Case No.

2360

Application, Transcript,
Small Exhibits, Etc.

CASE 2360: Application of SHELL for a pressure maintenance project, San Juan County, New Mexico.

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 microlog?

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 tc 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

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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.)

****

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 July 30, 1961.

Examiner
New Mexico Oil Conservation Commission

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 2360
Order No. R-2065

APPLICATION OF SHELL OIL COMPANY
FOR APPROVAL OF THE CARSON BISTI-
LOWER GALLUP PRESSURE MAINTENANCE
PROJECT, SAN JUAN COUNTY, NEW
MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on August 30, 1961, at Santa Fe, New Mexico, before Elvis A. Utz, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this 19th day of September, 1961, the Commission, a quorum being present, having considered the application, the evidence addused, and the recommendations of the Examiner, Elvis A. Utz, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Shell Oil Company, proposes to institute a pressure maintenance project in the Bisti-Lower Gallup Oil Pool by the injection of water into the Gallup formation in the Carson Unit Area in Sections 7, 17, 18, 19, 20 and 30, Township 25 North, Range 11 West, NMPM, and in Sections 11, 12, 13, 14, 23 and 24, Township 25 North, Range 12 West, NMPM, and in the proposed expansion of said Carson Unit Area in Sections 10 and 15, Township 25 North, Range 12 West, NMPM, all in San Juan County, New Mexico.

(3) That the applicant proposes that an administrative procedure be established whereby said pressure maintenance project may be expanded for good cause shown, and whereby additional wells in the project area may be converted to water injection.

(4) That Special Rules and Regulations for the operation of the Carson Bisti-Lower Gallup Pressure Maintenance Project should be promulgated and, for operational convenience, such rules should provide certain flexibility in authorizing the production of the

project allowable from any well or wells in the project in any proportion, provided that no well in the project area which directly or diagonally offsets a well outside the project area producing from the same common source of supply should be allowed to produce in excess of top unit allowable for the Bisti-Lower Gallup Oil Pool until such time as the well has experienced a substantial response to water injection. When such a response has occurred, the well should be permitted to produce up to two times top unit allowable for the Bisti-Lower Gallup Oil Pool. Production of such well at a higher rate should be authorized only after notice and hearing.

IT IS THEREFORE ORDERED:

(1) That the applicant is hereby authorized to institute a pressure maintenance project in the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico, to be designated as the Carson Bisti Lower-Gallup Pressure Maintenance Project, by the injection of water into the Gallup formation through the following wells:

TOWNSHIP 25 NORTH, RANGE 11 WEST, NMPM
Section 7: No. 24-7;
Section 17: Nos. 1, 23-17, 24-17, 31-17, 43-17;
Section 18: Nos. 21-18, 22-18, 23-18, 24-18;
Section 19: Nos. 21-19, 22-19;
Section 20: Nos. 11-20, 23-20, 32-20, 41-20;
Section 30: No. 11-30;

TOWNSHIP 25 NORTH, RANGE 12 WEST, NMPM
Section 10: No. 31-10;
Section 11: Nos. 22-11, 23-11, 24-11;
Section 12: No. 13-12;
Section 13: Nos. 21-13, 22-13, 23-13; 24-13;
Section 14: Nos. 21-14, 22-14, 23-14, 24-14;
Section 15: No. 14-15;
Section 23: No. 21-23;
Section 24: Nos. 21-24, 23-24, 32-24;

In addition, Mudge 6 Lease Wells No. 12-16A and 14-16A, located in the SW/4 NW/4 and SW/4 SW/4, respectively, of Section 16, Township 25 North, Range 11 West, NMPM, are hereby approved for conversion to water injection, to form a water barrier between the Carson Unit Area and the acreage to the east thereof.

(2) That Special Rules and Regulations governing the operation of the Carson Bisti Lower-Gallup Pressure Maintenance Project, San Juan County, New Mexico, are hereby promulgated as follows:

SPECIAL RULES AND REGULATIONS
FOR THE
CARSON RISTI LOWER-GALLUP PRESSURE MAINTENANCE PROJECT

RULE 1. The project area of the Carson Risti Lower-Gallup Pressure Maintenance Project, hereinafter referred to as the Project, shall comprise that area described as follows:

TOWNSHIP 25 NORTH, RANGE 11 WEST
Section 7: SW/4, S/2 SE/4
Section 17: All
Section 18: All
Section 19: All
Section 20: All
Section 30: W/2 NW/4

TOWNSHIP 25 NORTH, RANGE 12 WEST
Section 10: E/2, E/2 SW/4
Section 11: S/2, SW/4 NE/4, SE/4 NW/4, W/2 NW/4
Section 12: SW/4, S/2 SE/4
Section 13: All
Section 14: All
Section 15: E/2, SW/4, E/2 NW/4
Section 22: NW/4 NE/4
Section 23: NE/4, E/2 SE/4, SE/4 SE/4, E/2 NW/4, NW/4 NW/4
Section 24: All
Section 25: E/2 E/2

RULE 2. The allowable for the Project shall be the sum of the allowables of the several wells within the project area, including those wells which are shut-in, curtailed, or used as injection wells. Allowables for all wells shall be determined in a manner hereinafter prescribed.

RULE 3. Allowables for injection wells may be transferred to producing wells within the project area, as may the allowables for producing wells which, in the interest of more efficient operation of the Project, are shut-in or curtailed because of high gas-oil ratio or are shut-in for any of the following reasons: pressure regulation, control of pattern or sweep efficiencies, or to observe changes in pressures or changes in characteristics of reservoir liquids or progress of sweep.

RULE 4. The allowable assigned to each 80-acre proration unit with one or more injection wells located thereon shall be top unit allowable for the pool. The presence of a producing well on such a unit shall not entitle the unit to any increase in allowable. The allowable assigned to each 40-acre proration unit shall be one-half the top unit allowable for the pool.

RULE 5. The allowable assigned to any well which is shut-in or curtailed in accordance with Rule 3, shall be determined by a 24-hour test at a stabilized rate of production, which shall be the final 24-hour period of a 72-hour test throughout which the well should be produced in the same manner and at a constant rate. The daily tolerance limitation set forth in Commission Rule 502 I (a) and the limiting gas-oil ratio (2,000 to 1) for the Bisti-Lower Gallup Oil Pool shall be waived during such tests. The project operator shall notify all operators offsetting the well, as well as the Commission, of the exact time such tests are to be conducted. Tests may be witnessed by representatives of the offsetting operators and the Commission, if they so desire.

RULE 6. The allowable assigned to a proration unit with one or more producing wells but no injection wells located thereon shall be equal to the wells' ability to produce or to top unit allowable for the Bisti-Lower Gallup Oil Pool subject to the proration units' acreage factor, whichever is less. Each producing well shall be subject to the limiting gas-oil ratio (2,000 to 1) for the Bisti-Lower Gallup Oil Pool, except that any well or wells within the project area producing with a gas-oil ratio in excess of 2,000 cubic feet of gas per barrel of oil may be produced on a "net" gas-oil ratio basis, which net gas-oil ratio shall be determined by applying credit for daily average gas injected, if any, into the Bisti-Lower Gallup Oil Pool within the project area to such high gas-oil ratio well. The daily adjusted oil allowable for any well receiving gas injection credit shall be determined in accordance with the following formula:

$$A_{adj} = \frac{TUA \times F_a \times 2{,}000}{\frac{P_g - I_g}{P_o}}$$

Where:

A_{adj} = the well's daily adjusted allowable

TUA = top unit allowable for the pool

F_a = the well's acreage factor

P_g = average daily volume of gas produced by the well during the preceding month, cubic feet

I_g = the well's allocated share of the daily average gas injected during the preceding month, cubic feet

P_o = average daily volume of oil produced by the well during the preceding month, barrels

In no event shall the amount of injected gas being credited to a well be such as to cause the net gas-oil ratio, $\frac{P_g - I_g}{P_o}$, to be less than 2,000 cubic feet of gas per barrel of oil produced.

RULE 7. Credit for daily average net water injected into the Bisti-Lower Gallup Oil Pool through any injection well located within the project area may be converted to its gas equivalent and applied to any well producing with a gas-oil ratio in excess of two thousand cubic feet of gas per barrel of oil. Total credit for net water injected in the project area shall be the gas equivalent volume of the daily average net water injected during a one-month period. The daily average gas equivalent of net water injected shall be computed in accordance with the following formula:

$$E_g = (V_{w\ inj} - V_{w\ prod}) \times 5.61 \times \frac{P_a}{15.025} \times \frac{520^\circ}{T_r} \times \frac{1}{Z}$$

where:

E_g = Average daily gas equivalent of net water injected, cubic feet

$V_{w\ inj}$ = Average daily volume of water injected, barrels

$V_{w\ prod}$ = Average daily volume of water produced, barrels

5.61 = Cubic foot equivalent of one barrel of water

P_a = Average reservoir pressure at mid-point of the pay-zones of Bisti Lower-Gallup Oil Pool in project area, psig + 11.5, as determined from most recent survey

15.025 = Pressure base, psi

520° = Temperature base of 60°F expressed as absolute temperature

T_r = Reservoir temperature of 145°F expressed as absolute temperature (605°R)

Z = Compressibility factor from analysis of Bisti-Lower Gallup gas at average reservoir

pressure, P_a, interpolated from compressibility tabulation below:

Reservoir Pressure	Z	Reservoir Pressure	Z
50	.9950	800	.9000
100	.9900	850	.8938
150	.9825	900	.8875
200	.9775	950	.8825
250	.9725	1000	.8775
300	.9625	1050	.8713
350	.9563	1100	.8663
400	.9500	1150	.8600
450	.9425	1200	.8550
500	.9363	1250	.8500
550	.9300	1300	.8450
600	.9238	1350	.8400
650	.9175	1400	.8360
700	.9115	1450	.8325
750	.9050		

RULE 8. Each month the project operator shall, within three days after the normal unit allowable for Northwest New Mexico has been established, submit to the Commission a Pressure Maintenance Project Operator's Report, on a form prescribed by the Commission, outlining thereon the data required, and requesting allowables for each of the several wells in the Project as well as the total Project allowable. The aforesaid Pressure Maintenance Project Operator's Report shall be filed in lieu of Form C-120 for the Project.

RULE 9. The Commission shall, upon review of the report and after any adjustments deemed necessary, calculate the allowable for each well in the Project for the next succeeding month in accordance with these rules. The sum of the allowables so calculated shall be assigned to the Project and may be produced from the wells in the Project in any proportion.

RULE 10. The conversion of producing wells to injection, the drilling of additional wells for injection, and expansion of the project area shall be accomplished only after approval of the same by the Secretary-Director of the Commission. To obtain such approval, the Project operator shall file proper application with the Commission, which application, if it seeks authorization to convert additional wells to injection or to drill additional injection wells shall include the following:

(1) A plat showing the location of proposed injection

well, all wells within the project area, and offset operators, locating wells which offset the project area.

(2) A schematic drawing of the proposed injection well which fully describes the casing, tubing, perforated interval, and depth showing that the injection of gas or water will be confined to the Gallup formation.

(3) A letter stating that all offset operators to the proposed injection well have been furnished a complete copy of the application and the date of notification.

The Secretary-Director may approve the proposed injection well if, within 20 days after receiving the application, no objection to the proposal is received. The Secretary-Director may grant immediate approval, provided waivers of objection are received from all offset operators.

Expansion of the project area may be approved by the Secretary-Director of the Commission administratively when good cause is shown therefor.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

EDWIN L. MECHEM, Chairman

R. S. WALKER, Member

A. L. PORTER, Jr., Member & Secretary

esr/

GOVERNOR
EDWIN L. MECHEM
CHAIRMAN

State of New Mexico
Oil Conservation Commission

LAND COMMISSIONER
E. S. JOHNNY WALKER
MEMBER

STATE GEOLOGIST
A. L. PORTER, JR.
SECRETARY – DIRECTOR

P. O. BOX 871
SANTA FE

September 19, 1961

Re: Case No. 2360
Order No. R-2065
Applicant:
SHELL OIL COMPANY

Mr. Oliver Seth
Seth, Montgomery, Federici & Andrews
P. O. Box 828
Santa Fe, New Mexico

Dear Sir:

Enclosed herewith are two copies of the above-referenced Commission order recently entered in the subject case.

Very truly yours,

A. L. Porter, Jr.

A. L. PORTER, Jr.
Secretary-Director

ir/

Carbon copy of order also sent to:

Hobbs OCC x
Artesia OCC
Aztec OCC x
OTHER

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 1979
Order No. R-1699

APPLICATION OF THE ATLANTIC REFINING
COMPANY FOR A PRESSURE MAINTENANCE
PROJECT IN THE HORSESHOE-GALLUP OIL
POOL, SAN JUAN COUNTY, NEW MEXICO,
AND FOR THE PROMULGATION OF SPECIAL
RULES GOVERNING THE OPERATION OF
SAID PROJECT.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on June 1, 1960, at Santa Fe, New Mexico, before Elvis A. Utz, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this 10th day of June, 1960, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Elvis A. Utz, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, The Atlantic Refining Company, proposes to institute a pressure maintenance project in the Horseshoe-Gallup Oil Pool, San Juan County, New Mexico, by the injection of water into the Gallup formation through 15 wells initially, all of which wells are within the proposed project area which consists of the following-described acreage:

TOWNSHIP 31 NORTH, RANGE 16 WEST, NMPM

Section 18:	S/2 SW/4
Section 19:	W/2, W/2 E/2, SE/4 NE/4 and the E/2 SE/4
Section 20:	S/2, S/2 NW/4 and the SW/4 NE/4
Section 29:	All
Section 30:	All
Section 31:	E/2, E/2 W/2, NW/4 SW/4 and the W/2 NW/4
Section 32:	All

(3) That the applicant proposes that each month an allowable be established for the Horseshoe-Gallup Pressure Maintenance Project, said allowable to be determined by multiplying the current Northwest New Mexico normal unit allowable for a 40-acre proration unit times the number of 40-acre proration units in the project area on which an injection well is located, plus a normal unit allowable for each 40-acre proration unit on which is located a producing well which has received a response to the water injection, plus an amount for each 40-acre proration unit on which a producing well is located which has not received a response to water injection equal to the well's ability to produce up to normal unit allowable.

(4) That the "response" feature of the applicant's proposed project allowable formula would add considerably to the complexity of administering the project allowable, and it is not necessary from the standpoint of conservation or the protection of correlative rights, nor is it warranted on the basis of economics.

(5) That the necessary investment in order to develop a pressure maintenance project is based in large part on the total number of injection wells required for the efficient operation of the project, and the assignment of a top unit allowable to each injection well, together with the expected increased oil recovery, is an entirely adequate incentive for an operator to initiate a pressure maintenance project.

(6) That the allowable assigned to any producing well in the project area should be no greater than the demonstrated ability of the well to produce, subject to top unit allowable for the Pool. In the case of curtailed or shut-in producing wells, the allowable should be no greater than the demonstrated ability of such well to produce as reflected by a 24-hour test at a stabilized rate of production immediately prior to such shut-in or curtailment. In no event should such allowable be greater than the current normal unit allowable for the Horseshoe-Gallup Oil Pool during the month of transfer.

(7) That the applicant also proposes that an administrative procedure be established whereby the pressure maintenance project may be expanded for good cause shown, and whereby additional wells in the project area may be converted to water injection.

(8) That Special Rules and Regulations for the operation of the Horseshoe-Gallup Pressure Maintenance Project should be promulgated and, for operational convenience, such rules should provide certain flexibility in authorizing the production of the project allowable from any well or wells in the project in any proportion, provided that no well in the project area which directly or diagonally offsets a well outside the project area producing from the same common source of supply should be allowed

to produce in excess of two times top unit allowable for the Horseshoe-Gallup Oil Pool.

IT IS THEREFORE ORDERED:

(1) That the applicant be and the same is hereby authorized to institute a Pressure Maintenance Project in the Horseshoe-Gallup Oil Pool, San Juan County, New Mexico, by the injection of water into the Gallup formation through the following-described wells in Township 31 North, Range 16 West:

Navajo "B" Well No. 1, Unit N, Section 19
Navajo "B" Well No. 3, Unit P, Section 19
Navajo "B" Well No. 4, Unit J, Section 19
Navajo "B" Well No. 5, Unit F, Section 19
Navajo "B" Well No. 7, Unit N, Section 20
Navajo "B" Well No. 8, Unit L, Section 20
Navajo "A" Well No. 22, Unit J, Section 29
Navajo "A" Well No. 23, Unit F, Section 29
Navajo "A" Well No. 24, Unit D, Section 29
Navajo "A" Well No. 26, Unit B, Section 29
Navajo "A" Well No. 9, Unit B, Section 30
Navajo "A" Well No. 16, Unit H, Section 31
Navajo "A" Well No. 17, Unit B, Section 31
Navajo "A" Well No. 28, Unit J, Section 31
Navajo "A" Well No. 29, Unit F, Section 31

(2) That Special Rules and Regulations governing the operation of The Atlantic Refining Company Horseshoe-Gallup Pressure Maintenance Project, San Juan County, New Mexico, be and the same are hereby promulgated as follows, effective July 1, 1960:

SPECIAL RULES AND REGULATIONS FOR THE ATLANTIC REFINING COMPANY HORSESHOE-GALLUP PRESSURE MAINTENANCE PROJECT

RULE 1. The project area of The Atlantic Refining Company Horseshoe-Gallup Pressure Maintenance Project, hereinafter referred to as the Project, San Juan County, New Mexico shall comprise that area described as follows:

TOWNSHIP 31 NORTH, RANGE 16 WEST, NMPM

Section 18:	S/2 of the SW/4
Section 19:	W/2, W/2 E/2, SE/4 NE/4 and the E/2 SE/4
Section 20:	S/2, S/2 NW/4, SW/4 NE/4
Section 29:	All
Section 30:	All
Section 31:	E/2, E/2 W/2, NW/4 SW/4 and the W/2 NW/4
Section 32:	All

RULE 2. The allowable for the Project shall be the sum of the allowables of the several wells within the project area, including those wells which are shut-in, curtailed, or used as injection wells. Allowables for all wells shall be determined in a manner hereinafter prescribed.

RULE 3. Allowables for injection wells may be transferred to producing wells within the project area, as may the allowables for producing wells which, in the interest of more efficient operation of the Project, are shut-in or curtailed because of high gas-oil ratio or are shut-in for any of the following reasons: pressure regulation, control of pattern or sweep efficiencies, or to observe changes in pressures or changes in characteristics of reservoir liquids or progress of sweep.

RULE 4. The allowable assigned to any well which is shut-in or which is curtailed in accordance with the provisions of Rule 3, which allowable is to be transferred to any well or wells in the project area for production, shall in no event be greater than its ability to produce during the test prescribed by Rule 6, below, or greater than the current top unit allowable for the pool during the month of transfer, whichever is less.

RULE 5. The allowable assigned to any injection well on a 40-acre proration unit shall be top unit allowable for the Horseshoe-Gallup Oil Pool.

RULE 6. The allowable assigned to any well which is shut-in or curtailed in accordance with Rule 3, shall be determined by a 24-hour test at a stabilized rate of production, which shall be the final 24-hour period of a 72-hour test throughout which the well should be produced in the same manner and at a constant rate. The daily tolerance limitation set forth in Commission Rule 502 I (a) and the limiting gas-oil ratio (2,000 to 1) for the Horseshoe-Gallup Oil Pool shall be waived during such tests. The project operator shall notify all operators offsetting the well, as well as the Commission, of the exact time such tests are to be conducted. Tests may be witnessed by representatives of the offsetting operators and the Commission, if they so desire.

RULE 7. The allowable assigned to each producing well in the Project shall be equal to the well's ability to produce or to top unit allowable for the Horseshoe-Gallup Oil Pool, whichever is less, provided that any producing well in the project area which directly or diagonally offsets a well outside the project area producing from the same common source of supply shall not produce in excess of two times top unit allowable for the pool. Each producing well shall be subject to the limiting gas-oil ratio (2,000 to 1) for the Horseshoe-Gallup Oil Pool, except that any well or wells within the project area producing with a gas-oil ratio in excess of 2,000 cubic feet of gas per barrel of oil may be

produced on a "net" gas-oil ratio basis, which net gas-oil ratio shall be determined by applying credit for daily average gas injected, if any, into the Horseshoe-Gallup Oil Pool within the project area to such high gas-oil ratio well. The daily adjusted oil allowable for any well receiving gas injection credit shall be determined in accordance with the following formula:

$$A_{adj} = \frac{TUA \times F_a \times 2{,}000}{\frac{P_g - I_g}{P_o}}$$

where:

A_{adj} = the well's daily adjusted allowable

TUA = top unit allowable for the pool

F_a = the well's acreage factor

P_g = average daily volume of gas produced by the well during the preceding month, cubic feet

I_g = the well's allocated share of the daily average gas injected during the preceding month, cubic feet

P_o = average daily volume of oil produced by the well during the preceding month, barrels

In no event shall the amount of injected gas being credited to a well be such as to cause the net gas-oil ratio, $\frac{P_g - I_g}{P_o}$, to be less than 2,000 cubic feet of gas per barrel of oil produced.

RULE 8. Credit for daily average net water injected into the Horseshoe-Gallup Oil Pool through any injection well located within the project area may be converted to its gas equivalent and applied to any well producing with a gas-oil ratio in excess of two thousand cubic feet of gas per barrel of oil. Total credit for net water injected in the project area shall be the gas equivalent volume of the daily average net water injected during a one-month period. The daily average gas equivalent of net water injected shall be computed in accordance with the following formula:

$$E_g = (V_{w\ inj} - V_{w\ prod}) \times 5.61 \times \frac{P_a}{15.025} \times \frac{520^{\circ}}{T_r} \times \frac{1}{Z}$$

where:

E_g = Average daily gas equivalent of net water injected, cubic feet

$V_{w\ inj}$ = Average daily volume of water injected, barrels

$V_{w\ prod}$ = Average daily volume of water produced, barrels

5.61 = Cubic foot equivalent of one barrel of water

P_a = Average reservoir pressure at mid-point of the pay-zones of Horseshoe-Gallup Oil Pool in project area, psig + 12.01, as determined from most recent survey

15.025 = Pressure base, psi

520^o = Temperature base of 60^oF expressed as absolute temperature

T_r = Reservoir temperature of 87^oF expressed as absolute temperature (547^oR)

Z = Compressibility factor from analysis of Horseshoe-Gallup gas at average reservoir pressure, P_a, interpolated from compressibility tabulation below:

Reservoir Pressure	Z	Reservoir Pressure	Z	Reservoir Pressure	Z
50	.9725	300	.8325	550	.6560
100	.9465	350	.8030	600	.6135
150	.9215	400	.7710	650	.5655
200	.8885	450	.7220	700	.5220
250	.8600	500	.6900	750	.4630
				800	.3935

RULE 9. Each month the project operator shall, within three days after the normal unit allowable for Northwest New Mexico has been established, submit to the Commission a Pressure Maintenance Project Operator's Report, on a form prescribed by the Commission, outlining thereon the data required, and requesting allowables for each of the several wells in the Project as well as the total Project allowable. The aforesaid Pressure Maintenance Project Operator's Report shall be filed in lieu of Form C-120 for the Project.

RULE 10. The Commission shall, upon review of the report and

after any adjustments deemed necessary, calculate the allowable for each well in the Project for the next succeeding month in accordance with these rules. The sum of the allowables so calculated shall be assigned to the Project and may be produced from the wells in the Project in any proportion except that no well in the Project which directly or diagonally offsets a well outside the Project producing from the same common source of supply shall produce in excess of two times top unit allowable for the Pool.

RULE 11. The conversion of producing wells to injection, the drilling of additional wells for injection, and expansion of the project area shall be accomplished only after approval of the same by the Secretary-Director of the Commission. To obtain such approval, the Project operator shall file proper application with the Commission, which application, if it seeks authorization to convert additional wells to injection or to drill additional injection wells shall include the following:

(1) A plat showing the location of proposed injection well, all wells within the project area, and offset operators, locating wells which offset the project area.

(2) A schematic drawing of the proposed injection well which fully describes the casing, tubing, perforated interval, and depth showing that the injection of gas or water will be confined to the Gallup formation.

(3) A letter stating that all offset operators to the proposed injection well have been furnished a complete copy of the application and the date of notification.

The Secretary-Director may approve the proposed injection well, if within 20 days after receiving the application, no objection to the proposal is received. The Secretary-Director may grant immediate approval, provided waivers of objection are received from all offset operators.

Expansion of the project area may be approved by the Secretary-Director of the Commission administratively when good cause is shown therefor.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

S E A L

esr/

A. L. PORTER, Jr., Member & Secretary

No. 24-61

DOCKET: EXAMINER HEARING - WEDNESDAY - AUGUST 30, 1961

9:00 A.M. - OIL CONSERVATION COMMISSION CONFERENCE ROOM
STATE LAND OFFICE BUILDING - SANTA FE, NEW MEXICO

The following cases will be heard before Elvis A. Utz, Examiner, or Daniel S. Nutter, as alternate examiner:

Cases 2368 through 2372 will not be heard before 1:00 P.M.

CASE 2359: Application of Shell Oil Company for a pilot water flood project in the Townsend-Wolfcamp Pool, Lea County, New Mexico. Applicant, in the above-styled cause, seeks permission to institute a pilot water flood project in the Townsend-Wolfcamp Pool with water injection initially to be through the Texas Pacific Coal & Oil Company State "J" Well No. 2, located in the NE/4 SW/4 of Section 10, Township 16 South, Range 35 East, Lea County, New Mexico.

CASE 2360: 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 and 22, Township 25 North, Range 12 West, San Juan County, New Mexico.

CASE 2361: Application of Shell Oil Company for an exception to Rule 303, Lea County, New Mexico. Applicant, in the above-styled cause, seeks an exception to Rule 303 to permit commingling of the production from the Terry-Blinebry, Drinkard, and Hare Pools on its Taylor Glenn Lease, located in Sections 3 and 4, Township 21 South, Range 37 East, Lea County, New Mexico, and to allocate production to each pool on the basis of monthly well tests.

CASE 2362: Application of Shell Oil Company for an exception to Rule 303, Lea County, New Mexico. Applicant, in the above-styled cause, seeks an exception to Rule 303 to permit commingling of the production from the Brunson and Hare Pools on its State (Section 2) Lease located in Section 2, Township 21 South, Range 37 East, Lea County, New Mexico. Applicant further proposes to commingle the production from the Terry-Blinebry, Drinkard, Tubb and Wantz-Abo Pools on its said State (Section 2) Lease. Applicant proposes to allocate production to each pool on the basis of monthly well tests.

CASE 2363: Application of Shell Oil Company for exceptions to Rules 303 and 309, Lea County, New Mexico. Applicant, in the above-styled cause, seeks exceptions to Rules 303 and 309 to permit commingling of the production from the Drinkard, Blinebry, and Wantz-Abo Pools and from the Brunson and Hare Pools on its Argo-Argo (A) Lease in Sections 15 and 22, Township 21 South, Range 37 East, and to commingle the production from the aforesaid pools on its Turner Lease in said Section 22, allocating the production from each pool on each of the aforesaid leases on the basis of monthly well tests. Applicant further proposes to commingle the commingled production from each lease, prior to treating, allocating the production to each lease on the basis of continuous metering and sampling.

CASE 2364: Application of Texaco Inc. for a triple completion, Lea County, New Mexico. Applicant, in the above-styled cause, seeks permission to complete its A. H. Blinebry NCT-1 Well No. 14, located in Unit M, Section 28, Township 22 South, Range 38 East, Lea County, New Mexico, as a triple completion (conventional), in the South Paddock, Tubb and Drinkard Pools, the production of oil from each pool to be through parallel strings of 2 3/8 inch tubing.

CASE 2365: Application of Texaco Inc. for a triple completion, Lea County, New Mexico. Applicant, in the above-styled cause, seeks permission to complete its G. L. Erwin (b) NCT-2 Well No. 1, located in Unit P, Section 35, Township 24 South, Range 37 East, Lea County, New Mexico, as a triple completion (conventional) in undesignated Fusselman, McKee and Ellenburger pools, the production of oil from each pool to be through parallel strings of 2 3/8 inch tubing.

CASE 2366: Application of Texaco Inc. for a non-standard gas proration unit, Lea County, New Mexico. Applicant, in the above-styled cause, seeks the establishment of a 198.64-acre non-standard gas proration unit in the Jalmat Gas Pool, consisting of the SW/4 NW/4 of Section 4, and the NE/4 of Section 5, all in Township 24 South, Range 37 East, Lea County, New Mexico; said unit is to be dedicated to applicant's E. D. Fanning Well No. 7, located 1980 feet from the North and East lines of said Section 5.

CASE 2367: Application of Skelly Oil Company for an unorthodox gas proration unit in the Jalmat Gas Pool, Lea County, New Mexico. Applicant, in the above-styled cause, seeks the establishment of a 320-acre non-standard gas proration unit in the Jalmat Gas Pool, consisting of the NE/4, NW/4 SE/4, N/2 SW/4 and SW/4 SW/4 of Section 17, Township 23 South, Range 37 East, Lea County, New Mexico; said unit is to be dedicated to the E. L. Steeler Well No. 7, located 1980 feet from the South line and 660 feet from the West line of said Section 17.

The following cases will not be heard before 1:00 P.M.

CASE 2368: Application of Sinclair Oil & Gas Company for an exception to Rule 309, Lea County, New Mexico. Applicant, in the above-styled cause, seeks permission to commingle the Devonian oil production from its C. S. Stone lease, comprising the N/2 of Section 22, from its Reed Estate Lease, comprising the SE/4 of Section 22, and from its B. D. Buckley Lease, comprising the SW/4 of Section 22, all in Township 15 South, Range 38 East, Lea County, New Mexico, after separately metering the production from each lease.

CASE 2369: Application of Sunray Mid-Continent Oil Company for a dually completed oil-producing salt water disposal well, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks permission to dually complete its State "O" Well No. 3, located in Unit O, Section 12, Township 19 South, Range 28 East, Eddy County, New Mexico, in such a manner as to permit the production of oil through tubing from perforations at 1763 feet to 2178 feet and to dispose of produced salt water through the casing-tubing annulus into the Rustler Anhydrite and Yates formation through perforations at 386 feet to 884 feet.

CASE 2370: Application of Newmont Oil Company for special rules governing its Square Lake Pool Waterflood Project, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks the establishment of special rules governing its Square Lake Pool Waterflood Project in Eddy County, New Mexico, to include provisions for the immediate conversion to water injection of certain wells in said project and the conversion of additional wells to water injection at later stages in the life of said waterflood project.

CASE 2371: Application of Hudson & Hudson for an unorthodox oil well location, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks permission to locate its Puckett "B" Well No. 19, at an unorthodox oil well location in the Maljamar (Grayburg-San Andres) Pool, 2615 feet from the South and West lines of Section 25, Township 17 South, Range 31 East, Eddy County, New Mexico.

CASE 2372: Application of Aztec Oil & Gas Company for an unorthodox oil well location and for a non-standard oil proration unit in the Cha Cha-Gallup Oil Pool, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks the establishment of an 86.02-acre non-standard oil proration unit in the Cha Cha-Gallup Oil Pool, consisting of Lot 4 and the NE/4 SE/4 and SW/4 SE/4 of Section 30, Township 29 North, Range 13 West, San Juan County, New Mexico, to be dedicated to the Hagood Well No. 29-G to be located at an unorthodox location 450 feet from the South line and 3600 feet from the East line of said Section 30.

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Case 2360

J. O. SETH
A. K. MONTGOMERY
OLIVER SETH
Wm. FEDERICI
FRANK ANDREWS
FRED C. HANNAHS
GEORGE A. GRAHAM, JR.

SETH, MONTGOMERY, FEDERICI & ANDREWS
ATTORNEYS AND COUNSELORS AT LAW
301 DON GASPAR AVENUE
SANTA FE, NEW MEXICO

POST OFFICE BOX 828
TELEPHONE YU 3-7315

August 10, 1961

New Mexico Oil Conservation Commission
P. O. Box 871
Santa Fe, New Mexico

Attention: Mr. A. L. Porter, Jr.
Secretary-Director

Re: Application by Shell Oil Company for Hearing on Injection Program, Carson Unit Participating Areas (as expanded) Bisti Field, San Juan County, New Mexico.

Gentlemen:

We telephoned you yesterday requesting that two corrections be made in our application of August 7 in the above matter which was submitted on behalf of Shell Oil Company. The first correction was in the first paragraph to show the township should be 25 N., rather than 26 N.

The second correction was to add to the description following the first paragraph the $NE\frac{1}{4}NE\frac{1}{4}$ of Section 22.

We appreciate your making these changes for us and hope it did not inconvenience you.

Very truly yours,

OS:wcl

Received 8-17-61

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION OF THE STATE OF NEW MEXICO FOR THE PURPOSE OF CONSIDERING:

CASE NO. 1085
Order No. R-828

THE APPLICATION OF SHELL OIL COMPANY FOR THE APPROVAL OF THE CARSON UNIT AGREEMENT, EMBRACING 23.045 ACRES, MORE OR LESS, LOCATED IN TOWNSHIP 25 NORTH, RANGE 11 WEST AND TOWNSHIP 25 NORTH, RANGE 12 WEST, NMPM, SAN JUAN COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 10 o'clock a.m. on June 21, 1956 at Santa Fe, New Mexico, before Warren W. Mankin, Examiner duly appointed by the Oil Conservation Commission of New Mexico, in accordance with Rule 1214 of the Commission's Statewide Rules and Regulations.

NOW, on this 22nd day of June, 1956, the Oil Conservation Commission of New Mexico, a quorum being present, having considered the application, the evidence presented and the recommendations of the Examiner, Warren W. Mankin, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the proposed unit plan will in principle tend to promote the conservation of oil and gas and the prevention of waste.

IT IS THEREFORE ORDERED:

Section 1. That this order shall be known as the

CARSON UNIT AGREEMENT ORDER

Section 2. (a) That the project herein referred to shall be known as the Carson Unit Agreement and shall hereafter be referred to as the "Project".

(b) That the plan by which the project shall be operated shall be embraced in the form of a unit agreement for the development and operation of the Carson Unit Area, referred to in the petitioner's petition and filed with said petition, and such plan shall be known as the Carson Unit Agreement Plan.

Section 3. That the Carson Unit Agreement Plan shall be, and hereby is, approved in principle as a proper conservation measure; provided, however, that notwithstanding any of the provisions contained in said unit agreement, this approval shall not be considered as waiving or relinquishing in any manner, any right, duties or obligations which are now, or may hereafter, be vested in the New Mexico Oil Conservation Commission by law relative to the supervision and control of operations for exploration and development of any lands committed to said Carson Unit Agreement, or relative to the production of oil or gas therefrom.

Section 4. That the Unit Area shall be:

NEW MEXICO PRINCIPAL MERIDIAN

Township 25 North, Range 11 West
All of Sections 5 to 8, inclusive; 17 to 20 inclusive; and 29 to 32 inclusive;

Township 25 North, Range 12 West
All of Sections 1 to 4 inclusive; 9 to 16 inclusive; 21 to 28 inclusive; and 33 to 36 inclusive;

containing 23,045 acres, more or less.

Section 5. That the unit operator shall file with the Commission an executed original or executed counterpart of the Carson Unit Agreement within 30 days after the effective date thereof.

Section 6. That any party owning rights in the unitized substances who does not commit such rights to said unit agreement before the effective date thereof, may thereafter become a party thereto by subscribing to such agreement or counterpart thereof, or by ratifying the same. The unit operator shall file with the Commission within 30 days an original of any such counterpart of ratification.

Section 7. That this order shall become effective upon approval of said unit agreement by the Commissioner of Public Lands of the State of New Mexico and the Director of the United States Geological Survey and shall terminate ipso facto upon the termination of said unit agreement. The last unit operator shall immediately notify the Commission in writing of such termination.

DONE at Santa Fe, New Mexico on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN F. SIMMS, Chairman

E. S. WALKER, Member

A. L. PORTER, Jr., Member & Secretary

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BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION OF THE STATE OF NEW MEXICO FOR THE PURPOSE OF CONSIDERING:

CASE NO. 1085
Order No. R-828-A

THE APPLICATION OF SHELL OIL COMPANY FOR THE APPROVAL OF THE CARSON UNIT AGREEMENT, EMBRACING 15,366 ACRES, MORE OR LESS, LOCATED IN TOWNSHIP 25 NORTH, RANGE 11 WEST AND TOWNSHIP 25 NORTH, RANGE 12 WEST, NMPM, SAN JUAN COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 10 o'clock a.m. on June 21, 1956, and at 9:00 o'clock a.m. on September 9, 1956, at Santa Fe, New Mexico, before Warren W. Mankin, Examiner duly appointed by the Oil Conservation Commission of New Mexico, in accordance with Rule 1214 of the Commission's Statewide Rules and Regulations.

NOW, on this 13th day of September, 1956, the Oil Conservation Commission of New Mexico, a quorum being present, having considered the application, the evidence presented and the recommendations of the Examiner, Warren W. Mankin, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant has requested an amended order redefining the horizontal limits of the Carson Unit Area.

(3) That the proposed unit plan will in principle tend to promote the conservation of oil and gas and the prevention of waste.

IT IS THEREFORE ORDERED:

SECTION 1. That Order R-828, entered June 22, 1956, be and the same is hereby superseded.

SECTION 2. That this order shall be known as the

CARSON UNIT AGREEMENT ORDER

SECTION 3. (a) That the project herein referred to shall be known as the Carson Unit Agreement and shall hereafter be referred to as the "Project."

(b) That the plan by which the project shall be operated shall be embraced in the form of a unit agreement for the development and operation of the Carson Unit Area, referred to in the petitioner's petition and filed with said petition, and such plan shall be known as the Carson Unit Agreement Plan.

SECTION 4. That the Carson Unit Agreement Plan shall be, and hereby is, approved in principle as a proper conservation measure; provided, however, that notwithstanding any of the provisions contained in said unit agreement, this approval shall not be considered as waiving or relinquishing in any manner, any right, duties or obligations which are now, or may hereafter, be vested in the New Mexico Oil Conservation Commission by law relative to the supervision and control of operations for exploration and development of any lands committed to said Carson Unit Agreement, or relative to the production of oil or gas therefrom.

SECTION 5. That the Unit Area shall be:

NEW MEXICO PRINCIPAL MERIDIAN

TOWNSHIP 25 NORTH, RANGE 11 WEST
All of Sections 5 to 8, inclusive;
17 to 20 inclusive; and 29 to 32
inclusive;

TOWNSHIP 25 NORTH, RANGE 12 WEST
All Section 1; All Section 2;
All Sections 11 through 14 inclusive;
All Sections 23 through 26 inclusive;
All Section 35; All Section 36;

containing 15,366 acres, more or less.

SECTION 6. That the unit operator shall file with the Commission an executed original or executed counterpart of the Carson Unit Agreement within 30 days after the effective date thereof.

SECTION 7. That any party owning rights in the unitized substances who does not commit such rights to said unit agreement before the effective date thereof, may thereafter become a party thereto by subscribing to such agreement or counterpart thereof, or by ratifying the same. The unit operator shall file with the Commission within 30 days an original of any such counterpart of ratification.

SECTION 8. That this order shall become effective upon approval of said unit agreement by the Commissioner of Public Lands of the State of New Mexico and the Director of the United States Geological Survey and shall terminate ipso facto upon the termination of said unit agreement.

The last unit operator shall immediately notify the Commission in writing of such termination.

DONE at Santa Fe, New Mexico on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN F. SIMMS, Chairman

E. S. WALKER, Member

A. L. PORTER, Jr., Member & Secretary

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J. O. SETH
A. K. MONTGOMERY
OLIVER SETH
Wm. FEDERICI
FRANK ANDREWS
FRED C. HANNAHS
GEORGE A. GRAHAM, JR.

SETH, MONTGOMERY, FEDERICI & ANDREWS
ATTORNEYS AND COUNSELORS AT LAW
301 DON GASPAR AVENUE
SANTA FE, NEW MEXICO

POST OFFICE BOX 828
TELEPHONE YU 3-7315

Case 2360

August 8, 1961

New Mexico Oil Conservation Commission
Post Office Box 871
Santa Fe, New Mexico

Attention: Mr. A. L. Porter, Jr.
Secretary-Director

Re: Application by Shell Oil Company for Hearing on Injection Program, Carson Unit Participating Areas (as expanded) Bisti Field, San Juan County, New Mexico.

Gentlemen:

With reference to our August 7th letter of application on the above captioned matter, please find attached logs of the injection wells.

Very truly yours,

SHELL OIL COMPANY

By Oliver Seth

OS:dd
Attachments

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 1663
Order No. R-1416

APPLICATION OF BRITISH-AMERICAN
OIL PRODUCING COMPANY FOR
PERMISSION TO INSTITUTE A WATER
INJECTION PROJECT IN THE BISTI-
LOWER GALLUP OIL POOL, SAN JUAN
COUNTY, NEW MEXICO, AND FOR THE
PROMULGATION OF SPECIAL RULES
AND REGULATIONS GOVERNING SAID
PROJECT

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on May 12, 1959, at Santa Fe, New Mexico, before Daniel S. Nutter, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this 5th day of June, 1959, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Daniel S. Nutter, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, British-American Oil Producing Company, is the operator of the following-described acreage in the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico:

TOWNSHIP 25 NORTH, RANGE 13 WEST, NMPM
Section 1: All
Section 12: All

TOWNSHIP 26 NORTH, RANGE 13 WEST, NMPM
Section 35: All

(3) That the applicant proposes to institute a water injection project, for the purpose of pressure maintenance, on said acreage by the injection of water into the entire Lower Gallup perforated intervals of the following-described wells:

British-American Marye Well No. 2, located in the NE/4 NE/4 of Section 12

British-American Marye Well No. 5, located in the NE/4 SE/4 of Section 1

both in Township 25 North, Range 13 West, NMPM, San Juan County, New Mexico.

(4) That the applicant further proposes that special rules and regulations be promulgated to govern the operation of said project, which rules would include a provision permitting the transfer of allowables from injection wells to producing wells on the acreage described in Finding No. 2.

(5) That the applicant has established that approval of the subject application will not impair correlative rights and will result in greater ultimate recovery of oil from the Bisti-Lower Gallup Oil Pool.

IT IS THEREFORE ORDERED:

(1) That the applicant, British-American Oil Producing Company, be and the same is hereby authorized to operate a water injection project for pressure maintenance in the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, subject to the special rules and regulations for said project as hereinafter set forth.

(2) That the applicant be and the same is hereby authorized, for the purpose of pressure maintenance, to convert to water injection in the Lower Gallup formation, the following-described wells:

British-American Marye Well No. 2, located in the NE/4 NE/4 of Section 12

British-American Marye Well No. 5, located in the NE/4 SE/4 of Section 1

both in Township 25 North, Range 13 West, NMPM, San Juan County, New Mexico.

(3) That the interval of water injection in the aforesaid wells shall be between 4858 feet and 4964 feet for the said Marye Well No. 2 and between 4820 feet and 4914 feet for the said Marye Well No. 5.

(4) That special rules and regulations governing the operation of the above-described water injection project be and the same are hereby promulgated as follows, effective June 1, 1959:

SPECIAL RULES AND REGULATIONS FOR THE
BRITISH-AMERICAN OIL PRODUCING COMPANY
MARYE WATER INJECTION PROJECT

RULE 1. The project area of the British-American Oil Producing Company Marye Water Injection Project, hereinafter referred to as the "Project," shall comprise that area described as follows:

TOWNSHIP 25 NORTH, RANGE 13 WEST, NMPM
Section 1: All
Section 12: All

TOWNSHIP 26 NORTH, RANGE 13 WEST, NMPM
Section 35: All

RULE 2. The project operator may transfer the allowable for any duly authorized water injection well in the project area to any other well or wells in the project area producing from the Bisti-Lower Gallup Oil Pool, provided that such transfer of allowable shall be in accordance with the restrictions and limitations hereinafter set forth.

RULE 3. That the allowable assigned to any duly authorized water injection well located in the project area, which allowable is to be transferred to any other well or wells in the project area for production, shall in no event exceed the producing capacity of the well prior to conversion to water injection, as determined by the testing procedure prescribed in Rule 4. Conversion of producing wells to water injection, or the drilling of new wells for the purpose of water injection, shall be done only after approval of the same after notice and hearing.

RULE 4. The allowable assigned to any well which is used for the purpose of water injection shall be determined by a 24-hour test at a stabilized rate of production, which shall be the final 24-hour period of a 72-hour test throughout which the well shall be produced in the same manner and at a constant rate. In no event shall a well receive an allowable greater than its ability to produce during such test, or greater than top unit allowable for the pool at the time of such test multiplied by the well's acreage factor, or greater than the current top unit allowable for the pool during the month of transfer, multiplied by the well's acreage factor, whichever of the three is less. The project operator shall notify all operators offsetting the Project, as well as the Commission, of the exact time such tests are to be conducted. Tests may be witnessed by representatives of the offsetting operation and the Commission, if they so desire.

RULE 5. No well in the project area shall be assigned any allowable transferred from any other well or wells in the project area unless and until said well has been approved by the Commission as a duly authorized "Transfer Well." To receive approval for any such Transfer Well, the project operator shall file application with the Secretary-Director of the Commission for permission to transfer allowable to the well, setting forth therein the well's current

allowable and the maximum allowable which will be assigned to the well. Copies of the application shall be provided to all operators of wells offsetting the proration unit on which the transfer well is located. The Secretary-Director may designate the well as a Transfer Well subject to the maximum expected allowable for the well if, within 20 days after receiving the application, no objection to the designation is received. The Secretary-Director may grant immediate designation as a Transfer Well provided waivers of objection are received from all such offset operators.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

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(4) That inclusion of the above-described acreage in said Project will neither cause waste nor impair correlative rights.

IT IS THEREFORE ORDERED:

That Rule 1 of the Special Rules and Regulations for the Sunray Mid-Continent Oil Company Central Bisti LPG-Gas-Water Injection Project, as promulgated by Order No. R-1414 be and the same is hereby amended to include the following additional acreage within the defined project area, Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico:

NW/4 NW/4 of Section 6, Township 25 North, Range 12 West,

SW/4 SW/4 of Section 31, Township 26 North, Range 12 West,

all in San Juan County, New Mexico.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

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BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 1706
Order No. R-1414-A

APPLICATION OF SUNRAY MID-
CONTINENT OIL COMPANY FOR AN
ORDER AMENDING ORDER NO. R-1414
TO INCLUDE 80 ADDITIONAL ACRES
IN ITS CENTRAL BISTI LPG-GAS-
WATER INJECTION PROJECT, BISTI-
LOWER GALLUP OIL POOL. SAN
JUAN COUNTY, NEW MEXICO

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 8:00 o'clock a.m. on June 24, 1959, at Santa Fe, New Mexico, before Elvis A. Utz, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this 2nd day of July, 1959, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Elvis A. Utz, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That Order No. R-1414 authorized the applicant to initiate a liquefied petroleum gas-gas-water injection project in the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico.

(3) That the applicant seeks an amendment of Rule 1 of the Special Rules and Regulations for the Sunray Mid-Continent Oil Company Central Bisti LPG-Gas-Water Injection Project, as promulgated by Order No. R-1414, to include the following additional acreage in the said project area: NW/4 NW/4 of Section 6, Township 25 North, Range 12 West, and the SW/4 SW/4 of Section 31, Township 26 North, Range 12 West, NMPM, San Juan County, New Mexico.

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 1665
Order No. R-1414-B

APPLICATION OF SUNRAY MID-
CONTINENT OIL COMPANY FOR AN
ORDER AMENDING ORDER NO. R-1414
TO INCLUDE ADDITIONAL ACREAGE
IN ITS CENTRAL BISTI LPG-GAS-
WATER INJECTION PROJECT IN THE
BISTI-LOWER GALLUP OIL POOL IN
SAN JUAN COUNTY, NEW MEXICO,
AND FOR PERMISSION TO DRILL
FOUR ADDITIONAL WATER INJECTION
WELLS AND TO CONVERT ONE ADDI-
TIONAL WELL TO GAS INJECTION

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on August 5, 1959, at Santa Fe, New Mexico, before Elvis A. Utz, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this 20th., day of August, 1959, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Elvis A. Utz, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That Order No. R-1414 authorized the applicant to initiate a liquefied petroleum gas-gas-water injection project in the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico.

(3) That the applicant seeks an amendment of Rule 1 of the Special Rules and Regulations for the Sunray Mid-Continent Oil Company Central Bisti LPG-Gas-Water Injection Project, as promulgated by Order No. 1414 and amended by Order No. 1414-A, to include the following acreage in the said project area:

S/2 and S/2 N/2 of Section 32, Township 26 North, Range 12 West, NMPM
W/2 SW/4 of Section 10, Township 25 North, Range 12 West, NMPM
W/2 NW/4 of Section 15, Township 25 North, Range 12 West, NMPM

all in San Juan County, New Mexico, and within the defined limits of the Bisti-Lower Gallup Oil Pool.

(4) That in connection with the aforesaid Injection Project, the applicant further seeks permission to drill and complete the following-described water injection wells:

CBU-WI Well No. 4, located 2635 feet from the South line and 1315 feet from the West line of Section 10, Township 25 North, Range 12 West, NMPM

CBU-WI Well No. 5, located 1319 feet from the South line and 1315 feet from the West line of Section 10, Township 25 North, Range 12 West, NMPM

CBU-WI Well No. 6, located five feet from the North line and 1315 feet from the West line of Section 15, Township 25 North, Range 12 West, NMPM

CBU-WI Well No. 7, located 1315 feet from the North line and 1315 feet from the West line of Section 15, Township 25 North, Range 12 West, NMPM

(5) That the applicant further seeks permission to convert to dry gas injection the Val R. Reese Hickman Well No. 1, located in the SW/4 SW/4 of Section 32, Township 26 North, Range 12 West, NMPM, San Juan County, New Mexico.

(6) That approval of the subject application will neither cause waste nor impair correlative rights.

IT IS THEREFORE ORDERED:

(1) That Rule 1 of the Special Rules and Regulations for the Sunray Mid-Continent Oil Company Central Bisti LPG-Gas-Water Injection Project, as promulgated by Order No. R-1414 and amended by Order No. R-1414-A, be and the same is hereby further amended to include the following additional acreage within the defined project area, Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico:

S/2 and S/2 N/2 of Section 32, Township 26 North, Range 12 West, NMPM
W/2 SW/4 of Section 10, Township 25 North, Range 12 West, NMPM
W/2 NW/4 of Section 15, Township 25 North, Range 12 West, NMPM

(2) That the applicant be and the same is hereby authorized to drill and complete the following-described water injection wells:

CBU-WI Well No. 4, located 2635 feet from the South line and 1315 feet from the West line of Section 10, Township 25 North, Range 12 West, NMPM

CBU-WI Well No. 5, located 1319 feet from the South line and 1315 feet from the West line of Section 10, Township 25 North, Range 12 West, NMPM

CBU-WI Well No. 6, located five feet from the North line and 1315 feet from the West line of Section 15, Township 25 North, Range 12 West, NMPM

CBU-WI Well No. 7, located 1315 feet from the North line and 1315 feet from the West line of Section 15, Township 25 North, Range 12 West, NMPM

(3) That the applicant be and the same is hereby authorized to convert to dry gas injection the Val R. Reese Hickman Well No. 1, located in the SW/4 SW/4 of Section 32, Township 26 North, Range 12 West, NMPM, Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico.

PROVIDED HOWEVER, That prior to utilizing the above-described wells as injection wells, the casing in each such well shall be tested at a pressure equal to the hydrostatic head plus the maximum surface pressure of the injection fluid.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

SEAL

JOHN BURROUGHS, Chairman

yem/

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

For Hearing
on 8-30-61

Case 2360

J. O. SETH
A. K. MONTGOMERY
OLIVER SETH
WM. FEDERICI
FRANK ANDREWS
FRED C. HANNAHS
GEORGE A. GRAHAM, JR.

SETH, MONTGOMERY, FEDERICI & ANDREWS
ATTORNEYS AND COUNSELORS AT LAW
301 DON GASPAR AVENUE
SANTA FE, NEW MEXICO

POST OFFICE BOX 828
TELEPHONE YU 3-7315

August 7, 1961

New Mexico Oil Conservation Commission
Post Office Box 871
Santa Fe, New Mexico

Attention: Mr. A. L. Porter, Jr.
Secretary-Director

Re: Application by Shell Oil Company for Hearing on Injection Program, Carson Unit Participating Areas (as expanded) Bisti Field, San Juan County, New Mexico.

Gentlemen:

Application is hereby made by Shell Oil Company for approval of a pressure maintenance project to be known as the Carson Unit Pressure Maintenance Project. This proposed project would cover the participating areas of the Carson Unit as originally designated and including the approved revisions thereof through the 11th Revision, also an additional area adjoining the participating and unit area on the west, which consists of the following land in Township ~~26~~ 25 North, Range 12 West, N.M.P.M:

$E\frac{1}{2}$ Section 10
$E\frac{1}{2}SW\frac{1}{4}$ Section 10
$S\frac{1}{2}$ Section 15
$NE\frac{1}{4}$ Section 15
$E\frac{1}{2}NW\frac{1}{4}$ Section 15
NE/4 NE/4 Section 22

This unit participating area and the additional acreage is shown on the plat which is filed with this application. (Attachment 1).

It is proposed that water be injected into the Lower Gallup (Cretaceous) Formation through approximately thirty-five injection wells at an anticipated rate of about 17,000 barrels per day. The depth of the injection will be about 4800 to 4900 feet. The injection water will be obtained from the Lower Allison-Menefee and Point Lookout Formations.

Received
8-17-61

A sound casing program is proposed and is described in the data filed with this application (Attachment 2). This attachment also shows the perforated intervals in the injection wells.

Logs of the injection wells are also provided with this application.

It would be appreciated if this matter could be set down for hearing at an early date.

Very truly yours,

SHELL OIL COMPANY

By _____

OS:dd
Attachments

CC - Mr. Leslie Kell
Legal Division
Shell Oil Company
1008 West 6th St.
Los Angeles 54, Cal.

Mr. R. R. Robinson
Division Manager
Shell Oil Company
Post Office Box 1200
Farmington, N. M.

Case 9360

CASING DATA - PROPOSED INJECTION WELLS
SHELL CARSON UNIT PRESSURE MAINTENANCE PROJECT
BISTI FIELD, SAN JUAN COUNTY, NEW MEXICO

35 wells

WELL NO.	CASING SIZE	CASING WEIGHT	NUMBER SACKS CEMENT	EFFECTIVE DEPTH	PERFORATED INTERVAL	SURFACE CASING SIZE	SURFACE CASING DEPTH	TUBING SIZE	PROPOSED TUBING DEPTH
31-10	4-1/2"	14.9#	200	4933'	4830-39, 4844-51, 4887-97, 4904-09, 4914-18	8-5/8"	237'	2-3/8"	4820'
14-15	5-1/2	17	300	4860	4786-97, 4802-20, 4741-76, 4705-23	8-5/8	219	2-3/8	4695
22-11	4-1/2	9.5	150	5049	4918-50, 4984-98, 5002-12	8-5/8	107	2-3/8	4908
23-11	4-1/2	9.5	150	4938	4800-19, 4825-30, 4872-84, 4890-4904	8-5/8	106	2-3/8	4790
24-11	4-1/2	9.5	150	4925	4780-4804, 4808-14, 4853-64, 4869-79	8-5/8	110	2-3/8	4770
21-14	4-1/2	9.5	150	4908	4760-89, 4792-4801, 4835-48, 4856-70	8-5/8	101	2-3/8	4750
22-14	4-1/2	9.5	150	4927	4763-67, 4771-96, 4800-09, 4850-64, 4869-82	8-5/8	108	2-3/8	4753
23-14	4-1/2	9.5	150	5008	4807-32, 4843-54, 4872-81, 4888-99, 4904-21	8-5/8	104	2-3/8	4797
24-14	4-1/2	9.5	150	5010	4856-59, 4863-82, 4895-38, 4948-59, 4964-77	8-5/8	110	2-3/8	4846
21-23	4-1/2	9.5	150	4977	4874-94, 4902-14, 4923-35, 4941-57	8-5/8	109	2-3/8	4864
13-12	4-1/2	9.5	150	5041	4914-41, 4973-87, 4991-5007	8-5/8	108	2-3/8	4904
21-13	4-1/2	9.5	150	5002	4860-86, 4890-4900, 4940-54, 4958-74	8-5/8	103	2-3/8	4850
22-13	4-1/2	9.5	150	5034	4864-87, 4893-4906, 4943-53, 4962-70	8-5/8	121	2-3/8	4854
23-13	4-1/2	9.5	150	5004	4871-4900, 4907-16, 4946-51, 4956-70, 4974-84	8-5/8	101	2-3/8	4861
24-13	4-1/2	9.5	150	5031	4864-88, 4897-4905, 4932-38, 4946-58, 4964-78	8-5/8	111	2-3/8	4854
21-24	4-1/2	9.5	150	5002	4876-4904, 4939-50, 4956-68, 4973-90	8-5/8	107	2-3/8	4866
23-24	4-1/2	9.5	150	4980	4854-68, 4882-96, 4899-4910, 4914-26, 4936-47, 4952-68	8-5/8	103	2-3/8	4844
32-24	4-1/2	9.5	150	5002	4873-94, 4911-30, 4941-54, 4961-74, 4979-94	8-5/8	107	2-3/8	4863
24-7	4-1/2	9.5	150	5035	4910-32, 4956-66, 4972-86, 4992-5002	8-5/8	105	2-3/8	4900
21-18	4-1/2	9.5	150	5015	4883-4912, 4936-42, 4950-65, 4968-80	8-5/8	106	2-3/8	4873
22-18	4-1/2	9.5	150	5016	4881-91, 4895-4913, 4940-44, 4954-66, 4972-82	8-5/8	109	2-3/8	4871
23-18	4-1/2	9.5	150	5006	4875-91, 4901-13, 4944-51, 4954-70, 4974-84	8-5/8	102	2-3/8	4865
24-18	4-1/2	9.5	150	5007	4861-89, 4894-4902, 4934-41, 4946-60, 4963-76	8-5/8	106	2-3/8	4851
21-19	4-1/2	9.5	150	5022	4866-92, 4900-08, 4939-44, 4951-62, 4969-78	8-5/8	213	2-3/8	4856
22-19	4-1/2	9.5	150	5027	4868-88, 4898-4905, 4934-42, 4952-62, 4968-80	8-5/8	108	2-3/8	4858
11-30	4-1/2	9.5	150	4955	4834-49, 4861-70, 4873-77, 4879-89, 4893-4906, 4916-28, 4933-47	8-5/8	103	2-3/8	4824
11-20	4-1/2	9.5	150	5054	4906-26, 4937-48, 4979-85, 4992-5006, 5010-5022	8-5/8	104	2-3/8	4896
23-20	5-1/2	14-16#	200	5030	4870-90, 4902-09, 4940-47, 4955-69, 4974-84	8-5/8	211	2-3/8	4860
32-20	4-1/2	9.5	150	5015	4852-70, 4882-90, 4925-30, 4937-47, 4957-66	8-5/8	187	2-3/8	4842
41-20	4-1/2	9.5	150	5010	4909-18, 4922-28, 4936-45	8-5/8	183	2-3/8	4899
1*	5-1/2	14	150	4989	4883-94,	8-5/8	320	2-3/8	4873
23-17	5-1/2	14	200	5021	4872-76, 4881-83, 4888-96, 4934-36, 4949-55, 4967-72	8-5/8	214	2-3/8	4862
24-17	4-1/2	9.5	150	5023	4870-87, 4892-4901, 4932-43, 4952-62, 4970-78	8-5/8	105	2-3/8	4860
31-17	4-1/2	9.5	150	5030	4910-30, 4938-54	8-5/8	107	2-3/8	4900
43-17	4-1/2	9.5	150	5095	4970-84, 5014-21, 5035-46, 5056-62	8-5/8	217	2-3/8	4960

* Sanda Wall

Attachment 2

ENGINEERING REPORT

AND

PLAN OF DEVELOPMENT

CARSON UNIT PRESSURE MAINTENANCE PROJECT

BISTI FIELD

SAN JUAN COUNTY, NEW MEXICO

FARMINGTON DIVISION
PACIFIC COAST AREA
FEBRUARY, 1961

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CARSON UNIT
PRESSURE MAINTENANCE PROJECT

TEXT

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INTRODUCTION

Pressure maintenance by water flooding should substantially increase the ultimate recovery from the Bisti-Lower Gallup reservoir above that obtainable by the present primary producing mechanism which is predominantly solution gas-drive.

Enclosed are 17 illustrations which analyze the Bisti-Lower Gallup reservoir and set forth a plan of water injection in that portion of the reservoir underlying the Carson Unit. The burden of the analysis is carried by the exhibits; the text merely serves to point out important features and to summarize results.

HISTORY

The Bisti Field is located in the San Juan Basin in San Juan County, New Mexico (see Index Map - Figure 1). The discovery well, El Paso Kelly State 1, which is located in Section 16, Township 25 North, Range 12 West (see Figure 2), was completed in October, 1955. Subsequent development progressed northwesterly and southeasterly until the present limits of the field were defined (approximately 30 miles long and 1 to 3 miles wide). That portion of the field which is dealt with in this report, namely the Carson Unit, is located approximately midway between the northwest and southeast extremities of the field. The Carson Unit represents approximately one-fourth of the surface area of the field.

STRUCTURE AND STRATIGRAPHY

The productive measures which are exploited in the Bisti Field are the Lower Gallup sand bar deposits. The gross section averages about 130 feet thick in the Carson Unit. The sands are fine grained, of extremely variable shaliness and cementation, and have heterogeneous appearance caused by reworking by marine organisms.

The productive section has been divided into three intervals known as the GC sand, the GD sand and the GE sand. These intervals are commonly referred to

as the upper, middle and lower bench, respectively. The isopachs on Figure 2 are at five-foot intervals and represent the combined microlog pay in the GC and GD sands. These two intervals are the only intervals which contain sands of sufficient permeability to exhibit microlog separation. Figures 3 and 4 are isopach maps of the GC and GD sands, respectively, and Figure 5 is a Type Log showing the electric log markers. The microlog pay is considered to offer the only significant primary and secondary potential, and all recovery estimates are based solely on these better developed sands.

The elongated shape of the main sand bodies attests to their sand bar origin (see Figures 3 and 4), and as a result of the nature of these sands, a marked contrast in the continuity of the sand lenses is observed in different directions. For example, examination of some typical cross sections (Figure 6) reveals that the sand lenses are much more continuous on Section C-C', which runs parallel to the longitudinal axis of the GC sand than on the other two sections. The effect of this stratigraphy on the performance of the water flood has been recognized, and the recommended injection pattern is designed to take advantage of this orientation of the better sand continuity.

Structure contours on the top of the GC sand at 20-foot intervals are portrayed on Figure 7. These contours indicate a regional north to northeast dip (80 feet/mile or about 1°) toward the Basin center.

Oil occurrence in the Bisti Field is controlled by stratigraphy. No water table exists in the field and only small amounts of water production have been reported from the western portion of the field. A primary gas cap is located in the highest structural portions in the southeastern part of the field. A small portion of this gas cap extends onto the Carson Unit (see Figure 2).

RESERVOIR CHARACTERISTICS AND PRIMARY PERFORMANCE

Some of the more important reservoir parameters are summarized on Figure 8. The average petrophysical properties tabulated pertain only to the microlog net pay. The primary producing mechanism is predominantly solution gas-drive. The production performance is portrayed on Figure 9. Production had declined to 2200 barrels of oil per day, an average of 23 B/D per well, in December, 1960. Cumulative production from the expanded Carson Unit is about 4,300,000 barrels and 8,700,000 MCF as of January 1, 1961.

The ultimate production under primary operations is estimated to be 6,900,000 barrels, based on a study of individual well and lease production decline curves. This is equivalent to 18 per cent of the original oil in place (Figure 10) which leads us to considerations relevant to improved recovery by pressure maintenance.

PILOT TEST OF WATER INJECTION

In September and October, 1959, Sunray, as operator of the Central Bisti Unit with the cooperation of Shell, drilled and completed four water injection wells on the western boundary of Shell's Phillips No. 7 Lease. From Sunray's standpoint the prime reason for this project was to prevent the migration of hydrocarbons from their portion of the reservoir, which was to be repressured by LPG and dry gas, to our properties on which the reservoir pressure would continue to be depleted for some time. On the other hand, Shell regarded this project as a valuable pilot test of water injection in the Bisti Field and the information obtained to date has proven this to be the case. Additional information on the reaction of the Bisti reservoir to water flooding is available from five water injection wells (four old producers and one converted LPG injector) located near the west border of the Central Bisti Unit.

Injection at high rates and low surface injection pressures relative to the small thickness of net pay has been maintained in these wells (Figure 13). These rates have averaged almost 70 B/D per foot of microlog net pay for the West Water Barrier and 40 B/D per foot of microlog net pay for the East Water Barrier wells. The lower injection rates into the latter is merely a function of the capacity of the lift equipment installed on the Cliff House water source well serving this group of four injectors.

The production response to this injection has been satisfactory and in general the pilot flood results have shown that:

1. Relatively high water injectivity into the Gallup producing formation can be obtained.
2. It is possible to form an oil bank.
3. Water break-through generally is not premature. However, severe channeling can result as a result of an unsatisfactory completion technique in the injection wells.

FLOOD RECOVERY

Pressure maintenance by water injection will lead to the recovery of 6,600,000 barrels of oil, including 4,700,000 barrels of additional oil which would not be recovered by primary operations (Figure 10), bringing the combined primary and secondary ultimate recovery to 194 barrels per acre foot or 30 per cent of the original oil in place. The Unit Recovery Bar Diagram (Figure 11) shows how these estimates were made.

A prediction of performance for the Carson Unit Pressure Maintenance Project is made in Figure 12, a graph showing the flood oil production increasing from a low of 1200 B/D after the conversion of 35 producing wells to injection service, to a peak of 4,000 B/D (about 25 per cent of the injection rate) after 1.5 years of injection. After one year of producing at the peak rate the oil production then declines for 7.5 years to the economic limit of 350 B/D.

The total injected water requirement is estimated to be 60,000,000 barrels, on the basis of two floodable pore volumes injected to recover 6,600,000 barrels of oil. It is planned to inject at rates up to 20,000 B/D initially, but it is estimated the injection will average only 17,000 B/D for 5 years, at which time the minor injectors will be shut down and the injection will average 16,000 B/D for the remaining 5 years of the flood life.

FLOOD PLAN

The orientation of the better continuity of the sands was a large factor in the design of the injection pattern. Because we can expect the flood fronts to be distorted as they move preferentially in a direction parallel to the longitudinal axis of the sand bars, it is desirable that the spacing of the injectors be dense in the north-south direction. Similarly, it follows that the distance between injectors in the opposite direction, along the sand trend, can be made much greater. It appears that attempting to keep the flood fronts of a conventional five-spot pattern in balance would be practically impossible in a situation such as exists at Bisti. Therefore, a line-drive pattern has been chosen (Figure 13) that meets the above specifications, and should furnish adequate injection capacity to conclude the flood in a reasonable time. The plan includes 29 major injectors on the Unit, 5 major injectors on the west boundary, and 6 minor injectors. Two additional injectors are planned on the Mudge 6 Lease on the east boundary of the project. It is planned to inject an average of 500 B/D into each of the major injectors. The minor injectors are designed to drive some oil from the fringe areas into the fairway portions of the field, where it can be produced. The injectivity of these wells is expected to be low, about 150 B/D.

The pattern is modified in the southeastern portion of the Unit by the inclusion of a line of injectors (41-20, 32-20, and 23-20), designed to

prevent the migration of oil into the gas cap. A "water barrier" line of injectors along the common boundary of the Carson Unit and the Mudge 6 Lease has been proposed and tentatively agreed to by the Operators currently forming the East Bisti Unit.

In general, the basic flood plan is to drive the oil banks from the injectors (20 row wells) to the key producers (40 row wells), located midway between the injection lines. As the oil banks pass the intermediate producers (10 and 30 row wells), these wells will be produced in the interest of increased flood efficiency. It is anticipated that it will be unnecessary to produce most of these intermediate wells for long periods of time at high water cuts.

WATER SOURCE

No suitable surface source of water for this project is available; however, the Point Lookout and Lower Allison-Menefee sands offer a satisfactory subsurface water source. These sands are shown on the Type Log (see Figure 14), which illustrates the formations encountered in the Bisti Field wells. Development of this source requires the drilling of several wells to 3800 feet. The Point Lookout and Lower Allison-Menefee ~~formations~~ waters are saline and compatible with the Gallup reservoir water, analyses for which are shown on Figure 15. These water bearing formations are of sufficient thickness and areal extent to provide an adequate volume of water for the project.

A relatively simple system for handling the makeup water and the produced water is planned, since these waters can be commingled and re-injected into the reservoir with a minimum of treatment. As seen on Figure 16, produced and makeup waters will be commingled, passed through a flocculation cell for the removal of any residual oil and the larger suspended solids, and then through anthracite filter beds for final filtration. Control of bacteria, calcium carbonate scale

deposition, and corrosion will be effected with commercially available chemicals. Figure 17 shows a typical injection well. Water will flow down 2-inch tubing, which is set on a packer, and into the formation through perforations in the casing. The tubing-casing annulus will be filled with inhibited fresh water prior to setting the packer.

WORKING INTEREST OWNERSHIP

Shell Oil Company is the sole working interest owner of all lands in the proposed Carson Unit Pressure Maintenance Project.

CONCLUSIONS

It is recommended that pressure maintenance by water injection be initiated in the Carson Unit in the manner set forth herein in order to effect the recovery of 4,700,000 barrels of additional oil.

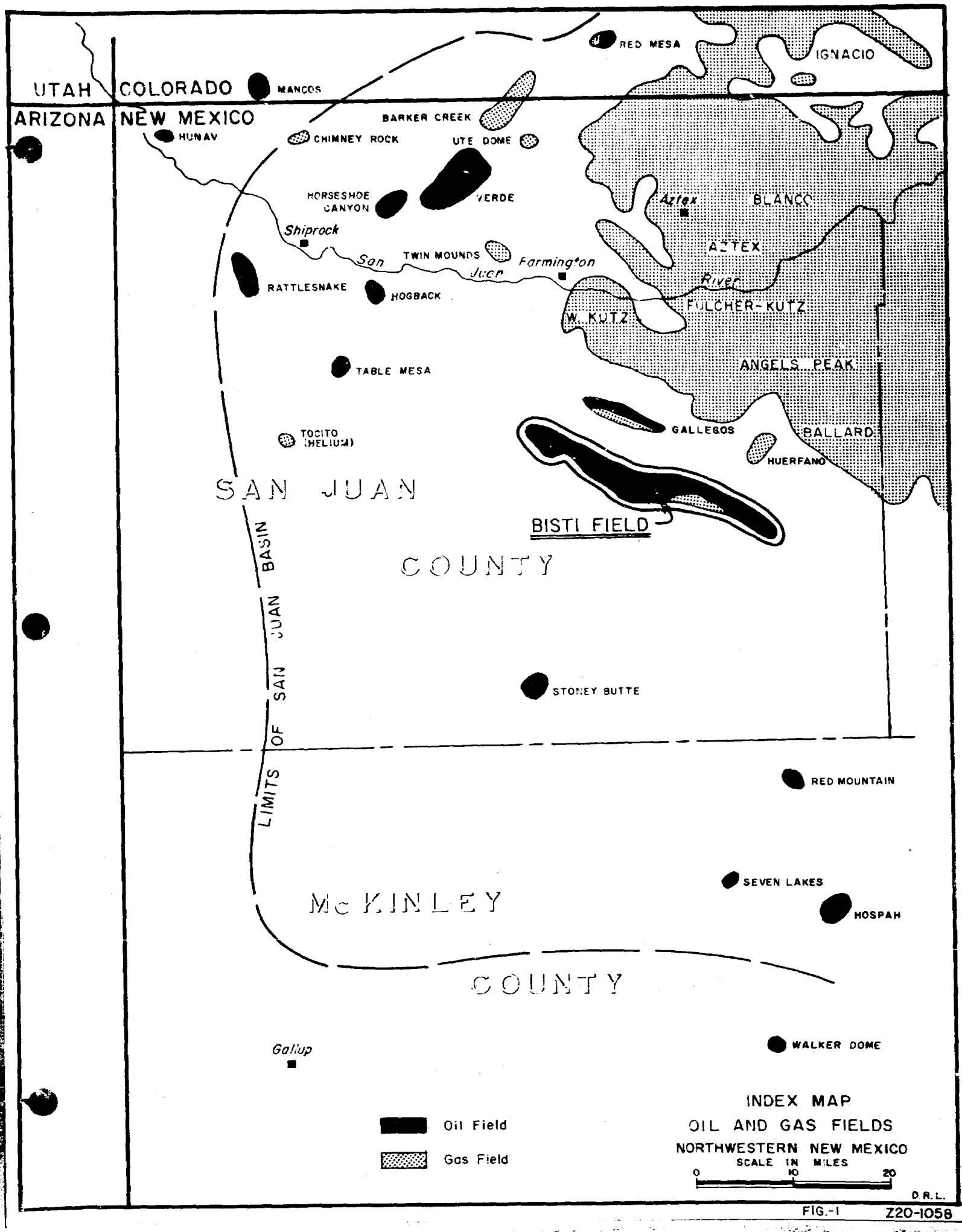


FIG.-1 Z20-1058

RESERVOIR DATA
LOWER GALLUP POOL - BISTI FIELD

Average Depth (GD Marker)	4850 feet
Average Formation Dip	1°
Average Porosity (158 samples from 17 wells)	15%
Average Air Permeability (158 samples from 17 wells)	57 md.
Connate Water Saturation (Logs and capillary pressure)	25%
Residual Oil Saturation (Water base core saturation)	30%
Reservoir Pressure at Datum (+1500')	
Original	1550 psig.
At Start of Flood	500 psig.
Reservoir Temperature	140° F.
Bubble Point Pressure	1550 psig.
Formation Volume Factor	
Original	1.33
At Start of Flood	1.21
Gas Solubility (Including Tank Vapors)	
Original	530 cf/b
At Start of Flood	240 cf/b
Oil Gravity	39° API
Oil Viscosity - Reservoir Conditions	
Original	0.6 cp.
At Start of Flood	0.8 cp.

FIG. 8

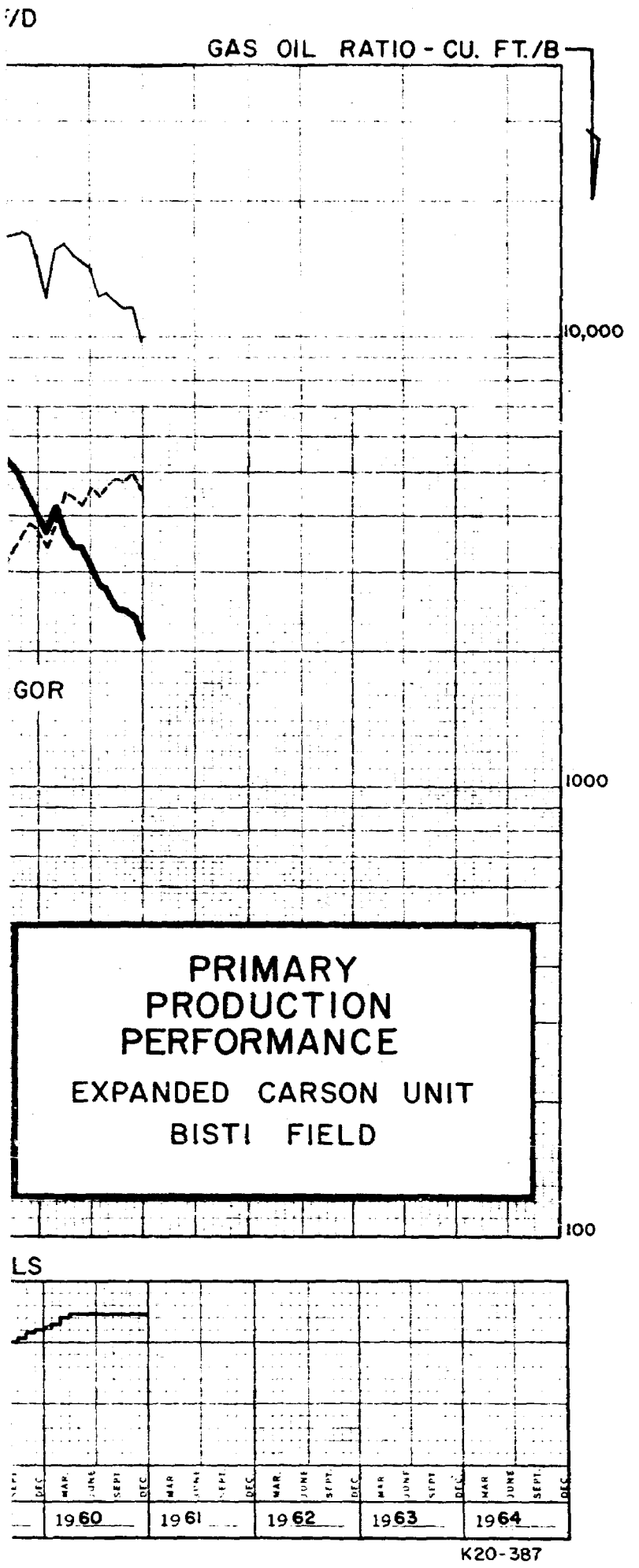

/D
GAS OIL RATIO - CU. FT./B
10,000
GOR
1000
100
LS
1960
1961
1962
1963
1964
PRIMARY
PRODUCTION
PERFORMANCE
EXPANDED CARSON UNIT
BISTI FIELD
K20-387

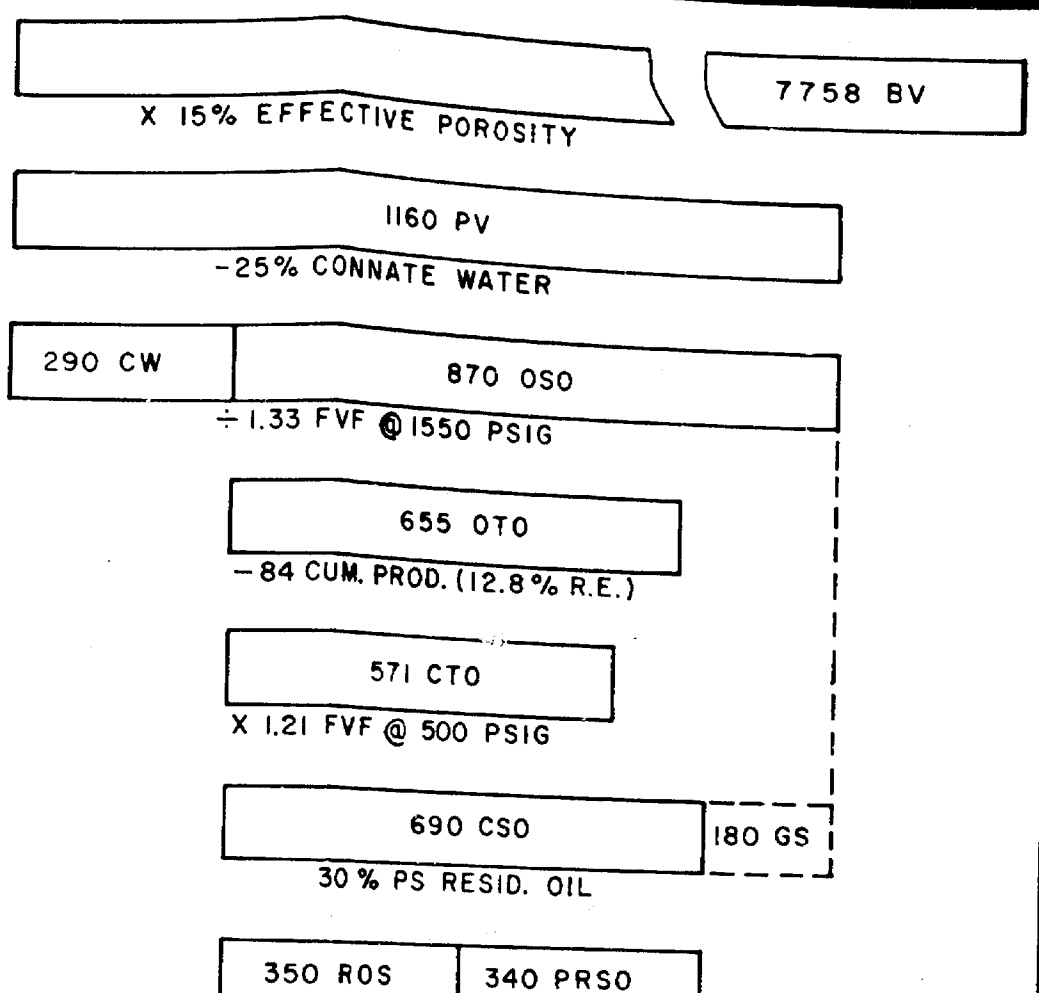
FIG. 9

VOLUMETRIC AND RECOVERY SUMMARY
LOWER GALLUP POOL - BISTI FIELD
EXPANDED CARSON UNIT

Productive Area	6,600 acres
Equivalent Net Pay Volume	59,000 ac.ft.
Tank Oil Originally in Place	38,700,000 bbl.
Total Number of Producing Wells (Dec. 1960)	124
Current Production Rate (Dec. 1960)	2,200 B/D
Estimated Cumulative Production at Start of Flood (Aug.1,1961)	5,000.000 bbl.
Primary Reserves as of August 1, 1961	1,900,000 bbl.
Estimated Ultimate Primary Recovery	6,900,000 bbl.
Estimated Ultimate Primary Recovery Efficiency	18 %
Water Flood Recovery (Includes Remaining Primary)	6,600,000 bbl.
Additional Reserves by Water Flooding	4,700,000 bbl.
Estimated Ultimate Recovery (Primary and Secondary)	11,600,000 bbl.
Estimated Ultimate Recovery Efficiency	30 %

FIG. 10

UNIT RECOVERY BAR DIAGRAM – BISTI
PRESSURE @ 500 PSIG
ALL FIGURES ARE BBL./AC. FT.



LEGEND

BV Bulk Volume	PS Pore Space
PV Pore Volume	ROS Residual Oil Saturation
CW Connate Water	PRSO Potentially Recoverable Subsurface Oil.
OSO Original Subsurface Oil	PRTO Potentially Recoverable Tank Oil
OTO Original Tank Oil	FR Flood Recovery
CTO Current Tank Oil	PR Primary Recovery
CSO Current Subsurface Oil	
GS Gas Saturation	

Z 20-1237

FIG. 11

WATER ANALYSES

		POINT LOOKOUT(1)	GALLUP(2)
Carbonate	CO_3	0 ppm	0 ppm
Bicarbonate	HCO_3	1,074	523
Chloride	Cl	15,265	17,400
Sulfate	SO_4	23	15
Borate	B_4O_7	8	9
Sulfide	S	-	0
Barium	Ba	70	40
Calcium	Ca	156	392
Magnesium	Mg	70	125
Ammonium	NH_4	15	14
Iron	Fe	4	75
Sodium	Na	9,951	10,725
Salinity (NaCl)		25,155	27,200
Ph		7.65	6.40

(1) Shell Oil Company Carson 2 - Date of test 4-13-60

(2) Shell Oil Company Carson Unit 23-14 - Date of test 6-17-60

FIG. 15