EXAMINER HEARING
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
April 9, 1958

IN THE MATTER OF: Case No. 1356

TRANSCRIPT OF PROCEEDINGS

DEARNLEY - MEIER & ASSOCIATES
INCORPORATED
GENERAL LAW REPORTERS
ALBUQUERQUE, NEW MEXICO
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NEW MEXICO OIL CONSERVATION COMMISSION

Mabry Hall

Santa Fe, NEW MEXICO

1356

REGISTER

HEARING DATE Examiner April 9, 1958 TIME: 9:00 a.m.

NAME:	REPRESENTING:	LOCATION:
Jason Kellahin	Kellahin & Fox	Santa Fe, N. M.
Kenneth McPeters	John M. Kelly	Hobbs N. Mex
John Hampton	Great Western Drlg	Midland
Jean H. Snoddy	Great Western Drlg	Midland Tex
A. L. Jacobsen	J. Lee Lee Co	Farmington. N M
Larry O'Kempton	Shell Oil Co.	" "
O. Seth	Seth & Morton	Santa Fe
H. N. Wadd	The Texas Co.	Ft. Worth
V. T. Lyon	CONTINENTAL OIL CO	EUNICE, N. M.
Warren W. Mankin	Aztec Oil & Gas Co.	Dallas, Texas
Ernest Carlin	Derek Taylor	— "
J. H. Daughman	" "	" "
R. M. Anderson	Sinclair	Midland
G. J. Savage	Gulf	Roswell
J. H. Hoover	"	"
W. V. Hackler	"	"
Eugene H. Dobbs	Austin Oil Expl. Co. INC.	Houston, Tex
Nancy Boyd	OCC Stenographer	Santa Fe

NEW MEXICO OIL CONSERVATION COMMISSION

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Santa Fe, NEW MEXICO

REGISTER

HEARING DATE Examiner April 9, 1958 TIME: 9:00 a.m.

NAME:	REPRESENTING:	LOCATION:
Horace N. Burton	Sinclair Oil & Gas Co.	Midland, Texas
W E Bondurant Jr.	Amstad Oil Exploration Co	Roswell, N.M.
F. L. Morgan	Phillips Petroleum Co.	Hobbs, N.M.
Weldon D. Casper	Fluid Packed Pump Co	Midland, Texas

EXAMINER HEARING
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
April 9, 1958

IN THE MATTER OF:

Application of Cities Service Oil Company for an order amending Order No. R-1128. Applicant, in the above-styled cause, seeks an order amending Order No. R-1128 to authorize the transfer of allowable from water injection wells to other wells on the same basic lease, to establish a lease allowable for the applicant's Government "B" Lease, and to authorize administrative approval for additions to, or deletions from the pilot area and/or injection wells. Case 1356

BEFORE: Elvis A. Utz, Examiner

TRANSCRIPT OF PROCEEDINGS

MR. UTZ: The next case on the docket will be Case 1356.

MR. PAYNE: Case 1356: Application of Cities Service Oil Company for an order amending Order No. R-1128.

MR. BRATTON: If the Examiner please, my name is Howard Bratton, Hervey, Dow and Hinkle, Roswell, New Mexico, representing Cities Service Oil Company. I would like to make a brief statement to the Examiner before presenting our case. Under date of February 12, 1958, the Commission issued its Order No. R-1128 in Case 1356, which authorized Cities Service Oil Company to inject water into four specified wells on its Government "B" Lease in the Caprock-Queen Pool. The order also carried the proviso that the injection of water shall be so regulated that the production

of wells affected by the injection project can be prorated without causing waste. In that Order, the Commission made certain findings. I won't read all of them, but I believe that I will mention a few of them for the purposes of laying the predicate for the testimony we are going to present today. The Commission found, among other things, that the production of oil from the wells on the subject area had not declined to the point where additional oil may be recovered only by water flooding or by other secondary recovery methods; and that the subject area may be said to be in the primary recovery stage.

It further found that the injection of water at the present time into the Queen Formation of the Caprock-Queen Pool through the four wells described above may stimulate the primary recovery of oil in the immediate area of the injection wells, but that the proposed program is not, however, a water flood project for purposes of secondary recovery as that term is generally understood. It is further found that the production from the wells which might be affected by the proposed injection program could be curtailed without causing waste, provided the rate of injection is regulated. Further, that the applicant should so regulate the injection of water.

Based upon that, the Commission ordered that water could be injected into the wells, provided that the applicant should regulate the injection of water into the wells so that the production from the wells affected by the injection project can be prorated

without causing waste. At the time the application was filed, it did not include a request for a consideration of the allowable to be granted to the injection wells or the affected wells; and therefore, that question was outside the scope of the prior hearing. We have now raised that question in our application in this hearing. We realize that the Commission has problems in connection with the allowable production from water flood projects, and I am sure that the Commission realizes that we have serious problems. I am sure the Commission realizes that if the present order were to remain in effect throughout the life of the flood, the flood could just never come into being. I'm sure that the Commission realizes that at some time there would have to be a consideration of the allowable to be granted to this flood, this pilot flood project.

Now, we believe we will be able to introduce evidence to show that the time is ripe for the consideration of the allowable to be granted to this pilot project. We believe further that we'll be able to go into a matter which caused the Commission some concern and which was reflected in its order. That was the matter that the Commission apparently was concerned about, its feeling that the area was not in a marginal or stripper state of production. We believe that we will be able to show that by the time the flood is effective and stimulation is achieved, that the area will be in a marginal or stripper state of production.

We believe further that regardless of whether you consider the area to be in this stripper stage of production or whether it

is somewhat above the stripper stage of production, that the plan for an allowable which we have requested in our application is reasonable and practical and fair under the circumstances.

We believe further that we can show that there will be greater ultimate recovery of oil under this area, or from this area if we are permitted to proceed with our project now, our pilot project.

For that reason, we have requested the following: The transfer of the full unit allowable from water injection wells to other wells on the Government "B" Lease. We further requested the establishment of a lease allowable to be the multiple of the top unit allowable and the total number of wells on the lease, such allowable to be produced in any proportion from the wells on the lease; and we further requested the authorization by administrative approval without notice and hearing for additions to or deletions from the pilot area and/or injection wells.

We have two witnesses, Mr. Motter and Mr. Funk, and I ask that they be sworn, now, please.

MR. UTZ: Are there any other appearances to be made in this case?. If not, we will proceed.

(Witnesses sworn.)

MR. BRATTON: Before we begin, I would like to ask that the transcript of the first proceedings in Case 1356 be made a part of this record. I presume they would be, since it is still under the case number.

MR. UTZ: It will be made a part of this record.

E. F. MOTTER

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

DIRECT EXAMINATION

By MR. BRATTON:

Q State your name, please.

A E. F. Motter.

Q By whom are you employed?

A Cities Service Oil Company, Hobbs, New Mexico.

Q In what capacity?

A Division Engineer.

Q Have you previously testified before this Commission?

A Yes, I have, on numerous times and also in the previous case.

Q The Caprock-Queen Pool is still directly under your supervision?

A Yes, it is.

Q You are familiar with Order No. R-1128 and with the application which has been filed in this case?

A Yes, I certainly am.

Q Mr. Motter, you have on the board what has been marked Applicant's Exhibit 1-A. Will you identify that and explain to the Commission what it shows?

A This is an area plat involving the Government "B" Lease;

actually it is one of the same exhibits we used previously. This shows the four injection wells, Government "B"-5, "B"-6, "B"-10, and "B"-14. The injection wells are all circled in red. These injection wells correspond to the injection program set up by Graridge, it follows the same pattern as their injection wells.

Q Mr. Motter, in your opinion under the provisions of Order R-1128, would it be feasible and practical for your company to now commence its authorized water injection project?

A No, sir, it would not.

Q Why?

A Well, the first place, it provides that the rate of water injection shall be so regulated that stimulated wells can be produced and prorated without causing waste. I believe in order to prevent waste, the stimulated wells should be produced at capacity. The amount they are stimulated, however, depends on the amount of water injected, and so their productivity can be controlled within certain limits. It's my opinion that there is a rare cases, or exceptions that producing wells in a flood will not be damaged by curtailment of oil production after stimulation. Water flooding increases formation pressures locally, so that oil will very likely be bypassed if not removed at the producing well as it's being swept toward that well.

Q Does the present order state to what extent a well should be prorated in this area?

A No, sir. There is a finding in the order which states that

no well shall receive a disproportionate share of the market demand for oil when production of oil from such well can be curtailed without waste.

Q The order as written restricts every stimulated well to the top per well allowable fixed for the pool?

A That is my understanding of the order.

Q Turning to your plat, Exhibit 1-A there, the five-spot well in the middle, I believe that's Well No. 8?

A That is our Government B-8, yes.

Q That is the well that would receive the most stimulation from the project?

A In all normal aspects, it would.

Q What is the current daily allowable of that well?

A Right now thirty-one barrels a day is the current daily allowable.

Q The allowable for the Caprock Pool is 33 barrels?

A Yes, that is the normal unit allowable for April for wells of this depth.

Q So that as the order is now written, if that well was now being stimulated, its daily allowable would be increased by two barrels?

A That is correct.

Q What is the current combined daily allowable of the four injection wells which you have marked in red?

A Their current allowable is 67 barrels per day.

Q So that allowable would be lost if these wells were converted to injection wells?

A Yes, it would, under this order.

Q Do you think that the injection rate could be controlled to the extent that a producing well would only be stimulated by one barrel or ten barrels or fifty barrels?

A No, sir, I don't believe it can be controlled that close.

Q Could your company justify the initiation of the water flood project under these conditions, even if it were to result in some additional recovery of oil?

A No, to start this flood we estimate it's going to cost approximately $160,000.00, the money that was budgeted for this project was the same as if it came out to drill new wells, so the expenditure would not have been authorized unless we could show that it would pay out.

Q In order to alleviate this situation, would you recommend that each injection well be created with a full unit allowable, which in turn would be assigned to other wells on the lease?

A Yes, I would. The transfer of allowables is an established and sound practice in the industry. It has been done in New Mexico, as well as other states having a market demand to control production. They are operational wells, all capable of producing, and only if taken off production in the interest of greater ultimate recovery.

Q Why would you recommend the transfer of the top unit allowable rather than the current allowable of these wells?

A Well, currently they are in the same category as other producing wells on the lease. When stimulation begins, the other wells will have increased allowables, and the wells causing that stimulation, we feel, should have the same consideration. Under a different flooding pattern, for instance, if we shifted this over one row of wells, those particular wells would become producing wells and would be stimulated. In our mind there should be no differentiation between the wells.

Q Mr. Motter, the second amendment that you have recommended is the request for the establishment of a lease allowable to be the multiple of the top unit allowable and the total number of wells on the lease, that allowable to be produced in any proportion from the wells on the lease. Now, do you recommend that amendment to the Commission?

A Yes, I do.

Q What are your reasons for that recommendation?

A This in effect puts the top lease allowable on the controlled water flood; on the Government "B" we have twenty-four wells, the current normal unit allowable for April is 33 barrels, so this would establish an allowable of 792 barrels for the entire lease. This serves a dual purpose, in the first place, assuming the flood is successful, it can be justified from economic standpoint and secondly, it prevents waste.

Q You said that it would prevent waste. Will you amplify that statement, please?

A Well, as I previously testified, in my opinion a well stimulated in production by water injection could not be curtailed in production without a resultant waste. It would be a bypassing of oil, if we could not take the oil out as it is being swept to the producing well. Under our proposed amendment this well would produce at capacity under the controlled injection program.

Q I believe in the previous hearing you testified that the injection rate would be 400 barrels per injection well per day?

A Yes.

Q Now, is there a possibility that there would be insufficient allowable under your proposal to produce the stimulated wells to capacity?

A Well, of course, there is always that possibility, but right now this is the most feasible plan, in our opinion, that can be started at this time. By controlled expansion we believe that we can avoid this difficulty.

Q Now, if there is some possibility of that, why not start your flood at an injection rate of less than 400 barrels a day?

A Well, as I testified previously, we believe that there is between eight and ten feet of sand in this area, and since this is an 80-acre pattern, that gives us approximately the 400 barrels, gives us approximately one-half barrel per acre foot injection. We consider this is a minimum for efficient flooding. This has been based on experience on numerous floods that the company operates throughout different areas of the country. Normally we try to

operate our floods somewhere between a half a barrel and one barrel per acre foot per day. The best results are possibly with the higher injection rates, but frequently the rate is not possible because of mechanical difficulties and other unforseen items that occur.

Q This would be a half a barrel per day per acre foot?

A That is correct.

Q What would happen if you used a lower rate than the half barrel?

A Of course, there are some cases that apparently a low rate is just as effective as a high rate, but there is still more cases where the higher rates are more effective. At low rates water seems to separate vertically in the formation, and might possibly flow through a depleted vein in the formation, so that there is absolutely no stimulation to a producing well. I believe that the exhibits presented by Sinclair in the Graridge hearing last October on their Browning Unit up in Kansas more or less bore this fact out.

Q Mr. Motter, in your opinion would the adoption of these two amendments which you are proposing result in giving these wells a disproportionate share of the market?

A No, sir, because we are asking to produce from the lease its proportionate share of the pool's reserves. Most certainly there are certain wells on the lease that will produce somewhat greater, some wells will produce somewhat lower, but on an average we feel that this is justified because an overall basis, this will

not be a disproportionate share.

Q So that you believe as a producer of this lease you would be producing your reasonable share?

A That is correct.

Q Do you believe that these proposed amendments would have any adverse effect on the other operators in the pool?

A No, I do not.

Q I believe you stated that both of the proposals which have been made in the application are in useage in New Mexico and elsewhere?

A Yes, that is correct.

Q Now I believe you stated that the reason we're requesting the adoption of these proposed amendments is in order to immediately begin flooding operations?

A That is correct.

Q Would one of these reasons for immediate commencement be the current status of our property?

A Yes, it would.

Q I believe you have an Exhibit 2-A. Would you distribute that and explain it?

A Exhibit 2-A is a data sheet on the Government "B" lease and also one well on the State "AN" Lease, this No. 1 well right over here.

MR. COOLEY: Where is that?

A That is the No. 1 well on the State "AN" Lease.

Q Describe that by subdivision.

A Yes. That is located in the southwest southwest of Section 2, Township 14 South, Range 31 East.

This data sheet shows the completion date of the well; the original potential, whether it was potential by flowing or pumping means; the date of the latest test, twenty-four hour test, which is all oil, we produced, no water on the lease; the current allowable assigned by the Commission; the cumulative production to April 1st, 1958; and most recent bottom-hole pressures we have obtained. I might point out that during this month of April we have tested all wells which will either be injection wells or which we believe will be affected by this flood, and of course some of the other tests were run at the last GOR test period as set up by the Commission.

Q But you do have tests on all injection wells and all wells that you believe will be affected by the flood, the current tests in April?

A Yes, they have all been taken since April 1st.

Q Will you refer to Exhibit 3-A?

A Well, Exhibit 3-A is a production curve on the Government "B" Lease. It is average daily oil production since we started drilling there in 1954, and I would like to point out that we have a very well established decline curve on this lease now. We have extrapolated that curve for some, oh, possibly two years. I think it is very definite by this trend that this lease is rapidly approaching what you might consider stripper stage. In other words,

we have made two assumptions on this curve, that if everything goes as we think it will in our construction, we hope to begin to put water in sometime in June, and basing evidence on the results of the Graridge flood, we expect stimulation four months later. You will notice at that time when stimulation occurs the lease production will probably be slightly below 220 barrels per day for the 24 wells which will be somewhere in the neighborhood of eight or nine barrels per well per day. Further extrapolation of the curve indicates that sometime late in 1959, this will probably be clear down to as low as four or five barrels per day.

One thing I would like to point out, based upon our results of these curves and some more data which we have had since the last hearing. I testified previously that we estimated 22.2 percent of the oil in the reservoir would be produced by primary means. That was taken from a material balance equation, and as everybody knows that is all that we usually have to work with until we do have decline curve. This decline curve, by extrapolating it on down to where we believe there will be no more primary recovery, indicates that there will be 18.1 percent of primary oil recovered, rather than the 22.2 as I stated previously.

Q Those two exhibits show that the lease is certainly beyond the flush stage of production right now?

A In my mind, they certainly do.

Q The earliest possible date that you could ancipate stimulation, it would be considerably further reduced and would probably

be below ten barrels per day average?

A Yes, I testified eight to nine barrels.

Q What's the current picture on recovery, and what do you anticipate?

A Well, as of April 1st, 1958, we estimate that we have recovered fifteen and a half percent of the oil in place. According to our calculations, we believe we can recover another 2.6 percent by primary means. At the end of this extrapolated eight-month period where we expect to get response from the flood, there will remain 1.7 percent of recoverable primary oil in place. Our estimate on additional water flood is 25.6 percent.

Q You said that you had made certain assumptions, actually those are very realistic assumptions, aren't they, Mr. Motter?

A To be honest with you, this is one of the best decline curves I have ever worked with on a field of this type. I think this is a very good picture of what is going to happen up there.

Q Mr. Motter, is there any other method, other than water flooding, by which the productivity of these wells could be stimulated?

A Yes, they can be fracked. We have fracked one well with very good results.

Q Would you recommend fracking the remaining wells on the lease?

A No, I have recommended against it, because in my opinion it is a needless expense if the person is expecting to water flood

the field. There could be special cases where fracking would actually be detrimental to the flood, by causing premature water breakthrough.

Q Which would result in lost oil and waste?

A That is correct.

Q If water flood operations are commenced now rather than delayed until such time as the lease has reached a truly marginal or abandonment status, do you believe that the ultimate recovery of oil from the property would be greater?

A Yes, I certainly do, formation volume factor would be one thing, the water-oil viscosity relationship is another. There are certain other factors that indicate that by starting now when the pressure is somewhat higher than if the field were entirely depleted, or the particular lease, we would actually recover more oil than by depleting down to an absolute stripper stage.

Q Any other reasons which would make the immediate commencement of flood operations desirable?

A Yes. If we can get the recoverable oil out of the ground faster, we will naturally reduce our cost by maintenance, lifting costs, and other such costs that may not be foreseen right now.

Q Mr. Motter, I believe you have already testified concerning your water supply?

A Yes, I've testified at the previous hearing that we have purchased a commercial water lease. We have two wells available on there which will give us more than adequate amount to start this

flood.

Q Mr. Motter, are you familiar with the definition of secondary recovery as found in the definitions of the Rules of the Oil Conservation Commission?

A Yes, I am. I would like to read that. It's on page 5, item 56. "Secondary Recovery shall mean a method of recovering quantities of oil or gas from a reservoir which quantities would not be recoverable by ordinary primary depletion methods."

Q Now in your opinion does the flood which you are proposing come within the bounds of that definition?

A Yes, it certainly does.

Q Mr. Motter, are you familiar with the definition of pressure maintenance which is definition 48, which states that: "Pressure Maintenance shall mean the injection of gas or other fluid into a reservoir, either to maintain the existing pressure in such reservoir or to retard the natural decline in the reservoir pressure."?

A Yes.

Q In your opinion does the flood proposal which you are making come within the bounds of that definition?

A No, sir, because we hope to actually increase the pressure in the formation when we start injecting water.

Q Mr. Motter, have you investigated other water floods in the Caprock-Queen Pool?

A Yes, I have.

Q What information have you used for that study?

A Well, principally, most of the data that I used in preparing this next curve came from forms filed with the Commission. This is on a Graridge Unit water flood that is --

Q (Interrupting) You are referring to Applicant's Exhibit 4-A?

A Yes, that is correct.

Q Will you explain what that exhibit shows?

A This is a graphic exhibit on Graridge Unit water flood in the north portion of this Caprock-Queen Pool. We have a small insert down here in the right-hand portion of the exhibit that indicates the injection wells are encircled or in squares in green. The wells which are being affected are circled with red, the bottom curve is the production history of that--I should say of those particular wells that I have either circled or in green. Actually up to the time of the water injection, this included production of the injection wells. The water injection was started in April, 1957, which we show, and the first response was in August of 1957. Currently their average daily production is about 920 barrels per day, and their current average injection of water is 200 -- excuse me, 2,000 and about 50 barrels per day, or slightly over 350 barrels per injection well.

Q Now, what is the purpose of that exhibit with relation to this application?

A Well, one thing I wanted to show, referring back to Exhibit 3-A, that's where we arrived at the four months period for the

response to the flood. Another thing, this is the same reservoir that we anticipate flooding, and we think that it has all the chances of operating quite satisfactorily.

Q At approximately a similar experience as far as injection and producing relationship or ratios?

A Yes, I believe that is about what we can expect.

Q Mr. Motter, in connection, I forgot to ask you, in connection with the definition of secondary recovery and pressure maintenance, would you anticipate that as soon as you have received stimulation in these wells that you would actually be recovering what would be considered to be secondary recovery oil?

A Yes, I believe it would be, because it certainly would have to be thrust over there by the water. Any increase of the production would have to come from the natural response to that water injection.

Q Do you have anything further in connection with that exhibit, Mr. Motter?

A No, I believe not. I think it's pretty self-explanatory. It's merely a compilation of data that's available in the Commission records.

Q The third amendment to Order R-1128 is for authorization by administrative approval without notice or hearing for additions to or deletions from the pilot area and/or injection wells. Will you explain to the Commission your reasons for this request?

A Well, I think I testified previously there is a uniform flooding pattern that has already been established by other operators,

and this pilot that we propose falls in line with that established pattern. Referring again to Exhibit 4-A, the feasibility of flooding is, certainly it looks like it is going to work in the Caprock-Queen Pool. We feel that as water flood progresses, any offsetting wells that might be stimulated should immediately have the benefit of an increased allowable. The time element involved from the time the application is filed with the Commission to the time of the order could only result in the loss of some production. This affects other owners and royalty owners that might be involved. The restriction imposed on the Government "B" could be carried over into other leases. As far as the Government "B" is concerned, it would be better to operate it smoothly rather than spasmodically, than having to wait for an order to come out when we could increase the flood.

Q Mr. Motter, you have testified that it would be at least eight months before you expect to receive stimulation. Now you don't recommend that you be granted full lease allowables now or a full lease allowable now, do you?

A No, sir. If we could start water in the ground in, say four months, I feel that we could keep the Commission informed possibly by letter as to what our expectations are for any increased oil which we might receive, and in turn they could possibly give us an allowable up to the time that we reach whatever this allowable is that we are asking for.

Q In other words, you recommend that the allowable be authorized

now, but that it not be granted except upon this periodic advice which you would furnish to the Commission?

A Yes. As the oil increases, there will be no need for them to actually give us the full unit allowables we have asked for, it could be done whenever we would so predict.

Q But if granted now, you would be in a position to plan and put into effect a planned and controlled flood?

A Oh, we most certainly could. Right now, we actually have no idea what we could put in the ground. It is something we must know before we start actually injecting water.

Q Do you have anything further that you would like to state at this time, Mr. Motter?

A No, I believe not. I think possibly Mr. Funk will cover some other aspects of the case.

Q The Exhibits 1-A through 4-A which have been introduced have been prepared under your supervision or by you?

A Yes, they have been.

MR. BRATTON: We ask that the exhibits be introduced in evidence, Exhibits 1-A through 4-A.

MR. UTZ: Any objection to the introduction of Exhibits 1-A through 4-A? They will be accepted.

MR. BRATTON: We have no further direct at this time.

MR. UTZ: Are there questions of the witness? Mr. Nutter.

CROSS EXAMINATION

By MR. NUTTER:

Q Mr. Motter, your Exhibit 4-A reflects the history of the Graridge Unit water flood since injection began. I wonder if you can tell me if water is being injected into those six wells equally?

A I think there is some slight variation factor, I know there is, I have studied the case, the difference being pressure. They are having a little trouble getting the water right up there in some of the wells.

Q The red-colored wells are the producing wells?

A Those are the producing wells and the ones being reported to the Commission as being affected by the results of the injection of the water.

Q Are they all producing oil at more or less uniform rate?

A No, there is one well down there -- these are new number designations since this has been formed into a unit -- it would be, I believe, the northeast northeast of Section 6, that well has been tested for as much as 550 barrels per day. In fact, in February it produced, I think, over 15,000 barrels.

Q So that one well is producing a good part of the total production that you show here?

A Yes, I think the production runs two, two, and over five hundred barrels per day.

Q Do you think that this pilot water flood that you have depicted on this exhibit has reached its peak as far as productivity

is concerned?

A No, but I think you can tell by the curve it will not be too much longer until the peak will be reached. Actually, in my understanding, they have not produced any water yet, so once they get water production the peak will start right back down.

Q What is the rate of production on the second highest well in this area?

A Well, the second highest well, No. 15, which is another inside location, that has not responded quite as good as some of the others. I think that, let me see, about 300 barrels per day is what one of the other wells has responded, I think in the month of February it was a little over 9,000 barrels.

Q That is the No. 15 well?

A No, that is not. When I made my study I had the old well numbers. I don't know which one corresponds right now, I only --

Q (Interrupting) Do you think there is a possibility that some of the other wells that you have shown as red dots on this exhibit might show a very sharp increase if they should suddenly become affected by the water flood?

A It can always happen, certainly.

Q This rate of production that you have shown here may continue to go up at a steep rate?

A No, I do not think that will occur. I think by the time that any of the outside wells will be stimulated that we are probably getting water at the inside, and the curve will more or less flatten

out. In fact, it will probably start back down sooner or later. I don't mean sooner or later, I mean in some short period of time, maybe next six or eight months.

Q You are depending on the wells that have responded to go down at about the same time that new wells show a response?

A Normally we expect water to break through, and of course, these wells can only produce at such a capacity and there will be that much less oil can come in if the water starts coming in.

Q How much oil, Mr. Motter -- first of all, the third requests of your application called for administrative approval of the pilot project and/or -- let me see, for additions to or deletions from the pilot area and/or injection wells. What do you mean "pilot area and/or injection wells"?

A Well, if we start injecting water in these four wells and water starts being produced in our producing wells to where we start falling below the established allowable, then we would like to come before you to add possibly one or two more injection wells from time to time.

Q What is the pilot area?

A The pilot area as we propose would be the four injection wells and there are nine wells which we expect to be affected by the flood sooner or later. I will point those out and read them off, if you would like.

Q I think that would be a good idea. These are the wells in the pilot area?

A Yes, and this was in the case before. I brought this out before. I'll start, Government B-19, B-15, B-12, B-8, B-11, B-2, B-3, and the State "AN" No. 1.

Those are also shown on Exhibit 2 with two asterisks indicating the wells which we expect to be affected by the flood and the single asterisks are the injection wells.

Q How much oil do you think that you will recover as a result of the pilot project from the nine wells in the pilot area within a reasonable length of time?

A Do I understand you, Mr. Nutter, to mean that what we consider as recoverable oil by secondary means per acre, or do you mean as a total from the nine?

Q As a total from the nine-well pilot area.

A Well, I have got that figure. We estimate 25.6 percent will be recovered by secondary means. I would have to work out on acreage basis, let me see, that would be thirteen times forty, five hundred twenty acres. I don't know how good my arithmetic is, about 914,800.

Q You would get a 914,800 increase as a result of a capital outlay of some $160,000?

A No, that would not be right. I probably couldn't say it was 914,000 if we had the pattern extended on around, we would recover the secondary oil. It will cost additional money to increase the injection wells, so I couldn't say that the 914,000 will be recovered, but not a $160,000 outlay. It is going to cost

somewhere in the neighborhood of fifteen to twenty thousand dollars per well to prepare the well or work it over for injection purposes.

Q How much oil will you recover from the pilot project then, if that is all that you put in, just the pilot project and didn't expand it?

A We would almost have to contribute ten acres to some of the outside wells, is about all we could contribute to those wells, so that would cut that down immensely. I think perhaps Mr. Funk has more experience, he would be glad to answer that question. I'll be glad to elaborate more on it if you would like.

Q Let's leave that for now. You would transfer the full unit allowable from the four injection wells, is that correct?

A Yes.

Q Which would be four times thirty-three?

A Well, yes, that in effect. We believe that the injection well should be treated the same as the producing well, because if the pattern were shifted over one line of wells, they in turn would be in a producing well themselves.

Q Yet the four injection wells have a total productivity of sixty-seven barrels?

A Yes, that is correct.

MR. NUTTER: I believe that is all.

MR. UTZ: Are there other questions of the witness?

MR. COOLEY: Yes, sir.

MR. UTZ: Mr. Cooley.

By MR. COOLEY:

Q Mr. Motter, it is your Exhibit 1-A on the board?

A Yes.

Q There is considerable area covered in yellow which represents Cities Service ownership, I presume?

A Yes, that's right.

Q But all that area is not contained within the Government "B" Lease, is it?

A No.

Q Would you please give the legal description of the Government "B"?

A All of Sections 3, Range 31 East, Township 14 South; the North Half of Section 10 in the same township and range.

Q In your application for this hearing, you request consideration only for the Government "B" Lease, is that correct?

A Yes, that is correct.

Q However, from your testimony and from the plat itself, Exhibit 1-A, it seems quite reasonable to assume that the No. 1 Well in the State "AN" Lease would also be affected?

A Yes, Mr. Cooley. Maybe I can elaborate that. Mr. Funk has testimony to show that we are working on a unit for this area. We hope possibly to get the unit established before stimulation on that well would occur. At that time we can take care of that in that unit.

Q Will he testify as to what the probable area of that unit

will be?

A He will. In fact, he will have exhibits to outline the area.

Q But by the present application, all you seek is a lease allowable for the Government "B" Lease?

A Yes. If for some reason this unit could not go through by the time we could get stimulation, I presume we would have the prerogative to come back and ask for possibly the same consideration for just the State "AN" Lease, which would take care of any increased production over there.

MR. NUTTER: If Mr. Penrose's well in Section 11 showed a response to water flood, should he have a right to come in and ask for an increase?

A I don't see why he couldn't. That would be money that we would be helping him out or pushing some oil over to him. It probably might be some of his oil or probably some of ours.

Q (By Mr. Cooley) You stated in answer to a question by Mr. Bratton that you did not feel that this project, injection project qualified as a pressure maintenance project for some reason. I didn't gather what that reason was. Would you repeat it?

A My reason was because I think as the Commission themselves defined pressure maintenance, it's either the maintaining of pressure, well, I'll have to look here again, it's on page 4. It is either to maintain existing pressure or to retard the natural decline. We expect to increase the present bottom-hole pressure by injection of water.

Q I'm going to put you on the spot. Do you think that is a reasonable interpretation of pressure maintenance? Is it not a known fact that the institution of a pressure maintenance program any time after the decline from the original pressure, reservoir pressure, will result in some increase in pressure?

A That is true. This problem has been argued, I guess, ever since there has been secondary recovery. I think there is one state actually had a secondary recovery group working and also a pressure maintenance group working, and neither one of them could decide who was working on whose project, and so on and so forth.

Q Certainly it is a nebulous line between the two, you will agree?

A Yes, we will certainly agree.

Q Again in answer to Mr. Bratton's question, you stated that any increase over and above the present production rates would in your opinion be secondary oil. Would you again repeat what reason you ascribe to that conclusion?

A Well, naturally if we get any increase in a well after water injection started, there can only be one reason, in my mind, why that increase would occur, and that would be because we are injecting water to force the oil toward that well.

Q I concur in that conclusion, but would it not also be possible that this oil is just being recovered sooner than it would have been under primary recovery and would nevertheless have been recovered in the economic life of the well, a portion of it?

A I brought out here that, I will grant you I believe I testified there would be 1.7 percent. We estimated the primary oil left to be recovered by the time we get response from the flood. I think I testified that I have extrapolated those curves out to show that we would recover some one million one hundred eighty thousand barrels of oil by primary means from this lease, but I did not take into consideration the economics at any time. I would say that the economic limit for wells in that area would probably be three to five barrels per day, which would naturally cut off or cut some of the ultimate recovery of primary oil that we would expect.

Q Economic limit on wells depends to some degree at least, does it not, upon the practices of the particular operator?

A It most certainly does.

Q Were there not a great number of wells in the area around what is known as the Graridge water project producing at the two-barrel level?

A Yes, they certainly were.

Q Would you give me the potential producing capacities of each of the four injection wells at the time of conversion?

A We have not converted any of the wells. We have not done any construction, physically.

Q They are still producing wells?

A Yes, they certainly are.

Q When do you anticipate converting them?

A We would like to convert the wells if and when we get water to the wells. In other words, we would like to use water for conversion. We will need it in our workover procedure, so they will probably be the last thing to be done in the construction.

Q When do you anticipate?

A Well, like I say here, if everything goes well, we expect to be putting water in in June of 1958.

Q Could you predict the potentials of these four wells, extrapolate them to June of '58?

A I think I possibly could by using this decline curve that is already established.

Q This is not the allowables?

A No, sir.

Q You referred a while ago to allowables. As you know, the allowables assigned to wells in many cases in marginal wells certainly do not represent their actual potential.

A That's right. In these recent tests we are going to ask for reduced allowables because we did not produce our 412 barrels.

Q Let's preface your extrapolation with a little of your most recent potentials on the four wells.

A If you will give me just a minute here, I'll see about what they will be. This will be at the time we start injecting water. From this curve it looks like we will be producing roughly about 280 barrels per day. This is, I tell you how I arrived at this; in March our average well, average daily production per well was

15 barrels per day, and in June it should be 12 barrels per day, so if we take three barrels off each one of the injection wells, No. 5 should have about 12 barrels; 6 should have 17; 14 should have about 11 barrels per day; and I guess it's 10, should be about 19 barrels per day. That's rather a rough extrapolation, but it's the best I can do right now.

Q That's quite satisfactory for the purpose of my question. Would you again give your reasons why you feel these wells should receive top allowable for the purposes of transfer, rather than their potential at the time of conversion?

A Well, Mr. Cooley, like I believe I stated to Mr. Nutter, if this pilot injection program, if it were shifted one line of wells, these four injection wells would actually be producing wells, which could possibly be stimulated by another row of wells, so therefore we feel they should be treated no different than a producing well.

Q I can't follow that reasoning, Mr. Motter.

A Let me point this out. Here is the four wells which we intend to inject water. Say that we changed our flood pattern and made these the injection wells. Then this well would in turn become a producer, this well also; in fact, all four of them would be producers, and they would be stimulated by the four injection wells. Therefore, we feel that it's just a matter of which way you space your pattern, they should all be treated the same. I hope I'm making it clear.

Q Well, the fact that under a different type of injection program you could obtain additional production from these wells is the premise upon which you base your conclusion?

A Yes, that's right. Actually we could go in and drill injection wells on a five-spot pattern, and then these wells would all be treated as producing wells.

Q Then that $160,000 cost would be substantially increased?

A Most certainly.

Q You stated in your direct testimony that you felt that the production from a water flood project could be controlled within some limits by the injection rate. Then I believe you used three figures, not this and not this and not fifty. What are the limits that you think they can be kept within?

A Well, that again is a pretty choice question. If we have a goal to arrive at, for instance, if we are given this 33 barrels times the 24 40-acre units, 792 barrels; it looks possible on this Graridge flood that the ratio is going to be, from injection water to produced oil, is going to be somewhere in the neighborhood of two to one.

Q Two barrels of injected water to one barrel of recovered oil?

A Yes. So by quick mathematics, we want to put in 400 barrels per injection well, or 1600 barrels, we hope that we could arrive at approximately 800 barrels per day.

Q Now back to that two to one ratio, you said two to one?

A Yes.

Q Two barrels of injected water to one barrel of recovered oil or recovered liquids?

A No, recovered oil.

Q Do you have any estimate on what it would be of injected liquid, as compared to recovered liquid?

A Of course, there could probably be one barrel for one barrel, barrel of injected water for a barrel of fluid taken out.

Q It certainly wouldn't exceed it?

A No, it wouldn't exceed it, and I don't think it will ever happen, but it could.

Q The reason for that question, on the recent trip to Oklahoma, I find that out there they have four or five times the amount of liquid withdrawn as that injected. I didn't expect that to happen in this case.

A That would be pretty good.

Q Pretty phenomenal?

A They must have an atomic project.

Q Two injection wells and seventy-five producing wells. By controlled expansion, Mr. Motter, do you mean that you would try to keep the production on the Government "B" Lease, once you do get water flood results, at approximately the 800 barrel level?

A Yes. I would like to expand on that a little. For instance, say we can control it up to 800 barrels, say we can control it in 50 barrels, if the stimulated wells start to drop off we would like

to come before the Commission for administrative approval to insert one or two more injection wells, because we know it will take an additional four months to stimulate any other wells, and possibly in four months the production from the producing wells will drop to some point. We would like to predict ahead all the time so we can keep the 800 barrels or so per day coming in at all times.

Q Might this very question of expansion and the time limits of expansion be one on which reasonable men could differ?

A Would you state that question again?

Q Might this question of expansion, the time limits on the point at which you should expand the flood to make up for any decline in existing wells' production be a controversial issue?

A It could be, that would be something we would have to predict. Of course, if we see a water breakthrough on a well, it has occurred in the Graridge, got up to 550 barrels, we know the production is going to start down pretty rapidly. We would have to start injecting in some other well to make up some place else.

Q The purpose of the question was the advisability of the administrative approval of any expansions of projects which were set up to be controlled projects, on the basis of controlled expansion.

A Well, well, as I have said, where Mr. Funk is going to testify on a proposed unit that we have for this area, and I think that any expansion will naturally come in this unit and lease lines at that time will make no difference, or -- if I assume what you are leading up to.

Q Well, that you are going to keep a water flood within a positive limit, a time which expansion would be necessitated to keep it at that level could be a very controversial issue?

A There would have to be a prediction based probably upon experience. I think possibly we will be able to tell by the results of the Graridge flood possibly when something like that can occur, and base some of our predictions on that when we have to add additional injection wells.

Q That brings up a point I would like to ask. You do not feel, I assume, that the discrepancies in the degree to which the two areas have been depleted, the Graridge Area being very marginal, down to five-barrel level, and the subject area being, I think, twenty-five barrels?

A No, fifteen.

Q You do not feel that this discrepancy will cause any discrepancy in results?

A Well, as I testified before, there are certain factors which we believe will actually increase our recovery by inaugurating a flood at this time rather than waiting until we get to a stripper stage.

Q That has been the impression left with the Commission from previous hearings. Consequently, I question whether the performance of the two floods would be substantially the same.

A I think they would be. I don't think that there would be too much difference in the two. Along that same line, if you refer

to Exhibit 3-A again, this extrapolation looks like possibly late in 1960 we would be clear down to what you would call a stripper stage, no doubt in my mind about it.

Q One last question, you did testify in connection with what you have just said that you feel that the ultimate amount of oil recovered would be greater if the Cities Service had been permitted to institute its flood at the present time rather than waiting until it is depleted, did you not?

A Yes, sir. Mr. Funk plans to elaborate on that. As I said before, formation volume factor, the viscosity of oil to water relationship, and certain other factors, gas in solution, those are all contributing factors which we can show that it would be better for us to inaugurate the flood at the present pressure, rather than waiting until it got down to 75 pounds.

Q Since it is your opinion that additional oil will be recovered, is it also your opinion that the production under your proposed plan will be greater than it would be if you waited until the stripper stage?

A No, sir, because I think I testified there is only about 1.7 percent oil to be recovered between absolute primary means and when we expect to be injecting water, and that although it is a lot, it is only 1.7 percent and it is not a big amount of oil, excuse me.

Q Where is the additional amount of oil going to come from, if it isn't going to come from what would be termed unrecoverable

oil, if you waited until the stripper stage?

A I think Mr. Funk is going to elaborate on that.

Q I will be glad to defer the question.

A Some of the oil left as residual oil, let me put it this way, as the pressure decreases the gas in solution decreases, so that means the formation volume factor decreases; thus you leave more residual oil in place, which probably there is 25 percent that there is no means that we can ever get out of the formation.

Q I vaguely understand these things.

A I think Mr. Funk will explain that.

Q It seems reasonable to assume if you are going to recover more oil under your proposed plan, that your peaks would also be higher?

A They might be higher to some extent, but like I said previously, there's only one or two percent more, should not affect the peaks to just one percent in seven or eight hundred barrels; we expect for allowable is not very much oil. This additional oil will come from, I think it's like Mr. Funk will testify, we actually think we will bring part of the oil that would naturally be left in the formation out with this flood by starting earlier.

Q One last question. You testified that you feel that there will only be nine wells which can reasonably be expected to be affected by this injection program. That is the nine wells you enumerated a few moments ago?

A Yes.

Q They occupy nine units, nine 40-acre proration units?

A Yes.

Q Then there are four additional proration units occupied--

A That is correct.

Q -- making a total of thirteen?

A Right, 520 acres.

Q And you request, however, a lease allowable for all of the rest of the wells on the Government "B" Lease. Why do you feel this is justified, that they are not going to be affected by the flood?

A They are not going to be affected, not right now. They will be affected as we expand the flood.

Q Then to treat the thing as a project and to have sufficient allowable at the end of the flood --

A (Interrupting) Yes, sir. We would like for it to be treated as one big unit, assigned one allowable, and we can take the oil out as we expand the flood. Certainly in time it will, possibly in ten years, cover the full area.

Q Would a program permitting only the nine wells which you mentioned to produce in excess of the normal unit allowable up to a limit of the twenty-four wells times the top unit allowable be a reasonable approach to this thing?

A Perhaps it would.

Q Then only the nine wells would be permitted to exceed their allowable; however, I don't think there is much danger, all

the rest of the wells are marginal?

A Oh, yes, they certainly are. I don't know any well -- no, there are no wells right now on the Government "B" Lease that approach the normal unit allowable.

Q All the wells on the Government "B" Lease are now producing at capacity?

A Yes.

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

By MR. UTZ:

Q What does the twenty-four hour test production in barrels indicate on your Exhibit 2-A?

A Well, that is the production test that we have run. As you will notice, there are some wells there that produce 40, 44 barrels; here is one 37, 40. As you realize, the facilities on lease, we cannot test or cannot produce all wells while we are testing some, so possibly some of these wells that are shown as high as 40 or 44 barrels might have been shut in for four or five days while we were producing other wells into that same battery.

Q That is not an average producing --

A (Interrupting) No, on some of these wells, especially some of the wells which I have indicated as being affected, we tried to produce some of those two or three days to try and establish an average. I think the No. 8 well was the only one that produced at 44 barrels, and if I remember correctly, that well has just been reworked. I think it was hot oil or had some work

done to increase the producing capacity. We have a terrific paraffine problem up there, it has been testified before this Commission previously.

Q Mr. Motter, do you believe that the radius of influence on your injection wells is any greater than 1320 feet?

A There could always be freak conditions that could stimulate a well, maybe a half or three-quarters of a mile away. Normally we think by pumping these wells just directly offsetting our injection wells, we will keep the pressure differential low enough that those will probably be the only wells affected. In other words, in flooding, actually what you do is try to create a pressure differential to cause the flow to flow to your low pressure areas caused by your producing wells.

Q Now, the premise on which you are asking the transfer of allowables on the Government "B" Lease is due to the fact that you are injecting water in four wells, is that correct?

A Well, that we want to inject the water in four wells. We are not doing it as yet.

Q You propose to?

A We propose to, yes.

Q If you did not inject water in these wells, then you wouldn't be in here asking for transfer of allowables on the lease?

A No, most certainly not.

Q You don't feel you would be entitled to it?

A No.

Q Then why are you asking for a transfer of allowables from wells which are not affected and that will not be affected by the injection of water?

A Well, that brings us back to the same thing I showed here, Mr. Utz, on my program. If this pilot was shifted over another row, we might approach this as if we would establish a five-spot water program, and actually drill injection wells in here, and then all these wells we currently have would be treated as producing wells. We feel they should be treated as producing wells, as the wells being affected by the flood. We have put out money to drill the wells, and what we are doing is driving it from the wells that is actually under the 40-acre tract that the injection well lies on, we are driving it over to producing wells, and it is being produced at these wells, as I have indicated.

Q Then the real reason for it is so you can produce the affected wells unrestrictedly, is that right?

A Well, no. I think I stated that the affected wells, we think, should be produced at capacity. We think we have a small enough pilot we can operate on this unit allowable.

Q What do you think the producing,maximum producing capacity of the affected wells will be?

A Well, like I say, if we inject 1600 barrels per day, which is a minimum of a half a barrel per day per acre foot that we feel that can be used to actually stimulate the wells, I think that somewhere in the neighborhood of around 800 barrels per day is

what we should expect from this flood.

Q You don't believe you could get along on any less than 800 barrels per day?

A No. Experience has shown that half a barrel per acre foot is the minimum we can operate under. I think you will find floods that have operated at less than that. It was probably due to the operator not wanting to put in more, but case of necessity where pressure was too high, he could not put in more water than half a barrel per acre foot.

Q One clarifying question on your Exhibit No. 4-A.

A Yes.

Q Since your vertical scale is a logarithmic scale, is not that second thousand that you have written there ten thousand?

A No, it should be -- well, let me think a minute.

Q This is daily?

A No, that should be, that's correct, Mr. Utz, 920 some barrels per day is what they are producing.

Q Nine hundred --

A (Interrupting) They're injecting slightly over 2,000 barrels per day.

Q Your lower scale is your production?

A Yes, that is correct.

Q Oil production?

A Oil production.

Q The maximum, or your last point, February point, is 920?

A 920 barrels per day, that is from 12 wells.

Q Shouldn't this be a hundred down here, the first circle?

A Maybe I have, no, the cycle on the bottom should be ten, then the next one should be one hundred, two hundred, three hundred, four hundred, five hundred, seven hundred, then on up to a thousand.

Q That straightens it out.

MR. UTZ: Any other questions of the witness? Mr. Nutter.

By MR. NUTTER:

Q Mr. Motter, in response to a question by Mr. Cooley, you said that if you started injecting water that all of the additional oil that would be recovered could be construed water flood oil, is that correct?

A Well, I would say any increase you are going to get from any producing well has to be affected by the injection of water.

Q Could you call it secondary recovery oil?

A Well, like I explained to Mr. Cooley, we still have the 1.7 percent that we think we could recover by primary means. That would be the only additional oil that I could see, except that we think we could recover some of the oil that would normally be left in place by starting at a higher pressure rather than letting the reservoir pressure get to somewhere in the neighborhood of 75 to 100 pounds.

Q But in the face of the testimony that you gave that these wells respond well to fracking treatment --

A Yes, they do.

Q -- would you say that the additional oil would be secondary recovery oil except for this 1.7 percent?

A Well, I could show you a well here that has been fracked, it's a Government "B"-18, was fracked about, oh, some six months ago, it potentialed after the frac for 87, it's back down to 27 right now. We have not gained a tremendous amount. We have probably paid for the frac job, but that's about all.

Q Now, Mr. Motter, you stated that you felt that no well in this project would receive a disproportionate share of the market for New Mexico oil, because all you would be recovering would be your share of the reserves in place in the Caprock-Queen Pool, is that correct?

A That's right.

Q Have you taken into consideration whether the wells would be receiving their proportionate share of the daily allowable of New Mexico oil, or the daily market demand?

A Well, they would not be receiving any more, Mr. Nutter, than if we went in there and fracked every well and establishing it back to 33 barrels a day, we probably couldn't keep them up there, but certainly if we do that we would be entitled, I'm sure, to the 33 barrels, and all we have done in effect is, rather than do that, we would like to spend our money down here to put it in a water flood and work through the entire lease, like I explained before, might take some period of six to ten years, but we feel

we would like to do it that way rather than spend our money in the fracture process, which fracking will not increase the ultimate recovery.

Q You answered "No" to a question by Mr. Utz that you didn't want unrestricted allowables here, but you wanted to produce the wells within a unit allowable, is that correct?

A If I answered his question in that manner, I misunderstood Mr. Utz. I meant to explain that we would like to produce the affected wells at capacity, but we feel by regulating the amount of water we put in, we can stay within the unit allowable we have asked for.

Q Because you have asked for a large enough unit allowable, is that it?

A Yes, that is correct.

Q If your unit allowable were any smaller, would you be able to stay within that?

A That is something we will be faced with. We think we can operate under any normal change. We haven't seen too many drastic changes. I'll admit it has come from 45 barrels down to 33 barrels in the last few years. It has only happened a barrel at a time. If we were cut, say, after this started, down to 20 barrels, then I think we would have to come back before the Commission and try to freeze our production or allowable at some rate, because we cannot curtail the flood without doing damage.

Q I might make the remark here at this point that that was

probably the reason the Commission entered those findings they did in that order that appeared in the last case, although it may not have been within the scope of the hearing.

A We feel we can operate with any normal change, a barrel per two per month, I think we can live with it. I won't say we can go out there if you cut it 15 barrels a month, that is entirely different.

Q What was the original oil in place?

A 6,798 barrels per acre foot.

Q What do you calculate will be recovered per acre foot in this area by secondary recovery means?

A 290 barrels per acre foot, 6,790 barrels per acre, and our recovery on 1740 barrels per acre by secondary recovery.

Q 1740 per acre. So assuming that this nine-well pilot project has 320 acres enclosed in it,you would recover the result of 320 times 1740, is that correct?

A Would you tell me what 320 you are referring to?

Q The nine-well pilot project has approximately 320 acres under it?

A Yes, something like that.

Q You would recover 1740 barrels per acre?

A Right.

Q So you would recover somewhere in the neighborhood of 557,000 barrels of oil by secondary recovery means?

A I'll accept your figures, I think that is probably about right.

Q As a result of a capital outlay of $160,000?

A No. We're going to have some more wells,we hope some day to put in for injection wells, we will have to pay for that, too.

Q They will recover more oil from additional acres, besides the 320 acres?

A They certainly should.

MR. UTZ: Any other questions?

MR. BRATTON: I have one or two questions.

MR. UTZ: You may proceed.

REDIRECT EXAMINATION

By MR. BRATTON:

Q Mr. Motter, I don't want to belabor this point, but I believe in discussing this question of when stimulation is achieved as to whether you are going to get primary or secondary oil, did you not actually testify that you would probably be getting both primary and secondary oil?

A Well, yes, I think we have some primary oil that we would possibly recover, like I stated before, I think it is 1.7 percent of the oil in place that would probably come with this secondary oil.

Q But it would actually not all be primary oil for some time, it would be secondary oil, some secondary oil?

A Certainly there would be secondary oil with it.

Q If you were allowed anything less than what has been requested in the application, the net result would be that you would have to inject less than 400 barrels per well per day?

A Yes. That would put us down below the half-barrel per acre foot which we strive to stay above.

Q In your opinion, if you get below the half-barrel per acre foot per day, is waste apt to occur?

A In most cases, I think it possibly has. There are certainly some floods that have operated less than that, but I think that most generally you'll find that floods are operated from half a barrel an acre foot on up. I think most people even strive to inject water around one barrel per acre foot.

Q You believe actually that you will be planning or programming this pilot at the minimum injection which you could make and still not result in waste?

A That is correct.

Q Mr. Motter, you were asked as to whether you believed any well would receive more than its proportionate part of the daily allowable. I would like to ask,if your two amendments were granted by the Commission,would the lease receive more than its fair share of the daily allowable?

A Not in my opinion, I don't think it would.

Q Mr. Motter, if the Commission should feel that there could be controversies as to expansion of the flood, do you believe you could institute and inaugurate the pilot flood without the granting of your request number three, as to administrative exception?

A Oh, certainly we could.

MR. BRATTON: I believe that's all.

MR. UTZ: Any further questions? The witness may be excused.

(Witness excused.)

MR. UTZ: We will take ten minutes recess.

(Recess.)

MR. UTZ: The hearing will come to order, please. Proceed, Mr. Bratton.

E. E. FUNK

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

DIRECT EXAMINATION

By MR. BRATTON:

Q Will you state your name, please.

A E. E. Funk.

Q By whom are you employed?

A Cities Service Oil Company.

Q Where and in what capacity, Mr. Funk?

A In Bartlesville, Oklahoma, Secondary Recovery Engineer is the title that I use.

Q As such, does the area covered by this hearing come within your jurisdiction?

A Yes, it does.

Q You testified in the previous hearing on this matter?

A I did.

Q Since that time you have continued your work in secondary

recovery matters?

A I have.

Q Are you the Chairman of the Engineering Committee of the Caprock-Queen secondary recovery project?

A Cities Service Oil Company as a company is designated as Chairman, and I have conducted the meetings that we have had so far.

Q I would like for you to refer to Applicant's Exhibit 5-A, Mr. Funk, and explain to the Commission what that is and what it shows.

A This map in general covers all of the Caprock-Queen Pool except the south portion. The area outlined in red represents what is now the Ambassador operated unit, and encircled in red are the six input wells.

Q Is that the Ambassador-or Graridge in red?

A I'm sorry, it is the Graridge. The six wells there represent their pilot area. Now they started a pilot on a cooperative basis and subsequently worked out the unit which I think went into effect the first of March of this year. Outlined in blue is an area which Ambassador is endeavoring to work into a unit. They also have a pilot area going on a cooperative basis at this time.

Below that we have outlined here in orange, I guess you would call it, a tentative unit that Great Western has taken the lead to form. Now, I understand Great Western has changed the boundaries of that thing a time or two, and currently may be planning to include quite a bit more of this area to the south.

Between the area shown for Great Western and this green line down here is somewhat of an area that plans have not been crystalized on, but I feel certain that that area will ultimately be put into some form of a unit for purposes of water flood, either by inclusion in the Great Western project, or the creation of a separate unit operated by Great Western or Gulf.

Below that, outlined in green, is an area covering eleven Sections, not all of which is productive, which encompasses nearly all of the Cities Service holdings and includes the four input well pilot test which is the subject of our current hearing. This area, Cities Service has taken the lead to form into an operating unit.

Below that is an area of about two Sections wide which again no plans have been laid on, but I feel certain that there again it will before too long be a subject for a unit. Not shown on the map, but starting at the bottom edge of the map, is the north boundary of the area Union Oil Company is trying to organize into a unit, includes all the remainder of the Caprock Pool.

In total, you can see it's falling into a very definite pattern. It looks like there will be some six or seven operating units in the Caprock Field.

Q Why is the Pool being divided as you outlined?

A Well, it's, for two reasons. One, I think, because the operators have outlined the amount that the one operator would like to operate, and, secondly, it's pretty generally the amount

of area that they have a water supply source available for.

Q Now, the general input pattern is constant throughout this area, is it not, Mr. Funk?

A Yes, it is. I think this organization, which we've called the Caprock-Queen's Engineering Committee, represents quite a step in putting this whole area into a very systematic pattern. I think by our action I think we are all going to be working together and as such are not competing for water sources, and I think we will be in much better shape to get along on this allowable question and we certainly will establish a pattern that everybody is using. The patterns, of course, are kind of, for the pilots are separated now, but when they do come to the edge of the various units, they will fit in without any difficulty and the various units then can have cooperative line agreements between themselves.

Q Now, referring to the portion shown on the map there, Mr. Funk, as the proposed Cities Service unit, is that area larger than what you mentioned in your testimony in the hearing in this case on January 6th?

A Yes, it is. In our hearing previously we indicated only the Cities Service leases which are shown here in yellow. We had in mind a royalty unit covering those tracts. The tracts are leases attained from either the State of New Mexico or the Federal Government. The United States Geological Survey office over at Roswell raised the question as to why we would want to unitize such an odd-shaped tract when there were other operations right around it.

Well, that was a logical question. That, plus the fact that some of these other sections have 40-acre leases with only one well in it, it just seemed imperative that we should go ahead and take the lead to make that into an operating unit.

Q In your opinion, Mr. Funk, will the granting of this application, the amendments which we have asked, will that serve to expedite the formation of a unit in this area and an orderly development of the area?

A Yes, I believe it definitely will. The desires we have are that before this pilot test has become very old, that the unit will be formed and we won't have any difficulties extending our flood pattern, and also we hope our allowable arrangement throughout the entire unit.

Q With reference to that, Mr. Funk, I refer you to Applicant's Exhibit 6-A, and ask you if you will explain to the Commission what that is and what that shows.

A This is a production record for the area outlined in green on the map on the wall there. This shows production rate in barrels per month. It is, I think, pertinent because you can see the total area has long since passed the stage where it produces top allowable. It's declining rapidly in much the same fashion as the Government "B" Lease of Cities Service, which is also shown on the same curve here. In other words, what we are proposing for this pilot area is what the whole proposed unit would like to have and would need for a water flood program.

Q That exhibit shows that the unit area is in approximately the same stage of decline as the pilot area?

A Yes, it does.

Q How will the construction work which you are starting fit in with the need of this proposed unit?

A Well, the main water lines which we are installing for the pilot area are sized to meet the needs of the entire proposed unit. At the proposed water plant, the layout is being designed for easy additions of filters and pressure pumps, although initially we will install only such filters and pressure pumps as we need for the pilot area.

Q And your water supply is sufficient, Mr. Funk?

A Yes, we believe our water supply is sufficient for that area. As I stated earlier, that was one of the reasons that most of these units were outlined with the size they have. It might be that that area to the south of us could be brought into the unit Cities Service proposes by later amendment, but we right now aren't sure we would have enough water for that.

Q Mr. Motter has stated that your plan is to inject 400 barrels per well per day, and that is still your proposed plan, for the pilot area?

A Yes. That's essentially the reason for this hearing. If we inject water at that rate and are allowed to transfer allowable from input wells and are permitted to produce the normal per unit New Mexico allowable on a lease-wide basis, we should be able to.

Q If the proposed Cities Service Unit is organized, you would expect it to develop substantially along the same lines?

A Yes, the anticipated allowable should, and, of course, will be used as a guide to the rate of water flood development. I think the normal per well allowable assigned to this unit that we have outlined here will permit us to develop at such a rate that all the stimulated wells will be operated at capacity and prevent any waste.

Q Mr. Funk, I believe Mr. Motter has discussed the increased ultimate recovery which could be obtained if water flooding were initiated now in accordance with your proposed amendments. In your opinion, if water flood operations are commenced now, rather than delayed until such time as the lease has reached a marginal or stripper status, do you believe that the ultimate recovery of oil from the property would be greater?

A Yes, I do. Now in operating a reservoir so as to gain the greatest recovery, we have to recognize that the character of the reservoir fluid is about the only factor over which we have any measure of control. We can do very little concerning the size and the shape of the pores of the rock. This oil under the original 946 pounds bottom-hole pressure, I believe it was, had a gas saturation of 215 cubic feet per barrel. Each barrel of reservoir oil occupied 1.126 times as much pore space as a barrel of gas-free oil would occupy. Now at the time we started our flood we expect the reservoir pressure will be down to about 200 pounds. At this

pressure each barrel of reservoir oil will contain approximately 140 cubic feet of gas per barrel. The formation volume factor, that term I used up above, will drop to about 1.105. If we deplete by primary means before starting our flood, the gas in solution will amount to -- I'm guessing -- about 75 cubic feet per barrel, and the reservoir volume factor will be about 1.07. Now we are estimating that after water flooding 27.8 percent of this por space will still be occupied by oil. That oil will have the characteristics existing at the time we start the flood, which will be the point of lowest pressure.

On a straight volume basis, the inclusion of the present solution gas in the residual oil will mean a recovery of about 80 barrels per acre more secondary oil, or 80 barrels per acre more oil. This means our secondary recovery will be about 4.6 percent higher than if we were to deplete. Now that's not a very big figure, but it certainly is some oil. I am talking about 4.6 percent of the estimated total recovery if we were to deplete completely by primary means. Our total oil recovered would be about 2.7 percent more.

Now, this gas that we would be leaving in the formation is chiefly nitrogen and has no other value. That's one consideration. Another consideration is the viscosity. Originally the reservoir oil had 2.27 centipoise viscosity at the saturation pressure. We estimate the viscosity is now at 3.8 and will be four and a half centipoises at the end of primary depletion. The water viscosity

under reservoir temperature should be about .8 of a centipoise.

Now flooding efficiency is partially a function of the viscosity relationship between the driving fluid and the driven fluid. The more nearly alike the two fluids are, the water and the oil, the better the efficiency. I would say roughly that the better efficiency gained by closer relation between the two viscosities could yield some 100 to 130 barrels per acre more oil than if we let the viscosities continue to get farther apart.

Now there's other possible benefits by earlier commencement of flooding, one that has been advanced, I don't know that it has ever been proved in any field test, and that is that free gas that is trapped in the formation will replace residual oil; therefore, more of your oil will be recovered. I don't know how to put any figure on that, so I just say in summary that I would guess about 200 barrels per acre more oil will be recovered from this Government "B" Lease if we are able to start our flood as quickly as possible, rather than waiting until it is completely depleted.

The surrounding leases, of course, will continue to decline in pressure until they have their flood started and the gains that they have will be somewhat less, but I think in every case the sooner it is started the higher the ultimate recovery.

Q I believe you said that you estimated 200 barrels per acre more would be recovered if the flood were started now, than if it were allowed to go on primary production to the state of depletion?

A Yes.

Q What does that total in terms of total barrels of oil that would be recovered if this flood is started now as proposed?

A Well, on the Government "B" Lease, that would amount to about 190,000 barrels.

Q Of more ultimate recovery?

A Yes.

Q Were Exhibits 5-A and 6-A prepared by you or under your direction?

A Under my direction, yes.

MR. BRATTON: I would like to move that they be introduced in evidence.

MR. UTZ: Is there objection to the introduction of Exhibits 5-A and 6-A? If not, they will be accepted.

Q Do you have anything else that you would care to say about this application, Mr. Funk?

A Oh, I believe not.

MR. BRATTON: I believe that's all the direct.

MR. UTZ: Any questions of the witness? Mr. Nutter.

CROSS EXAMINATION

By MR. NUTTER:

Q Mr. Funk, you state that by commencing the injection of water at this time while the formation volume factor is comparatively high, you will have an additional 4.6 percent increase in secondary recovery than if you wait until the field is depleted by primary means?

A I think we have a problem here of knowing what percent we're referring to. Now I meant by that that the estimated ultimate recovery of 25.6 percent of the oil in place is 4.6 percent higher than if we were to allow it to go to primary depletion. In other words, 4.6 percent of that 25.6.

Q Four percent of twenty-five percent?

A Yes.

Q Not 4 percent or 4.6 of the total oil in the reservoir?

A No, I do not mean that.

Q Mr. Funk, at the hearing of this case originally in January, you made a statement that I would like to have you elaborate on a little bit now, in which you said what Cities Service's position was in the Graridge case. You said on the Graridge application in the Caprock-Queen water flood," I was not here at that hearing, I have read about it. "Our position is this, that water floods can be controlled in a fashion if the control is known and the plan is initiated, I mean the control is initiated at the time the flood is initiated. The area to be flooded should be considered and prorated on a project basis with allowable being assigned to the project rather than to the individual wells." I was asking you in reference to the Graridge. Mr. Motter stated that the pilot project that we're considering here today is a nine-well area surrounding the four proposed injection wells. That would be the project, in your opinion?

A No, I don't believe so. I think what I had in mind there,

that a project sufficiently large could be assigned an allowable, and then the operator could start his pilot within that project and use the entire number of wells in his project to calculate his allowable, which is, of course, what we have asked for in the case of the Government "B" Lease.

Q In other words, if the project is to be considered a very large area, even an area that is not affected by the water injection wells, the question of allowable actually doesn't enter into the thing, the per well allowables, if you make the project big enough?

A What I intended to convey at that time, and that was more or less an ad lib statement that I made, was that we recognize that the States, not only New Mexico but other States have a problem facing them because water flooding in particular, or other means of secondary recovery in general, are becoming more and more a part of the total daily production. Their position pretty much exclusive from proration, of course, has not only been challenged, but it has created a problem for the State Regulatory bodies. Now if the project is sufficiently large, and an operator can know where he is going and produce at capacity and still stay within the allowable, that would be assigned to that project, I mean he would produce his wells within that area at capacity but stay within the overall project allowable and not have any well that would have to be curtailed after it had received a stimulation. Looking at the Caprock Pool as a whole, I think the per well top allowable, if it were applied to all the wells in the field, would mean maybe a

fifty percent increase over what is now being produced. Now, I think that the State could live with something like that. Now they might have trouble if every individual lease started in and wanted to produce at capacity, and all tried to do it at one time. I think they would find the allowable so great, I mean the request for capacity so great that they just wouldn't have any place to send the oil, wouldn't have purchasers or pipe lines to handle it. It would be a very temporary situation, it wouldn't last long.

Q What did you mean in your statement that water floods could be controlled if the control was known at the time the flood was initiated? What control is there, if you have a sufficiently large project that you can produce at capacity?

A I mean control on the rate of development. Now if you have an area that has a hundred wells in it and you want to inject water into an area that would stimulate only nine wells, why, you wouldn't increase that hundred-well area very much; and if you knew that you had to stay within a certain limit, why, you could develop that pilot area and expand it at such a rate that you would never bring your allowable any higher than this top that you were looking at at the time that you made your first injection program, or started your first pilot.

Q What's the answer to the problem, if the number of units in a project is stabilized but the allowable per unit goes down?

A Well, I think that same question Mr. Motter asked, or answered. It's a case of degree. Now right now it's 33 barrels,

and that is one of the lowest in the history of the State, I think, but even at that they have changed only a barrel or two at a time. If it were a drastic drop, say we were to suddenly have it cut from 33 down to, say 15 or something like that, why, we would just be caught. We would come in and ask for relief. I just hope that doesn't occur. I think you do, too, it would be a problem.

Q Mr. Funk, the Commission in Case No. 1381 entered Order No. R - SS 27, in which they provided that the total allowable assigned to the wells in the Red Lake-Premier Sand Unit would not be greater than an amount to be determined by multiplying the number of 40-acre tracts on which there is located an authorized injection well, plus the number of developed 40-acre proration units, either directly or diagonally offsetting the 40-acre tracts on which the 40-acre units are located, times the top unit allowable. Would it be possible to operate this unit in accordance with a plan like that?

A I don't believe it would. I think we would have to have a larger allowable than that would grant.

Q How many wells are directly and diagonally offsetting these injection wells?

A In this particular case we have nine wells.

Q I think those are direct offsets, Mr. Funk.

A Let me see. I don't know what you mean by diagonal, then. I believe Mr. Motter spelled out a group of nine oil wells plus the four input wells there.

Q If there were a total of 21 wells directly and diagonally offsetting your injection project, would you have sufficient allowable?

A Well, that's getting very near the total number on the lease.

Q We are taking a couple that aren't on the lease by doing that, two wells on the State "AN" Lease, and one well belonging to Penrose in Section 11.

A Frankly, I don't think that would be quite enough. We are figuring on putting in about 400 barrels a day, and it looks like the peak rate of production is going to be somewhere in the neighborhood of one barrel of oil for each two barrels of water injected, so by multiplication you will come out around 800, and that is just about what the 24 wells on the lease times 33 will give.

Q Will these wells directly offsetting this pilot project be producing the 800 barrels at one time? You expect a peak of 800 barrels from these wells?

A 800.

Q In this four-well project that you are talking about now?

A Oh, I think we would come close to that, yes. The few wells outside of the area there would be making, oh, I would guess only maybe fifty barrels of it.

Q How much do you anticipate your No. 8 well, which is in the center of the injection pattern, will make at its peak?

A Well, I've watched a lot of water floods, and I don't believe anyone can predict any single well. That's been one of

the mysteries to me, as to why in a water flood you will have a few of your oil wells far superior to all the others. Now just on a straight barrel basis, I would think it would be possible to say that that well might make 400 barrels a day.

Q Although the total number of units offsetting directly and diagonally the four well injection project is 21, that approximates what you have requested here today, a total of 24 40-acre units to be assigned to the project, you don't think you could get along with that sort of an allowable?

A No, I don't. Particularly because part of those 21 are not on the Government "B" Lease. I think at least one of them is over on the State "AN", and I believe there is another one that is off the Cities Service property, it would be the Penrose Lease.

MR. NUTTER: That's all.

By MR. UTZ:

Q Mr. Funk, do you intend to try to communitize the State "AN" Lease with the Government "B" Lease?

A We intend to try to form a unit for both operations and royalty covering all this eleven Section area as shown on this Exhibit 6-A, I believe it is.

Q Which would also include the Penrose-Alston Lease?

A It would include any number of leases, and one of the difficulties is that part of the land is Government land, part of it is State land, and part of it is private land.

Q Are you now in the process of trying to communitize that area?

A We are. The work that's being done is all being done by Cities Service at that, which is a matter of compiling data to make a recommendation on participation. We figure that we have to make a recommendation on that matter before we should approach any of the other parties involved.

MR. UTZ: Any other questions of the witness?

MR. BRATTON: I have one or two questions, Mr. Utz.

REDIRECT EXAMINATION

By MR. BRATTON:

Q Mr. Funk, when you were discussing the ultimate recovery and how much it would be better if the project were started now, I think you said that, in response to a question by Mr. Nutter, that it would be 4.6 percent of 25 percent. Don't you mean that it would be 4.6 percent from 25 percent; in other words, that the primary would be, or the secondary recovery would be somewhere around 21 percent if the project were started later?

A No, I don't think so. Let me do a little checking here to make sure. I'm confusing myself now. What I meant, put it this way, that our secondary recovery would amount to roughly 80 barrels per acre more. Now 80 barrels per acre in reference to an estimated ultimate recovery of 1740, I believe it is, yes, would be 4.6 percent of that 1740 barrels per acre that were estimated recoverable by water flood.

Q The net result is that you would anticipate an ultimate recovery of approximately 190,000 barrels if the project were started

now?

A Yes.

Q Now, Mr. Funk, you've heard Mr. Motter testify that the approximate half-barrel per acre foot per day is a desirable level or is a minimum desirable level for injection. Is that your opinion, too?

A Yes, sir, it is.

Q Do you believe if you inject less than that, that waste might result?

A I think it's very likely to result. I will have to admit, there are some rare cases where it wouldn't, but I wouldn't want to take the chance.

MR. BRATTON: I believe that's all.

MR. UTZ: Mr. Cooley.

MR. COOLEY: With your permission, Mr. Bratton, I would like to inject one more question.

MR. BRATTON: Thank you.

RECROSS EXAMINATION

By MR. COOLEY:

Q Mr. Funk, have you had considerable experience in Texas in the operation of water floods in that State?

A Yes.

Q Are you familiar with the manner in which the Texas Railroad Commission handles such matters?

A Yes, I know from experience on the various projects that

Cities Service is interested in or operates, their practice is somewhat variable.

Q They don't treat all water injection or water flood projects the same, from the standpoint of allowable, do they?

A That is correct.

Q Is one of the basic determining factors in that regard the degree to which the particular area has been depleted?

A Yes.

Q On primary depletion?

A I would say that's right.

Q How do they range those degrees, according to your knowledge?

A I wouldn't know what their plan is. In fact, we have some of the same issues to take up with them from time to time. It seems that in the North Texas area that most anything in that area is considered stripper, and they will allow capacity production. I would say that might be true in some other areas, but the West Texas area, pretty generally they have been much more critical of capacity production. Now, in West Texas they granted capacity production in the older South Ward, I think other Yates Sands Pools down there, I don't know. It would just be a matter of opinion, but I think their position is one of trying to institute a regulation in line with their market demand situation prevailing at the time.

Q Well, of course, we have to face the market demand problem in this State, too, since we are prorated in market demand, and the particular question I wanted to ask you with regard to the

policy there,in the event they find that a particular area is not in the stripper stage, is somewhere in between the initial flush stage and the stripper stage, isn't it their practice to put it on an MER basis?

A Yes, I would say it is.

Q Then they are prorated?

A They will put it on a project basis very similar to what we have asked for here.

Q They are prorated on a project basis?

A That's right.

Q Which would be contrasted with the capacity type of allowable that was authorized in the Graridge case?

A Yes. Now, one thing I might bring up, that the South Ward Pool was a place where the State of Texas gained an awful lot of experience in how enormous the problem might become. In that Pool they have granted capacity production, and I think if one had a lease in that area where he was starting to flood today and go to the State for capacity production, he would still be allowed it. In other words, once they started it in the Pool, they stayed with it. If it's an entirely new area, they might use a different rule on it.

MR. COOLEY: Thank you very much.

MR. BRATTON: Could I ask one further question.

REDIRECT EXAMINATION

By MR. BRATTON:

Q In the State of Texas, in cases where the production has declined below the flush production and is not quite down to the stripper production, if it is put on a project basis as you discussed, it is on a lease allowable and transfer of allowables such as we have requested here?

A Yes, sir, it is.

MR. BRATTON: Thank you.

MR. UTZ: Mr. Funk, is your 400 barrels a day injection rate predicated on 80-acre injection pattern per injection well, or ten foot pay?

A Yes, sir, well, we said eight to ten feet.

MR. UTZ: Are there any other questions of the witness? If not, the witness may be excused.

(Witness excused.)

MR. UTZ: Any other statements to be made in this case? If there are not, the case will be taken under advisement.

* * * * * * * *

C E R T I F I C A T E

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Notary Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Proceedings before the New Mexico Oil Conservation Commission was reported by me in stenotype and reduced to typewritten transcript under my personal supervision, and that the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal this 14th day of April, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Ada Dearnley
NOTARY PUBLIC

My commission expires:

June 19, 1959.

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 1356, heard by me on Jan. 9, 1958.

Elvis A. Utz, Examiner
New Mexico Oil Conservation Commission