Have you marked those for identification?

A Yes, Sir. Those are the graphs of production of the Continental State H-35 San Andres wells and they are marked as Exhibits 12A through 12F. On each of those exhibits I have shown the extrapolated decline extrapolated that I have used in estimating remaining primary reserves for each of those wells.

Q Did you finish your explanation of Exhibit 12 before we pass on?

A I thought I did.

Q Alright. That is your assessment of past performance of the State H-35. Now, would you refer to what has been marked as Exhibit 12G, please and explain what that is intended

to show.

A Exhibit 12G is just a tabulation of the remaining primary reserves that I have estimated for the State H-35 lease wells exclusive of Well No. 2. Those range from 57,000 barrels as a maximum for Well No. 5 in the South Central part of the lease down to 5,000 barrels for Well No. 6 in the Northwest part of the lease and, of course, zero for Well No. 4 which is not currently producing, I don't believe.

Q Alright. Will you refer to Exhibit 12H.

A To further evaluate the risks that I think are involved for Continental in our conducting the waterflood along the South side of the Bridges State lease as we have requested I tried to estimate the volume of waterflood oil that Continental's H-35 No. 6 and H-35 No. 3 would recover as a result of Mobil's injection into the well that we have requested a location for drilling one hundred feet from the lease line South of our well No. 26 and also into Bridges State No. 15 directly North of No. 3. The well that we want to drill for injection South of No. 26 to close up that pattern for Well No. 26 will be, if our permit is granted, 760 feet from the No. 6 well. I have used the data that we developed in a one-way push flood up here in the pilot for purposes of estimating the future oil that these wells should be expected to recover. I have used saturation data based upon the performance of Well No. 26 in analyzing the reserves for Well No. 6 and I have used average saturation

data for the South end of the lease and analyzing the oil that might be pushed to Well No. 3 by injection into Bridges No. 15. I used the average data in that case because No. 15 is also completed in the upper and lower San Andres and it is, of course, one of the best wells we have on the lease and I don't have confidence in any method of allocation between the zones that I have generated so far so I have just assumed in that area at least that the upper San Andres saturation would be the average for the entire South end of the lease. I have generated those calculations by directly comparing with the performance around the pilot and determined that if similar performance is observed between Continental and Mobil's property that the No. 6 well should be expected to produce 5114 barrels of waterflood oil after the drilled well goes on injection. Similarly I have estimated that Well No. 3 should be expected to recover 16,787 barrels of upper San Andres waterflood oil before the upper zone would reach the economic limit in the No. 3 Well.

Q The calculations that you have made with respect to those two wells, that is Continental No. 6 and No. 3 wells, that you have pointed out on the plat there, are contained on 12H to which you have already referred and Exhibit 12I, is that correct?

A Yes, Sir.

Q What do you mean by your reference to reaching the

economic limit insofar as those two wells are concerned?

A Well, at the point where the value of the oil entering into the well on a rate basis declines below the cost of operating the well so as to produce that oil.

Q Alright, would you refer to what has been marked as Exhibit 12J, please?

A Yes, Sir. 12J is a tabulation of some estimates that I have made or prepared on some workover, theoretical workover expenses or investment that would be incurred under different configurations, under different plans. I had these worked up because I know from conversations that I have had with Continental's representatives that Continental is very concerned about the quality of its possible lower San Andres reserve on the West side of the lease and certainly those that appear already to be in evidence on the East side of the lease and so I wanted to be in a position to compare as well as I can the cost of handling the situation by Continental. In the event that our application is granted and we do inject into the upper San Andres and along the South line and Continental's wells along their North line do finally water out in the upper San Andres and leave them with the problem of high water production or executing some sort of a remedial operation to get rid of the water so as to continue producing the lower San Andres reserves, I reasoned that there are a couple of different ways for that to happen. I think it is altogether probable that Continental could, if it had lower San Andres production

in Well No. 6 which had not been demonstrated yet, that Continental could lift the extra water that would come to the well after its waterflood reserves have been produced in the upper zone and in order to keep producing the lower San Andres oil, if it is there. Also another method of control they could elect would be to set a line in the well if it is an open hole completion, if it all happens. In the case of Well No. 6, of course, the estimated oil waterflood oil that I have estimated will come to the well from our injection is 5,000 barrels -- about equal to the remaining primary -- about the same as the remaining primary and so in that case there would be no incremental oil to the well which would, you might say, pay Continental for doing any work on the well. Although it is a possibility that Continental could elect -- if they have confidence at the time they do deepen Well No. 6 -- if they have confidence in the lower zone at that time they can go ahead and set a line then which would cost them about a total of about \$14,000 as compared with a total cost of close to \$18,000 for first completing the well open hole, including the upper and lower San Andres, and then setting a line at a later date and shutting off the upper zone so as to get rid of the water from the upper zone.

In case of Well No. 3, I believe that the upper San Andres reserves remaining in that well are minimal and that in fact the 42,000 barrels that I have estimated remaining

to that well on the primary are, for the most part, coming out of the lower zone, so I think almost 17,000 barrels of oil that I think Well No. 15 would push to Well No. 3 and that would be recovered by it would more than compensate Continental for any remedial measures that they might feel compelled to take. They could either choose to produce the water when it comes in on the well and continue to get their oil in that way -- that would entail higher operating expenses -- or they could set a liner at a cost of some \$9,000 to control the water production from the upper zone. I recommend a lot of investments of \$9,000 to get 17,000 barrels of oil. It looks like a good deal to me.

Q Well now, you have stated on several occasions, Mr. Kelly, that it is Mobil's plan to inject only into the upper San Andres, yet a number of these wells on the southern end of the Bridges State lease are open hole completions in both the upper and lower San Andres. How would you propose to control the injection of water into those wells so as to isolate injection into the upper zone only?

A I have prepared wellbore sketches which show the method that I expect that we will employ if this application is granted to control the injected water and insure that it enters just the upper San Andres. The open hole completions that we have out there right now are Bridges State No. 29, 15 and 25. The other wells that we are asking for authority to inject

into are case hole completions and some -- in those cases -- in the case of the case hole completions we will either set a bridge plug or plugs or perhaps a cement plug opposite or above any perforations that are open currently to the lower San Andres so as to confine the water to the upper San Andres. In the case of the open hole completions I think we would probably plug those wells back with cement which would generally come a hundred or so feet above any lower San Andres porosity and in this way I think we will be able to control, insure that the water doesn't enter the lower San Andres.

Q Well, I take it from what you say that Mobil is willing to forego whatever contribution there might be from the lower San Andres to Mobil's wells by that method?

A Yes, Sir. At this time we are willing to give that up. We have got an awful lot of money tied up in this water-flood and the order we are operating under now costs us an awful lot of oil we were counting on getting when we made this investment and we have got to flood the South end of the lease to make it -- to afford the investment, to have integrity. I believe we can do it without harming our neighbors.

I haven't commented on the Marathon lease. I might observe here that the colors somehow got changed between these two exhibits and Marathon suddenly became orange on this exhibit and here it is purple again. Marathon's wells are, according to my understanding, except perhaps with exception of

Well No. 2 -- and I don't know what its situation is -- all equipped with liners. Sometime back they, after having produced the upper and lower San Andres and having had very good wells there, they are indicated to have gone into those wells and set liners isolating the zones from each other; perforating the lower San Andres only and treating and putting the wells back on production. The producing ability of those wells is generally at least equal to top allowable at the present time and I don't know how much greater it might be. That is just from the lower San Andres only except for Well No. 2. There was a paper filed with the Commission indicating plans to work over Well No. 2 in much the same way that the other wells had been worked over, but I never did find a report in the Commission's files indicating the work had actually been done. About the time that the report was filed I did notice that the producing characteristics of the well seemed to change. As I remember, it started making a little more oil and quite a lot of water about that time but the production curve would have to speak for themselves on that so I don't know whether Well No. 2 is still producing open hole or is producing with a liner and the upper zone shut off.

In the case of the other three wells, No. 1, No. 3 and No. 4, those wells are producing just from the lower San Andres. The upper San Andres is isolated behind the pipe. I believe that any injection that Mobil would undertake in the

area offsetting Marathon's property would be -- that that injection would have a low probability of pushing any oil off of their lease so long as -- in fact, I don't believe that the water front would invade on the lease to any significant extent so long as Mobil continues to produce its wells as we expect it to do and so long as Marathon has the upper zone shut in. The water, the injected water is going to move to the areas of lower pressure and I think with the upper zone shut in on the State McCallister lease right now, that that has got to be a higher pressure area than the areas surrounding it which are indicated to be open in the upper San Andres. As long as Marathon doesn't produce their upper San Andres zone I don't believe that there is going to be any significant entrance of water on that lease. I think, on the contrary, that the water would move preferentially towards the areas that are voiding production from the upper San Andres, that is back towards Mobil's producing wells.

Q I believe you did identify Exhibit 13 as being diagrammatic well sketches which show the proposed completion methods for the wells which are the subject of the application for conversion to injection, is that correct?

A Yes, Sir. I have marked Exhibit 13, a package of wellbore sketches, which show the intended completion method that we expect to employ on these additional injection wells if our application is granted.

Q Mr. Kelly, I think I have neglected to ask you when you were talking about Exhibit No. 11, the vertical separation in distance in feet as between the upper and the lower San Andres on the lower portion of the Bridges State lease and the lease to the South of the Bridges State lease; what kind of a vertical interval do we have in there?

A On the South end of the Bridges State lease, that interval which I identify as generally an impervious barrier to communication, covers an interval generally between two and three hundred feet in thickness between the porosities in the upper and lower San Andres. I see here that in the Continental State H-35 No. 8 it is about two hundred feet. It is also about two hundred feet in the State McCallister No. 8 and over in Mobil's Bridges State No. 105, it comes up to -- well -- a little over two hundred feet. It is quite a wide separation.

Q What is Mobil's total investment to date in the waterflood project in the San Andres?

A Our investment just in waterflood facilities on this San Andres flood is close to two million dollars at this point -- about 1.9 million.

Q Do you have anything further?

A Not that I can think of, Sir.

MR. SPERLING: Mr. Porter, at this time we'd like to offer Mobil's Exhibits 1 through 13, including the alphabetical designations referable.

MR. PORTER: If there are no objections, the exhibits will be admitted.

MR. SPERLING: For the record, Mr. Porter, I'd like to have included as a part of it the Waiver of Objection from Phillips Petroleum concerning Mobil's application; Phillips operating the West Half of the North West of Section 35 in 17 South, 34 East.

MR. PORTER: No objection. This will be admitted.

MR. MORRIS: If the Commission, please, at this time, in behalf of Marathon, I'd like to move that this case be recessed and continued until the next Commissioner Hearing that is -- I mean, the next regular hearing of the Commission in October, or, if the Commission sees fit, to the regular hearing that would be held in November. As grounds for a motion for continuance I'd like to state that the evidence that has been presented here upon the direct presentation of the applicant is contrary to its application in this case and is contrary to and differs substantially from anything that Marathon Oil Company was led to believe to be presented as the applicant's position in this case. We are entirely taken by surprise by the position that is being taken here. The case that we have presented both for our direct examination and for the case that we have presented for cross examination of Mobil's witnesses have been directed to what we believe to be the issues in this case. We now find that those issues are changed and we

would be substantially prejudiced unless this case is continued for at least a month and we are given ample opportunity to prepare to continue in this matter.

MR. SPERLING: I think I have already stated Mobil's position with reference to that. I really can't understand what prejudice has accrued to Marathon as a result of the presentation here today. The situation as I see it has changed very little except for the granting of several concessions insofar as Mobil is concerned in the possible effect upon Marathon or Continental, for that matter, and I think it is perfectly in order to proceed. It is the same oil field. It is the same horizons we are talking about that we have always talked about and since this matter was originally filed and I think we should have some demonstration of the degree of prejudice or what constitutes the prejudice other than the statement that it exists.

MR. KELLAHIN: Commission, please, I wasn't aware that the applicant admitted concessions insofar as Continental is concerned. I think we are in the same position we were, however, we do feel that the continuance should be granted at the request of Marathon because of the change of the nature of the application insofar as they are concerned.

MR. PORTER: Gentlemen, we won't rule on this motion until 1:30. We are going to recess the hearing at this time until 1:30 and, in the meantime, there is at least one attorney

here, I believe, that will be involved in the case upstairs that the Examiner is going to hear during this recess.

(Whereupon the hearing was adjourned for lunch.)

MR. PORTER: The hearing will come to order, please.

The first order of business, Mr. Morris, will be to deny your motion for a continuance, so we will proceed with the case. Mr. Kelly is available for cross examination.

CROSS-EXAMINATION

BY MR. MORRIS:

Q Mr. Kelly, first I would like to make sure that I understand definitely what the status of your present application is to the Commission. First, with regard to your Bridges State Well No. 14, is the proposed injection well in the Southwest Quarter of the Northeast Quarter of Section 25 -- I take it from the diagramatic sketch included within your Exhibit 13 that injection into this well will be through perforations from 4470 to 4563.

A Yes, Sir. That is correct.

Q Now, does that confine the injection entirely into the upper San Andres zone?

A Yes, Sir, upon the Lovington Sand.

Q And what rate of injection do you plan to use into that well?

A Most probably whatever the well will take. We will attempt to get a thousand barrels a day into it at the outset.

The experience that I have had with other wells in here indicates to me that over a period of two or three months a well that starts out taking a thousand barrels a day will likely be down to five hundred barrels per day or less. Down in this area, the area of Well No. 14, I will be very pleased if we are able to maintain as much as five hundred barrels per day injection into the well.

Q Now, initially what pressure do you intend to apply to the injection in this well?

A As much as two thousand pounds at the wellhead, if that is required.

Q Do you intend to maintain this pressure regardless of the amount of water that the well is actually taking?

A No, Sir.

Q If your capacity at the well produces to from a thousand barrels a day to five hundred barrels a day, would you maintain or increase that pressure?

A Over a period of time I would expect to increase the pressure as necessary to maintain a balanced flood. It all depends on what the other wells in the pattern take also -- up to a maximum of approximately twenty five hundred pounds. Our system is designed to handle twenty five hundred pounds. It is a fact that it is impossible to get that much pressure out the wellhead because of the line losses and so on. On the North end of the lease where we are operating our flood currently

we are able to get up to about twenty four hundred pounds at the wellhead and I expect that this will be about the same experience we have on the South end.

Q Moving West over to the Bridges State Well No. 13, -- wait a minute -- first on your Bridges State Well No. 14, what you are proposing varies from your original proposal for injection as presented by your original application in this case, does it not?

A Yes, Sir. In referring to the sketch of Well No. 14 you can see that the well is bottomed at 4803 feet. It is a fact that at the present time all the perforations that are in this well are open to the wellbore including the open hole interval that extends from 4763, the casing show, down to 4803. We are currently making quite a lot of water out of that bottom zone which includes the perforated interval from 4750 down to the total depth of 4803.

Q Now, your original application --

A At such time as our application might be approved I would expect that we would recomplete the well consistent with the wellbore sketch offered here and inject only into the upper San Andres.

Q Alright, so your proposal to inject into the perforated interval from 4470 to 4563 differs from your original application which was to inject into the open -- all of the open perforations and into the open hole down to 4803?

A Yes, Sir. The top of the previously proposed injection interval was 4470, the uppermost perforation, and the bottom of it was 4803, the total depth of the well.

MR. PORTER: Is that in Well No. 14?

MR. MORRIS: Yes, Sir.

Q Alright, moving West over to your well, your Bridges State Well No. 13, now, in your original application to the Commission you had proposed drilling a new well.

A Yes, Sir. I had proposed drilling a new well three hundred thirty feet closer to Marathon's lease line in Well No. 13 as at the prior hearing for the purpose of injecting into the entire San Andres pay interval. That assumed, of course, that we might pick up some lower San Andres pay in the well. At the present time that portion of the application has been modified; that is we have retreated from that proposal to a request to inject into Well No. 13 into the upper San Andres interval at such time as Well No. 13 depletes its Blinbry reserves and becomes available for injection into the San Andres.

Q So your application now -- well, your original application was to drill a new well for injection. Your application now is to convert this Bridges State Well No. 13 from an injection well -- excuse me -- from a producing well to an injection well?

A From a Blinbry producing well to an injection well with the San Andres. Yes, Sir.

Q Alright, there was nothing said in your original application or in the notice that was given to this hearing with respect to conversion of this Well No. 13 to an injection well, was there, Mr. Kelly?

A I have read the notice and I don't recall any such mention of it. No, Sir.

Q Now, the manner in which you propose to convert this Well No. 13 to injection would confine the water to the upper San Andres zone entirely?

A Yes, Sir.

Q And that would be through the perforations as shown on the exhibit 13 of 4433 and 4449?

A Yes, Sir. That is the interval in which our geologist has identified upper San Andres porosity, at that location, and that is the interval that we would plan to open up and inject into.

Q Is it your testimony that injection into that interval will confine the water to the upper San Andres zone?

A It is my opinion that it will. Yes, Sir.

Q Alright, moving on up around the lower tier here of the injection wells we come to Well No. 25. That is the Bridges State Well No. 25 which is a direct offset from Marathon's acreage, a direct offset to its Well No. 4. What is your proposal with respect to this well?

A To convert it to injection in the upper San Andres.

Q Now, the diagrammatic sketch that you have shown in Exhibit 13 shows a total depth of this well of 4,750, a plug back total depth of 4600.

A Yes, Sir.

Q Would injection in the open hole at the 4600 foot level confine water to the upper San Andres?

A It is my opinion that it would.

Q You don't feel that that level is a -- would place water into the lower San Andres as well?

A I think there is very little likelihood that that can happen.

Q You think there is some likelihood that that would happen?

A I think anything is possible. I am certain that the 4600 plug back total depth indicated on this diagrammatic sketch is in excess of one hundred feet above the uppermost lower zone and porosity that is in that well and I think it is very remote that a one hundred foot cement plug will break down, although I think it is a possibility.

Q Is this Well No. 25 shown on any of your cross sections?

A I don't remember whether it is or not. Yes, Sir. It is on cross section BB Prime.

Q Excuse me.

A I say 25 is on it. That is not correct either. The

twin wells are. 25 is on that cross section number 99.

Q Alright, and your proposal for this well at the present time differs from your original proposal in that your original proposal was to inject in the entire interval down to the 4750 total depth of the well?

A The original proposal was with respect to Bridges State No. 25 and all of the other injection wells that were omitted from the order that we had asked for injection authority in encompassed all of the oil bearing zones that we had or could find in the San Andres formation. It is a fact that at the time of the June 10th hearing the No. 25 well was jumped in the bottom of the hole and the lower San Andres was not available to it. Also the lower San Andres had been plugged off very nearly at the time of completion just a short while after the well was initially drilled in 1938 or 9 and it wasn't open in the wellbore then. It is open in the wellbore now and if we are granted authority to inject into this well we expect to set a cement plug in the bottom of the well and inject into the upper San Andres. That would be the same with all of our open hole completions that penetrate to the depth of the lower San Andres porosity on the South line of the lease.

Q You gave some pressure and information concerning the volumes of water that you would propose to inject into the Well No. 14. Would that same testimony apply equally to Wells 13 and 25?

A Let me say that the figure that I gave you with respect to No. 14 is an order of magnitude that I am in a position to give you right now. Ordinarily I try to design injection rates based upon reservoir volume in the pattern and I would, based on the isopach map, calculate some volume for each well that we tried to put water into them at the outset. I haven't calculated those volumes for any of these wells as yet and I can just speculate whether I -- I don't think it would run over a thousand barrels a day. I will be tickled pink if we can get five hundred barrels a day into it.

Q Is there a possibility it might run over a thousand barrels?

A I think anything is possible.

Q That is part of the variables involved in your making these calculations, Mr. Kelly. Why is it not possible to tell the Commission at this time what amount of water and what rate of injection you propose to use?

A I just haven't made the calculations. It takes some time to do it and I haven't done it.

Q Do your calculations vary depending upon the reservoir characteristics you find existing in the different -- from well to well?

A They differ from well to well in proportion that the reservoir volume surrounding each injection well bears to the

reservoir volume surrounding other wells in the pattern. The attempt -- my attempt in designing injection rates in a waterflood is to inject sufficient water into each well to flood out all portions of the pattern at approximately the same time so I must use principally the reservoir volume in each pattern for purposes of making this designed calculation. In practice we are seldom able to match those volumes in waterflood and usually end up injecting quite a lot less than we'd like to.

Q These same characteristics that you deal with in designing your rate of injection also determine how fast the floods move through the reservoir?

A The rate at which the wells take the water do determine -- and the water enters the pay -- do determine the velocity of the flood front, yes, Sir.

Q And they would determine the rate at which water would encroach upon the Marathon acreage.

A It would be proportional to the injection rate, I think, yes, Sir.

Q But you haven't determined that at this time. You don't have that information available.

A The best thing I can tell you at this time is, as I have stated, that I'd estimate the maximum rate would be the order of one thousand barrels per day and I will be real pleased if we can get five hundred barrels per day in them. We have a lot of wells farther North that won't take five hundred barrels per day -- a good many that won't take appreciably over a

hundred barrels a day.

Q Mr. Kelly, you gave us your version of your understanding of the state of completion of four Marathon wells involved here and that they are producing through a liner entirely from the lower zone having been deepened and completed in the lower zone. Is that essentially your testimony?

A I don't recall making any direct comment with respect to the stage of completion. I think I did say that all four wells on the lease, it is my understanding, have been produced for a good many years since their original completions as open hole completions and that the open hole intervals in those wells encompassed both the upper and the lower porosity or some part of the lower San Andres porosity. I have examined reports filed with the Commission to satisfy myself that at least three of the wells on that lease have been equipped with liner, as I testified, and perforated just in the lower San Andres. I didn't find a report that indicated that any work had actually been done on Well No. 2, although I did notice, in examining its production history, there was a significant change in production characteristics for the well at about the time the notice of intention to deepen and recomplete was filed.

Q From your study of these wells did you note that Wells 1, 3 and 4 are top allowable wells?

A Yes, Sir. I believe they are. I believe No. 2 is showing a decline. The water cut seems to be picking up.

Q No. 2 is very close to being a top allowable well

at the present time, is it not?

A I would have to look back at the production data to be certain, but speaking from memory I would say that well, with a seventy barrel per day allowable, it is probably delivering somewhere in the neighborhood of forty to fifty five barrels per day reported production.

Q You testified earlier that the upper and lower portions of the San Andres are considered by the Commission as being one pool for purposes of completion and for purposes of assignment of allowable.

A I don't believe I said I knew how they considered it., I know it is regulated as a single reservoir, as a single oil field.

Q Yes. At least with respect to Marathon's top allowable wells on its lease it would not be possible for Marathon to increase its productivity, its production, excuse me, from these wells even if they were to open up these wells in the upper zone at the present time, would they?

A I doubt whether the productivity of the wells would be increased very much, if any. That is just an opinion.

Q Well, you have talked here, Mr. Kelly, about if you were permitted to -- if your application is granted in this case, that, if I understand your testimony correctly, that Marathon would receive the effect of the injection of water into the upper zone and that it would be in a position to produce oil from the upper zone and its wells.

A I don't remember commenting in any such manner, Sir. I believe what I said or intended to say was that as long as Marathon is not withdrawing from the upper -- is not producing from the upper zone, which I have reason to believe Marathon is not doing at the present time -- at least three wells and perhaps four -- that I do not believe there will be any significant encroachment of water onto Marathon's lease as a result of the granting of Mobil's flood. In any event, the granting of Mobil's flood application would result in the pushing of some oil off of Mobil's lease towards and at least onto Marathon's lease -- certainly onto Marathon's lease if the water front ever advanced to the lease line.

Q If your application is granted you would expect water from your injection wells 13 and 14 to advance toward and onto Marathon's lease within a reasonably short period of time, would you not?

A No, Sir. I think that is the opposite of what I testified to; that in fact it is my opinion that as long as Marathon is not taking any oil out of those wells, or any production out of the upper zone, that the water, the injected fluids will be much more inclined to move in the other direction toward the Mobil producing wells than it will be toward the Marathon lease and that if in fact the water ever does encroach onto the Marathon property from Mobil's flood that it would be preceded by waterflood oil which would serve to in-

crease the oil saturation in the upper zone beneath Marathon's lease and I just don't believe that we can inject long enough there and keep our own flood going long enough, as long as Marathon doesn't produce the upper zone, to flood any oil off the lease. I really don't think there is any likelihood of a water bank ever reaching one of Marathon's producing wells in the upper San Andres as long as they don't produce it.

Q Let's take for example Marathon's Well No. 4 which under your proposal would be a direct offset to your injection Well 13 on the North and your injection Well 25 on the West. How far away from Marathon's lease line is your Well No. 13?

A Approximately six hundred sixty feet.

Q The same would be true for Well 25?

A Yes, Sir.

Q And it is your testimony that the injection of water at the rate of up to a thousand barrels a day under two thousand pounds pressure would not cause water to move onto to Marathon's lease and as far as that Well No. 4?

A I think my testimony was to the effect that I had hopes of gaining as much as a thousand barrels per day at the injection rate in these wells although with specific regard to Well No. 13, I don't believe there is a chance we will ever approach that because the pay is so thin and of such poor quality in that well by the available logs that we have. I also indicated that if we were able to achieve an injection

rate of such magnitude that I didn't think -- I don't believe that it would last longer than two or three months at the most. I believe that within a period of two or three months our injection rate on any of these wells that are able to take as much as a thousand barrels per day, on the first day we'll be down to five hundred barrels per day or less and I don't believe the injection program that we will be able to carry on there under two thousand pounds wellhead injection pressure or twenty four hundred pounds wellhead injection pressure will result in any water bank intruding to the vicinity of any of Marathon's producing wells on that lease unless and until they produce the response fluids out of those wells, out of the upper San Andres.

Q Do you have any information on what the bottom hole pressure was on the Marathon No. 4 at the time it was worked over by Marathon?

A I have looked at a lot of pressure reports, Sir, and I don't remember whether I have seen one on No. 4 or not. I believe I have seen more than one pressure report on Well No. 1 in the Southeast corner of the lease, but I don't remember whether I have seen any one on No. 4.

Q Do you know whether the wells were pumping at the time they were converted?

A I really don't know. I assume they were. Most of the wells out there are pumping wells. I believe the new

potentials on the three wells that were worked over, that workover reports were submitted on, were completed pumping. Their potentials were reported as pumping potentials after the workover.

Q Mr. Kelly, in your work with this project have you studied the effect of water injection in other portions of the field with a view toward seeing how fast breakthrough will occur from injection well to producing well for a certain period of time?

A Yes, Sir. I have looked at quite a lot of that information and, as I testified at length this morning, I made a lot of investigations into those water breakthrough problems that were encountered.

Q Generally speaking do you state that your experience in this field that you had experienced breakthrough in approximately a year to a year and a half?

A I don't have the data in front of me and I will have to speak from memory, but I think that in the wells where we have had severe water problems that, yes, the time that water showed up in the producing wells was somewhere between twelve and twenty four months after injections had started into the offset wells. I think that is always just a general statement. I know that it has proven definitely true in some of the wells in the expanded area. Of course, around the old pilot, we injected under low pressure and at low rates for a long time -- well, five years, almost -- before expanding it

in 1963 and there was quite a lot of water out in the rock at that time which moved pretty fast once we kicked up the injection rates and pressure.

Q You made a comparison, Mr. Kelly, in connection with the work you did on Exhibit No. 5, where you studied the losses that would occur where you only have a one well push compared with other types of where you had two or three or a four well push and then you transferred the results of that study. You assumed that the results of that study would also apply not only in the area of that reservoir up in Sections 14 and 23, but you assumed that would apply equally down here in Sections 25 and 26. Now, wouldn't you also have to assume that your reservoir characteristics so far as breakthrough of water on injection are concerned would be about the same up in those same sections as compared with Section 25?

A Not necessarily the economic limit where those wells around the pilot where those wells were reached because they quit making oil and that is what the reserve estimates are made on. I might add, if you had a chance to look at the curve by now, you can see that as soon as we expanded the flood and got the pilot back we were able to get the flood front back into the wells and are enjoying fairly decent oil production even though there is a lot of water production with it.

Q Would you agree with me, Mr. Kelly, that there are reserves in the upper San Andres zone lying, underlying

Marathon's lease?

A I accept that there are.

Q Well, all four of these wells were producing from the upper San Andres at the time they were worked over, is that correct?

A Would you just inform me if No. 2 was worked over too?

Q No. Excuse me. Just a moment. I will see if we can get rid of this hypothetical we have been laboring with. Alright, I am informed, Mr. Kelly, and I will ask you to accept that Well No. 2 also has been worked over in the same manner.

A I accept that there are reserves or most probably reserves in the upper San Andres beneath the Marathon tract. I think there are upper San Andres reserves every place in here where it has produced in the past which it takes in the Bridges State lease, the Continental State H-35 lease and also the State McCallister lease. I do recall noting, though, that at the time that the four Marathon wells were indicated to have been completed open hole in both the upper and lower San Andres during most of their producing lives and that at the time the wells were deepened into it that additional lower San Andres porosity was opened in the wells, liner was set and the wells stimulated in the lower San Andres and that the oil production picked up, so they produced more oil. That logic

would not follow through by itself. They actually produced more oil after they got just the lower San Andres opened and they did when they had both of them open at a higher producing rate.

Q Referring to your Exhibit No. 8, where did you get the information as to the net pay in the wells shown on the Marathon lease that furnished the information from which this isopach map was prepared?

A First let me say that these picks of net pay were in general reviewed by me but I didn't make those picks. I can say, without having examined the data closely myself, that I feel reasonably sure that the net pay picks on the Marathon lease was on the basis of the well logs of twin wells to the San Andres wells. There have been twin wells drilled near by each of the Marathon and San Andres wells on that lease and the logs formed the basis of net pay picks.

Q Do you know what cut off porosity was used in making these picks?

A It was our intention to use a 5% cut off and this map is intended to reflect net thickness of 5% or greater porosity.

Q If you used a cut off of say 3% rather than 5%, your isopach would look considerably different than this?

A I don't know how different it would look, but I assume that it would look different. Three percent is a

lower porosity. If you use that cut off, it follows that in all probability many of the wells have a greater net pay thickness.

Q Even using your five percent figure, this exhibit shows a considerable amount of net pay in the upper San Andres underlying Marathon's tract, does it not?

A Yes, Sir. I think it has got a good bit of upper pay underneath it.

Q And based upon the actual production that has been experienced from this acreage up to the present time would it be reasonable to say that there is still considerable production as yet unproduced from the upper San Andres underlying Marathon's tract?

A I don't know if I would go that far, Sir. I really have not analyzed the upper and lower San Andres production on the Marathon tract as yet in the same way that I have with the Continental tract and I really don't have any opinion in that regard. I did notice, as I pointed out before, the productivity of Marathon's wells improved after they were completed just in the lower San Andres, so I don't know whether the upper San Andres would give up very much additional primary oil or not. It might do it.

Q Have you made any -- given any consideration at all to not only the remaining amount of primary oil available on this lease but also the amount of secondary oil that might be produced if secondary operations were commenced at an optimum

time?

A I haven't estimated the secondary reserves for the Marathon lease.

Q If I understand your testimony, Mr. Kelly, you are proposing to inject water into the upper San Andres formation in three wells immediately offsetting Marathon's lease but you haven't made any calculations or given any consideration to the amount of reserves that are still remaining under Marathon's lease in the upper San Andres formation. Is that your testimony?

A I think in a sense that would be a fair statement. I will clarify my meaning on it. Because I don't believe there is any likelihood that Mobil's waterflood under the circumstances that I have described is going to result in any oil being pushed off of Marathon's lease in the upper San Andres. I believe that whatever reserves are there right now, secondary reserves, will be there whenever Marathon gets ready to flood the lease in addition to whatever Mobil has pushed to Marathon as long as, of course, Marathon does not withdraw production from the upper San Andres as is the case at the present time. If Marathon does withdraw production from the upper San Andres I would expect that Marathon would get a portion of those waterflood reserves at that time and then at such future time as Marathon might be able to engage in a cooperative flood with offsets because I don't think you can flood that one hundred

sixty acres efficiently without cooperation. I think the reserves would still be there to produce. I don't believe there is any loss in upper San Andres reserves that would be incurred by Mobil's waterflood. On the contrary, I think that the greatest likelihood that those reserves would probably be increased by our waterflood -- that is the oil saturation beneath the lease would be increased.

Q Are you assuming that there is any kind of a pressure barrier or any other kind of barrier that is going to keep the water from your injection wells from coming onto the Marathon lease?

A In a sense, yes, Sir. As I stated, the water will move toward the area of lower pressure. Now, I have no way of measuring pressure profiles between injection wells and production wells and knowing at what point the pressure falls to what level, but I do know that it is our intention to produce every barrel of fluid that enters our producing wells and this is what we have been successful in doing so far in our waterfloods. If we continue to be successful in doing that, as I expect us to be, I think the water that we inject will tend to move preferentially toward our producing wells. As long as Marathon doesn't withdraw anything from the upper zone I think the likelihood is slight of very much flood moving in that direction.

Q Isn't it indisputable, Mr. Kelly, if you are inject-

ing water into your injection wells at a rate in excess of a thousand pounds and our wells down here in the upper zone are considerably lower than a thousand pounds pressure, that whether those wells are being produced or not, that you are going to have movement of water from the injection wells down onto the Marathon lease?

A My opinion is that that movement would probably -- yes -- I think this is a reasonable statement which I am going to clarify my opinion on it. As long as there is an ample gas saturation I think the flood will move pretty fast until the gas saturation is filled up. Then I feel like there is going to be ample resistance encountered to further flow, that is unless there are withdrawals taken from it. I think that the pressure differentials, while they will still be in that direction will be much greater in the other direction and the predominant flow of the water will be towards Mobil's wells and not towards Marathon's lease and I haven't estimated the magnitude. It is just an opinion that I have.

Q Gas saturation varies with the pressure?

A And oil that is there to fill it up, yes.

Q What bothers me, Mr. Kelly, is that you are stating as a definite opinion that this water is not going to move down on to Marathon's lease, yet you have admitted that you have made no study of the production that has occurred in the upper San Andres from the Marathon lease or the existing pressures

in the upper San Andres on the marathon lease.

A Well, I don't believe there have been any recent measurements of pressure in the upper San Andres on that lease.

Q So when you say that the water is not going to move onto the Marathon lease, this is just a conclusion you'd like to reach, isn't it -- you don't really have any basis for that without having made a study of the upper San Andres formation on the Marathon lease itself?

A I disagree, Sir. As I have stated over and over, I believe that the injected fluid will move preferentially toward the areas of lower pressure which in my opinion will be in those areas where fluids are being produced and withdrawn. I cannot conceive of there being a pressure sink in the upper San Andres in the vicinity of Marathon's lease since they are not withdrawing anything from it. My opinion is just based on these facts, knowing that Marathon does not produce its upper San Andres. My opinion is that the pressure differentials at this time are away from Marathon and that if any fluids are being moved, they are probably moving away from the Marathon lease onto the adjacent tracts because the adjacent tracts are removing fluids from the upper San Andres.

Q Wouldn't you agree with me, Mr. Kelly, that water is going to move onto the Marathon lease eventually and that what we are talking about here is a matter of time until water has flooded out the upper San Andres zone at least in Wells Nos 2

and 4, if not all four of them?

A I am sorry, I don't follow that question.

Q Alright. Let's come back and just talk about No. 4. Isn't it just a matter of time until well water from Wells 13 and 25 are going to flood out the upper San Andres zone that is available to the Marathon Well No. 4?

A Yes, Sir. I think it is a matter of time and injection volumes, yes. I don't believe that the time that I expect this flood to operate, which is the order of fifteen years, I don't believe that within that time, unless Marathon recompletes those wells and begins to withdraw out of the upper San Andres, that any such condition would occur. Of course, to the extent that while I say anything is possible, to the extent it would occur if it did occur, Marathon would have recovered some incremental oil sooner than they would have got it otherwise, assuming that in fifteen or twenty or thirty years, whenever Marathon gets around to it, a cooperative flood could be operated on that lease with the adjacent properties.

Q Mr. Kelly, assume with me for a moment that Marathon really has not agreed with your opinion on this and I assure you that this is a valid assumption that you can make; that there is a difference of opinion on how fast the water is going to come toward this No. 4 well. If water encroaches toward that No. 4 well and Marathon is making top allowable from the lower San Andres in that well there is no way that Marathon can protect its correlative rights in the upper San

Andres portion of the reservoir by producing the oil that is being swept past that well --if you make that assumption --

A I don't know to what extent I am entitled to have an opinion on correlative rights. I will say this, though, that in such event as Marathon would open up the upper San Andres in the No. 4 well and produce waterflood oil that was pushed to them by Mobil's waterflood, I think, yes, that would represent incremental oil to Marathon, but I agree that it would not represent an increased recovery rate. There would be no incremental rate but there would be incremental oil as long as the allowable controls the well production and as long as it can deliver the top allowable. Certainly there is no incremental rate, but there is incremental oil and extra oil recovered.

Q Just one other point and I will switch off to something else, Mr. Kelly, but if Marathon cannot recover the oil as it comes by, not only is waste occurring, but our correlative rights are being impaired. Now, can't we agree to that -- doesn't it come down to that and that you are saying that that won't happen because water is not going to encroach on our lease and we might have different opinions -- isn't that what it boils down to?

A I think the likelihood of water encroaching materially on Marathon's short of the upper San Andres being produced on that lease is very slight. Yes, Sir. I don't know how to answer the rest of your question. If you care to state it over,

I'll take a shot at it.

Q I think that is enough.

MR. PORTER: I think he knows the answer anyway, Mr. Kelly, probably.

Q Mr. Kelly, have you given any thought -- has Mobil given any consideration to recompleting any of your San Andres wells located adjacent to Marathon's acreage, either deepening or recompleting them in the lower San Andres in a method similar to the method that was utilized by Marathon on its four wells?

A Well, I'd have to say yes. We have given consideration to that and various other possibilities. The fact is that because of some work that had been done years ago in attempting to get some oil out of the lower San Andres on the Bridges State lease a lot of our people had in fact condemned the lower San Andres as being non-productive and when going on the cross sections, I made some reference to Well No. 27 as having been perforated and fraced in several lower San Andres porosities and really never making any commercial oil, we have even tried once again to get some oil out of the lower San Andres since our application was in part rejected pursuant to the June 10th hearing and we ran in and set a packer above the bottom perforations in Bridges State No. 14, which it is my view it is perforated in the lower San Andres and completed in the lower San Andres porosity and we, for three or four days, made twenty

four or twenty five barrels of oil a day out of that zone with sixty to seventy barrels of water. That production of twenty four or twenty five barrels a day lasted for four days. For the following month it averaged five barrels a day and approximately eighty barrels of water. My opinion is that at least at that location there is no commercial oil in the lower San Andres.

Q Which well was that?

A That was 14. There is some oil in it, obviously. We got some out, but I don't believe there is any commercial oil there for Well No. 14. We had a little better luck with Well No. 25, if the production holds up. I don't remember whether I said anything about it at the earlier hearing, but it is true that Well No. 25 was drilled initially to a total depth of 4750 feet and had a good section of lower porosity open in it. It made five barrels a day of water and whoever was looking after the well at the time didn't like the water production and filled the bottom of the well with cement and so shut off the lower zone. Within the past recent time period we have succeeded in getting that lower zone opened up again. I believe it had picked up a little bit of oil production. We got forty, forty two barrels of oil the first twenty four hours out of the combined interval in that well along with quite a bit of water. Of course, there is a lot of load water lost in the well, so I don't know whether it is load water or San Andres

water that we are producing, but, yes, I think in three wells on the Bridges State lease we have a pretty decent chance to make some lower San Andres oil and those are at the locations of 25, 12 and 15. All three of those wells are now completed in the upper and lower San Andres.

Q Now, if your Well No. 25 -- is that the same well that you are now proposing to convert to an injection?

A Yes, Sir.

Q Have you abandoned the idea of possibly converting some of these wells adjacent to Marathon's lease to producing wells in the lower San Andres at this time?

A No, Sir. The three wells that I named, 12, 15 and 25, are currently producing from both the upper and lower San Andres. At such time as we convert either of those wells 15 or 25 to injection by cementing off the bottom of the well, it will be necessary for us to drill the replacement well to get those lower zone reserves.

Q When you talk in terms of having a cooperative flood in this area with Marathon, wouldn't it be appropriate to have a cooperative flood by your developing the lower San Andres and then at a later time entering into a cooperative flood with us for flooding both the upper and lower San Andres?

A The problem is that aside from three well locations we have seven hundred thirty acres on the south end of the Bridges State lease which is hardly economical to operate. It

is at the end of its primary depletion and the logical thing to do is try to improve the recovery, increase the reserves and increase the production by stimulating that production with some sort of secondary recovery effort. We started in 1958 to trying out a waterflood in this field and it has just expanded up to the south line. We are trying to take in the rest of it now.

Q Just a couple of more questions, Mr. Kelly, and I will be through. Down south of Marathon's lease in Section 36 there are Getty wells shown on the map. Are those wells producing, presently producing from the upper San Andres formation?

A Let me say that I have, at one time or another, checked, looked at the completion information on wells in Section 36 in general and have the opinion that both the upper and lower San Andres is open in a good many of those wells.

Q Are these top allowable wells at the present time?

A I think it would be fair to say that they generally are.

Q Would they be creating a pressure draw down that would set up a gradient from your injection wells across Marathon's acreage down to the Getty acreage?

A I think that possibility exists. That could happen, of course, I don't really know what the pressure in the upper zone is down there. I do know that in general that both the upper and lower pay improved quite a lot down in that area and

I suppose it is conceivable that even with Getty continuing to produce down there it might possibly be that the pressure differential is still -- the gradient is still from south to north. I just don't know. I just don't know.

Q Have you made a recent study of the Getty production in Section 36?

A Just in a general way. I have noted they have got good wells and they have got good looking pay sections on the logs.

Q Do you know what their bottom hole pressures are?

A I don't remember now but I have seen it. I have seen all of the pressures that are reported in the New Mexico Engineering Committee Report and there may be one in there, I don't recall specifically whether there was one on Getty or not. If there is one in there, I have seen it, but I couldn't tell you what it is.

Q On the Well No. 13 that you propose to convert to an injection well, how is that well presently completed at this time?

A It is completed through perforations in the Blinebry pay.

Q What is your current level of production in the Blinebry?

A The order of five hundred barrels per month. I think that it should continue to produce for a minimum of another

three years, perhaps as much as five, before reaching the economic limit and it has got to be down close to the economic limit before I can justify converting it.

Q Do you plan to convert it at this time?

A No, Sir. I want authority to convert No. 13 at such time as the wellbore becomes available for injection into the upper San Andres and I will state that it is my current estimate that the remaining reserves will be produced from that well somewhere between three and five years time from now.

Q You want authority now for something that you may not do for three or five years, is that correct?

A Yes, Sir.

MR. MORRIS: I have no further questions.

MR. PORTER: Mr. Kellahin?

CROSS-EXAMINATION

BY MR. KELLAHIN:

Q In connection with the testimony about water and the encroachment on the Marathon lease, as I understand, it is your position that there will be no encroachment because of the pressure, is that correct?

A Well, I suppose it could boil down to that. That is not just what I said or intended to say.

Q What did you intend to say?

A Well, what I said was that as long as Marathon is not withdrawing fluids from the upper San Andres interval beneath

their lesse I think the likelihood is very slight that a significant amount of water will invade their lease during the life of Mobil's flood. I think that is the substance of what I have tried to say several times.

Q Well, the fact that they are not withdrawing then would create a pressure?

A I think in a way it would. In all probability there would still be a pressure gradient from the injection well to the Marathon lease and still be some movement, but I think it would be a slow thing.

Q But if Mobil were to shut in the tier of wells in the South Half of Section 26 there would be no water down in their direction, would there? -- Encroachment of water down in that direction, would there?

A That is to the same extent, yes, Sir. That is basically true.

Q That oil then would stay there until the offsetting operators were prepared and ready to join you in a cooperative flood?

A I suppose if we would pool enough not to produce, it would stay there.

Q And it would be available for a later flood?

A It could be. It all depends upon, you know, how things developed. If our flood comes along and we get through with it and plug the wells out and still are faced with some

possible secondary reserves laying down there, we will just have to re-evaluate the economics of it at the time.

Q Now, in connection with the Continental lease, it is your proposal to convert the No. 29 well to injection?

A Yes, Sir.

Q What is the present state of that well -- is it completed in both zones?

A The well is at this time completed to a sufficient depth, I believe, to expose both zones. I don't know whether 29 has any lower zone in it or not.

Q In any event, you will plug it back?

A I don't know whether there is any porosity in it or not and --

Q You will plug it back?

A Yes, Sir, to the upper San Andres.

Q And is the same true with your 15 well?

A Yes, Sir.

Q Now, you propose to drill a well, I think, directly south of your No. 26 well.

A Yes, Sir.

Q And directly to the north of Continental No. 6 well.

A Yes, Sir.

Q Seven hundred sixty feet.

A I expect the well to be -- if the application is granted -- approximately seven hundred sixty feet from

Continental's No. 6 well and five hundred fifty feet from Mobil's No. 26 well.

Q Where is the No. 26 well producing from?

A I believe it is producing just from the upper San Andres now, although I say producing now, it is really not really producing anything right now it is shut in. It went to a hundred percent water a couple or three weeks before the June 10th hearing. I don't really know where the water is coming from. I thought at that time it must be coming from the bottom of the hole, but since then I have decided I really don't have an opinion as to where it is coming from.

Q Is the well open?

A It is not intended to be. It was drilled into the lower San Andres and some water production was picked up there and it was plugged back with cement.

Q You say it was not intended to be. What I want to know is it or do you know?

A I just don't know. The cement was placed in the bottom of the hole and I don't know whether --

Q Do you know whether it was effective or not?

A That is right. I don't know.

Q I think the No. 12 well would be the well we are talking about there, would it not -- is that in the San Andres, that well, that cluster of three wells there?

A The No. 12 is the San Andres well. Yes, Sir.

Q And how is it completed?

A It is an open hole completion.

Q In both zones?

A Yes, Sir.

Q Now, if the No. 26 and the No. 12 watered out, what would you do with those wells at that stage?

A At such time as producing wells 26 and 12 were watered out from the waterflood --

Q Well, whatever would cause it --

A Well, I can't enforce any decision I might make now on who is concerned with this at the time, but my opinion is that the wells would probably be plugged.

Q If the wells were not plugged or if water encoached in any volume in those wells, would it not be possible it would get into the lower San Andres zone through those two wells?

A Through which two wells?

Q 12 and 26 -- if you have an effective cement job on the 26 I suppose it would not.

A That all depends on whether it would shut the well in or continue to produce it. I think it would continue to produce it. No. I don't believe water would get into the lower San Andres.

Q If you shut in for any cause it would not?

A I think it is logical to conclude that due to whatever pressure differential could be developed in the wellbore between

the upper San Andres and the lower San Andres, if the well were shut-in, yes, fluids would exit from it, would enter the well from the higher pressure zone and leave through the lower pressure zone and if it happened that the differentials were in that direction, yes, I think that would happen.

Q If you had a waterflood in one zone and none in the other the pressure would build up in the waterflood zone, would it not, logically?

A Yes. I don't really know how high it would build up in the producing well. I know that we have one or two wells out there in the flood proper and these are wells that are tied in to injection wells where the injection wells and producing wells are tied together with this high permeability zone that I have talked about where the wells will stand just about full when they are pooled, but, in general, our wells don't run over out there in the waterflood when they are pooled, so using that information as a basis for estimating bottom hole pressure in the vicinity of a producing well, I could probably come up with some number that would represent an order of magnitude that we can usually encounter.

Q You don't have a bottom hole pressure on any of the producing wells up in the upper part where the flood has been in effect?

A No, Sir. Those are all pumping wells, of course, and we don't take pressures on them.

Q Do you have any estimate of the bottom hole pressure of the injection wells?

A Yes, Sir. I could generate one. At the rock face I think it ranges up to about thirty five to thirty eight hundred pounds, something like that. I'd have to sit down and calculate it to give you a real good number, but I think it is that order of magnitude.

Q That is approximately?

A Yes.

Q In connection with your Exhibit No. 4, you defined the red area there in which, as I understand your testimony, you said there was only a one way push from the injection proposal, I take it.

A I think what I said was that the red area is generally subject to a one way push.

Q Actually that would only apply to the South Half of Section 26, would it not?

A It would apply, as I went on to clarify in Exhibit, I believe it is, 7, the one way push by itself applies only to the red area on Exhibit 7 and there is a three way push that influences the blue area on Exhibit 7, both of which are found in the red area on Exhibit 4.

Q In other words, you have more than a one way push in Exhibit 4 in the red area?

A Yes, Sir. As I attempted to illustrate with Exhibit 7

and companion exhibits, there are two kinds of push that will be affected in that area; a three way push on the blue areas and a one way push on the red areas and no push at all on the green areas.

Q Now, I believe that you indicated that in connection with that exhibit that if you had cooperation with it to the south you'd have a closed flood pattern. Isn't that what you said?

A Which exhibit is that, Sir?

Q Well, if you had cooperation from the south, would that give you a closed flood pattern?

A Yes, Sir. To the extent that we have cooperation it would close it up. It would. If we could cooperate all the way around we could get enclosed pattern reserves off the entire red areas on Exhibit 4.

Q And leave Continental Oil with an open pattern and no cooperation from the south, is that right -- that would be exactly the same situation you are in now.

A You'll have to clarify your question for me.

Q If Continental cooperated with you on a line flood, then they would be in the same position you are in now insofar as their operations to the south are concerned?

A I have formed some opinions about Continental's water-flood reserves.

Q I am not talking about reserves. I am talking about

a pattern.

A In order to answer your question it is necessary for me to tell you this and I don't believe the situations are comparable at all. No, Sir.

Q You don't think it is the same thing?

A No, Sir. I don't think it is.

Q They'd have no backup flood to the south.

A Well, to that extent, yes. That is true. From that standpoint, if Continental did not have cooperation to the south of the State H-35 lease, from that standpoint the situations would be similiar, but from the standpoint of what we have here, the recovery, the oil that we are in a position to lose as a result of carrying on our flood under the existing order, is quite a lot different from what Continental --

Q In other words, you say you will lose more oil?

A I will say that it is my opinion that Continental will not suffer any loss in recoverable reserves if they were to cooperate with Mobil.

Q Providing they recover the reserves.

A They will recover part of them now, that is as the wells respond, and the rest of them whenever they engage in a cooperative flood with other people in other directions to the south, east and west. I don't think Continental will lose any recoverable reserves.

Q Why can't you do the same thing with Continental you

are expecting Continental to do?

A Well, Continental is faced with a different problem than we are.

Q What?

A Continental has only one -- the distance of only the distance between two wells; that is, for example, the distance between Well No. 6 and Well No. 4 it has to flood the oil. Mobil, in recovering the oil in the one way flood, has to push it across in excess of a half a mile in places.

Q Just using the illustration you just gave, doesn't Mobil have the identical situation with the No. 35 injection well and 25 and 26 as a producer -- it goes the same distance, doesn't it?

A I am not sure I follow your question.

Q You just testified, did you not, that Continental only had to be concerned with the distance between Well No. 6 and Well No. 4?

A That is right. Between 6 and 4 and between 6 and 3 and between 6 and 5, yes.

Q And don't you have the same situation with your Well No. 35 to the north, the distance between 35 and 26?

A Yes, but there is a further distance to the east there over to 25 and, of course, we'd have to keep injecting into 35 to get the oil across to No. 25, under the configuration that I think you are talking about, and in such event we'd push all the

oil, off of our lease to the south on beyond 26. Of course it is possible that we'd sit there and produce one hundred fifty or two hundred barrels of water a day out of No. 26 for five or six or seven years or without getting any oil to stop that, but I kind of doubt if we'd produce an oil free well for very long.

Q Well, Mr. Kelly, along that line, wouldn't the same thing happen to Continental in their Well No. 6 -- you don't say that water won't encroach on Continental's lease, do you?

A No, Sir.

Q It will encroach their Well No. 6?

A I think it will.

Q How do they protect their No. 4, then?

A From what standpoint?

Q Do they produce a hundred fifty barrels of water from the No. 6 well -- won't the same illustration apply?

A You mean after the water encroaches on No. 6?

Q Yes, Sir?

A Well, of course, we have switched horses back and forth. We are not talking about cooperative flooding any longer.

Q No. We are not. We are talking about now you have made certain comparisons and I am trying to point out, at least for the Commission's benefit -- I think they are getting it -- I hope -- that the comparison you made applies equally to your lease as to Continental's. That is what I am trying to get at.

In the specific instance of the so called -- what I will call the line injection well between No. 26 and No. 6, that Mobil is recommending to be authorized for drilling, it will be two hundred feet closer to Well No. 26, Mobil's only producing well in that pattern, than it will be to No. 6, Continental's producing well that will be influenced by that injector. There is no reason at all for Mobil to continue injecting into that well after the waterflood reserves have been recovered by No. 26. Now, because the well is two hundred feet closer to our producing well in that pattern, the only one that we have to allow on to get the oil is Continental's No. 6 producing well.

A I think there is very little likelihood that anything such as what I think you are talking about would have occurred; that the water bank would advance beyond Well No. 6. I think that it will. I think that the level of injection it will have to maintain in that well to keep from watering out our own producing well which is two hundred feet closer to it than your well is such that there would never be any real problem encountered in Continental's No. 6 well.

Q The only problem they will encounter is if you water it out.

A I think that over a period of time the well will water out and produce five thousand barrels of waterflood oil. Yes, Sir. That is it would water out from the north and because I think that will take place over a period of about fifteen years,

because that is how long it will take us to flood out that pattern that No. 26 produces from, so I think at the end of that time Continental will just about have recovered its five thousands barrels of waterflood oil plus whatever else enters the well from a primary mechanism and the water bank will be just about at the vicinity of the No. 6 well. There will be a higher oil saturation south of it as a result of the injection and those reserves will be laying there for Continental to recover on any cooperative flood that they might engage in sometime in the future because the injection will cease in the Mobil's wells when our producing wells are gone.

Q Well, what injection rates will you have on that well offsetting Continental No. 6?

A I haven't designed that injection rate either, but speaking broadly, I'd say that it ought to be about -- let's see -- it is five hundred sixty feet from the producing well as compared with thirteen hundred twenty feet for the other injection well -- it would be somewhat less than half of the injection rate of the other injection wells in that pattern.

Q What is the other injection wells?

A Well, I don't really know what they are going to be. I haven't calculated them and my opinion is that the physical factors will control it finally. I believe probably, after a period of a few months, it will be down to the vicinity of five hundred barrels per day or perhaps less in those wells.

If that is the case, we are looking at injection rates into the well that we want to drill north of Continental's lease -- somewhere in the order of two hundred barrels a day.

Q Which wells are you talking about now, two hundred barrels a day?

A The well that we want to drill north of Continental's lease.

Q That one you are talking about, four hundred barrels in the other wells --

A I hope up to five hundred.

Q Is that the figure you had in mind when you said Continental wouldn't be watered out for fifteen years?

A Well, I know that it will take -- if everything goes according to my plan -- about fifteen years for us to flood out Well No. 26, the pattern of No. 26, just as on the average, that is the time we will take to complete the flood and I know that we are not going to inject into the line injector a sufficient volume to water out our No. 26 well which is two hundred feet closer to the injection well than Continental's well and so, yes, I think that that is where the fifteen years comes from. Whatever the design injection rate is, finally controls what the production well does. If the thing is watering out with fifty barrels a day, we will have to cut it back to twenty five.

Q As of right now, you don't know, isn't that the

truth?

A That is right, but I can speak relative.

Q Now, you testified as to the waterflood oil to be recovered by Continental.

MR. PORTER: Mr. Kellahin, we will take a ten minute break.

(Whereupon there was a short recess.)

MR. PORTER: The hearing will come to order, please.

Q Mr. Kelly, before the recess I started to ask you about this waterflood oil that you say the No. 6 well would recover. About five thousand barrels did I understand you to say?

A Yes, Sir.

Q And you just testified that you don't think that well will be watered out for approximately fifteen years?

A Well, in that range. I expect that the No.6 well of Continental's will be watered out contemporary with the watering out of No. 26 and I haven't any better estimate right now than the estimated flood life which is about fifteen years. It could be less than that.

Q Well, let's assume for a moment it is fifteen years and the well would recover five thousand barrels of waterflood oil. That comes out to about three hundred thirty three barrels a year, doesn't it?

A I will accept your arithmetic.

Q Or thirty barrels per month. Have you considered the economic limits of production?

A Yes, Sir. The economic limits that I have determined from Mobil's wells is about seventy barrels per month on primary and about one hundred fifty barrels per month after a good deal of water comes in on them.

Q Well, Continental's No. 6 well would never achieve that would it?

A It would never achieve what?

Q One hundred fifty barrels a month?

A It is conceivable that it would not. Of course, in that event there would be no harm caused to it at all.

Q If it couldn't produce, it is not condemned, is that what you are saying?

A If the well plays out and our injection into the well offsetting Continental has no influence on its productivity, why, it follows that the likelihood of any harm having been caused is very slim.

Q But you do say it has five thousand barrels of water-flood oil. This is your best estimate?

A Yes, Sir.

Q It has five thousand barrels, roughly, of primary oil?

A Yes. About the same.

Q Now, will that be recovered -- as I understood your testimony, you said five thousand barrels after injection was

started in your offsetting well.

A Yes, Sir.

Q So that primarily --

A That is five thousand barrels will be pushed to it. Of course, it depends on the pressure differentials affecting the well. If the oil comes to the well as so we have discussed that it might do so, why, in that case I would expect the No. 6 well to go ahead and produce its five thousand barrels of remaining primary, if that is a good figure, in addition to whatever is pushed to it.

Q Now, getting back to your Exhibit No. 4, in the red area I believe you testified that there was a million six hundred fifty six barrels of recoverable oil underlying that area.

A Underlying the red area. Yes, Sir.

Q You didn't mean to infer that that oil would not be recovered unless this application is approved, did you?

A I went on to estimate the amount of that oil that I think will not be recovered.

Q Well, going on over to your next exhibit -- No. 6, I believe it is -- did you testify that in the red area you recovered fifty percent?

A Yes, Sir.

Q And that is all. In other words, your flooding in the North Half of Section 25 is just not an effective flood

then, is it?

A In the North Half of Section 25.

Q That is it.

A Very slim, yes.

Q And then you say that none of the oil underlying the light green area would be recovered at all?

A Under this flood configuration Mobil wouldn't recover any of the oil underneath the green area. I think that inasmuch as I have calculated there is some nine hundred nineteen thousand barrels of recoverable oil under the red and the blue areas and the green area that won't be recovered by Mobil. I think that a good portion of that would go ahead and be pushed across the line. There would be, at the end of the flood -- I envision the green area would be highly saturated with waterflood oil and such as to accommodate nine hundred nineteen thousand barrels and however much space is required across the lease lines to accommodate oil that is what would be required. I think, without having calculated it, I'd estimate in all probability that a good amount of that nine hundred nineteen thousand barrels would probably be pushed across the lease line.

Q To whose lease?

A To the adjacent leases to the south. That would take in, in part, Texaco on the Shell Q lease, Marathon on the State McCallister lease, Continental on the State H-35 lease and Phillips on the Mobil lease.

Q Now, you say the oil will be pushed across there if you don't put these wells on injection. Is that your testimony?

A Yes, Sir. If we don't inject into the wells that we are asking for permission to inject into today and carry on our flood under the orders that we have at the present time, yes.

Q Yet you testified that if the 13 well, for example, and the 14 well offsetting Marathon to the north were put on injection, the water would not encroach but the oil will. Is this your testimony?

A I don't believe I said exactly what you say. I will try to restate what I said with respect to injection into No. 13 and 14 and 25.

Q Please do.

A So long as Marathon is not withdrawing fluids from the upper San Andres on the State McCallister lease I believe there will be very little water encroach on the Marathon lease as a result of Mobil's waterflood.

Q O. K. So long as Marathon is not withdrawing from the upper San Andres lease.

A Yes, Sir.

Q Your oil would not encroach either, would it?

A Oh, yes it would encroach to the extent that the gas saturation is substantially eliminated. Of course the oil goes in front of the water. I hope that is what happens.

That is what usually happens. That is the aim of the whole thing. The oil goes in front and resaturates the gas saturation that is ahead of the oil bank and, of course, wherever the water bank stops immediately in front of it is a very richly saturated interval and I have tried not to say where it will stop. I don't know where it will stop, but in my opinion the water will not encroach significantly onto the Marathon tract under the assumptions that I made.

Q In connection with your Exhibit No. 10 -- I don't think we need to refer to it -- you recall what it is -- you showed a high permeability area and did I understand you correctly to say that this area accounts for the early water production in offsetting wells?

A It is that interval which I understand I interpret as being responsible for the early breakthrough of water production on the producing wells -- yes, Sir. That interval and one comparable to it farther south.

Q Have you ever run an injectivity profile on any of your wells?

A Yes, Sir.

Q Did it reflect this?

A Yes. In and around the old pilot we ran a good many injection profiles and found ample quantities of water going into the interval that we could identify as being the highly porous outer permeable zone.

Q All of the oil is not produced solely from this highly permeable zone, is it?

A No, Sir. It is not.

Q Then you are actually bypassing the oil in the formation?

A Well, yes and no. It depends on when you are talking -- what stage you are talking about. The water continues to enter the lower permeability rock as it continues to enter the high permeability rock, but we have observed that by maintaining the injection the way we have controlled it that we can get enough water into the low permeability rock to push oil out of it into the producing wells to justify continuing to operate the flood. In the case of No. 10, for example, this ranges up to about seventy barrels of oil a day at the present time. No. 10 was substantially gone. It was gone before the flood was expanded in 1967 and it has come on back and we make a lot of water out of it now. I think it is coming through that streak.

Q The water is coming through the permeability streak?

A Yes, Sir, but the oil is coming too.

Q Have you made any effort to selectively inject in any of these wells?

A I don't know how to answer that question properly. We are dealing with open hole completions. Most of them are shot. It is a pretty difficult thing. I don't know of any mechanical way that you could control injection. There is

always, you know -- there are various additives that you can use that are intended to improve profiles.

Q Now, were any of these wells fraced?

A A good many of them have been fraced.

Q Could that have caused vertical fractures into the lower zone?

A I beg your pardon?

Q Could the frac job cause vertical fractures into the lower zone?

A If the lower zone was opened to the frac treatment, I suppose that it would, yes, Sir.

Q What I am getting at is, I am talking about vertical fractures connecting the upper and lower zones. Is there any possibility of that?

A Well, I have said before anything is possible, but I think that would be extremely remote to frac down two hundred feet. I think that is a very remote possibility. Besides, treatments that we use out there, when it is considered there are two hundred or four hundred feet of open hole interval open in the well, I think it is inconceivable that a frac treatment would go down another two hundred feet. There is so much rock opening in the well to suck up the fluid.

Q How many analyses have you made in relation to the fractures?

A I don't understand.

Q How many analyses have you made of the length of the fractures in the formation?

A I haven't made any analyses of the length of fractures in formations.

Q Mr. Kelly, in your direct testimony you testified that Mobil had invested a million nine hundred thousand dollars in a waterflood project. You can recover a considerable amount in that, can't you?

A We have recovered a good bit of waterflood oil, yes. I don't know right now whether the project has paid out or not. I do know the six hundred thousand dollars we have got tied up in the south flood hasn't paid out and it won't if we don't get this acreage under flood.

Q Which well?

A In this expansion that we ask for permission to go to, in the June 10th hearing.

Q Are you telling me you spent six hundred thousand dollars on this already?

A Yes, Sir.

Q When did you spend that?

A During the first half of 1970.

Q What did you do with it?

A We built a ten thousand barrel a day injection station. We put in injection lines. We converted wells.

Q Did you get approval of this Commission to convert

these?

A We filed the necessary reports to convert them. Yes, Sir. In that sense, we didn't get permission to inject into them. We obtained permission to convert the wells into injection.

Q And you have not injected them?

A We have injected into all of the wells that the Commission has given us permission to inject into.

Q But that does not include the wells offsetting Marathon and Continental, does it?

A That is correct. We don't have permission to inject into those.

Q Now, you made a suggestion that Continental spend its own money and protect itself against your flood by the installation of liners. What would be the purpose of the liners?

A The purpose that I envision of setting line in one of these open hole completions of Continental's would be to shut off the water that is entering the well from the upper San Andres and at such time as that water production becomes prohibited.

Q And that is water that you have put into it?

A Yes, Sir.

Q Mr. Kelly, one other question here. In connection with your Exhibit 5D, you have the productive history of the Bridges State well No. 57.

A Yes.

Q In the exhibit it states that it was found that the reported production from Well No. 57 in 1965 and in 1966 was substantially greater than the well test capacity in that actual production for the No. 57 had declined to the economic limit late in 1966. A re-allocation of battery production based on well tests through the period and so forth was made. To what wells did you then attribute this production?

A I don't know. I had somebody else do that for me.

Q Do you know whether that excess production reflected on Exhibit 5D is reflected in the other exhibits which are a part of your Exhibit 5?

A I am not sure I follow your question.

Q Well, you made a --

A You are asking if the excess production that was attributed to No. 57 was taken from the other wells?

Q No.

A What is your question?

Q What I mean is when you re-allocated it, is this re-allocation reflected in any other Exhibits before this Commission?

A No, Sir. In that exhibit, that plot of production for Well No. 57 represents what was reported to the Commission and it is my opinion that it was in error by the amount that I have indicated and that is an estimate, of course.

Q Is it possible that that production could have been

produced from wells shown on Exhibit 5A, B, and C?

A I don't remember which of those wells produced into which batteries and I suppose that would be a possibility. The wells are generally in the same geographical area, although I seem to remember that these wells were producing into two different batteries around the old pilot and I just don't remember whether 57 was in the same battery with the other three wells or not.

Q Well, then, to the extent that Exhibit 5D is in error, your other exhibits, 5A, B and C could be in error also?

A I don't believe I accept that. I don't.

Q You don't know where the oil comes from but it didn't come from 5D?

A It came from some place on the lease. You see, in this instance we were dealing with allocated battery production. Now, I am not quite sure right now just how Mobil allocates its production between the wells on lease in making the production reports. I know it is done on a computer and it may well be done on a lease basis in which event the production could have come from anywhere. Of course, it is supposed to be -- the well tests are supposed to be input to the computer program as they come in, but they are not always input and a high test or low test will be carried forward too long on a well and as a result its production will be reported too high or too low.

Q Mr. Kelly, I will accept your explanation how these

things occur. What I am trying to arrive at is the information you have presented to this Commission is not accurate to the extent that the production from the 5D is wrong, is that correct?

A I think the information that I presented to the Commission is correct in that I have reported to them the best testament that we can generate of the production from Well No. 57.

Q Well, could any of that production have come from your Well No. 10?

A It is possible.

Q And that is the one you said showed 40% efficiency?

A About 43.

Q So it could have been a 50 or 60% efficiency?

A Oh, no, Sir. I don't think it would even approach it. Of course, the average for the four wells was 42%. There was such close agreement between the daily generated from the four wells I was pretty well ready to accept that somewhere around 42 or 43 or 40 or 45% is correct and the reserve calculations that I made didn't utilize the 42% recovery. I used 50% recovery affording a greater reserve to Mobil than the pilot performance actually indicated which, I think, makes my figures tend to be on the conservative side.

MR. KELLAHIN: That is all. Thank you, Mr. Kelly.

MR. PORTER: Any further questions of Mr. Kelly?

You may be excused.

This concludes the testimony of the applicant?

MR. SPERLING: It does.

MR. PORTER: Now, I believe that we have an indication that we have testimony from both Continental and Marathon.

MR. LOPEZ: At this time, Mr. Porter, I believe Marathon is going to precede Continental in presenting their evidence, so if you are willing, we will just go ahead.

MR. PORTER: It is absolutely all right. It doesn't make any difference so far as we are concerned.

MR. LOPEZ: At this time I'd like to call Mr. Zeman.

PAUL ZEMAN

a witness, being duly sworn according to law, upon his oath testified as follows:

MR. PORTER: Let the record show Mr. Zeman has previously been sworn.'

MR. LOPEZ: Then I assume his records are acceptable to the Commission -- his qualifications?

MR. PORTER: Well, he was sworn earlier this morning.

DIRECT EXAMINATION

BY MR. LOPEZ:

Q Mr. Zeman, would you please state your full name?

A Paul Robert Zeman.

Q What is your occupation?

A I am District Reservoir Engineer Supervisor for

Marathon Oil Company in Midland, Texas.

Q You are familiar with the application of Mobil in Case No. 4367 and 4368?

A I am.

Q You are also familiar with the Vacuum Field in Lea County, New Mexico?

A I am.

MR. PORTER: Did you testify in a previous case?

THE WITNESS: Yes, I have, Sir.

MR. PORTER: Alright.

MR. LOPEZ: Are his qualifications acceptable?

MR. PORTER: Yes.

Q Mr. Zeman, have you prepared or had prepared under your supervision some exhibits in connection with these cases?

A I have.

Q Referring to that exhibit as Marathon Exhibit No. 1, would you please refer to it and explain to the Commission what the exhibit represents?

A Exhibit No. 1 is a portion of the Vacuum Field in Lea County, New Mexico. It covers the area of the field which is pertinent to Mobil's request for expansion of their Bridges State Waterflood. Mobil's Bridges State lease is shown bordered in green on the map. Marathon's acreage in the area is shown in yellow. Mobil's present injection wells are shown in blue as the other operators' wells. There is a few in the West

Vacuum Unit and there are some cooperative Amarada wells and Texaco has a well. This map is as of June of this year, 1970. Mobil has requested an expansion of their waterflood to include all of the southern portion of their Bridges State lease and have requested the conversion of thirteen wells to injection. The wells proposed for conversions are shown in red circles. Mobil also proposed to drill two injection wells. They have since eliminated that to one and done away with one. These wells were originally located in E25, 17, 34 and in 26, 17, 34 and are shown as red triangles on the map.

Referring to Section 25, Township 17 South, Range 34 East, Marathon is the operator of the State of New Mexico McCallister lease. Mobil's Bridges State lease offsets our acreage to the north and west. Three of Mobil's proposed injection wells directly or diagonally offset our acreage. These wells are the Bridges State No. 25, proposed conversion 660 feet west of our acreage. In I25 to the north Mobil proposed originally to drill a well three hundred thirty feet from the lease line -- our lease line. They have since scuttled that well and propose to, at some future date, convert No. 13, which is a Blinbry producer, to an injection well. Mobil's Bridges State No. 14 is a proposed conversion, is a northeast diagonal offset to our acreage. Actual Grayburg wells in here are shown in little circles around it and all the wells are shown on the map and the rest of them are just plain dots.

Marathon presently has four producing Grayburg wells on the State of New Mexico McCallister lease. Three of our wells are capable of making top allowable and one is a marginal well but still making a considerable amount of oil. These wells are wells 1, 2, 3, and 4. Marathon's wells on the McCallister lease are no where near stripper category and the acreage is not ready for waterflood.

Marathon is of the opinion that injection of water into the three offset wells offsetting our acreage may cause premature water breakthrough in our wells thereby reducing our oil productivity of the wells and the ultimate recovery from our lease.

This assumption was made on the basis of going down and picking both zones of porosity. We assumed that through this workover program that we have started and completed on this lease -- I will go into that in some detail -- that we will be able to go up into the upper section later, much later and get some oil from there.

That takes care of Exhibit No. 1.

Q Referring now -- I refer to Exhibit No. 2 which is in booklet form.

A Yes.

Q And I would ask that you commence explaining what Exhibit 2 is.

A I have here in this booklet data relating to lease

well production, production tests, well completion information and some reserve data for our McCallister lease in the Vacuum San Andres Field.

Turning to Page 1, we have four producing wells there. Our wells or lease commenced production in July 16, 1938. As of August the 1st of this year we have produced one million eight hundred forty eight thousand four hundred sixty eight barrels of oil; a little over eighteen thousand barrels of water and one million eight hundred eighty six thousand MCF of gas, approximately.

During July, 1970, our wells have produced eight thousand four hundred fifty eight barrels; less than a thousand barrels of water and a little over ten thousand MCF of gas.

Turning to Page 2, this is a lease plot of the annual oil production and the annual water production for the four wells. I have taken it from 1959, which is the year we started our deepening program in running liners on the first well. It also coincides about the time that Mobil's Bridges State started to be flooded. As you can see, in 1959, our oil, annual oil production from the lease was 46,000 barrels a year. In 1969, the oil has increased to 87,000 barrels per year and the dashed line there is anticipated 1970 production of 95,000 per year based on the first six months' production of the lease.

Our water production has been nominal since 1967 and has been real low. The maximum is around ten thousand barrels

per year.

Now, continuing on over -- before I get into the individual wells and what we have done I'd like to refer to Exhibit 3, which is a cross section, AA Prime. I will refer back to Exhibit 2 later when we go through our workover program. We can use Exhibit AA as a kind of a visual aid.

Exhibit No. 3 is a cross section AA using sonic or acoustic logs through the San Andres section of four of our deeper producers in the lease. Each of the wells that we use here is a twin to a Grayburg San Andres producer. If you look at the map in the corner here it starts with Well No. 10, McCallister State No. 10, which is a twin to the Grayburg Well No. 1. It goes over, counter clockwise, to Well No. 8 which is a twin to 3; goes north to Well No. 6 which is a well to 4 and it goes to 9 which is a twin to 2.

These deeper wells are dual completions in the Glorietta and Blinebry.

Referring to the cross section, I have marked the top of the San Andres. It comes in about -320 to 350. I have marked the top of the Lovington Sand and the base of the Lovington Sand so in effect this upper section of the San Andres is the upper San Andres section.

I have marked the base of the Lovington Sand. I have taken the estimated oil water contact of -750, based on our work in this lease of deepening the wells. As you know, down

between the Lovington Sand and the oil water contact we have come up with a body of porosity. For purposes of identification, I have called it "top of the lower massive porosity". It has got quite a bit of continuity and I think it is pretty obvious to see.

I'd like to now go back and we will discuss our workover program for Well No. 1. This Well No. 1 is the first log on your left hand side and I have superimposed on these deep wells the original completions and the deepening and the liners that we ran and I also have a porosity scale and the coloring in red is what I estimate to be net pay.

Referring to Page 3 in the booklet on Exhibit 2, our No. 1 well, which is the first well on the cross section, or the twin of 10, was completed in July, 1938 and here I want to make a comment that I have accumulative production to August 1st and after I had this thing printed up I checked and some of our computer sheets have a few bugs in it, so this number is not quite right, but for purposes of this hearing the magnitude is correct.

Cumulative production for August 1st for No. 1 well was over four hundred twenty thousand barrels. It never had any water and gas is about the same, thousand one ratio.

Listed below I have a production test for this well. On August the 3rd, 1970, the well flowed through a 18/64th inch choke, one hundred three barrels of oil and no water. September

11th, 1970, the well flowed 85.5 barrels of oil in twenty one hours at a reduced choke of 15/64th.

September the 12th, reduced the choke lower to 13/64ths inch and the well flowed eighty four barrels of oil per day and no water.

Turning to Page 4, this well was originally drilled to a total depth of 4,680 and I have that shown on the log and it was open hole from 4,083 to 4,680. There was no treatment from this interval included. Of the lower Grayburg, it flowed fifty one barrels of oil per hour or at the rate of 1,224 barrels of oil per day through a one inch choke.

Other data here, in January, 1941, the well was still flowing forty six barrels through a 19/64th inch choke.

In April, 1947, we installed our pumping unit. Before the pump installation the well pumped ten barrels per day. After the pump installation the well pumped forty barrels per day.

In 1959, September, October, 1959, we commenced our first workover. It consisted of drilling the well deeper and running a liner.

Prior to this workover the well was pumping 13.8 barrels of oil per day. The workover procedure stated here cleaned out the open hole from 4,083 to 4,680. Drilled six and one-eighth inch hole to 4,705. We set the four and one-half inch liner from 3,904 to 4,670 and cemented with a hundred

sacks. We drilled out the cement and shoe and cleaned out to 4,705 total depth.

Now, we tried to get the liner all the way to the bottom but couldn't make it so the well was producing from an open interval 4,670 to 4,705. That is shown in green. Everything up above the hole is colored in red. It is net pay. That is the upper section of the San Andres, that is behind pipe.

If you look at the curve on Page 5 you can see in 1959 we have established a pick as a result of this workover in No. 1. Production has been rather uniform from 1960 to 1964 which is just the result of a low normal unit allowable and you can see what is happening as the normal unit allowable is going up. The well still has never made any water.

Referring to Well No. 2 and that is a twin to No. 9, which is the last log on your right --

Q Excuse me, Mr. Zeman. This Well No. 2 is the well that is a good well but not making a top allowable at the present time?

A It is a marginal well but still making a considerable amount of oil. I will touch on that shortly. This well was drilled, commenced production of September 1938 and it has made over four hundred thousand barrels of oil and it has made sixteen thousand barrels of -- over sixteen thousand barrels of water and most of this water as a result of a

recent workover.

We have some production tests here. In July 2nd, 1970, the well pumped thirty four barrels - - a little over thirty four barrels of oil per day and twenty three barrels of water. On September the 9th, 1970, the well pumped about forty barrels of oil and twenty six barrels of water.

We took some pumping fluid levels by sonic measurement September the 4th, 1970. The flood level was seven hundred forty two feet over the pump. On September the 10th, 1970, it was eleven hundred seventy six feet over the pump.

The original completion in the No. 2 well was drilled to 4,700 feet and completed open hole, seven inch casing set at 4,101 and it flowed from both the Grayburg and the San Andres forty five barrels of oil per hour or at the rate of 1,080 barrels of oil per day. There was no treatment. It flowed naturally.

In January, 1941, the well on the test flowed one hundred ninety two barrels of oil per day through an 11/64th inch choke. In January, 1949, we installed our pumping unit. Before the pump was installed we produced about ten barrels of oil per day and after the pump we pumped seventy five barrels of oil per day.

In July, 1968 through August, 1968, we worked this well over the same procedure we did in the No. 1 well. We drilled it deeper, ran a liner.

I want to state here that these liner jobs, they have cost Marathon Oil Company anywhere from \$28,000 to \$42,000 apiece. We have other leases in this field that are open hole and we are going to run liners as warranted. I think next year we have two or three set up.

Going back to this No. 2 well --

MR. PORTER: How much on the No. 2 -- how much oil is that well making at the present time?

THE WITNESS: The latest was it was making about forty barrels a day pumping. We plan, looking at it in the area office, to frac this well. This thing was never fraced and they are thinking about it anyway, to try to improve the production a little bit, but we have cleaned up the whole workover procedure.

The well was making nineteen barrels of oil per day before the workover procedure. We cleaned out the hole to 4700 and we drilled to 4,788; set a four and a half inch liner and we did some perforating and that is all discussed there and the gross perforated interval is from 4,680 to 4,736. We gave a treatment of four thousand acid and it did pump on initial potential as a result of the workover seventy one barrels of oil per day; but four barrels of water, pumping twelve fifty four inch strokes per minute.

Referring to the curve, you can see we were pumping along pretty even and when we worked our well over we got a

kick. We also got a kick in the water and this well is accounting for most of the water on the lease. It has gone down. As I say, the area office is looking at working this over, fracing it, bringing the production up.

Going to the No. 3 well on Page 9, that is a twin to 8. That is the second log over from your left. This well commenced production in around December, 1938 and it has produced about four hundred eighty thousand barrels of oil; very little water -- a little over a thousand -- and I have two production tests shown for this well. On August the 2nd, 1970, the well pumped seventy barrels of oil per day, about 7/10ths water. September 1st, it pumped seventy three barrels of oil per day and about 7/10ths water.

We took our flood, our pumping flood levels by sonic measurement on September 4th. The flood level was 1,998 over the pump. September 10, 1970, we have 2,059 feet over the pump.

This well, I am sure, could produce a little more oil than seventy barrels. We have a good fluid level in it.

The well was originally --- turning to Page 10 -- the well was originally drilled to a TD of 4,690 and completed open hole from 4,081 to 4,690. No treatment. It flowed thirty eight barrels of oil per hour or at the rate of 912 barrels of oil per day.

In March, 1949, we installed a pumping unit. Prior

to pump it was making about ten barrels a day. After the pump installation it was making eighty barrels a day.

This well was drilled deeper and liner run in March and April, 1968. Prior to the production of -- prior to the workover the well pumped twenty one barrels of oil per day. Workover procedure is basically the same as all of them so far discussed. We cleaned out the open hole to 4,690; drilled to 4,786; set a liner to 4,782 and reperforated over a gross interval from 4,663 to 4,763; treated with two hundred gallons of acid -- two thousand gallons of acid -- I am sorry -- and the well pumped seventy one barrels of oil per day plus ten barrels of water per day pumping fourteen forty-four inch strokes per minutes.

Looking at the curve for this well you can see the results of our workover. In this well in 1969, which is the first full year after the workover, the well has gone from about seventeen thousand up to twenty six thousand, approximately -- very little water produced.

No. 4 well, which is the last well on the lease and is a twin to No. 6, which is the third log over on the cross section, commenced production in February, 1939. It has produced over four hundred eighty thousand barrels of oil; very little water. The gas oil ratio has a little over a thousand to one.

~~water per day. That water production has gone down somewhat,~~

Our production tests, in August 23, 1970 the well pumped 76.4 barrels of oil per day, very little water -- .8 barrels per day.

September the 6th, 1970, the well pumped 84.1 barrels of oil per day and 8/10ths barrel water.

Our sonic measurement flood level September 4th, 218 barrels over the pump; September 10th it was the same thing, 218 barrels over the pump.

The original TD on the well was 4,710. It is completed open hole from 4,099 to 4,710. No treatment.

The well flowed thirty five barrels of oil per hour or at the rate of eight hundred forty barrels of oil per day -- no water.

Other data; March, 1949 we installed our pump unit. Before pump, flowed ten barrels a day. After pump, one hundred twenty barrels oil a day.

Again, in 1969, completed in January of this year, this is the last well, we drilled the well deeper, ran a liner. Prior to our workover program the well pumped twenty one barrels a day. Again, the workover procedure was drill the well deeper to 4,780; we perforated at 4,737 to 4,747. The well was treated with two thousand gallons of acid and pumped ninety two barrels of oil per day plus twelve barrels of water per day. That water production has gone down somewhat,

the latest test shows.

Referring to the curve on the well, Page 14, you can see that the production has gone down in 1969 and the only thing I can do is forecast 1970 and we have gone from about thirteen thousand barrels a year to approximately twenty thousand barrels per day.

Q Mr. Zeman, am I to understand that this marked increase in production after your well fell off was due to your re-working the wells in the manner indicated?

A Yes.

Q How much do you estimate that it cost to re-work each one of these wells?

A Well, as I say, in the McCallister lease they run anywhere to twenty eight, twenty nine thousand and we had trouble with one and she went up over forty two, forty five thousand.

What I am showing on the cross section, as you will note, all our present production open interval is shown in green and it is all in the lower massive porosity. We do have porosity in the upper San Andres section. We have this cased off. We are looking, trying to deplete this reservoir in an orderly manner.

Our production is top allowable for all practicable purposes. We can't get any more oil because we don't recog-

nize the upper section and the lower section as two separate reservoirs.

I have just tried to discuss the capacity of our wells and I'd like to now talk a little possibly about some of the reserves.

Q Before you do, isn't it true that had you known that Mobil was going to change its application and just inject into the upper Lovington or had our count been granted you could have focused all of your attention on just the upper?

A That is right.

Turning to Page 15, I originally looked at this, all the pay is shown in red here on each of the wells. Now, in Well No. 6 we have this all the way down to oil water contact -- this includes both zones. We have two hundred seventeen feet of pay above a three percent porosity. Our average porosity was 7.7 percent and here I planimetered all this area and got a weighted average. There are streaks in here that are considerably higher, but this is a weighted average.

In No. 8 we have one hundred fifty seven feet gross, both sections of net pay at 6.3 percent porosity.

McCallister 9 had two hundred twenty one feet at 7.3 percent porosity and the McCallister Penn had one hundred forty nine feet at 5.5 percent porosity.

Now, what I have done here, I have tried to say that each of these well logs represents the forty acres that that

well is located on and I have calculated in place reserves for the total one hundred sixty acres and this came to nine million seven hundred twenty six thousand barrels of in place oil.

Now, this afternoon I had to make some readjustments, trying to break out what we have in this upper zone. Of the two hundred seventeen feet in the No. 6 well, seventy five feet is located in the upper San Andres section. In Well No. 8, fifty five feet is located in the upper San Andres section. In No. 9, sixty five feet is located in the upper section. In No. 10, forty nine feet is located in the upper section.

Now, I left the porosity approximately the same and I just proportioned out the original oil in place on the basis of my net pay and I come up with, totaling it up, that out of the 9.7 in place oil, 3.2 million is located in the upper San Andres reservoir. Now, I realize that both the upper and the lower sections were opened for a considerable time before we ran our liner job and I don't know how much oil is coming from each of these zones when in an open hole section, but if I take this 3.2 million barrels of oil that is located in the upper San Andres section and assume a solution gas drive approximately twenty five percent, I come up with a recovery from this zone of eight hundred thousand barrels approximately.

If I say fifteen percent of it has been recovered due to the open hole section, there is some left, I have a

future primary in this zone of say ten percent of three hundred twenty three barrels. This is pointed out by Mobil's testimony. They say that I can get -- you can get half a barrel for every barrel of primary on the waterflood. If the primary in the upper section is eight hundred thousand barrels, then half of it would be, for secondary, four hundred thousand. Add that to the three hundred twenty three thousand that I estimated remaining primary, we have a total volume of seven hundred thousand barrels. Now --

Q Mr. Zeman, since you indicate that there are seven hundred thousand barrels of oil and primary reserve in the upper San Andres, have you been able to estimate how long it will be before you feel that you will deplete the lower San Andres and then begin to selectively perforate the upper San Andres?

A If we can go back to the curve on Page 2 -- you can't use the decline curve -- this thing is just going up. If I started with ninety five thousand barrels of oil per annually and arbitrarily declined it at fifteen percent, I would produce another five hundred fifty thousand barrels of oil, primary oil, and it would take Marathon between seventeen and nineteen years to produce it from this lower section.

Q And that is without the benefit of any re-working or --

A That is right, and that is assuming that I am starting

to decline right next year. I don't see how that is possible, I mean, I am going to let this thing ride at say the current rate for at least a couple of years. Hopefully we might be able to bring No. 2 up if we work it over.

Q Then am I to conclude that Marathon will not be in a position to begin to deplete its primary reserves in the upper San Andres for at least fifteen years?

A At least.

Q Now, do you have anything else to offer concerning Exhibit No. 2?

A No, that takes care of Exhibit No. 2.

I would like to go to Exhibit No. 4.

Q Referring to Exhibit 4, would you please explain to the Commission what that means.

A This is a cross section, a very short cross section that goes from Mobil's State Bridges No. 58 through their No. 36, going, continuing South through their 13, which I understand now is going to be their proposed injection well in the future, and terminates in our Well No. 6, which is a twin to No. 4. What I have tried to show here is the continuity of the Bets. We have the upper San Andres, we have the top of the Lovington Sand, we have the base of the Lovington Sand and I have tried to correlate here the top of the lower massive porosity. I realize that it deteriorates as you go North from our acreage, but I still think there is porosity there. I

cannot read permeability off of the log.

Let's go to No. 58. I'd like to read stuff on each of these wells. This well was completed in April, 1940. It was drilled to a total depth of forty six hundred feet and seven inch casing was set at 4,250 feet with two hundred twenty sacks. Production was from an open hole interval from 4,250 to 4,600 feet. The well was shot with three hundred eighty quarts of nitro from 4,473 to 4,600 feet and had an initial flowing potential of two hundred eighty eight barrels of oil -- no water. They re-completed in the Glorietta in November, 1963.

Now, if you look at the caliper log you can see part of the hole. The large hole goes to the right.

Going to the second well, 36, this well was originally completed July the 9th, 1959. It was drilled to a total depth of 4,590. Casing was set at 4,220 with two hundred ten sacks and produced open hole from 4,220 to 4,590. Original completion in both these two wells I discussed was just in the upper San Andres. They didn't have any treatment listed and the well flowed three hundred seventy six barrels of oil per day. I am getting my data from scalp tickets.

In 1962, the well was drilled deeper and completed as a Blinebry San Andres dual. According to the scalp ticket I don't think the well produced too long in the San Andres.

The San Andres was perforated from 4,743 to 4,811 over a gross interval, treated twenty five hundred acid, twenty thousand sand frac and pumped six barrels of oil, forty barrels of water. This was in the lower massive porosity.

Well No. 13 is the well they plan to use for an injection well, as I understand it now, sometime in the future. This well was originally completed in October 11, 1938. TD was 4,763. Seven inch casing was set 4,200 feet with two hundred ten sacks and we were producing from an open hole interval 4,200 to 4,763. In this case both the upper San Andres and the lower massive porosity were open in the well.

They treated this well with three hundred twenty quarts of nitro from 4,390 to 4,550 and if you look at those depths on that log and you look at the caliper you can see the enlarged hole. We cannot use these logs for porosity determination because it is a sonic and it is susceptible to cycle skipping and actually is meaningless for determining any porosity zone or permeability zones.

The well was drilled deeper in January, 1963 and completed in the Blinbry formation.

In No. 6, as I have already discussed in our cross section, I contend that if they put water in No. 13 here, the upper section, they are going to be putting water on our lease and as Mr. Paxon will discuss later, this water should

get over there within a year to eighteen months and when we get in a position to, in an orderly manner, to deplete our reservoir by going up our liners and perforating these zones in the upper zones in the upper section, I contend they will be full of water.

Q Mr. Zeman, you may recall Mr. Kellahin's question of Mr. Kelly regarding shooting and if there was not a good possibility that such shooting as indicated on these logs would some how vertically fracture the Lovington Sand whereby the injection of water into the upper San Andres you couldn't assure it would not also fall into the lower San Andres.

A That is right. If they ran the liner, if they ran the casing or a liner to complete their Blinbry, I am sure I don't know how high their cement is in this well and if they got a pretty enlarged hole in the upper section, I don't know if you get a real good cement job around your casing and if you are going to have to perforate 13 in the upper section of the large hole, I don't know if you are going to get out in this formation too far.

Q Referring to exhibit marked No. 5, would you please explain what that stands for.

A Cross section CC Prime goes from Mobil Bridges No. 27 down to their Bridges State 25 which they propose to use as an injection well into their 99 which is a deep test and then he is tying back and terminating in the No. 6 well. Again I

have tried to show the continuity of the Bets in the upper San Andres, the Lovington Sand, correlated all the way across. You can see the massive section at the bottom. I'd like to discuss each of the individual wells.

No. 27, which I presume will be their producer in that proposed five spot, this well was originally completed in the San Andres in 1939. It was drilled to a total depth of 4,727. The case was seven inches, was set at 4,220 with two hundred ten sacks and was completed open hole 4,220 to 4,727. It was shot with two hundred forty quarts of nitro from 4,330 to 4,450 and if you look at the caliper log on that well it looks like they shot right above the San Andres and got the lower Grayburg and again your sonic log is chattering all over the place. You can't analyze any porosity there.

In 1962 they drilled deep to the Blinebry and this was the discovery well in the Vacuum Blinebry Field. They perforated, they dualled with the Blinebry and the San Andres perforations were from 4,743 to 4,811 which was in the lower massive at the time and that well potential, after treatment, was twenty four barrels of oil per day and forty barrels of water.

Going over to the second well, this is their proposed injection 25, I have a log shown here that only on 25, that only goes part way to the total depth that was originally

drilled, 4,750. As I understood it, this well had junk in a hole and that is why I used a twin dual Well 99.

Referring to 25 again, it was completed in February 26, 1939 to a total depth of 4,750. The casing was set at 4,200 feet with two hundred twenty sacks and producing interval was open hole from 4,200 to 4,750.

Now, I don't know when they lost the hole or part of the hole. There was no treatment and the well flowed one hundred forty barrels of oil per day.

In the September 1st, 1970 issue of the Oil Reports Mobil submitted application to drill their Bridges State No. 25 by setting a whipstock and drilling around the junk in the hole to the old TD of 4,750.

Again, if they drilled it down to 4,750 they would have penetrated the lower massive porosity in which we are producing now.

I used the No. 99 well just to try to evaluate the part of the No. 25 well that was junked.

Q Mr. Zeman, is it your opinion that had they not changed their minds and proceeded with the project we thought they were up to this morning, that they would probably have an oil well if they did whipstock and take No. 25 back to 4,750?

A I think they have a good possibility.

I have tried to show the continuity of the upper

Bets and you can kind of correlate the porosity. Now, I have no way of knowing what the permeability is there. This is a Dolomite reservoir and very heterogenous and comes and goes. I presume in our acreage it might be somewhat better in the multiples but if they start putting water in there and you have any kind of permeability streaks, whether it is one in the upper part or one in the middle part or the upper zone -- I don't know how many permeability streaks there are there -- the only thing I'm saying if they put water and as Mr. Paxon will show later on, you do have some premature water breakthrough and we can't benefit at the present time from any increase in allowable -- we have spent considerable amount of money to keep our wells on top production -- we have our wells in such a situation that we can deplete this reservoir in an orderly manner -- I have stated we have anywhere from fifteen to twenty years in the lower section. We are going -- as we go out, we are going to try everything that looks like porosity and I feel before it is all said and done, this reservoir, it will probably be Two Thousand Twenty Five before they abandon it. It is one of the better fields in the State of New Mexico.

Q Do you have anything further to add, Mr. Zeman?

A No, Sir.

Q Mr. Zeman, did Mobil ever contact you or indicate in any fashion that they were changing their approach and only

going to inject in the upper San Andres, before this morning?

A No, Sir. I never had any contact with Mobil on any part of this hearing.

MR. LOPEZ: Mr. Examiner, or if the Commission please, I would like to offer Marathon's exhibits 1 through 6 into evidence. However, I would also indulge the Commission's permission to have Mr. Zeman modify the last page on Exhibit No. 2 to reflect his rapid calculations as to the reserves, the figures that would be self evident regarding the reserves in the upper San Andres.

MR. PORTER: The last page, on Page 15 of Exhibit 2.

MR. LOPEZ: Right. Where the calculations there are made for both the upper and the lower San Andres -- what he has done is right next to the net pay, the first column, made calculations as to the amount of pay in the upper San Andres and then taking one half of the average porosity he has come out with calculations that resemble that of both and the lower San Andres but apply only to the upper San Andres and he has already testified to those and, if you don't mind, I think it would be helpful if they were included in the original exhibit.

MR. PORTER: Are there any objections to the admission of these exhibits with the corrections being made in Exhibit No. 2?

The exhibits will be admitted into evidence.

We had a discussion, as I recall it, now, 1 through 13 with all of the parts of the various ones --

MR. SPERLING: Yes. I recall making a reference to the numerical and alphabetical parts.

MR. PORTER: Alright. Would you like to have these exhibits to make these changes and corrections on our copies of Exhibit 2?

THE WITNESS: Alright. I will make those corrections later this afternoon and return them to you.

MR. LOPEZ: That concludes our case.

MR. PORTER: Mr. Sperling, do you have some questions?

MR. SPERLING: I have some on cross examination.

CROSS-EXAMINATION

BY MR. SPERLING:

Q Mr. Zeman, it is evident from the exhibits that you have introduced here and discussed that you concur in Mobil's opinion that there are two zones of porosity within what is designated as the San Andres formation?

A Oh, yes.

Q And you apparently concur in the conclusion that the two zones of porosity are separated by the Lovington Sand, is that correct?

A That is right.

Q What is the character of the rock other than the

Lovington Sand which separates the two porosity intervals?

A What is the character of the rock?

Q Yes. What is the nature of it -- is it Dolomite?

A Well, there is streaks of probably shaliness in the Dolomite. I have tried to show what I think is the porosity.

Q Do you consider this interval including the Lovington Sand to be impervious?

A I really don't know.

Q Well, are rocks of the character that you have described generally to be impervious -- is Dolomite and shale stringers, sand stringers --

A I think that the Lovington Sand will probably be tight and be a seal.

Q How do you reach the conclusion that with your Marathon wells having been re-completed with liners so that the upper San Andres is isolated from the lower San Andres that injection of water into the upper San Andres is going to affect the upper San Andres in the vicinity of your wells?

A Well, I believe that there is all kinds of production still open hole. We are one of the few people that have liners in the wells. There is all kind of production offsetting this to the South and East that are producing from both zones, still causing a sink and having a pressure gradient across the whole field. I will admit part of the upper might be depleted be-

cause it has been open for a good many years and it will probably be lower pressure than the water you are going to inject and you are going to have a gradient from high to low and you are going to have movement from high to low.

Q Have you made any investigation to substantiate that conclusion?

A I haven't done this. I leave this to our waterflood expert that is going to testify, Mr. Paxon, the next witness.

Q Well, I take it, Mr. Zeman, in your testimony you did not mean to imply that injection of water into the upper San Andres at this time that your wells, as complete as they are, would adversely affect your lower San Andres production, would it?

A No, but --

Q You didn't mean to imply that, did you?

A No, no. I am implying that at some later date when we go up in an orderly manner to deplete this reservoir by testing all these porosity zones or what looks like porosity on a log, that if we get up there, it will be full of water.

Q What do you base that conclusion on, which gets back to the question that I asked before?

A Because we are going to be down there lower zone for at least fifteen to sixteen years and your waterflood will be long gone by then.

Q Well, you don't intend to open the upper San Andres for seventeen or eighteen years?

A Not if we are making top allowable.

Q But you conclude that even if the upper zone is not open during that interval in time, that by the time that you do get around to it, in seventeen or eighteen years, you are going to be flooded out, is that right?

A That is right.

Q What do you base that on?

A If you put this water in, you are going to be -- if you convert this injection, you are going to be putting water in -- we have no control over what you are -- how much water you are going to be putting in there.

Q Do you feel Mobil has a right to recover by secondary methods the upper San Andres production underlying its acreage to the West and North?

A If they can do it without adversely affecting us.

MR. SPERLING: That is all.

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

CROSS-EXAMINATION

BY MR. MCADAMS:

Q I was looking at this cross section here of your AA Prime and you show some interval between the bottom of

Lovington Sand and the top of what you call the lower massive porosity. Now, in the log of the McCallister State No. 6 well you show this lower porosity colored in red.

A Yes.

Q And you show other portions of this porosity extending on up to almost the base of the Lovington Sand.

A Yes.

Q Now, move back over to the McCallister State No. 8 just to the left of that cross section.

A Yes.

Q Now, you show these red porosity zones going almost up and touching the base of the Lovington Sand, is that right?

A Yes.

Q Is there communication, vertical communication between those portions?

A Communication between the upper sets here?

Q Where you show the red markings at the base of the Lovington Well No. 8?

A I think we'd have to go up and perforate to get it.

Q I am not talking about that. I am talking about in your opinion is there vertical communication between those two?

A Between the --

Q Between that portion of porosity you show at the base of the Lovington down to the --

A I don't know.

Q O. K., in Well 25 of Mobil's, on cross section CC Prime, at what interval did they shoot that well with nitro?

A In 25?

Q Yes.

A They didn't. They didn't treat that with nitro. They didn't, that is, not as far as the scalp ticket is concerned. They don't have -- this is a gamma ray neutron -- there is no log on there.

Q What is the lowest depth of the Mobil wells that have been shot with nitro -- what is the lowest depth at which that explosion occurred or the hole is located or shown on the caliper log?

A On which well?

Q The ones that you are familiar with?

A Well, the only ones that I am really familiar with are the ones on the cross section.

Q Look at them and tell me which ones.

A Well No. 27 was never shot. It looks like it was shot in the lower Grayburg. Now, going on to cross section BB prime, the bottom section shot in No. 27 -- I am sorry -- 58, rather, was 4,600 feet. Although the original completion in No. 36 showed it to have no treatment, I looked at the caliper log and the sonic skipping there in the caliper log,

it looks like somebody shot it at maybe a later date. I don't know, but the bottom of the hole there is about 4,520, approximately.

Coming over to Well No. 13, the bottom of the hole shot was 4,550. That is about where the top of the Lovington Sand is. You can see the bow.

MR. MCADAMS: That is all.

MR. PORTER: Any further questions of this witness?

CROSS-EXAMINATION

BY MR. KALLAHIN:

Q Mr. Zeman, did I understand you to say that the upper San Andres had been opened in your No. 4 well prior to running the liner or running a liner?

A All our wells were open in the upper.

Q Have you any idea what the present pressures would be in that zone?

A No, Sir. I do not. I think they have taken pressures there and I think it is down to about seven -- I think the pressure was originally a little over sixteen hundred pounds and it is down anywhere from six hundred fifty to seven hundred pounds and some of the flowing wells to the South, some of our flowing wells to the South, this Lovington Sand deteriorates and the whole formation becomes one. This starts deteriorating to the South about a mile and a half South of

our lease. The whole reservoir becomes one.

Q You couldn't give us an estimate, though, of the pressure at your No. 4 well?

A No, Sir. I think our No. 1 well a couple years ago was seven hundred fifteen pounds or fifty pounds and that was from the lower zone.

Q Would you consider the bottom hole pressure at your No. 4 well site to be low enough that it would be affected by a bottom hole injection pressure of approximately thirty eight hundred pounds?

A Oh, yes. Oh, yes.

Q And the fact that an offsetting well to the West was being produced, would that prevent water encroachment to your No. 4 well?

A I'd rather, if you would, leave that to Mr. Paxon. He is our waterflood expert and he will testify after me.

MR. KALLAHIN: Thank you. That is all.

MR. PORTER: Any further questions?

RE-DIRECT EXAMINATION

BY MR. LOPEZ:

Q Referring to Mobil's Exhibit No. 8, I believe -- perhaps it is later on -- the isopach map --

A Yes.

Q (Continuing) -- are the indications on that isopach

map concerning Marathon's acreage correct?

A This is 6. They have eight feet of upper porosity for the No. 6 well and I come up with seventy five. They have thirty five, I believe, for 8 and I have fifty five. 9, they have fifty five and I have sixty five. In No.1 they don't have anything listed. So far as I am concerned I have forty nine and then the fifty line goes through 1, so --

MR. LOPEZ: Fine. No more questions.

RE-CROSS EXAMINATION

BY MR. SPERLING:

Q That prompts one more for me. You testified previously that your cut off porosity for the purposes of your calculations was 3%?

A Yes, Sir.

Q Alright, and do you recall Mr. Kelly's testimony to the effect that his cut off was 5%?

A He stated that. Yes, Sir.

Q Well, you stated that yours was 3%?

A Yes.

Q Do you have any reason to question it?

A Question the 5 or the 3?

Q Either.

A No.

Q Could that account for some of the variations that

you have just pointed out?

A Not too much, I don't think, because you have a sharp break and if you have a sharp break on that thing, it pops out there pretty fast and you are not going to lose too much, if you look on the colored AA Section, Exhibit 3.

MR. SPERLING: That is all.

MR. PORTER: Any further questions?

(Off the record)

(Whereupon there was a discussion off the record.)

MR. PORTER: We will adjourn. We will recess the hearing until 8:30 in the morning. We'd like to get started as early as possible and conclude the hearing.

(Whereupon the hearing was adjourned.)

STATE OF NEW MEXICO    )  
                                  )  
COUNTY OF BERNALILLO    )

I, Peter A. Lumia, Certified Shorthand Reporter, in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached transcript of hearing before the New Mexico Oil Conservation Commission was reported by me; and that the same is a true and correct record of the said proceeding, to the best of my knowledge, skill and ability.

  
\_\_\_\_\_  
Peter A. Lumia, C.S.R.

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