EASX 6890: TENNECO OIL COMPANY FOR A
THERMAL ENHANCED RECOVERY PROJECT,
McKINLEY COUNTY, NEW MEXICO

Case No.

6890

Application

Transcripts

Small Exhibits

ETC

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

BRUCE KING
GOVERNOR
LARRY KEHOE
SECRETARY

POST OFFICE BOX 2088
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO 87501
(505) 827-2434

August 5, 1980

Kellahin & Kellahin
P. O. Box 1769
Santa Fe, New Mexico 87501

Attention: Mr. Thomas Kellahin

Re: Correct Well Locations
Tenneco Order No. R-6389

Gentlemen:

Reference is made to your letter dated July 7, 1980, wherein you advise that Tenneco Oil Company had caused to be resurveyed the well locations for the pilot thermal enhanced recovery project said company was authorized by the subject order to initiate in the Hospah Pool in McKinley County.

As a result of the resurvey, the well locations of the two existing wells in the project area are corrected and the location of the three wells which are to be drilled must necessarily be amended to complete the pilot project well pattern.

Inasmuch as the project area is not displaced in any manner, but simply tied to a corrected location for each of two existing wells, we do not feel that the order is in effect being amended and that no hearing will be necessary to permit Tenneco to proceed.

Said company is, therefore, hereby authorized to drill its pilot injection well at a point 1532 feet from the North line and 2718 feet from the East line of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico, and to drill two producing wells, one at a point 1418 feet from the North line and 2769 feet from the East line, the other at a point 1646 feet from the North line and 2667 feet from the East line, both in the aforesaid Section 12. These locations would tie said wells into a pilot project area based on the corrected locations of the two existing wells, which have been determined to be as follows: Well No. 18, 1495 feet from the North line and 2632 feet from the East line, and Well No. 48, 1569 feet from the North line and 2800 feet from the East line, both in said Section 12.

Very truly yours,

JOE D. RAMEY,
Director

JDR/DSN/dr

✓cc: Case File 6890

RECEIVED
JUL 09 1980
OIL CONSERVATION DIVISION
SANTA FE

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Jason Kellahin
W. Thomas Kellahin
Karen Aubrey

Telephone 982-4285
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July 7, 1980

Mr. Dan Nutter
Oil Conservation Division
P. O. Box 2088
Santa Fe, New Mexico 87501

re: Tenneco Oil Company
Division Case 6890
Order No. R-6389
Thermal Enhanced Recovery

Dear Dan:

I have received a copy of the referenced Division Order dated July 7, 1980.

In reviewing the order with Tenneco personnel, I discover that the locations have been resurveyed and the information supplied as to well locations is in error.

The following are the corrected locations:

a) injection well 2718' E line and 1532' N line.
b) well 48: 1569' north line and 2800' east line.
c) well 18: 1495' north line and 2632' east line.
d) well 65: 1418' north line and 2769' east line.
e) well 66: 1646' north line and 2667' east line.

I assume that the order might be changed to reflect the resurveyed locations by a Nunc Pro Tunc Order and that Tenneco may commence their project at the amended locations without having this matter heard again.

Please let me know.

Best regards,

Tom Kellahin

W. Thomas Kellahin

cc: Mr. Glenn Strobl
(Tenneco - Denver)

WTK:msf

STATE OF NEW MEXICO

# ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION

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Mr. Thomas Kellahin
Kellahin & Kellahin
Attorneys at Law
Post Office Box 1769
Santa Fe, New Mexico

Re: CASE NO. 6890
ORDER NO. R-6389

Applicant:

Tenneco Oil Company

Dear Sir:

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

Yours very truly,

JOE D. RAMEY
Director

JDR/fd

Copy of order also sent to:

Hobbs OCD x
Artesia OCD x
Aztec OCD x

Other

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION
STATE LAND OFFICE BLDG.
SANTA FE, NEW MEXICO
7 May 1980

EXAMINER HEARING

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IN THE MATTER OF: )

Application of Tenneco Oil Company for a thermal enhanced recovery project, McKinley County, New Mexico. ) CASE 6890

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BEFORE: Daniel S. Nutter

TRANSCRIPT OF HEARING

A P P E A R A N C E S

| | |
|---|---|
| For the Oil Conservation Division: | Ernest L. Padilla, Esq.<br>Legal Counsel to the Division<br>State Land Office Bldg.<br>Santa Fe, New Mexico 87501 |
| For the Applicant: | W. Thomas Kellahin, Esq.<br>KELLAHIN & KELLAHIN<br>500 Don Gaspar<br>Santa Fe, New Mexico 87501 |

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# E X H I B I T S



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MR. NUTTER: We'll call now Case Number 6890.

MR. PADILLA: Application of Tenneco Oil Company for a thermal enhanced recovery project, McKinley County, New Mexico.

MR. KELLAHIN: Tom Kellahin of Santa Fe, New Mexico, appearing on behalf of the applicant, and I have two witnesses to be sworn.

(Witnesses sworn.)

GLEN C. STROB

being called as a witness and having been duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. KELLAHIN:

Q. Would you please state your name?

A. Glen C. Strobl.

Q. How do you spell your last name, Mr. Strobl.

A. S-T-R-O-B-L.

Q. Where are you employed and in what capacity?

A. Employed in the Denver office of Tenneco

Oil Company as a Senior Petroleum Engineer.

Q. When and where did you obtain your degree in engineering?

A. I obtained my degree, BS in petroleum and natural gas engineering, June, 1973, Pennsylvania State University.

Q. Subsequent to your graduation where have you been employed and in what capacity?

A. For the Shell Oil Company as a production engineer for a year and a half and then for two years as a reservoir engineer; I worked with Gulf Research and Development as a reservoir engineer. And then with Tenneco for a year and a half as a reservoir engineer.

Q. And as a reservoir engineer for Tenneco Oil Company, what do your duties include?

A. For the past year I've been working on enhanced recovery; in particular this project.

Q. But involving the Lower and Upper Hospah formations in McKinley County, New Mexico?

A. Correct.

Q. Pursuant to that study, Mr. Strobl, what if any other in situ combustion projects have you examined in the United States?

A. I have made field trips to some projects and done extensive literature research, talked with a number

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of people that have worked on projects, who we might consider experts on the subject, and in relation to this project, also.

Q. What are the locations of any existing projects that you examined?

A. The Fireflood in Belleview, Louisiana, was the one I actually toured.

Q. Did you or anyone in conjunction with Tenneco Oil Company examine any firefloods in California?

A. No, we have not yet. We have discussed some with people there.

Q. In accordance with your testimony today, you have done research and prepared certain exhibits for presentation.

A. Yes.

MR. KELLAHIN: We tender Mr. Strobl as an expert petroleum engineer.

MR. NUTTER: Mr. Strobl is qualified.

Q. Mr. Strobl, would you turn to what we've marked as Exhibit Number One and orient us to where in New Mexico you propose to commence this pilot in situ combustion project?

A. The pilot project is designed for the Hospah Field, which is in the southern area of San Juan Basin, the area. It's in McKinley County, and this exhibit shows the relationship of the field location to

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the cities of Farmington, Santa Fe, and Albuquerque.

Q. All right, sir, let's turn to Exhibit Number Two. Would you identify this plat for us and tell us in general terms what is contained on this exhibit?

A. This is a plat of the South Hospah area in McKinley County, and basically it shows the cross hatched area in the middle, that's Section 12 of 17 North, 9 West, as our unit, the Hospah Unit. We have 100 percent working interest in that area, the cross hatched area. It's not really cross hatched, but it's outlined in a dotted line.

Q. Okay. You have platted all the Lower and Upper Hospah Wells in this pool?

A. Yes. This map does show all the completions and the current status of those completions in that area.

Q. The plat also identifies who the operators are in the different sections.

A. Right.

Q. And what is indicated by the inner circle?

A. The inner circle is a half mile radius immediately around the pilot area, the center of that being 18 and 48 are Hospah wells.

Q. Let's take a moment, then, and within the center of that circle would you locate for us the site of the proposed injection well for this pilot project?

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A. The injection well would be halfway between our Hospah Nos. 18 and 48 Wells.

Q. It's not specifically platted on your exhibit, is it?

A. No, because of the scale it would be very close together and not show up very well.

Q. But it's going to be halfway between Wells 48 and 18?

A. Yes.

Q. Right above the word Hospah on your plat?

A. Yes.

Q. All right, we'll come to a later exhibit in a minute --

A. Okay.

Q. -- that shows that better.

What is indicated by the outer circle?

A. The outer circle is a 2-mile radius.

Q. Would you describe, or refresh the Examiner's memory, as to what the history of production has been for the Lower and Upper Hospah formations?

MR. NUTTER: Mr. Strobl, before you leave that exhibit.

A. Yes, sir.

MR. NUTTER: You mentioned that this was in the unit and outlined by a dotted line.

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A Yes.

MR. NUTTER: I think to show that this is inside the lease and not near any other lease line, if you define what that unit boundary is, so that I can mark it on my exhibit with a red pen, the dotted line that outlines this particular unit that would be working.

A Okay. Actually we're dealing with a unit in only the Upper Hospah. The Lower Hospah has never been unitized.

The unit does run along the north line of Section 12, completely across that section.

MR. NUTTER: Okay.

A And then about I'd say 75 percent of the way down the east boundary of that section. As you can see, then it follows across half way and then continues down -- I'm sorry, it does follow all the way across that section.

MR. NUTTER: It goes all the way across into Section 11, I think, doesn't it?

A Into Section 11. Again that is an Upper Hospah Unit, and continues up about a quarter or half of the way, let's say, cuts across to Section 12's boundary line again and then up to the northern boundary line.

MR. NUTTER: So that's the boundary of the Upper?

A Yes.

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MR. NUTTER: And the South Hospah Lower Sand is not unitized, is that it?

A. No, it isn't.

MR. NUTTER: So it's on a lease. Now what is the boundary of the lease that it's on?

A. I believe, if I'm not mistaken, the lease encompasses that whole section, or at least the greater part of that section.

Q. And that's a Federal lease?

A. That is a Federal lease. My basic reason for showing this was to show that we are the only operator in that section on that lease and we have a 100 percent working interest.

MR. NUTTER: Okay. So this is not near any boundary of any property that's owned by any other operator or any other royalty owners, is that it?

A. That's correct.

MR. NUTTER: Okay, proceed to your next exhibit.

Q. The closest operator is Tesoro to the north in Section 1, is that not true?

A. That's true. They also operate on the east of that section in Section 7. We -- we did pick this pilot area to isolate them by many producing wells in between ours and the boundary line of that section. There are also

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water injection wells between the pilot area and Tesoro's property.

Q Mr. Strobl, would you summarize for us what has been the history of the Upper and Lower Hospah formations? Well, let me go back, and indicate to you that the application as originally filed requests approval of a pilot project for both the Upper and Lower Hospah formations and as of the date of this hearing, what is Tenneco's intention?

A Our intention now is to only have a pilot in situ combustion project in the Lower Hospah, and at the same time to do just an injectivity test in the Upper Hospah.

Q The proposed injection well will still be completed as applied for, I assume.

A Yes.

Q And the location of additional wells will be on the four producing wells included in the application as opposed to the 8-spot pattern?

A Correct.

Q All right. Let me have you take an exhibit out of order, if you will, please.

If you'll turn to Exhibit Number Six and if you'll demonstrate for the Examiner, using Exhibit Number Six, and perhaps Exhibit Number Two, explain to him what you propose to do for this pilot project in the Lower Hospah.

A. The pilot is designed as an inverted 5-spot pattern utilizing two wells that already exist in the field, the Lower Hospah No. 48 Well, as shown on the left of Exhibit Six, and our Upper Hospah No. 18 Well.

We plan on recompleting the 18 Well to the Lower Hospah. That is, it is drilled all the way through and has casing through the Lower Hospah.

We also plan on drilling three additional wells, the Lower Hospah No. 65 to the north; the Lower Hospah No. 66 to the south. These will be producing wells, and our air injection well on the center of this pattern. The air injection well will, as Mr. Kellahin just previously said, is a dual injection well.

Q. What is the approximate area involved in the pilot project in terms of surface acreage?

A. Approximately .68 acres.

Q. All right. Would you summarize for Mr. Nutter what has been the producing history of the Lower Hospah?

A. Basically the field was discovered as an Upper Hospah Field in 1965. Tenneco purchased the field, the property, in 1966. We began the production in 1967 in the Lower Hospah. The field was aggressively developed in those days, drilling of wells. By 1968 we deemed that water flooding would be beneficial in the Upper Hospah, started a

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waterflood project on the Upper Hospah. By 1972 we decided to try to enhance the recovery of the Lower Hospah and attempted a gas/water injection project. We did see some results of that but found that the gas was really not beneficial and all the benefit was coming from the waterflood. Both waterfloods have continued to the present date.

In 1977 and '78 we had an infill drilling program in the Lower Hospah, which had increased our reserves and recovery from the Lower. At this point in time we're in the latter stages of secondary or waterflooding production and we feel like we've done about all we can to increase production from this reservoir in a secondary phase.

At this point in time we think it's a good idea to go to enhanced recovery or tertiary recovery to optimize production, increase our recovery from these two reservoirs.

Q. Can you give us an indication and perhaps some rough numbers or percentages of what you recovered from the Lower Hospah in the primary phase and then in the secondary waterflood phase of the project?

A. Primary production was about 15 percent of the oil in place in the Lower Hospah. There was some water drive and that accounted for some of this production.

The expected secondary recovery should add up to another 19 percent of the oil in place.

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The expected incremental tertiary oil from a field-wide project, if it is successful, should add another 13 percent recovery to the field.

That will give us a total of 47 percent ultimate recovery from the field, from the Lower Hospah reservoir.

Q Let me see what you've got.

MR. NUTTER: Now, Mr. Strobl, am I reading this correct on this statement here, down at the bottom line, where you say projected ultimate recovery from the Lower under primary and secondary would be 3,255,000? Am I reading that right?

A. Yes, sir.

MR. NUTTER: Okay.

A. That's a combination of the two phases.

MR. NUTTER: Okay, thank you, and that would amount to 34 percent?

A. Yes, sir.

MR. NUTTER: Okay.

Q In general terms, Mr. Strobl, why don't you narrate for us how you propose to make this pilot work; what it's supposed to do and how it does it? Give us an overview of what we're doing.

A. Basically what we intend to do is inject air in the air injection well and using some artificial means,

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and I think we plan on using a gas ignitor to heat this air downhole to a temperature approximately 600 degrees, which should ignite the oil. The oil -- not all the oil will burn. There is a part of the oil, the heavier ends, called coke, which settles out on the formation and will supply the fuel. The heat from this combustion vaporizes the oil, distills some of the lighter ends, pushes it away from the wellbore, the injection wellbore, leaving the coke behind.

As this proceeds we have gases generated; we have steam generated; and of course the distillation products. This provides the driving mechanism which pushes the oil ahead and to the production well, naturally.

Q. What other methods of tertiary recovery have you examined for the Lower Hospah formation?

A. Okay. With the particular crude and reservoir properties that we have in the Lower Hospah we found that chemical and thermal means would probably be the best, and in particular polymer caustic, mycellar polymer, caustic polymer combination, steam, in situ combustion were examined, and evaluated for application here. Of these we did do some lab testing on these. Of these, in situ combustion was the best for most optimum recovery.

Q. What do you propose to accomplish by the pilot project?

A. The pilot is designed to answer a number

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questions.

The first and most important, I guess, is to verify the engineering evaluation in our prediction model. And after that I think we really want to find out what the operational aspects of in situ combustion are going to be like in this particular reservoir; what type of problems we will have to handle.

We also want to determine the injectivity for sizing compression equipment we have to order many months in advance of getting it in the field.

Q. Let's turn to Exhibit Number Three and have you identify that for me.

A. Exhibit Number Three is an induction electrical log of Hospah No. 18. As I indicated previously, that is in the pattern area that we're proposing and it is very typical of the type of sand development that we have in the Upper and Lower Hospah. You can see the proximity of the two sands and the type of development on this well.

Q. Would you take Exhibits Four and Five now and summarize those exhibits for us?

A. This Exhibit Four is a production history of the Upper Hospah Unit. The black curve, solid line curve, is barrels of oil per day, and the upper curve, the red dashed curve, is barrels of water per day.

As you can see, I've indicated when we

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began water injection in JUne of '68 and you can see the dramatic increase in water -- or water and oil production due to that water injection. You can also see that we are in an established decline and the latter phases of this water injection.

On Exhibit Number Five we show the production history of the Lower Hospah. Again, the black solid curve is barrels of oil per day and the red dashed curve is barrels of water per day.

I've indicated when we started the gas/water injection and when the gas injection ceased. You don't see the dramatic increase from water injection here because we've always had mobile water. We've always had a water influx from the aquifer in this reservoir. But I think you do see that we have more or less by water injection stopped the decline and leveled out production.

You can also see in '77 where we did the deepening and perforating of those eleven wells and the increase of production that followed that and the effect of the four infill wells in the Lower Hospah.

Q. Subject to the approval of the Division, when would you propose to commence drilling the injection well?

A. As soon as possible.

Q. When do you propose to have the pilot

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project operational?

A. Very soon after that. It would be a matter of basically just lining up the compression equipment. I would expect by June, July, we should have this going pretty well.

Q. Once the pilot project is operational, what do you anticipate to be the life of the project in order to answer the questions that you've posed?

A. We plan on running the project for six months total, six to eight months, I should say, depending on the injection rates.

MR. KELLAHIN: I have another witness, Mr. Nutter, that's going to discuss the method of drilling and completing the injection well. He has examined sources for potential fresh water in the area. He has analyzed all the wells within the area to determine the casing program, the quality of cement, and that sort of thing, and is prepared to answer questions in that regard.

Both gentlemen, I'm sure, are qualified to answer all your questions, but perhaps it might be easier to let me complete the testimony with my second witness and then have both witnesses available to answer questions.

MR. NUTTER: I think I've only got a couple of questions for Mr. Strobl at this time.

CROSS EXAMINATION

BY MR. NUTTER:

Q. Mr. STrobl, now you are going to abandon the project insofar as the upper sand is concerned at this time?

A. Yes, sir.

Q. But you said you would dually complete the well, the injection well?

A. Yes, sir, we would like to do some air injectivity tests in the upper sand, again to size our compression equipment so that we can go ahead and order that and be ready for the field-wide project in the upper.

Q. In the event that you did decide to go into the upper later?

A. Yes. If the lower proves out, we will do the upper. There's no question of that.

Q. You feel like you can evaluate the process feasibility by injection into the lower sand only.

A. Yes, sir.

Q. For six or eight months?

A. Yes.

Q. Okay. Now, in the process of burning this oil, you mentioned that there would be a certain amount of it would be coke and that's going to remain behind. Have

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any calculations been made as to the percentage of oil in place that is coke?

A. The saturation percentage is around 10 percent. The original oil saturation was 65 percent.

Q. Original oil saturation, 65 percent. Present saturation?

A. Present saturation volumetric average is about 49 percent.

Now, this coke will not be left behind. It will be burned. There will be nothing left in that sand.

Q. That coke eventually is burned?

A. Is burned.

Q. Okay. Now what percent of the oil that's there, this 49 percent saturation that you have at the present time as coke, can burn?

A. That's roughly 1/4th or 1/5th of the oil.

Q. 1/5th to 1/4th of oil in place coked and burned and consumed.

A. I might add that that will only be in the areas that are swept by the air. Of course the heat is conducted from the swept areas and up to 40 percent of the oil in areas that are not air swept is produced.

Q. How far from the injection well do you get on this 119 feet to the No. 48 over here, for example.

A. Yes, sir.

Q How far do you expect the actual combustion to extend and then beyond that simply the vapors sweeping through the reservoir?

A We hope to propogate the fire front as far as one of these older wells. We do want to see if we can handle the heat in these production wells.

Q I see.

A We plan on setting up a circulating system of cooling water in the wellbore, and we want to see if we can control this heat to a manageable level.

But I expect we will burn out this pilot to a reasonable economic air/oil ratio in that six to eight month period.

Q And you would hope that you could achieve combustion all the way to the producing wells out there.

A At the rate of -- yes, I think we can very easily. That's why we chose such a small pilot area.

Q Uh-huh.

MR. NUTTER: I believe that's all for now. Thank you.

STEVEN H. HUDSON

being called as a witness and having been duly sworn upon his oath, testifies as follows, to-wit:

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DIRECT EXAMINATION

BY MR. KELLAHIN:

Q Would you please state your name and occupation?

A. Steven H. Hudson. I'm a production engineer with Tenneco Oil in Denver.

Q Mr. Hudson, when and where did you obtain your engineering degree?

A. I obtained a BS in mechanical engineering from the University of Texas in December, 1978.

Q Subsequent to graduation where have you been employed and in what capacity?

A. I began as a production engineer with Amoco Production Company and since that time, or up to December of '79, and then joined Tenneco in Denver.

Q What are your responsibilities as a production engineer with Tenneco Oil Company?

A. Upon employment with Tenneco I started on work on this project, specifically working on the production phase of implementing this pilot or full scale fireflood.

MR. KELLAHIN: We tender Mr. Hudson as an expert petroleum engineer.

MR. NUTTER: Mr. Hudson is qualified.

Q I'd like you to begin, Mr. Hudson, with

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Exhibit Number Seven, which is the proposed injection well, and have you describe how you propose to drill and complete this well for injection.

A. Due to our specific case of having two sands in close proximity which we wish to expose to this fireflood, it became necessary by looking through several designs to attempt air injection by two casing strings. We attempted a single casing string with two tubing strings and packers, or we proposed that, and upon a little bit of intensive study on that we found that downhole equipment as far as packers and expansion joints and things like that are not really developed for the heat that we expected to be placed upon these wells.

So we therefor decided to go with a two casing strings to eliminate the downhole problems that we might see with packers or expansion joints.

This diagram of Exhibit Seven then shows two strings of 4-1/2 inch casing, which would be set to a total depth of approximately 1715 feet as determined by the Exhibit Three, which was the log on Well 18, which we have for depth determination.

In that I'd like to point out that we will not be running 1.66 IJ tubing. It will be 2-3/8ths standard 8-round tubing to facilitate our ignition process only. The present ignition systems that are available on the

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market within our time frame, will not allow us, under these conditions of running two strings of casing, will not allow us to run a packer system; therefor we have not proposed one.

The methane system of ignition would involve running a burner on a slick line downhole and landing that at the bottom of the tubing and then injecting air down the tubing -- I mean, excuse me, methane down the tubing with air down the casing under the ignition process only, and by a lab test with the company we plan to use for this ignition, you can determine the amount of heat you have to supply to the reservoir to make sure you have ignition. There is also a test on offset wells.

Anyway, the methane ignition process will only encompass a week to ten days, something in that area. We're not -- we haven't really decided completely on that.

After that, the methane will be shut off and only air will be injected down the casing, as the tubing will not be -- or the same as if the tubing was not there. At a later time we might inject water down the tubing string in a process known as COFCAW, which is a combination of forward combustion and waterflooding.

Q. Do you want to spell that for us?

A. C-O-F-C-A-W, and that's -- it's a combination of waterflooding and forward combustion where you

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inject water and air simultaneously or water/air/water in different phases.

The reason we would inject downhole in this system is any time you mix air and water you're going to have definite corrosion problems and we sought to minimize those by mixing the air and water downhole, if we go in a combination.

MR. NUTTER: Well now, Mr. Hudson, you're going to inject air only down the one string of casing that's landed at the upper perforations, is that it?

A. No, sir. Oh --

MR. NUTTER: Because you say you don't have a packer here, so how are you going to have an ignition in the lower zone and not in the upper zone?

A. Okay, if I understand your question correctly, in one string of casing we will be injecting air plus the methane and igniting the lower sand.

In the other string of casing we will be injecting only air for a period of time that we deem necessary to establish what we feel is a good injectivity rate into the upper sand to size our compressors.

We do not plan to ignite the upper sand, at this time.

MR. NUTTER: How do you keep the ignition from going from one zone to the other?

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A. We planned to not have our air injectivity test in the upper sand until a period of time has elapsed where the fire has moved away from the wellbore in the lower sand; therefor, you would only have a temperature in the upper -- or in the lower sand at the sand face of approximately 80 to 100 degrees, whatever your discharge air temperature.

MR. NUTTER: I see, I thought both these were going to be conducted simultaneously.

You would go ahead and inject air and methane at first in the long casing string here, or long tubing string.

A. Yes.

MR. NUTTER: To obtain combustion; wait until that has moved away from the wellbore, and then start the air injection into the other sand.

A. Yes, sir, and it would not be an extended period of time, just what we feel would be long enough to establish a good pressure value so we would know how to size our compressors. But that would be at a time where we would not obtain a spontaneous combustion in the upper from the heat from the lower.

MR. NUTTER: Okay.

A. So we looked at that, yes, sir.

Q. Tell me about your cement program for the well.

A. The cement we've proposed, and you notice on the righthand side of this Exhibit Seven it says 1450 feet approximate top of the aluminite cement. Aluminite cement is a calcium aluminate slurry which is not a standard Portland cement, which is used by steel industry or whoever for containing a fire, a power plant. It's a firebrick compound. It's been used with very good success by other operators in firefloods and steam floods, so we definitely want to try this in our injection well, as well as a couple of our producing wells. One of our main aims of the pilot was to determine whether our standard Portland cement in the drilled wells in the field can withstand the temperatures, but we also want to test the -- how this material works, also.

Above the aluminite cement we plan to run Class H with 40 percent silica flour, which is a known high temperature cement for oil well cementing; good to approximately 650 degrees. That's not listed on this diagram but that's our cementing program. It would be cement all the way to the surface with a thermal type cement.

The firebrick aluminate cement, good to approximately 1200 degrees.

Q. What kind of surface injection pressures do you anticipate for the injection of air into the injection well?

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A. From our reservoir calculations that Mr. Strobl made, he has indicated that a stabilized injection pressure into the upper and lower sands should be in the neighborhood of 4 to 500 pounds surface pressure at a rate of a million to a million and a half cubic feet per day.

However, since this reservoir has no gas saturation, it has no gas permeability, and to begin air injection into either sand, we anticipate a possible maximum pressure of 1000 pounds surface. That, based on your ruling memo 3-77, issued in August of 1977, exceeds the fracture gradient limitation of .2 psi plus the hydrostatic head, or .43. However, based on that, and we have another exhibit I'll refer to in a minute, we do not expect to fracture the formation.

Do you want to go into that?

Q. Yeah, let's talk about Exhibit Number Eleven, Mr. Hudson, and have you tell us why you don't think you would fracture the confining strata.

A. This Exhibit Eleven was prepared a few years ago for a hearing in which we sought to dually complete two water injection wells and at the time of this hearing the ruling for the .2 psi per foot gradient was in effect. It was Commission Case 5995, Order 5506, as outlined in our application for this pilot.

At that time this letter was prepared,

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which indicated from fracture stimulations we had performed in the Upper Hospah Sand, that the fracture gradient was on the average of 1.01 psi per foot with a standard deviation of .09.

So basically with that data, assuming a fracture gradient in the area of .92, we would not be fracturing the formation at 1000 pounds air pressure at the surface, which an air gradient is negligible. You would assume, say, 1100 bottom hole pressure at 1600 feet. That would still be less than our present water sand face injection pressure, which in the upper sand are running on the order of 800 psi plus the hydrostatic head, which would put you at, say, 13 to 1400 psi sand face pressure.

So we do not anticipate our air pressure at the sand face to be as high as what we now are doing under waterflood, and we are ordering our compressor for the pilot with a maximum discharge pressure of 1000 pounds, based on our reservoir calculations for air injectivity.

We do not have any information on the lower, but -- because no fracture stimulations have ever been done, but it is the same geological age and it was deposited only 20 feet lower. So based on those assumptions we assume that it has a fracture gradient similar.

Q. I assume you're familiar with the waterflood order that you've just made reference to, and I think

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you'll find in the typical Division waterflood orders they indicate that the injection wells shall be completed with a method where water injection pressure can be relieved at the surface through some type of pop-off valve.

Is that type of requirement applicable to an air injection well?

A. In this case we do not feel we'd need to complete the well with a pop-off at the wellhead. We plan to have a similar type pressure relief device at the compressor. The reason we don't want to do it at the wellhead under this specific situation is that should be pop-off that valve for a malfunction, or whatever reason, it would allow the air well to backflow, possibly, into the wellbore, creating a high temperature situation, possibly, at the wellbore, or actual fire in the wellbore if oil flows back into the -- into the well itself.

We will have a check valve system at the wellhead to prevent any kind of backflow of air from this air injection well.

Q. Would you turn to Exhibit Number Eight for us and describe that?

A. Exhibit Eight is a wellbore schematic of our proposed producing well. It will be completed with 7 or 8-5/8ths inch casing down to TD, cemented in a similar manner to our air injection well, with aluminite cement to about

1450 feet, which is approximately 100 feet above the top of the Upper Hospah, with Class H and silica flour to surface.

This will be a rod pump well with gas being produced up the annulus and the fluid being pumped up the tubing. Also, we have allowed for cooling water to be circulated down the annulus in this case. There could be a possibility that sufficient gas rates will not allow us to pump water straight into the annulus and we may have to run a dual tubing string to TD just to get the water down there, but research from other operators who have conducted fire-floods has shown that the cooling water system is essential to maintain your wellbore integrity on your producing wells, as well as keep your fluids cool enough to treat at the surface.

MR. NUTTER: What do you anticipate the rate of injection of water will be?

A. We have some simulation studies from the literature that I've used and made a model with that estimate a maximum of 100 barrels per day, and that's based on approximately 100 barrels of oil a day, 500 barrels of water and 500 Mcf of gas being produced at 800 degrees.

MR. NUTTER: Okay, you ran through those too fast for me here. You expect to inject a maximum of 100 --

A. Approximately 100 barrels.

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MR. NUTTER: Okay.

A. And that was based on an oil rate of about 500 -- of a 100 barrels per day, a water rate of 500 barrels per day, and a gas rate of 500 Mcf per day, and a reservoir temperature of 800, and that's -- that's a maximum condition. We don't anticipate that much fluid, but that's the condition we used to determine the maximum cooling water amount.

And that was based on a computer model out of the literature.

Q. Mr. Hudson, would you turn to Exhibit Number Nine and in conjunction with Exhibit Number Two, would you demonstrate what's indicated on Exhibit Number Nine?

A. Okay. Exhibit Two, the map of the 2-1/2 mile radius; Exhibit Nine, then, lists as per Order 3-77, or memo 3-77 pertaining to waterfloods, Exhibit Nine is then a tabulation of all the present completions inside a half mile radius of our pilot area, listing location, casing cement, and producing interval.

Q. Did your examination of that 1/2 mile radius, Mr. Hudson, indicate to you the presence of any well that poses a potential risk as a result of the fireflood operation?

A. No, sir, it doesn't.

Q. In your opinion are all those wells ade-

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quately cemented at the present time to confine the Lower Hospah activities to that formation and not result in contamination to any other source?

A. Yes, sir, it does.

Q. Would you refer to Exhibit Number Ten and identify that for us?

A. Exhibit Ten is another exhibit based on memo 3-77, pertaining to waterflooding, and is a schematic of the only plugged and abandoned well inside a half mile radius.

This well, our well No. 37, is shown in the upper lefthand quarter of Section 12. It would be the northwest quarter of the northwest quarter, and it's shown plugged and abandoned.

This well was actually drilled on the opposite side of a fault which exists in this field and though it has been plugged according to Oil Commission rules, it is also across a fault, which we anticipate being a sealing fault and therefor will not be in communication either, any way.

Q. Would you identify Exhibit Number Twelve for us?

A. Exhibit Twelve is a listing of all the fresh water sands in the area. This was based on the electric log of Well 18, and it's a -- notes the chlorides content calculated from this log combined with a porosity based on density log. This was in conjunction with determining what, if any, possible contamination could be done to any fresh water sands in the area.

Q. All the fresh water sands are at a substantially shallower depth than the proposed project?

A. Yes, sir.

Q. And is the separation between fresh water sands and the project one through which the fresh water sands will remain uncontaminated by the project?

A. Yes, sir.

Q. Would you refer to Exhibit Number Thirteen and identify that?

A. Exhibit Thirteen is an affidavit prepared by Mr. Kellahin for us stating that the records of the State Engineer of New Mexico does not have -- there are not any fresh water wells within the surrounding sections of Section 12 or in Section 12.

Q. Are you aware of any fresh water wells, Mr. Hudson?

A. In this search it then became apparent to us that there is a well on this area which is Tenneco's well, which is for drinking water only. This is located approximately 2000 feet from the pilot area. If you refer to the map of -- it's Exhibit Two, it's approximately --

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it's near Well No. 23, which is in a lower portion of the -- or directly south of our pilot, southwest.

This well has not been permitted according to these rules. It became apparent that the permit was never received by the office or was neglected in the process. We are in the process right now of filing the correct permits and having this well documented in the State Engineer's office.

Q. When was that well drilled, do you know?

A. That well was drilled in January of 1971.

Q. And it's still being used by personnel in the site, Tenneco personnel in the site, for drinking water?

A. Yes, sir.

MR. NUTTER: What depth does that produce water from?

A. That well produces from perforations approximately 550 to 600 feet.

MR. NUTTER: Thank you.

Q. Mr. Hudson, were Exhibits One through Twelve prepared by you directly or compiled under your direction and supervision or that of Mr. Strobl?

A. Yes, sir, excepting the Exhibit Eleven, which was the frac pressure gradient exhibit which had been presented in a previous Commission hearing, as so documented

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earlier.

Q. Have you re-examined the numbers used in Exhibit Number Eleven and to your own information and belief are those numbers correct and accurate?

A. Yes, sir.

Q. Do you concur that the fracture gradient for the Lower Hospah formation is something greater than .92 psi per foot of depth?

A. Yes, sir.

Q. In your opinion, Mr. Hudson, will approval of this application be in the best interests of conservation, the prevention of waste, and the protection of correlative rights?

A. Yes, sir.

Q. Now let me direct your attention to one further point, the fact that the two new wells that will be drilled as producers, plus the proposed injection well, are unorthodox locations, are they not?

A. Yes, sir, they are.

Q. And in the order approving this pilot would also require approval of those particular items as exception to well location.

A. Yes, sir.

Q. In your opinion will approval of this pilot project result in the recovery of oil that would otherwise not be recovered?

A. Yes, sir.

MR. KELLAHIN: That concludes my examination of Mr. Hudson.

We'd move the introduction of Exhibits One through Thirteen.

MR. NUTTER: Tenneco's Exhibits One through Thirteen will be admitted in evidence.

CROSS EXAMINATION

BY MR. NUTTER:

Q. Mr. Hudson, looking at your Exhibit Nine I see six wells on the first page, four wells on the second page, three wells on the third page, one well on the fourth page, and one well on the fifth page that have been cemented with less than 100 sacks of cement on the long string. Now, do you think that's going to be adequate cement to contain whatever products or by-proucts result from this flooding operation and keep them from penetrating into some fresh water sand. We know there's fresh water sand here at 550 to 600 feet?

A. Based on our present knowledge of this fireflooding operation and cementing in general, we believe they will be adequate for the pilot. That's one of our major considerations or pieces of information that we want

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to find from the pilot, is can we use the existing wellbores or do we need to redrill the field because of cementing conditions.

But based on our present knowledge, we do deem that this is an adequate cementing job.

Q. Okay, let's take this No. 48 Well for example.

A. Okay.

Q. It was cemented with 125 sacks. It's one of the wells that's in your project, your immediate project area. Where is the top of cement on the long string in that well? Did we have a schematic diagram of that well? I don't think we did, did we?

A. No, sir, that's not supplied.

Q. Do you know what the top of cement is on the long string in that well?

A. Based on that volume and the hole volume that would have been drilled for 5-1/2 casing, which is set in that well, I would estimate it's possibly about 4 to 500 feet above the Upper Hospah.

Q. I notice that most of the wells are completed with either 4-1/2 or 7-inch casing. There are a few 5-1/2 inch.

A. Yes, sir.

Q. Now, what size of a hole would you nor-mally drill for these 4-1/2 inch cased wells?

A. Approximately a 6-3/4, something in that neighborhood.

Q. And then for the 7-inch casing well?

A. 7-inch I'd say an 8-7/8ths, something in that neighborhood.

Q. And then for the 5-1/2 inch casing wells?

A. I'd say 7 to 7-1/4.

Q. Now do you know if there have been any problems with hole cavings or washouts or anything like this that would require any abnormal amounts of cement in casing and cementing these wells?

A. No, not --

Q. What has the experience been?

A. In this field generally there has been no problem drilling the wells or washouts in the drilling in process.

Q. Were cement tops determined on these wells when they were drilled?

A. The information from the -- that was compiled for this exhibit was taken from sundry notices either to USGS or the -- whatever body was involved, and it was not listed on those notices.

In the cases in this field it was deemed adequate for the cementing that has been done.

Q But that was before you were going to put a fire in there at 1000 pounds pressure.

A Only on our air pressure. We don't anticipate producing bottom hole pressures to be much more than they are now. From our research in the literature the fireflood process does not significantly raise the reservoir pressure. We still anticipate having to rod pump these wells, which would --

Q That's in producing?

A That's in a producing well, yes, sir.

Q Could you make an estimate of your cement tops on these wells that I've mentioned that have less than 100 sacks of cement on them and send that to me?

A Yes, sir, we can do that.

Q There's about 15 or 20, I guess, there.

A Basically you're -- less than 100 sacks you would like to see something on that?

Q Yeah, those wells that I mentioned that have less than 100 sacks.

A Okay.

Q I'm sure some of these have lots of cement on them, adequate cement, no question, but there are a few there that were cemented with a minimal amount and I'm kind of concerned about those.

Now, do you know of any other water sands that are in this area besides this 550 to 600 foot sand?

A. When we were drilling this water well back in '71, from what I've been told, they tested every sand on the way down and this was the first sand that they came to that was not brackish and that would provide a sufficient volume for drinking water only.

Q. This is camp water. This is drinking water for the camp?

A. Yes sir, there's no irrigation in this section being done from any water sand out there. The volume that this sand produces is in the order of less or approximately 60 gallons an hour. It's not a very prolific sand at all.

Q. Now, is there anything about this project that is going to cause any new or unusual and adverse environmental effects? Are we going to have clouds of smoke and steam and hot oil gushing up in the air and spreading over the countryside, or are we going to have the animal life and the bird life in the area endangered because of this flood? Are there going to be any outward effects of this operation that are not normal outward effects as far as an oilfield operation is concerned?

A. No, sir. We planned around the environmental aspect of it on, you know, purpose. Calculations that we've done now, based on some exhaust gas analysis performed

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in our laboratory tests of in situ combustion, revealed that a maximum amount that we expect just based on this laboratory work, is approximately 2 pounds per hour of any sulphur compounds, which be EPA regulations you do not need a permit if it's less than 10 pounds per hour or 25 tons per year.

So based on what we know at this time, we do not anticipate any kind of noxious gas emissions from the pipe.

We will, however, do extensive exhaust gas analysis testing for this reason as well as to determine air fuel ratios and such things.

Q. Where do these exhaust gases come from, Mr. Hudson?

A. What we plan to do as far as field development is all exhaust gases taken off the annulus will be sent to a central facility for vapor recovery, which we intend to knock out any recoverable hydrocarbons in such a system, a tank system, and then vent whatever will then not condense into this system, and the fluids coming off this vapor recovery will be sent to -- back into our treating facilities to be treated and sold or re-injected if it's water.

Q. Well, I'm sure someone's going to ask us what the environmental effects of the project will be.

A. We have looked into that as far as the

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permitting required by the EPA, and based on our present calculations we do not foresee the need for a permit for the project.

Q. And you'll have check valves on the -- on the wellheads where this air and this methane are going into the injection well so if you have a break back up the line you won't have a backflow from the well out into the atmosphere.

A. No, sir, not -- we definitely do not want to do that in the air injection well, and the methane will only be injected for a week to 10-day period and when that is being done there will be 24-hour monitoring of the injection well during the ignition phase, so -- and then other than that, the only thing that could backflow would be -- would be air, but we plan to have safety devices which would not -- which would not allow that to happen.

Q. Okay.

MR. NUTTER: Are there any further questions of Mr. Hudson?

MR. CHAVEZ: Yes, sir.

MR. NUTTER: Yes, sir, Mr. Chavez?

QUESTIONS BY MR. CHAVEZ:

Q. Mr Hudson, on your Exhibit Eight you show a wellbore schematic of a producing well.

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A. Yes, sir.

Q. Yet the No. 48 and the 18 will not be exactly this way because of the cement they're completed with. Do you intend to circulate cement, to go in and perforate above the cement top and circulate cement in those wells?

A. At this time -- at this time we did not plan to do that, no, sir.

Q. What type of temperature rises do you get in a production well just directly from the pilot --

A. Based on research, as well as our trip to Shreveport, Louisiana, that Glen mentioned earlier, for the life of the project you only see reservoir temperature, and as your fire approaches your gas rate increases and you start seeing an increase in temperatures. At a certain point, which we believe to be approximately 250 degrees bottom hole temperature, we plan to shut the producing well in so that the fire will not adversely affect the well.

In this pilot we do hope to see if a fire burn through these older wells to determine the integrity of the cement there, but in a normal field operation, you would not produce the well as the fire burns through it.

Q. So in a sense you're testing the 48 and the 18 to failure?

A. We don't want them to fail but that's one of the things we definitely want to find out from it, if they do or if they don't.

The Shreveport test that Cities Service has in the Field, they had some old wells that they burned through several times and did not notice any adverse downhole effects other than a little corrosion on the casing. They were able to go back and squeeze off the burned through interval and continue to produce the well. That was with a different gravity oil system and from our literature research every one of these reservoirs acts a little bit different. That's why we propose a pilot instead of a full scale type project.

Q. Okay, then as soon as the temperature starts rising to a certain point you will shut the producers in?

A. Yes, sir. Standard cement that was used in this project is good to approximately 300 degrees before it began strength retrogression, so -- and that doesn't mean it completely fails at 300 degrees, it just gets weaker as the temperature rises.

But the cooling water should keep the bottom hole pressure -- bottom hole temperature, excuse me, down to approximately 150, 180. That's what we're planning on.

Q. How fast do you expect the flood front or the fire front to advance to the producers from the air injectio

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A. Could I direct that to Glen, please?
Q. Yes. Fine.
MR. STROBL: It's design to advance approximately 70 percent of the way if it is a true vertical piston-like displacement in a 6-month period.
Q. Within 6 months?
MR. STROBL: Yes, that's providing we can obtain the 1/2 million cubic feet a day injection rate.
Q. And what effects will the heat generated in the Lower Hospah have on the Upper Hospah? They're only separated by 20 feet, will there be any thermal --
MR. STROBL: There could be and I can only see good -- good effects or benefits. The Upper Hospah is a 12 centipoise viscosity oil. That should lower the viscosity. Any heat loss to the upper should be --
Q. Will you be monitoring the Upper Hospah in that area?
A. Yes, we will. We plan on like you said, taking gas analysis of all these wells, we plan on the oil production from all these wells and doing some additional testing, more testing than we do now on these particular wells in the pilot and surrounding the pilot area.
Q. Okay, but specifically in the upper, in the Upper Hospah distinctly, if you're fireflooding the Lower Hospah, you will be monitoring the Upper Hospah also.

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A. Yes.

Q. Okay, and -- but you don't have any idea as to how much temperature, say, from your fireflood may be transmitted upward to that?

MR. STROBL: I don't foresee very much temperature. It's very hard, you know, to pin that down. We plan on looking at some simulation studies, model studies, while we're running this pilot and might be able to pinpoint that a little better. It's very hard to do, you know, analytically; it's easier to do it in a model.

A. Rock conducts heat very poorly so we don't anticipate;major heat loss in a project like this is in an aquifer and not necessarily surrounding beds by conduction; mainly to an aquifer, which we do have in the Lower.

Q. So you expect the heat to spread outward then, more.

A. More likely than upward, due to that fact.

Q. How about -- you talked about exhaust gases. Will these exhaust gases be the gases generated by that actual combustion itself show up in the producing wells? How much gas will be, say, carbon dioxide or carbon monoxide?

MR. STROBL: Of course most of the biproducts of combustion are carbon monoxide and carbon dioxide and the greatest being nitrogen, because nitrogen is the

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largest component of air.

81 percent of the gas produced will be nitrogen and 4 percent carbon monoxide and roughly 12 percent carbon dioxide.

If we inject 1.5 million cubic feet of air a day, we're looking at about 1.2 million cubic feet of nitrogen a day, 2175 Mcf a day of $CO_2$, and about 60 Mcf a day of carbon monoxide.

Q. T·· your Exhibit Nine you showed some Tesoro wells in Section 1 within the 2-mile radius that had no cement shown on the long string, nc record of cement. Was that because you just couldn't get these?

A. Information was just unavailable to us.

Q. Okay.

MR. GHOLSON: We probably have that in our files.

MR. NUTTER: Which well was that?

MR. KELLAHIN: The Tesoro wells in the last part of Exhibit Nine.

MR. CHAVEZ: Page 5.

MR. NUTTER: Oh, yeah.

MR. CHAVEZ: Those are all the questions I have.

MR. NUTTER: Are there any other questions of the witness? He may be excused.

Do you have anything further, Mr. Kellahin?

MR. KELLAHIN: No, sir.

MR. NUTTER: Does anyone have anything they wish to offer in Case Number 6890?

We'll take the case under advisement, and the hearing is adjourned.

(Hearing concluded.)

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C E R T I F I C A T E

I, SALLY W. BOYD, C.S.R., DO HEREBY CERTIFY that the foregoing Transcript of Hearing before the Oil Conservation Division was reported by me; that the said transcript is a full, true, and correct record of the hearing, prepared by me to the best of my ability.

Sally W. Boyd C.S.R.

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 6899 heard by me on 5/7 19 80.
_______________, Examiner
Oil Conservation Division

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION FOR THE PURPOSE OF CONSIDERING:

CASE NO. 6890
Order No. R-6389

APPLICATION OF TENNECO OIL COMPANY FOR A THERMAL ENHANCED RECOVERY PROJECT, McKINLEY COUNTY, NEW MEXICO.

ORDER OF THE DIVISION

BY THE DIVISION:

This cause came on for hearing at 9 a.m. on May 7, 1980, at Santa Fe, New Mexico, before Examiner Daniel S. Nutter.

NOW, on this 7th day of July, 1980, the Division Director, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

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

(2) That the applicant, Tenneco Oil Company, is the owner and operator of the South Hospah Unit Area in the South Hospah-Upper Sand Oil Pool, and of the Hospah Lease in the South Hospah-Lower Sand Oil Pool, both in Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico.

(3) That the applicant proposes to institute a thermal enhanced tertiary recovery project (fire flood) on said Hospah Lease by the underground ignition of hydrocarbons in the South Hospah-Lower Sand Oil Pool in a pilot area comprising some 0.68 acres in Unit G of Section 12, Township 17 North, Range 9 West, NMPM.

(4) That primary development of the Lower Hospah pool on the subject lease occurred from 1967 until 1972, at which time a gas-water injection project was instituted.

(5) That said gas-water injection project was continued until 1976, when gas injection was terminated, but water injection into the Lower Hospah pool has been continued to date.

(6) That primary production from the Lower Hospah pool accounted for approximately 15 percent of the original oil in place and secondary recovery under the gas-water injection program and waterflood operations should yield an additional 19 percent of the original oil in place.

(7) That the 34 percent total production expected under primary and secondary recovery operations amounts to 3,255,000 barrels, of a total of approximately 9,575,000 barrels of original oil in place, and it is expected that the proposed thermal enhanced tertiary recovery project, if expanded to a field-wide operation, would add about 13 percent recovery to the pool, or 1,245,000 barrels.

(8) That the applicant proposes to drill an air injection well at a point approximately 1474 feet from the North line and 2725 feet from the East line of the aforesaid Section 12, said point being approximately midway between applicant's Lower Hospah Well No. 48 and its Upper Hospah Unit Well No. 18 (which will be recompleted in the Lower Hospah pool) and to also drill two additional wells, Nos. 65 and 66, which would be located immediately North and South of the air injection well at points 1350 feet from the North line and 2725 feet from the East line, and 1600 feet from the North line and 2725 feet from the East line, respectively, thereby creating a 0.68-acre pilot project area with one air injection well in the center and four producing wells, one each to the North, South, East, and West, thereof.

(9) That said wells would be cased through the Lower Hospah producing formation and would be cemented with a special high temperature-resistant cement.

(10) That the applicant proposes to inject approximately 500,000 cubic feet of air per day into the Lower Hospah pool through the aforesaid air injection well and to then ignite the oil in the reservoir by the injection and ignition of methane gas, creating a fire front which would advance through the reservoir, sweeping the unburned oil towards the producing wells by a wall of hot vapors advancing ahead of the fire front.

(11) That the applicant may also attempt to further stimulate production from the reservoir by a combination of such forward combustion and water injection.

(12) That the feasibility of the proposed thermal enhanced tertiary recovery process has been proven in other reservoirs in other states, and should be determined in this State.

(13) That although some small percentage of the oil in place in the reservoir would be consumed by the advancing fire front, the proposed pilot fire flood, if successful, should result in the recovery of a substantial amount of otherwise unrecoverable oil reservas, thereby preventing waste.

(14) That provided the injection and producing wells are cased and cemented properly, and the injected air, methane and water are confined to the Lower Hospah producing sand, no impairment of water quality in any potable water sands should occur.

(15) That the proposed enhanced recovery project will not impair the correlative rights of any other interest owner in the Lower Hospah pool and should be approved.

(16) That the applicant also proposes to inject air into the Upper Hospah pool through the proposed air injection well which will have two strings of casing cemented therein, one open to the upper pool and one open to the lower pool.

(17) That siad injection into the upper pool would be for test purposes only, and no ignition of hydrocarbons is planned for said Upper Hospah pool at this time.

(18) That said air injection into the Upper Hospah pool will not cause waste nor impair correlative rights and should be approved.

(19) That the proposed air injection well and producing Wells Nos. 65 and 66 would be at unorthodox locations, but such unorthodox locations will neither cause waste nor impair correlative rights and should be approved.

(20) That the applicant proposes a maximum surface injection pressure for the air injection well of approximately 1000 psi, and this proposed injection pressure will not fracture the confining strata and should be approved.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby authorized to institute a thermal enhanced tertiary recovery project in the South Hospah-Lower Sand Oil Pool, McKinley County,

New Mexico, by the injection of air, gas, and water into one injection well to be located 1474 feet from the North line and 2725 feet from the East line of Section 12, Township 17 North, Range 9 West, NMPM, and by the ignition of hydrocarbons in situ around the injection well, and by the production of hydrocarbons from two existing wells, applicant's Well No. 48, located 1485 feet from the North line and 2817 feet from the East line, and Well No. 18, located 1600 feet from the North line and 3100 feet from the West line, and from two additional wells to be drilled, applicant's Well No. 65, to be located 1350 feet from the North line and 2725 feet from the East line, and Well No. 66, to be located 1600 feet from the North line and 2725 feet from the East line, all in the aforesaid Section 12.

(2) That the aforesaid wells to be drilled shall be cased through the Lower Hospah sand formation and shall be cemented with high temperature-resistant cement, provided however, that said cement shall be brought back to a point at least 100 feet above the top of the Upper Hospah sand formation.

(3) That allowable restrictions are hereby removed from wells in the pilot project area for the duration of the combustion and post-combustion life of the project.

(4) That injection of air and methane into the South Hospah-Lower Sand Oil Pool shall be limited to 1000 psi pressure at the wellhead and injection of water into said pool shall be limited to 800 psi pressure at the wellhead; that the Division Director is authorized to permit higher injection pressures upon adequate showing by the operator that no adverse effects would result.

(5) That the injection of air into the South Hospah-Upper Sand Oil Pool through the air injection well herein approved is hereby authorized, provided however, that such injection shall be at no more than 1000 psi pressure at the wellhead.

(6) That jurisdiction of this cause is retained for the entry of such further orders as the Division may deem necessary.

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

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

JOE D. RAMEY
Director

S E A L

fd/

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STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION
STATE LAND OFFICE BLDG.
SANTA FE, NEW MEXICO
7 May 1980

EXAMINER HEARING

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IN THE MATTER OF:

Application of Tenneco Oil Company for a thermal enhanced recovery project, McKinley County, New Mexico.

CASE 6890

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BEFORE: Daniel S. Nutter

TRANSCRIPT OF HEARING

A P P E A R A N C E S

For the Oil Conservation Division: Ernest L. Padilla, Esq.
Legal Counsel to the Division
State Land Office Bldg.
Santa Fe, New Mexico 87501

For the Applicant: W. Thomas Kellahin, Esq.
KELLAHIN & KELLAHIN
500 Don Gaspar
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EXHIBITS

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MR. NUTTER: We'll call now Case Number 6890.

MR. PADILLA: Application of Tenneco Oil Company for a thermal enhanced recovery project, McKinley County, New Mexico.

MR. KELLAHIN: Tom Kellahin of Santa Fe, New Mexico, appearing on behalf of the applicant, and I have two witnesses to be sworn.

(Witnesses sworn.)

GLEN C. STROB

being called as a witness and having been duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. KELLAHIN:

Q Would you please state your name?

A. Glen C. Strobl.

Q How do you spell your last name, Mr. Strobl.

A. S-T-R-O-B-L.

Q Where are you employed and in what capacity?

A. Employed in the Denver office of Tenneco

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Oil Company as a Senior Petroleum Engineer.

Q. When and where did you obtain your degree in engineering?

A. I obtained my degree, BS in petroleum and natural gas engineering, June, 1973, Pennsylvania State University.

Q. Subsequent to your graduation where have you been employed and in what capacity?

A. For the Shell Oil Company as a production engineer for a year and a half and then for two years as a reservoir engineer; I worked with Gulf Research and Development as a reservoir engineer. And then with Tenneco for a year and a half as a reservoir engineer.

Q. And as a reservoir engineer for Tenneco Oil Company, what do your duties include?

A. For the past year I've been working on enhanced recovery; in particular this project.

Q. But involving the Lower and Upper Hospah formations in McKinley County, New Mexico?

A. Correct.

Q. Pursuant to that study, Mr. Strobl, what if any other in situ combustion projects have you examined in the United States?

A. I have made field trips to some projects and done extensive literature research, talked with a number

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of people that have worked on projects, who we might consider experts on the subject, and in relation to this project, also.

Q What are the locations of any existing projects that you examined?

A The Fireflood in Belleview, Louisiana, was the one I actually toured.

Q Did you or anyone in conjunction with Tenneco Oil Company examine any firefloods in California?

A No, we have not yet. We have discussed some with people there.

Q In accordance with your testimony today, you have done research and prepared certain exhibits for presentation.

A Yes.

MR. KELLAHIN: We tender Mr. Strobl as an expert petroleum engineer.

MR. NUTTER: Mr. Strobl is qualified.

Q Mr. Strobl, would you turn to what we've marked as Exhibit Number One and orient us to where in New Mexico you propose to commence this pilot in situ combustion project?

A The pilot project is designed for the Hospah Field, which is in the southern area of San Juan Basin, the area. It's in McKinley County, and this exhibit shows the relationship of the field location to

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the cities of Farmington, Santa Fe, and Albuquerque.

Q All right, sir, let's turn to Exhibit Number Two. Would you identify this plat for us and tell us in general terms what is contained on this exhibit?

A. This is a plat of the South Hospah area in McKinley County, and basically it shows the cross hatched area in the middle, that's Section 12 of 17 North, 9 West, as our unit, the Hospah Unit. We have 100 percent working interest in that area, the cross hatched area. It's not really cross hatched, but it's outlined in a dotted line.

Q Okay. You have platted all the Lower and Upper Hospah Wells in this pool?

A. Yes. This map does show all the completions and the current status of those completions in that area.

Q The plat also identifies who the operators are in the different sections.

A. Right.

Q And what is indicated by the inner circle?

A. The inner circle is a half mile radius immediately around the pilot area, the center of that being 18 and 48 are Hospah wells.

Q Let's take a moment, then, and within the center of that circle would you locate for us the site of the proposed injection well for this pilot project?

A. The injection well would be halfway between our Hospah Nos. 18 and 48 Wells.

Q. It's not specifically platted on your exhibit, is it?

A. No, because of the scale it would be very close together and not show up very well.

Q. But it's going to be halfway between Wells 48 and 18?

A. Yes.

Q. Right above the word Hospah on your plat?

A. Yes.

Q. All right, we'll come to a later exhibit in a minute --

A. Okay.

Q. -- that shows that better.

What is indicated by the outer circle?

A. The outer circle is a 2-mile radius.

Q. Would you describe, or refresh the Examiner's memory, as to what the history of production has been for the Lower and Upper Hospah formations?

MR. NUTTER: Mr. Strobl, before you leave that exhibit.

A. Yes, sir.

MR. NUTTER: You mentioned that this was in the unit and outlined by a dotted line.

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A. Yes.

MR NUTTER: I think to show that this is inside the lease and not near any other lease line, if you define what that unit boundary is, so that I can mark it on my exhibit with a red pen, the dotted line that outlines this particular unit that would be working.

A. Okay. Actually we're dealing with a unit in only the Upper Hospah. The Lower Hospah has never been unitized.

The unit does run along the north line of Section 12, completely across that section.

MR. NUTTER: Okay.

A. And then about I'd say 75 percent of the way down the east boundary of that section. As you can see, then it follows across half way and then continues down -- I'm sorry, it does follow all the way across that section.

MR. NUTTER: It goes all the way across into Section 11, I think, doesn't it?

A. Into Section 11. Again that is an Upper Hospah Unit, and continues up about a quarter or half of the way, let's say, cuts across to Section 12's boundary line again and then up to the northern boundary line.

MR. NUTTER: So that's the boundary of the Upper?

A. Yes.

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MR. NUTTER: And the South Hospah Lower Sand is not unitized, is that it?

A. No, it isn't.

MR. NUTTER: So it's on a lease. Now what is the boundary of the lease that it's on?

A. I believe, if I'm not mistaken, the lease encompasses that whole section, or at least the greater part of that section.

Q. And that's a Federal lease?

A. That is a Federal lease. My basic reason for showing this was to show that we are the only operator in that section on that lease and we have a 100 percent working interest.

MR. NUTTER: Okay. So this is not near any boundary of any property that's owned by any other operator or any other royalty owners, is that it?

A. That's correct.

MR. NUTTER: Okay, proceed to your next exhibit.

Q. The closest operator is Tesoro to the north in Section 1, is that not true?

A. That's true. They also operate on the east of that section in Section 7. We -- we did pick this pilot area to isolate them by many producing wells in between ours and the boundary line of that section. There are also

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water injection wells between the pilot area and Tesoro's property.

Q Mr. Strobl, would you summarize for us what has been the history of the Upper and Lower Hospah formations? Well, let me go back, and indicate to you that the application as originally filed requests approval of a pilot project for both the Upper and Lower Hospah formations and as of the date of this hearing, what is Tenneco's intention?

A. Our intention now is to only have a pilot in situ combustion project in the Lower Hospah, and at the same time to do just an injectivity test in the Upper Hospah.

Q The proposed injection well will still be completed as applied for, I assume.

A. Yes.

Q And the location of additional wells will be on the four producing wells included in the application as opposed to the 8-spot pattern?

A. Correct.

Q All right. Let me have you take an exhibit out of order, if you will, please.

If you'll turn to Exhibit Number Six and if you'll demonstrate for the Examiner, using Exhibit Number Six, and perhaps Exhibit Number Two, explain to him what you propose to do for this pilot project in the Lower Hospah.

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A. The pilot is designed as an inverted 5-spot pattern utilizing two wells that already exist in the field, the Lower Hospah No. 48 Well, as shown on the left of Exhibit Six, and our Upper Hospah No. 18 Well.

We plan on recompleting the 18 Well to the Lower Hospah. That is, it is drilled all the way through and has casing through the Lower Hospah.

We also plan on drilling three additional wells, the Lower Hospah No. 65 to the north; the Lower Hospah No. 66 to the south. These will be producing wells, and our air injection well on the center of this pattern. The air injection well will, as Mr. Kellahin just previously said, is a dual injection well.

Q. What is the approximate area involved in the pilot project in terms of surface acreage?

A. Approximately .68 acres.

Q. All right. Would you summarize for Mr. Nutter what has been the producing history of the Lower Hospah?

A. Basically the field was discovered as an Upper Hospah Field in 1965. Tenneco purchased the field, the property, in 1966. We began the production in 1967 in the Lower Hospah. The field was aggressively developed in those days, drilling of wells. By 1968 we deemed that water flooding would be beneficial in the Upper Hospah, started a waterflood project on the Upper Hospah. By 1972 we decided to try to enhance the recovery of the Lower Hospah and attempted a gas/water injection project. We did see some results of that but found that the gas was really not beneficial and all the benefit was coming from the waterflood. Both waterf! ods have continued to the present date.

In 1977 and '78 we had an infill drilling program in the Lower Hospah, which had increased our reserves and recovery from the Lower. At this point in time we're in the latter stages of secondary or waterflooding production and we feel like we've done about all we can to increase production from this reservoir in a secondary phase.

At this point in time we think it's a good idea to go to enhanced recovery or tertiary recovery to optimize production, increase our recovery from these two reservoirs.

Q. Can you give us an indication and perhaps some rough numbers or percentages of what you recovered from the Lower Hospah in the primary phase and then in the secondary waterflood phase of the project?

A. Primary production was about 15 percent of the oil in place in the Lower Hospah. There was some water drive and that accounted for some of this production.

The expected secondary recovery should add up to another 19 percent of the oil in place.

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The expected incremental tertiary oil from a field-wide project, if it is successful, should add another 13 percent recovery to the field.

That will give us a total of 47 percent ultimate recovery from the field, from the Lower Hospah reservoir.

Q Let me see what you've got.

MR. NUTTER: Now, Mr. Strobl, am I reading this correct on this statement here, down at the bottom line, where you say projected ultimate recovery from the Lower under primary and secondary would be 3,255,000? Am I reading that right?

A Yes, sir.

MR. NUTTER: Okay.

A That's a combination of the two phases.

MR. NUTTER: Okay, thank you, and that would amount to 34 percent?

A Yes, sir.

MR. NUTTER: Okay.

Q In general terms, Mr. Strobl, why don't you narrate for us how you propose to make this pilot work; what it's supposed to do and how it does it? Give us an overview of what we're doing.

A Basically what we intend to do is inject air in the air injection well and using some artificial means, and I think we plan on using a gas ignitor to heat this air downhole to a temperature approximately 600 degrees, which should ignite the oil. The oil -- not all the oil will burn. There is a part of the oil, the heavier ends, called coke, which settles out on the formation and will supply the fuel. The heat from this combustion vaporizes the oil, distills some of the lighter ends, pushes it away from the wellbore, the injection wellbore, leaving the coke behind.

As this proceeds we have gases generated; we have steam generated; and of course the distillation products. This provides the driving mechanism which pushes the oil ahead and to the production well, naturally.

Q. What other methods of tertiary recovery have you examined for the Lower Hospah formation?

A. Okay. With the particular crude and reservoir properties that we have in the Lower Hospah we found that chemical and thermal means would probably be the best, and in particular polymer caustic, mycellar polymer, caustic polymer combination, steam, in situ combustion were examined, and evaluated for application here. Of these we did do some lab testing on these. Of these, in situ combustion was the best for most optimum recovery.

Q. What do you propose to accomplish by the pilot project?

A. The pilot is designed to answer a number

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questions.

The first and most important, I guess, is to verify the engineering evaluation in our prediction model. And after that I think we really want to find out what the operational aspects of in situ combustion are going to be like in this particular reservoir; what type of problems we will have to handle.

We also want to determine the injectivity for sizing compression equipment we have to order many months in advance of getting it in the field.

Q Let's turn to Exhibit Number Three and have you identify that for me.

A Exhibit Number Three is an induction electrical log of Hospah No. 18. As I indicated previously, that is in the pattern area that we're proposing and it is very typical of the type of sand development that we have in the Upper and Lower Hospah. You can see the proximity of the two sands and the type of development on this well.

Q Would you take Exhibits Four and Five now and summarize those exhibits for us?

A This Exhibit Four is a production history of the Upper Hospah Unit. The black curve, solid line curve, is barrels of oil per day, and the upper curve, the red dashed curve, is barrels of water per day.

As you can see, I've indicated when we

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began water injection in JUne of '68 and you can see the dramatic increase in water -- or water and oil production due to that water injection. You can also see that we are in an established decline and the latter phases of this water injection.

On Exhibit Number Five we show the production history of the Lower Hospah. Again, the black solid curve is barrels of oil per day and the red dashed curve is barrels of water per day.

I've indicated when we started the gas/water injection and when the gas injection ceased. You don't see the dramatic increase from water injection here because we've always had mobile water. We've always had a water influx from the aquifer in this reservoir. But I think you do see that we have more or less by water injection stopped the decline and leveled out production.

You can also see in '77 where we did the deepening and perforating of those eleven wells and the increase of production that followed that and the effect of the four infill wells in the Lower Hospah.

Q. Subject to the approval of the Division, when would you propose to commence drilling the injection well?

A. As soon as possible.

Q. When do you propose to have the pilot project operational?

A. Very soon after that. It would be a matter of basically just lining up the compression equipment. I would expect by June, July, we should have this going pretty well.

Q. Once the pilot project is operational, what do you anticipate to be the life of the project in order to answer the questions that you've posed?

A. We plan on running the project for six months total, six to eight months, I should say, depending on the injection rates.

MR. KELLAHIN: I have another witness, Mr. Nutter, that's going to discuss the method of drilling and completing the injection well. He has examined sources for potential fresh water in the area. He has analyzed all the wells within the area to determine the casing program, the quality of cement, and that sort of thing, and is prepared to answer questions in that regard.

Both gentlemen, I'm sure, are qualified to answer all your questions, but perhaps it might be easier to let me complete the testimony with my second witness and then have both witnesses available to answer questions.

MR. NUTTER: I think I've only got a couple of questions for Mr. Strobl at this time.

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CROSS EXAMINATION

BY MR. NUTTER:

Q Mr. STrobl, now you are going to abandon the project insofar as the upper sand is concerned at this time?

A Yes, sir.

Q But you said you would dually complete the well, the injection well?

A Yes, sir, we would like to do some air injectivity tests in the upper sand, again to size our compression equipment so that we can go ahead and order that and be ready for the field-wide project in the upper.

Q In the event that you did decide to go into the upper later?

A Yes. If the lower proves out, we will do the upper. There's no question of that.

Q You feel like you can evaluate the process feasibility by injection into the lower sand only.

A Yes, sir.

Q For six or eight months?

A Yes.

Q Okay. Now, in the process of burning this oil, you mentioned that there would be a certain amount of it would be coke and that's going to remain behind. Have

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any calculations been made as to the percentage of oil in place that is coke?

A. The saturation percentage is around 10 percent. The original oil saturation was 65 percent.

Q. Original oil saturation, 65 percent. Present saturation?

A. Present saturation volumetric average is about 49 percent.

Now, this coke will not be left behind. It will be burned. There will be nothing left in that sand.

Q. That coke eventually is burned?

A. Is burned.

Q. Okay. Now what percent of the oil that's there, this 49 percent saturation that you have at the present time as coke, can burn?

A. That's roughly 1/4th or 1/5th of the oil.

Q. 1/5th to 1/4th of oil in place coked and burned and consumed.

A. I might add that that will only be in the areas that are swept by the air. Of course the heat is conducted from the swept areas and up to 40 percent of the oil in areas that are not air swept is produced.

Q. How far from the injection well do you get on this 119 feet to the No. 48 over here, for example.

A. Yes, sir.

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Q How far do you expect the actual combustion to extend and then beyond that simply the vapors sweeping through the reservoir?

A We hope to propogate the fire front as far as one of these older wells. We do want to see if we can handle the heat in these production wells.

Q I see.

A We plan on setting up a circulating system of cooling water in the wellbore, and we want to see if we can control this heat to a manageable level.

But I expect we will burn out this pilot to a reasonable economic air/oil ratio in that six to eight month period.

Q And you would hope that you could achieve combustion all the way to the producing wells out there.

A At the rate of --- yes, I think we can very easily. That's why we chose such a small pilot area.

Q Uh-huh.

MR. NUTTER: I believe that's all for now. Thank you.

STEVEN H. HUDSON

being called as a witness and having been duly sworn upon his oath, testifies as follows, to-wit:

DIRECT EXAMINATION

BY MR. KELLAHIN:

Q Would you please state your name and occupation?

A Steven H. Hudson. I'm a production engineer with Tenneco Oil in Denver.

Q Mr. Hudson, when and where did you obtain your engineering degree?

A I obtained a BS in mechanical engineering from the University of Texas in December, 1973.

Q Subsequent to graduation where have you been employed and in what capacity?

A I began as a production engineer with Amoco Production Company and since that time, or up to December of '79, and then joined Tenneco in Denver.

Q What are your responsibilities as a production engineer with Tenneco Oil Company?

A Upon employment with Tenneco I started on work on this project, specifically working on the production phase of implementing this pilot or full scale fireflood.

MR. KELLAHIN: We tender Mr. Hudson as an expert petroleum engineer.

MR. NUTTER: Mr. Hudson is qualified.

Q I'd like you to begin, Mr. Hudson, with

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Exhibit Number Seven, which is the proposed injection well, and have you describe how you propose to drill and complete this well for injection.

A. Due to our specific case of having two sands in close proximity which we wish to expose to this fireflood, it became necessary by looking through several designs to attempt air injection by two casing strings. We attempted a single casing string with two tubing strings and packers, or we proposed that, and upon a little bit of intensive study on that we found that downhole equipment as far as packers and expansion joints and things like that are not really developed for the heat that we expected to be placed upon these wells.

So we therefor decided to go with a two casing strings to eliminate the downhole problems that we might see with packers or expansion joints.

This diagram of Exhibit Seven then shows two strings of 4-1/2 inch casing, which would be set to a total depth of approximately 1715 feet as determined by the Exhibit Three, which was the log on Well 18, which we have for depth determination.

In that I'd like to point out that we will not be running 1.66 IJ tubing. It will be 2-3/8ths standard 8-round tubing to facilitate our ignition process only. The present ignition systems that are available on the market within our time frame, will not allow us, under these conditions of running two strings of casing, will not allow us to run a packer system; therefor we have not proposed one.

The methane system of ignition would involve running a burner on a slick line downhole and landing that at the bottom of the tubing and then injecting air down the tubing -- I mean, excuse me, methane down the tubing with air down the casing under the ignition process only, and by a lab test with the company we plan to use for this ignition, you can determine the amount of heat you have to supply to the reservoir to make sure you have ignition. There is also a test on offset wells.

Anyway, the methane ignition process will only encompass a week to ten days, something in that area. We're not -- we haven't really decided completely on that.

After that, the methane will be shut off and only air will be injected down the casing, as the tubing will not be -- or the same as if the tubing was not there. At a later time we might inject water down the tubing string in a process known as COFCAW, which is a combination of forward combustion and waterflooding.

Q. Do you want to spell that for us?

A. C-O-F-C-A-W, and that's -- it's a combination of waterflooding and forward combustion where you

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inject water and air simultaneously or water/air/water in different phases.

The reason we would inject downhole in this system is any time you mix air and water you're going to have definite corrosion problems and we sought to minimize those by mixing the air and water downhole, if we go in a combination.

MR. NUTTER: Well now, Mr. Hudson, you're going to inject air only down the one string of casing that's landed at the upper perforations, is that it?

A. No, sir. Oh --

MR NUTTER: Because you say you don't have a packer here, so how are you going to have an ignition in the lower zone and not in the upper zone?

A. Okay, if I understand your question correctly, in one string of casing we will be injecting air plus the methane and igniting the lower sand.

In the other string of casing we will be injecting only air for a period of time that we deem necessary to establish what we feel is a good injectivity rate into the upper sand to size our compressors.

We do not plan to ignite the upper sand, at this time.

MR. NUTTER: How do you keep the ignition from going from one zone to the other?

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A. We planned to not have our air injectivity test in the upper sand until a period of time has elapsed where the fire has moved away from the wellbore in the lower sand; therefor, you would only have a temperature in the upper -- or in the lower sand at the sand face of approximately 80 to 100 degrees, whatever your discharge air temperature.

MR. NUTTER: I see, I thought both these were going to be conducted simultaneously.

You would go ahead and inject air and methane at first in the long casing string here, or long tubing string.

A. Yes.

MR. NUTTER: To obtain combustion; wait until that has moved away from the wellbore, and then start the air injection into the other sand.

A. Yes, sir, and it would not be an extended period of time, just what we feel would be long enough to establish a good pressure value so we would know how to size our compressors. But that would be at a time where we would not obtain a spontaneous combustion in the upper from the heat from the lower.

MR. NUTTER: Okay.

A. So we looked at that, yes, sir.

Q. Tell me about your cement program for the well.

A. The cement we've proposed, and you notice on the righthand side of this Exhibit Seven it says 1450 feet approximate top of the aluminite cement. Aluminite cement is a calcium aluminate slurry which is not a standard Portland cement, which is used by steel industry or whoever for containing a fire, a power plant. It's a firebrick compound. It's been used with very good success by other operators in firefloods and steam floods, so we definitely want to try this in our injection well, as well as a couple of our producing wells. One of our main aims of the pilot was to determine whether our standard Portland cement in the drilled wells in the field can withstand the temperatures, but we also want to test the -- how this material works, also.

Above the aluminite cement we plan to run Class H with 40 percent silica flour, which is a known high temperature cement for oil well cementing; good to approximately 650 degrees. That's not listed on this diagram but that's our cementing program. It would be cement all the way to the surface with a thermal type cement.

The firebrick aluminate cement, good to approximately 1200 degrees.

Q What kind of surface injection pressures do you anticipate for the injection of air into the injection well?

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A. From our reservoir calculations that Mr. Strobl made, he has indicated that a stabilized injection pressure into the upper and lower sands should be in the neighborhood of 4 to 500 pounds surface pressure at a rate of a million to a million and a half cubic feet per day.

However, since this reservoir has no gas saturation, it has no gas permeability, and to begin air injection into either sand, we anticipate a possible maximum pressure of 1000 pounds surface. That, based on your ruling memo 3-77, issued in August of 1977, exceeds the fracture gradient limitation of .2 psi plus the hydrostatic head, or .43. However, based on that, and we have another exhibit I'll refer to in a minute, we do not expect to fracture the formation.

Do you want to go into that?

Q. Yeah, let's talk about Exhibit Number Eleven, Mr. Hudson, and have you tell us why you don't think you would fracture the confining strata.

A. This Exhibit Eleven was prepared a few years ago for a hearing in which we sought to dually complete two water injection wells and at the time of this hearing the ruling for the .2 psi per foot gradient was in effect. It was Commission Case 5995, Order 5506, as outlined in our application for this pilot.

At that time this letter was prepared,

which indicated from fracture stimulations we had performed in the Upper Hospah Sand, that the fracture gradient was on the average of 1.01 psi per foot with a standard deviation of .09.

So basically with that data, assuming a fracture gradient in the area of .92, we would not be fracturing the formation at 1000 pounds air pressure at the surface, which an air gradient is negligible. You would assume, say, 1100 bottom hole pressure at 1600 feet. That would still be less than our present water sand face injection pressure, which in the upper sand are running on the order of 800 psi plus the hydrostatic head, which would put you at, say, 13 to 1400 psi sand face pressure.

So we do not anticipate our air pressure at the sand face to be as high as what we now are doing under waterflood, and we are ordering our compressor for the pilot with a maximum discharge pressure of 1000 pounds, based on our reservoir calculations for air injectivity.

We do not have any information on the lower, but -- because no fracture stimulations have ever been done, but it is the same geological age and it was deposited only 20 feet lower. So based on those assumptions we assume that it has a fracture gradient similar.

Q I assume you're familiar with the waterflood order that you've just made reference to, and I think

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you'll find in the typical Division waterflood orders they indicate that the injection wells shall be completed with a method where water injection pressure can be relieved at the surface through some type of pop-off valve.

Is that type of requirement applicable to an air injection well?

A. In this case we do not feel we'd need to complete the well with a pop-off at the wellhead. We plan to have a similar type pressure relief device at the compressor. The reason we don't want to do it at the wellhead under this specific situation is that should be pop-off that valve for a malfunction, or whatever reason, it would allow the air well to backflow, possibly, into the wellbore, creating a high temperature situation, possibly, at the wellbore, or actual fire in the wellbore if oil flows back into the -- into the well itself.

We will have a check valve system at the wellhead to prevent any kind of backflow of air from this air injection well.

Q. Would you turn to Exhibit Number Eight for us and describe that?

A. Exhibit Eight is a wellbore schematic of our proposed producing well. It will be completed with 7 or 8-5/8ths inch casing down to TD: cemented in a similar manner to our air injection well, with aluminite cement to about

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1450 feet, which is approximately 100 feet above the top of the Upper Hospah, with Class H and silica flour to surface.

This will be a rod pump well with gas being produced up the annulus and the fluid being pumped up the tubing. Also, we have allowed for cooling water to be circulated down the annulus in this case. There could be a possibility that sufficient gas rates will not allow us to pump water straight into the annulus and we may have to run a dual tubing string to TD just to get the water down there, but research from other operators who have conducted fire-floods has shown that the cooling water system is essential to maintain your wellbore integrity on your producing wells, as well as keep your fluids cool enough to treat at the surface.

MR. NUTTER: What do you anticipate the rate of injection of water will be?

A. We have some simulation studies from the literature that I've used and made a model with that estimate a maximum of 100 barrels per day, and that's based on approximately 100 barrels of oil a day, 500 barrels of water and 500 Mcf of gas being produced at 800 degrees.

MR. NUTTER: Okay, you ran through those too fast for me here. You expect to inject a maximum of 100 --

A. Approximately 100 barrels.

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MR. NUTTER: Okay.

A. And that was based on an oil rate of about 500 -- of a 100 barrels per day, a water rate of 500 barrels per day, and a gas rate of 500 Mcf per day, and a reservoir temperature of 800, and that's -- that's a maximum condition. We don't anticipate that much fluid, but that's the condition we used to determine the maximum cooling water amount.

And that was based on a computer model out of the literature.

Q. Mr. Hudson, would you turn to Exhibit Number Nine and in conjunction with Exhibit Number Two, would you demonstrate what's indicated on Exhibit Number Nine?

A. Okay. Exhibit Two, the map of the 2-1/2 mile radius; Exhibit Nine, then, lists as per Order 3-77, or memo 3-77 pertaining to waterfloods, Exhibit Nine is then a tabulation of all the present completions inside a half mile radius of our pilot area, listing location, casing cement, and producing interval.

Q. Did your examination of that 1/2 mile radius, Mr. Hudson, indicate to you the presence of any well that poses a potential risk as a result of the fireflood operation?

A. No, sir, it doesn't.

Q. In your opinion are all those wells ade-

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quately cemented at the present time to confine the Lower Hospah activities to that formation and not result in contamination to any other source?

A. Yes, sir, it does.

Q. Would you refer to Exhibit Number Ten and identify that for us?

A. Exhibit Ten is another exhibit based on memo 3-77, pertaining to waterflooding, and is a schematic of the only plugged and abandoned well inside a half mile radius.

This well, our well No. 37, is shown in the upper lefthand quarter of Section 12. It would be the northwest quarter of the northwest quarter, and it's shown plugged and abandoned.

This well was actually drilled on the opposite side of a fault which exists in this field and though it has been plugged according to Oil Commission rules, it is also across a fault, which we anticipate being a sealing fault and therefor will not be in communication either, any way.

Q. Would you identify Exhibit Number Twelve for us?

A. Exhibit Twelve is a listing of all the fresh water sands in the area. This was based on the electric log of Well 18, and it's a -- notes the chlorides content calculated from this log combined with a porosity based on density log. This was in conjunction with determining what, if any, possible contamination could be done to any fresh water sands in the area.

Q All the fresh water sands are at a substantially shallower depth than the proposed project?

A. Yes, sir.

Q And is the separation between fresh water sands and the project one through which the fresh water sands will remain uncontaminated by the project?

A. Yes, sir.

Q Would you refer to Exhibit Number Thirteen and identify that?

A. Exhibit Thirteen is an affidavit prepared by Mr. Kellahin for us stating that the records of the State Engineer of New Mexico does not have -- there are not any fresh water wells within the surrounding sections of Section 12 or in Section 12.

Q Are you aware of any fresh water wells, Mr. Hudson?

A. In this search it then became apparent to us that there is a well on this area which is Tenneco's well, which is for drinking water only. This is located approximately 2000 feet from the pilot area. If you refer to the map of -- it's Exhibit Two, it's approximately --

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it's near Well No. 23, which is in a lower portion of the -- or directly south of our pilot, southwest.

This well has not been permitted according to these rules. It became apparent that the permit was never received by the office or was neglected in the process. We are in the process right now of filing the correct permits and having this well documented in the State Engineer's office.

Q When was that well drilled, do you know?

A That well was drilled in January of 1971.

Q And it's still being used by personnel in the site, Tenneco personnel in the site, for drinking water?

A Yes, sir.

MR. NUTTER: What depth does that produce water from?

A That well produces from perforations approximately 550 to 600 feet.

MR. NUTTER: Thank you.

Q Mr. Hudson, were Exhibits One through Twelve prepared by you directly or compiled under your direction and supervision or that of Mr. Strobl?

A Yes, sir, excepting the Exhibit Eleven, which was the frac pressure gradient exhibit which had been presented in a previous Commission hearing, as so documented

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earlier.

Q Have you re-examined the numbers used in Exhibit Number Eleven and to your own information and belief are those numbers correct and accurate?

A. Yes, sir.

Q Do you concur that the fracture gradient for the Lower Hospah formation is something greater than .92 psi per foot of depth?

A. Yes, sir.

Q In your opinion, Mr. Hudson, will approval of this application be in the best interests of conservation, the prevention of waste, and the protection of correlative rights?

A. Yes, sir.

Q Now let me direct your attention to one further point, the fact that the two new wells that will be drilled as producers, plus the proposed injection well, are unorthodox locations, are they not?

A. Yes, sir, they are.

Q And in the order approving this pilot would also require approval of those particular items as exception to well location.

A. Yes, sir.

Q In your opinion will approval of this pilot project result in the recovery of oil that would other-

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wise not be recovered?

A. Yes sir.

MR. KELLAHIN: That concludes my examination of Mr. Hudson.

We'd move the introduction of Exhibits One through Thirteen.

MR. NUTTER: Tenneco's Exhibits One through Thirteen will be admitted in evidence.

CROSS EXAMINATION

BY MR. NUTTER:

Q. Mr. Hudson, looking at your Exhibit Nine I see six wells on the first page, four wells on the second page, three wells on the third page, one well on the fourth page, and one well on the fifth page that have been cemented with less than 100 sacks of cement on the long string. Now, do you think that's going to be adequate cement to contain whatever products or by-proucts result from this flooding operation and keep them from penetrating into some fresh water sand. We know there's fresh water sand here at 550 to 600 feet?

A. Based on our present knowledge of this fireflooding operation and cementing in general, we believe they will be adequate for the pilot. That's one of our major considerations or pieces of information that we want

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to find from the pilot, is can we use the existing wellbores or do we need to redrill the field because of cementing conditions.

But based on our present knowledge, we do deem that this is an adequate cementing job.

Q. Okay, let's take this No. 48 Well for example.

A. Okay.

Q. It was cemented with 125 sacks. It's one of the wells that's in your project, your immediate project area. Where is the top of cement on the long string in that well? Did we have a schematic diagram of that well? I don't think we did, did we?

A. No, sir, that's not supplied.

Q. Do you know what the top of cement is on the long string in that well?

A. Based on that volume and the hole volume that would have been drilled for 5-1/2 casing, which is set in that well, I would estimate it's possibly about 4 to 500 feet above the Upper Hospah.

Q. I notice that most of the wells are completed with either 4-1/2 or 7-inch casing. There are a few 5-1/2 inch.

A. Yes, sir.

Q. Now, what size of a hole would you nor-mally drill for these 4-1/2 inch cased wells?

A. Approximately a 6-3/4, something in that neighborhood.

Q. And then for the 7-inch casing well?

A. 7-inch I'd say an 8-7/8ths, something in that neighborhood.

Q. And then for the 5-1/2 inch casing wells?

A. I'd say 7 to 7-1/4.

Q. Now do you know if there have been any problems with hole cavings or washouts or anything like this that would require any abnormal amounts of cement in casing and cementing these wells?

A. No, not --

Q. What has the experience been?

A. In this field generally there has been no problem drilling the wells or washouts in the drilling in process.

Q. Were cement tops determined on these wells when they were drilled?

A. The information from the -- that was compiled for this exhibit was taken from sundry notices either to USGS or the -- whatever body was involved, and it was not listed on those notices.

In the cases in this field it was deemed adequate for the cementing that has been done.

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Q But that was before you were going to put a fire in there at 1000 pounds pressure.

A. Only on our air pressure. We don't anticipate producing bottom hole pressures to be much more than they are now. From our research in the literature the fireflood process does not significantly raise the reservoir pressure. We still anticipate having to rod pump these wells, which would --

Q That's in producing?

A. That's in a producing well, yes, sir.

Q Could you make an estimate of your cement tops on these wells that I've mentioned that have less than 100 sacks of cement on them and send that to me?

A. Yes, sir, we can do that.

Q There's about 15 or 20, I guess, there.

A. Basically you're -- less than 100 sacks you would like to see something on that?

Q Yeah, those wells that I mentioned that have less than 100 sacks.

A. Okay.

Q I'm sure some of these have lots of cement on them, adequate cement, no question, but there are a few there that were cemented with a minimal amount and I'm kind of concerned about those.

Now, do you know of any other water sands that are in this area besides this 550 to 600 foot sand?

A. When we were drilling this water well back in '71, from what I've been told, they tested every sand on the way down and this was the first sand that they came to that was not brackish and that would provide a sufficient volume for drinking water only.

Q. This is camp water. This is drinking water for the camp?

A. Yes sir, there's no irrigation in this section being done from any water sand out there. The volume that this sand produces is in the order of less or approximately 60 gallons an hour. It's not a very prolific sand at all.

Q. Now, is there anything about this project that is going to cause any new or unusual and adverse environmental effects? Are we going to have clouds of smoke and steam and hot oil gushing up in the air and spreading over the countryside, or are we going to have the animal life and the bird life in the area endangered because of this flood? Are there going to be any outward effects of this operation that are not normal outward effects as far as an oilfield operation is concerned?

A. No, sir. We planned around the environmental aspect of it on, you know, purpose. Calculations that we've done now, based on some exhaust gas analysis performed in our laboratory tests of in situ combustion, revealed that a maximum amount that we expect just based on this laboratory work, is approximately 2 pounds per hour of any sulphur compounds, which be EPA regulations you do not need a permit if it's less than 10 pounds per hour or 25 tons per year.

So based on what we know at this time, we do not anticipate any kind of noxious gas emissions from the pipe.

We will, however, do extensive exhaust gas analysis testing for this reason as well as to determine air fuel ratios and such things.

Q. Where do these exhaust gases come from, Mr. Hudson?

A. What we plan to do as far as field development is all exhaust gases taken off the annulus will be sent to a central facility for vapor recovery, which we intend to knock out any recoverable hydrocarbons in such a system, a tank system, and then vent whatever will then not condense into this system, and the fluids coming off this vapor recovery will be sent to -- back into our treating facilities to be treated and sold or re-injected if it's water.

Q. Well, I'm sure someone's going to ask us what the environmental effects of the project will be.

A. We have looked into that as far as the

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permitting required by the EPA, and based on our present calculations we do not foresee the need for a permit for the project.

Q And you'll have check valves on the -- on the wellheads where this air and this methane are going into the injection well so if you have a break back up the line you won't have a backflow from the well out into the atmosphere.

A No, sir, not -- we definitely do not want to do that in the air injection well, and the methane will only be injected for a week to 10-day period and when that is being done there will be 24-hour monitoring of the injection well during the ignition phase, so -- and then other than that, the only thing that could backflow would be -- would be air, but we plan to have safety devices which would not -- which would not allow that to happen.

Q Okay.

MR. NUTTER: Are there any further questions of Mr. Hudson?

MR. CHAVEZ: Yes, sir.

MR. NUTTER: Yes, sir, Mr. Chavez?

QUESTIONS BY MR. CHAVEZ:

Q Mr Hudson, on your Exhibit Eight you show a wellbore schematic of a producing well.

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A. Yes, sir.

Q. Yet the No. 48 and the 18 will not be exactly this way because of the cement they're completed with. Do you intend to circulate cement, to go in and perforate above the cement top and circulate cement in those wells?

A. At this time -- at this time we did not plan to do that, no, sir.

Q. What type of temperature rises do you get in a production well just directly from the pilot --

A. Based on research, as well as our trip to Shreveport, Louisiana, that Glen mentioned earlier, for the life of the project you only see reservoir temperature, and as your fire approaches your gas rate increases and you start seeing an increase in temperatures. At a certain point, which we believe to be approximately 250 degrees bottom hole temperature, we plan to shut the producing well in so that the fire will not adversely affect the well.

In this pilot we do hope to see if a fire burn through these older wells to determine the integrity of the cement there, but in a normal field operation, you would not produce the well as the fire burns through it.

Q. So in a sense you're testing the 48 and the 18 to failure?

A. We don't want them to fail but that's one of the things we definitely want to find out from it, if

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they do or if they don't.

The Shreveport test that Cities Service has in the Field, they had some old wells that they burned through several times and did not notice any adverse downhole effects other than a little corrosion on the casing. They were able to go back and squeeze off the burned through interval and continue to produce the well. That was with a different gravity oil system and from our literature research every one of these reservoirs acts a little bit different. That's why we propose a pilot instead of a full scale type project.

Q Okay, then as soon as the temperature starts rising to a certain point you will shut the producers in?

A Yes, sir. Standard cement that was used in this project is good to approximately 300 degrees before it began strength retrogression, so -- and that doesn't mean it completely fails at 300 degrees, it just gets weaker as the temperature rises.

But the cooling water should keep the bottom hole pressure -- bottom hole temperature, excuse me, down to approximately 150, 180. That's what we're planning on.

Q How fast do you expect the flood front or the fire front to advance to the producers from the air injectio

A. Could I direct that to Glen, please?

Q. Yes. Fine.

MR. STROBL: It's design to advance approximately 70 percent of the way if it is a true vertical piston-like displacement in a 6-month period.

Q. Within 6 months?

MR. STROBL: Yes, that's providing we can obtain the 1/2 million cubic feet a day injection rate.

Q. And what effects will the heat generated in the Lower Hospah have on the Upper Hospah? They're only separated by 20 feet, will there be any thermal --

MR. STROBL: There could be and I can only see good -- good effects or benefits. The Upper Hospah is a 12 centipoise viscosity oil. That should lower the viscosity. Any heat loss to the upper should be --

Q. Will you be monitoring the Upper Hospah in that area?

A. Yes, we will. We plan on like you said, taking gas analysis of all these wells, we plan on the oil production from all these wells and doing some additional testing, more testing than we do now on these particular wells in the pilot and surrounding the pilot area.

Q. Okay, but specifically in the upper, in the Upper Hospah distinctly, if you're fireflooding the Lower Hospah, you will be monitoring the Upper Hospah also.

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A. Yes.

Q. Okay, and -- but you don't have any idea as to how much temperature, say, from your fireflood may be transmitted upward to that?

MR. STROBL: I don't foresee very much temperature. It's very hard, you know, to pin that down. We plan on looking at some simulation studies, model studies, while we're running this pilot and might be able to pinpoint that a little better. It's very hard to do, you know, analytically; it's easier to do it in a model.

A. Rock conducts heat very poorly so we don't anticipate;major heat loss in a project like this is in an aquifer and not necessarily surrounding beds by conduction; mainly to an aquifer, which we do have in the Lower.

Q. So you expect the heat to spread outward then, more.

A. More likely than upward, due to that fact.

Q. How about -- you talked about exhaust gases. Will these exhaust gases be the gases generated by that actual combustion itself show up in the producing wells? How much gas will be, say, carbon dioxide or carbon monoxide?

MR. STROBL: Of course most of the biproducts of combustion are carbon monoxide and carbon dioxide and the greatest being nitrogen, because nitrogen is the

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largest component of air.

81 percent of the gas produced will be nitrogen and 4 percent carbon monoxide and roughly 12 percent carbon dioxide.

If we inject 1.5 million cubic feet of air a day, we're looking at about 1.2 million cubic feet of nitrogen a day, 2175 Mcf a day of $CO_2$, and about 60 Mcf a day of carbon monoxide.

Q In your Exhibit Nine you showed some Tesoro wells in Section 1 within the 2-mile radius that had no cement shown on the long string, no record of cement. Was that because you just couldn't get those?

A. Information was just unavailable to us.

Q Okay.

MR. GHOLSON: We probably have that in our files.

MR. NUTTER: Which well was that?

MR. KELLAHIN: The Tesoro wells in the last part of Exhibit Nine.

MR. CHAVEZ: Page 5.

MR. NUTTER: Oh, yeah.

MR. CHAVEZ: Those are all the questions I have.

MR. NUTTER. Are there any other questions of the witness? He may be excused.

Do you have anything further, Mr. Kellahin?

MR. KELLAHIN: No, sir.

MR. NUTTER: Does anyone have anything they wish to offer in Case Number 6890?

We'll take the case under advisement, and the hearing is adjourned.

(Hearing concluded.)

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

CERTIFICATE

I, SALLY W. BOYD, C.S.R., DO HEREBY CERTIFY that the foregoing Transcript of Hearing before the Oil Conservation Division was reported by me; that the said transcript is a full, true, and correct record of the hearing, prepared by me to the best of my ability.

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 6890 heard by me on 5/7 1980.

______________, Examiner
Oil Conservation Division

KELLAHIN and KELLAHIN
*Attorneys at Law*
500 Don Gaspar Avenue
Post Office Box 1769
Santa Fe, New Mexico 87501

Jason Kellahin
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Area Code 505

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MAY 1 ? 1980
OIL CONSERVATION DIVISION
SANTA FE

May 14, 1980

Mr. Dan Nutter
Oil Conservation Division
P. O. Box 2088
Santa Fe, NM 87501

Re: Tenneco Oil Company
Case No. 6890

Dear Dan:

Please find enclosed the tabulation of the cement tops you requested at the hearing on May 7, 1980.

Please call me if you need anything further.

Very Truly Yours,

W. Thomas Kellahin

WTK:ym
Encl.
cc: Mr. Brad Fischer-Tenneco

**Tenneco Oil**
**Exploration and Production**
A Tenneco Company

Rocky Mountain Division

Penthouse
720 South Colorado Blvd
Denver, Colorado 80222
(303) 758-7130

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OIL CONSERVATION DIVISION
SANTA FE
May 8, 1980

Mr. W. Thomas Kellahin
Kellahin and Kellahin
Attorneys At Law
500 Don Gaspar Avenue
P. O. Box 1769
Santa Fe, New Mexico 87501

Re: Tenneco Oil Company
In Situ Combustion Project

Dear Tom:

Pursuant to Mr. Dan Nutter's instructions, the attached tabulation is offered as an addition to Exhibit 9 of Case 6890 heard May 7, 1980, Santa Fe, New Mexico. This tabulation is a summary of the cement tops for the long strings of the referenced wells. These values were obtained either by a volumetric calculation or from the drilling reports. The top of the Upper Hospah sand is on the average found at a depth greater than 1525' from the surface.

Yours very truly,

TENNECO OIL COMPANY

Brad Fischer

B. W. Fischer
Production Engineering
Supervisor

BWF:vv
Attachments

LTOEP 103A 12/78

# CEMENT TOPS

| WELL NO. (Tenneco Hospah) | CEMENT TOP (ft from surf) |
|---|---|
| 1X | 850' |
| 2 | 933' |
| 3 | 900' |
| 4 | 926' |
| 5 | 943' |
| 6 | 1095' |
| 7 | 675' |
| 8 | 810' |
| 9 | 500' |
| 10 | 275' |
| 11 | 730' |
| 12 | 895' |
| 13 | 400' |
| 14 | Surface |
| 16 | Surface |
| 17 | Surface |
| 18 | Surface |
| 19 | 940' |
| 20 | 1021' |
| 21 | 980' |
| 22 | 1030' |
| 23 | 810' |
| 24 | 70' |
| 25 | Surface |
| 26 | Surface |
| 27 | Surface |
| 28 | Surface |
| 29 | 1020' |
| 30 | 1020' |
| 31 | 960' |
| 32 | 1065' |
| 33 | 1080' |
| 34 | 1080' |
| 35 | 1010' |
| 36 | 1060' |
| 37X | 1020' |
| 38 | 875' |
| 39 | 935' |
| 40 | 945' |
| 41 | 920' |
| 46 | 665' |
| 47 | 650' |
| 48 | 760' |
| 49 | 745' |
| 50 | 585' |

| WELL NO. | CEMENT TOP |
|---|---|
| (Tenneco Hospah) | (ft from surf) |
| 51 | 625' |
| 52 | 580' |
| 53 | 760' |
| 55 | 785' |
| 56 | 825' |
| 58 | Surface |
| 59 | 100' |
| 60 | 100' |
| 61 | Surface |
| 62 | Surface |
| 63 | Surface |
| 64 | Surface |
| (Tesoro Hospah) (SFPRR "A") | |
| 72 | Surface |
| 73 | 1245' |
| 79 | 1175' |
| 80 | 920' |
| 81 | 950' |
| 84 | 840' |
| 87 | 890' |
| 89 | 1075' |

ENHANCED OIL RECOVERY PROPOSAL
SOUTH HOSPAH FIELD

Tenneco Oil Company proposes to implement a pilot In Situ Combustion Project in the South Hospah Field, McKinley County, New Mexico. The purpose of this pilot is to corroborate preliminary engineering evaluation of the technical feasibility of this enhanced oil recovery process. The economic viability of a full-field combustion project will also be ascertained.

The South Hospah Field is located approximately 100 miles southeast of Farmington, New Mexico (Exhibit 1). The field consists of two separate reservoirs. The Upper Hospah reservoir was discovered in 1965. Production from the Lower Hospah reservoir began in April, 1967. These two sands are depicted on the log of Hospah No.18 in Exhibit 3.

Under primary production field recovery from the Upper Hospah sand was 510 MSTB. Primary production from the Lower Hospah was 1465 MSTB.

Waterflooding was initiated in the Upper Hospah sand in 1968. Response to water injection was very dramatic and has proven highly successful. Ultimate recovery from primary and secondary production in this sand is projected to be 3029 MSTB.

Gas/water injection was implemented in the Lower Hospah sand in 1972 as a means of enhancing oil recovery. Gas injection was not beneficial and was discontinued in 1976. Waterflooding was continued and has proven successful. During 1977 and 1978 a deepening and infill drilling program further improved Lower Hospah performance. Projected ultimate recovery from the Lower Hospah sand under primary and secondary recovery is 3255 MSTB. 3,255,000 (=34%)

primary prod Lower Hospah
15% of orig oil in place
19% on secondary
13% on tertiary expected

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. O
CASE NO. 6890

Field development and production response are depicted on Exhibits 4 and 5.

The South Hospah field is now fully developed and in the latter, declining years of secondary production. A thorough study of the reservoir and crude properties at South Hospah was made to determine the applicability of tertiary processes to further improve recovery from the field. Steamflooding, in situ combustion, caustic-polymer flooding, and micellar-polymer flooding were considered technically appropriate. Based on laboratory tests and engineering calculations, in situ combustion is the most technically and economically feasible process for extending the producing life of this field.

The proposed in situ combustion pilot is designed to supplement our studies, providing certain additional information. Specifically:

1. Confirm that ignition and sustained combustion can be achieved.
2. Verification of the prediction model (i.e., recovery and response vs. time).
3. Injection rates and pressure for compressor sizing.
4. Lift requirements in producing wells.
5. The magnitude of operations problems:
    a. Gas production and handling
    b. Emulsions
    c. Corrosion.
6. Effect of heat on standard cement and completions.

10 sat
orig 65
present sat 49%
14 to 5% of oil in place coked & consumed

The small pattern area (0.68 acres) proposed should facilitate a maximum of information gained in a minimum amount of time.

A dual air injection well will be drilled as presented on Exhibit 7. With the ignition equipment currently available, a packer cannot be used in this well. It will be necessary to inject air down the casing for ignition by either a gas or electric down-hole heater.

Two existing producing wells will be utilized. In addition, two new producing wells will be drilled. These four producing wells will be completed in the Lower Hospah sand. Ignition and combustion will be attempted in only the Lower Hospah sand. Air injectivity testing in the Upper Hospah sand will be accomplished simultaneously through use of the second casing string of the dual air injection well.

Separate production facilities will be constructed to monitor the combustion front progress and combustion efficiency, incremental tertiary oil recovery, and exhaust gas composition.

The information obtained from this pilot test is expected to confirm our preliminary evaluations and indicate whether fieldwide expansion is warranted.

ENHANCED OIL RECOVERY PROPOSAL
SOUTH HOSPAH FIELD

EXHIBIT #

1. Hospah location map
2. Field map w/all wells w/i 2 mile radius
3. Log of No.18
4. UH decline curve
5. LH decline curve
6. Plat showing proposed pilot (w/dimensions)
7. Schematic - AIW
8. Schematic prod. well
9. Tabulation of wells w/i 1/2 mile radius
10. Schematic of all P&A wells w/i 1/2 mile radius
11. Frac grad. info
12. Tabulation of fresh water sands encountered.

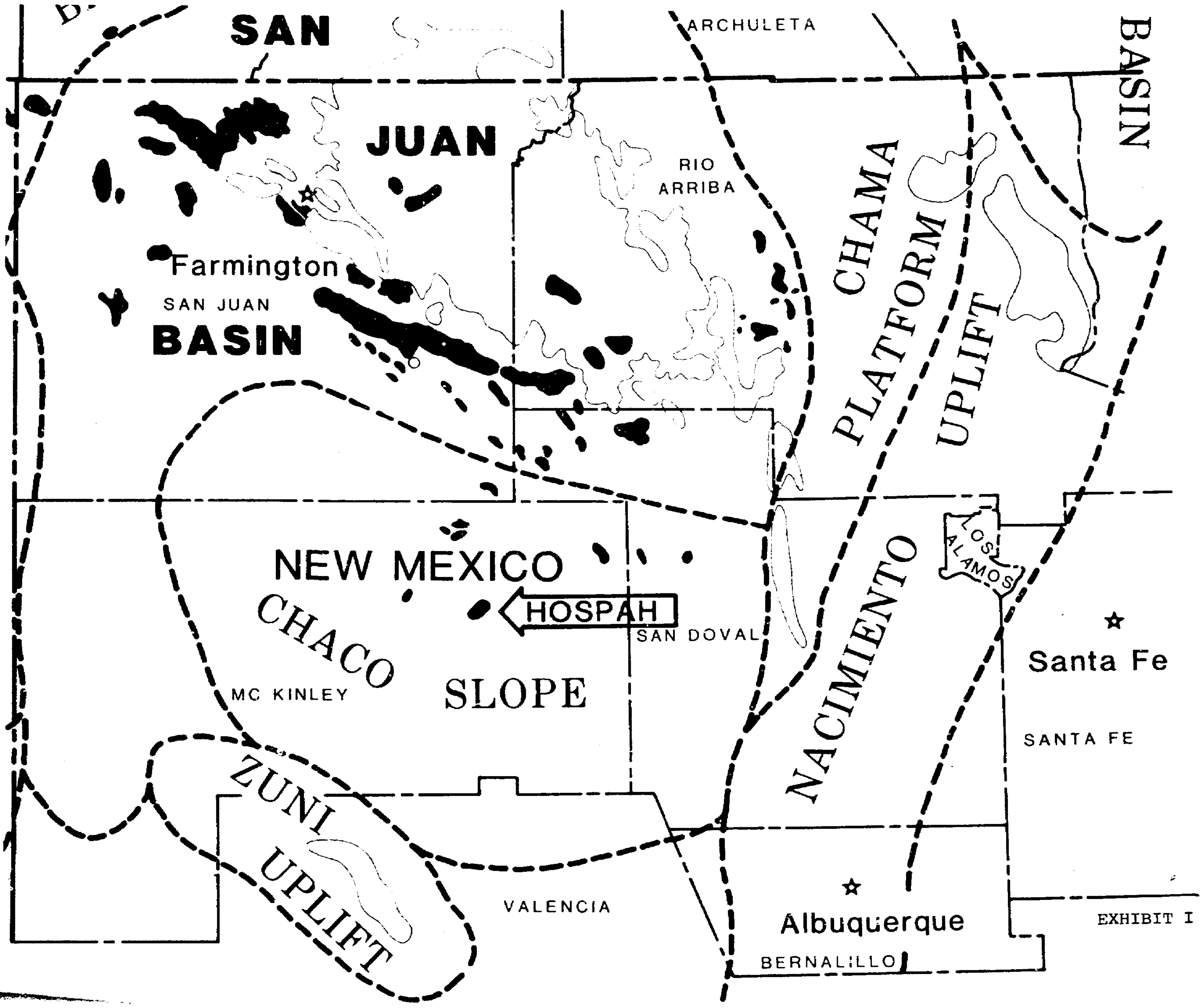
SAN
JUAN
BASIN
Farmington
SAN JUAN
BASIN
ARCHULETA
RIO
ARRIBA
CHAMA
PLATFORM
UPLIFT
BASIN
NEW MEXICO
HOSPAH
CHACO
SLOPE
MC KINLEY
SAN DOVAL
NACIMIENTO
LOS ALAMOS
Santa Fe
SANTA FE
ZUNI
UPLIFT
VALENCIA
Albuquerque
BERNALILLO

EXHIBIT I

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. 1
CASE NO. 6890

EXHIBIT 9

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **TENNECO OIL COMPANY** | | | | | | | | | | | |
| Upper Hospah No.1X | 12-17N-9W | 1980'FNL&2052'FEL | 1565' | 7-5/8 | (24#) | 31' | 10 sx - surface | 4-1/2 | (11.6#) | 1505' | 75 sx |
| Upper Hospah No.2 | 12-17N-9W | 2310'FNL&2310'FWL | 1637' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1635' | 60 sx |
| Lower Hospah No.3 | 12-17N-9W | 1650'FNL&1392'FEL | 1603' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | (10.5#) | 1602' | 60 sx |
| Upper Hospah No.4 | 12-17N-9W | 990'FNL&2310'FWL | 1640' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | (10.5#) | 1628' | 60 sx |
| Upper Hospah No.5 | 12-17N-9W | 990'FNL&2712'FEL | 1645' | 7 | (17#) | 30' | 10 sx- surface | 4-1/2 | (10.5#) | 1644' | 60 sx |
| Lower Hospah No.6 | 12-17N-9W | 330'FNL& 330'FEL | 1710' | 10-3/4 | (32.4#) | 45' | 50 sx - surface | 7 | (23#) | 1694' | 75 sx |
| Lower Hospah No.7 | 12-17N-9W | 1650'FNL& 330'FEL | 1750' | 10-3/4 | (32.75#) | 45' | 75 sx - surface | 7 | (20#) | 1713' | 130 sx |
| Lower Hospah No.8 | 12-17N-9W | 1650'FNL&2051'FEL | 1709' | 10-3/4 | (22.75#) | 55' | 50 sx - surface | 7 | (20#) | 1687' | 110 sx |
| Lower Hospah No.9 | 12-17N-9W | 330'FNL&2051'FEL | 3945' | 10-3/4 | (32.75#) | 86' | 90 sx - surface | 7 | (23&20#) | 3933' | 510 sx |
| Lower Hospah No.10 | 12-17N-9W | 990'FNL&2300'FWL | 2827' | 10-3/4 | (32.75#) | 85' | 150 sx - surface | 7 | (20#) | 2827' | 320 sx |
| Lower Hospah No.11 | 12-17N-9W | 1650'FNL&2310'FWL | 1774' | 10-3/4 | (32.75#) | 45' | 50 sx - surface | 7 | (20#) | 1766' | 130 sx |
| Lower Hospah No.12 | 12-17N-9W | 2160'FNL& 990'FWL | 1840' | 10-3/4 | (32.75) | 47' | 70 sx - surface | 7 | (20#) | 1772' | 110 sx |
| Upper Hospah No.13 | 12-17N-9W | 2280'FNL&1620'FWL | 1720' | 7-5/8 | (26) | 44' | 50 sx - surface | 4-1/2 | (10.5#) | 1702' | 150 sx |

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. 9
CASE NO. 6890

EXHIBIT 9

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9W | 1980'FNL&2052'FEL | 1565' | 7-5/8 | (24#) | 31' | 10 sx - surface | 4-1/2 | (11.6#) | 1505' | 75 sx | Producer-Upper |
| 9W | 2310'FNL&2310'FWL | 1637' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1635' | 60 sx | Producer-Upper |
| 9W | 1650'FNL&1392'FEL | 1603' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | (10.5#) | 1602' | 60 sx | Producer-Lower |
| 9W | 990'FNL&2310'FWL | 1640' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | (10.5#) | 1628' | 60 sx | Producer-Upper |
| 9W | 990'FNL&2712'FEL | 1645' | 7 | (17#) | 30' | 10 sx- surface | 4-1/2 | (10.5#) | 1644' | 60 sx | Wtr.Inj.-Upper |
| 9W | 330'FNL& 330'FEL | 1710' | 10-3/4 | (32.4#) | 45' | 50 sx - surface | 7 | (23#) | 1694' | 75 sx | Producer-Lower |
| 9W | 1650'FNL& 330'FEL | 1750' | 10-3/4 | (32.75#) | 45' | 75 sx - surface | 7 | (20#) | 1713' | 130 sx | Producer-Lower |
| 9W | 1650'FNL&2051'FEL | 1709' | 10-3/4 | (22.75#) | 55' | 50 sx - surface | 7 | (20#) | 1687' | 110 sx | Producer-Lower |
| 9W | 330'FNL&2051'FEL | 3945' | 10-3/4 | (32.75#) | 86' | 90 sx - surface | 7 | (23&20#) | 3933' | 510 sx | Producer-Lower |
| 9W | 990'FNL&2300'FWL | 2827' | 10-3/4 | (32.75#) | 85' | 150 sx - surface | 7 | (20#) | 2827' | 320 sx | Producer-Lower T&A-Dakota |
| 9W | 1650'FNL&2310'FWL | 1774' | 10-3/4 | (32.75#) | 45' | 50 sx - surface | 7 | (20#) | 1766' | 130 sx | Producer-Lower |
| 9W | 2160'FNL& 990'FWL | 1840' | 10-3/4 | (32.75) | 47' | 70 sx - surface | 7 | (20#) | 1772' | 110 sx | Producer-Lower |
| 9W | 2280'FNL&1620'FWL | 1720' | 7-5/8 | (26) | 44' | 50 sx - surface | 4-1/2 | (10.5#) | 1702' | 150 sx | Wtr.Inj.-Upper |

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. 9
CASE NO. 6890

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | |
| Lower Hospah No.14 | 12-17N-9W | 1700'FNL&1300'FWL | 1790' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1763' | 200 s |
| Upper Hospah No.16 | 12-17N-9W | 1755'FNL&2330'FWL | 1710' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1692' | 200 s |
| Upper Hospah No.17 | 12-17N-9W | 2250'FNL&3000'FWL | 1787' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1691' | 200 s |
| Upper Hospah No.18 | 12-17N-9W | 1475'FNL&3055'FWL | 1750' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1729' | 200 |
| Upper Hospah No.19 | 12-17N-9W | 2310'FSL&2712'FEL | 1638' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1638' | 60 s |
| Upper Hospah No.20 | 12-17N-9W | 2310'FSL&1392'FEL | 1647' | No surface pipe | | | - | 4-1/2 | (10.5#) | 1647' | 60 s |
| Upper Hospah No.21 | 12-17N-9W | 2310'FSL&2310'FWL | 1690' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1685' | 60 s |
| Upper Hospah No.22 | 12-17N-9W | 2210'FSL& 990'FWL | 1734' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1734' | 60 s |
| Upper Hospah No.23 | 12-17N-9W | 1650'FSL&1800'FWL | 2968' | 8-5/8 | (20#) | 91' | 70 sx surface | 4-1/2 | (10.5#) | 2940' | 245 s |
| Lower Hospah No.24 | 12-17N-9W | 330'FNL&2650'FEL | 1725' | 8-5/8 | (26#) | 51' | 40 sx - surface | 4-1/2 | (10.5#) | 1720' | 190 s |
| Lower Hospah No.25 | 12-17N-9W | 330'FNL&1505'FEL | 1702' | 8-5/8 | (36#) | 51' | 40 sx surface | 4-1/2 | ( 9.5#) | 1683' | 240 s |
| Upper Hospah No.26 | 12-17N-9W | 330'FNL& 380'FEL | 1660' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 225 s |
| Upper Hospah No.27 | 12-17N-9W | 1570'FNL& 330'FEL | 1669' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1652' | 240 s |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9W | 1700'FNL&1300'FWL | 1790' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1763' | 200 sx | Producer-Lower |
| 9W | 1755'FNL&2330'FWL | 1710' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1692' | 200 sx | Producer-Upper |
| 9W | 2250'FNL&3000'FWL | 1787' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1691' | 200 sx | Wtr.Inj.-Upper |
| 9W | 1475'FNL&3055'FWL | 1750' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1729' | 200 sx | Producer-Upper |
| 9W | 2310'FSL&2712'FEL | 1638' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1638' | 60 sx | Producer-Upper |
| 9W | 2310'FSL&1392'FEL | 1647' | No surface pipe | | | - | 4-1/2 | (10.5#) | 1647' | 60 sx | Wtr.Inj.-Upper |
| 9W | 2310'FSL&2310'FWL | 1690' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1685' | 60 sx | Producer-Upper |
| 9W | 2210'FSL& 990'FWL | 1734' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1734' | 60 sx | Producer-Upper |
| 9W | 1650'FSL&1800'FWL | 2968' | 8-5/8 | (20#) | 91' | 70 sx surface | 4-1/2 | (10.5#) | 2940' | 245 sx | T&A-Dakota Gas<br>Wtr.Inj.-Upper |
| 9W | 330'FNL&2650'FEL | 1725' | 8-5/8 | (26#) | 51' | 40 sx - surface | 4-1/2 | (10.5#) | 1720' | 190 sx | Producer-Lower |
| 9W | 330'FNL&1505'FEL | 1702' | 8-5/8 | (36#) | 51' | 40 sx surface | 4-1/2 | ( 9.5#) | 1683' | 240 sx | Producer-Lower |
| 9W | 330'FNL& 380'FEL | 1660' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 225 sx | Producer-Upper |
| 9W | 1570'FNL& 330'FEL | 1669' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1652' | 240 sx | Producer-Upper |

PAGE THREE.........

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **TENNECO OIL COMPANY** (cont'd) | | | | | | | | | | | |
| Upper Hospah No.28 | 12-17N-9W | 933'FNL&1485'FEL | 1675' | 8-5/8 | (36#) | 51' | 40 sx - surface | 4-1/2 | 7-1/4 ( 9.5#) | 1658' | 240 sx |
| Upper Hospah No.29 | 12-17N-9W | 410'FNL&1870'FEL | 1606' | 8-5/8 | (24#) | 75' | 70 sx - surface | 5-1/2 | (15.5#) | 1606' | 85 sx |
| Upper Hospah No.30 | 12-17N-9W | 950'FNL&1980'FEL | 1605' | 8-5/8 | (24#) | 71' | 70 sx - surface | 5-1/2 | (15.5#) | 1605' | 85 sx |
| Upper Hospah No.31 | 12-17N-9W | 330'FNL&2800'FEL | 1626' | 8-5/8 | (24#) | 78' | 70 sx - surface | 5-1/2 | (15.5#) | 1626' | 96 sx |
| Lower Hospah No.32 | 12-17N-9W | 550'FNL&2370'FWL | 1647' | 10-3/4 | (32.75#) | 64' | 70 sx - surface | 7 | (20#) | 1632' | 125 sx |
| Lower Hospah No.33 | 12-17N-9W | 1340'FNL&1710'FWL | 1660' | 10-3/4 | (32.75#) | 61' | 70 sx - surface | 7 | (20#) | 1647' | 125 sx |
| Upper & Lower Hospah #34 | 12-17N-9W | 1820'FNL&1700'FWL | 1661' | 10-3/4 | (32.75#) | 67' | 70 sx - surface | 7 | (20#) | 1648' | 125 sx |
| Lower Hospah No.35 | 12-17N-9W | 330'FNL& 850' FEL | 1591' | 10-3/4 | (32.75#) | 75' | 60 sx - surface | 7 | (20#) | 1577' | 125 sx |
| Lower Hospah No.36 | 12-17N-9W | 900'FNL&2630'FEL | 1635' | 10-3/4 | (32.75#) | 78' | 60 sx - surface | 7 | (20#) | 1624' | 125 sx |
| Lower Hospah No.37X | 12-17N-9W | 1280'FNL&1280'FWL | 1666' | 10-3/4 | (32.75#) | 72' | 40 sx - surface | 7 | (20#) | 1635' | 135 sx |
| Lower Hospah No.38 | 12-17N-9W | 660'FNL& 660'FEL | 1565' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1565' | 100 sx |
| Upper Hospah No.39 | 12-17N-9W | 2180'FNL& 660'FEL | 1627' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1627' | 100 sx |
| Upper Hospah No.40 | 12-17N-9W | 2420'FNL&1650'FEL | 1637' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 100 sx |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17N-9W | 933'FNL&1485'FEL | 1675' | 8-5/8 | (36#) | 51' | 40 sx - surface | 4-1/2 (7-4/4) | (9.5#) | 1658' | 240 sx | Producer-Upper |
| 17N-9W | 410'FNL&1870'FEL | 1606' | 8-5/8 | (24#) | 75' | 70 sx - surface | 5-1/2 | (15.5#) | 1606' | 85 sx | Producer-Upper |
| 17N-9W | 950'FNL&1980'FEL | 1605' | 8-5/8 | (24#) | 71' | 70 sx - surface | 5-1/2 | (15.5#) | 1605' | 85 sx | Producer-Upper |
| 17N-9W | 330'FNL&2800'FEL | 1626' | 8-5/8 | (24#) | 78' | 70 sx - surface | 5-1/2 | (15.5#) | 1626' | 96 sx | Producer-Upper |
| 17N-9W | 550'FNL&2370'FWL | 1647' | 10-3/4 | (32.75#) | 64' | 70 sx - surface | 7 | (20#) | 1632' | 125 sx | Producer-Lower |
| 17N-9W | 1340'FNL&1710'FWL | 1660' | 10-3/4 | (32.75#) | 61' | 70 sx - surface | 7 | (20#) | 1647' | 125 sx | Wtr.Inj.-Lower |
| 17N-9W | 1820'FNL&1700'FWL | 1661' | 10-3/4 | (32.75#) | 67' | 70 sx - surface | 7 | (20#) | 1648' | 125 sx | Producer-Dual |
| 17N-9W | 330'FNL& 850' FEL | 1591' | 10-3/4 | (32.75#) | 75' | 60 sx - surface | 7 | (20#) | 1577' | 125 sx | Producer-Lower |
| 17N-9W | 900'FNL&2630'FEL | 1635' | 10-3/4 | (32.75#) | 78' | 60 sx - surface | 7 | (20#) | 1624' | 125 sx | Wtr.Inj.-Lower |
| 17N-9W | 1280'FNL&1280'FWL | 1666' | 10-3/4 | (32.75#) | 72' | 40 sx - surface | 7 | (20#) | 1635' | 135 sx | Upper-T&A Producer-Lower |
| 17N-9W | 660'FNL& 660'FEL | 1565' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1565' | 100 sx | Producer-Lower |
| 17N-9W | 2180'FNL& 660'FEL | 1627' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1627' | 100 sx | Producer-Upper |
| 17N-9W | 2420'FNL&1650'FEL | 1637' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 100 sx | Producer-Upper |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **TENNECO OIL COMPANY** (cont'd) | | | | | | | | | | | |
| Upper Hospah No.41 | 12-17N-9W | 5'FNL&1650'FEL | 1611' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1610' | 100 sx |
| Lower Hospah No.46 | 12-17N-9W | 1700'FNL& 700'FWL | 1680' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1664' | 125 sx |
| Lower Hospah No.47 | 12-17N-9W | 785'FNL&1775'FWL | 1780' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1647' | 125 sx |
| Lower Hospah No.48 | 12-17N-9W | 1485'FNL&2817'FWL | 1635' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1625' | 125 sx |
| Lower Hospah No.49 | 12-17N-9W | 885'FNL&2117'FEL | 1639' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1610' | 125 sx |
| Lower Hospah No.50 | 12-17N-9W | 950'FNL& 900'FEL | 1593' | 9-5/8 | (36#) | 71' | 40 sx - surface | 7 | (20#) | 1583' | 125 sx |
| Upper Hospah No.51 | 12-17N-9W | 1775'FNL& 620'FWL | 1662' | 8-5/8 | (24#) | 64' | 50 sx - surface | 5-1/2 | (15.5#) | 1662' | 150 sx |
| Upper Hospah No.52 | 12-17N-9W | 720'FNL&1850'FWL | 1622' | 8-5/8 | (24#) | 74' | 50 sx - surface | 5-1/2 | (15.5#) | 1620' | 150 sx |
| Lower Hospah No.53 | 12-17N-9W | 950'FNL& 330'FEL | 1578' | 8-5/8 | (24#) | 63' | 50 sx - surface | 7 | (20#) | 1559' | 100 sx |
| Upper Hospah No.55 | 12-17N-9W | 1750'FNL&1550'FEL | 1583' | 9-5/8 | (36#) | 100' | 90 sx - surface | 7 | (20#) | 1583' | 100 sx |
| Upper Hospah No.56 | 12-17N-9W | 1100'FNL&1275'FEL | 1584' | 9-5/8 | (36#) | 102' | 90 sx - surface | 7 | (20#) | 1584' | 95 sx |
| Upper & Lower Hospah No.58 | 12-17N-9W | 2580'FNL&1640'FWL | 1679' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 350 sx |
| Upper & Lower Hospah No.59 | 12-17N-9W | 2340'FNL&2500'FEL | 1657' | 8-5/8 | (24#) | 89' | 75 sx - surface | 5-1/2 | (15.5#) | 1657' | 225 sx |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| d) | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -17N-9W | 5'FNL&1650'FEL | 1611' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1610' | 100 sx | Wtr.Inj.-Dual Upper-T&A |
| 17N-9W | 1700'FNL& 700'FWL | 1680' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1664' | 125 sx | Producer-Lower |
| 17N-9W | 785'FNL&1775'FWL | 1780' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1647' | 125 sx | Producer-Lower |
| .7N-9W | 1485'FNL&2817'FWL | 1635' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1625' | 125 sx | Producer-Lower |
| 17N-9W | 885'FNL&2117'FEL | 1639' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1610' | 125 sx | Producer-Lower |
| .7N-9W | 950'FNL& 900'FEL | 1593' | 9-5/8 | (36#) | 71' | 40 sx - surface | 7 | (20#) | 1583' | 125 sx | Producer-Lower |
| 7N-9W | 1775'FNL& 620'FWL | 1662' | 8-5/8 | (24#) | 64' | 50 sx - surface | 5-1/2 | (15.5#) | 1662' | 150 sx | Wtr.Inj.-Upper |
| 7N-9W | 720'FNL&1850'FWL | 1622' | 8-5/8 | (24#) | 74' | 50 sx - surface | 5-1/2 | (15.5#) | 1620' | 150 sx | Wtr.Inj.-Upper |
| 7N-9W | 950'FNL& 330'FEL | 1578' | 8-5/8 | (24#) | 63' | 50 sx - surface | 7 | (20#) | 1559' | 100 sx | Producer-Lower |
| 7N-9W | 1750'FNL&1550'FEL | 1583' | 9-5/8 | (36#) | 100' | 90 sx - surface | 7 | (20#) | 1583' | 100 sx | Producer-Upper |
| N-9W | 1100'FNL&1275'FEL | 1584' | 9-5/8 | (36#) | 102' | 90 sx - surface | 7 | (20#) | 1584' | 95 sx | Wtr.Inj.-Upper |
| N-9W | 2580'FNL&1640'FWL | 1679' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 350 sx | Wtr.Inj.-Dual |
| -9W | 2340'FNL&2500'FEL | 1657' | 8-5/8 | (24#) | 89' | 75 sx - surface | 5-1/2 | (15.5#) | 1657' | 225 sx | Wtr.Inj.Dual |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **TENNECO OIL COMPANY** (cont'd) | | | | | | | | | | | |
| Lower Hospah No.60 | 12-17N-9W | 2210'FNL&1300'FEL | 1648' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1648' | 225 sx |
| Lower Hospah No.61 | 12-17N-9W | 1120'FNL&2510'FEL | 1715' | 9-5/8 | (36#) | 87' | 90 sx - surface | 7 | (23#) | 1715' | 375 sx |
| Lower Hospah No.62 | 12-17N-9W | 650'FNL&1770'FEL | 1710' | 9-5/8 | (36#) | 93' | 90 sx - surface | 7 | (23#) | 1710' | 375 sx |
| Lower Hospah No.63 | 12-17N-9W | 710'FNL&1325'FEL | 1695' | 9-5/8 | (36#) | 94' | 90 sx - surface | 7 | (23#) | 1690' | 375 sx |
| Lower Hospah No.64 | 12-17N-9W | 1360'FNL& 900'FEL | 1685' | 9-5/8 | (36#) | 90' | 90 sx - surface | 7 | (23#) | 1680' | 375 sx |
| **TESORO** | | | | | | | | | | | |
| SFPRR A-72 | 1-17N-9W | 330'FSL&1250'FEL | 1608' | 7 | | 58' | 35 sx | 4-1/2 | | 1608' | 150 sx |
| SFPRR A-73 | 1-17N-9W | 330'FSL&2000'FEL | 1665' | 8-5/8 | | 63' | 40 sx | 4-1/2 | | 1639' | 75 sx |
| SFPRR A-79 | 1-17N-9W | 330'FSL&2300'FEL | 1624' | 8-5/8 | | 58' | - | 5-1/2 | | 1593' | |
| SFPRR A-80 | 1-17N-9W | 1310'FEL& 630'FSL | 1622' | 8-5/8 | | 72' | - | 7 | | 1612' | |
| SFPRR A-81 | 1-17N-9W | 580'FSL&2090'FEL | 1655' | 8-/58 | | 73' | - | 5-1/2 | (14#) | 1643' | |
| SFPRR A-84 | 1-17N-9W | 5'FSL&2950'FEL | 1643' | 9-5/8 | (32.3#) | 91' | 100 sx | 7 | | 1639' | 100 sx |
| SFPRR A-87 | 1-17N-9W | 5'FSL& 50'FEL | 1598' | 8-5/8 | (24#) | 105' | 80 sx | 5-1/2 | (14#) | 1585' | 100 sx |
| SFPRR A-89 | 1-17N-9W | - - | 1769' | - | | - | - | | - | - | - |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

:'d)

| LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12-17N-9W | 2210'FNL&1300'FEL | 1648' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (1[illegible].5#) | 1648' | 225 sx | Wtr.Inj.-Lower |
| 12-17N-9W | 1120'FNL&2510'FEL | 1715' | 9-5/8 | (36#) | 87' | 90 sx - surface | 7 | (23#) | 1715' | 375 sx | Producer-Lower |
| 12-17N-9W | 650'FNL&1770'FEL | 1710' | 9-5/8 | (36#) | 93' | 90 sx - surface | 7 | (23#) | 1710' | 375 sx | Producer-Lower |
| 12-17N-9W | 710'FNL&1325'FEL | 1695' | 9-5/8 | (36#) | 94' | 90 sx - surface | 7 | (23#) | 1690' | 375 sx | Producer-Lower |
| 12-17N-9W | 1360'FNL& 900'FEL | 1685' | 9-5/8 | (36#) | 90' | 90 sx - surface | 7 | (23#) | 1680' | 375 sx | Producer-Lower |
| 1-17N-9W | 330'FSL&1250'FEL | 1608' | 7 | | 58' | 35 sx | 4-1/2 | | 1608' | 150 sx | Producer-Lower |
| 1-17N-9W | 330'FSL&2000'FEL | 1665' | 8-5/8 | | 63' | 40 sx | 4-1/2 | | 1639' | 75 sx | Producer-Lower |
| 1-17N-9W | 330'FSL&2300'FEL | 1624' | 8-5/8 | | 58' | - | 5-1/2 | | 1593' | | Producer-Upper |
| 1-17N-9W | 1310'FEL& 630'FSL | 1622' | 8-5/8 | | 72' | - | 7 | | 1612' | | Producer-Lower |
| 1-17N-9W | 580'FSL&2090'FEL | 1655' | 8-/58 | | 73' | - | 5-1/2 | (14#) | 1643' | | Producer-Lower |
| 1-17N-9W | 5'FSL&2950'FEL | 1643' | 9-5/8 | (32.3#) | 91' | 100 sx | 7 | | 1639' | 100 sx | Wtr.Inj.-Lower |
| 1-17N-9W | 5'FSL& 50'FEL | 1598' | 8-5/8 | (24#) | 105' | 80 sx | 5-1/2 | (14#) | 1585' | 100 sx | Wtr.Inj.-Lower |
| 1-17N-9W | - - | 1769' | - | | - | - | | - | - | - | Producer-Lower |

PLUGGED AND ABANDONED WELLS WITHIN A 1/2 MILE RADIUS

Only one well located within a 1/2 mile radius of the Hospah In Situ Combustion Project was plugged and abandoned. This well is the Tenneco Hospah No. 37, located 1150' FNL & 1080' FWL of Section 12-17N-9W. A wellbore schematic is on the following page.

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. 10
CASE NO. 6890

EXHIBIT 10

**TENNECO OIL COMPANY**

CALCULATION SHEET

COMPANY ______ DEPT. ______

SUBJECT ______

LOCATION ______ BY ______ DATE ______

WELLBORE SCHEMATIC - HOSPAH 37

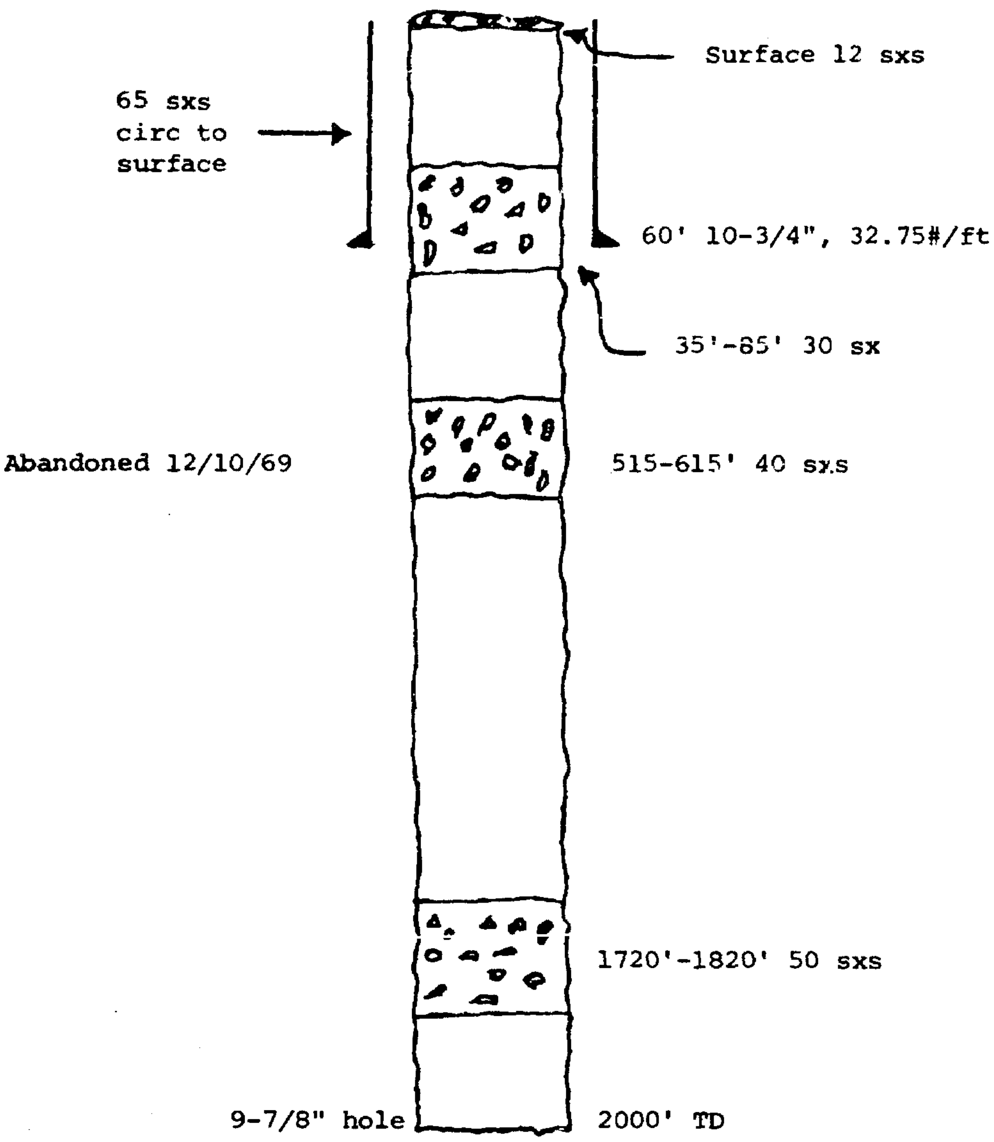


EXHIBIT 10A

**Tenneco Oil**
A Tenneco Company

Suite 1200
Lincoln Tower Building
Denver Colorado 80203
(303) 292-9920

July 27, 1977

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. 11
CASE NO. 6890

Mr. Tom Kellahin
Kellahin and Fox
P.O. Box 1769
500 Don Gaspar Avenue
Santa Fe, New Mexico 87501

Dear Tom:

In response to your telephone request I am sending you in attachment a list of calculated Upper Hospah fracture gradients for the Upper Hospah Gallup Sandstone formation, S. Hospah field, McKinley County, New Mexico. All of these wells are located in Sec. 12-T17N-R9W.

In this matter Fracture Gradient was considered to be hydrostatic pressure plus initial shut-in pressure divided by the depth to mid-perforation, or

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

I am also enclosing a copy of actual daily rates and month-end pressures for Upper Hospah injection wells observed during May, 1977. As can be seen average wellhead pressure is ± 750 psig. If you foresee the N.M.O.C.C. rules pertaining to wellhead pressure adversely affecting our Hospah operations I would appreciate hearing your opinion as soon as possible.

I have no comparable data for the Lower Hospah Sand and have no explanation as to why the Upper Hospah F.G. is so high. It is my intention to stay below fracture pressure in this project. In the case of Hospah #58 or #59, assuming minimum FG = 0.92 psi/ft and a flow rate of 1000 BWPD, friction loss would amount to approximately 25 psi and maximum allowable wellhead pressure would be 804 psia (or about 816 psig),

$$F.G. = \frac{(804 - 25) + 693}{1600} = 0.92 \text{ psi/ft}$$

Such a pressure would fall within the likely operating pressure range for the Upper Hospah Sand and may require reducing the desired 1000 BWPD rate.

As I see it the main problem with high injection wellhead pressure is vertical fracturing downward into the Lower Hospah Sand, located some 30' below the base of the Upper Sand.

Very truly yours,

Brad W. Fischer
Sr. Production Engineer

BWF:cam
Attachments
cc: Millard Carr

G 5995

EXHIBIT 11

E

ATTACHMENT #1

Calculation of Fracture Gradients in the Upper Hospah Sand, Sec. 12-17N-9W, South Hospah Field, McKinley County, New Mexico, using data collected from well stimulation reports and assuming

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

| Well | $P_H$, psig | ISIP, psig | F.G., psi/ft |
|---|---|---|---|
| 5 | 675 | 800 | 1475/1560 = 0.95 |
| 18 | 682 | 800 | 1482/1575 = 0.94 |
| 19 | 694 | 800 | 1494/1602 = 0.93 |
| 27 | 676 | 800 | 1476/1562 = 0.95 |
| 38 | 662 | 1000 | 1662/1528 = 1.09 |
| 39 | 696 | 1000 | 1696/1605 = 1.06 |
| 41 | 686 | 850 | 1536/1580 = 0.97 |
| 42 | 716 | 1200 | 1916/1650 = 1.16 |

$\overline{X}$ = 1.01 psi/ft

S = 0.09 psi/ft

Attachment #2

| Well #5 WHP | Well #5 Water | Well #13 WHP | Well #13 Water | Well #17 WHP | Well #17 Water | Well #20 WHP | Well #20 Water | Well #23 WHP | Well #23 Water | Well #41 WHP | Well #41 Water | Well #42 WHP | Well #42 Water | Well #4[illegible] WHP | Well #4[illegible] Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 865 | | 1019 | | 1740 | | 2 | | 734 | | 0 | | 0 | | 133 |
| | 904 | | 1088 | | 1802 | | 4 | | 804 | | 0 | | 0 | | 165 |
| | 845 | | 1134 | | 1849 | | 3 | | 841 | | 0 | | 0 | | 145 |
| | 873 | | 1070 | | 1790 | | 1 | | 742 | | 0 | | 0 | | 106 |
| | 892 | | 1087 | | 1816 | | 0 | | 773 | | 0 | | 0 | | 15 |
| | 885 | | 1057 | | 1834 | | 1 | | 765 | | 0 | | 0 | | 61 |
| | 893 | | 1072 | | 1799 | | 2 | | 790 | | 0 | | 0 | | 40 |
| | 862 | | 1062 | | 1757 | | 2 | | 733 | | 0 | | 0 | | 77 |
| | 763 | | 654 | | 1600 | | 15 | | 624 | | 0 | | 0 | | 128 |
| | 926 | | 704 | | 1832 | | 4 | | 831 | | 0 | | 0 | | 120 |
| | 902 | | 690 | | 1819 | | 11 | | 806 | | 0 | | 0 | | 145 |
| | 919 | | 657 | | 1819 | | 4 | | 903 | | 0 | | 0 | | 114 |
| | 904 | | 1087 | | 1841 | | 1 | | 790 | | 0 | | 0 | | 50 |
| | [illegible] | | [illegible] | | [illegible] | | 5 | | [illegible] | | [illegible] | | 0 | | [illegible] |
| [illegible] | 791 | 500 | [illegible]147 | 500 | [illegible] | 700 | 15 | 500 | 597 | | 0 | | [illegible] | 300 | 1 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | 13 | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | | [illegible] | | 0 | | [illegible] |
| | | | | | | | | | | | [illegible] | | [illegible] | | |
| | | | | | | | | | | | [illegible] | | [illegible] | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | [illegible] | | [illegible] | [illegible] | |
| | | | | | | | | | | | | | | | |

| #52 | Well | #56 |
|---|---|---|
| WATer | WHP | WATer |
| 492 | | 0 |
| 507 | | 0 |
| 505 | | 0 |
| 461 | | 0 |
| 542 | | 0 |
| 506 | | 0 |
| 532 | | 0 |
| 516 | | 0 |
| 444 | | 0 |
| 570 | | 0 |
| 563 | | 0 |
| 568 | | 0 |
| 533 | | 0 |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
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| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |

$\bar{X} = 755$ psig

$s = 130$ psig

FRESH WATER SANDS

Listed below are the sands encountered from surface to 1550' in Sec.12-T17N-R9W, McKinley County, New Mexico which calculate from logs an equivalent chlorides of less than 10,000 ppm.

| Depth | Thickness | Log Porosity | Calculated Total Chlorides |
|---|---|---|---|
| 188'-196' | 8' | 21% | 5500 |
| 270'-308' | 38' | 35% | 1000 |
| 312'-346' | 34' | 33% | 500 |
| 348'-356' | 8' | 38% | <200 |
| 368'-376' | 8' | 38% | <200 |
| 382'-448' | 66' | 36% | <200 |
| 452'-484' | 32' | 38% | <200 |
| 870'-876' | 6' | 25% | 6000 |
| 880'-886' | 6' | 25% | 6000 |
| 908'-920' | 12' | 23% | 6000 |

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. 12
CASE NO. 6890

EXHIBIT 12

STATE OF NEW MEXICO

DEPARTMENT OF ENERGY AND MINERALS

OIL CONSERVATION DIVISION

| | | |
|---|---|---|
| TENNECO OIL COMPANY<br>IN SITU COMBUSTION PILOT<br>PROJECT, McKINLEY COUNTY,<br>NEW MEXICO | §<br>§<br>§<br>§ | Case No. 6890 |

AFFIDAVIT

STATE OF NEW MEXICO )
) ss.
COUNTY OF SANTA FE )

I, W. THOMAS KELLAHIN, being first duly sworn upon my oath, state:

1. That I am a licensed New Mexico Attorney.

2. On behalf of Tenneco Oil Company on April 28, 1980, I examined the well records in the Office of the State Engineer, Santa Fe, New Mexico.

3. The records of the State Engineer's Office do not indicate the existence of any fresh water wells drilled in any of the following sections:

T17N, R9W, NMPM

Sections 1, 2, 11, 12, 13, and 14

T17N, R8W, NMPM

Sections 6, 7, and 18

Affiant further sayeth ~~not~~.

W. T. Kellahin

W. THOMAS KELLAHIN
Kellahin & Kellahin
P. O. Box 1769
Santa Fe, New Mexico 87501
Phone: (595) 982-4285

SUBSCRIBED AND SWORN TO before me on this 6th day of May, 1980.

(seal)

Marilyn Forrest
Notary Public

My commission expires:
10-13-80

BEFORE EXAMINER NUTTER
OIL CONSERVATION DIVISION
Tenneco EXHIBIT NO. 13
CASE NO. 6890

EXHIBIT 8
Case 6890

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TENNECO OIL COMPANY** | | | | | | | | | | | | |
| Upper Hospah No.1X | 12-17N-9W | 1980'FNL&2052'FEL | 1565' | 7-5/8 | (24#) | 31' | 10 sx - surface | 4-1/2 | (11.6#) | 1505' | 75 sx | |
| Upper Hospah No.2 | 12-17N-9W | 2310'FNL&2310'FWL | 1637' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1635' | 60 sx | |
| Lower Hospah No.3 | 12-17N-9W | 1650'FNL&1392'FEL | 1603' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | (10.5#) | 1602' | 60 sx | |
| Upper Hospah No.4 | 12-17N-9W | 990'FNL&2310'FWL | 1640' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | (10.5#) | 1628' | 60 sx | |
| Upper Hospah No.5 | 12-17N-9W | 990'FNL&2712'FEL | 1645' | 7 | (17#) | 30' | 10 sx- surface | 4-1/2 | (10.5#) | 1644' | 60 sx | |
| Lower Hospah No.6 | 12-17N-9W | 330'FNL& 330'FEL | 1710' | 10-3/4 | (32.4#) | 45' | 50 sx - surface | 7 | (23#) | 1694' | 75 sx | |
| Lower Hospah No.7 | 12-17N-9W | 1650'FNL& 330'FEL | 1750' | 10-3/4 | (32.75#) | 45' | 75 sx - surface | 7 | (20#) | 1713' | 130 sx | |
| Lower Hospah No.8 | 12-17N-9W | 1650'FNL&2051'FEL | 1709' | 10-3/4 | (22.75#) | 55' | 50 sx - surface | 7 | (20#) | 1687' | 110 sx | |
| Lower Hospah No.9 | 12-17N-9W | 330'FNL&2051'FEL | 3945' | 10-3/4 | (32.75#) | 86' | 90 sx - surface | 7 | (23&20#) | 3933' | 510 sx | |
| Lower Hospah No.10 | 12-17N-9W | 990'FNL&2300'FWL | 2827' | 10-3/4 | (32.75#) | 85' | 150 sx - surface | 7 | (20#) | 2827' | 320 sx | |
| Lower Hospah No.11 | 12-17N-9W | 1650'FNL&2310'FWL | 1774' | 10-3/4 | (32.75#) | 45' | 50 sx - surface | 7 | (20#) | 1766' | 130 sx | |
| Lower Hospah No.12 | 12-17N-9W | 2160'FNL& 990'FWL | 1840' | 10-3/4 | (32.75) | 47' | 70 sx - surface | 7 | (20#) | 1772' | 110 sx | |
| Upper Hospah No.13 | 12-17N-9W | 2280'FNL&1620'FWL | 1720' | 7-5/8 | (26) | 44' | 50 sx - surface | 4-1/2 | (10.5#) | 1702' | 150 sx | |

EXHIBIT 9

Case 6890

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17N-9W | 1980'FNL&2052'FEL | 1565' | 7-5/8 | (24#) | 31' | 10 sx - surface | 4-1/2 | (11.6#) | 1505' | 75 sx | Producer-Upper |
| 17N-9W | 2310'FNL&2310'FWL | 1637' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1635' | 60 sx | Producer-Upper |
| 17N-9W | 1650'FNL&1392'FEL | 1603' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | (10.5#) | 1602' | 60 sx | Producer-Lower |
| 17N-9W | 990'FNL&2310'FWL | 1640' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | (10.5#) | 1628' | 60 sx | Producer-Upper |
| 17N-9W | 990'FNL&2712'FEL | 1645' | 7 | (17#) | 30' | 10 sx- surface | 4-1/2 | (10.5#) | 1644' | 60 sx | Wtr.Inj.-Upper |
| 17N-9W | 330'FNL& 330'FEL | 1710' | 10-3/4 | (32.4#) | 45' | 50 sx - surface | 7 | (23#) | 1694' | 75 sx | Producer-Lower |
| 17N-9W | 1650'FNL& 330'FEL | 1750' | 10-3/4 | (32.75#) | 45' | 75 sx - surface | 7 | (20#) | 1713' | 130 sx | Producer-Lower |
| 7N-9W | 1650'FNL&2051'FEL | 1709' | 10-3/4 | (22.75#) | 55' | 50 sx - surface | 7 | (20#) | 1687' | 110 sx | Producer-Lower |
| 7N-9W | 330'FNL&2051'FEL | 3945' | 10-3/4 | (32.75#) | 86' | 90 sx - surface | 7 | (23&20#) | 3933' | 510 sx | Producer-Lower |
| 7N-9W | 990'FNL&2300'FWL | 2827' | 10-3/4 | (32.75#) | 85' | 150 sx - surface | 7 | (20#) | 2827' | 320 sx | Producer-Lower T&A-Dakota |
| 7N-9W | 1650'FNL&2310'FWL | 1774' | 10-3/4 | (32.75#) | 45' | 50 sx - surface | 7 | (20#) | 1766' | 130 sx | Producer-Lower |
| 7N-9W | 2160'FNL& 990'FWL | 1840' | 10-3/4 | (32.75) | 47' | 70 sx - surface | 7 | (20#) | 1772' | 110 sx | Producer-Lower |
| 7N-9W | 2280'FNL&1620'FWL | 1720' | 7-5/8 | (26) | 44' | 50 sx - surface | 4-1/2 | (10.5#) | 1702' | 150 sx | Wtr.Inj.-Upper |

PAGE TWO..........

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | |
| Lower Hospah No.14 | 12-17N-9W | 1700'FNL&1300'FWL | 1790' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1763' | 200 sx |
| Upper Hospah No.16 | 12-17N-9W | 1755'FNL&2330'FWL | 1710' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1692' | 200 sx |
| Upper Hospah No.17 | 12-17N-9W | 2250'FNL&3000'FWL | 1787' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1691' | 200 sx |
| Upper Hospah No.18 | 12-17N-9W | 1475'FNL&3055'FWL | 1750' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1729' | 200 s |
| Upper Hospah No.19 | 12-17N-9W | 2310'FSL&2712'FEL | 1638' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1638' | 60 sx |
| Upper Hospah No.20 | 12-17N-9W | 2310'FSL&1392'FEL | 1647' | No surface pipe | | | - | 4-1/2 | (10.5#) | 1647' | 60 sx |
| Upper Hospah No.21 | 12-17N-9W | 2310'FSL&2310'FWL | 1690' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1685' | 60 sx |
| Upper Hospah No.22 | 12-17N-9W | 2210'FSL& 990'FWL | 1734' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1734' | 60 sx |
| Upper Hospah No.23 | 12-17N-9W | 1650'FSL&1800'FWL | 2968' | 8-5/8 | (20#) | 91' | 70 sx surface | 4-1/2 | (10.5#) | 2940' | 245 sx |
| Lower Hospah No.24 | 12-17N-9W | 330'FNL&2650'FEL | 1725' | 8-5/8 | (26#) | 51' | 40 sx - surface | 4-1/2 | (10.5#) | 1720' | 190 sx |
| Lower Hospah No.25 | 12-17N-9W | 330'FNL&1505'FEL | 1702' | 8-5/8 | (36#) | 51' | 40 sx surface | 4-1/2 | ( 9.5#) | 1683' | 240 sx |
| Upper Hospah No.26 | 12-17N-9W | 330'FNL& 380'FEL | 1660' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 225 sx |
| Upper Hospah No.27 | 12-17N-9W | 1570'FNL& 330'FEL | 1669' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1652' | 240 sx |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| :'d) | | | | | | | | | | | |
| 12-17N-9W | 1700'FNL&1300'FWL | 1790' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1763' | 200 sx | Producer-Lower |
| 12-17N-9W | 1755'FNL&2330'FWL | 1710' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1692' | 200 sx | Producer-Upper |
| 12-17N-9W | 2250'FNL&3000'FWL | 1787' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1691' | 200 sx | Wtr.Inj.-Upper |
| 12-17N-9W | 1475'FNL&3055'FWL | 1750' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1729' | 200 sx | Producer-Upper |
| 12-17N-9W | 2310'FSL&2712'FEL | 1638' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1638' | 60 sx | Producer-Upper |
| 12-17N-9W | 2310'FSL&1392'FEL | 1647' | No surface pipe | | | - | 4-1/2 | (10.5#) | 1647' | 60 sx | Wtr.Inj.-Upper |
| 12-17N-9W | 2310'FSL&2310'FWL | 1690' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1685' | 60 sx | Producer-Upper |
| 12-17N-9W | 2210'FSL& 990'FWL | 1734' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1734' | 60 sx | Producer-Upper |
| 12-17N-9W | 1650'FSL&1800'FWL | 2968' | 8-5/8 | (20#) | 91' | 70 sx surface | 4-1/2 | (10.5#) | 2940' | 245 sx | T&A-Dakota Gas Wtr.Inj.-Upper |
| 12-17N-9W | 330'FNL&2650'FEL | 1725' | 8-5/8 | (26#) | 51' | 40 sx - surface | 4-1/2 | (10.5#) | 1720' | 190 sx | Producer-Lower |
| 12-17N-9W | 330'FNL&1505'FEL | 1702' | 8-5/8 | (36#) | 51' | 40 sx surface | 4-1/2 | ( 9.5#) | 1683' | 240 sx | Producer-Lower |
| 12-17N-9W | 330'FNL& 380'FEL | 1660' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 225 sx | Producer-Upper |
| 12-17N-9W | 1570'FNL& 330'FEL | 1669' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1652' | 240 sx | Producer-Upper |

PAGE THREE..........

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TENNECO OIL COMPANY** (cont'd) | | | | | | | | | | | | |
| Upper Hospah No.28 | 12-17N-9W | 933'FNL&1485'FEL | 1675' | 8-5/8 | (36#) | 51' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 240 sx | P |
| Upper Hospah No.29 | 12-17N-9W | 410'FNL&1870'FEL | 1606' | 8-5/8 | (24#) | 75' | 70 sx - surface | 5-1/2 | (15.5#) | 1606' | 85 sx | P |
| Upper Hospah No.30 | 12-17N-9W | 950'FNL&1980'FEL | 1605' | 8-5/8 | (24#) | 71' | 70 sx - surface | 5-1/2 | (15.5#) | 1605' | 85 sx | P |
| Upper Hospah No.31 | 12-17N-9W | 330'FNL&2800'FEL | 1626' | 8-5/8 | (24#) | 78' | 70 sx - surface | 5-1/2 | (15.5#) | 1626' | 96 sx | P |
| Lower Hospah No.32 | 12-17N-9W | 550'FNL&2370'FWL | 1647' | 10-3/4 | (32.75#) | 64' | 70 sx - surface | 7 | (20#) | 1632' | 125 sx | P |
| Lower Hospah No.33 | 12-17N-9W | 1340'FNL&1710'FWL | 1660' | 10-3/4 | (32.75#) | 61' | 70 sx - surface | 7 | (20#) | 1647' | 125 sx | W |
| Upper & Lower Hospah #34 | 12-17N-9W | 1820'FNL&1700'FWL | 1661' | 10-3/4 | (32.75#) | 67' | 70 sx - surface | 7 | (20#) | 1648' | 125 sx | P |
| Lower Hospah No.35 | 12-17N-9W | 330'FNL& 850' FEL | 1591' | 10-3/4 | (32.75#) | 75' | 60 sx - surface | 7 | (20#) | 1577' | 125 sx | P |
| Lower Hospah No.36 | 12-17N-9W | 900'FNL&2630'FEL | 1635' | 10-3/4 | (32.75#) | 78' | 60 sx - surface | 7 | (20#) | 1624' | 125 sx | W |
| Lower Hospah No.37X | 12-17N-9W | 1280'FNL&1280'FWL | 1666' | 10-3/4 | (32.75#) | 72' | 40 sx - surface | 7 | (20#) | 1635' | 135 sx | U P |
| Lower Hospah No.38 | 12-17N-9W | 660'FNL& 660'FEL | 1565' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1565' | 100 sx | P |
| Upper Hospah No.39 | 12-17N-9W | 2180'FNL& 660'FEL | 1627' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1627' | 100 sx | P |
| Upper Hospah No.40 | 12-17N-9W | 2420'FNL&1650'FEL | 1637' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 100 sx | P |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 933'FNL&1485'FEL | 1675' | 8-5/8 | (36#) | 51' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 240 sx | Producer-Upper |
| 410'FNL&1870'FEL | 1606' | 8-5/8 | (24#) | 75' | 70 sx - surface | 5-1/2 | (15.5#) | 1606' | 85 sx | Producer-Upper |
| 950'FNL&1980'FEL | 1605' | 8-5/8 | (24#) | 71' | 70 sx - surface | 5-1/2 | (15.5#) | 1605' | 85 sx | Producer-Upper |
| 330'FNL&2800'FEL | 1626' | 8-5/8 | (24#) | 78' | 70 sx - surface | 5-1/2 | (15.5#) | 1626' | 96 sx | Producer-Upper |
| 550'FNL&2370'FWL | 1647' | 10-3/4 | (32.75#) | 64' | 70 sx - surface | 7 | (20#) | 1632' | 125 sx | Producer-Lower |
| 1340'FNL&1710'FWL | 1660' | 10-3/4 | (32.75#) | 61' | 70 sx - surface | 7 | (20#) | 1647' | 125 sx | Wtr.Inj.-Lower |
| 1820'FNL&1700'FWL | 1661' | 10-3/4 | (32.75#) | 67' | 70 sx - surface | 7 | (20#) | 1648' | 125 sx | Producer-Dual |
| 330'FNL& 850' FEL | 1591' | 10-3/4 | (32.75#) | 75' | 60 sx - surface | 7 | (20#) | 1577' | 125 sx | Producer-Lower |
| 900'FNL&2630'FEL | 1635' | 10-3/4 | (32.75#) | 78' | 60 sx - surface | 7 | (20#) | 1624' | 125 sx | Wtr.Inj.-Lower |
| 1280'FNL&1280'FWL | 1666' | 10-3/4 | (32.75#) | 72' | 40 sx - surface | 7 | (20#) | 1635' | 135 sx | Upper-T&A<br>Producer-Lower |
| 660'FNL& 660'FEL | 1565' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1565' | 100 sx | Producer-Lower |
| 2180'FNL& 660'FEL | 1627' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1627' | 100 sx | Producer-Upper |
| 2420'FNL&1650'FEL | 1637' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 100 sx | Producer-Upper |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | |
| Upper Hospah No.41 | 12-17N-9W | 5'FNL&1650'FEL | 1611' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1610' | 100 sx |
| Lower Hospah No.46 | 12-17N-9W | 1700'FNL& 700'FWL | 1680' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1664' | 125 sx |
| Lower Hospah No.47 | 12-17N-9W | 785'FNL&1775'FWL | 1780' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1647' | 125 sx |
| Lower Hospah No.48 | 12-17N-9W | 1485'FNL&2817'FWL | 1635' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1625' | 125 sx |
| Lower Hospah No.49 | 12-17N-9W | 885'FNL&2117'FEL | 1639' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1610' | 125 sx |
| Lower Hospah No.50 | 12-17N-9W | 950'FNL& 900'FEL | 1593' | 9-5/8 | (36#) | 71' | 40 sx - surface | 7 | (20#) | 1583' | 125 sx |
| Upper Hospah No.51 | 12-17N-9W | 1775'FNL& 620'FWL | 1662' | 8-5/8 | (24#) | 64' | 50 sx - surface | 5-1/2 | (15.5#) | 1662' | 150 sx |
| Upper Hospah No.52 | 12-17N-9W | 720'FNL&1850'FWL | 1622' | 8-5/8 | (24#) | 74' | 50 sx - surface | 5-1/2 | (15.5#) | 1620' | 150 sx |
| Lower Hospah No.53 | 12-17N-9W | 950'FNL& 330'FEL | 1578' | 8-5/8 | (24#) | 63' | 50 sx - surface | 7 | (20#) | 1559' | 100 sx |
| Upper Hospah No.55 | 12-17N-9W | 1750'FNL&1550'FEL | 1583' | 9-5/8 | (36#) | 100' | 90 sx - surface | 7 | (20#) | 1583' | 100 sx |
| Upper Hospah No.56 | 12-17N-9W | 1100'FNL&1275'FEL | 1584' | 9-5/8 | (36#) | 102' | 90 sx - surface | 7 | (20#) | 1584' | 95 sx |
| Upper & Lower Hospah No.58 | 12-17N-9W | 2580'FNL&1640'FWL | 1679' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 350 sx |
| Upper & Lower Hospah No.59 | 12-17N-9W | 2340'FNL&2500'FEL | 1657' | 8-5/8 | (24#) | 89' | 75 sx - surface | 5-1/2 | (15.5#) | 1657' | 225 sx |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 7N-9W 5'FNL&1650'FEL | 1611' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1610' | 100 sx | Wtr.Inj.-Dual Upper-T&A |
| 7N-9W 1700'FNL& 700'FWL | 1680' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1664' | 125 sx | Producer-Lower |
| 7N-9W 785'FNL&1775'FWL | 1780' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1647' | 125 sx | Producer-Lower |
| 7N-9W 1485'FNL&2817'FWL | 1635' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1625' | 125 sx | Producer-Lower |
| 7N-9W 885'FNL&2117'FEL | 1639' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1610' | 125 sx | Producer-Lower |
| 7N-9W 950'FNL& 900'FEL | 1593' | 9-5/8 | (36#) | 71' | 40 sx - surface | 7 | (20#) | 1583' | 125 sx | Producer-Lower |
| 17N-9W 1775'FNL& 620'FWL | 1662' | 8-5/8 | (24#) | 64' | 50 sx - surface | 5-1/2 | (15.5#) | 1662' | 150 sx | Wtr.Inj.-Upper |
| 17N-9W 720'FNL&1850'FWL | 1622' | 8-5/8 | (24#) | 74' | 50 sx - surface | 5-1/2 | (15.5#) | 1620' | 150 sx | Wtr.Inj.-Upper |
| 17N-9W 950'FNL& 330'FEL | 1578' | 8-5/8 | (24#) | 63' | 50 sx - surface | 7 | (20#) | 1559' | 100 sx | Producer-Lower |
| 17N-9W 1750'FNL&1550'FEL | 1583' | 9-5/8 | (36#) | 100' | 90 sx - surface | 7 | (20#) | 1583' | 100 sx | Producer-Upper |
| 17N-9W 1100'FNL&1275'FEL | 1584' | 9-5/8 | (36#) | 102' | 90 sx - surface | 7 | (20#) | 1584' | 95 sx | Wtr.Inj.-Upper |
| 17N-9W 2580'FNL&1640'FWL | 1679' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 350 sx | Wtr.Inj.-Dual |
| 17N-9W 2340'FNL&2500'FEL | 1657' | 8-5/8 | (24#) | 89' | 75 sx - surface | 5-1/2 | (15.5#) | 1657' | 225 sx | Wtr.Inj.Dual |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | |
| Lower Hospah No.60 | 12-17N-9W | 2210'FNL&1300'FEL | 1648' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1648' | 225 sx |
| Lower Hospah No.61 | 12-17N-9W | 1120'FNL&2510'FEL | 1715' | 9-5/8 | (36#) | 87' | 90 sx - surface | 7 | (23#) | 1715' | 375 sx |
| Lower Hospah No.62 | 12-17N-9W | 650'FNL&1770'FEL | 1710' | 9-5/8 | (36#) | 93' | 90 sx - surface | 7 | (23#) | 1710' | 375 sx |
| Lower Hospah No.63 | 12-17N-9W | 710'FNL&1325'FEL | 1695' | 9-5/8 | (36#) | 94' | 90 sx - surface | 7 | (23#) | 1690' | 375 sx |
| Lower Hospah No.64 | 12-17N-9W | 1360'FNL& 900'FEL | 1685' | 9-5/8 | (36#) | 90' | 90 sx - surface | 7 | (23#) | 1680' | 375 sx |
| TESORO | | | | | | | | | | | |
| SFPRR A-72 | 1-17N-9W | 330'FSL&1250'FEL | 1608' | 7 | | 58' | 35 sx | 4-1/2 | | 1608' | 150 sx |
| SFPRR A-73 | 1-17N-9W | 330'FSL&2000'FEL | 1665' | 8-5/8 | | 63' | 40 sx | 4-1/2 | | 1639' | 75 sx |
| SFPRR A-79 | 1-17N-9W | 330'FSL&2300'FEL | 1624' | 8-5/8 | | 58' | - | 5-1/2 | | 1593' | |
| SFPRR A-80 | 1-17N-9W | 1310'FEL& 630'FSL | 1622' | 8-5/8 | | 72' | - | 7 | | 1612' | |
| SFPRR A-81 | 1-17N-9W | 580'FSL&2090'FEL | 1655' | 8-/58 | | 73' | - | 5-1/2 | (14#) | 1643' | |
| SFPRR A-84 | 1-17N-9W | 5'FSL&2950'FEL | 1643' | 9-5/8 | (32.3#) | 91' | 100 sx | 7 | | 1639' | 100 sx |
| SFPRR A-87 | 1-17N-9W | 5'FSL& 50'FEL | 1598' | 8-5/8 | (24#) | 105' | 80 sx | 5-1/2 | (14#) | 1585' | 100 sx |
| SFPRR A-89 | 1-17N-9W | - - | 1769' | - | | - | - | - | | - | - |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

1)

| LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -17N-9W | 2210'FNL&1300'FEL | 1648' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1648' | 225 sx | Wtr.Inj.-Lower |
| -17N-9W | 1120'FNL&2510'FEL | 1715' | 9-5/8 | (36#) | 87' | 90 sx - surface | 7 | (23#) | 1715' | 375 sx | Producer-Lower |
| 17N-9W | 650'FNL&1770'FEL | 1710' | 9-5/8 | (36#) | 93' | 90 sx - surface | 7 | (23#) | 1710' | 375 sx | Producer-Lower |
| 17N-9W | 710'FNL&1325'FEL | 1695' | 9-5/8 | (36#) | 94' | 90 sx - surface | 7 | (23#) | 1690' | 375 sx | Producer-Lower |
| 17N-9W | 1360'FNL& 900'FEL | 1685' | 9-5/8 | (36#) | 90' | 90 sx - surface | 7 | (23#) | 1680' | 375 sx | Producer-Lower |
| 7N-9W | 330'FSL&1250'FEL | 1608' | 7 | | 58' | 35 sx | 4-1/2 | | 1608' | 150 sx | Producer-Lower |
| 7N-9W | 330'FSL&2000'FEL | 1665' | 8-5/8 | | 63' | 40 sx | 4-1/2 | | 1639' | 75 sx | Producer-Lower |
| 7N-9W | 330'FSL&2300'FEL | 1624' | 3-5/8 | | 58' | - | 5-1/2 | | 1593' | | Producer-Upper |
| 7N-9W | 1310'FEL& 630'FSL | 1622' | 8-5/8 | | 72' | - | 7 | | 1612' | | Producer-Lower |
| 7N-9W | 580'FSL&2090'FEL | 1655' | 8-/58 | | 73' | - | 5-1/2 | (14#) | 1643' | | Producer-Lower |
| 7N-9W | 5'FSL&2950'FEL | 1643' | 9-5/8 | (32.3#) | 91' | 100 sx | 7 | | 1639' | 100 sx | Wtr.Inj.-Lower |
| 7N-9W | 5'FSL& 50'FEL | 1598' | 8-5/8 | (24#) | 105' | 80 sx | 5-1/2 | (14#) | 1585' | 100 sx | Wtr.Inj.-Lower |
| 7N-9W | - - | 1769' | - | | - | - | | - | - | - | Producer-Lower |

PLUGGED AND ABANDONED WELLS WITHIN A 1/2 MILE RADIUS

Only one well located within a 1/2 mile radius of the Hospah In Situ Combustion Project was plugged and abandoned. This well is the Tenneco Hospah No. 37, located 1150' FNL & 1080' FWL of Section 12-17N-9W. A wellbore schematic is on the following page.

EXHIBIT 10
Case 6880

TOC 841 - 7/61

# TENNECO OIL COMPANY

## CALCULATION SHEET

COMPANY ____ DEPT. ____

SUBJECT ____

LOCATION ____ BY ____ DATE ____

WELLBORE SCHEMATIC - HOSPAH 37

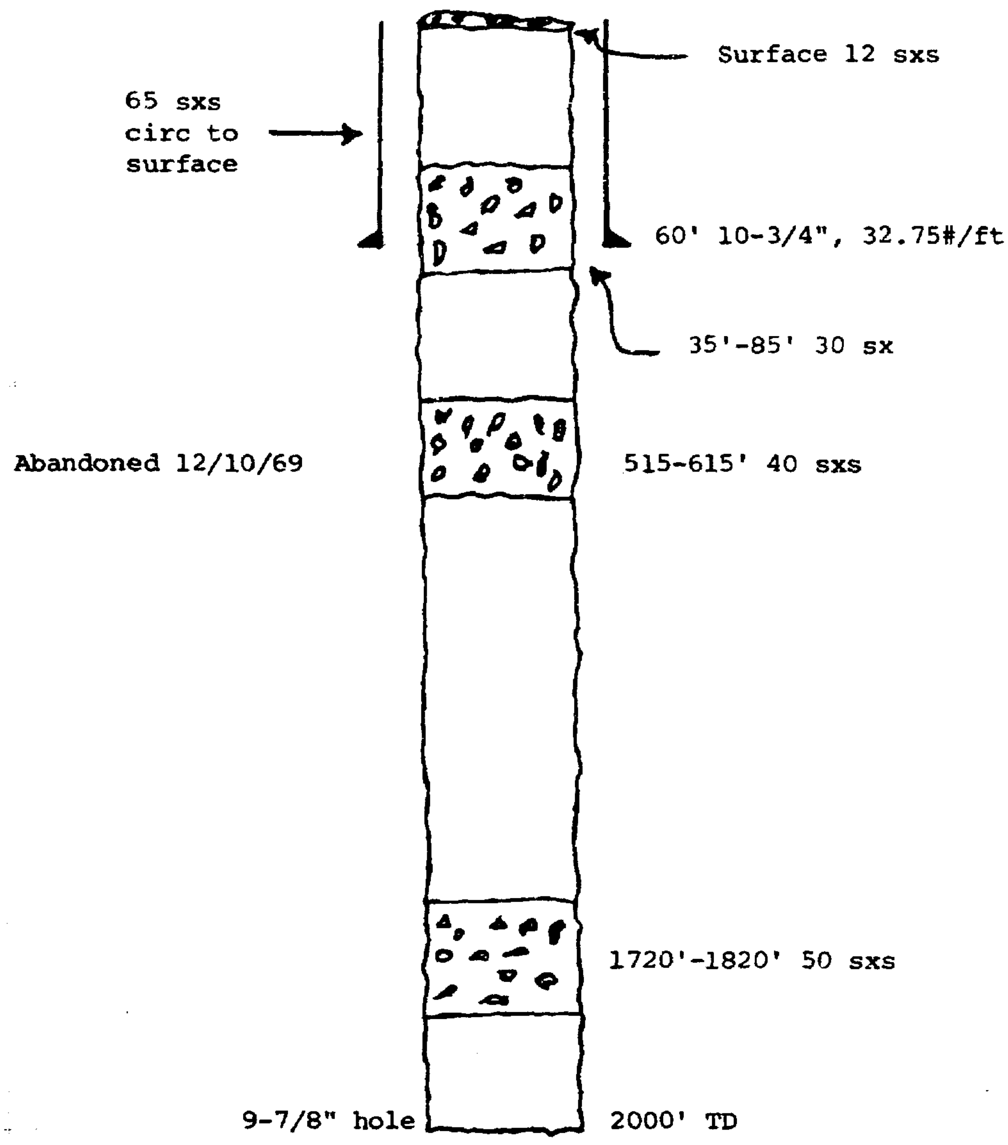


EXHIBIT 10A

**Tenneco Oil**
A Tenneco Company

Suite 1200
Lincoln Tower Building
Denver Colorado 80203
(303) 292-9920

July 27, 1977

Mr. Tom Kellahin
Kellahin and Fox
P.O. Box 1769
500 Don Gaspar Avenue
Santa Fe, New Mexico 87501

Dear Tom:

In response to your telephone request I am sending you in attachment a list of calculated Upper Hospah fracture gradients for the Upper Hospah Gallup Sandstone formation, S. Hospah field, McKinley County, New Mexico. All of these wells are located in Sec. 12-T17N-R9W.

In this matter Fracture Gradient was considered to be hydrostatic pressure plus initial shut-in pressure divided by the depth to mid-perforation, or

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

I am also enclosing a copy of actual daily rates and month-end pressures for Upper Hospah injection wells observed during May, 1977. As can be seen average wellhead pressure is $\pm$ 750 psig. If you foresee the N.M.O.C.C. rules pertaining to wellhead pressure adversely affecting our Hospah operations I would appreciate hearing your opinion as soon as possible.

I have no comparable data for the Lower Hospah Sand and have no explanation as to why the Upper Hospah F.G. is so high. It is my intention to stay below fracture pressure in this project. In the case of Hospah #58 or #59, assuming minimum FG = 0.92 psi/ft and a flow rate of 1000 BWPD, friction loss would amount to approximately 25 psi and maximum allowable wellhead pressure would be 804 psia (or about 816 psig),

$$F.G. = \frac{(804 - 25) + 693}{1600} = 0.92 \text{ psi/ft}$$

Such a pressure would fall within the likely operating pressure range for the Upper Hospah Sand and may require reducing the desired 1000 BWPD rate.

As I see it the main problem with high injection wellhead pressure is vertical fracturing downward into the Lower Hospah Sand, located some 30' below the base of the Upper Sand.

Very truly yours,

Brad W. Fischer
Sr. Production Engineer

BWF:cam

Attachments

cc: Millard Carr

EXHIBIT 11
Case 6840

E

## ATTACHMENT #1

**Calculation of Fracture Gradients in the Upper Hospah Sand, Sec. 12-17N-9W, South Hospah Field, McKinley County, New Mexico, using data collected from well stimulation reports and assuming**

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

| Well | $P_H$, psig | ISIP, psig | F.G., psi/ft |
|---|---|---|---|
| 5 | 675 | 800 | 1475/1560 = 0.95 |
| 18 | 682 | 800 | 1482/1575 = 0.94 |
| 19 | 694 | 800 | 1494/1602 = 0.93 |
| 27 | 676 | 800 | 1476/1562 = 0.95 |
| 38 | 662 | 1000 | 1662/1528 = 1.09 |
| 39 | 696 | 1000 | 1696/1605 = 1.06 |
| 41 | 686 | 850 | 1536/1580 = 0.97 |
| 42 | 716 | 1200 | 1916/1650 = 1.16 |

$\bar{X}$ = 1.01 psi/ft

$S$ = 0.09 psi/ft

Attachment #2

| Well #5 WHP | Well #5 Water | Well #13 WHP | Well #13 Water | Well #17 WHP | Well #17 Water | Well #20 WHP | Well #20 Water | Well #23 WHP | Well #23 Water | Well #41 WHP | Well #41 Water | Well #42 WHP | Well #42 Water | Well #4 WHP | Well #4 Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 865 | | 1019 | | 1740 | | 2 | | 734 | | 0 | | 0 | | 153 |
| | 904 | | 1088 | | 1802 | | 4 | | 704 | | 0 | | 0 | | 165 |
| | 845 | | 1134 | | 1849 | | 3 | | 841 | | 0 | | 0 | | 145 |
| | 883 | | 1070 | | 1790 | | 1 | | 742 | | 0 | | 0 | | 106 |
| | 892 | | 1087 | | 1816 | | 0 | | 773 | | 0 | | 0 | | 15 |
| | 845 | | 1057 | | 1834 | | 1 | | 765 | | 0 | | 0 | | 61 |
| | 893 | | 1072 | | 1799 | | 2 | | 790 | | 0 | | 0 | | 40 |
| | 862 | | 1062 | | 1757 | | 2 | | 733 | | 0 | | 0 | | 77 |
| | 763 | | 654 | | 1600 | | 15 | | 624 | | 0 | | 0 | | 128 |
| | 926 | | 704 | | 1832 | | 4 | | 831 | | 0 | | 0 | | 120 |
| | 902 | | 690 | | 1819 | | 11 | | 806 | | 0 | | 0 | | 145 |
| | 919 | | 657 | | 1819 | | 4 | | 903 | | 0 | | 0 | | 114 |
| | 904 | | 1087 | | 1841 | | 1 | | 790 | | 0 | | 0 | | 50 |
| | [illegible] | | [illegible] | | [illegible] | | 5 | | [illegible] | | 0 | | 0 | | [illegible] |
| [illegible] | 891 | 500 | 147 | 500 | 1849 | [illegible] | 15 | [illegible] | [illegible] | | 0 | | 0 | 380 | 1 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | 12 | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | | | | | | | | | | | [illegible] | | [illegible] | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | [illegible] | | 0 | [illegible] | |
| | | | | | | | | | | | | | | | |

| #52 | Well #56 | |
|---|---|---|
| WATER | WHP | WATER |
| 492 | | 0 |
| 567 | | 0 |
| 505 | | 0 |
| 461 | | 0 |
| 542 | | 0 |
| 506 | | 0 |
| 532 | | 0 |
| 516 | | 0 |
| 444 | | 0 |
| 590 | | 0 |
| 563 | | 0 |
| 568 | | 0 |
| 533 | | 0 |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
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| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| | | [illegible] |
| | | [illegible] |
| | | [illegible] |
| | | [illegible] |

$\overline{X} = 755$ psig

$s = 130$ psig

## FRESH WATER SANDS

Listed below are the sands encountered from surface to 1550' in Sec.12-T17N-R9W, McKinley County, New Mexico which calculate from logs an equivalent chlorides of less than 10,000 ppm.

| Depth | Thickness | Log Porosity | Calculated Total Chlorides |
|---|---|---|---|
| 188'-196' | 8' | 21% | 5500 |
| 270'-308' | 38' | 35% | 1000 |
| 312'-346' | 34' | 33% | 500 |
| 348'-356' | 8' | 38% | <200 |
| 368'-376' | 8' | 38% | <200 |
| 382'-448' | 66' | 36% | <200 |
| 452'-484' | 32' | 38% | <200 |
| 870'-876' | 6' | 25% | 6000 |
| 880'-886' | 6' | 25% | 6000 |
| 908'-920' | 12' | 23% | 6000 |

EXHIBIT 12
Case 6890

STATE OF NEW MEXICO

DEPARTMENT OF ENERGY AND MINERALS

OIL CONSERVATION DIVISION

| | | |
|---|---|---|
| TENNECO OIL COMPANY<br>IN SITU COMBUSTION PILOT<br>PROJECT, McKINLEY COUNTY,<br>NEW MEXICO | §<br>§<br>§<br>§ | Case No. 6890 |

AFFIDAVIT

STATE OF NEW MEXICO )
) ss.
COUNTY OF SANTA FE )

I, W. THOMAS KELLAHIN, being first duly sworn upon my oath, state:

1. That I am a licensed New Mexico Attorney.

2. On behalf of Tenneco Oil Company on April 28, 1980, I examined the well records in the Office of the State Engineer, Santa Fe, New Mexico.

3. The records of the State Engineer's Office do not indicate the existence of any fresh water wells drilled in any of the following sections:

T17N, R9W, NMPM

Sections 1, 2, 11, 12, 13, and 14

T17N, R8W, NMPM

Sections 6, 7, and 18

Affiant further sayeth ~~not~~.

W. T. Kellahin

W. THOMAS KELLAHIN
Kellahin & Kellahin
P. O. Box 1769
Santa Fe, New Mexico 87501
Phone: (595) 982-4285

SUBSCRIBED AND SWORN TO before me on this 6th day of May, 1980.

(seal)

Marilyn Forrest
Notary Public

My commission expires:
10-13-80

Case 6890

ENHANCED OIL RECOVERY PROPOSAL
SOUTH HOSPAH FIELD

Tenneco Oil Company proposes to implement a pilot In Situ Combustion Project in the South Hospah Field, McKinley County, New Mexico. The purpose of this pilot is to corroborate preliminary engineering evaluation of the technical feasibility of this enhanced oil recovery process. The economic viability of a full-field combustion project will also be ascertained.

The South Hospah Field is located approximately 100 miles southeast of Farmington, New Mexico (Exhibit 1). The field consists of two separate reservoirs. The Upper Hospah reservoir was discovered in 1965. Production from the Lower Hospah reservoir began in April, 1967. These two sands are depicted on the log of Hospah No.18 in Exhibit 3.

Under primary production field recovery from the Upper Hospah sand was 510 MSTB. Primary production from the Lower Hospah was 1465 MSTB.

Waterflooding was initiated in the Upper Hospah sand in 1968. Response to water injection was very dramatic and has proven highly successful. Ultimate recovery from primary and secondary production in this sand is projected to be 3029 MSTB.

Gas/water injection was implemented in the Lower Hospah sand in 1972 as a means of enhancing oil recovery. Gas injection was not beneficial and was discontinued in 1976. Waterflooding was continued and has proven successful. During 1977 and 1978 a deepening and infill drilling program further improved Lower Hospah performance. Projected ultimate recovery from the Lower Hospah sand under primary and secondary recovery is 3255 MSTB.

Exhibit O
Case 6890

Field development and production response are depicted on Exhibits 4 and 5.

The South Hospah field is now fully developed and in the latter, declining years of secondary production. A thorough study of the reservoir and crude properties at South Hospah was made to determine the applicability of tertiary processes to further improve recovery from the field. Steamflooding, in situ combustion, caustic-polymer flooding, and micellar-polymer flooding were considered technically appropriate. Based on laboratory tests and engineering calculations, in situ combustion is the most technically and economically feasible process for extending the producing life of this field.

The proposed in situ combustion pilot is designed to supplement our studies, providing certain additional information. Specifically:

1. Confirm that ignition and sustained combustion can be achieved.
2. Verification of the prediction model (i.e., recovery and response vs. time).
3. Injection rates and pressure for compressor sizing.
4. Lift requirements in producing wells.
5. The magnitude of operations problems:
   a. Gas production and handling
   b. Emulsions
   c. Corrosion.
6. Effect of heat on standard cement and completions.

The small pattern area (0.68 acres) proposed should facilitate a maximum of information gained in a minimum amount of time.

A dual air injection well will be drilled as presented on Exhibit 7. With the ignition equipment currently available, a packer cannot be used in this well. It will be necessary to inject air down the casing for ignition by either a gas or electric down-hole heater.

Two existing producing wells will be utilized. In addition, two new producing wells will be drilled. These four producing wells will be completed in the Lower Hospah sand. Ignition and combustion will be attempted in only the Lower Hospah sand. Air injectivity testing in the Upper Hospah sand will be accomplished simultaneously through use of the second casing string of the dual air injection well.

Separate production facilities will be constructed to monitor the combustion front progress and combustion efficiency, incremental tertiary oil recovery, and exhaust gas composition.

The information obtained from this pilot test is expected to confirm our preliminary evaluations and indicate whether fieldwide expansion is warranted.

ENHANCED OIL RECOVERY PROPOSAL
SOUTH HOSPAH FIELD

EXHIBIT #

1. Hospah location map
2. Field map w/all wells w/i 2 mile radius
3. Log of No.18
4. UH decline curve
5. LH decline curve
6. Plat showing proposed pilot (w/dimensions)
7. Schematic - AIW
8. Schematic prod. well
9. Tabulation of wells w/i 1/2 mile radius
10. Schematic of all P&A wells w/i 1/2 mile radius
11. Frac grad. info
12. Tabulation of fresh water sands encountered.

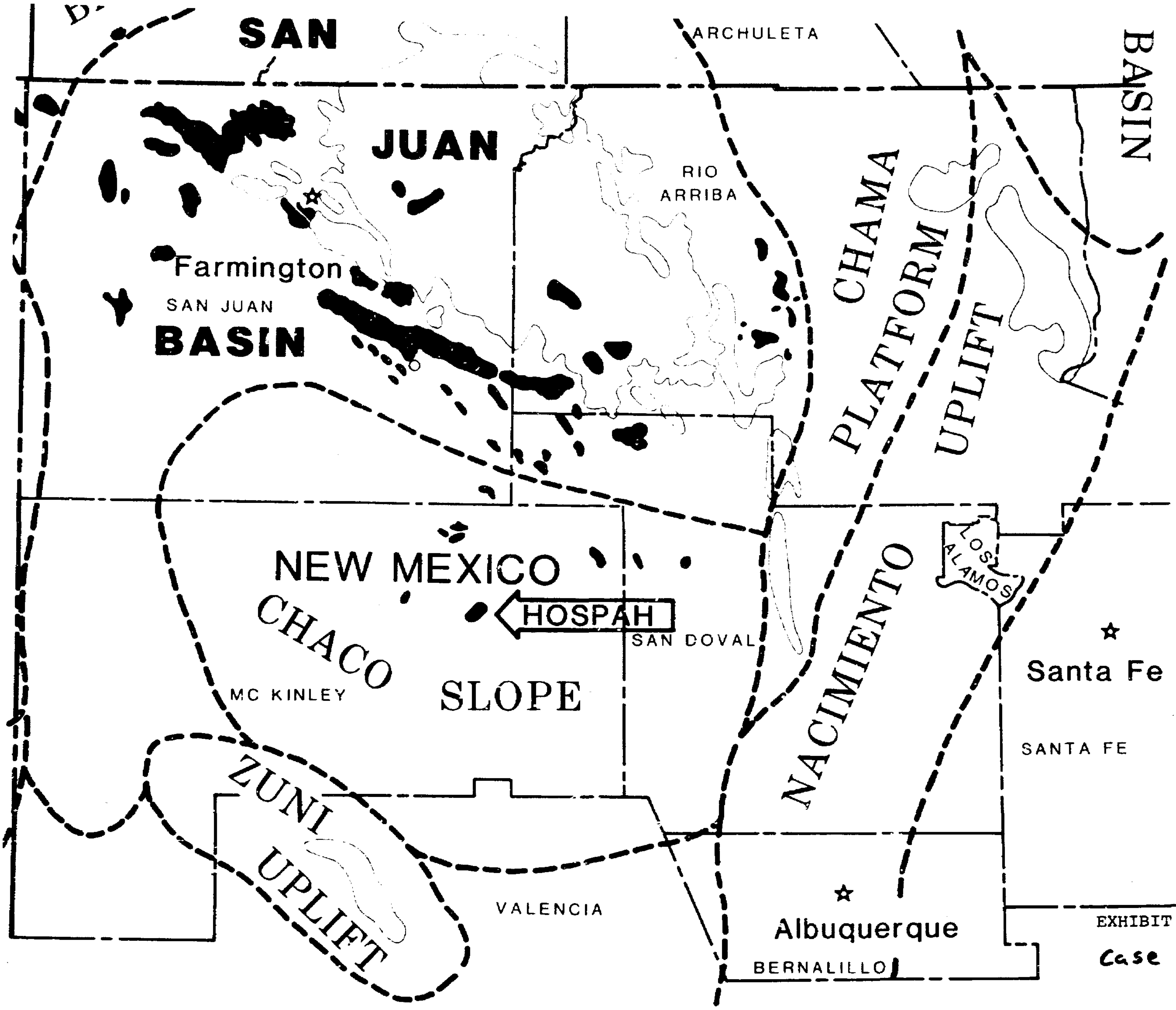



EXHIBIT 1

Case 6890

## PLUGGED AND ABANDONED WELLS WITHIN A 1/2 MILE RADIUS

Only one well located within a 1/2 mile radius of the Hospah In Situ Combustion Project was plugged and abandoned. This well is the Tenneco Hospah No. 37, located 1150' FNL & 1080' FWL of Section 12-17N-9W. A wellbore schematic is on the following page.

EXHIBIT 10

Case 6890

TOC 541 - 7/61

# TENNECO OIL COMPANY

## CALCULATION SHEET

COMPANY ____ DEPT. ____

SUBJECT ____

LOCATION ____ BY ____ DATE ____

WELLBORE SCHEMATIC - HOSPAH 37

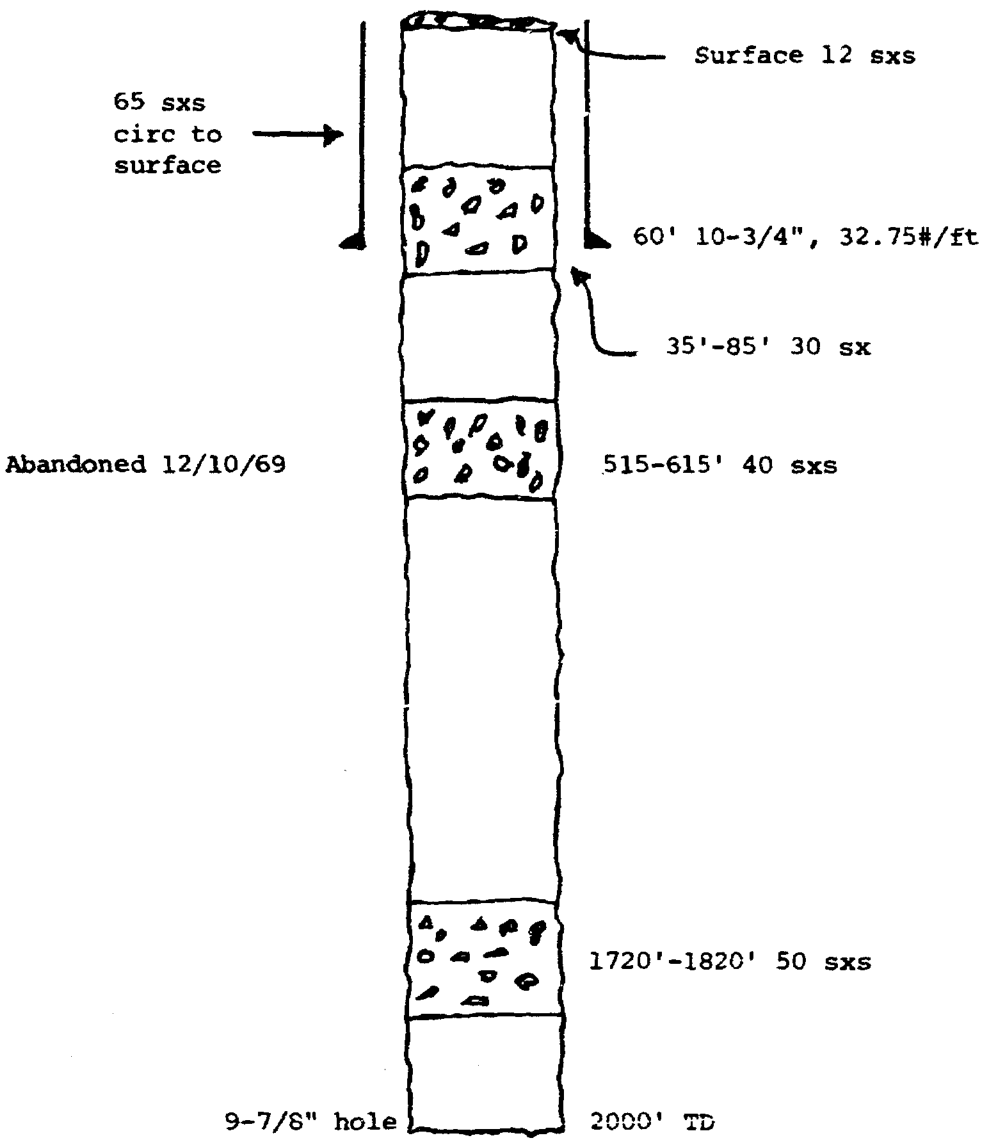



EXHIBIT 10A

**Tenneco Oil**
A Tenneco Company

Suite 1200
Lincoln Tower Building
Denver Colorado 80203
(303) 292-9920

July 27, 1977

Mr. Tom Kellahin
Kellahin and Fox
P.O. Box 1769
500 Don Gaspar Avenue
Santa Fe, New Mexico 87501

Dear Tom:

In response to your telephone request I am sending you in attachment a list of calculated Upper Hospah fracture gradients for the Upper Hospah Gallup Sandstone formation, S. Hospah field, McKinley County, New Mexico. All of these wells are located in Sec. 12-T17N-R9W.

In this matter Fracture Gradient was considered to be hydrostatic pressure plus initial shut-in pressure divided by the depth to mid-perforation, or

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

I am also enclosing a copy of actual daily rates and month-end pressures for Upper Hospah injection wells observed during May, 1977. As can be seen average wellhead pressure is $\pm$ 750 psig. If you foresee the N.M.O.C.C. rules pertaining to wellhead pressure adversely affecting our Hospah operations I would appreciate hearing your opinion as soon as possible.

I have no comparable data for the Lower Hospah Sand and have no explanation as to why the Upper Hospah F.G. is so high. It is my intention to stay below fracture pressure in this project. In the case of Hospah #58 or #59, assuming minimum FG = 0.92 psi/ft and a flow rate of 1000 BWPD, friction loss would amount to approximately 25 psi and maximum allowable wellhead pressure would be 804 psia (or about 816 psig),

$$F.G. = \frac{(804 - 25) + 693}{1600} = 0.92 \text{ psi/ft}$$

Such a pressure would fall within the likely operating pressure range for the Upper Hospah Sand and may require reducing the desired 1000 BWPD rate.

As I see it the main problem with high injection wellhead pressure is vertical fracturing downward into the Lower Hospah Sand, located some 30' below the base of the Upper Sand.

Very truly yours,

Brad W. Fischer
Sr. Production Engineer

BWF:cam
Attachments
cc: Millard Carr

EXHIBIT 11
Case 6890

ATTACHMENT #1

**Calculation** of Fracture Gradients in the Upper Hospah Sand, Sec. 12-17N-9W, **South** Hospah Field, McKinley County, New Mexico, using data collected from **well** stimulation reports and assuming

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

| Well | $P_H$, psig | ISIP, psig | F.G., psi/ft |
|---|---|---|---|
| 5 | 675 | 800 | 1475/1560 = 0.95 |
| 18 | 682 | 800 | 1482/1575 = 0.94 |
| 19 | 694 | 800 | 1494/1602 = 0.93 |
| 27 | 676 | 800 | 1476/1562 = 0.95 |
| 38 | 662 | 1000 | 1662/1528 = 1.09 |
| 39 | 696 | 1000 | 1696/1605 = 1.06 |
| 41 | 686 | 850 | 1536/1580 = 0.97 |
| 42 | 716 | 1200 | 1916/1650 = 1.16 |

$\overline{X}$ = 1.01 psi/ft

S = 0.09 psi/ft

Attachment #2

| Well #5 WHP | Well #5 Water | Well #13 WHP | Well #13 Water | Well #17 WHP | Well #17 Water | Well #20 WHP | Well #20 Water | Well #23 WHP | Well #23 Water | Well #41 WHP | Well #41 Water | Well #42 WHP | Well #42 Water | Well #4[illegible] WHP | Well #4[illegible] Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 865 | | 1019 | | 1742 | | 2 | | 734 | | 0 | | 0 | | 133 |
| | 904 | | 1088 | | 1802 | | 4 | | 704 | | 0 | | 0 | | 165 |
| | 845 | | 1134 | | 1849 | | 3 | | 841 | | 0 | | 0 | | 145 |
| | 883 | | 1070 | | 1790 | | 1 | | 742 | | 0 | | 0 | | 106 |
| | 892 | | 1087 | | 1816 | | 0 | | 773 | | 0 | | 0 | | 15 |
| | 895 | | 1057 | | 1834 | | 1 | | 765 | | 0 | | 0 | | 61 |
| | 893 | | 1072 | | 1799 | | 2 | | 790 | | 0 | | 0 | | 40 |
| | 862 | | 1062 | | 1757 | | 2 | | 733 | | 0 | | 0 | | 77 |
| | 763 | | 654 | | 1600 | | 15 | | 624 | | 0 | | 0 | | 128 |
| | 926 | | 704 | | 1832 | | 4 | | 831 | | 0 | | 0 | | 120 |
| | 902 | | 695 | | 1819 | | 11 | | 806 | | 0 | | 0 | | 145 |
| | 919 | | 657 | | 1819 | | 4 | | 903 | | 0 | | 0 | | 114 |
| | 904 | | 1087 | | 1841 | | 1 | | 790 | | 0 | | 0 | | 50 |
| | [illegible] | | [illegible] | | [illegible] | | 5 | | [illegible] | | [illegible] | | 0 | | [illegible] |
| [illegible] | 891 | 500 | 147 | 500 | 1849 | 880 | 15 | 580 | 587 | | 0 | | [illegible] | 880 | 1 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | 12 | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | | | | | | | | | | | [illegible] | | [illegible] | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | [illegible] | | [illegible] | [illegible] | |
| | | | | | | | | | | | | | | | |

| #52 | Well #56 | | | | |
|---|---|---|---|---|---|
| WATER | WHP | WATER | | | |
| 492 | | 0 | | | |
| 567 | | 0 | | | |
| 505 | | 0 | | | |
| 461 | | 0 | | | |
| 542 | | 0 | | | |
| 506 | | 0 | | | |
| 532 | | 0 | | | |
| 516 | | 0 | | | |
| 444 | | 0 | | | |
| 590 | | 0 | | | |
| 563 | | 0 | | | |
| 568 | | 0 | | | |
| 533 | | 0 | | | |
| [illegible] | | 0 | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| [illegible] | | [illegible] | | | |
| | | [illegible] | | | |
| | | [illegible] | | | |
| | | [illegible] | | | |
| | | [illegible] | | | $\bar{X}$ = 755 psig |
| | | | | | s = 130 psig |

## FRESH WATER SANDS

Listed below are the sands encountered from surface to 1550' in Sec.12-T17N-R9W, McKinley County, New Mexico which calculate from logs an equivalent chlorides of less than 10,000 ppm.

| Depth | Thickness | Log Porosity | Calculated Total Chlorides |
|---|---|---|---|
| 188'-196' | 8' | 21% | 5500 |
| 270'-308' | 38' | 35% | 1000 |
| 312'-346' | 34' | 33% | 500 |
| 348'-356' | 8' | 38% | <200 |
| 368'-376' | 8' | 38% | <200 |
| 382'-448' | 66' | 36% | <200 |
| 452'-484' | 32' | 38% | <200 |
| 870'-876' | 6' | 25% | 6000 |
| 880'-886' | 6' | 25% | 6000 |
| 908'-920' | 12' | 23% | 6000 |

EXHIBIT 12
Case 6840

STATE OF NEW MEXICO

DEPARTMENT OF ENERGY AND MINERALS

OIL CONSERVATION DIVISION

| | | |
|---|---|---|
| TENNECO OIL COMPANY<br>IN SITU COMBUSTION PILOT<br>PROJECT, McKINLEY COUNTY,<br>NEW MEXICO | §<br>§<br>§<br>§ | Case No. 6890 |

**AFFIDAVIT**

STATE OF NEW MEXICO )
) ss.
COUNTY OF SANTA FE )

I, W. THOMAS KELLAHIN, being first duly sworn upon my oath, state:

1. That I am a licensed New Mexico Attorney.

2. On behalf of Tenneco Oil Company on April 28, 1980, I examined the well records in the Office of the State Engineer, Santa Fe, New Mexico.

3. The records of the State Engineer's Office do not indicate the existence of any fresh water wells drilled in any of the following sections:

T17N, R9W, NMPM

Sections 1, 2, 11, 12, 13, and 14

T17N, R8W, NMPM

Sections 6, 7, and 18

Affiant further sayeth ~~not~~.

W. T. Kellahin

W. THOMAS KELLAHIN
Kellahin & Kellahin
P. O. Box 1769
Santa Fe, New Mexico 87501
Phone: (595) 982-4285

SUBSCRIBED AND SWORN TO before me on this 6th day of May, 1980.

Marilyn Forrest
Notary Public

(seal)

My commission expires:
10-13-80

Exhibit 13
Case 6890

KELLAHIN and KELLAHIN
*Attorneys at Law*
500 Don Gaspar Avenue
Post Office Box 1769
Santa Fe, New Mexico 87501

Jason Kellahin
W. Thomas Kellahin

Karen Aubrey

Telephone 982-4285
Area Code 505

April 17, 1980

Rec'd 2:20 pm 4/17/80 [signature]

Mr. Joe Ramey
Oil Conservation Division
P. O. Box 2088
Santa Fe, New Mexico 87501

re: Tenneco Oil Company
In Situ Combustion Project
South Hospah Field,
McKinley County, NM

Case 6890

Dear Joe:

Please set the enclosed application for hearing on May 7, 1980.

Very truly yours,

Tom

W. Thomas Kellahin

encl.
cc: Mr. Millard Carr
Mr. Brad Fischer
WTK:mmr

STATE OF NEW MEXICO
DEPARTMENT OF ENERGY AND MINERALS
OIL CONSERVATION DIVISION

IN THE MATTER OF THE APPLICATION OF
TENNECO OIL COMPANY FOR APPROVAL OF
A PILOT IN SITU COMBUSTION PROJECT,
INCLUDING WELL-SPACING EXCEPTIONS
FOR INJECTION AND PRODUCING WELLS,
UPPER AND LOWER HOSPAH FORMATIONS,
SOUTH HOSPAH FIELD, McKINLEY COUNTY,
NEW MEXICO.

# APPLICATION

COMES NOW TENNECO OIL COMPANY, by and through its attorneys, KELLAHIN & KELLAHIN, and applies to the Oil Conservation Division of the State of New Mexico for approval of a pilot in situ combustion project for the Upper and Lower Hospah formations of the South Hospah Field, McKinley County, New Mexico and in support thereof would show:

1. Applicant is the operator in both the Upper and Lower Hospah formations of the South Hospah field, McKinley County, New Mexico, including Section 12, T17N, R9W, NMPM.

2. Applicant seeks to initiate a pilot in situ combustion project in each of the two Hospah formations, at a location in Section 12, T17N, R9W, NMPM hereinafter set forth.

3. The South Hospah field is now in its later stages of secondary recovery by waterflood and applicant proposes to determine by the proposed pilot project the feasibility of a tertiary recovery project by in situ combustion. Attached as Exhibit "A" is a plat showing all wells in the area.

4. Applicant proposes to drill a dual injection well at a depth sufficient to penetrate both the Upper and Lower Hospah formations at a location 1474 feet from the North line and 2725 feet from the East Line of Section 12. Said injection well is to be completed

without a packer and as outlined on the wellbore schematic attached as Exhibit "B", which is incorporated by reference herein. Ignition shall be initiated either by the injection of air, methane, water, or an electric ignitor or combination thereof.

5. It is proposed that the pilot project shall include either four or eight producing wells in a pattern as shown on Exhibit "C" attached hereto and incorporated herein by reference. There will not be any commingling of the Upper and Lower Hospah production.

6. The first alternative of four producing wells will include two existing Hospah wells:

(a) Well LH-48, located 1485 feet from the North line and 2817 feet from the East line of Section 12;

(b) Well UH-18, located 1600 feet from the North line and 3100 feet from the West line of Section 12;

and two new producing wells to be located as follows:

(a) Well H-65, located 1350 feet from the North line and 2725 feet from the East line of Section 12;

(b) Well H-66, located 1600 feet from the North line and 2725 feet from the East line of Section 12.

7. The second alternative would be to have eight producing wells, which in addition to the four wells described above would include the following four new producing wells in Section 12:

(a) Well H-67, 1388 feet from the North line, 2825 feet from the East line;

(b) Well H-68, 1387 feet from the North Line, 2637 feet from the East line;

(c) Well H-69, 1575 feet from the North line, 2637 feet from the East line;

(d) Well H-70, 1575 feet from the North line; 2825 feet from the East line;

8. All new producing wells in the pilot project will conform to the welbore schematic attached as Exhibit "D" and incorporated herein.

9. The injection of air, water, or methane into the proposed injection well will be at pressures below that required to fracture the confining strata as shown in Exhibit E attached hereto and incorporated herein by reference.

10. A tabulation of wells within a one-half mile of the injection well, and schematics of all plugged and abandoned wells within one-half mile pursuant to Memo 3-77, are to be found in the case file for Commission Case 5995, Order R-5506, dated August 9, 1977, attached hereto as Exhibit "F" and incorporated by reference.

11. The proposed pilot project as outlined in Exhibit "H" attached hereto and incorporated herein by reference will not present a risk of contamination of fresh-water sources in the area, will not impair the correlative rights of others, will be in the best interests of conservation, will determine the feasibility of an in-situ combustion project for these formations, will not cause waste.

WHEREFORE, Applicant seeks approval for this application for a pilot in situ combustion project in the Lower and Upper Hospah formations of the South Hospah field, McKinley County, including but not limited to authority to:

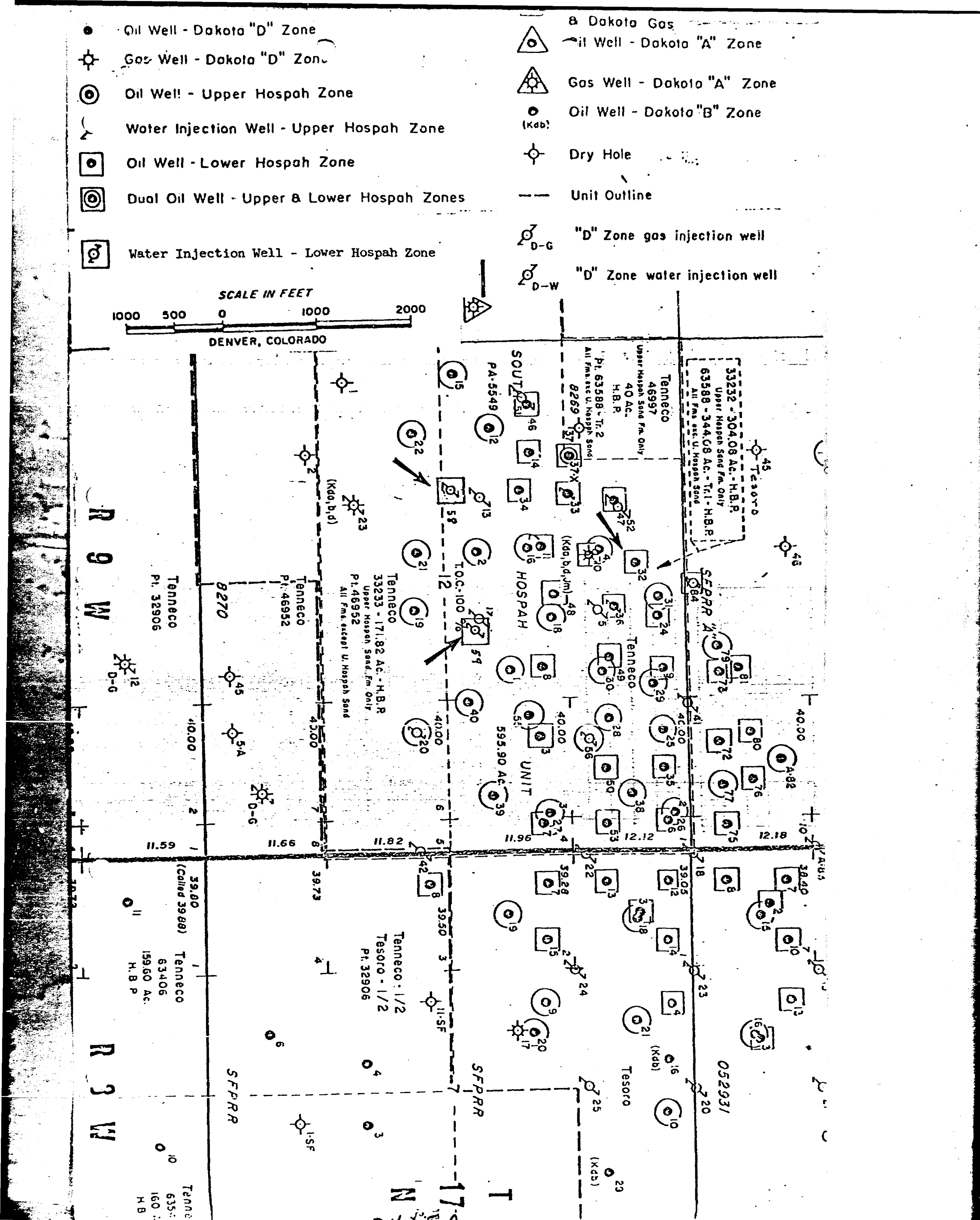
(a) to drill and complete the injection well at the proposed location and method of completion; and,

(b) to approve the drilling and spacing of the proposed production wells; and,

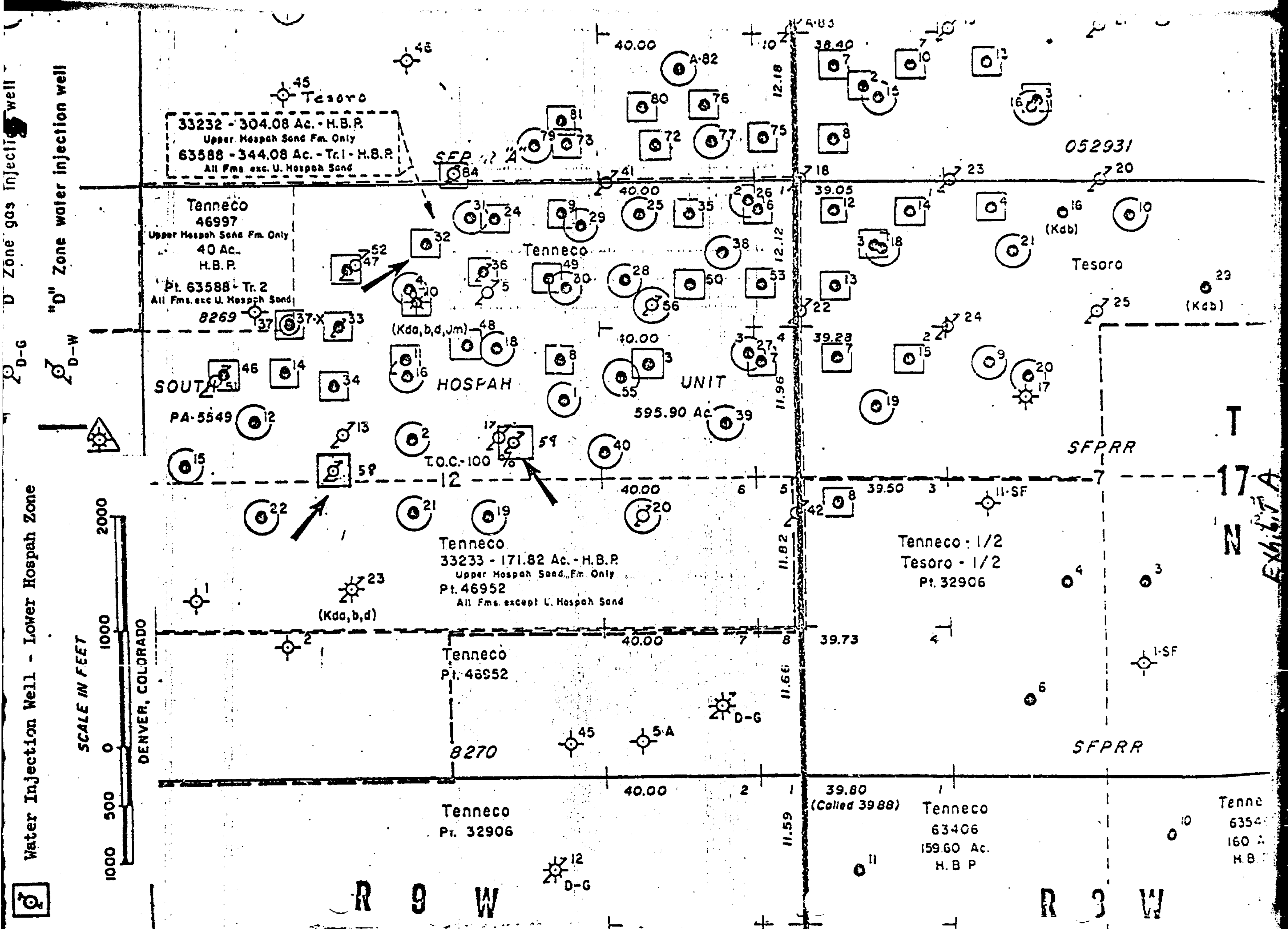
(c) such additional authority and approval as may be required to implement the proposed project.

TENNECO OIL COMPANY

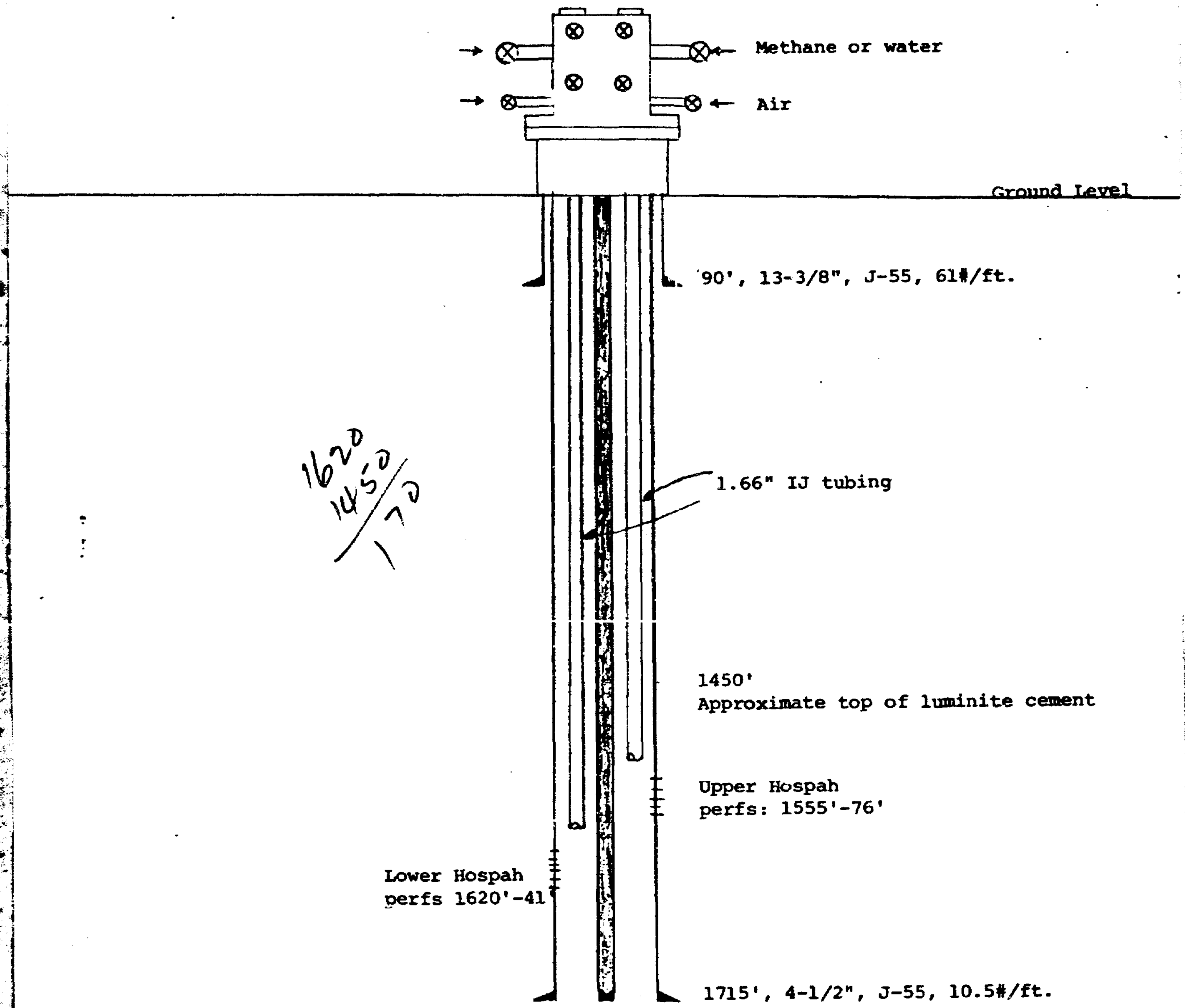
By [signature]
W. Thomas Kellahin
Kellahin & Kellahin
P. O. Box 1769
Santa Fe, New Mexico 87501
(505) 982-4285
ATTORNEYS FOR APPLICANT



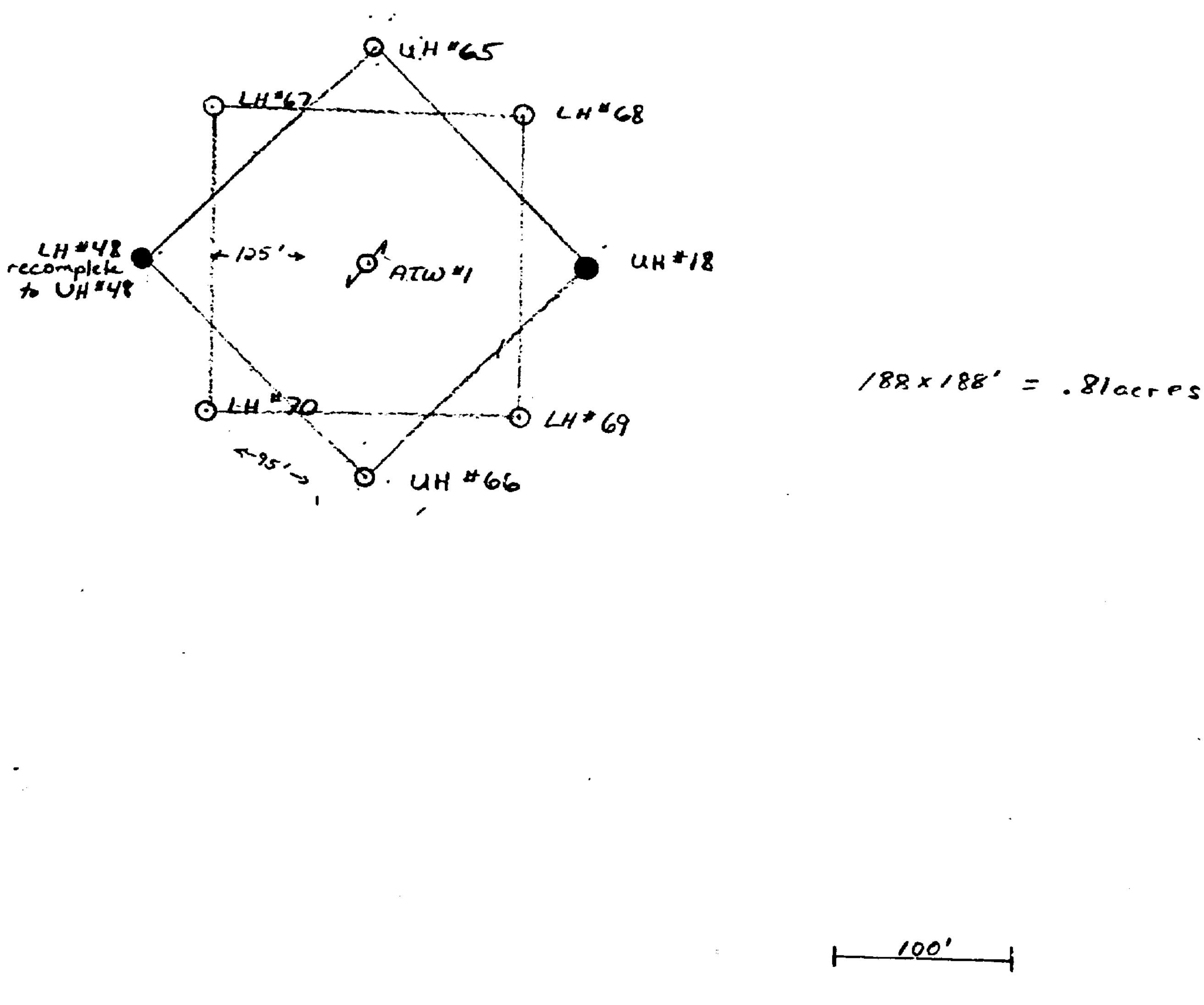
Oil Well - Dakota "D" Zone
Gas Well - Dakota "D" Zone
Oil Well - Upper Hospah Zone
Water Injection Well - Upper Hospah Zone
Oil Well - Lower Hospah Zone
Dual Oil Well - Upper & Lower Hospah Zones
Water Injection Well - Lower Hospah Zone
& Dakota Gas
Oil Well - Dakota "A" Zone
Gas Well - Dakota "A" Zone
Oil Well - Dakota "B" Zone
(Kdb)
Dry Hole
Unit Outline
D-G
"D" Zone gas injection well
D-W
"D" Zone water injection well
SCALE IN FEET
1000 500 0 1000 2000
DENVER, COLORADO
R 9 W
R 3 W
SOUTH HOSPAH UNIT
595.90 Ac.
T.O.C. 100 %
Tenneco
46997
40 Ac.
H.B.P.
Tenneco
Pt. 46952
Tenneco
33233 - 171.82 Ac. - H.B.P.
Tenneco
Pt. 32906
Tesoro
SFPRR "A"
Tenneco
63406
159.60 Ac.
H.B.P.
Tenneco - 1/2
Tesoro - 1/2
Pt. 32906
SFPRR
Tesoro
052931
8270
8269


"D" Zone gas injection well
"D" Zone water injection well
Water Injection Well - Lower Hospah Zone
SCALE IN FEET
DENVER, COLORADO
33232 - 304.08 Ac. - H.B.P.
Upper Hospah Sand Fm. Only
63588 - 344.08 Ac. - Tr.1 - H.B.P.
All Fms. exc. U. Hospah Sand
Tesoro
Tenneco
46997
Upper Hospah Sand Fm. Only
40 Ac.
H.B.P.
Pt. 63588 - Tr. 2
All Fms. exc U. Hospah Sand
SOUTH HOSPAH UNIT
595.90 Ac.
PA-5549
T.O.C.-100 %
Tenneco
33233 - 171.82 Ac. - H.B.P.
Upper Hospah Sand Fm. Only
Pt. 46952
All Fms. except U. Hospah Sand
Tenneco
Pt. 46952
Tenneco
Pt. 32906
Tenneco - 1/2
Tesoro - 1/2
Pt. 32906
Tenneco
63406
159.60 Ac.
H.B.P.
052931
SFPRR
T 17 N
R 9 W
R 8 W
(Called 39.88)
Exhibit A

WELLBORE SCHEMATIC - AIR INJECTION WELL

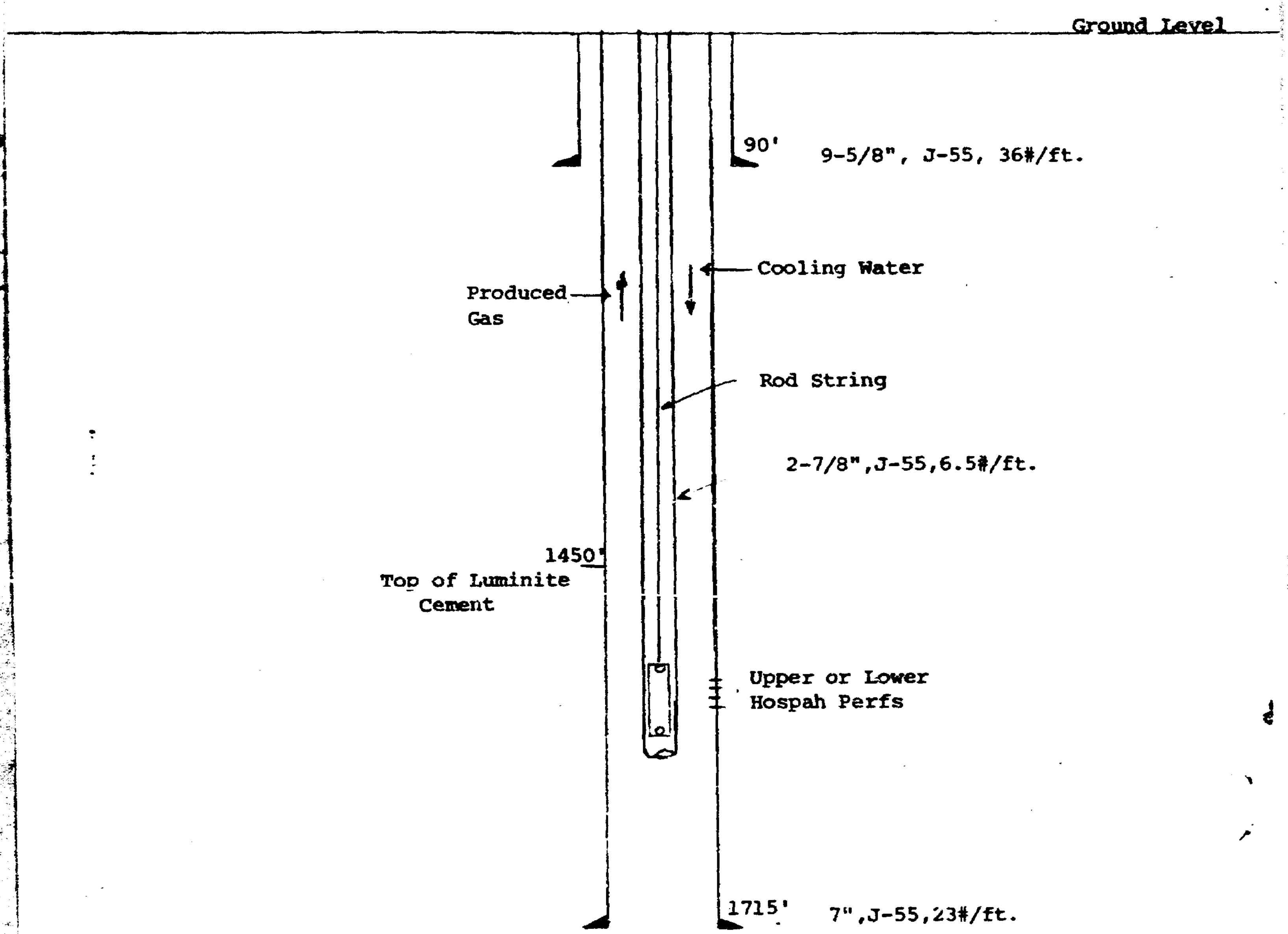


HOSPAH COMBUSTION
PILOT




C

WELLBORE SCHEMATIC - PRODUCING WELL



**Tenneco Oil**
A Tenneco Company

Suite 1200
Lincoln Tower Building
Denver, Colorado 80203
(303) 292-9920

July 27, 1977

Mr. Tom Kellahin
Kellahin and Fox
P.O. Box 1769
500 Don Gaspar Avenue
Santa Fe, New Mexico 87501

Dear Tom:

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In this matter Fracture Gradient was considered to be hydrostatic pressure plus initial shut-in pressure divided by the depth to mid-perforation, or

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

I am also enclosing a copy of actual daily rates and month-end pressures for Upper Hospah injection wells observed during May, 1977. As can be seen average wellhead pressure is $\pm$ 750 psig. If you foresee the N.M.O.C.C. rules pertaining to wellhead pressure adversely affecting our Hospah operations I would appreciate hearing your opinion as soon as possible.

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$$F.G. = \frac{(804 - 25) + 693}{1600} = 0.92 \text{ psi/ft}$$

Such a pressure would fall within the likely operating pressure range for the Upper Hospah Sand and may require reducing the desired 1000 BWPD rate.

As I see it the main problem with high injection wellhead pressure is vertical fracturing downward into the Lower Hospah Sand, located some 30' below the base of the Upper Sand.

Very truly yours,

Brad W. Fischer
Sr. Production Engineer

BWF:cam

Attachments

cc: Millard Carr

E

ATTACHMENT #1

Calculation of Fracture Gradients in the Upper Hospah Sand, Sec. 12-17N-9W, South Hospah Field, McKinley County, New Mexico, using data collected from well stimulation reports and assuming

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

| Well | $P_H$, psig | ISIP, psig | F.G., psi/ft |
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| 39 | 696 | 1000 | 1696/1605 = 1.06 |
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| 42 | 716 | 1200 | 1916/1650 = 1.16 |

$\overline{X}$ = 1.01 psi/ft

S = 0.09 psi/ft

Attachment #2

| Well #5 WHP | Well #5 Water | Well #13 WHP | Well #13 Water | Well 17 WHP | Well 17 Water | Well #20 WHP | Well #20 Water | Well #23 WHP | Well #23 Water | Well #41 WHP | Well #41 Water | Well #42 WHP | Well #42 Water | Well #43 WHP | Well #43 Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 865 | | 1019 | | 1740 | | 3 | | 734 | | 0 | | 0 | | 133 |
| | 904 | | 1088 | | 1802 | | 4 | | 804 | | 0 | | 0 | | 165 |
| | 845 | | 1134 | | 1849 | | 3 | | 841 | | 0 | | 0 | | 145 |
| | 883 | | 1070 | | 1790 | | 1 | | 742 | | 0 | | 0 | | 106 |
| | 892 | | 1087 | | 1816 | | 0 | | 773 | | 0 | | 0 | | 15 |
| | 885 | | 1058 | | 1804 | | 1 | | 765 | | 0 | | 0 | | 61 |
| | 893 | | 1072 | | 1799 | | 2 | | 790 | | 0 | | 0 | | 40 |
| | 863 | | 1062 | | 1757 | | 2 | | 733 | | 0 | | 0 | | 77 |
| | 763 | | 654 | | 1600 | | 15 | | 624 | | 0 | | 0 | | 128 |
| | 926 | | 704 | | 1832 | | 4 | | 831 | | 0 | | 0 | | 120 |
| | 902 | | 680 | | 1819 | | 11 | | 806 | | 0 | | 0 | | 145 |
| | 919 | | 657 | | 1819 | | 4 | | 803 | | 0 | | 0 | | 114 |
| | 904 | | 1087 | | 1841 | | 1 | | 790 | | 0 | | 0 | | 50 |
| | 795 | | 1023 | | 1629 | | 5 | | 710 | | 0 | | 0 | | 30 |
| 720 | 891 | 500 | 1147 | 500 | 1849 | 870 | 15 | 880 | 588 | | 0 | | 0 | 800 | 1 |
| | [illegible] | | [illegible] | | 1735? | | 2 | | 727? | | 0 | | 0 | | 0 |
| | [illegible] | | 433? | | [illegible] | | 1 | | 192? | | 0 | | 0 | | 1 |
| | [illegible] | | 830? | | [illegible] | | 20? | | 651 | | 0 | | 0 | | [illegible] |
| | 764 | | 1047? | | 1775? | | 13 | | 196 | | 0 | | 0 | | 1 |
| | [illegible] | | [illegible] | | [illegible] | | 8? | | 51 | | 0 | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | 0 |
| | | | [illegible] | | [illegible] | | 13? | | 65? | | 0 | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 27? | | 0 | | [illegible] | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | 9? | | 30 | | 0 | | 0 | | 3? |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 71? | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | 0 |
| | | | | | | | | | | | 0 | | 0 | | |
| | | | | | | | | | | | 0 | | 0 | | |
| | | | | | | | | | | | 0 | | 0 | | |
| [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | 0 | | 0 | 800 | |

E K

| Well #52 WHP | Well #52 Water | Well #56 WHP | Well #56 Water | | | |
|---|---|---|---|---|---|---|
| | 492 | | 0 | | | |
| | 507 | | 0 | | | |
| | 505 | | 0 | | | |
| | 461 | | 0 | | | |
| | 542 | | 0 | | | |
| | 506 | | 0 | | | |
| | 532 | | 0 | | | |
| | 516 | | 0 | | | |
| | 444 | | 0 | | | |
| | 570 | | 0 | | | |
| | 563 | | 0 | | | |
| | 568 | | 0 | | | |
| | 533 | | 0 | | | |
| | [illegible] | | [illegible] | | | |
| 410 | 575 | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | [illegible] | | [illegible] | | | |
| | | | [illegible] | | | |
| | | | [illegible] | | | |
| | | | [illegible] | | | |
| [illegible] | | | [illegible] | | | $\overline{X}$ = 755 psig |
| | | | | | | s = 130 psig |
| | | | | | | |

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. 5995
Order No. R-5506

APPLICATION OF TENNECO OIL COMPANY
FOR DUAL COMPLETIONS AND WATERFLOOD
EXPANSIONS, McKINLEY COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on July 20, 1977, at Santa Fe, New Mexico, before Examiner Richard L. Stamets.

NOW, on this 9th day of August, 1977, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, 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, Tenneco Oil Company, seeks authority to expand its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones through parallel strings of tubing.

(3) That the applicant proposes to complete said Hospah Unit Wells Nos. 58 and 59 with parallel strings of tubing, packers set immediately above the injection intervals, and provide for testing to determine any leakage of the tubing, casing or upper packers.

(4) That the mechanics of the proposed dual completions are feasible and in accordance with good conservation practices.

(5) That before injection into either of said wells should begin, the applicant should consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata.

F

(6) That the operator should take all steps necessary to ensure that the injected water enters only the proposed injection interval and is not permitted to escape to other formations or onto the surface.

(7) That approval of the subject application will prevent the drilling of unnecessary wells and otherwise prevent waste and protect correlative rights.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby granted authority to expend its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones.

PROVIDED HOWEVER, that each of said wells shall be equipped with parallel strings of 2 1/16-inch tubing, packers set immediately above each injection zone, and that the casing-tubing annulus shall be filled with an inert fluid; and that a pressure gauge shall be attached to the annulus or the annulus shall be equipped with an approved leak detection device in order to determine leakage in the casing, tubing, or packer.

(2) That prior to commencing injection into either of the subject wells, the operator shall consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata in said projects.

(3) That the injection wells or systems shall be equipped with pop-off valves or acceptable substitutes which will limit the wellhead pressure on the injection wells to a pressure no higher than that determined pursuant to Order No. (2) above.

(4) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

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

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

PHIL R. LUCERO, Chairman

EMERY C. ARNOLD, Member

JOE D. RAMEY, Member & Secretary

S E A L
jr/

# DISCUSSION

## FIELD HISTORY

The South Hospah field is located in McKinley County, New Mexico (Section 12, T17N-R9W), approximately 120 miles south of Farmington. The field is in the Chaco Slope region of the San Juan Basin. The Upper Hospah was discovered in 1965. Tenneco purchased the property in September, 1966 and began developing the Upper Hospah during 1967. Production of the Lower Hospah began in April, 1967.

The Upper Hospah reservoir performed as a pressure depletion drive (since solution gas was negligible). Graph No. 1 depicts the steep production decline experienced under this drive mechanism. Because of a very low expected primary recovery, a waterflood was initiated in the reservoir in June, 1968. The response to water injection can be seen very vividly on Graph No. 1. Figure No. 1 shows the Upper Hospah Unit, with the current well locations. The injection scheme developed into a fairly irregular pattern, with an average well spacing of 10 acres. Currently, the Unit has 20 active producers and 10 active water injection wells. Production averages 180 BOPD and 4700 BWPD, resulting in a field oil cut of 3.7%. Water injection is about 4700 BPD. The Upper Hospah Unit was classified as stripper in September, 1979.

The Lower Hospah reservoir has an active aquifer and mobile water at original saturations, as exhibited on Graph No. 2 as very early water production. The crude from the Lower Hospah is fairly viscous, 55 cp. at reservoir temperature, and contributes to an unfavorable water-oil mobility ratio. An attempt to improve the mobility ratio and, thereby, increase the recovery was initiated in September, 1972, when a simultaneous gas-water injection project began. The basic goal of the process was for the gas to swell the oil and reduce the oil viscosity, improving the mobility ratio. Water would then be able to displace

Exhibit H

the oil more effectively. Gas injection was expensive due to a number of operational problems (gas-locking of pumps, emulsion treating, and venting the casing) and was discontinued for a period of time during 1976. When no negative production effects were seen, it was decided to terminate gas injection completely; however, water injection has continued to the present. Figure 2 shows there are 26 active producers and 11 active injectors. Average production is 720 BOPD and 21,400 BWPD (a field oil cut of 3.25%), with water injection of 21,200 BPD.

As seen on Graph 2, response to water injection in the Lower Hospah was not as dramatic as that of the Upper Hospah. The waterflood was considered effective, because of the abatement of the apparent production decline after 1973. The large production increase exhibited in 1977 and 1978 was a result of the deepening of 11 wells, the drilling of 4 infill wells, and increased lift capacity in many of the producers.

## GEOLOGY

The Upper Hospah sand is composed of 3-4 major stringers separated by thin shale beds. The type log labeled Figure 3 shows these members. The Upper Hospah is a marine sand bar deposit with areas of poorer rock type due to channeling. Directional permeability is oriented along a northeast to southwest line. The productive limits are defined by a fault along the northwest and a decrease in rock permeability to the east and south (areas proven as non-productive). The structure is fairly simple and flat. The structure map presented as Figure 4 shows the dip is approximately 1°.

The Lower Hospah sand is a blanket sand deposit. Productive limits are defined by the fault on the northwest flank and the original oil-water contact at ± 5,375'. The aquifer is active, tilted 25-30 feet and encountered by every well in the field. The structure is fairly flat, with a dip of 1° (see Figure 5).

EOR PROCESS DESCRIPTIONS

Because of the reservoir and fluid factors discussed previously and the results of laboratory core tests, in situ combustion, steamflooding, and micro-emulsion flooding were evaluated for application to the Lower Hospah.

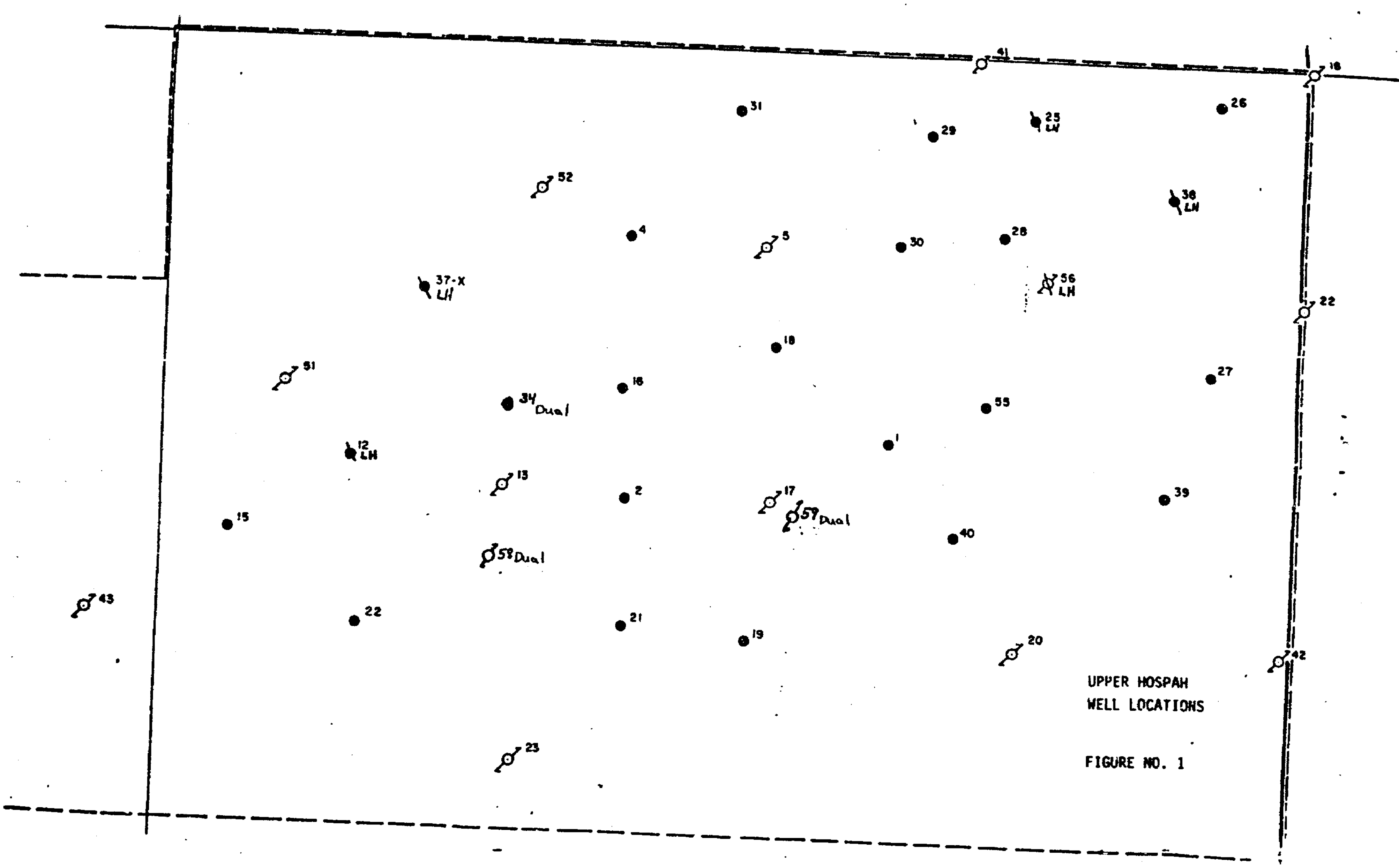
In situ combustion involves the injection of air into the reservoir; the mechanical, chemical, or spontaneous ignition of the oil in the reservoir; and the continued injection of air and combustion of a fraction of the oil in the reservoir. The fraction of crude that provides the fuel is called coke, the heavier ends of the crude deposited on the formation as a result of the heat of combustion vaporizing the lighter ends. The vaporization of the lighter ends, steam generated from formation water, and the gases generated as products of combustion reduce the oil viscosity and provide the driving force to enhance the oil recovery. Oil is not only swept from the area immediately ahead of the burn front, but 40% or more of the oil outside of the swept area is affected by the heat and recovered. Temperatures in the burn front usually are in the range of 700-1200°F. The various regions in the reservoir are depicted in the cross-section on Figure 6. The burned region behind the burn front is 100% air-saturated, leaving no residual oil behind. A large amount of heat remains in this burned region to eventually dissipate to the base and cap rock. The efficiency of this system can be improved by scavenging this heat through the injection of water. When water and air are simultaneously or alternately injected, the water flashes to steam near the injection well, superheated steam traverses the burn front, and this steam aids in the viscosity reduction and distillation of oil ahead of the burn front. Optimum "wet combustion" displaces most of the excess heat from behind the burn front to the

oil bank and results in a two-thirds reduction in air requirements over dry combustion and a considerable reduction in fuel consumption. Obviously, both reductions serve to improve the process recovery and economics. One such process that was proven effective is the COFCAW process (Combination of Forward Combustion and Waterflooding).

ECONOMIC DEVELOPMENT

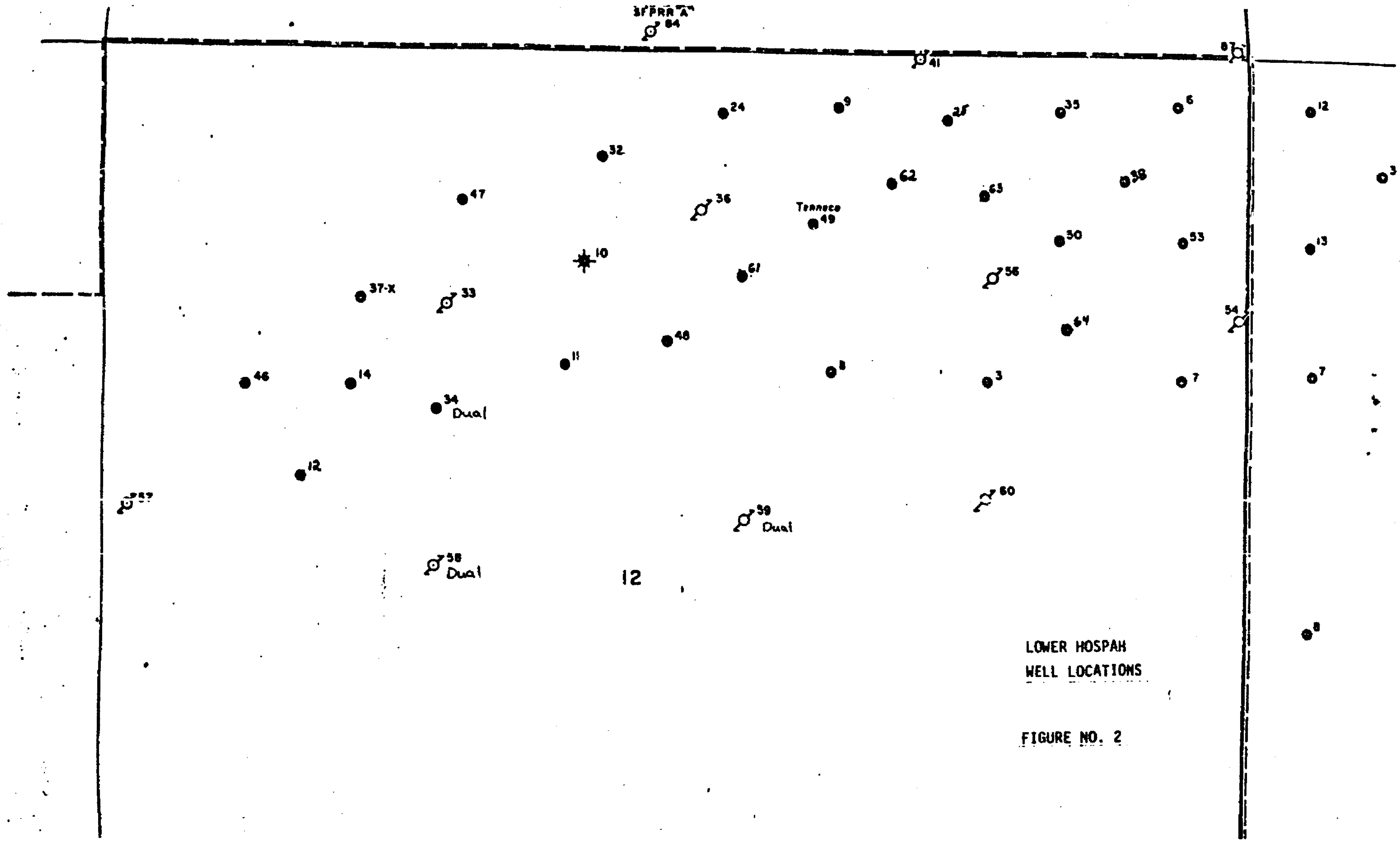
Table No. 10 presents the general economic parameters that apply to all processes. All economic evaluations were performed using only the incremental tertiary production, the capital expenditures to get that production, and the O&M expense applicable only to the EOR operation. Incremental tertiary oil (projected EOR response less the remaining secondary production) enjoys market incentive prices which were $32/BO at 1/1/80. A 50% excise tax was imposed resulting in a net price of $24/BO. Pattern development was assumed to begin the second quarter of 1980. As a 5-spot or set of patterns developed, it was assumed the injection plant would be available for injection in the completed areas. Recoupment of allowable expenditures occurs in the quarter the expenditure is made and no recoupment was credited after October 1, 1981 (when all oil is assumed decontrolled).

The DOE has passed a ruling which will allow operators of certain EOR projects begun after Sepember 30, 1979, to recoup 75% of certain capital expenditures involved with that project. The recoupment process involves the release of enough Lower Tier oil to Upper Tier prices to cover the recoupable amount. The allowable recoupment can be taken whether the project is a success or not. The purpose behind this ruling is to help operators defray the larger front-end capital expenditures mandated by most EOR projects; thereby, making these projects economically attractive so that more projects will be initiated and the U.S. dependence on imported crude might be decreased.



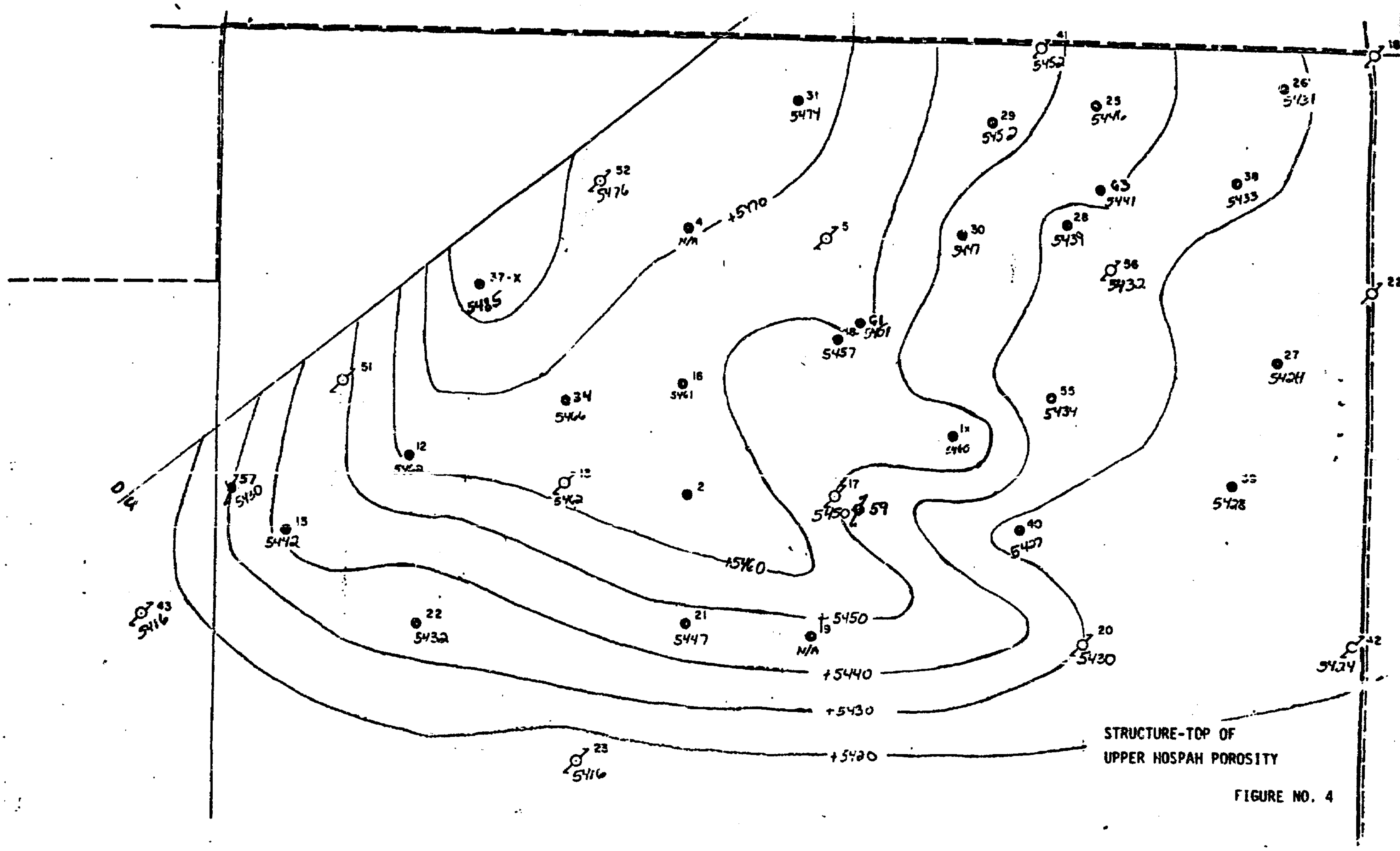

UPPER HOSPAH
WELL LOCATIONS

FIGURE NO. 1




LOWER HOSPAH
WELL LOCATIONS

FIGURE NO. 2




STRUCTURE-TOP OF
UPPER HOSPAH POROSITY

FIGURE NO. 4

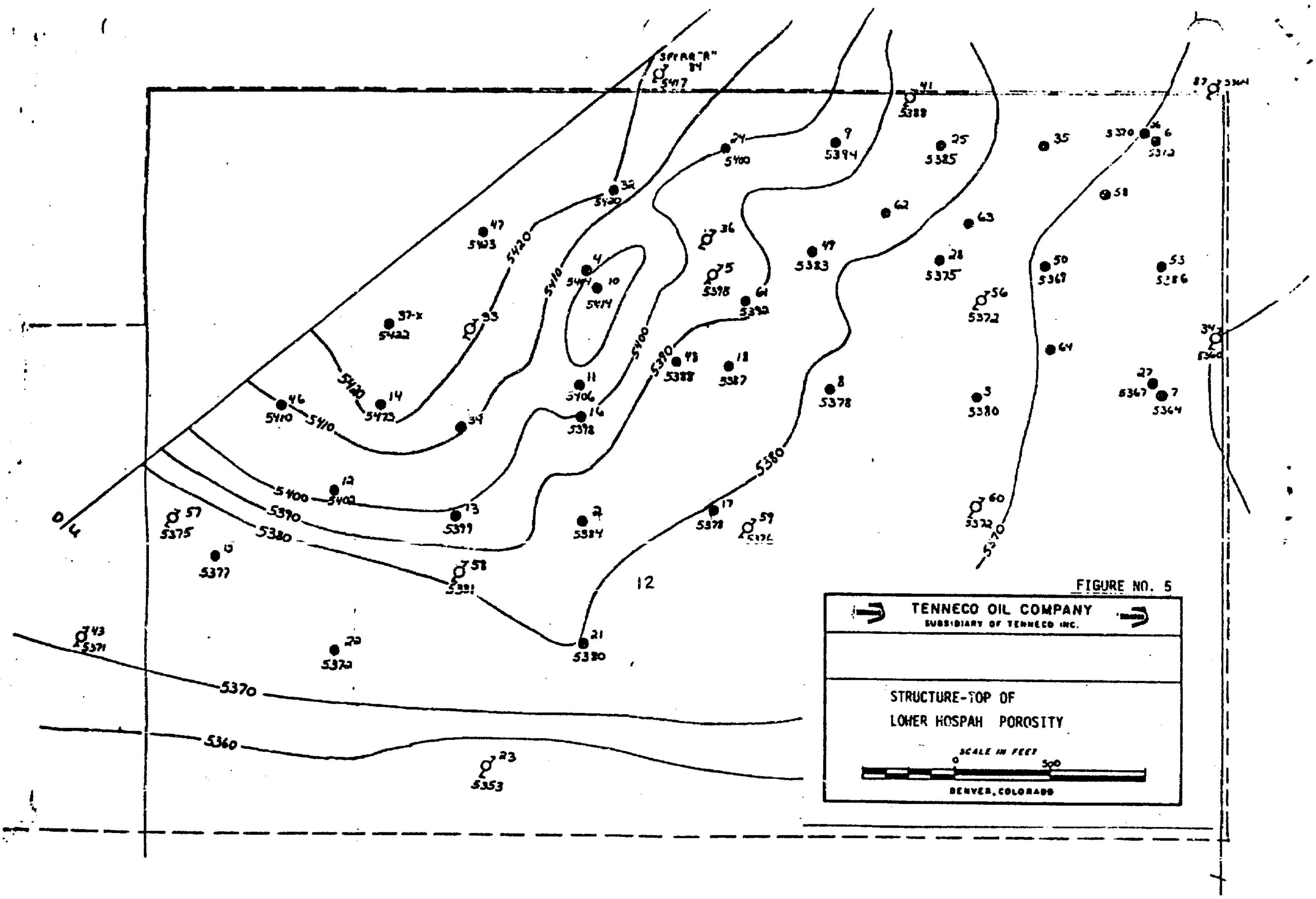
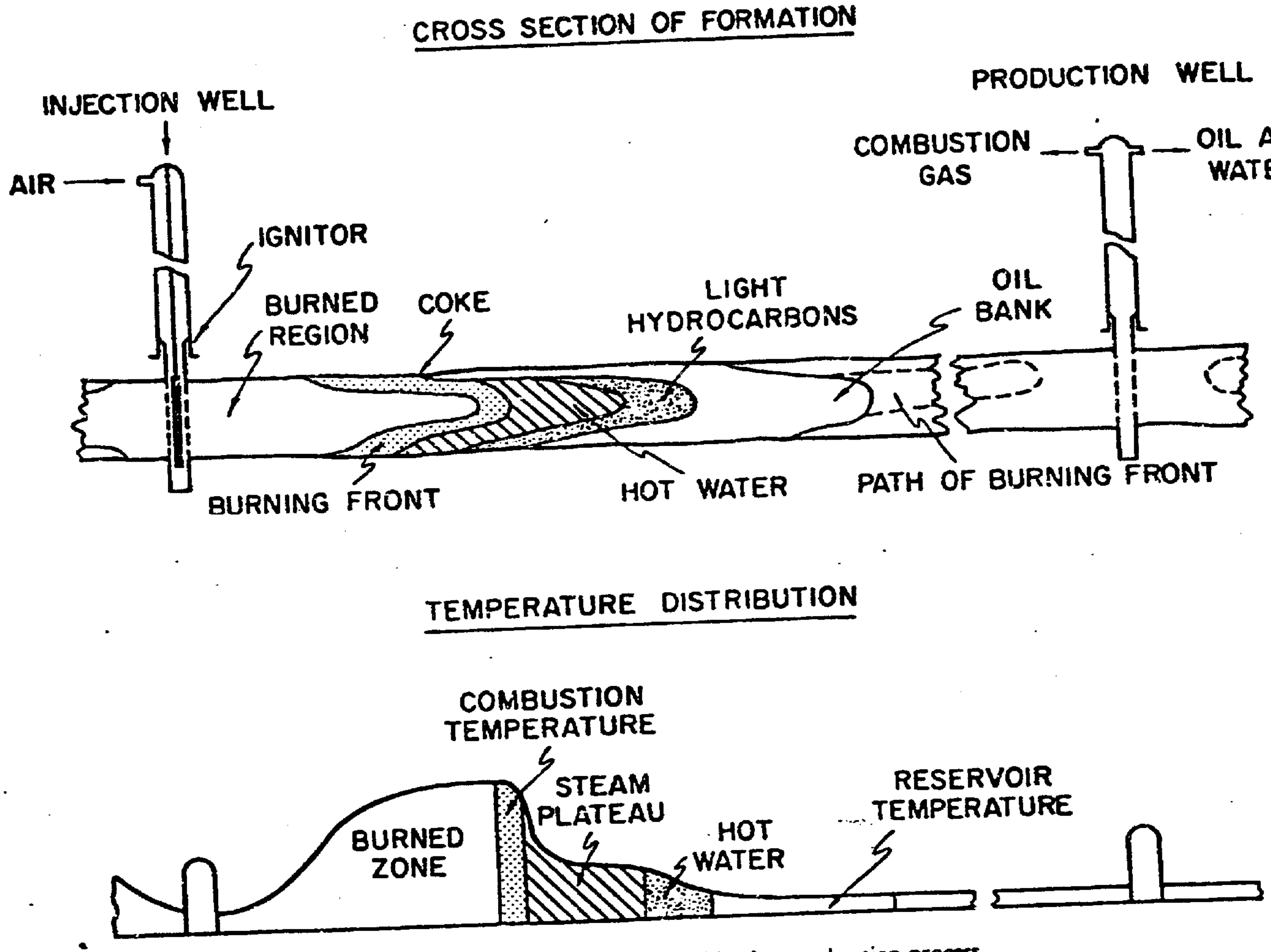

TENNECO OIL COMPANY
SUBSIDIARY OF TENNECO INC.
STRUCTURE-TOP OF
LOWER HOSPAH POROSITY
SCALE IN FEET
0
500
DENVER, COLORADO
12
5420
5410
5400
5390
5380
5370
5360

FIGURE NO. 5




Schematic diagram of in situ combustion process.

FIGURE NO. 6

(reprinted from Ref. No. 12)

Rec'd 4:20 pm 4/17/80

STATE OF NEW MEXICO
DEPARTMENT OF ENERGY AND MINERALS
OIL CONSERVATION DIVISION

IN THE MATTER OF THE APPLICATION OF TENNECO OIL COMPANY FOR APPROVAL OF A PILOT IN SITU COMBUSTION PROJECT, INCLUDING WELL-SPACING EXCEPTIONS FOR INJECTION AND PRODUCING WELLS, UPPER AND LOWER HOSPAH FORMATIONS, SOUTH HOSPAH FIELD, McKINLEY COUNTY, NEW MEXICO.

Case 6890

## APPLICATION

COMES NOW TENNECO OIL COMPANY, by and through its attorneys, KELLAHIN & KELLAHIN, and applies to the Oil Conservation Division of the State of New Mexico for approval of a pilot in situ combustion project for the Upper and Lower Hospah formations of the South Hospah Field, McKinley County, New Mexico and in support thereof would show:

1. Applicant is the operator in both the Upper and Lower Hospah formations of the South Hospah field, McKinley County, New Mexico, including Section 12, T17N, R9W, NMPM.

2. Applicant seeks to initiate a pilot in situ combustion project in each of the two Hospah formations, at a location in Section 12, T17N, R9W, NMPM hereinafter set forth.

3. The South Hospah field is now in its later stages of secondary recovery by waterflood and applicant proposes to determine by the proposed pilot project the feasibility of a tertiary recovery project by in situ combustion. Attached as Exhibit "A" is a plat showing all wells in the area.

4. Applicant proposes to drill a dual injection well at a depth sufficient to penetrate both the Upper and Lower Hospah formations at a location 1474 feet from the North line and 2725 feet from the East Line of Section 12. Said injection well is to be completed

without a packer and as outlined on the wellbore schematic attached as Exhibit "B", which is incorporated by reference herein. Ignition shall be initiated either by the injection of air, methane, water, or an electric ignitor or combination thereof.

5. It is proposed that the pilot project shall include either four or eight producing wells in a pattern as shown on Exhibit "C" attached hereto and incorporated herein by reference. There will not be any commingling of the Upper and Lower Hospah production.

6. The first alternative of four producing wells will include two existing Hospah wells:

(a) Well LH-48, located 1485 feet from the North line and 2817 feet from the East line of Section 12;

(b) Well UH-18, located 1600 feet from the North line and 3100 feet from the West line of Section 12;

and two new producing wells to be located as follows:

(a) Well H-65, located 1350 feet from the North line and 2725 feet from the East line of Section 12;

(b) Well H-66, located 1600 feet from the North line and 2725 feet from the East line of Section 12.

7. The second alternative would be to have eight producing wells, which in addition to the four wells described above would include the following four new producing wells in Section 12:

(a) Well H-67, 1388 feet from the North line, 2825 feet from the East line;

(b) Well H-68, 1387 feet from the North Line, 2637 feet from the East line;

(c) Well H-69, 1575 feet from the North line, 2637 feet from the East line;

(d) Well H-70, 1575 feet from the North line; 2825 feet from the East line;

8. All new producing wells in the pilot project will conform to the welbore schematic attached as Exhibit "D" and incorporated herein.

9. The injection of air, water, or methane into the proposed injection well will be at pressures below that required to fracture the confining strata as shown in Exhibit E attached hereto and incorporated herein by reference.

10. A tabulation of wells within a one-half mile of the injection well, and schematics of all plugged and abandoned wells within one-half mile pursuant to Memo 3-77, are to be found in the case file for Commission Case 5995, Order R-5506, dated August 9, 1977, attached hereto as Exhibit "F" and incorporated by reference.

11. The proposed pilot project as outlined in Exhibit "H" attached hereto and incorporated herein by reference will not present a risk of contamination of fresh-water sources in the area, will not impair the correlative rights of others, will be in the best interests of conservation, will determine the feasibility of an in-situ combustion project for these formations, will not cause waste.

WHEREFORE, Applicant seeks approval for this application for a pilot in situ combustion project in the Lower and Upper Hospah formations of the South Hospah field, McKinley County, including but not limited to authority to:

(a) to drill and complete the injection well at the proposed location and method of completion; and,

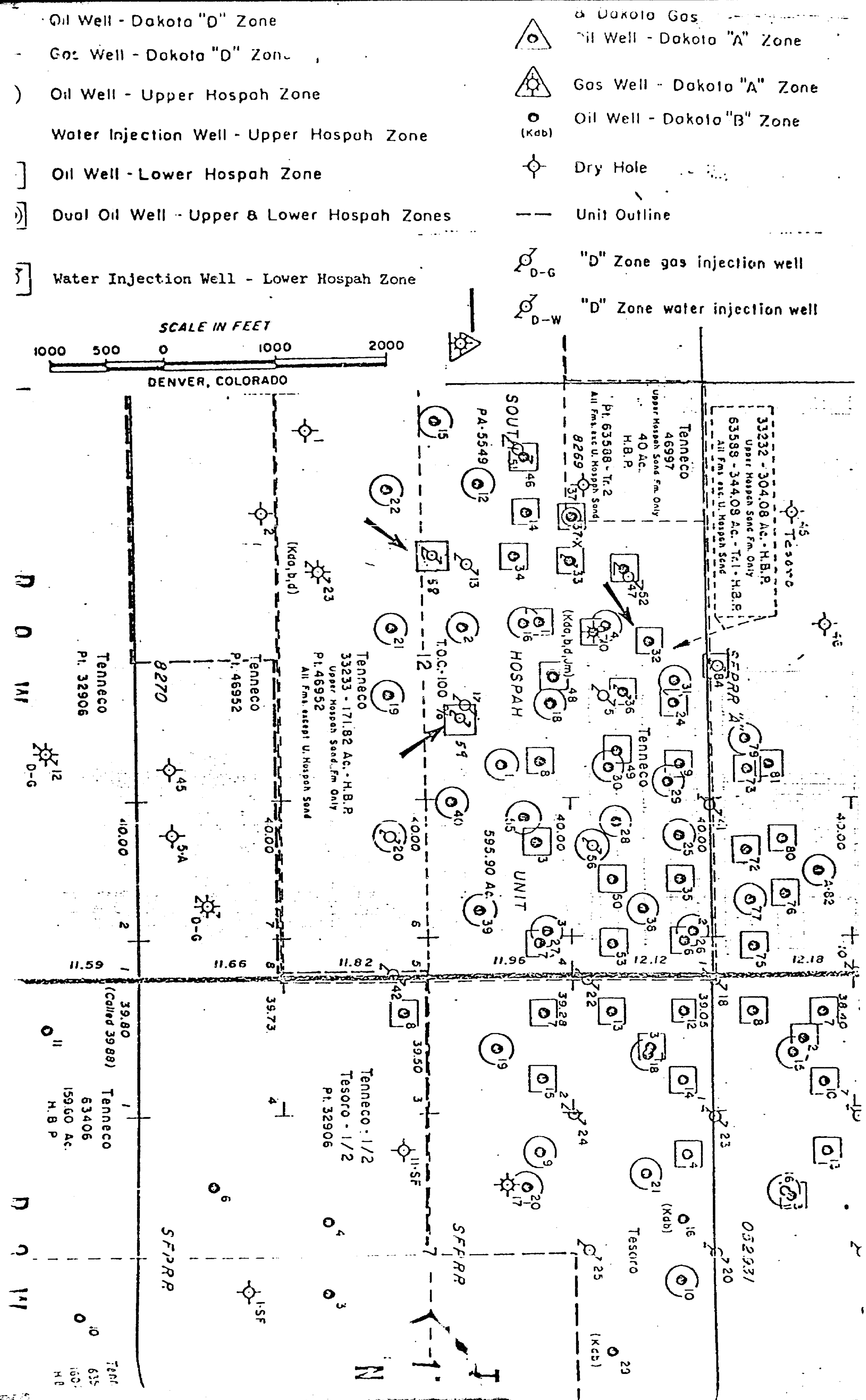
(b) to approve the drilling and spacing of the proposed production wells; and,

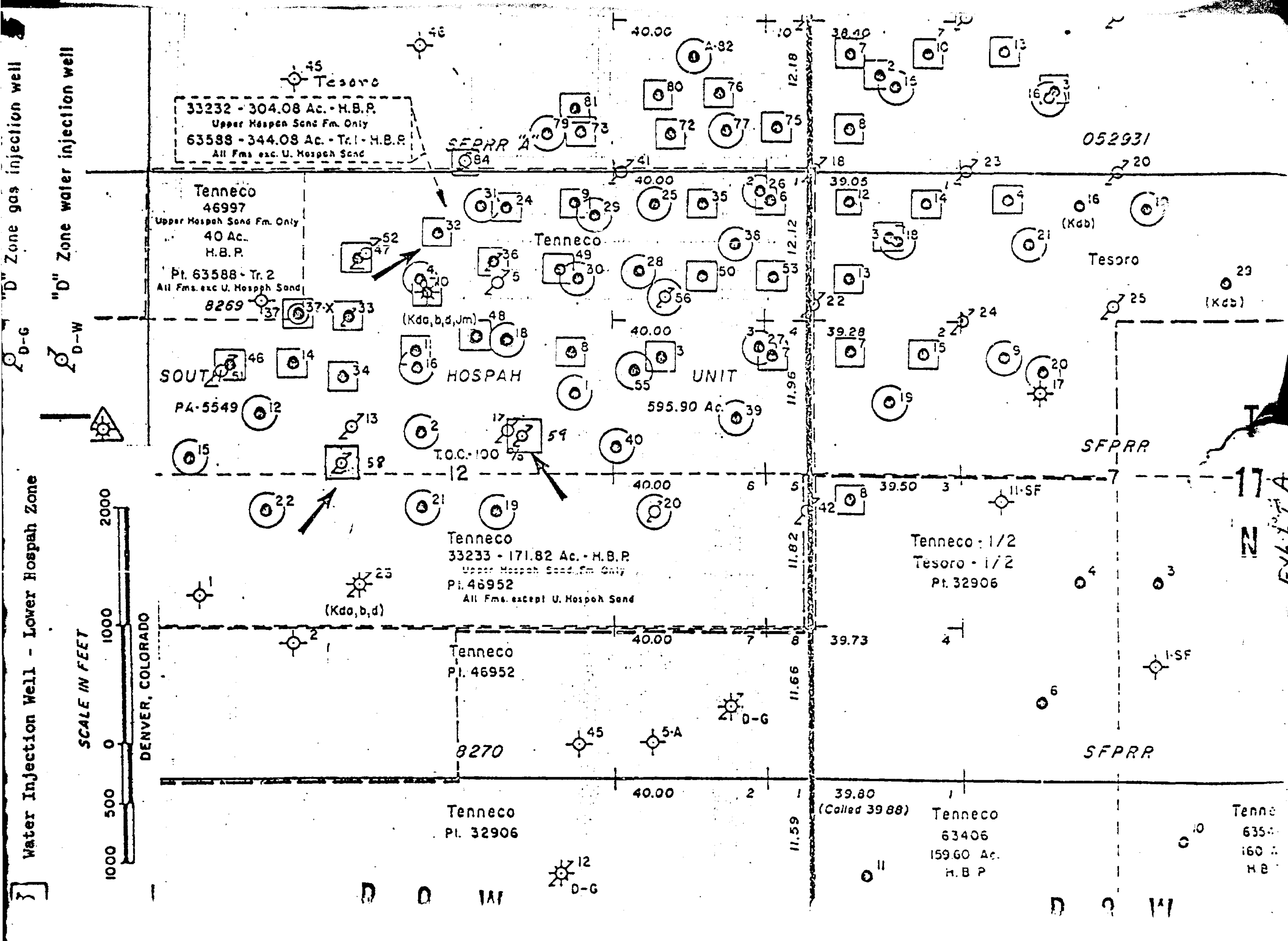
(c) such additional authority and approval as may be required to implement the proposed project.

TENNECO OIL COMPANY

By [signature]

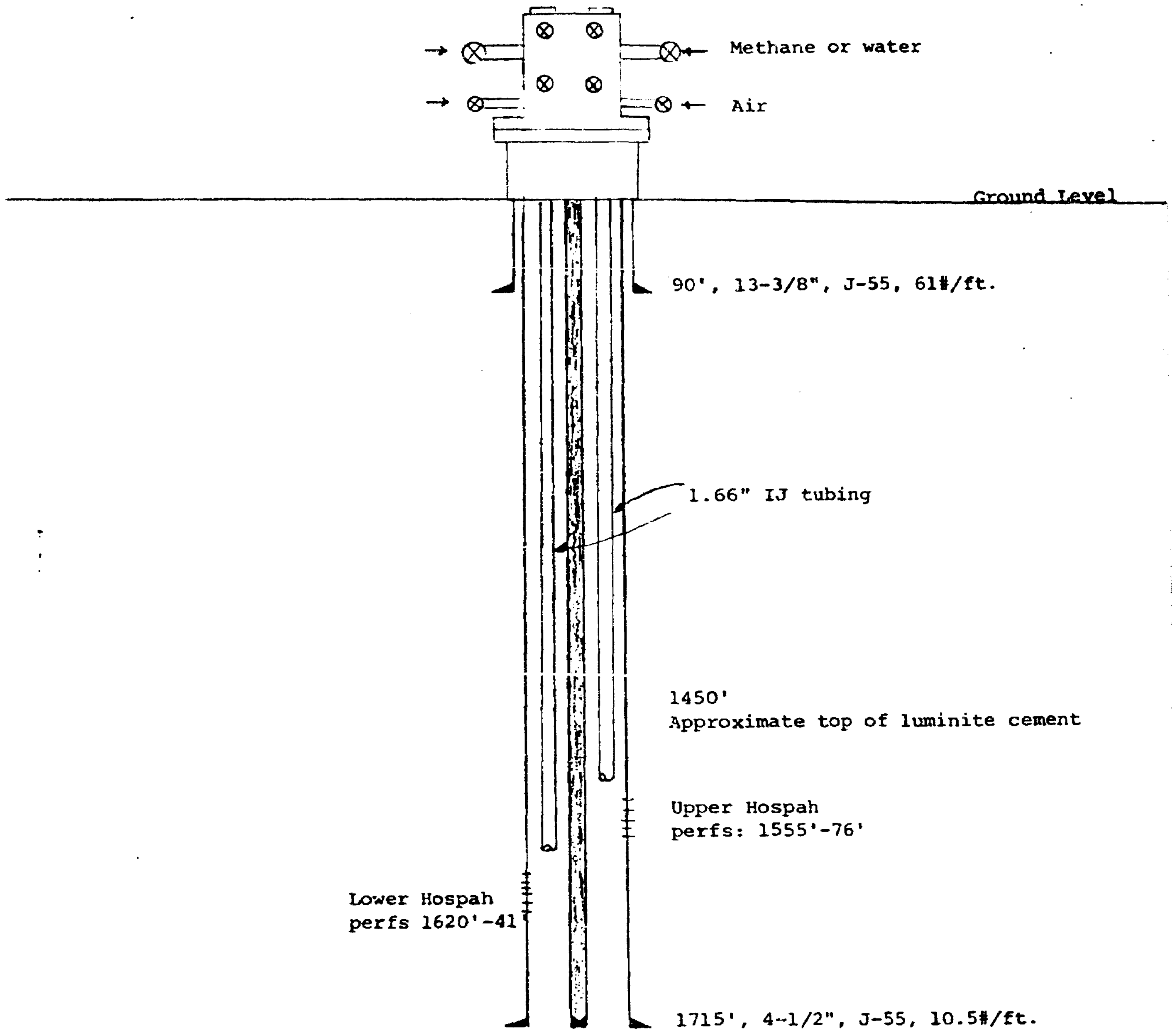
W. Thomas Kellahin
Kellahin & Kellahin
P. O. Box 1769
Santa Fe, New Mexico 87501
(505) 982-4285
ATTORNEYS FOR APPLICANT


Oil Well - Dakota "D" Zone
Gas Well - Dakota "D" Zone
Oil Well - Upper Hospah Zone
Water Injection Well - Upper Hospah Zone
Oil Well - Lower Hospah Zone
Dual Oil Well - Upper & Lower Hospah Zones
Water Injection Well - Lower Hospah Zone
Oil Well - Dakota "A" Zone
Gas Well - Dakota "A" Zone
Oil Well - Dakota "B" Zone
(Kdb)
Dry Hole
Unit Outline
"D" Zone gas injection well
D-G
"D" Zone water injection well
D-W
SCALE IN FEET
1000 500 0 1000 2000
DENVER, COLORADO
SOUTH HOSPAH UNIT
595.90 Ac.
PA-5549
Tenneco
46997
Upper Hospah Sand Fm. Only
40 Ac.
H.B.P.
Pt. 63588 - Tr. 2
All Fms. exc U. Hospah Sand
33232 - 304.08 Ac. - H.B.P.
Upper Hospah Sand Fm. Only
63588 - 344.09 Ac. - Tr. 1 - H.B.P.
All Fms. exc. U. Hospah Sand
Tesoro
Tenneco
33233 - 171.82 Ac. - H.B.P.
Upper Hospah Sand Fm Only
Pt. 46952
All Fms. except U. Hospah Sand
Tenneco
Pt. 46952
Tenneco
Pt. 32906
8270
8269
T.O.C. 100 %
SFPRR "A"
Tenneco
Tenneco 63406
1560 Ac.
H.B.P.
(Called 39.88)
Tenneco - 1/2
Tesoro - 1/2
Pt. 32906
SFPRR
Tesoro
032931
(Kda, b, d)
(Kda, b, d, jm)
(Kdb)
11.59
11.66
11.82
11.96
12.12
12.18
40.00
39.80
39.73
39.50
39.28
39.05
38.40
N

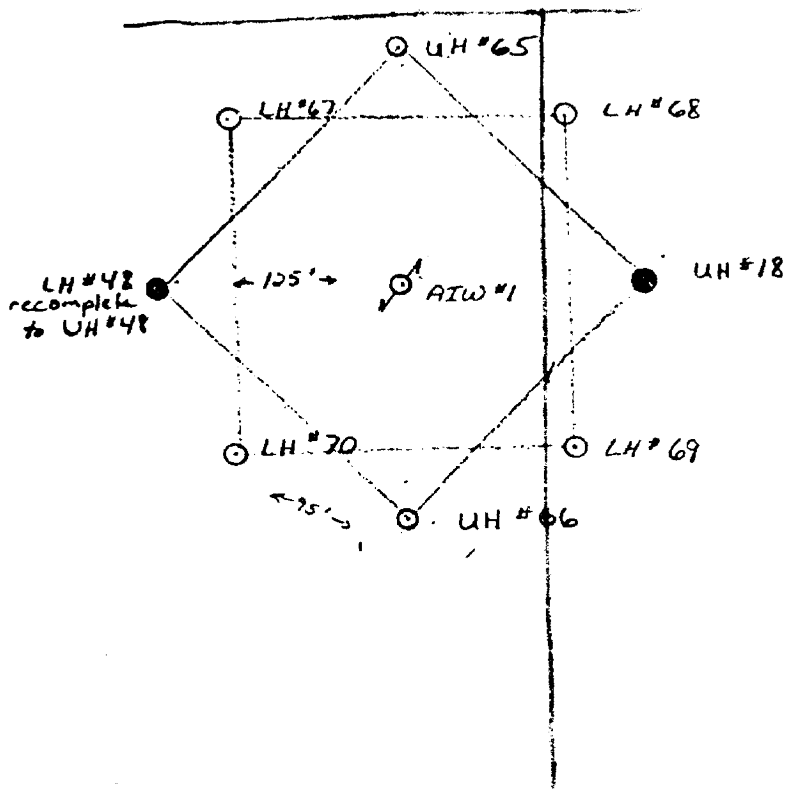


"D" Zone gas injection well
"D" Zone water injection well
Water Injection Well - Lower Hospah Zone
SCALE IN FEET
DENVER, COLORADO
Tesoro
33232 - 304.08 Ac. - H.B.P.
Upper Hospah Sand Fm. Only
63588 - 344.08 Ac. - Tr. I - H.B.P.
All Fms. exc. U. Hospah Sand
SFPRR "A"
052931
Tenneco
46997
Upper Hospah Sand Fm. Only
40 Ac.
H.B.P.
Pt. 63588 - Tr. 2
All Fms. exc U. Hospah Sand
8269
Tenneco
Tesoro
SOUTH HOSPAH UNIT
PA-5549
595.90 Ac.
T.O.C.-100 %
SFPRR
Tenneco
33233 - 171.82 Ac. - H.B.P.
Upper Hospah Sand Fm. Only
Pt. 46952
All Fms. except U. Hospah Sand
Tenneco - 1/2
Tesoro - 1/2
Pt. 32906
Tenneco
Pt. 46952
8270
SFPRR
39.80
(Called 39.88)
Tenneco
Pt. 32906
Tenneco
63406
159.60 Ac.
H.B.P.
17
N

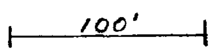
WELLBORE SCHEMATIC - AIR INJECTION WELL



HOSPAH COMBUSTION
PILOT

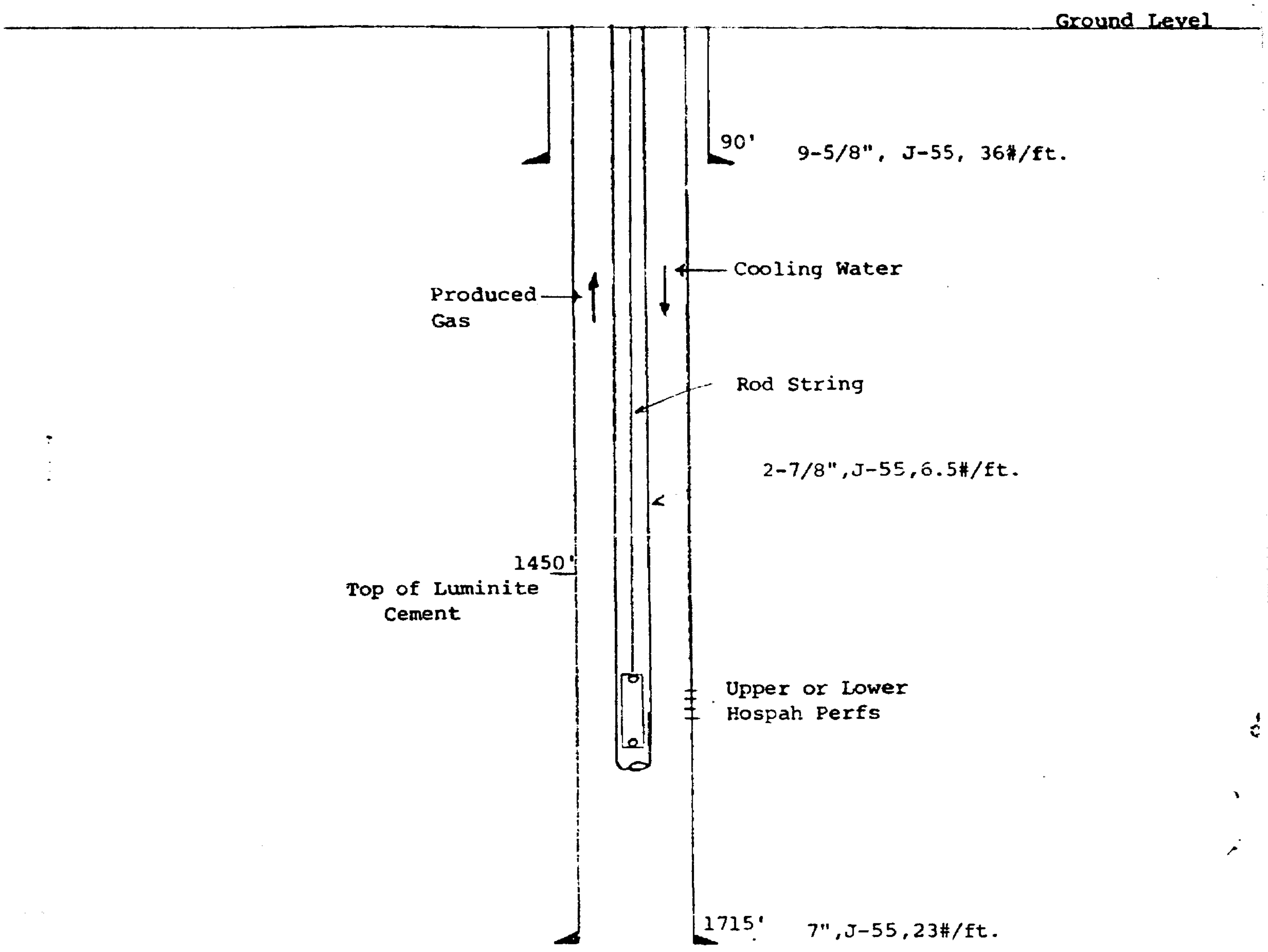



188 x 188' = .81 acres




C

WELLBORE SCHEMATIC - PRODUCING WELL




D

**Tenneco Oil**
A Tenneco Company

Suite 1200
Lincoln Tower Building
Denver, Colorado 80203
(303) 292 9920

July 27, 1977

Mr. Tom Kellahin
Kellahin and Fox
P.O. Box 1769
500 Don Gaspar Avenue
Santa Fe, New Mexico 87501

Dear Tom:

In response to your telephone request I am sending you in attachment a list of calculated Upper Hospah fracture gradients for the Upper Hospah Gallup Sandstone formation, S. Hospah field, McKinley County, New Mexico. All of these wells are located in Sec. 12-T17N-R9W.

In this matter Fracture Gradient was considered to be hydrostatic pressure plus initial shut-in pressure divided by the depth to mid-perforation, or

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

I am also enclosing a copy of actual daily rates and month-end pressures for Upper Hospah injection wells observed during May, 1977. As can be seen average wellhead pressure is ± 750 psig. If you foresee the N.M.O.C.C. rules pertaining to wellhead pressure adversely affecting our Hospah operations I would appreciate hearing your opinion as soon as possible.

I have no comparable data for the Lower Hospah Sand and have no explanation as to why the Upper Hospah F.G. is so high. It is my intention to stay below fracture pressure in this project. In the case of Hospah #58 or #59, assuming minimum FG = 0.92 psi/ft and a flow rate of 1000 BWPD, friction loss would amount to approximately 25 psi and maximum allowable wellhead pressure would be 804 psia (or about 816 psig),

$$F.G. = \frac{(804 - 25) + 693}{1600} = 0.92 \text{ psi/ft}$$

Such a pressure would fall within the likely operating pressure range for the Upper Hospah Sand and may require reducing the desired 1000 BWPD rate.

As I see it the main problem with high injection wellhead pressure is vertical fracturing downward into the Lower Hospah Sand, located some 30' below the base of the Upper Sand.

Very truly yours,

Brad W. Fischer
Sr. Production Engineer

BWF:cam

Attachments

cc: Millard Carr

E

ATTACHMENT #1

Calculation of Fracture Gradients in the Upper Hospah Sand, Sec. 12-17N-9W, South Hospah Field, McKinley County, New Mexico, using data collected from well stimulation reports and assuming

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

| Well | $P_H$, psig | ISIP, psig | F.G., psi/ft |
|---|---|---|---|
| 5 | 675 | 800 | 1475/1560 = 0.95 |
| 18 | 682 | 800 | 1482/1575 = 0.94 |
| 19 | 694 | 800 | 1494/1602 = 0.93 |
| 27 | 676 | 800 | 1476/1562 = 0.95 |
| 38 | 662 | 1000 | 1662/1528 = 1.09 |
| 39 | 696 | 1000 | 1696/1605 = 1.06 |
| 41 | 686 | 850 | 1536/1580 = 0.97 |
| 42 | 716 | 1200 | 1916/1650 = 1.16 |

$\overline{X}$ = 1.01 psi/ft

S = 0.09 psi/ft

Attachment #2

| Well #5 WHP | Well #5 Water | Well #13 WHP | Well #13 Water | Well #17 WHP | Well #17 Water | Well #20 WHP | Well #20 Water | Well #23 WHP | Well #23 Water | Well #41 WHP | Well #41 Water | Well #42 WHP | Well #42 Water | Well #43 WHP | Well #43 Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 865 | | 1019 | | 1790 | | 3 | | 734 | | 0 | | 0 | | 133 |
| | 904 | | 1088 | | 1802 | | 4 | | 704 | | 0 | | 0 | | 165 |
| | 845 | | 1134 | | 1849 | | 3 | | 841 | | 0 | | 0 | | 145 |
| | 883 | | 1070 | | 1790 | | 1 | | 742 | | 0 | | 0 | | 106 |
| | 892 | | 1087 | | 1816 | | 0 | | 773 | | 0 | | 0 | | 15 |
| | 885 | | 1058 | | 1834 | | 1 | | 765 | | 0 | | 0 | | 61 |
| | 893 | | 1072 | | 1799 | | 2 | | 790 | | 0 | | 0 | | 40 |
| | 862 | | 1062 | | 1757 | | 2 | | 733 | | 0 | | 0 | | 77 |
| | 763 | | 654 | | 1600 | | 15 | | 624 | | 0 | | 0 | | 128 |
| | 926 | | 704 | | 1832 | | 4 | | 831 | | 0 | | 0 | | 120 |
| | 902 | | 680 | | 1819 | | 11 | | 806 | | 0 | | 0 | | 145 |
| | 919 | | 657 | | 1819 | | 4 | | 803 | | 0 | | 0 | | 114 |
| | 904 | | 1087 | | 1841 | | 1 | | 790 | | 0 | | 0 | | 50 |
| | 795 | | 1023 | | 1629 | | 5 | | 710 | | 0 | | 0 | | 30 |
| [illegible] | 891 | 500 | 1147 | 500 | 1849 | 870 | 15 | 580 | 587 | | 0 | | 0 | 380 | 1 |
| | [illegible] | | [illegible] | | [illegible] | | 2 | | [illegible] | | 0 | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | 1 |
| | [illegible] | | 930 | | [illegible] | | [illegible] | | 651 | | 0 | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | 13 | | [illegible] | | 0 | | 0 | | 1 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | 0 |
| | | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | 0 |
| | | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | | [illegible] | | 0 | | [illegible] |
| | | | | | | | | | | | 0 | | [illegible] | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | 0 | | 0 | 300 | [illegible] |

| #52 WATer | Well #56 WHP | WATer |
|---|---|---|
| 492 | | 0 |
| 507 | | 0 |
| 505 | | 0 |
| 461 | | 0 |
| 542 | | 0 |
| 506 | | 0 |
| 532 | | 0 |
| 516 | | 0 |
| 444 | | 0 |
| 590 | | 0 |
| 563 | | 0 |
| 568 | | 0 |
| 533 | | 0 |
| [illegible] | | 0 |
| 575 | | 0 |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| | | [illegible] |
| | | [illegible] |
| | | [illegible] |
| | | [illegible] |
| | | [illegible] |

$\bar{X}$ = 755 psig

s = 130 psig

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. 5995
Order No. R-5506

APPLICATION OF TENNECO OIL COMPANY
FOR DUAL COMPLETIONS AND WATERFLOOD
EXPANSIONS, McKINLEY COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on July 20, 1977, at Santa Fe, New Mexico, before Examiner Richard L. Stamets.

NOW, on this 9th day of August, 1977, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, 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, Tenneco Oil Company, seeks authority to expand its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones through parallel strings of tubing.

(3) That the applicant proposes to complete said Hospah Unit Wells Nos. 58 and 59 with parallel strings of tubing, packers set immediately above the injection intervals, and provide for testing to determine any leakage of the tubing, casing or upper packers.

(4) That the mechanics of the proposed dual completions are feasible and in accordance with good conservation practices.

(5) That before injection into either of said wells should begin, the applicant should consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata.

F

(6) That the operator should take all steps necessary to ensure that the injected water enters only the proposed injection interval and is not permitted to escape to other formations or onto the surface.

(7) That approval of the subject application will prevent the drilling of unnecessary wells and otherwise prevent waste and protect correlative rights.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby granted authority to expend its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones.

PROVIDED HOWEVER, that each of said wells shall be equipped with parallel strings of 2 1/16-inch tubing, packers set immediately above each injection zone, and that the casing-tubing annulus shall be filled with an inert fluid; and that a pressure gauge shall be attached to the annulus or the annulus shall be equipped with an approved leak detection device in order to determine leakage in the casing, tubing, or packer.

(2) That prior to commencing injection into either of the subject wells, the operator shall consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata in said projects.

(3) That the injection wells or systems shall be equipped with pop-off valves or acceptable substitutes which will limit the wellhead pressure on the injection wells to a pressure no higher than that determined pursuant to Order No. (2) above.

(4) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

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

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

PHIL R. LUCERO, Chairman

EMERY C. ARNOLD, Member

JOE D. RAMEY, Member & Secretary

S E A L
jr/

## DISCUSSION

### FIELD HISTORY

The South Hospah field is located in McKinley County, New Mexico (Section 12, T17N-R9W), approximately 120 miles south of Farmington. The field is in the Chaco Slope region of the San Juan Basin. The Upper Hospah was discovered in 1965. Tenneco purchased the property in September, 1966 and began developing the Upper Hospah during 1967. Production of the Lower Hospah began in April, 1967.

The Upper Hospah reservoir performed as a pressure depletion drive (since solution gas was negligible). Graph No. 1 depicts the steep production decline experienced under this drive mechanism. Because of a very low expected primary recovery, a waterflood was initiated in the reservoir in June, 1968. The response to water injection can be seen very vividly on Graph No. 1. Figure No. 1 shows the Upper Hospah Unit, with the current well locations. The injection scheme developed into a fairly irregular pattern, with an average well spacing of 10 acres. Currently, the Unit has 20 active producers and 10 active water injection wells. Production averages 180 BOPD and 4700 BWPD, resulting in a field oil cut of 3.7%. Water injection is about 4700 BPD. The Upper Hospah Unit was classified as stripper in September, 1979.

The Lower Hospah reservoir has an active aquifer and mobile water at original saturations, as exhibited on Graph No. 2 as very early water production. The crude from the Lower Hospah is fairly viscous, 55 cp. at reservoir temperature, and contributes to an unfavorable water-oil mobility ratio. An attempt to improve the mobility ratio and, thereby, increase the recovery was initiated in September, 1972, when a simultaneous gas-water injection project began. The basic goal of the process was for the gas to swell the oil and reduce the oil viscosity, improving the mobility ratio. Water would then be able to displace

Exhibit H

the oil more effectively. Gas injection was expensive due to a number of operational problems (gas-locking of pumps, emulsion treating, and venting the casing) and was discontinued for a period of time during 1976. When no negative production effects were seen, it was decided to terminate gas injection completely; however, water injection has continued to the present. Figure 2 shows there are 26 active producers and 11 active injectors. Average production is 720 BOPD and 21,400 BWPD (a field oil cut of 3.25%), with water injection of 21,200 BPD.

As seen on Graph 2, response to water injection in the Lower Hospah was not as dramatic as that of the Upper Hospah. The waterflood was considered effective, because of the abatement of the apparent production decline after 1973. The large production increase exhibited in 1977 and 1978 was a result of the deepening of 11 wells, the drilling of 4 infill wells, and increased lift capacity in many of the producers.

GEOLOGY

The Upper Hospah sand is composed of 3-4 major stringers separated by thin shale beds. The type log labeled Figure 3 shows these members. The Upper Hospah is a marine sand bar deposit with areas of poorer rock type due to channeling. Directional permeability is oriented along a northeast to southwest line. The productive limits are defined by a fault along the northwest and a decrease in rock permeability to the east and south (areas proven as non-productive). The structure is fairly simple and flat. The structure map presented as Figure 4 shows the dip is approximately 1°.

The Lower Hospah sand is a blanket sand deposit. Productive limits are defined by the fault on the northwest flank and the original oil-water contact at ± 5,375'. The aquifer is active, tilted 25-30 feet and encountered by every well in the field. The structure is fairly flat, with a dip of 1° (see Figure 5).

EOR PROCESS DESCRIPTIONS

Because of the reservoir and fluid factors discussed previously and the results of laboratory core tests, in situ combustion, steamflooding, and micro-emulsion flooding were evaluated for application to the Lower Hospah.

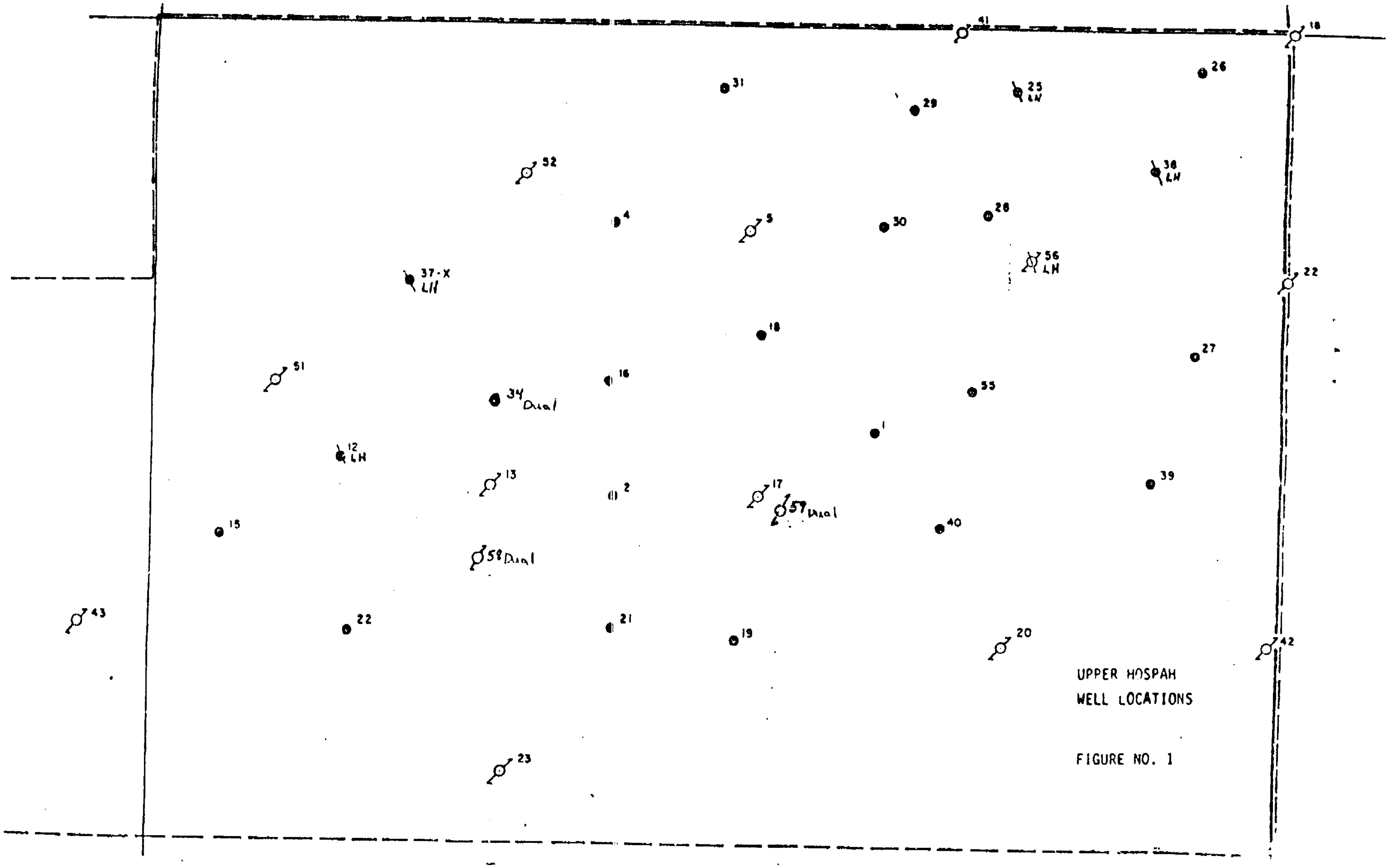
In situ combustion involves the injection of air into the reservoir; the mechanical, chemical, or spontaneous ignition of the oil in the reservoir; and the continued injection of air and combustion of a fraction of the oil in the reservoir. The fraction of crude that provides the fuel is called coke, the heavier ends of the crude deposited on the formation as a result of the heat of combustion vaporizing the lighter ends. The vaporization of the lighter ends, steam generated from formation water, and the gases generated as products of combustion reduce the oil viscosity and provide the driving force to enhance the oil recovery. Oil is not only swept from the area immediately ahead of the burn front, but 40% or more of the oil outside of the swept area is affected by the heat and recovered. Temperatures in the burn front usually are in the range of 700-1200°F. The various regions in the reservoir are depicted in the cross-section on Figure 6. The burned region behind the burn front is 100% air-saturated, leaving no residual oil behind. A large amount of heat remains in this burned region to eventually dissipate to the base and cap rock. The efficiency of this system can be improved by scavenging this heat through the injection of water. When water and air are simultaneously or alternately injected, the water flashes to steam near the injection well, super-heated steam traverses the burn front, and this steam aids in the viscosity reduction and distillation of oil ahead of the burn front. Optimum "wet combustion" displaces most of the excess heat from behind the burn front to the

oil bank and results in a two-thirds reduction in air requirements over dry combustion and a considerable reduction in fuel consumption. Obviously, both reductions serve to improve the process recovery and economics. One such process that was proven effective is the COFCAW process (Combination of Forward Combustion and Waterflooding).

ECONOMIC DEVELOPMENT

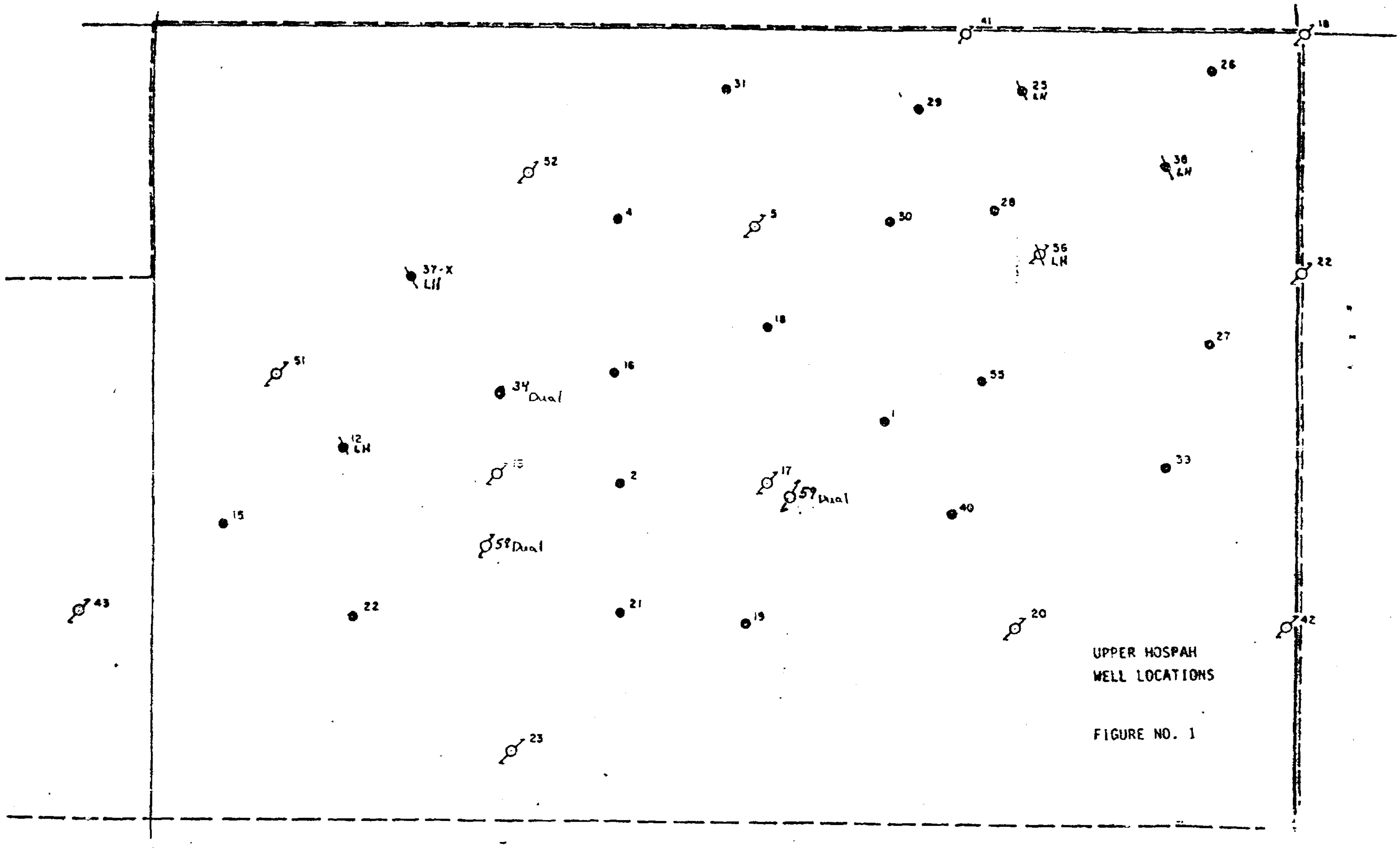
Table No. 10 presents the general economic parameters that apply to all processes. All economic evaluations were performed using only the incremental tertiary production, the capital expenditures to get that production, and the O&M expense applicable only to the EOR operation. Incremental tertiary oil (projected EOR response less the remaining secondary production) enjoys market incentive prices which were $32/BO at 1/1/80. A 50% excise tax was imposed resulting in a net price of $24/BO. Pattern development was assumed to begin the second quarter of 1980. As a 5-spot or set of patterns developed, it was assumed the injection plant would be available for injection in the completed areas. Recoupment of allowable expenditures occurs in the quarter the expenditure is made and no recoupment was credited after October 1, 1981 (when all oil is assumed decontrolled).

The DOE has passed a ruling which will allow operators of certain EOR projects begun after Sepember 30, 1979, to recoup 75% of certain capital expenditures involved with that project. The recoupment process involves the release of enough Lower Tier oil to Upper Tier prices to cover the recoupable amount. The allowable recoupment can be taken whether the project is a success or not. The purpose behind this ruling is to help operators defray the larger front-end capital expenditures mandated by most EOR projects; thereby, making these projects economically attractive so that more projects will be initiated and the U.S. dependence on imported crude might be decreased.



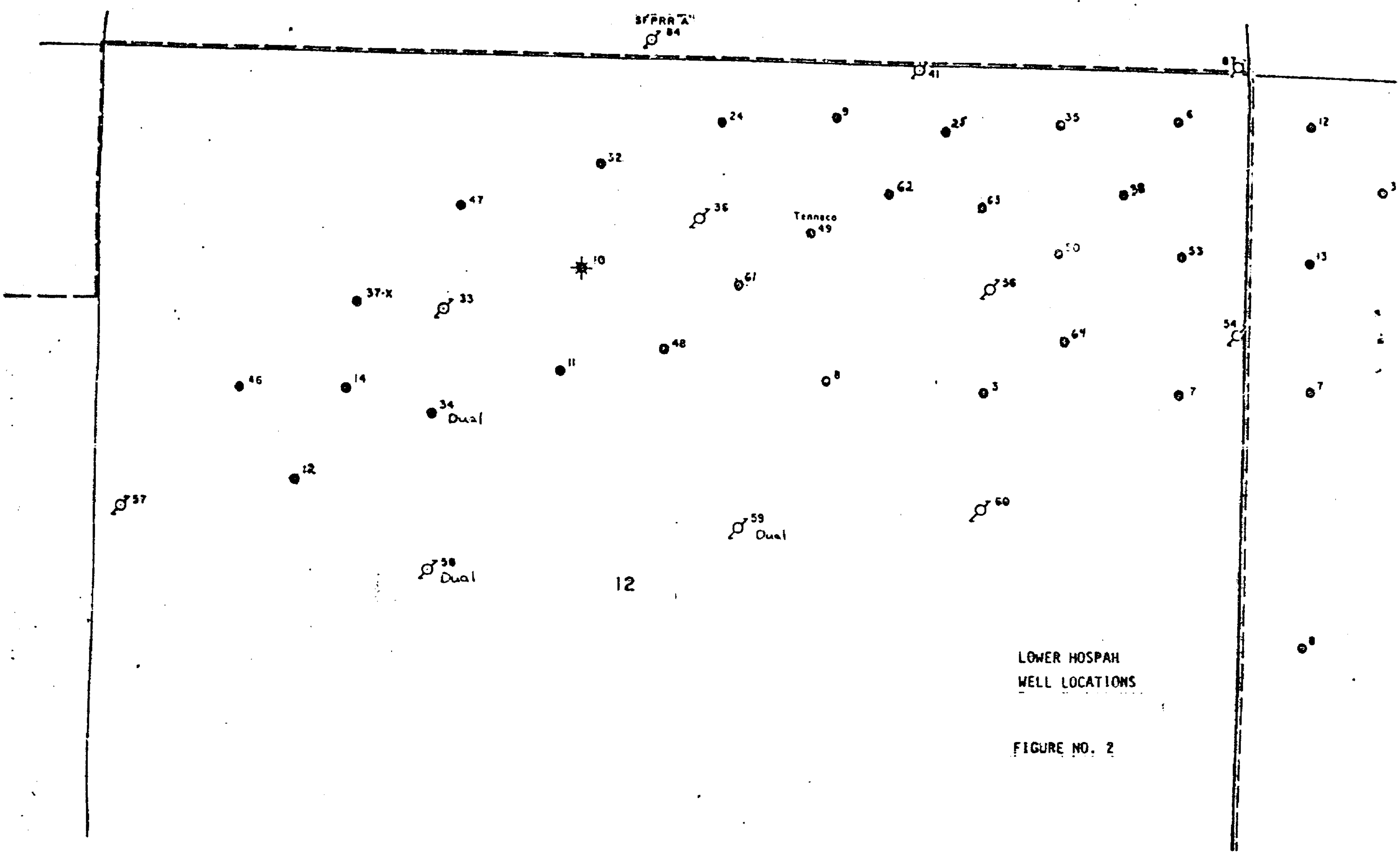

UPPER HOSPAH
WELL LOCATIONS

FIGURE NO. 1



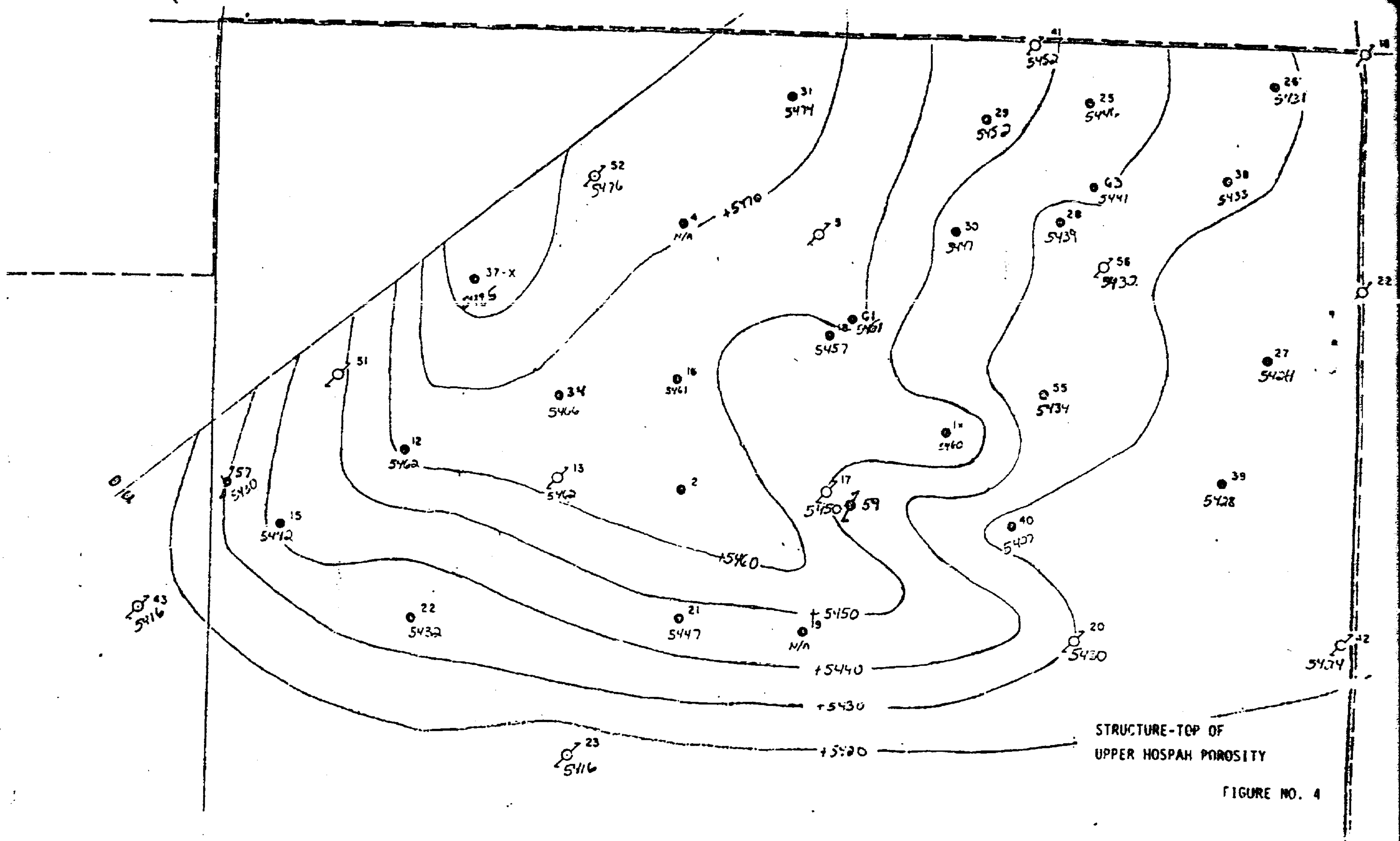

UPPER HOSPAH
WELL LOCATIONS

FIGURE NO. 1




LOWER HOSPAH
WELL LOCATIONS

FIGURE NO. 2




STRUCTURE-TOP OF
UPPER HOSPAH POROSITY

FIGURE NO. 4

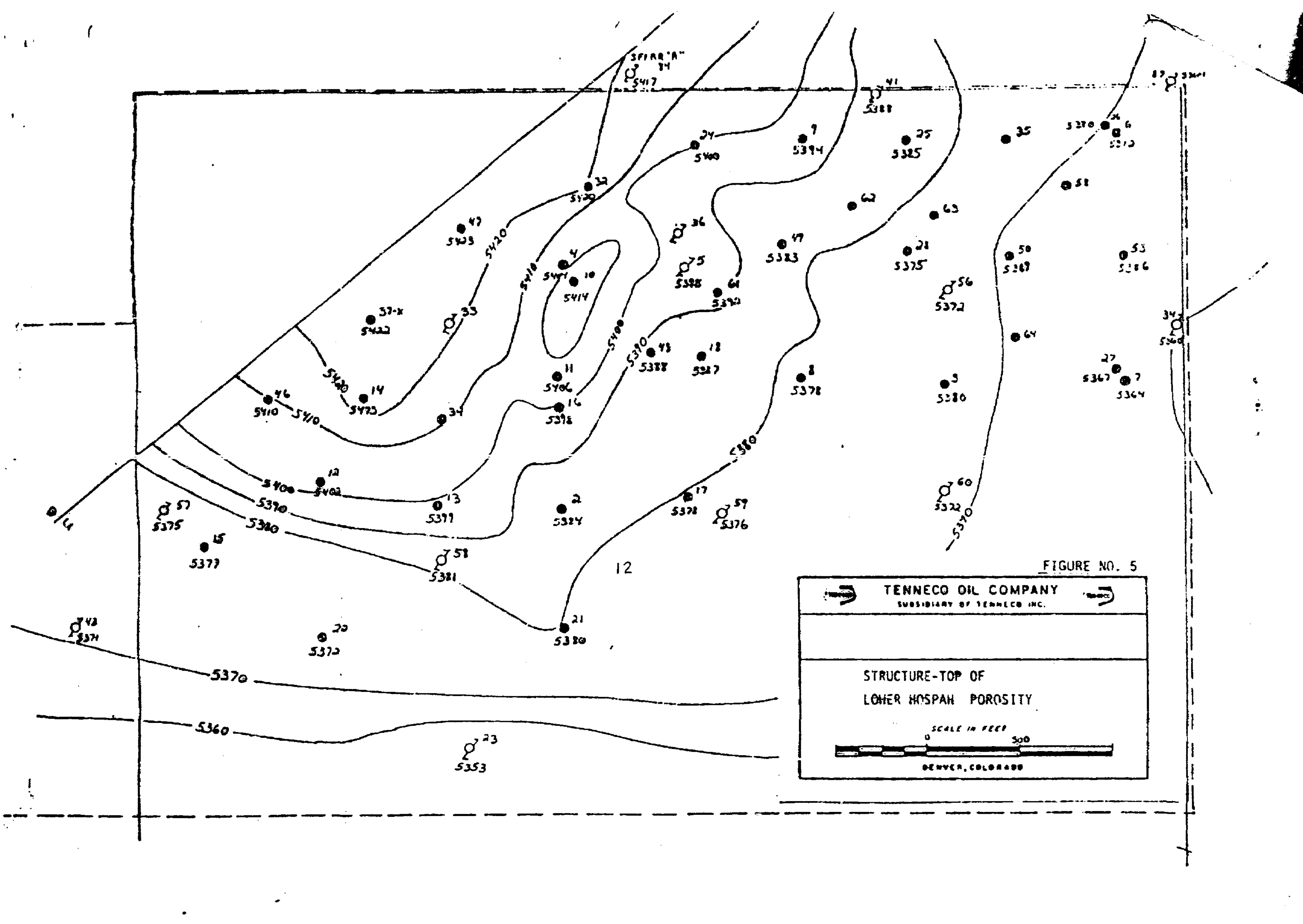
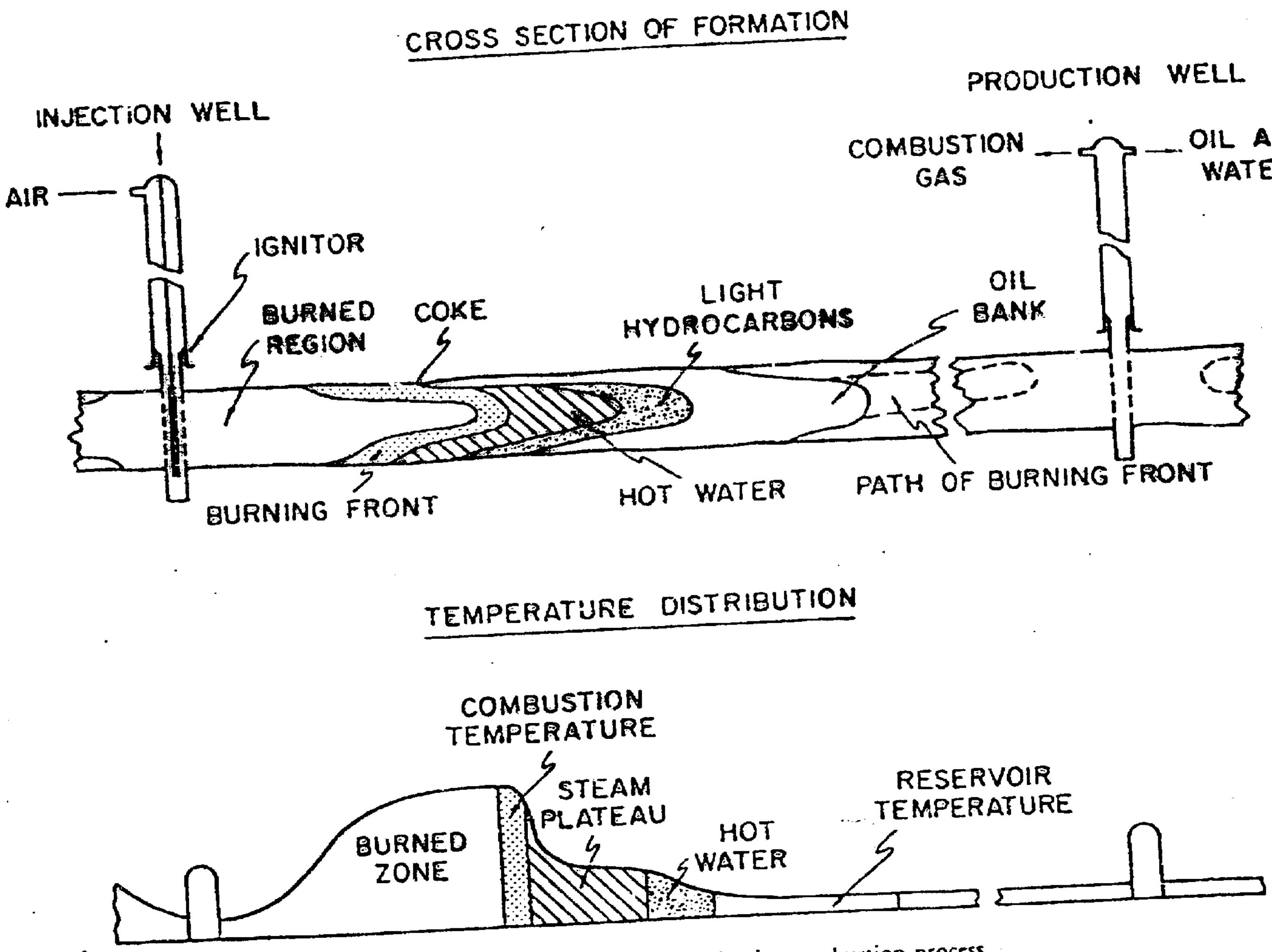

TENNECO OIL COMPANY
SUBSIDIARY OF TENNECO INC.
STRUCTURE-TOP OF
LOWER HOSPAH POROSITY
SCALE IN FEET
0
500
DENVER, COLORADO
12
5370
5360
5380
5390
5400
5410
5420

FIGURE NO. 5




Schematic diagram of in situ combustion process.

FIGURE NO. 6

(reprinted from Ref. No. 12)

STATE OF NEW MEXICO
DEPARTMENT OF ENERGY AND MINERALS
OIL CONSERVATION DIVISION

IN THE MATTER OF THE APPLICATION OF
TENNECO OIL COMPANY FOR APPROVAL OF
A PILOT IN SITU COMBUSTION PROJECT,
INCLUDING WELL-SPACING EXCEPTIONS
FOR INJECTION AND PRODUCING WELLS,
UPPER AND LOWER HOSPAH FORMATIONS,
SOUTH HOSPAH FIELD, McKINLEY COUNTY,
NEW MEXICO.

Case 6890

APPLICATION

COMES NOW TENNECO OIL COMPANY, by and through its attorneys, KELLAHIN & KELLAHIN, and applies to the Oil Conservation Division of the State of New Mexico for approval of a pilot in situ combustion project for the Upper and Lower Hospah formations of the South Hospah Field, McKinley County, New Mexico and in support thereof would show:

1. Applicant is the operator in both the Upper and Lower Hospah formations of the South Hospah field, McKinley County, New Mexico, including Section 12, T17N, R9W, NMPM.

2. Applicant seeks to initiate a pilot in situ combustion project in each of the two Hospah formations, at a location in Section 12, T17N, R9W, NMPM hereinafter set forth.

3. The South Hospah field is now in its later stages of secondary recovery by waterflood and applicant proposes to determine by the proposed pilot project the feasibility of a tertiary recovery project by in situ combustion. Attached as Exhibit "A" is a plat showing all wells in the area.

4. Applicant proposes to drill a dual injection well at a depth sufficient to penetrate both the Upper and Lower Hospah formations at a location 1474 feet from the North line and 2725 feet from the East Line of Section 12. Said injection well is to be completed

without a packer and as outlined on the wellbore schematic attached as Exhibit "B", which is incorporated by reference herein. Ignition shall be initiated either by the injection of air, methane, water, or an electric ignitor or combination thereof.

5. It is proposed that the pilot project shall include either four or eight producing wells in a pattern as shown on Exhibit "C" attached hereto and incorporated herein by reference. There will not be any commingling of the Upper and Lower Hospah production.

6. The first alternative of four producing wells will include two existing Hospah wells:

(a) Well LH-48, located 1485 feet from the North line and 2817 feet from the East line of Section 12;

(b) Well UH-18, located 1600 feet from the North line and 3100 feet from the West line of Section 12;

and two new producing wells to be located as follows:

(a) Well H-65, located 1350 feet from the North line and 2725 feet from the East line of Section 12;

(b) Well H-66, located 1600 feet from the North line and 2725 feet from the East line of Section 12.

7. The second alternative would be to have eight producing wells, which in addition to the four wells described above would include the following four new producing wells in Section 12:

(a) Well H-67, 1388 feet from the North line, 2825 feet from the East line;

(b) Well H-68, 1387 feet from the North Line, 2637 feet from the East line;

(c) Well H-69, 1575 feet from the North line, 2637 feet from the East line;

(d) Well H-70, 1575 feet from the North line; 2825 feet from the East line;

8. All new producing wells in the pilot project will conform to the welbore schematic attached as Exhibit "D" and incorporated herein.

9. The injection of air, water, or methane into the proposed injection well will be at pressures below that required to fracture the confining strata as shown in Exhibit E attached hereto and incorporated herein by reference.

10. A tabulation of wells within a one-half mile of the injection well, and schematics of all plugged and abandoned wells within one-half mile pursuant to Memo 3-77, are to be found in the case file for Commission Case 5995, Order R-5506, dated August 9, 1977, attached hereto as Exhibit "F" and incorporated by reference.

11. The proposed pilot project as outlined in Exhibit "H" attached hereto and incorporated herein by reference will not present a risk of contamination of fresh-water sources in the area, will not impair the correlative rights of others, will be in the best interests of conservation, will determine the feasibility of an in-situ combustion project for these formations, will not cause waste.

WHEREFORE, Applicant seeks approval for this application for a pilot in situ combustion project in the Lower and Upper Hospah formations of the South Hospah field, McKinley County, including but not limited to authority to:

(a) to drill and complete the injection well at the proposed location and method of completion; and,

(b) to approve the drilling and spacing of the proposed production wells; and,

(c) such additional authority and approval as may be required to implement the proposed project.

TENNECO OIL COMPANY

By [signature]
W. Thomas Kellahin
Kellahin & Kellahin
P. O. Box 1769
Santa Fe, New Mexico 87501
(505) 982-4285
ATTORNEYS FOR APPLICANT

Oil Well - Dakota "D" Zone

Gas Well - Dakota "D" Zone

Oil Well - Upper Hospah Zone

Water Injection Well - Upper Hospah Zone

Oil Well - Lower Hospah Zone

Dual Oil Well - Upper & Lower Hospah Zones

Water Injection Well - Lower Hospah Zone

& Dakota Gas

Oil Well - Dakota "A" Zone

Gas Well - Dakota "A" Zone

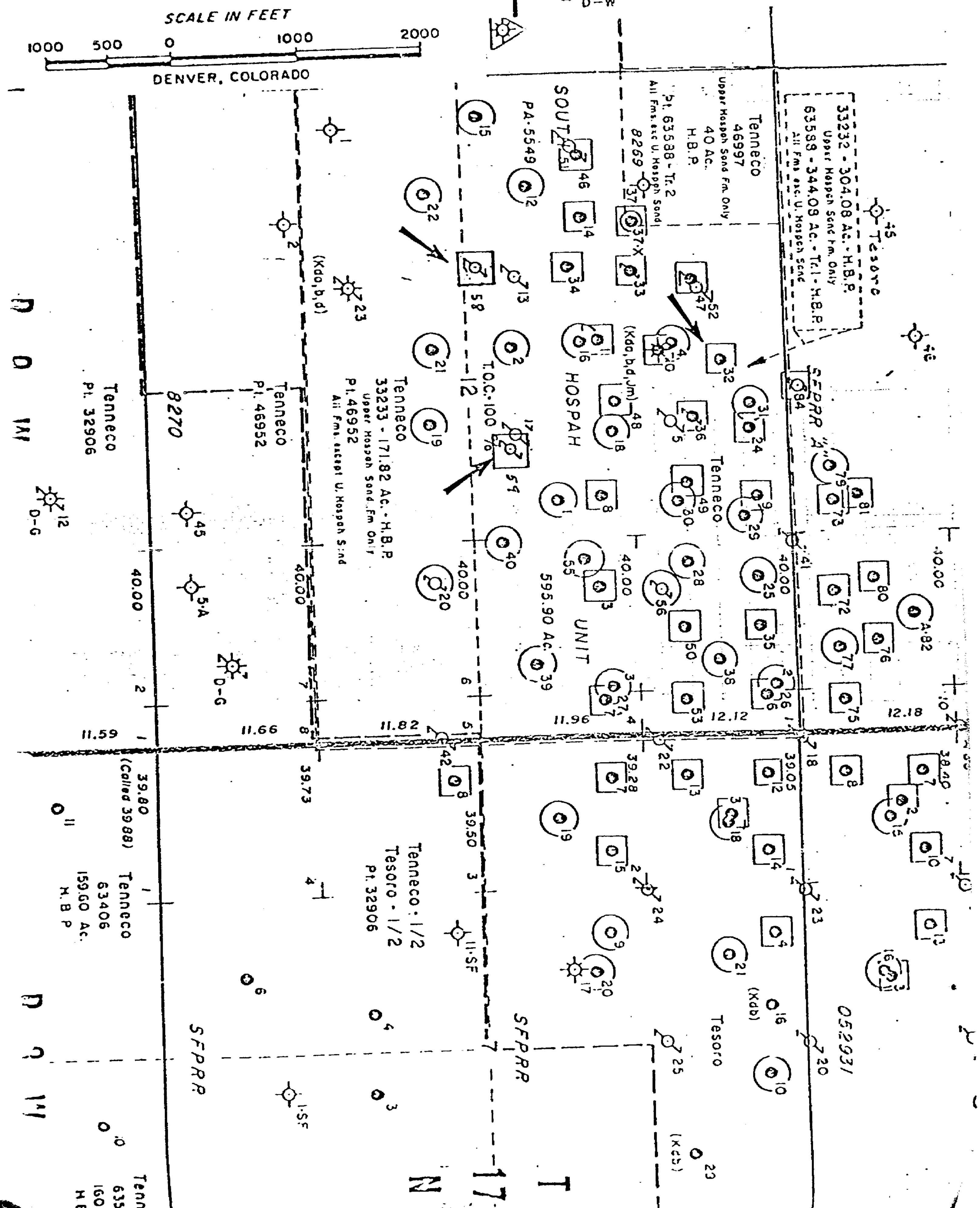
Oil Well - Dakota "B" Zone (Kdb)

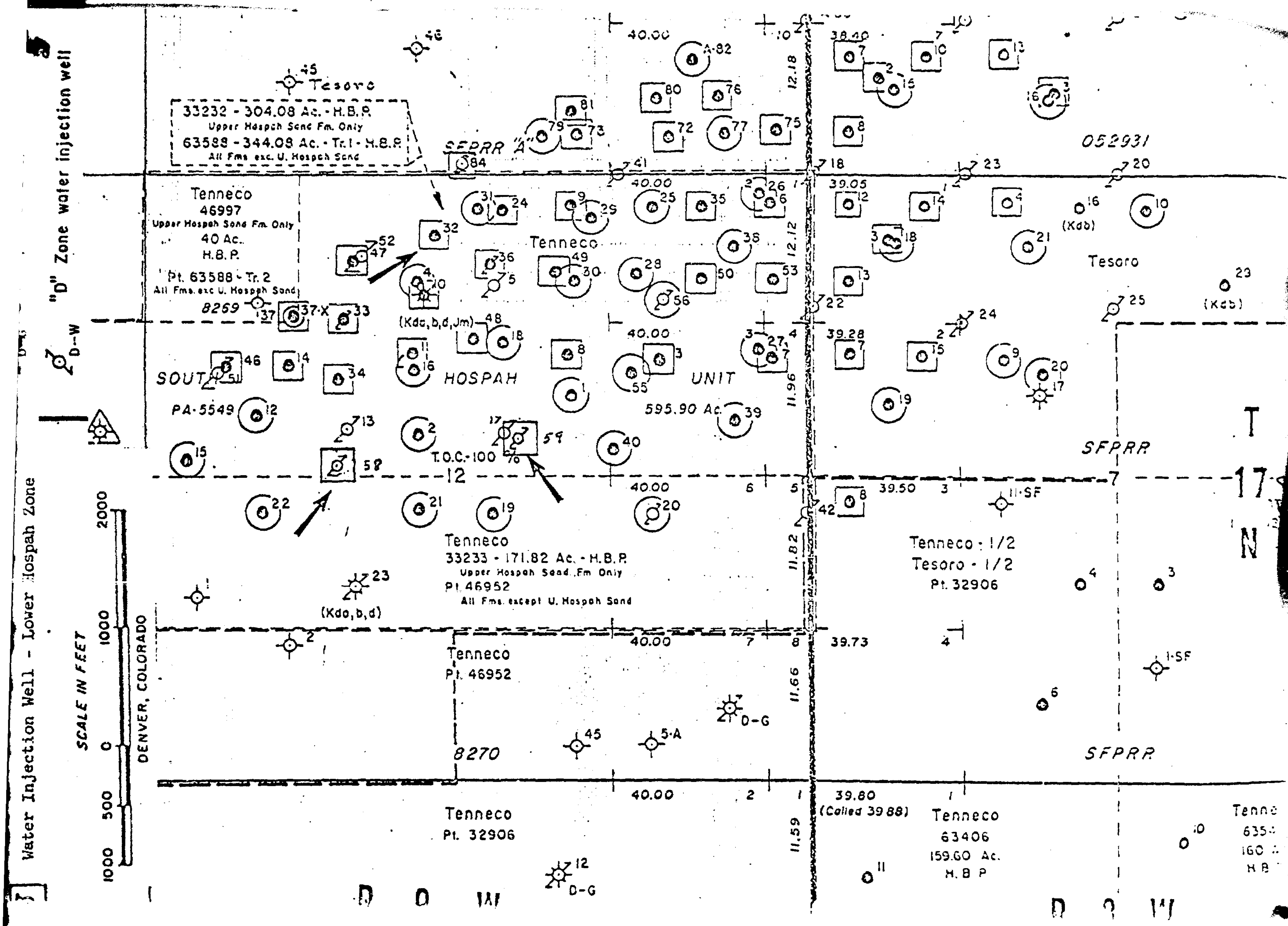
Dry Hole

Unit Outline

"D" Zone gas injection well (D-G)

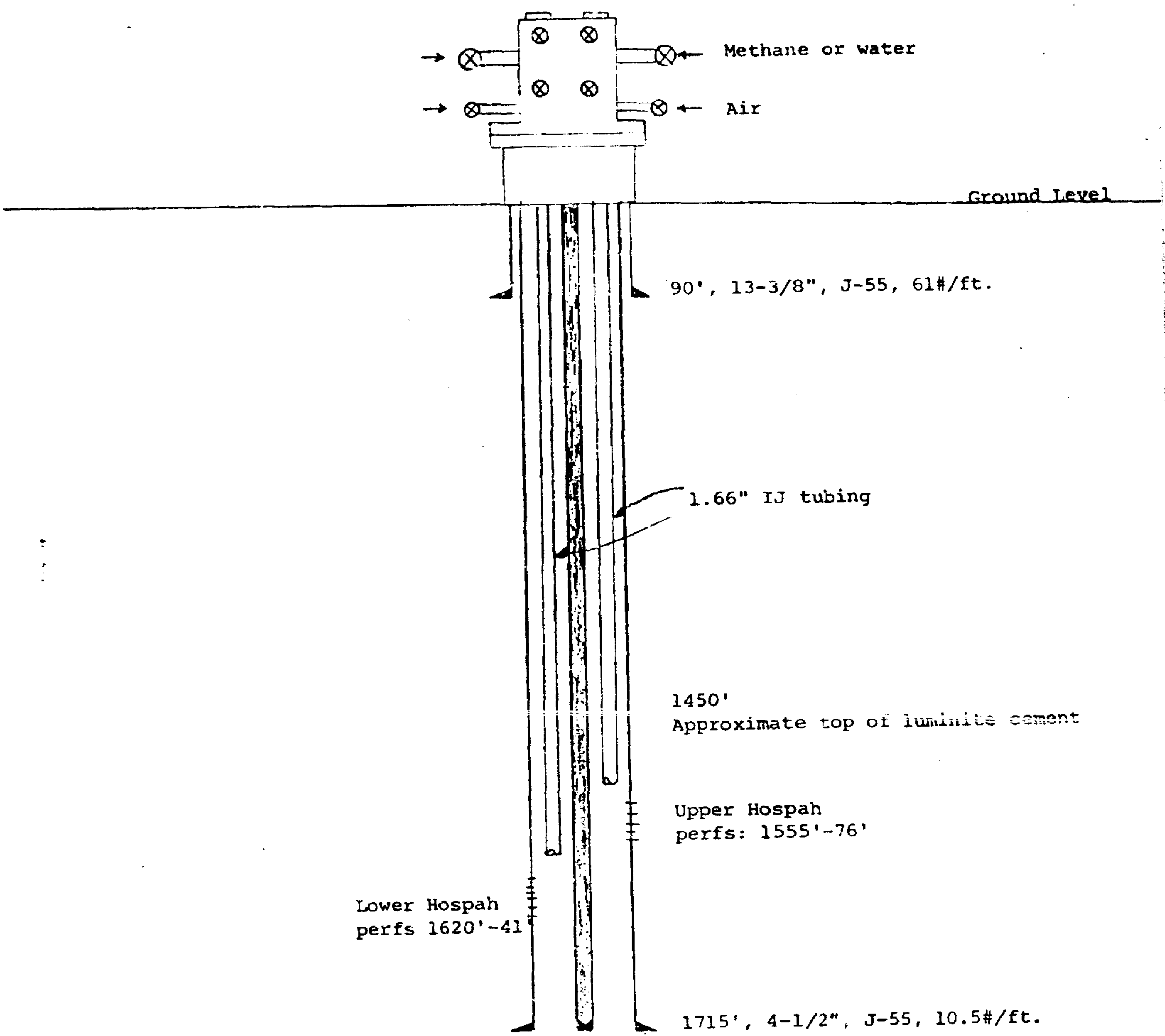
"D" Zone water injection well (D-W)



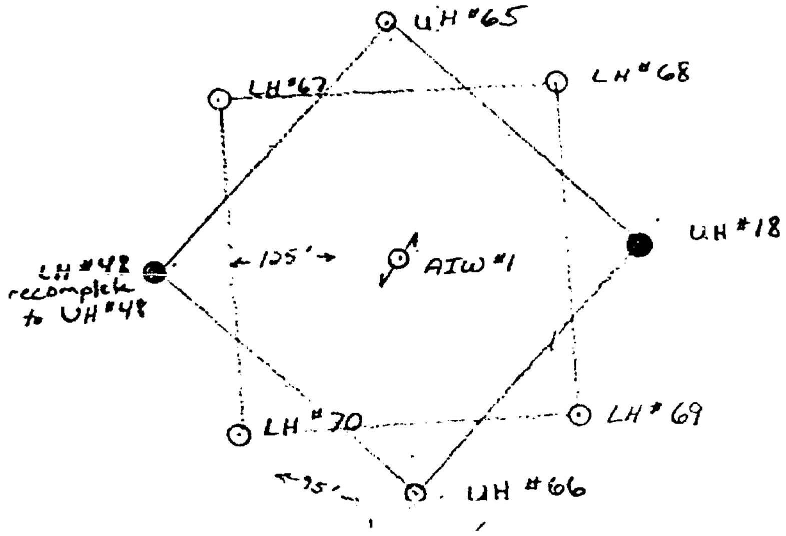


"D" Zone water injection well
Water Injection Well - Lower Hospah Zone
SCALE IN FEET
2000 1000 0 500 1000
DENVER, COLORADO
33232 - 304.08 Ac. - H.B.P.
Upper Hospah Sand Fm. Only
63588 - 344.08 Ac. - Tr.1 - H.B.P.
All Fms. exc. U. Hospah Sand
Tesoro
Tenneco
46997
Upper Hospah Sand Fm. Only
40 Ac.
H.B.P.
Pt. 63588 - Tr. 2
All Fms. exc U. Hospah Sand
8269
SFPRR "A"
SOUTH HOSPAH UNIT
595.90 Ac.
PA-5549
(Kda, b, d, Jm)
T.O.C.-100 %
052931
(Kdb)
Tesoro
SFPRR
T 17 N
Tenneco
33233 - 171.82 Ac. - H.B.P.
Upper Hospah Sand Fm Only
Pt. 46952
All Fms. except U. Hospah Sand
(Kda, b, d)
Tenneco - 1/2
Tesoro - 1/2
Pt. 32906
Tenneco
Pt. 46952
8270
D-G
Tenneco
Pt. 32906
39.80
(Called 39.88)
Tenneco
63406
159.60 Ac.
H.B.P.
40.00
39.05
39.28
39.50
39.73
12.18
12.12
11.96
11.82
11.66
11.59

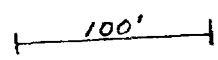
WELLBORE SCHEMATIC - AIR INJECTION WELL



# HOSPAH COMBUSTION PILOT

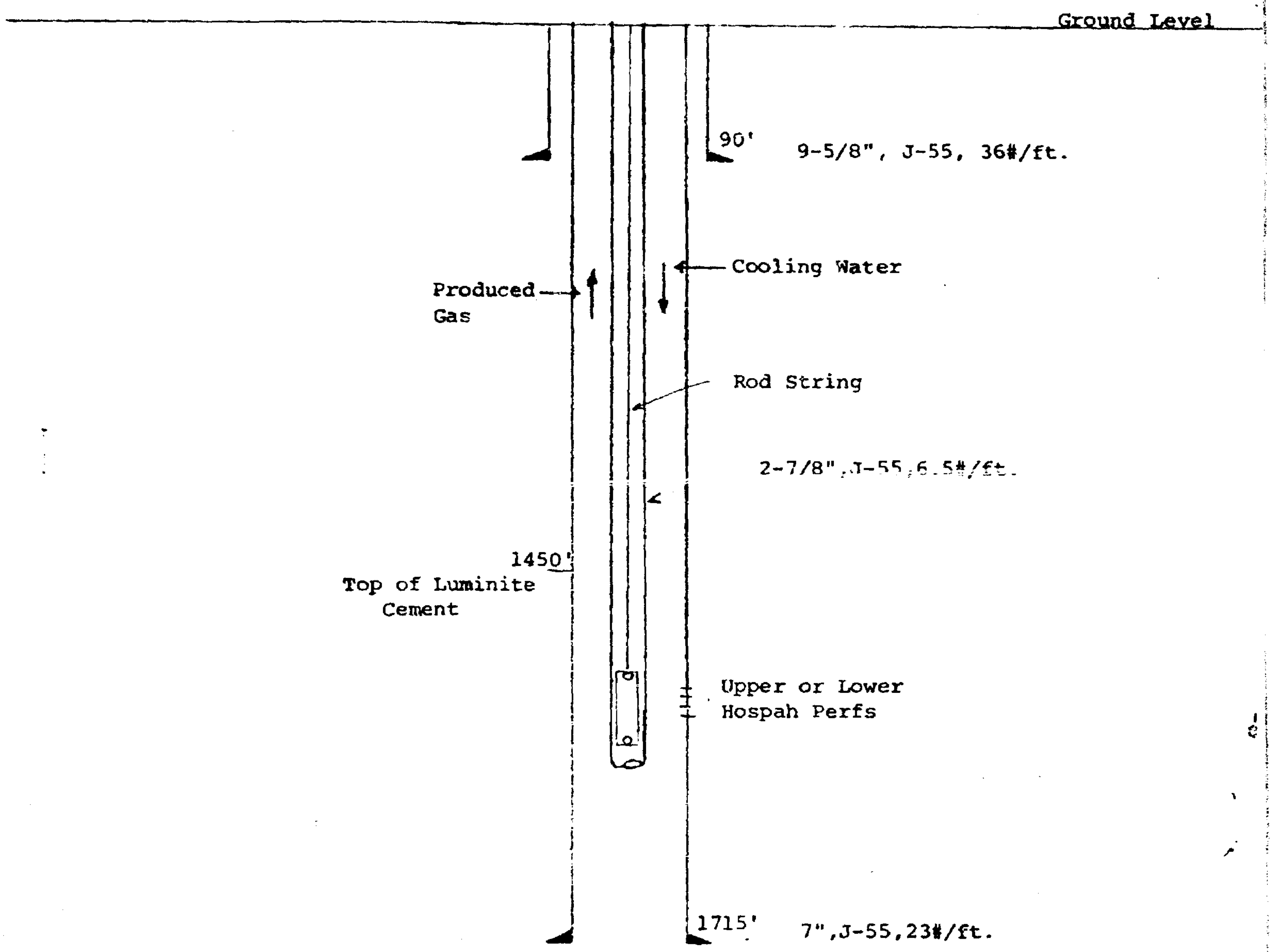



188 x 188' = .81 acres




C

WELLBORE SCHEMATIC - PRODUCING WELL



Tenneco Oil
A Tenneco Company

Suite 1200
Lincoln Tower Building
Denver, Colorado 80203
(303) 292-9920

July 27, 1977

Mr. Tom Kellahin
Kellahin and Fox
P.O. Box 1769
500 Don Gaspar Avenue
Santa Fe, New Mexico 87501

Dear Tom:

In response to your telephone request I am sending you in attachment a list of calculated Upper Hospah fracture gradients for the Upper Hospah Gallup Sandstone formation, S. Hospah field, McKinley County, New Mexico. All of these wells are located in Sec. 12-T17N-R9W.

In this matter Fracture Gradient was considered to be hydrostatic pressure plus initial shut-in pressure divided by the depth to mid-perforation, or

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

I am also enclosing a copy of actual daily rates and month-end pressures for Upper Hospah injection wells observed during May, 1977. As can be seen average wellhead pressure is $\pm$ 750 psig. If you foresee the N.M.O.C.C. rules pertaining to wellhead pressure adversely affecting our Hospah operations I would appreciate hearing your opinion as soon as possible.

I have no comparable data for the Lower Hospah Sand and have no explanation as to why the Upper Hospah F.G. is so high. It is my intention to stay below fracture pressure in this project. In the case of Hospah #58 or #59, assuming minimum FG = 0.92 psi/ft and a flow rate of 1000 BWPD, friction loss would amount to approximately 25 psi and maximum allowable wellhead pressure would be 804 psia (or about 816 psig),

$$F.G. = \frac{(804 - 25) + 693}{1600} = 0.92 \text{ psi/ft}$$

Such a pressure would fall within the likely operating pressure range for the Upper Hospah Sand and may require reducing the desired 1000 BWPD rate.

As I see it the main problem with high injection wellhead pressure is vertical fracturing downward into the Lower Hospah Sand, located some 30' below the base of the Upper Sand.

Very truly yours,

Brad W. Fischer
Sr. Production Engineer

BWF:cam

Attachments

cc: Millard Carr

E

ATTACHMENT #1

Calculation of Fracture Gradients in the Upper Hospah Sand, Sec. 12-17N-9W, South Hospah Field, McKinley County, New Mexico, using data collected from well stimulation reports and assuming

$$F.G. = \frac{P_H + ISIP}{Depth}, \text{ psi/ft}$$

| Well | $P_H$, psig | ISIP, psig | F.G., psi/ft |
|---|---|---|---|
| 5 | 675 | 800 | 1475/1560 = 0.95 |
| 18 | 682 | 800 | 1482/1575 = 0.94 |
| 19 | 694 | 800 | 1494/1602 = 0.93 |
| 27 | 676 | 800 | 1476/1562 = 0.95 |
| 38 | 662 | 1000 | 1662/1528 = 1.09 |
| 39 | 696 | 1000 | 1696/1605 = 1.06 |
| 41 | 686 | 850 | 1536/1580 = 0.97 |
| 42 | 716 | 1200 | 1916/1650 = 1.16 |

$\overline{X}$ = 1.01 psi/ft

S = 0.09 psi/ft

AHachment #2

| Well #5 | | Well #13 | | Well #17 | | Well #20 | | Well #23 | | Well #41 | | Well #42 | | Well #43 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WHP | WATer | WHP | WATer | WHP | WATer | WHP | WATer | WHP | WATer | WHP | WATer | WHP | WATer | WHP | WATer |
| | 835 | | 1019 | | 1790 | | 3 | | 734 | | 0 | | 0 | | 133 |
| | 904 | | 1088 | | 1802 | | 4 | | 804 | | 0 | | 0 | | 165 |
| | 845 | | 1134 | | 1849 | | 3 | | 841 | | 0 | | 0 | | 145 |
| | 883 | | 1070 | | 1790 | | 1 | | 742 | | 0 | | 0 | | 106 |
| | 892 | | 1087 | | 1816 | | 0 | | 773 | | 0 | | 0 | | 15 |
| | 885 | | 1058 | | 1834 | | 1 | | 765 | | 0 | | 0 | | 61 |
| | 893 | | 1072 | | 1799 | | 2 | | 790 | | 0 | | 0 | | 40 |
| | 862 | | 1062 | | 1757 | | 2 | | 733 | | 0 | | 0 | | 77 |
| | 763 | | 654 | | 1600 | | 15 | | 624 | | 0 | | 0 | | 128 |
| | 926 | | 704 | | 1832 | | 4 | | 831 | | 0 | | 0 | | 120 |
| | 902 | | 680 | | 1819 | | 11 | | 806 | | 0 | | 0 | | 145 |
| | 919 | | 657 | | 1819 | | 4 | | 803 | | 0 | | 0 | | 114 |
| | 904 | | 1087 | | 1841 | | 1 | | 790 | | 0 | | 0 | | 50 |
| | 795 | | 1023 | | 1629 | | 5 | | 710 | | 0 | | 0 | | 30 |
| [illegible] | 891 | 500 | 1147 | 500 | 1849 | 870 | 15 | 550 | 587 | | 0 | | 0 | 330 | 1 |
| | [illegible] | | [illegible] | | [illegible] | | 2 | | [illegible] | | 0 | | 0 | | 0 |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | 13 | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | [illegible] | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | 0 | | 0 | | [illegible] |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | | | | | | | | | | [illegible] | | 0 | | |
| | | [illegible] | | [illegible] | | [illegible] | | [illegible] | | | 0 | | 0 | 300 | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

| #52 | Well #56 | |
| --- | --- | --- |
| Water | WHP | Water |
| 492 | | 0 |
| 507 | | 0 |
| 505 | | 0 |
| 461 | | 0 |
| 542 | | 0 |
| 506 | | 0 |
| 532 | | 0 |
| 516 | | 0 |
| 444 | | 0 |
| 590 | | 0 |
| 563 | | 0 |
| 568 | | 0 |
| 533 | | 0 |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |

$\overline{X} = 755$ psig

$s = 130$ psig

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. 5995
Order No. R-5506

APPLICATION OF TENNECO OIL COMPANY
FOR DUAL COMPLETIONS AND WATERFLOOD
EXPANSIONS, McKINLEY COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on July 20, 1977, at Santa Fe, New Mexico, before Examiner Richard L. Stamets.

NOW, on this 9th day of August, 1977, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, 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, Tenneco Oil Company, seeks authority to expand its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones through parallel strings of tubing.

(3) That the applicant proposes to complete said Hospah Unit Wells Nos. 58 and 59 with parallel strings of tubing, packers set immediately above the injection intervals, and provide for testing to determine any leakage of the tubing, casing or upper packers.

(4) That the mechanics of the proposed dual completions are feasible and in accordance with good conservation practices.

(5) That before injection into either of said wells should begin, the applicant should consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata.

F

(6) That the operator should take all steps necessary to ensure that the injected water enters only the proposed injection interval and is not permitted to escape to other formations or onto the surface.

(7) That approval of the subject application will prevent the drilling of unnecessary wells and otherwise prevent waste and protect correlative rights.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby granted authority to expend its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones.

PROVIDED HOWEVER, that each of said wells shall be equipped with parallel strings of 2 1/16-inch tubing, packers set immediately above each injection zone, and that the casing-tubing annulus shall be filled with an inert fluid; and that a pressure gauge shall be attached to the annulus or the annulus shall be equipped with an approved leak detection device in order to determine leakage in the casing, tubing, or packer.

(2) That prior to commencing injection into either of the subject wells, the operator shall consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata in said projects.

(3) That the injection wells or systems shall be equipped with pop-off valves or acceptable substitutes which will limit the wellhead pressure on the injection wells to a pressure no higher than that determined pursuant to Order No. (2) above.

(4) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

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

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

PHIL R. LUCERO, Chairman

EMERY C. ARNOLD, Member

JOE D. RAMEY, Member & Secretary

S E A L
jr/

## DISCUSSION

### FIELD HISTORY

The South Hospah field is located in McKinley County, New Mexico (Section 12, T17N-R9W), approximately 120 miles south of Farmington. The field is in the Chaco Slope region of the San Juan Basin. The Upper Hospah was discovered in 1965. Tenneco purchased the property in September, 1966 and began developing the Upper Hospah during 1967. Production of the Lower Hospah began in April, 1967.

The Upper Hospah reservoir performed as a pressure depletion drive (since solution gas was negligible). Graph No. 1 depicts the steep production decline experienced under this drive mechanism. Because of a very low expected primary recovery, a waterflood was initiated in the reservoir in June, 1968. The response to water injection can be seen very vividly on Graph No. 1. Figure No. 1 shows the Upper Hospah Unit, with the current well locations. The injection scheme developed into a fairly irregular pattern, with an average well spacing of 10 acres. Currently, the Unit has 20 active producers and 10 active water injection wells. Production averages 180 BOPD and 4700 BWPD, resulting in a field oil cut of 3.7%. Water injection is about 4700 BPD. The Upper Hospah Unit was classified as stripper in September, 1979.

The Lower Hospah reservoir has an active aquifer and mobile water at original saturations, as exhibited on Graph No. 2 as very early water production. The crude from the Lower Hospah is fairly viscous, 55 cp. at reservoir temperature, and contributes to an unfavorable water-oil mobility ratio. An attempt to improve the mobility ratio and, thereby, increase the recovery was initiated in September, 1972, when a simultaneous gas-water injection project began. The basic goal of the process was for the gas to swell the oil and reduce the oil viscosity, improving the mobility ratio. Water would then be able to displace

Exhibit H

the oil more effectively. Gas injection was expensive due to a number of operational problems (gas-locking of pumps, emulsion treating, and venting the casing) and was discontinued for a period of time during 1976. When no negative production effects were seen, it was decided to terminate gas injection completely; however, water injection has continued to the present. Figure 2 shows there are 26 active producers and 11 active injectors. Average production is 720 BOPD and 21,400 BWPD (a field oil cut of 3.25%), with water injection of 21,200 BPD.

As seen on Graph 2, response to water injection in the Lower Hospah was not as dramatic as that of the Upper Hospah. The waterflood was considered effective, because of the abatement of the apparent production decline after 1973. The large production increase exhibited in 1977 and 1978 was a result of the deepening of 11 wells, the drilling of 4 infill wells, and increased lift capacity in many of the producers.

GEOLOGY

The Upper Hospah sand is composed of 3-4 major stringers separated by thin shale beds. The type log labeled Figure 3 shows these members. The Upper Hospah is a marine sand bar deposit with areas of poorer rock type due to channeling. Directional permeability is oriented along a northeast to southwest line. The productive limits are defined by a fault along the northwest and a decrease in rock permeability to the east and south (areas proven as non-productive). The structure is fairly simple and flat. The structure map presented as Figure 4 shows the dip is approximately 1°.

The Lower Hospah sand is a blanket sand deposit. Productive limits are defined by the fault on the northwest flank and the original oil-water contact at ± 5,375'. The aquifer is active, tilted 25-30 feet and encountered by every well in the field. The structure is fairly flat, with a dip of 1° (see Figure 5).

EOR PROCESS DESCRIPTIONS

Because of the reservoir and fluid factors discussed previously and the results of laboratory core tests, in situ combustion, steamflooding, and micro-emulsion flooding were evaluated for application to the Lower Hospah.

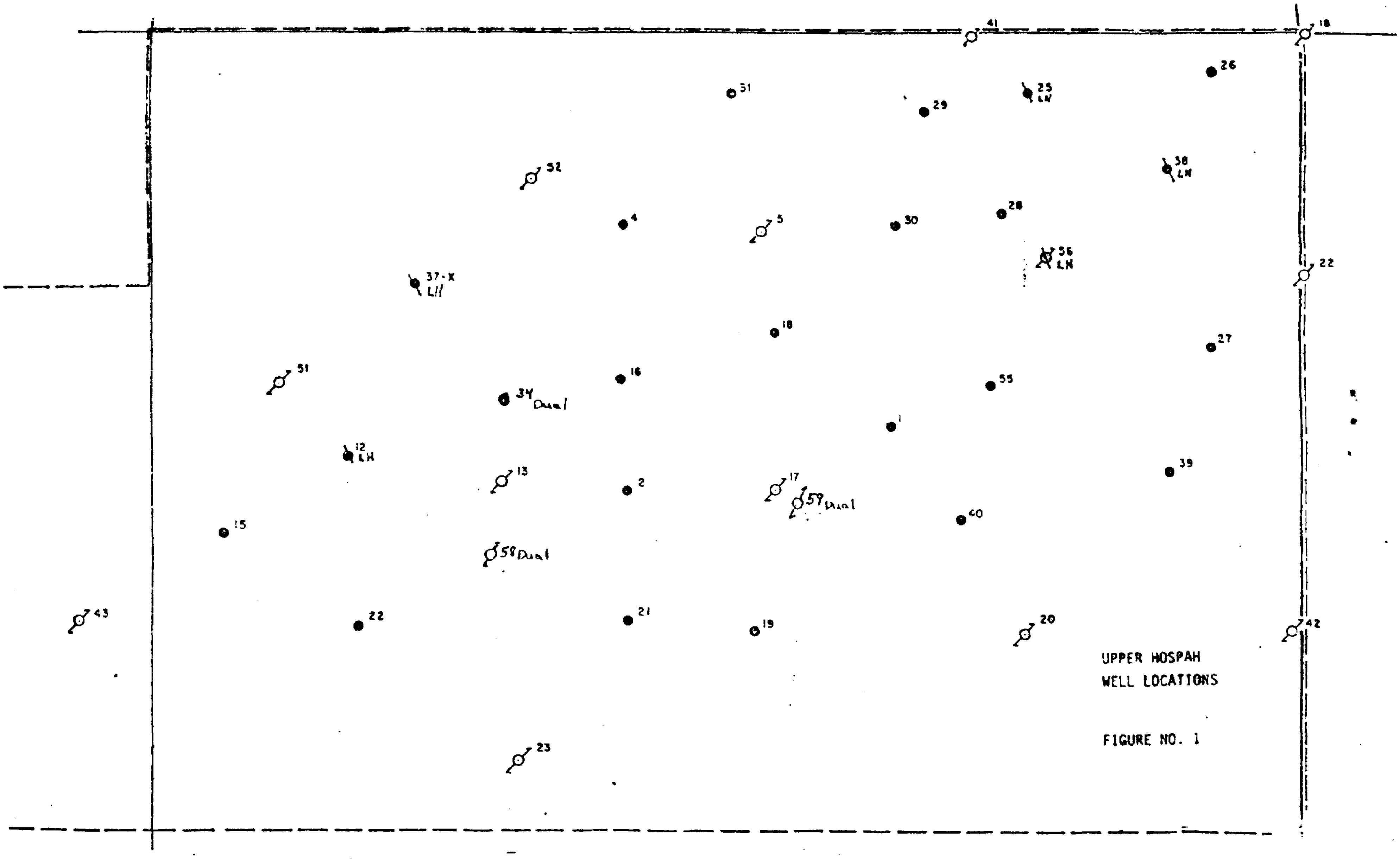
In situ combustion involves the injection of air into the reservoir; the mechanical, chemical, or spontaneous ignition of the oil in the reservoir; and the continued injection of air and combustion of a fraction of the oil in the reservoir. The fraction of crude that provides the fuel is called coke, the heavier ends of the crude deposited on the formation as a result of the heat of combustion vaporizing the lighter ends. The vaporization of the lighter ends, steam generated from formation water, and the gases generated as products of combustion reduce the oil viscosity and provide the driving force to enhance the oil recovery. Oil is not only swept from the area immediately ahead of the burn front, but 40% or more of the oil outside of the swept area is affected by the heat and recovered. Temperatures in the burn front usually are in the range of 700-1200°F. The various regions in the reservoir are depicted in the cross-section on Figure 6. The burned region behind the burn front is 100% air-saturated, leaving no residual oil behind. A large amount of heat remains in this burned region to eventually dissipate to the base and cap rock. The efficiency of this system can be improved by scavenging this heat through the injection of water. When water and air are simultaneously or alternately injected, the water flashes to steam near the injection well, superheated steam traverses the burn front, and this steam aids in the viscosity reduction and distillation of oil ahead of the burn front. Optimum "wet combustion" displaces most of the excess heat from behind the burn front to the

oil bank and results in a two-thirds reduction in air requirements over dry combustion and a considerable reduction in fuel consumption. Obviously, both reductions serve to improve the process recovery and economics. One such process that was proven effective is the COFCAW process (Combination of Forward Combustion and Waterflooding).

ECONOMIC DEVELOPMENT

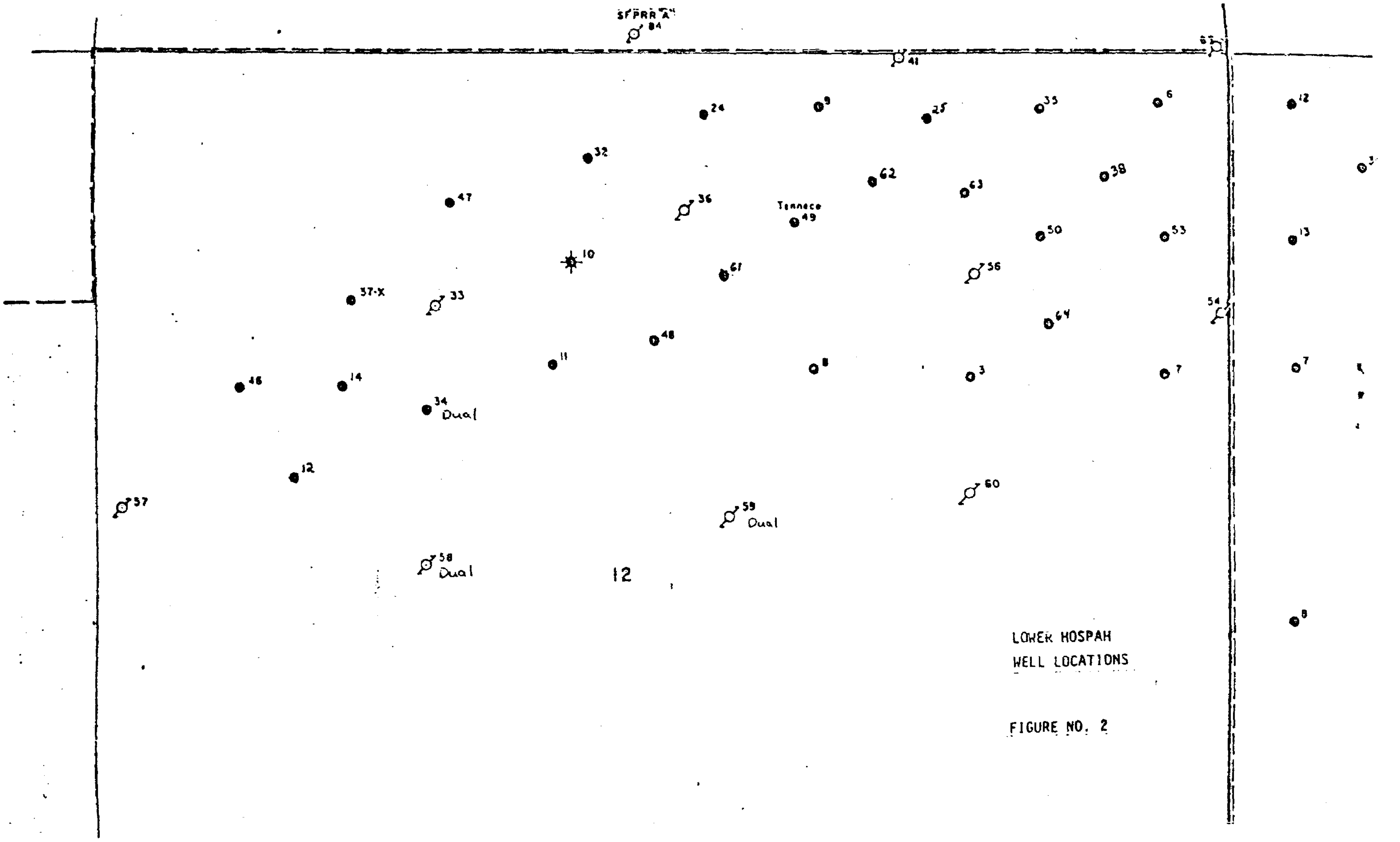
Table No. 10 presents the general economic parameters that apply to all processes. All economic evaluations were performed using only the incremental tertiary production, the capital expenditures to get that production, and the O&M expense applicable only to the EOR operation. Incremental tertiary oil (projected EOR response less the remaining secondary production) enjoys market incentive prices which were $32/BO at 1/1/80. A 50% excise tax was imposed resulting in a net price of $24/BO. Pattern development was assumed to begin the second quarter of 1980. As a 5-spot or set of patterns developed, it was assumed the injection plant would be available for injection in the completed areas. Recoupment of allowable expenditures occurs in the quarter the expenditure is made and no recoupment was credited after October 1, 1981 (when all oil is assumed decontrolled).

The DOE has passed a ruling which will allow operators of certain EOR projects begun after Sepember 30, 1979, to recoup 75% of certain capital expenditures involved with that project. The recoupment process involves the release of enough Lower Tier oil to Upper Tier prices to cover the recoupable amount. The allowable recoupment can be taken whether the project is a success or not. The purpose behind this ruling is to help operators defray the larger front-end capital expenditures mandated by most EOR projects; thereby, making these projects economically attractive so that more projects will be initiated and the U.S. dependence on imported crude might be decreased.



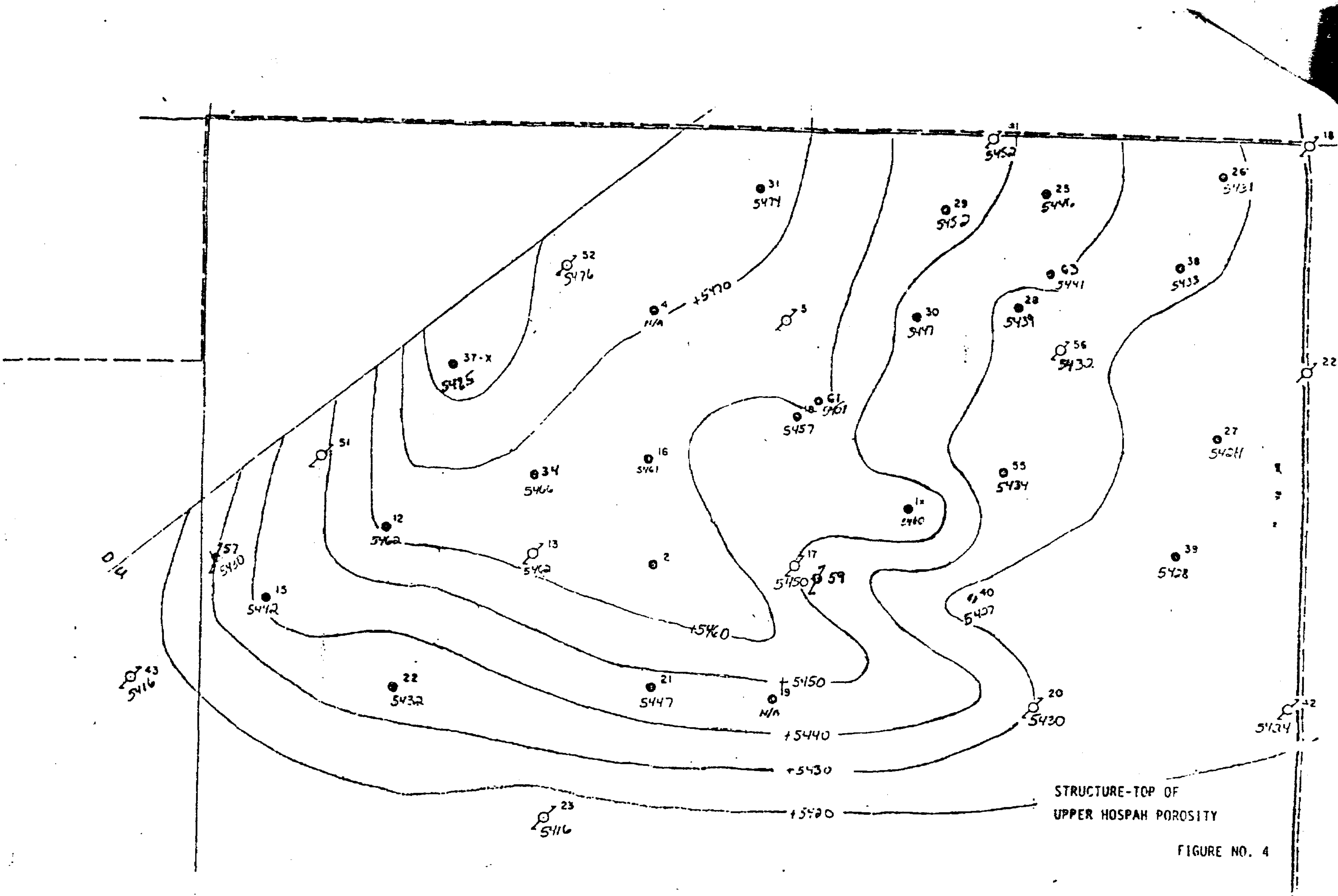

UPPER HOSPAH
WELL LOCATIONS

FIGURE NO. 1




LOWER HOSPAH
WELL LOCATIONS

FIGURE NO. 2




STRUCTURE-TOP OF
UPPER HOSPAH POROSITY

FIGURE NO. 4

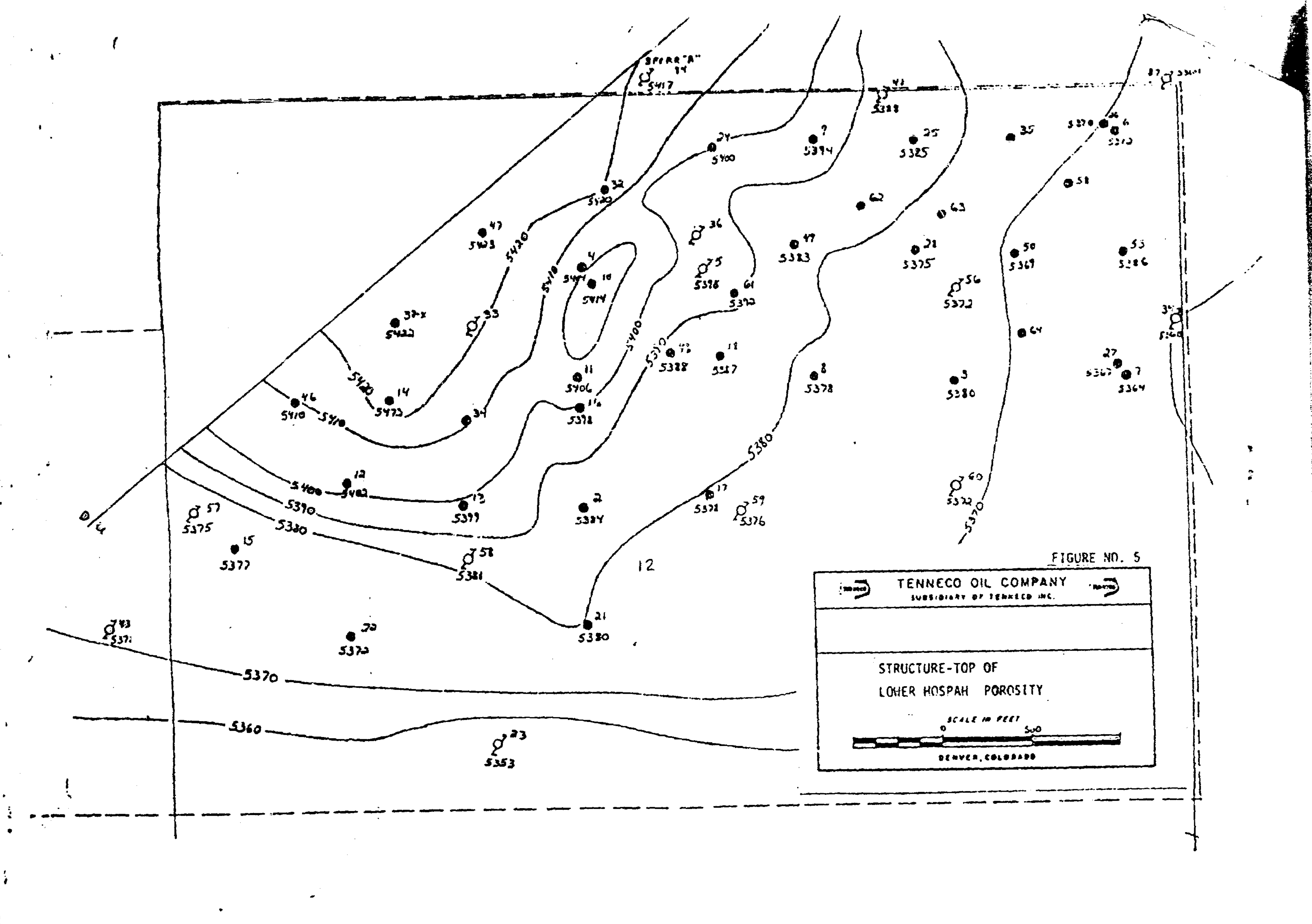
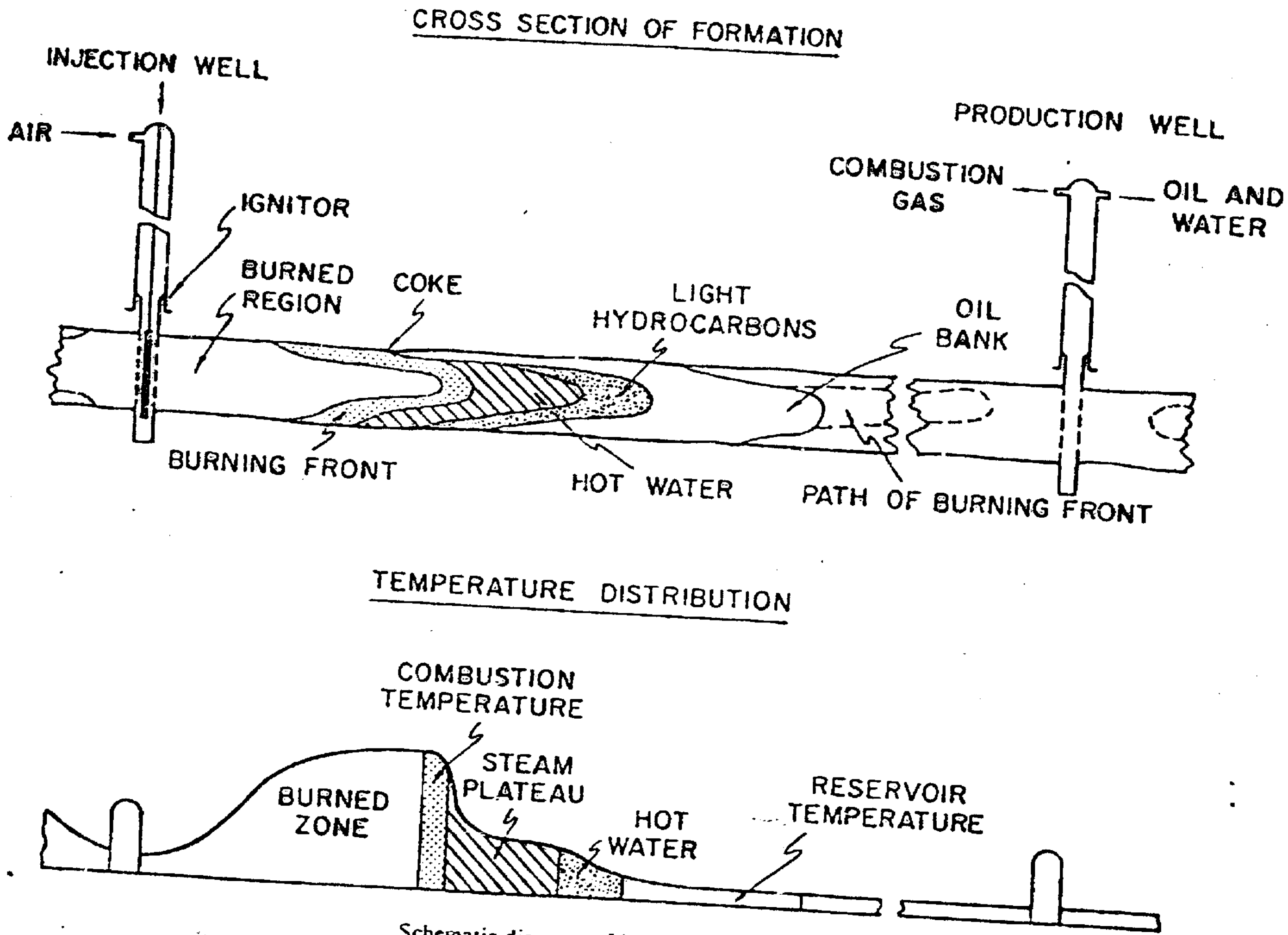


FIGURE NO. 5
TENNECO OIL COMPANY
SUBSIDIARY OF TENNECO INC.
STRUCTURE-TOP OF
LOWER HOSPAH POROSITY
SCALE IN FEET
DENVER, COLORADO
5370
5360
5380
5390
5400
5410
5420
12




Schematic diagram of in situ combustion process.

FIGURE NO. 6

(reprinted from Ref. No. 12)

CEIPTS WORKSHEET

| TION | CODE | INSTITUTION | CODE | RIGHT OF WAYS | CODE |
|---|---|---|---|---|---|
| chools | 12 | Miners Hospital | 01 | Pipeliner | 01 |
| ty | 13 | N.M. State Hospital | 02 | Power Lines | 02 |
| ty Saline | 14 | Penitentiary | 03 | Tele & Tele Lines | 03 |
| ural College | 15 | N.M.School for Deaf | 04 | Railroad Lines | 04 |
| 1 Silver City | 16 | Sch.Visual Handicap | 05 | Private Roads | 05 |
| Las Vegas | 17 | Charity-Penal-Reform | 06 | State,County Roads | 06 |
| El Rito | 18 | Water Reservoirs | 07 | Dams & Spillways | 07 |
| n | 19 | Improve Rio Grande | 08 | Avigation | |
| f Mines | 20 | Public Buildings | 09 | Borrow Pits | |
| Institute | 21 | Carrie Tingley Hsptl | 10 | Cattle Drives | |
| o Boys School | 22 | State Park Commission | 11 | Radio Towers | |
| | | | 12 | Cathodic Sites | |
| | | | 13 | Coal Permits | |

37 Billing Date | Due Date 49 | Penalty 56 | Intere

me

me, Pertinent Information

me, Pertinent Information 4647 Sales 54 Net Value

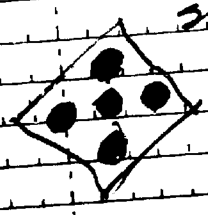
27 [redacted] 31 Beginning 38 39 Production [redacted]

Name, First) Cary Kaltenbacher

Tesoro

11 Hospah Unit

shallow 350' 7 lab. zone



527 31 3738 4344 4950 5657 6

**CASE 6876:** (Continued from April 23, 1980, Examiner Hearing)

Application of Maurice L. Brown Co. for compulsory pooling, Lea County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Vada-Pennsylvanian Pool underlying the SW/4 of Section 5, Township 9 South, Range 34 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision. Also to be considered will be the designation of applicant as operator of the well and a charge for risk involved in drilling said well.

**CASE 6886:** Application of Aminoil USA, Inc. for compulsory pooling and an unorthodox location, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Wolfcamp and Pennsylvanian formations underlying the S/2 of Section 10, Township 24 South, Range 28 East, to be dedicated to a well to be drilled at an unorthodox location 2080 feet from the South line and 1773 feet from the East line of said Section 10. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision. Also to be considered will be the designation of applicant as operator of the well and a charge for risk involved in drilling said well.

**CASE 6887:** Application of General Crude Processing for an oil treating plant permit, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks authority for the construction and operation of an oil treating plant for the purpose of treating and reclaiming sediment oil at a site in the SE/4 SE/4 of Section 21, Township 30 North, Range 12 West.

**CASE 6888:** Application of Conoco Inc. for a non-standard gas pr[illegible]tion unit and an unorthodox gas well location, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of a 120-acre non-standard Eumont gas proration unit comprising the S/2 SE/4 and NE/4 SE/4 of Section 12, Township 19 South, Range 36 East, to be dedicated to its State KN-12 Well No. 7 drilled at an unorthodox location 330 feet from the South line and 1650 feet from the East line of said Section 12.

**CASE 6889:** Application of Belco Petroleum Corporation for directional drilling, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks authority to directionally drill a well, the surface location of which is 1980 feet from the North line and 920 feet from the West line of Section 36, Township 22 South, Range 30 East, in such a manner as to bottom it at an unorthodox location within 100 feet of a point 1320 feet from the North line and 2640 feet from the West line of said Section 36 in the Morrow formation, the N/2 of said Section 36 to be dedicated to the well.

**CASE 6861:** (Continued from April 23, 1980, Examiner Hearing)

Application of Zia Energy, Inc. for pool creation, special pool rules, and an NGPA determination, Lea County, New Mexico. Applicant, in the above-styled cause, seeks the creation of a new San Andres oil pool for its State "C" Well No. 1 located in Unit F of Section 17, Township 22 South, Range 37 East, and special rules therefor, including a provision for a limiting gas-oil ratio of 10,000 to 1. Applicant further seeks a new onshore reservoir determination for said State "C" Well No. 1.

**CASE 6890:** Application of Tenneco Oil Company for a thermal enhanced recovery project, McKinley County, New Mexico. Applicant, in the above-styled cause, seeks authority to initiate a pilot in situ combustion enhanced recovery project in the South Hospah Upper Sand and South Hospah Lower Sand Oil Pools by the completion of an injection/ignition well at a point 1474 feet from the North line and 2725 feet from the East line of Section 12, Township 17 North, Range 9 West, and by the drilling of up to six producing wells, all at unorthodox locations in close proximity to the injection/ignition well, and all located in Units F or G of said Section 12.

Dockets Nos. 14-80 and 15-80 are tentatively set for May 21 and June 4, 1980. Applications for hearing must be filed at least 22 days in advance of hearing date.

DOCKET: EXAMINER HEARING - WEDNESDAY - MAY 7, 1980

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

The following cases will be heard before Daniel S. Nutter, Examiner, or Richard L. Stamets, Alternate Examiner:

CASE 6880: Application of Union Oil Company of California for a unit agreement, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval for the West Lynch Deep Unit Area, comprising 1,280 acres, more or less, of fee and federal lands in Township 20 South, Range 34 East.

CASE 6857: (Readvertised)

Application of Holly Energy, Inc. for an unorthodox gas well location, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks approval for the unorthodox location of a Wolfcamp-Pennsylvanian test well to be drilled 660 feet from the South line and 990 feet from the East line of Section 14, Township 18 South, Range 28 East, the E/2 of said Section 14 to be dedicated to the well.

CASE 6881: Application of Yates Petroleum Corporation for an unorthodox gas well location, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks approval for the unorthodox location of a Morrow test well to be drilled 1980 feet from the North line and 660 feet from the East line of Section 30, Township 17 South, Range 26 East, the N/2 of said Section 30 to be dedicated to the well.

CASE 6843: (Continued from April 9, 1980, Examiner Hearing)

Application of Yates Petroleum Corporation for two compulsory poolings, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Yeso formation underlying two 40-acre proration units, the first being the SE/4 SE/4 and the second being the SW/4 SE/4 of Section 6, Township 19 South, Range 25 East, Penasco Draw Field, each unit to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said wells and the allocation of the cost thereof as well as actual operating costs and charges for supervision. Also to be considered will be the designation of applicant as operator of the wells and a charge for risk involved in drilling said wells.

CASE 6882: Application of Amoco Production Company for compulsory pooling, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Pennsylvanian formation underlying the W/2 of Section 1, Township 19 South, Range 25 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision. Also to be considered will be the designation of applicant as operator of the well and a charge for risk involved in drilling said well.

CASE 6883: Application of Amoco Production Company for a waterflood project, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a waterflood project in the Indian Draw-Delaware Pool by the injection of water into the Delaware formation through its Old Indian Draw Unit Wells Nos. 4 located in Unit I of Section 18 and 11 located in Unit A of Section 19, both in Township 22 South, Range 28 East.

CASE 6884: Application of Supron Energy Corporation for compulsory pooling and a dual completion, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Mesaverde and Dakota formations underlying the N/2 of Section 4, Township 30 North, Range 11 West, to be dedicated to a proposed dual completion to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision. Also to be considered will be the designation of applicant as operator of the well and a charge for risk involved in drilling said well.

CASE 6885: Application of Supron Energy Corporation for compulsory pooling and a dual completion, Rio Arriba County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Mesaverde and Pictured Cliffs formations underlying the E/2 of Section 8, Township 25 North, Range 3 West, to be dedicated to a proposed dual completion to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision. Also to be considered will be the designation of applicant as operator of the well and a charge for risk involved in drilling said well.

# ENHANCED OIL RECOVERY PROPOSAL
## SOUTH HOSPAH FIELD

Tenneco Oil Company proposes to implement a pilot In Situ Combustion Project in the South Hospah Field, McKinley County, New Mexico. The purpose of this pilot is to corroborate preliminary engineering evaluation of the technical feasibility of this enhanced oil recovery process. The economic viability of a full-field combustion project will also be ascertained.

The South Hospah Field is located approximately 100 miles southeast of Farmington, New Mexico (Exhibit 1). The field consists of two separate reservoirs. The Upper Hospah reservoir was discovered in 1965. Production from the Lower Hospah reservoir began in April, 1967. These two sands are depicted on the log of Hospah No.18 in Exhibit 3.

Under primary production field recovery from the Upper Hospah sand was 510 MSTB. Primary production from the Lower Hospah was 1465 MSTB.

Waterflooding was initiated in the Upper Hospah sand in 1968. Response to water injection was very dramatic and has proven highly successful. Ultimate recovery from primary and secondary production in this sand is projected to be 3029 MSTB.

Gas/water injection was implemented in the Lower Hospah sand in 1972 as a means of enhancing oil recovery. Gas injection was not beneficial and was discontinued in 1976. Waterflooding was continued and has proven successful. During 1977 and 1978 a deepening and infill drilling program further improved Lower Hospah performance. Projected ultimate recovery from the Lower Hospah sand under primary and secondary recovery is 3255 MSTB.

Field development and production response are depicted on Exhibits 4 and 5.

The South Hospah field is now fully developed and in the latter, declining years of secondary production. A thorough study of the reservoir and crude properties at South Hospah was made to determine the applicability of tertiary processes to further improve recovery from the field. Steamflooding, in situ combustion, caustic-polymer flooding, and micellar-polymer flooding were considered technically appropriate. Based on laboratory tests and engineering calculations, in situ combustion is the most technically and economically feasible process for extending the producing life of this field.

The proposed in situ combustion pilot is designed to supplement our studies, providing certain additional information. Specifically:

1. Confirm that ignition and sustained combustion can be achieved.
2. Verification of the prediction model (i.e., recovery and response vs. time).
3. Injection rates and pressure for compressor sizing.
4. Lift requirements in producing wells.
5. The magnitude of operations problems:
    a. Gas production and handling
    b. Emulsions
    c. Corrosion.
6. Effect of heat on standard cement and completions.

The small pattern area (0.68 acres) proposed should facilitate a maximum of information gained in a minimum amount of time.

A dual air injection well will be drilled as presented on Exhibit 7. With the ignition equipment currently available, a packer cannot be used in this well. It will be necessary to inject air down the casing for ignition by either a gas or electric down-hole heater.

Two existing producing wells will be utilized. In addition, two new producing wells will be drilled. These four producing wells will be completed in the Lower Hospah sand. Ignition and combustion will be attempted in only the Lower Hospah sand. Air injectivity testing in the Upper Hospah sand will be accomplished simultaneously through use of the second casing string of the dual air injection well.

Separate production facilities will be constructed to monitor the combustion front progress and combustion efficiency, incremental tertiary oil recovery, and exhaust gas composition.

The information obtained from this pilot test is expected to confirm our preliminary evaluations and indicate whether fieldwide expansion is warranted.

ENHANCED OIL RECOVERY PROPOSAL
SOUTH HOSPAH FIELD

EXHIBIT #

1. Hospah location map
2. Field map w/all wells w/i 2 mile radius
3. Log of No.18
4. UH decline curve
5. LH decline curve
6. Plat showing proposed pilot (w/dimensions)
7. Schematic - AIW
8. Schematic prod. well
9. Tabulation of wells w/i 1/2 mile radius
10. Schematic of all P&A wells w/i 1/2 mile radius
11. Frac grad. info
12. Tabulation of fresh water sands encountered.

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

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IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION FOR THE PURPOSE OF CONSIDERING:

CASE NO. 6890
Order No. R-6389

APPLICATION OF TENNECO OIL COMPANY FOR A THERMAL ENHANCED RECOVERY PROJECT, McKINLEY COUNTY, NEW MEXICO.

ORDER OF THE DIVISION

BY THE DIVISION:

This cause came on for hearing at 9 a.m. on May 7, 1980, at Santa Fe, New Mexico, before Examiner Daniel S. Nutter.

NOW, on this ________ day of June, 1980, the Division Director, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

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

(2) That the applicant, Tenneco Oil Company, is the owner and operator of the South Hospah Unit Area in the South Hospah-Upper Sand Oil Pool, and of the Hospah Lease in the South Hospah-Lower Sand Oil Pool, both in Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico.

(3) That the applicant proposes to institute a thermal enhanced tertiary recovery project (fire flood) on said Hospah Lease by the underground ignition of hydrocarbons in the South Hospah-Lower Sand Oil Pool in a pilot area comprising some 0.68 acres in Unit G of Section 12, Township 17 North, Range 9 West, NMPM.

(4) That primary development of the Lower Hospah Pool on the subject lease occurred from 1967 until 1972, at which time a gas-water injection project was instituted.

(5) That said gas-water injection project was continued until 1976, when gas injection was terminated, but water injection into the Lower Hospah pool has been continued to date.

(6) That primary production from the Lower Hospah pool accounted for approximately 15 percent of the original oil in place. and secondary recovery under the gas-water injection program and waterflood operations should yield an additional 19 percent of the original oil in place.

(7) That the 34 percent total production expected under primary and secondary recovery operations amounts to 3,255,000 barrels, of a total of approximately 9,575,000 barrels of original oil in place, and it is expected that the proposed thermal enhanced tertiary recovery project, if expanded to a field-wide operation, would add about 13 percent recovery to the pool, or 1,245,000 barrels.

(8) That the applicant proposes to drill an air injection well at a point approximately 1474 feet from the North line and 2725 feet from the East line of the aforesaid Section 12, ~~and~~ said point being approximately midway between applicant's Lower Hospah Well No. 48 and its Upper Hospah Unit Well No. 18 (which will be recompleted in the Lower Hospah pool) and to also drill two additional wells, Nos. 65 and 66, which would be located immediately North and South of the air injection well at points 1350 feet from the North line and 2725 feet from the East line, and 1600 feet from the North line and 2725 feet from the East line, respectively, thereby creating a 0.68-acre pilot project area with one air injection well in the center and four producing wells, one each to the North, South, East, and West, thereof.

(9) That said wells would be cased through the Lower Hospah producing formation and would be cemented with a special high temperature-resistant cement.

(10) That the applicant proposes to inject approximately 500,000 cubic feet of air per day into the Lower Hospah Pool through the aforesaid air injection well and to then ignite the oil in the reservoir by the injection and ignition of methane gas, creating a fire front which would advance through the reservoir, sweeping the unburned oil towards the producing wells by a wall of hot vapors advancing ~~in front of~~ ahead of the fire front.

(11) That the applicant may also attempt to further stimulate production from the reservoir by a combination of such forward combustion and water injection.

(12) That the feasibility of the proposed thermal enhanced tertiary recovery ~~project~~ process has been proven in other reservoirs in other states, and should be determined in this State.

(13) That although some small percentage of the oil in place in the reservoir would be consumed by the advancing fire front, the proposed pilot fire flood, if successful, should result in the recovery of ~~up to 1,245,000 barrels~~ a substantial amount of otherwise unrecoverable oil reserves, thereby preventing waste.

(14) That provided the injection and producing wells are cased and cemented properly, and the injected air, methane and water are confined to the Lower Hospah producing sand, no impairment of water quality in any potable water sands should occur.

(15) That the proposed enhanced recovery project will not impair the correlative rights of any other interest owner in the Lower Hospah pool and should be approved.

(16) That the applicant also proposes to inject air into the Upper Hospah pool through the proposed air injection well which will have two strings of casing cemented therein, one open to the upper pool and one open to the lower pool.

(17) That said injection into the upper pool would be for test purposes only, and no ignition of hydrocarbons is planned for said Upper Hospah ~~Upper~~ pool at this time.

Case No. 6890
Order No. R-__________

(18) That said air injection into the Hospah Lower Pool will not cause waste nor impair correlative rights and should be approved.

(19) That the proposed air injection well and producing Wells Nos. 65 and 66 would be at unorthodox locations, but such unorthodox locations will neither cause waste nor impair correlative rights and should be approved.

(20) That the applicant proposes a maximum surface injection pressure for the air injection well of approximately 1000 psi, and this proposed injection pressure will not fracture the confining strata and should be approved.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby authorized to institute a thermal enchanced tertiary recovery project in the South Hospah-Lower Sand Oil Pool, McKinley County, New Mexico, by the injection of air, gas, and water into one injection well to be located 1474 feet from the North line and 2725 feet from the East line of Section 12, Township 17 North, Range 9 West, NMPM, and by the ignition of hydrocarbons *in situ* around the injection well, and by the production of hydrocarbons from two existing wells, applicant's Well No. 48, located 1485 feet from the North line and 2817 feet from the East line, and Well No. 18, located 1600 feet from the North line and 3100 feet from the West line, and from two additional wells to be drilled, applicant's Well No. 65, to be located 1350 feet from the North line and 2725 feet from the East line, and Well No. 66, to be located 1600 feet from the North line and 2725 feet from the East line, all in the aforesaid Section 12.

(2) That the aforesaid wells to be drilled shall be cased through the Lower Hospah sand formation and shall be cemented with high temperature-resistant cement, provided however, that said cement shall be brought back to a point at least 100 feet above the top of the Upper Hospah sand formation.

(3) That allowable restrictions are hereby removed from wells in the pilot project area for the duration of the combustion and post-combustion life of the project.

(4) That injection of air and methane into the South Hospah-Lower Sand Oil Pool ~~should be~~ shall be limited to 1000 psi pressure at the wellhead and injection of water into said pool shall be limited to 800 psi pressure at the wellhead; that the Division Director is authorized to permit higher injection pressures upon adequate showing by the operator that no adverse effects would result.

(5) That the injection of air into the South Hospah-Upper Sand Oil Pool through the air injection well herein approved ~~[illegible]~~ is hereby authorized, provided however, that such injection shall be at no more than 1000 psi pressure at the wellhead.

(6)~~(5)~~ That jurisdiction of this cause is retained for the entry of such further orders as the Division may deem necessary.

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

EXHIBIT 9
Case 6890

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **TENNECO OIL COMPANY** | | | | | | | | | | | |
| Upper Hospah No.1X | 12-17N-9W 1980'FNL&2052'FEL | 1565' | 7-5/8 | (24#) | 31' | 10 sx - surface | 4-1/2 | (11.6#) | 1505' | 75 sx | |
| Upper Hospah No.2 | 12-17N-9W 2310'FNL&2310'FWL | 1637' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1635' | 60 sx | |
| Lower Hospah No.3 | 12-17N-9W 1650'FNL&1392'FEL | 1603' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | (10.5#) | 1602' | 60 sx | |
| Upper Hospah No.4 | 12-17N-9W 990'FNL&2310'FWL | 1640' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | (10.5#) | 1628' | 60 sx | |
| Upper Hospah No.5 | 12-17N-9W 990'FNL&2712'FEL | 1645' | 7 | (17#) | 30' | 10 sx- surface | 4-1/2 | (10.5#) | 1644' | 60 sx | |
| Lower Hospah No.6 | 12-17N-9W 330'FNL& 330'FEL | 1710' | 10-3/4 | (32.4#) | 45' | 50 sx - surface | 7 | (23#) | 1694' | 75 sx | |
| Lower Hospah No.7 | 12-17N-9W 1650'FNL& 330'FEL | 1750' | 10-3/4 | (32.75#) | 45' | 75 sx - surface | 7 | (20#) | 1713' | 130 sx | |
| Lower Hospah No.8 | 12-17N-9W 1650'FNL&2051'FEL | 1709' | 10-3/4 | (22.75#) | 55' | 50 sx - surface | 7 | (20#) | 1687' | 110 sx | |
| Lower Hospah No.9 | 12-17N-9W 330'FNL&2051'FEL | 3945' | 10-3/4 | (32.75#) | 86' | 90 sx - surface | 7 | (23&20#) | 3933' | 510 sx | |
| Lower Hospah No.10 | 12-17N-9W 990'FNL&2300'FWL | 2827' | 10-3/4 | (32.75#) | 85' | 150 sx - surface | 7 | (20#) | 2827' | 320 sx | |
| Lower Hospah No.11 | 12-17N-9W 1650'FNL&2310'FWL | 1774' | 10-3/4 | (32.75#) | 45' | 50 sx - surface | 7 | (20#) | 1766' | 130 sx | |
| Lower Hospah No.12 | 12-17N-9W 2160'FNL& 990'FWL | 1840' | 10-3/4 | (32.75) | 47' | 70 sx - surface | 7 | (20#) | 1772' | 110 sx | |
| Upper Hospah No.13 | 12-17N-9W 2280'FNL&1620'FWL | 1720' | 7-5/8 | (26) | 44' | 50 sx - surface | 4-1/2 | (10.5#) | 1702' | 150 sx | |

EXHIBIT 9
Case 6890

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17N-9W | 1980'FNL&2052'FEL | 1565' | 7-5/8 | (24#) | 31' | 10 sx - surface | 4-1/2 | (11.6#) | 1505' | 75 sx | Producer-Upper |
| 17N-9W | 2310'FNL&2310'FWL | 1637' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1635' | 60 sx | Producer-Upper |
| 17N-9W | 1650'FNL&1392'FEL | 1603' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | (10.5#) | 1602' | 60 sx | Producer-Lower |
| 17N-9W | 990'FNL&2310'FWL | 1640' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | (10.5#) | 1628' | 60 sx | Producer-Upper |
| 17N-9W | 990'FNL&2712'FEL | 1645' | 7 | (17#) | 30' | 10 sx- surface | 4-1/2 | (10.5#) | 1644' | 60 sx | Wtr.Inj.-Upper |
| 17N-9W | 330'FNL& 330'FEL | 1710' | 10-3/4 | (32.4#) | 45' | 50 sx - surface | 7 | (23#) | 1694' | 75 sx | Producer-Lower |
| 17N-9W | 1650'FNL& 330'FEL | 1750' | 10-3/4 | (32.75#) | 45' | 75 sx - surface | 7 | (20#) | 1713' | 130 sx | Producer-Lower |
| 17N-9W | 1650'FNL&2051'FEL | 1709' | 10-3/4 | (22.75#) | 55' | 50 sx - surface | 7 | (20#) | 1687' | 110 sx | Producer-Lower |
| 17N-9W | 330'FNL&2051'FEL | 3945' | 10-3/4 | (32.75#) | 86' | 90 sx - surface | 7 | (23&20#) | 3933' | 510 sx | Producer-Lower |
| 17N-9W | 990'FNL&2300'FWL | 2827' | 10-3/4 | (32.75#) | 85' | 150 sx - surface | 7 | (20#) | 2827' | 320 sx | Producer-Lower<br>T&A-Dakota |
| 17N-9W | 1650'FNL&2310'FWL | 1774' | 10-3/4 | (32.75#) | 45' | 50 sx - surface | 7 | (20#) | 1766' | 130 sx | Producer-Lower |
| 17N-9W | 2160'FNL& 990'FWL | 1840' | 10-3/4 | (32.75) | 47' | 70 sx - surface | 7 | (20#) | 1772' | 110 sx | Producer-Lower |
| 17N-9W | 2280'FNL&1620'FWL | 1720' | 7-5/8 | (26) | 44' | 50 sx - surface | 4-1/2 | (10.5#) | 1702' | 150 sx | Wtr.Inj.-Upper |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | |
| Lower Hospah No.14 | 12-17N-9W | 1700'FNL&1300'FWL | 1790' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1763' | 200 sx |
| Upper Hospah No.16 | 12-17N-9W | 1755'FNL&2330'FWL | 1710' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1692' | 200 sx |
| Upper Hospah No.17 | 12-17N-9W | 2250'FNL&3000'FWL | 1787' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1691' | 200 sx |
| Upper Hospah No.18 | 12-17N-9W | 1475'FNL&3055'FWL | 1750' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1729' | 200 s |
| Upper Hospah No.19 | 12-17N-9W | 2310'FSL&2712'FEL | 1638' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1638' | 60 sx |
| Upper Hospah No.20 | 12-17N-9W | 2310'FSL&1392'FEL | 1647' | No surface pipe | | | - | 4-1/2 | (10.5#) | 1647' | 60 sx |
| Upper Hospah No.21 | 12-17N-9W | 2310'FSL&2310'FWL | 1690' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1685' | 60 sx |
| Upper Hospah No.22 | 12-17N-9W | 2210'FSL& 990'FWL | 1734' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1734' | 60 sx |
| Upper Hospah No.23 | 12-17N-9W | 1650'FSL&1800'FWL | 2968' | 8-5/8 | (20#) | 91' | 70 sx surface | 4-1/2 | (10.5#) | 2940' | 245 sx |
| Lower Hospah No.24 | 12-17N-9W | 330'FNL&2650'FEL | 1725' | 8-5/8 | (26#) | 51' | 40 sx - surface | 4-1/2 | (10.5#) | 1720' | 190 sx |
| Lower Hospah No.25 | 12-17N-9W | 330'FNL&1505'FEL | 1702' | 8-5/8 | (36#) | 51' | 40 sx surface | 4-1/2 | ( 9.5#) | 1683' | 240 sx |
| Upper Hospah No.26 | 12-17N-9W | 330'FNL& 380'FEL | 1660' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 225 sx |
| Upper Hospah No.27 | 12-17N-9W | 1570'FNL& 330'FEL | 1669' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1652' | 240 sx |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

a)

| | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -17N-9W | 1700'FNL&1300'FWL | 1790' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1763' | 200 sx | Producer-Lower |
| -17N-9W | 1755'FNL&2330'FWL | 1710' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1692' | 200 sx | Producer-Upper |
| -17N-9W | 2250'FNL&3000'FWL | 1787' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1691' | 200 sx | Wtr.Inj.-Upper |
| -17N-9W | 1475'FNL&3055'FWL | 1750' | 7-5/8 | (26#) | 59' | 50 sx - surface | 4-1/2 | (10.5#) | 1729' | 200 sx | Producer-Upper |
| -17N-9W | 2310'FSL&2712'FEL | 1638' | 7 | (17#) | 31' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1638' | 60 sx | Producer-Upper |
| 2-17N-9W | 2310'FSL&1392'FEL | 1647' | No surface pipe | | | - | 4-1/2 | (10.5#) | 1647' | 60 sx | Wtr.Inj.-Upper |
| 2-17N-9W | 2310'FSL&2310'FWL | 1690' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1685' | 60 sx | Producer-Upper |
| 2-17N-9W | 2210'FSL& 990'FWL | 1734' | 7 | (17#) | 30' | 10 sx - surface | 4-1/2 | ( 9.5#) | 1734' | 60 sx | Producer-Upper |
| 2-17N-9W | 1650'FSL&1800'FWL | 2968' | 8-5/8 | (20#) | 91' | 70 sx surface | 4-1/2 | (10.5#) | 2940' | 245 sx | T&A-Dakota Gas<br>Wtr.Inj.-Upper |
| 2-17N-9W | 330'FNL&2650'FEL | 1725' | 8-5/8 | (26#) | 51' | 40 sx - surface | 4-1/2 | (10.5#) | 1720' | 190 sx | Producer-Lower |
| 2-17N-9W | 330'FNL&1505'FEL | 1702' | 8-5/8 | (36#) | 51' | 40 sx surface | 4-1/2 | ( 9.5#) | 1683' | 240 sx | Producer-Lower |
| 2-17N-9W | 330'FNL& 380'FEL | 1660' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 225 sx | Producer-Upper |
| 2-17N-9W | 1570'FNL& 330'FEL | 1669' | 8-5/8 | (36#) | 50' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1652' | 240 sx | Producer-Upper |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | |
| Upper Hospah No.28 | 12-17N-9W | 933'FNL&1485'FEL | 1675' | 8-5/8 | (36#) | 51' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1658' | 240 sx |
| Upper Hospah No.29 | 12-17N-9W | 410'FNL&1870'FEL | 1606' | 8-5/8 | (24#) | 75' | 70 sx - surface | 5-1/2 | (15.5#) | 1606' | 85 sx |
| Upper Hospah No.30 | 12-17N-9W | 950'FNL&1980'FEL | 1605' | 8-5/8 | (24#) | 71' | 70 sx - surface | 5-1/2 | (15.5#) | 1605' | 85 sx |
| Upper Hospah No.31 | 12-17N-9W | 330'FNL&2800'FEL | 1626' | 8-5/8 | (24#) | 78' | 70 sx - surface | 5-1/2 | (15.5#) | 1626' | 96 sx |
| Lower Hospah No.32 | 12-17N-9W | 550'FNL&2370'FWL | 1647' | 10-3/4 | (32.75#) | 64' | 70 sx - surface | 7 | (20#) | 1632' | 125 sx |
| Lower Hospah No.33 | 12-17N-9W | 1340'FNL&1710'FWL | 1660' | 10-3/4 | (32.75#) | 61' | 70 sx - surface | 7 | (20#) | 1647' | 125 sx |
| Upper & Lower Hospah #34 | 12-17N-9W | 1820'FNL&1700'FWL | 1661' | 10-3/4 | (32.75#) | 67' | 70 sx - surface | 7 | (20#) | 1548' | 125 sx |
| Lower Hospah No.35 | 12-17N-9W | 330'FNL& 850' FEL | 1591' | 10-3/4 | (32.75#) | 75' | 60 sx - surface | 7 | (20#) | 1577' | 125 sx |
| Lower Hospah No.36 | 12-17N-9W | 900'FNL&2630'FEL | 1635' | 10-3/4 | (32.75#) | 78' | 60 sx - surface | 7 | (20#) | 1624' | 125 sx |
| Lower Hospah No.37X | 12-17N-9W | 1280'FNL&1280'FWL | 1666' | 10-3/4 | (32.75#) | 72' | 40 sx - surface | 7 | (20#) | 1635' | 135 sx |
| Lower Hospah No.38 | 12-17N-9W | 660'FNL& 660'FEL | 1565' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1565' | 100 sx |
| Upper Hospah No.39 | 12-17N-9W | 2180'FNL& 660'FEL | 1627' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1627' | 100 sx |
| Upper Hospah No.40 | 12-17N-9W | 2420'FNL&1650'FEL | 1637' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 100 sx |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -9W | 933'FNL&1485'FEL | 1675' | 8-5/8 | (36#) | 51' | 40 sx - surface | 4-1/2 | ( 9.5#) | 1656' | 240 sx | Producer-Upper |
| -9W | 410'FNL&1870'FEL | 1606' | 8-5/8 | (24#) | 75' | 70 sx - surface | 5-1/2 | (15.5#) | 1606' | 85 sx | Producer-Upper |
| -9W | 950'FNL&1980'FEL | 1605' | 8-5/8 | (24#) | 71' | 70 sx - surface | 5-1/2 | (15.5#) | 1605' | 85 sx | Producer-Upper |
| -9W | 330'FNL&2800'FEL | 1626' | 8-5/8 | (24#) | 78' | 70 sx - surface | 5-1/2 | (15.5#) | 1626' | 96 sx | Producer-Upper |
| -9W | 550'FNL&2370'FWL | 1647' | 10-3/4 | (32.75#) | 64' | 70 sx - surface | 7 | (20#) | 1632' | 125 sx | Producer-Lower |
| -9W | 1340'FNL&1710'FWL | 1660' | 10-3/4 | (32.75#) | 61' | 70 sx - surface | 7 | (20#) | 1647' | 125 sx | Wtr.Inj.-Lower |
| N-9W | 1820'FNL&1700'FWL | 1661' | 10-3/4 | (32.75#) | 67' | 70 sx - surface | 7 | (20#) | 1648' | 125 sx | Producer-Dual |
| N-9W | 330'FNL& 850' FEL | 1591' | 10-3/4 | (32.75#) | 75' | 60 sx - surface | 7 | (20#) | 1577' | 125 sx | Producer-Lower |
| N-9W | 900'FNL&2630'FEL | 1635' | 10-3/4 | (32.75#) | 78' | 60 sx - surface | 7 | (20#) | 1624' | 125 sx | Wtr.Inj.-Lower |
| N-9W | 1280'FNL&1280'FWL | 1666' | 10-3/4 | (32.75#) | 72' | 40 sx - surface | 7 | (20#) | 1635' | 135 sx | Upper-T&A Producer-Lower |
| N-9W | 660'FNL& 660'FEL | 1565' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1565' | 100 sx | Producer-Lower |
| 7N-9W | 2180'FNL& 660'FEL | 1627' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1627' | 100 sx | Producer-Upper |
| 7N-9W | 2420'FNL&1650'FEL | 1637' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 100 sx | Producer-Upper |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | LOCATION | | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PRO[illegible] I[illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | | |
| Upper Hospah No.41 | 12-17N-9W | 5'FNL&1650'FEL | 1611' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1610' | 100 sx | Wt[illegible] Up[illegible] |
| Lower Hospah No.46 | 12-17N-9W | 1700'FNL& 700'FWL | 1680' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1664' | 125 sx | Pr[illegible] |
| Lower Hospah No.47 | 12-17N-9W | 785'FNL&1775'FWL | 1780' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1647' | 125 sx | Pr[illegible] |
| Lower Hospah No.48 | 12-17N-9W | 1485'FNL&2817'FWL | 1635' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1625' | 125 sx | Pr[illegible] |
| Lower Hospah No.49 | 12-17N-9W | 885'FNL&2117'FEL | 1639' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1610' | 125 sx | Pr[illegible] |
| Lower Hospah No.50 | 12-17N-9W | 950'FNL& 900'FEL | 1593' | 9-5/8 | (36#) | 71' | 40 sx - surface | 7 | (20#) | 1583' | 125 sx | Pr[illegible] |
| Upper Hospah No.51 | 12-17N-9W | 1775'FNL& 620'FWL | 1662' | 8-5/8 | (24#) | 64' | 50 sx - surface | 5-1/2 | (15.5#) | 1662' | 150 sx | Wt[illegible] |
| Upper Hospah No.52 | 12-17N-9W | 720'FNL&1850'FWL | 1622' | 8-5/8 | (24#) | 74' | 50 sx - surface | 5-1/2 | (15.5#) | 1620' | 150 sx | Wt[illegible] |
| Lower Hospah No.53 | 12-17N-9W | 950'FNL& 330'FEL | 1578' | 8-5/8 | (24#) | 63' | 50 sx - surface | 7 | (20#) | 1559' | 100 sx | Pr[illegible] |
| Upper Hospah No.55 | 12-17N-9W | 1750'FNL&1550'FEL | 1583' | 9-5/8 | (36#) | 100' | 90 sx - surface | 7 | (20#) | 1583' | 100 sx | Pr[illegible] |
| Upper Hospah No.56 | 12-17N-9W | 1100'FNL&1275'FEL | 1584' | 9-5/8 | (36#) | 102' | 90 sx - surface | 7 | (20#) | 1584' | 95 sx | Wt[illegible] |
| Upper & Lower Hospah No.58 | 12-17N-9W | 2580'FNL&1640'FWL | 1679' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 350 sx | Wt[illegible] |
| Upper & Lower Hospah No.59 | 12-17N-9W | 2340'FNL&2500'FEL | 1657' | 8-5/8 | (24#) | 89' | 75 sx - surface | 5-1/2 | (15.5#) | 1657' | 225 sx | Wt[illegible] |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 5'FNL&1650'FEL | 1611' | 8-5/8 | (24#) | 71' | 75 sx - surface | 5-1/2 | (15.5#) | 1610' | 100 sx | Wtr.Inj.-Dual Upper-T&A |
| 1700'FNL& 700'FWL | 1680' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1664' | 125 sx | Producer-Lower |
| 785'FNL&1775'FWL | 1780' | 9-5/8 | (36#) | 62' | 40 sx - surface | 7 | (20#) | 1647' | 125 sx | Producer-Lower |
| 1485'FNL&2817'FWL | 1635' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1625' | 125 sx | Producer-Lower |
| 885'FNL&2117'FEL | 1639' | 8-5/8 | (24#) | 62' | 40 sx - surface | 5-1/2 | (15.5#) | 1610' | 125 sx | Producer-Lower |
| 950'FNL& 900'FEL | 1593' | 9-5/8 | (36#) | 71' | 40 sx - surface | 7 | (20#) | 1583' | 125 sx | Producer-Lower |
| 1775'FNL& 620'FWL | 1662' | 8-5/8 | (24#) | 64' | 50 sx - surface | 5-1/2 | (15.5#) | 1662' | 150 sx | Wtr.Inj.-Upper |
| 720'FNL&1850'FWL | 1622' | 8-5/8 | (24#) | 74' | 50 sx - surface | 5-1/2 | (15.5#) | 1620' | 150 sx | Wtr.Inj.-Upper |
| 950'FNL& 330'FEL | 1578' | 8-5/8 | (24#) | 63' | 50 sx - surface | 7 | (20#) | 1559' | 100 sx | Producer-Lower |
| 1750'FNL&1550'FEL | 1583' | 9-5/8 | (36#) | 100' | 90 sx - surface | 7 | (20#) | 1583' | 100 sx | Producer-Upper |
| 1100'FNL&1275'FEL | 1584' | 9-5/8 | (36#) | 102' | 90 sx - surface | 7 | (20#) | 1584' | 95 sx | Wtr.Inj.-Upper |
| 2580'FNL&1640'FWL | 1679' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1637' | 350 sx | Wtr.Inj.-Dual |
| 2340'FNL&2500'FEL | 1657' | 8-5/8 | (24#) | 89' | 75 sx - surface | 5-1/2 | (15.5#) | 1657' | 225 sx | Wtr.Inj.Dual |

TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| WELL IDENTIFICATION | | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TENNECO OIL COMPANY (cont'd) | | | | | | | | | | | |
| Lower Hospah No.60 | 12-17N-9W | 2210'FNL&1300'FEL | 1648' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1648' | 225 sx |
| Lower Hospah No.61 | 12-17N-9W | 1120'FNL&2510'FEL | 1715' | 9-5/8 | (36#) | 87' | 90 sx - surface | 7 | (23#) | 1715' | 375 sx |
| Lower Hospah No.62 | 12-17N-9W | 650'FNL&1770'FEL | 1710' | 9-5/8 | (36#) | 93' | 90 sx - surface | 7 | (23#) | 1710' | 375 sx |
| Lower Hospah No.63 | 12-17N-9W | 710'FNL&1325'FEL | 1695' | 9-5/8 | (36#) | 94' | 90 sx - surface | 7 | (23#) | 1690' | 375 sx |
| Lower Hospah No.64 | 12-17N-9W | 1360'FNL& 900'FEL | 1685' | 9-5/8 | (36#) | 90' | 90 sx - surface | 7 | (23#) | 1680' | 375 sx |
| TESORO | | | | | | | | | | | |
| SFPRR A-72 | 1-17N-9W | 330'FSL&1250'FEL | 1608' | 7 | | 58' | 35 sx | 4-1/2 | | 1608' | 150 sx |
| SFPRR A-73 | 1-17N-9W | 330'FSL&2000'FEL | 1665' | 8-5/8 | | 63' | 40 sx | 4-1/2 | | 1639' | 75 sx |
| SFPRR A-79 | 1-17N-9W | 330'FSL&2300'FEL | 1624' | 8-5/8 | | 58' | - | 5-1/2 | | 1593' | |
| SFPRR A-80 | 1-17N-9W | 1310'FEL& 630'FSL | 1622' | 8-5/8 | | 72' | - | 7 | | 1612' | |
| SFPRR A-81 | 1-17N-9W | 580'FSL&2090'FEL | 1655' | 8-/58 | | 73' | - | 5-1/2 | (14#) | 1643' | |
| SFPRR A-84 | 1-17N-9W | 5'FSL&2950'FEL | 1643' | 9-5/8 | (32.3#) | 91' | 100 sx | 7 | | 1639' | 100 sx |
| SFPRR A-87 | 1-17N-9W | 5'FSL& 50'FEL | 1598' | 8-5/8 | (24#) | 105' | 80 sx | 5-1/2 | (14#) | 1585' | 100 sx |
| SFPRR A-89 | 1-17N-9W | - - | 1769' | - | | - | - | | - | - | - |

## TABULATION OF ALL WELLS WITHIN A 1/2 MILE RADIUS

| | LOCATION | TD | SURF. CSG. SIZE | SURF. CSG. WEIGHT | DEPTH SET | CMT USED & TOP | PROD. CSG. SIZE | PROD. CSG. WEIGHT | DEPTH SET | CMT | PROD. OR INJ. INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -9W | 2210'FNL&1300'FEL | 1648' | 8-5/8 | (24#) | 88' | 75 sx - surface | 5-1/2 | (15.5#) | 1648' | 225 sx | Wtr.Inj.-Lower |
| -9W | 1120'FNL&2510'FEL | 1715' | 9-5/8 | (36#) | 87' | 90 sx - surface | 7 | (23#) | 1715' | 375 sx | Producer-Lower |
| -9W | 650'FNL&1770'FEL | 1710' | 9-5/8 | (36#) | 93' | 90 sx - surface | 7 | (23#) | 1710' | 375 sx | Producer-Lower |
| -9W | 710'FNL&1325'FEL | 1695' | 9-5/8 | (36#) | 94' | 90 sx - surface | 7 | (23#) | 1690' | 375 sx | Producer-Lower |
| -9W | 1360'FNL& 900'FEL | 1685' | 9-5/8 | (36#) | 90' | 90 sx - surface | 7 | (23#) | 1680' | 375 sx | Producer-Lower |
| -9W | 330'FSL&1250'FEL | 1608' | 7 | | 58' | 35 sx | 4-1/2 | | 1608' | 150 sx | Producer-Lower |
| -9W | 330'FSL&2000'FEL | 1665' | 8-5/8 | | 63' | 40 sx | 4-1/2 | | 1639' | 75 sx | Producer-Lower |
| -9W | 330'FSL&2300'FEL | 1624' | 8-5/8 | | 58' | - | 5-1/2 | | 1593' | | Producer-Upper |
| -9W | 1310'FEL& 630'FSL | 1622' | 8-5/8 | | 72' | - | 7 | | 1612' | | Producer-Lower |
| -9W | 580'FSL&2090'FEL | 1655' | 8-/58 | | 73' | - | 5-1/2 | (14#) | 1643' | | Producer-Lower |
| -9W | 5'FSL&2950'FEL | 1643' | 9-5/8 | (32.3#) | 91' | 100 sx | 7 | | 1639' | 100 sx | Wtr.Inj.-Lower |
| -9W | 5'FSL& 50'FEL | 1598' | 8-5/8 | (24#) | 105' | 80 sx | 5-1/2 | (14#) | 1585' | 100 sx | Wtr.Inj.-Lower |
| -9W | - - | 1769' | - | | - | - | | - | - | - | Producer-Lower |