BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
AUGUST 30, 1961

EXAMINER HEARING

IN THE MATTER OF:
CASE 2360

TRANSCRIPT OF HEARING

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
AUGUST 30, 1961

IN THE MATTER OF: Application of Shell Oil Company for a pressure maintenance project, San Juan County, New Mexico. Applicant in the above-styled cause, seeks permission to institute a Pressure Maintenance Project in the Bisti-Lower Gallup Oil Pool in the Carson Unit Area and also in Sections 10, 15, 22, Township 25 North, Range 12 West, San Juan County, New Mexico.	Case 2360

BEFORE:

Elvis A. Utz, Examiner

EXAMINER HEARING

MR. UTZ: Case 2360.

MR. NUTTER: Application of Shell Oil Company for a pressure maintenance project.

MR. SETH: Mr. Leslie Kell and Oliver Seth appearing for the Applicant. We have two witnesses. Would you like to swear them in?

MR. UTZ: Would you please stand and be sworn.

(Witnesses sworn.)

MR. UTZ: Are there other Appearances in this case? You may proceed.

WARREN M. MARSHALL,

called as a witness herein, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. SETH:

Q Would you state your name, please, and your professional background experience?

A My name is W. Marshall. I am presently Division Exploitation Engineer for Shell in Farmington, New Mexico. I have held this position for just over a year. Prior to that time, I was an Exploitation Engineer dealing with several phases of exploitation, but principally in reservoir engineering. This experience covers a period of 10 years.

Q What is your educational background?

A I was graduated in 1948 from the California Institute of Technology in Pasadena, California; Bachelor of Science in Engineering.

Q Are you generally familiar with the conditions in the Bisti Field in San Juan County?

A Yes, I am.

Q Have you made a particular study of the field conditions, reservoir conditions?

A In that portion of the field where Shell operates, yes, I have, and including adjoining properties, but not the entire field.

MR. SETH: May he testify?

MR. UTZ: Yes, sir. He is qualified.

Q (By Mr. Seth) Would you state, please, first, what is the general purpose of the application Shell has made in this case.

A To obtain approval of a full-scale pressure maintenance project in the Carson Unit of the Bisti Field.

Q Now, where is this Carson Unit with regard to pressure maintenance projects or secondary recovery projects?

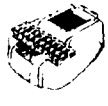
A There are 4 projects in the Bisti Field. Beginning on the northwest end is the British-American and moving on the southeast, next, is the Central Bisti Unit. Thereafter, the proposed Carson Unit project, and in the southeast part of the field, the proposed Bisti Unit, which is presently in the process of being formed.

Q Now, could you tell us a little bit about the field conditions, and a little bit about the overall program?

Q Are you interested in the plan?

A In a general way, give us a little preliminary picture of what the program is.

A This program involves water injection into a total of 35 wells. There will be 80 producing wells, this to be in the Gallup Sands Reservoir at a depth of 4,850 feet. The injection rate is planned to be about 17,000 barrels per day, and the life of the flood will be about 10 years.



Q Is this the proposed pattern?

A That is the proposed pattern. It will be a line drive, with the oil being driven on the parallel of the long axis of the reservoir.

Q Now, the reservoir conditions. What about the gas and the water present in the field?

A Current production, Mr. Seth?

Q Yes.

A The current production in the portion of the reservoir that we are concerned with is about 10,000,000 cubic feet of gas per day, and just over 1,600 barrels of oil per day.

Q Now, would you go ahead with your other reservoir characteristics?

A These are summarized in this report. I guess we had better --

Q Do you want to present the report now? Do you have any other preliminary data you want to present?

A No, sir. I can describe this very briefly. The reservoir porosity is 15 per cent. The water saturation is 25 per cent. The porosity, I mention porosity, the permeability is an average of 38 millidarcies.

Q Do you have an exhibit showing the data?

A Yes, sir; I do.

Q Now, this booklet that you have presented has been marked Shell's Exhibit 1 in Case 2360. Now, this Exhibit contains a

number of separate diagrams and figures, 17 in all. Now, does this Exhibit represent your compilation of the reservoir data at that flood plan and related materials?

A Yes, sir; it does.

Q Would you explain the data used in this Exhibit?

A First, I might mention that the written portion of this Exhibit is rather brief. It totals only 7 pages, and it does not purport to describe each exhibit in detail. There are a total of 17 exhibits which describe the reservoir and our plans for carrying out this pressure maintenance project.

Q You will cover this written portion in your description of the Exhibits?

A Yes. That is right, with some elaboration since the section is rather brief. As a breakdown, the nature of the presentation, the first 7 exhibits deal with the physical description of the project, location, the depth, the sand thickness, the structural features, etc. The next 4 exhibits will deal with the characteristics of the reservoir and the fluid contained therein, together with volumetric and production data. The next 2 exhibits deal with our plan for carrying out this project,and provides a prediction of performance. And the last 4 exhibits deal with the water source, the nature of the water, the water facilities. So with that general description --

Q Your Exhibit 1, of course, is just a general vicinity map.

A Just a location map.

Q And No. 2, would you tell us briefly what No. 2 is?

A Exhibit 2 is an isopackic map of the Gallup net pay. The isopacks on this map relate only to pay which is identified by microlog separation. It is our judgment that pay, microlog pay is the only really significant pay in this flood, and all of our calculations deal only with the pay as it shows microlog separation. The sand varies for the microlog pay, varies from zero to the edge to a maximum of just over 20 feet. The physical limits of this pool, I might mention, the Carson Unit, as outlined with the stippled area, which extends from the north side down to the south side of the pool, so that it completely brackets or sits astride the reservoir. There is a dashed line or a hatched line running near the zero isopack on the north and the south ends. This line represents the 11 revisions to the participating area, and as will be noted, essentially conforms with the zero isopack of the pool. Immediately to the west of the Carson Unit, in Sections 10 and 15 and a portion of Section 22, a parcel is outlined with X's. This is the Phillips 7 Lease, which borders on the Central Bisti Unit on the west, and at the present time, is not a part of the Carson Unit. However, the procedures for bringing this into the Unit are in progress. We have received the tentative approval of the State Agencies, and the USGS, that is, the Notice of Expansion. We have notified all royalty interest owners, and have obtained no objections, or received no objections.

We are presently in the process of receiving joinders from all of these interests, this being approximately one third completed, and again, no objections. Now, all of the numbers that we will be talking about in this discussion include the Phillips 7 Lease to the west of the Carson Unit, and at various times this has been referred to as the Expanding Carson Unit, but for purposes of this report, simply refer to as the Carson Unit.

Q The Application for Hearing covers this additional area; does it not?

A That is right.

Q And all your data will cover that?

A That is correct.

Q Have you anything further on Figure 2 there?

A The next two exhibits are nothing more than a breakdown of Exhibit 2, where the two principal sand bodies, which Shell designates the GC Sand and the GD Sand, showing these isopacks separately.

Q Now, referring to Figure 3. This is an isopack of the micrologs?

A On the GC Sand. And, I might mention that this is also known as the Upper Bench. Going to Figure 4, is a detail of the GD Sand.

Q That is known among other operators as the Lower Sand?

A As the Middle or the Second Bench. Now, one thing we might point out on Figure 4 are the two distinctly separate

portions of the reservoir, one lying along the south side, another lying across the north side; and we will draw attention to this later as relates to the continuity of the reservoir in the direction along the axis, and also across the axis which, in turn, relates to our plan for a line drive type flood. The continuity is better in the northeast and the north, excuse me, northeast southwest direction. Figure 3 serves to identify the various sand members in the Gallup Reservoir, showing the approximate depth, the markers, GC, GD, and the Deeper Sands. You will note a heavy section just to the right of the well column. This represents microlog pay and is that portion of the reservoir which our study deals with. I might mention at this time that the completion of the well, in the completion of the wells perforations were placed opposite all sands with SP, not limited simply to the microlog pay. This will be shown on a later exhibit in more detail, but all of the sands are open to production.

Q Figure 6.

A Figure 6 is a group of three cross-sections. In the upper right-hand corner of this Exhibit is a location map which shows the sections in the field. The section labeled A prime A is on the west side of the unit, and runs across the field. Section BBis towards the east side of the unit, and again runs across the field. The last Section CC runs along the axis of the field. The first two sections, A and B, are on the top of this Exhibit AA on the left, and BB on the right. Markers are

shown on each well so that stratographic correlation is clear, and the lack of continuity in this direction is shown by this Exhibit.

Q Lack of continuity north and south?

A North and south across the field.

Q Well, there is some indication longitudinally; is that right?

A That is correct, the last Section CC on the bottom of this Exhibit, sand continuity is much better in correlation from well to well and is good. This Exhibit also shows the perforated intervals in each well, and as mentioned previously, all of the sands which showed significant SP development have been perforated.

Figure 7 is a structural map. The contours are on the GC Sand, which is the uppermost sand number in the reservoir. The contours are at 20 foot intervals with a sea level datum. The dip is approximately 1 degree towards the north, which is to the basin center.

Q Is this sufficient depth to interfere with any flooding program?

A In our judgment, no. There should be negligible gravity force active in the flood. The next few exhibits deal with the character of the reservoir. Figure 8 is a summary of some of the more pertinent data.

Q What are the more significant figures on this Exhibit,

or Figure 8, that you will refer to later?

A The porosity, which is 15 per cent.

Q How would you characterize that? Is that high or low for this type of flood?

A For this type of Sand, it is about average. It would not be considered a high porosity nor a low porosity.

Q Suitable for this type of flood?

A Yes. The permeability is 57 millidarcies. The connate water saturation, we estimate at 25 per cent, as indicated, this being based on log calculations and capillary pressure data. The residual oil saturation, we estimate at 30 per cent, this being based, largely, on water base core saturation. The subsequent reservoir pressure is 500 PSI. The current gas sizability is 240 cubic feet per barrel, and those I would consider to be pertinent items.

Q The Figure 9, what does this show?

A Figure 9 is a graph showing the primary performance of the unit and, as is here referred to, the expanded Carson Unit. This shows as a function of time, the oil rate, the gas rate, the gas-oil ratio, and all these curves are suitably labeled on this graph. Down at the bottom is a record of the development history leading to the current number of wells in the field of, excuse me, in the project, of 124 wells. This graph is not up to date. This report was issued earlier in the year; but for present information, the oil decline has continued essentially a

straight line, having reached a level of 620 barrels a day in July of this year. The GOR has continued to climb, and in July was about 6,600. The gas rate for July was 10,600,000.

Q Where are you roughly in the life of the field, then?

A We are something over 70 per cent depleted. We will get to the reserves in a minute. About 73 per cent depleted.

MR. UTZ: As of July?

THE WITNESS: As of July, or more particularly, August the 1st. And this figure you mentioned relates to the oil.

Proceeding to Figure 10, it is a volumetric summary, and this relates both to continued primary operations and our estimates in connection with pressure maintenance. The productive area is 6,600 acres. The net pay volume is 59,000 acre feet. This word "equivalent", which we tossed in there, relates to conversion of a small amount of the gas cap to equivalent oil volumes. The estimated tank oil in place, originally 38,700,000. We have covered the wells in the producing rate. The cumulative production as of August 1st, 5,000,000 barrels. Actually, that is four million nine hundred ninety seven. The primary reserves we estimate at one million nine hundred thousand. This would provide an ultimate recovery by primary means of 69,000,000 barrels, this being equivalent to the recovery efficiency of 18 per cent.

This is getting a bit ahead of ourselves, here, but the water flood recovery we estimate at 6,600,000, and by extracting the one million nine that we would get otherwise, that leads to an

additional recovery of 4,700,000. The addition of recovery to date, plus the estimated recovery by pressure maintenance, gives an ultimate recovery by both primary and secondary means of 11,600,000 barrels, this being equivalent to 10 per cent of the original oil in place.

I have been using the term "water flooding", as it appears in this report. That should not be confused with the terminology in the New Mexico Rules. We do not intend this to be a water flood in that sense, but this, rather, relates to the physical process that we are talking about.

Q What is Figure 11? Will you explain that, please?

A Figure 11 is what we call a unit recovery bar diagram, and that exhibit summarizes all the reservoir data together with the fluid properties, and shows the manner in which we have arrived at our estimates. We have used a layman-type, here, rather than some of the standard-type legends that might indicate these things. But beginning at the top of the page where we show the 15 per cent porosity, which is equivalent to the 1160 barrels per acre foot total volume, deducting the 25 per cent connate water, leaves 870 barrels per acre foot original sub-surface oil, which converted to tank conditions is 655 barrels per acre foot original tank oil in place. Subtracting the production to date, which is equivalent to 84 barrels per acre foot, leaves 571 barrels per acre foot tank oil currently in place, which at current reservoir conditions is equivalent to 900 barrels per acre

foot. The dashed portion of the bar to the right is the current gas filled space, 180 barrels per acre foot, deducting from this figure, our estimated residual oil which is 350 barrels per acre foot, leaves 340 barrels per acre foot potentially recoverable sub-surface oil, which is equivalent to 280 barrels per acre foot tank oil. Now, by this term "potentially recoverable", we mean a flood or a project which would be 100 per cent efficient, would recover 280 barrels per acre foot. Our estimate of the efficiency is 40 per cent, which leads to 110 barrels per acre foot recovery in this project.

I would like to comment, briefly, on the 40 per cent recovery efficiency. A project of this nature might generally show a higher efficiency, certainly, 50 and possibly 60. It is our judgment that the discontinuities in the reservoir, together with poor performance in some instances by the wells, points to a lower recovery efficiency than might normally be expected, or if conditions were more ideal. So this is our way of taking into account some of the features of the reservoir which are not ideal. That is all I have on Figure 11.

The next exhibit, Figure 12, is a prediction of the second recovery performance. Again, this report was issued early in the year, and we show, as I mentioned, August 1, 1961. It will be somewhat later than that, but that does not alter the validity of this prediction. This curve, or this Exhibit shows our estimated performance of their primary, which is labeled primary oil

production. It is a dashed line, a short dashed line. We also show our estimated production under this project. It is labeled water flood oil. This reaches a peak of 4,000 barrels per day of a little over a year after the project is commenced. And this is an increase over the minimum, or at the time of conversion of about 1,200 barrels per day. At the top is shown a curve indicating the injection rate, initially 17,000 barrels of oil per day. This is equivalent to about 500 barrels per day per well, with the exception of some edge wells which will have a lower injection rate, probably in the neighborhood of 150 barrels per day. The reduction, about midway through the flood, itself, a minor reduction in the water injection rate reflects the shutting in of some of the edge injection wells. At the bottom of this Exhibit, the number of wells is shown, one curve labeled producers, the other injectors. The reason for the successive reduction in the number of producing wells can best be shown on the next exhibit. Up in the right-hand corner -- before going to that next exhibit -- Up in the right-hand corner of this Exhibit is a summary of our estimates of production, both under primary means and under water flood. We have already covered these numbers as such.

Q Your curve on water injection obviously contemplates simultaneous injection in all initial injection wells.

A That is correct. We propose to convert all wells simultaneously within physical practicability, and commence

injection of all wells at once.

Q That would be in the neighborhood of a month?

A A minimum of a month, and possibly two or three months, but a very short time span.

Exhibit 13 illustrates the general plan for flooding. The wells with a circle around them are what we call major injectors. The wells with small circles, which along the edge of the field, for the most part are minor injectors. The wells with a square around them we have termed major producers. The wells with no identification are minor producers.

Q Now, starting off on the west side, there, what about the wells on the boundary of the Central Bisti Unit, there?

A Those wells are actually in operation at the present time. They are active water injectors.

Q Now, which ones are you referring to?

A WI4, 5, 6, and 7. No. 45 is in the process of being converted to injection and may, in fact, have to be converted to injection. I am not up to date on those.

Q Those are operated by Sunray as a barrier on the edge of this unit; is that correct?

A That is correct. These were instituted as water injectors to create a barrier at the time the Central Bisti Unit was put into operation.

Q Will it be necessary for you to extend the barrier north and south to some extent?

A To some extent, it will. The conversion of Sunray's 45 Well is a part of that program. At the time we commence our flood, we will convert Well No. 1415, in the Southwest Quarter, to injection, and also No. 3115, in the Northwest Quarter, and in our judgment will complete the water barrier between the two units.

Q Now, what about the similar problem on the east side?

A That problem will be handled in a similar manner, except that existing wells will be used: two injectors on the Carson Unit, and two injectors in the proposed east Bisti Unit. This has been tentatively accepted by the proposed operator of the east Bisti Unit, and we feel that this can be consumated in the near future.

Q Now, you have some extensions on the north and south, there, too, don't you?

A Primarily to the south. I might call attention to Wells 4120, 3220, and 2320 across the Southeast Quarter of the unit. The purpose of this line of wells is to isolate the gas cap which, for the most part, lies to the east of the Carson Unit, but which does lap over into the Southeast Quarter of the Carson Unit.

Q The north and south will pretty well take care of itself, I assume; is that correct?

A Because we have a zero isopack, yes. There will be no problem so far as the boundary on the north and the south sides. I would like to add that you will note that in general the producing

wells, excuse me, the injection wells are in the 20 row, and the primary or principal procedure wells are the 40-row wells. The wells in between, which we call minor producers, we would expect to water out very early in the life of the flood. We would expect some water production within the first year, and after these wells reach a high cut, we would expect to close these wells in and use the major producers for the balance of the life of the flood to recover the bulk of the oil. The water will drive the oil past these minor producers without any significant pressure build up or squeeze such that the center row, or 40-row wells will become the major producers. You will note some variations from a strictly uniform pattern. This is to take account of the variations in the Sands at those particular locations.

Q Is there anything more on 13, there, that you want to add?

A No, sir.

Turning now to our water source problem. Figure 14 is a type log of the Bisti Field which identifies the various formations that are encountered. And on the right side of this log we note a bracket covering the lower Allison-Menefee formation and the Point Lookout formation, which contains 330 feet net sand. This is the interval from which we propose to obtain water for this project. We estimate a rate of 4,000 barrels per well, hence, our estimate of five wells being required. These five wells have been drilled and completed in this formation. The first four have

been completed, Well No. 5 presently being on test. We shortly will complete No. 5. These wells, in general, have measured up to our expectations. The current well is pumping about 3,800 barrels per day.

Q The next witness will discuss the characteristics of the water and the mechanical aspects of it; is that right?

A Yes. I would prefer that he discuss the further problems with the water. I can add that this is lapping over Mr. Quevreaux's testimony. To some extent, these waters in the Point Lookout and Menefee locations are saline, and the waters in the Gallup, and they are compatible, and we anticipate no problems in using these waters or in commingling them after the waters are produced.

Q This is not in an area of any closed water basins?

A That is correct.

Q You have made necessary requirements to secure the water, drilling the wells, and so forth?

A Yes, sir; we have.

Q Now, do you have any other general comments on the plan, that you would like to cover?

A No, sir; I don't.

Q Have you examined the order that covers the Central Bisti Unit, in a general way, the Commission Order?

A Yes, I have.

Q If the Commission considers this application favorably, do you believe an order somewhat similar to that would be workable

and satisfactory in this area, also?

A Yes, sir. We feel that would be satisfactory.

Q Are you requesting, as granted in that order, a project allowable --

A We would prefer to operate on a project allowable.

Q -- for this entire project. And, I believe you are operating now on a monthly tolerance. I assume the same physical conditions would warrant the continuation of that allowable; is that right, or that tolerance?

A We believe that the conditions do warrant the extension of the monthly tolerance, and we would so request that we be permitted to operate on a monthly tolerance.

Q Now, Shell is the operator of the Carson Unit, and presumably you would be the operator of this project if it is approved by the Commission.

A We would be the operator, and I failed to mention that we are the sole working interest owner in this project.

Q Are there any other comments, Mr. Marshall, that you would like to make on this?

A No, sir.

MR. SETH: We would offer the Exhibit 1, then, if the Commission please. Now, we have an additional mechanical witness.

MR. UTZ: Without objection, Exhibit 1 will be entered into the record.

(Whereupon Applicant's Exhibit 1 received in evidence.)

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

Q (By Mr. Nutter) Mr. Marshall, now, you stated, I believe, and probably examination of the cross-sections show that there is more continuity from well to well along the longitudinal axis of the field than north and south; is that correct?

A Yes, sir; that is correct.

Q Well now, actually will the water in driving the oil from the injection wells to the major producing wells be traveling in that direction?

A Yes, sir; it will.

Q So, it will be running along the line of the major continuity?

A That is correct.

Q Now, in most cases, are the wells perforated in both of the main benches of the Gallup formation?

A Yes, sir; they are.

Q So an injection well will be injecting into both Sands, and the producing wells to be producing from both Sands?

A That is correct, and that would also include the Lower Bench, or the GE Sand, which does not have microlog pay, but which will be flooded along with the other two sands. If there is any oil there to recover, this project will recover it.

Q Now, the isopacks of the two individual Sands, the GC and the GD show a gas cap in each of those. It shows water injection wells which will block off that gas cap. Will they be injected into both of those Sands?

A Yes.

Q Now, what about the gas that is in the gas cap? Is that going to be recovered?

A Not in this project. We cannot recover that gas.

Q Will that gas be produced further to the southeast?

A It is possible.

Q The wells in the unit to the east of this are completed in the gas cap; are they not?

A Yes, sir; they are.

Q Now, what did you mean, Mr. Marshall, when you were talking about a monthly tolerance to the production from the well?

A To operate on a monthly project allowable rather than being restricted, necessarily, by the day or the degree to which we could depart from the allowable.

Q In other words, you would want an exception to the daily tolerance requirement, rather than the monthly requirements?

A That is correct.

Q I see. Is this project presently operating with any sort of a daily tolerance, do you know, Mr. Marshall?

MR. SETH: I believe that it has a monthly tolerance.

Now, that is my recollection.

THE WITNESS: The Carson Unit is operating on a monthly tolerance by waiver.

Q (By Mr. Nutter) So there is no daily requirement at the present time?

A That is correct.

MR. NUTTER: I believe that is all.

Q (By Mr. Utz) What is the magnitude of this monthly tolerance?

A I don't understand your question, Mr. Utz. You mean in per cent, or barrels?

Q Well, in per cent or barrels, either one.

A Well, the Sands is 125 per cent as a maximum on the daily.

Q On the individual wells?

A Per well, yes.

Q But, the unit has no tolerance, the allowable for the unit?

A Yes. I understand that.

Q Yes. Now, you stated that you weren't going to be able to recover this gas in these local gas caps. Why is that?

A There are no wells there which are in a position to recover it, and there is so little gas there it is not attractive to make an effort to recover it.

Q I see. You don't intend to inject any gas into this

reservoir at all?

A No, we do not. It will be all water.

Q Would you have any need for the gas equivalent of the Sunray order, in this project?

A We feel it would be desirable. Our estimates of what the allowable might be under a presumed set of orders is approximately equal to our predicted peak rate. So that this may not be necessary, but we feel that it might be necessary to permit the project to operate essentially at capacity.

Q You would want the privilege of shutting in high GOR wells, would you?

A Yes, sir; we would.

MR. UTZ: Are there other questions? The witness may be excused.

MR. SETH: Mr. Kell will examine the next witness.

W. F. QUEVREAUX,

called as a witness herein, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. KELL:

Q Would you state your name.

A Mr. name is W. F. Quevreaux.

Q And your employer?

A Shell Oil Company.

Q Would you spell that name, please?

A Q-u-e-v-r-e-a-u-x.

Q What is your present position with Shell Oil Company?

A I am the Division Mechanical Engineer in Shell's Farmington Division.

Q Would you state, briefly, your educational background.

A I am a graduate with a Bachelor of Science in Mechanical Engineering from the Missouri School of Mines in Rolla, Missouri.

Q Since your graduation, what experience have you had?

A I have been with Shell approximately 13 years. During this time, I have worked in field and office engineer assignments in conjunction with both producing and drilling operations, and for approximately the last 3 years, I have been a supervising mechanical engineer.

Q Are you familiar with the proposed pressure maintenance program in the Carson Unit, particularly with regard to the surface facilities and the water?

A Yes, I am.

Q Have you made a study of these facilities in the general conditions in the Bisti Field?

A Yes, I have.

MR. KELL: Are the witness' qualifications acceptable?

MR. UTZ: Yes, sir; they are.

Q (By Mr. Kell) Has there been a detailed analysis, chemical analysis of the source water which you contemplate utilizing in this pressure maintenance project?

A Yes, sir; there has.

Q And that is Figure 15; is it not?

A That is correct.

Q Would you care to comment upon that and point out any factors you regard as particularly significant.

A Well, generally, Mr. Marshall summarized any statement I could make, in that the salinities of the source water are almost identical to those of the Gallup formation water. The waters are compatible in every respect, both from the chemical analysis and from actual laboratory tests, and, well, essentially those two comments, I believe, are about all I could make.

Q In view of the similarity to the water and their compatibility, you would not, I take it, anticipate any greater or any more problems that might possibly result from corrosion than you would from the regular formation water?

A That is correct. We had actually, in the laboratory, tested the corrosiveness of the cores and the formation water, and find it to be virtually negligible.

Q Now, as a further aid to minimize this corrosion, do you contemplate some kind of a chemical treatment of the water?

A Yes. We have made provision in our flood plan, and I think this could best be depicted by glancing at Figure 16 of Exhibit 1. In direct answer to your question, you will note there are two points in which we have made mechanical plans for the injection of inhibitors, which would be corrosion R scale inhibitors

as required by experience and testing, and also the injection of a bacteria side for the control of bacterial growth.

Q As I understand it, this will also be a closed system in terms of avoiding contact with any oxygen.

A That is correct. The system is entirely gas blanketed and will be free of any air.

Q And that, in turn, should minimize any possible difficulties?

A That is right.

Q Now, most of the casing in these wells, which will be used as injection wells and which will be producers, approximately when was that installed?

A Most of the wells drilled in the Carson Unit were drilled from the latter part of 1957 into the middle part of 1955, so all of the casing is relatively new by normal standards.

Q And this is first-quality casing?

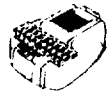
A Yes, sir; it is new casing in almost every case.

Q Do you have some information relative to the cement work that was done in these various wells?

A Yes, we do, which was covered in the next exhibit. Perhaps if the Examiner would like, we can run through, briefly, the surface flow system, and complete our examination of this particular exhibit.

MR. UTZ: Proceed.

THE WITNESS: We have attempted schematically merely



to give these Gentlmen an idea of the very basic flow system that we plan to use, namely, coming from the various source wells and commingling this water with produced water, going through a skimming arrangement to remove any oil which may come over to the produced water, going through a flotation cell and anthracite filter bank for the cleaning of the water, both final cleaning of oil and any suspended solids, and into a clear water storage, through our injection pumps, which, in this case, would be vertical turbine pumps, onto a distribution water system throughout the field, through meters to each of the injector wells, variable chokes to cut volume, and into the injection well proper.

MR. UTZ: What material do you use in your anthracite filters?

THE WITNESS: Coal, grated anthracite beds.

Q (By Mr. Kell) Would it be a fair statement to say that in your past three or four years of operation you have encountered only negligible evidence of any corrosion?

A That is correct.

Q And if in the future you should have some difficulty with corrosion, probably casing, would you anticipate that it would be reflected in a short period of time, in your present facilities?

A That is correct, both from the actual operating viewpoint in that the corrosion would show up in the form of leaks and what have you, but more particularly it is Shell's plan to control, using normal laboratory procedures, the corrosiveness of the

injected water.

Q Do you feel that the current casing program will adequately protect the shallower formations?

A Yes, I do. Referring to Figure 17, which is the last figure of Exhibit 1. This figure represents an average injection well from almost every standpoint: the total depth, the area of existing perforations, the average packer setting depth, casing size, tubing size, and what have you, are arithmetic averages of the injection wells. As you will note, the estimated top of the cement in the injection wells is some 350 feet over the lowermost, or the uppermost perforation. We do not anticipate that we will have any circulation from without the casing into the annulus pores of the casing above the top of the cement.

Q I think Mr. Marshall may have covered it, briefly, but what is your anticipated injection rate in this pressure maintenance project?

A We anticipate that the rate will be in the neighborhood of 17,000 barrels per day, and basically our system is designed to generate approximately 28,000 barrels, if this seems to be advisable.

Q And breaking it down into a per-well rate on your maximum rate injectors, that would come out to approximately what per well?

A Those wells marked as major injectors on the previous Exhibit 1, approximately 500 barrels per day, and minor injectors would be something of the order of 150 barrels per day.

Q And based upon the injection histories of comparable wells in the Central Bisti Unit, do you feel that the wells will be able to accommodate that injection rate?

A Yes, we do.

Q Do you also anticipate that the present source wells will be adequate to supply your water needs for the pressure maintenance project?

A Yes, we do. We are currently testing our existing source wells and plan to make any necessary additions to these wells should the occasion arise to generate the needed 10,000 barrels per day.

Q What is the present status of these facilities that you have described for the Examiner? I mean, are they presently in construction, now?

A Yes, they are. The water wells are drilled and currently being tested. Plant facilities are now under construction.

Q In your opinion, will this pressure maintenance project protect conservation and result in a substantially greater recovery from the resource area involved?

A Yes, sir. As Mr. Marshall pointed out, I think the reserve figures speak for themselves.

MR. KELL: That is all the questions I have.

MR. UTZ: Are there questions of the witness?

MR. NUTTER: Yes, sir.

Q (By Mr. Nutter) Mr. Quevreaux.

A That is correct.

Q Mr. Quevreaux, will all of the injection wells be equipped with a packer?

A Yes, sir. This is our intention. We have one well which has 4 1/2-inch pipe threaded into a couple of drill pipes, and it is our intention to run a packer in it. However, there may be some physical limitations but I believe that we will be able to equip it as this well is shown.

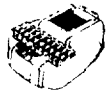
Q In each of the injection wells, the annulus will be filled with an inhibitor?

A That is correct. The question was asked previously in another case of this type of packer, it is also our plan to set a retrievable wall packer complete with any necessary mechanical devices to insure it will stay where we put it.

Q What type of injection pressures do you think you will run into on this project?

A Our current designs to run into, handle 17,000 barrels per day, adding maximum pressure of 1,000 PSI. However, we can expand the pressure rating by the addition of a third pump to generate 1,500 PSI, obviously, the bottom hole pressure now being 500 PSI. The initial injection, until we create some bank, would be on a vacuum.

Q Now, these two turbines that you showed on the diagram, back here, will be all that will be needed as far as you know unless you had to go to higher pressure?



A That is correct. This is an over-simplified drawing, obviously. The pumps run in series, each one being able to handle 20,000 barrels per day at a differential pressure of 500 PSI. We can run one pump and inject at 500 PSI, or run both and inject at 1,000 PSI.

Q And what would you lift the water from the Mesa Verde with, Rita pumps, or pumps of that nature?

A Well, the lower Menefee, we would use a submergible type of pump, a Rita type pump.

Q Now, I noticed in your diagram, and you mentioned that you would use produced water in the system. Is it anticipated that the produced water will amount to a larger percentage of the total imput as the life of the project goes on?

A As I recall, the produced water should not exceed approximately 5,000 BD of the total of 17 barrels.

Q So you will also have a minimum of at least 12,000 barrels from the source well?

A That is correct; yes, sir.

Q And you will drill 5 source wells; is that correct?

A We have 5, and we also had converted one oil well which was drilled south of the line of permeability and which was a dry oil well.

MR. NUTTER: I believe that is all. Thank you.

MR. UTZ: Are there other questions? The witness may be excused.

Do you have anything further.

MR. KELL: No, sir.

MR. UTZ: Are there any other statements to be made in this case? The case will be taken under advisement.

(Whereupon the Hearing of Case 2360 was concluded.)

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STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

I, MICHAEL P. HALL, Court Reporter, do hereby certify that the foregoing and attached transcript of proceedings before the New Mexico Oil Conservation Commission at Santa Fe, New Mexico, is a true and correct record to the best of my knowledge, skill, and ability.

IN WITNESS WHEREOF, I have affixed my hand and notary seal this 30th day of August 1961.

Michael P. Hall
Court Reporter - Notary Public

My Commission expires:

June 20, 1965.

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 2360, heard by me on August 30, 1961.

Examiner
New Mexico Oil Conservation Commission