CASE 2851: Application of SHELL for a waterflood project on its EAST PEARL QUEEN UNIT.

Case No.

2851

Application, Transcript,
Small Exhibits, Etc.

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
July 24, 1963

EXAMINER HEARING

IN THE MATTER OF:
(Continued from July 10, 1963 examiner hearing)
Application of Shell Oil Company for a unit agreement, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the East Pearl-Queen Unit Area comprising 2440 acres of State and Fee lands in Township 19 South, Range 35 East, Lea County, New Mexico. CASE 2850

IN THE MATTER OF:
(Continued from July 10, 1963 examiner hearing and readvertised)
Application of Shell Oil Company for a water-flood project, Lea County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a waterflood project on its East Pearl Queen Unit by the injection of water into the Queen formation through 31 wells in Sections 15, 21, 22, 26, 27, 28, 34, and 35, Township 19 South, Range 35 East, Lea County, New Mexico. CASE 2851

BEFORE: Daniel S. Nutter, Examiner

TRANSCRIPT OF HEARING

MR. NUTTER: We will call Case 2850.

MR. DURRETT: Application of Shell Oil Company for a unit agreement, Lea County, New Mexico.

MR. MORRIS: Off the record.

(Whereupon, a discussion off the record was held.)

MR. NUTTER: Is there objection to consolidation of Cases 2851 and 2852? The cases will be consolidated and continued

for an hour and a half.

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AFTERNOON SESSION

MR. NUTTER: The hearing will come to order, please. We'll now call Cases 2850 and 2851, which have been consolidated for hearing.

(Whereupon, Applicant's Exhibits Nos. 1 through 6-EE marked for identification.)

MR. MORRIS: Mr. Examiner, I am Richard Morris of Seth, Montgomery, Federici and Andrews, Santa Fe, appearing on behalf of the applicant, Shell Oil Company, in these two cases. We will have one witness, Mr. George Carnahan, and I ask that he be sworn at this time.

(Witness sworn.)

GEORGE G. CARNAHAN

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

DIRECT EXAMINATION

BY MR. MORRIS:

Q Please state your name and position.

A George G. Carnahan, Senior Reservoir Engineer, Shell Oil Company, Roswell, New Mexico.

Q Have you previously testified before the New Mexico Oil Conservation Commission or one of its examiners?

A No, I haven't.

Q Then would you briefly outline your education and professional experience in the oil business?

A I have a Bachelor's and Master's Degree in Petroleum Engineering from the University of Oklahoma; had five and a half years experience as production engineer and in reservoir engineering in West Texas and New Mexico.

Q Are you familiar with Shell's application in Cases 2850 and 2851?

A Yes, I am.

Q Did you do most of the reservoir engineering work in connection with the waterflood project that is the subject of this hearing?

A Yes, I did.

MR. MORRIS: Mr. Examiner, are the witness' qualifications acceptable?

MR. NUTTER: Yes, sir, they are.

Q (By Mr. Morris) Referring to what has been marked as Exhibit No. 1 in this case, Mr. Carnahan, would you point out the pertinent data on that exhibit?

A Exhibit No. 1 is a plat which outlines the proposed East Pearl Queen Unit, which comprises 2440 acres of State and Fee lands, Township 19 South, Range 35 East, Lea County, New Mexico. Injection wells are color coded red and green, and they will be subject to later testimony. All wells within a two mile radius of the proposed injection wells are located and identified as to

producing formation. Also indicated are lessees within a two mile radius.

Q We will come back to Exhibit 1 a little bit later, Mr. Carnahan, but would you refer to what has been marked as Exhibit No. 2, the unit agreement for the East Pearl Queen Pool? Referring to that agreement, what are the unitized formations covered by that unit agreement?

A As defined by the unit agreement, Section 1, subparagraph 2, page 2, the united formation is that certain stratigraphical interval underlying the unit area, extending from the top of the Queen formation to a depth of 50 feet below the base of Zone 4 of the Queen formation.

I would like to define a little more clearly exactly the meaning of Zone 4 as mentioned. Shell has divided the productive Queen sand interval underlying the unit area into four main zones, and two subzones, which have been designated Zones 1, 2 A and B, 3 A, B, and 4, the lowestmost zone being Zone 4. The correlation of these zones will be discussed later.

MR. NUTTER: Are all of those zones in the Queen?

A They're all in the Queen.

MR. NUTTER: So in effect you have all of these zones defined as unitized zones from the top of the Queen below the base of Zone 4; the base of Zone 4 would include all of them?

A Would include all the Queen sand zones.

Q (By Mr. Morris) This classification of zones is Shell's

classification; that may or may not be recognized by other operators in the area?

A That is exactly right.

Q Does the unit agreement recognize and provide for the waterflood project to be conducted in the unit area?

A Yes, it does provide for the waterflood to be operated within the unit area, and the participation in this project is based on a split formula; phase one being the expected remaining primary production; phase two being the anticipated secondary production.

Q Does the agreement contain the standard provisions with respect to subsequent joinder that are found in other unit agreements?

A Yes, it does provide for subsequent joinder to the unit.

Q Does the agreement contain provisions making the operation of the unit and then, of course, necessarily, the waterflood project subject to regulation by the Oil Conservation Commission?

A Yes, Section 15, subparagraph 1, page 14, so provides.

Q Who are the working interest owners within this unit area?

A Shell currently owns a 100 percent working interest and approximately 82 percent or 2,000 acres. The remaining acreage, being 440 acres, is operated currently by Gulf Oil Corporation, Mid Texas Gas and Oil Corporation, Collier Drilling Company, J. D. Sanford, E. G. Colton, and the Cabot Corporation. Shell Oil

Company is designated the unit operator in the unit operating agreement.

Q Of these working interest owners that you have mentioned, how many have committed their acreage to the unit agreement?

A To date, acreage-wise, 93 percent have committed to the unit. To break this down, of the State lands involved, 89 percent of the working interest in State lands have committed to the unit, and 97 percent of the working interest in Fee lands have committed to the unit. Tract-wise, there being 29 tracts, 90 percent of the working intereat in 90 percent of the tracts have committed. The breakdown of this, 86 percent of the State land tracts have committed to the unit and 93 percent of the Fee land tracts have committed to the unit.

Q What part of the total acreage is State-owned?

A 46 percent, or 1120 acres, are State lands.

Q Has this unit agreement been submitted to the State Land Office?

A Yes, it has, and tentative approval has been given.

Q Now, 46 percent of the acreage is State acreage, that would make 54 percent of the acreage Fee acreage, right?

A That is correct.

Q What is the status of the approval of this unit agreement by the royalty interests and overriding royalty interests in the Fee acreage?

A There are two of the 14 State tracts have overriding royalty interest against them. All of these interests have either signed or have indicated that they will sign as to these two tracts.

Q I believe the only thing we have left out on that point is the status of the overriding royalty interest on the State acreage. Have we covered that?

A Yes. I said there were two of them.

Q Going back to Exhibit No. 1 for a moment, would you give the basis for the unit outline as it is shown on that exhibit?

A Yes. Shell initiated an action by calling together all Pearl Queen Field operators in June, 1962 to discuss the feasibility of secondary recovery operations for the Field. As a result of this meeting, the Field was tentatively divided into four areas of study, the first area, the east area, being primarily in Sections 21, 22, 27, 28, and 34, Township 19 South, 35 East; the west area being Sections 28, 29, 30, 31, 32, and 33 in Township 19 South, 35 East; the south area being Sections 3, 4, 9, and 10, Township 20 South, Range 35 East; and the fourth area, the northeast area, being Sections 23 and 24, Township 19 South, Range 35 East.

The reason for the division of the field was that since both Shell and Gulf desire to continue operations in the field, the acreage comprising the east and west areas were divided along operational lines. The south area, which comprised acreage at

that time and currently under step-out development, with most wells being top allowable. The northeast area was also under development, with production being from two lower sand zones, approximately 100 feet below the base of Zone 4, which have not been found to be productive in the other areas of the field.

As a result of this meeting, Shell prepared a study of the east area, now designated the East Unit, recommending the immediate initiation of waterflood operations. The East Unit, as outlined in the Exhibit 1, takes in all wells in the East Half of the field, including the northeast area, which produce from the proposed unitized interval. I might add one thing; I think that I covered it here, but I would like to bring it out, that in the subdivision in these various areas, one of the primary reasons for so doing, in addition to what I discussed, was that the east and west areas were in the later stages of depletion and were rapidly approaching stripper production.

Both the south area and the northeast area, like I mentioned, were currently being developed, and a majority of the wells were top allowable; and it was felt that in order to successfully unitize this area and be able to proceed rapidly with a waterflood project, that it would be necessary to include these areas so that we might proceed on to waterflood the area which was seriously depleted.

Q Do you have a cross section showing what you have previously referred to as the unitized interval, being these Zones

1, 2, 3, and 4 of the Queen, and also showing the relationship of those zones to one another?

A Yes, Exhibit No. 3, which is entitled East Pearl Queen Unit Waterflood Study. I would like to refer to figure 13 towards the back part of the book, about a third of the way through, which is entitled Index to Cross Sections, East Pearl Queen Unit. I would in particular like to refer to Cross Section C-C', which you will notice there is a north-south cross section; then refer on to figure 16 which is C-C' cross section.

MR. MORRIS: I might state, Mr. Examiner, we are going to be referring to various figures in this exhibit from time to time, and will be presenting the whole thing as an exhibit insofar as it's pertinent to Mr. Carnahan's testimony.

Q (By Mr. Morris) Go ahead.

A This figure No. 16, Cross Section C-C' shows the correlation of the top of the Queen through the four main zones and the two sub-zones that I previously mentioned. Also shown on the cross section is Zone 5, which is not to be included, or is not included in the unitized formation. This Zone 5 is one of the two lower productive sand intervals which is productive in the northeast portion of the field. These zones, Zones 1 through 4, can be correlated throughout the field; however, in some areas the sand development is not of reservoir quality.

To specifically outline the unitized formation, as previously mentioned, the top of the Queen is the top interva'

and 50 feet below the base of Zone 4 is the base of the unitized interval.

Q This cross section also contains the well that is the key well mentioned in the unit agreement, from which these zones should be picked, is that correct?

A Yes. The Trainer Rushing No. 1, which is the third well from the right, is referred to in subsection 1, paragraph 2, as being the reference well for outlining the unitized formation.

Q Could you give a little more detailed information on the characteristics of Zones 1, 2, 3, and 4, by reference to other figures within this Exhibit 3?

A Yes. Briefly, before I refer to the exhibit, I would like to describe lithologically the character of these sands. In addition to being zoned, more or less, the character of the sands are very similar to each other and I will give a brief description which should cover them all.

Lithologically, the sand zones are fine-grained gray dolomitic and anhydritic sandstones interbedded with tan anhydritic dolomite anhydrite. The reservoir characteristics, average-wise, for the four zones and two sub-zones: average permeability, 12 millidarcies: average porosity, 15.1 percent; connate water saturation, 35 percent.

These sand zones produce primarily under solution gas drive, no indication of any other drive mechanism. Referring to Exhibit 3 again and in other figures 2, 3, 4, and 5, these are

structural maps contoured on the top of Zones 1, 2-A, 3-A, and 4. Water levels are present in all zones; however, only the water level in Zone 1 shown on figure 2 and in Zone 4, which would be figure 5, are shown as they occur within the unit area. The accumulation is controlled downstructure by these water levels and upstructure by porosity deterioration where the sands are cemented and the porosity is below reservoir quality.

Figures 6, 7, 8, 9, 10, 11, are quality isopacous maps on each of the four main sand zones and sub-zones. These maps were contoured on a factor of porosity as a percent times the net feet of pay present in each well in that particular zone. These figures were arrived at from an analysis of the available logs and core analysis data in the area. It can be seen from looking at these maps and referring back to the structural position of these various zones that as you go upstructure, which would be to the northeast, these sand zones tend to deteriorate where there is no pay present in those zones. Also, the downstructure quality of these sand zones is limited in the case of Zones 1 and 4 by the water level which is present in the unit area.

Q Mr. Carnahan, these structural maps and isopacous maps were originally prepared by you in looking at this portion of the pool with a view toward waterflooding, is that correct?

A That is right.

Q Based on your study, what are your proposals for waterflooding in this area?

A Referring back to Exhibit 1, which is an outline of the unit area, and referring in particular to the color coded injection wells, we have established or plan to establish an 80-acre five-spot pattern flood. This pattern has been determined to be the most efficient pattern, considering the zone characteristic of this reservoir. A total of 13 injection wells and 28 producers are included in this project.

As seen, the injection wells are color coded, as I mentioned, red and green; the green indicating single injection wells, the red being dual injection wells. To more fully explain this, I would like to refer now to Exhibits 4-A and B, which are diagrammatic sketches of typical single and dual injection wells respectively. Copies of these exhibits have been given to the State Engineer.

Referring in particular to Exhibit 4-A, diagrammatic sketch of single injection well, briefly I will discuss what we plan to do here We plan to inject down plastic-coated tubing with a packer set above the prospective injection zones, the casing tubing annulus filled with fresh water inhibited, casing is cemented to the surface and to protect any fresh water zones that may occur above the top of the red beds behind the casing is also cemented above all the perforations.

Exhibit No. 4-B is a diagrammatic sketch of a dual injection well. In this we plan to utilize two strings of plastic-

coated tubing, a dual packer set above Zone 1 and a single packer set between Zone 1 and the lower zones, being 2, 3, and 4, whichever of those may be open. The casing is again filled with inhibited water. The casing is set such that the cement is up behind the pipe above the uppermost perforation. The casing is cemented to the surface to protect the fresh water below the red beds.

To describe actually why we plan to use this dual injection system, this was set up mainly to flood Zone 1, which is volumetrically the single largest zone, comprising 38 percent of the productive reservoir volume in the East Unit. By so selectively injecting into this zone and separating it from injection into the lower three zones and sub-zones, we feel like that we can control the flood advance and ultimately recover more oil by way of the waterflood.

Exhibits 5-A and B are casing and cement details and injection tubing, packer, and perforations, respectively, on the proposed injection wells. Copies of these exhibits have also been given to the State Engineer.

Q I might interrupt you there, Mr. Carnahan.

MR. MORRIS: While we have given copies of Exhibits 4-A and B and 5-A and B to the State Engineer, I think it's only fair to say we only give 5-B to you this morning, but the other exhibits were furnished some time ago, is that right, Mr. Irby?

MR. IRBY: That's correct.

Q (By Mr. Morris) Excuse me, go ahead.

A Exhibit 5-A is a casing and cement detail on the 31 injection wells. Listed for both the surface and production casing is the casing size, the depth at which it is set, the amount of cement used in cementing the pipe, and the top of the cement.

Exhibit 5-B, which is a detail on the injection tubing, packers, and perforation for the 31 injection wells. Listed on this exhibit is, first, the type of injection well, referring back to the single or dual type which we have previously mentioned; and also a breakdown in the case where we have for the upper and lower injection intervals where they may be present. Here we have indicated the gross perforated interval, the size and the depth of the tubing, the type and the depth at which the packers are set for both the upper and the lower injection intervals.

For the dual, where we are using a dual injection system, we are using a retrievable dual packer with hydraulic hold-down similar to the Baker Model "K". For the single, where we're only using one packer for one string of tubing, we are using a hydraulic hold-down in a packer similar to the Baker Model "R".

To proceed on, Exhibits 6-A through EE are logs on all of the 31 injection wells, and actually there's nothing much to explain on these. They are logs which show the interval at which we are contemplating our waterflood project on the injection wells.

Q Those logs have been submitted to the Commission and are part of the Commission's files?

A That is correct.

Q Still referring to Exhibit 3, Mr. Carnahan, is there some information in here showing the production history of the wells in the proposed unit and waterflood area?

A Yes. Referring, like you said, to Exhibit 3, figure 20 -- excuse me -- this figure which is found on Exhibit 3, I might add, is the oil production history with predicted continued primary and waterflood performance for the East Pearl Queen Unit. We have indicated here the production from the start in January, 1957, plotted through July, 1962.

At that time that was the amount of production we had in the time the report was written. From there, based on the analysis of the performance of the wells, we have extrapolated or predicted the continued primary production which, if allowed to continue without any secondary recovery or waterflood operation should be complete by the early part of 1968. This is indicated by the dark hashered lines, being the continued or predicted continued primary. The small hashered lines were a start of injection indicated at approximately the first of 1964; indicated, like I say, by the small light hashered lines is the predicted waterflood performance by utilizing the pattern which we have previously discussed.

Q Now this information shown on this figure 20 was prepared as part of this report which was dated last November. Is the information, though, that is shown on figure 20 -- has that

proved to be correct and by the more recent production history of the wells in this unit?

A Yes. The monthly production rates from August, 1962, through May, 1963, have fallen very closely on the predicted continued primary performance curve. Actual May production from the unit area, there was 16,684 barrels, while predicted production for this month was 17,200 barrels. Cumulative production through May, 1963, has been 1,715,903 barrels. The average per well daily production for May, 1963, was 10.8 barrels. During May there were 50 wells producing, two wells shut-in, four wells temporarily abandoned, giving a total of 56 wells that have or are currently producing from the unit area.

I might add that four of these 50 wells are now top allowable. The per well daily production, as I mentioned, during May, 1963, at 10.8 barrels, was based strictly on the wells that actually produced oil during the month. So during May, using 50 wells, based on an extrapolation of the last nine months of the average per well daily production, the current average rate is below 10 barrels per day which I feel should classify the project as stripper.

Q Could you amplify a little bit, Mr. Carnahan, on what your plan of operation would be, assuming that the waterflood project as you propose it is approved by the Commission?

A Yes. We plan to start construction of waterflood installations immediately. We hope that injection can be commenced,

at least on a limited basis, during the later part of this year.

Q Would you plan to put all of the wells within the project area, all of the injection wells on injection at this time?

A This kind of boils down to the fact that currently Gulf Oil Corporation is studying the west area which we'll probably assume will be designated the West Unit; and their development or their status of their unit is not quite as far along as ours, although we hope it will be complete sometime around the first of this year, so that if they are delayed beyond the time when we're ready to start injection, which it appears like they will be, we plan to start injection on a limited basis in the North Half of the unit which comprises primarily Zone 4.

Referring back to Exhibit No. 3, the quality isopacous map of Zone 4, which is figure 11, you can see that Zone 4 is restricted to the East Unit, the water level downstructure and porosity deterioration to the north. We contemplate initially starting injection in the wells in the area comprising approximately 1,000 acres of the 2440 acres, to inject water into Zone 4 and other zones that may be present in this area in order to start our flooding operation; and then we plan to expand it as soon as we can be assured of cross line agreements with Gulf in the West Unit.

Q But at the present time it is your intention, is it not, to put the whole unit on production at the same time, if that is possible, taking into account the progress made in the Gulf Unit?

A That is correct. We would prefer to put the whole thing on at once, but it's like I say, subject to timing with the other unit in the area.

Q Have you made any computations concerning the allowables to which you would be entitled under Rule 701 of the Commission's rules, assuming the approval of this project?

A Yes. Initially we visualize, should we start injection on a limited basis, that the project area would include approximately 1,000 acres in Sections 15, 21, 22, 23, 27, and 28. The allowable for this acreage would amount to 1,008 barrels per day, based on 24 proration units utilizing the 42-barrel basic unit waterflood allowable.

The entire project area, including 2400 acres, the allowable would be based on 59 proration units; utilizing the 42 basic waterflood allowable would amount to 2478 barrels per day.

Q What would be the rate at which you would anticipate injecting water in this waterflood project?

A Should we continue on the limited area to start with, we visualize approximately 3,000 barrels per day to be injected in ten injection wells. The full scale flood would amount to injecting approximately 10,000 barrels through 31 injection wells per day, barrels per day. The total water requirement for the full scale waterflood should amount to approximately 50,000,000 barrels of water, of which 20,000,000 or 40 percent will be make-up water. The other 60 percent will be recycled produced water.

Q What is going to be the source of that injected water, Mr. Carnahan?

A Currently we have narrowed our investigation to two possible sources, being the Capitan Reef located approximately 20 miles southwest of the proposed unit area, and Ogalala fresh water which is located nearby to the proposed unit. Both these waters are compatible with the Queen water. We intend on utilizing a closed injection system in either case.

Q Compatibility tests have been made on both possible sources of water?

A That is correct.

Q Do you have some figures to offer that would give the over-all picture on the benefits to be derived from instituting waterflood in this proposed area?

A Yes. Making reference again to Exhibit 3, figure 20, which is the oil production history with predicted continued primary and waterflood performance, the estimated primary recovery from the unit as estimated and indicated here is 2,192,000 barrels of oil. Combined primary and secondary recovery from the unit area is estimated at 6,780,000 barrels of oil. This amounts to a recovery, additional recovery due to waterflood operations, of an estimated 4,588,000 barrels.

Q From those figures, Mr. Carnahan, it's obvious there's going to be substantially enhanced recovery by this waterflood project and recovery of oil that would not otherwise be recovered.

I think it would be safe to say that that would result in the prevention of waste, is that correct?

A I would say so, yes.

Q Are correlative rights going to be protected by operating the flood in the manner which you are proposing?

A Yes. Referring again to Exhibit No. 1, as I've previously mentioned, we anticipate a cross line agreement with the West Gulf Unit; the Gulf Unit, which is to the west of our unit, which we anticipate them continuing on with our five-spot flood pattern. In our discussions with them, we also have some acreage in that unit -- the unitized interval to the northeast is not productive, the Zones 1 through 4 are not productive in the northeast area of the field and to the south. In the south area these wells do produce from Zones 1 and 2 and 3; 1, 2, and 3. However, as I mentioned, they have been developed later.

There appears to be a restriction permeability-wise as we drilled one dry hole in Section 3, and Mr. C. W. Trainer drilled his Lynam No. 1 and completed as a well offsetting the Mid Texas State lease. This is the only well which offsets our unit to the south. We have anticipated there or discussed with them that they are considering forming a waterflood unit and hope that we can establish a tentative cross line agreement, although it doesn't appear to be too severe, sometime in the later part of 1964. Those wells are currently now starting to decline, so I think they are going to start to be more interested in initiating some type

of additional recovery.

Q Do you have anything further that you wish to add to your testimony in these consolidated cases?

A No, I believe that fairly well covers what I intended to discuss here.

Q Now Exhibit 2 was the unit agreement with which you stated to be familiar, and Exhibit 6 are the logs. Were Exhibits 1, 3, 4, and 5 prepared by you or under your direction?

A Yes, those exhibits were prepared by me and under my direction.

MR. MORRIS: We offer Exhibits 1 through 6 into evidence.

MR. NUTTER: Applicant's Exhibits 1 through 6 will be admitted in evidence.

(Whereupon, Applicant's Exhibits Nos. 1 through 6-EE admitted in evidence.)

MR. MORRIS: That's all I have at this time.

MR. NUTTER: Does anyone have any questions of Mr. Carnahan? Mr. Irby.

CROSS EXAMINATION

BY MR. IRBY:

Q Mr. Carnahan, you said that about 60 percent of the water injected would be recycled water?

A Yes, we anticipate that the make-up water or the additional water which we will have to procure will amount to approximately 40 percent of the total water required, which would amount

to 20,000,000 barrels.

Q The total water requirement is 20,000,000 barrels?

A The total water that we'll have to procure outside in order to project; the 30,000,000 would be recycled water.

Q I see.

A I might add here that in reference to an earlier case by Mr. Buckles, in which this 10 to 1 ratio was discussed of injection water requirement to oil recovery, this is very close to what we have utilized here. We have approximately 50,000,000 barrels of water to be injected, and approximately 5,000,000 barrels of oil to be recovered secondary-wise.

Q What is going to be the determining factor in your decision as to whether you use water from the Capitan Reef or the Ogalala?

A I'll have to say that primarily it will be based on economics as to the feasibility of using one or the other of the two waters. Like I mentioned, we have studied several possible sources in this area in which some of them have been tested and proved to be unsatisfactory to supply water for the project. We have tried to coordinate our efforts along this line with the other unit so we could establish a source which would be sufficient for flooding the entire area, and participate, whereby it would be cheaper for everybody concerned to establish one source of water for the whole area; but like I say, primarily it will be economics.

Q Have you any knowledge of the chemical quality of the water in the reef?

A I have an analysis if you would care to know what it is.

Q Please.

A On the Capitan Reef water, the analysis that we had made, the chlorine content, 1470 parts per million.

Q Clorine?

A Chloride, excuse me. I am sorry.

Q That was how much?

A 1470. HCO_3, 410 parts per million; CO_3, zero; SO_4, 2580.

Q What was that CO_3?

A There was no indication of any.

Q And the next one?

A SO_4, 2580 parts per million. Sodium, 1240; calcium, 750; magnesium, 250; no iron; total solids, 7,005; H_2S, 305.

Q 305?

A 305, yes. No dissolved oxygen.

MR. MORRIS: We'd be glad to give you a copy of this.

MR. IRBY: That would be better.

A I can give you a copy of this.

MR. MORRIS: Unless you have some question that you want to bring out right now.

Q (By Mr. Irby) The principal components that I find here, that chloride is 1470 and sodium 1240?

MR. NUTTER: I believe that was 1400 --

A Chlorides, 1470. That's the one we kind of got mixed up on chlorine.

Q (By Mr. Irby) And the total dissolved solids, 7,005?

A Yes.

Q No iron?

A No iron, no oxygen.

Q No iron, no oxygen. That's good.

MR. IRBY: That's all the questions I have. Thank you.

BY MR. NUTTER:

Q You stated that the selection of the water source would be a matter of economics. Have you made any preliminary cost estimates on what it would cost you to transport this Capitan Reef water from a point 20 miles away?

A A considerable amount. This is one thing that may weigh heavily on possible use of fresh water. However, there's a possibility that we might possibly use this source for maybe some other floods in the area, such that then the cost per barrel would naturally be reduced, so this is what we are thinking about.

Q This is what you were talking about, attempting to coordinate your water supply?

A Yes, maybe for these units and some other floods, too. If it was just for this field, I am sure it wouldn't be economical, but the over-all picture, it might prove to be economical.

Q Have you made any preliminary estimates on what the cost

would be to bring the Capitan Reef water up here?

A I believe it was somewhere in the neighborhood of $400,000 plus an operation cost which would be considerably higher, due to the necessity of pumping water; where if we went to Ogalala which is primarily developed to the north of here, we would have the aid of gravity drainage. Very expensive.

Q Is Ogalala water present in this immediate area?

A Yes. Actually, the Ogalala isn't present in the Pearl acreage as such, but within a six-mile radius of the field there is good Ogalala development and unappropriated water.

MR. NUTTER: Mr. Irby, go ahead.

BY MR. IRBY:

Q And you would probably have to pipe your water several miles if you went for the Ogalala?

A In either case we would have to pipe it several miles. There's not an adequate source. We've tested everything and studied everything in the immediate area, and there's no adequate source to sustain the injection rates which we will require for the flood operation.

Q But if you go for the reef water, you'll have to pipe approximately three times as far as the Ogalala?

A The indication would be, yes, roughly in that magnitude.

Q There isn't sufficient produced oil field brine in the area to sustain your flood?

A There is production in the Monument area; however, I

believe there's some other floods which have other designs on this water. We have investigated this and feel like that we couldn't depend upon it to be a source for the whole unit, because some of these other floods I believe would have first call on it, plus the fact it's very corrosive and would provide some additional problems which we hope we wouldn't have with these other two waters. So combining those two things, we have more or less eliminated that as a possible source. The pipe lining would also require something in the neighborhood of 12 to 15 miles of pipeline to come from the distribution system over there, also. So there are quite a few factors which kind of make it really not satisfactory for our use here.

BY MR. NUTTER:

Q Is there any Devonian water available in this area?

A There is some up north, South Vacuum-Devonian. We have investigated this also and have an analysis of the water. Current production up there is not enough to supply our requirements, and there is some doubt as to whether we could depend on it for the length of time when we're going to be requiring it; so that if we used it we would have to supplement it from some other source, which would probably require the building of two pipelines, at least for a portion of the way. So we have more or less discontinued this for our use here.

Q In your opinion, Mr. Carnahan, what is the source of water going to be if you can get it, Ogalala fresh water?

A What is the source?

Q Yes, sir.

A Well, like I say, I haven't been given an okay on which one of the two. I made my recommendations and we have discussed it, but I haven't been given an okay as to which one that I'm going to have to worry about here.

Q Which appears to be the most economical to you?

A It would appear on the surface that the use of the Ogalala would be, over-all, if you are just discussing the use of water for just this one particular area.

Q Mr. Carnahan, I note here on Exhibit No. 5-A that there's quite a variation in the setting depth of the surface pipe. To what do you attribute that among these wells?

A Well, probably inexperience to start with, and trying to make sure that we protect everything. I think some of the -- I was just trying to look, we have a short string of our own here, a couple, three of them, being Kimberley No. 4, 98 feet. I guess that's what you are referring to?

Q Yes, sir.

A Allen State No. 3, 96 feet, and P.E. No. 2, 94 feet. Well, those latter two wells were drilled later on, later in development; and I would assume that -- I know there's no problem, as far as I know we were well into the red beds when we set the pipe. It appears like there was quite a bit of pipe wasted, really, surface pipe was.

Q You feel that the short strings have been adequate and some of the longer strings would have been more than adequate?

A Actually just poor economics. However, there may be some other individual problems that may have caused them to set that deep for one reason or another.

Q The cement on the production string is given as surface on some of the wells and as a figure on others. Is that an estimate or top that's taken from a survey, or just what?

A Now I have indicated estimated would be actually estimated based on the volume of cement, utilizing a factor of one sack of cement per cubic foot. We felt like that was a very conservative estimate. Utilizing this would be utilizing Neat Cement actually we would probably -- we wanted to make sure that these are conservative estimates.

Now I realize it looks a little strange to say that you have an estimated at surface, because it ought to be, you ought to be able to see it, most of these were on wells that were not operated by Shell and we did not have that information available to us as to whether they actually saw it or not.

Q But of the total wells here, only a couple of them are actually survey tops?

A That is right. Those indicated as "S" are survey tops and there's only one of them, I believe, on the production casing.

Q I notice on your Exhibit 5-B that in some of these wells, I think most of them are equipped with 5-1/2 inch pipe. There may

be a few that have 4-1/2 inch pipe. But you are going to use a rather small tubing diameter, particularly on the dual injection wells?

A Yes, this has posed somewhat of a problem to us. We initially, before we went into this dual type of injection, we investigated what we could get in the wells and what requirements we were going to need for these particular zones. The injection into each one of the wells is not going to be 150 barrels per zone or a total of 300 barrels per well. It is primarily based on the sand volume into which we are going to be injecting, and there's only about one or two of them that we're not going to be able to inject quite the volume which we would like to, based on the sand volume. It has actually worked out fairly convenient.

Q You will be restricted to an amount that you desire --

A In a couple of wells, that's right. This is due to the size of the casing and the size of the tubing that we are going to be able to put in there. We are going to approach the volumes such as we desire, so we consider ourselves lucky that we didn't have 2-7/8 casing in some of the wells that we want to use this dual injection.

Q What is the inner diameter of this tubing that has the outside diameter of 1.315?

A The inside diameter -- I don't happen to have that figure available to me as to what the inner diameter is. We primarily wanted to list the outside to show what we could get in the pipe.

Q Get in the pipe?

A Right.

Q I notice also, Mr. Carnahan, that up in the north end there you show some net feet of pay in Zone No. 1,that would be on figure 6, on the C-1 Trainer Signal State lease, the No. 1 and 2 Wells?

A Yes.

Q Now that Zone No. 1 is not going to be flooded in the north end, however?

A That is very true. The sand volume, we feel, up there is indicated to us to be actually from the log analysis we show 52 feet or a number of 52, which might represent a figure like five feet of ten percent porosity.

Q This is porosity feet?

A Right. It could represent a figure of five feet of pay, ten percent porosity, which will give you 10.5 percent. The log analysis indicated that this was very close to what we considered a cut-off, being ten percent porosity. We didn't feel like it would warrant the additional equipment to try to inject into one and produce out of the other for this very thin, poorly developed section in Zone 1. It could very well be, although these figures were included in the parameter,that the logs were reading pretty close, and it could be that it was actually not of pay quality and we would be wasting our money trying to inject into it.

Q However, this tract will share on that parameter right

there?

A That's right. If you figured the amount of oil that would be in there and what could be recovered, it would not pay out the additional expense, tubing-wise and injection facilities, to inject into one and produce out of the other. We feel it is more or less isolated. As you notice, there are several wells that have no pay indicated to the side of that.

Q Right, it's an island?

A That's right, and it truly might not be there.

Q But that island will not be flooded?

A That is true, it will not be flooded.

MR. NUTTER: Are there any other questions of Mr. Carnahan? Mr. Irby.

BY MR. IRBY:

Q To go back to Mr. Nutter's questioning on this depth of setting of the surface casing, I believe you stated that in all cases it is set into the red beds. Do you find that the red beds surface is highly eroded and -- well, not at all uniform in this area as it is in the northern part?

A That is very true. In fact, actually there has been some fresh water found out here very shallow, between 30 and 50 feet, primarily in the north area of the field, although this has been tested and we consider this is a possible source of water. We utilized some of this water to put out a fire on Hooper 1 when we drilled it. We know that we have water to put out a fire and

to drill with, but we don't have enough to inject into. The south end of this field, there doesn't appear to be any fresh water at all, even this very shallow sand or whatever it may be is not even water-bearing or not present to the south; the red beds are very close to the surface.

There is a very limited amount of fresh water, it's not Ogalala, in the north part of this field, and it appears to be rather patchy and not too well developed. I don't know if that answers your question, but I will answer, yes, that the red beds surface is very irregular.

Q The irregularity of the red beds might to some degree account for the difference in the setting of this surface casing?

A That very well could be, just the fact that they didn't know whether they had gotten to them or not, or they just weren't there.

Q Can you tell me what the location would be of the well in the reef that provided you the water analysis?

A Well, of course, now, the Ogalala Reef covers a pretty good size area.

Q Ogalala?

A Excuse me, you are talking about the Capitan Reef. Well. I still say, the Capitan Reef covers a very large area. As I mentioned, the use of this water would possibly be in conjunction with the use somewhere else so that the exact location of the well would be somewhat dependent, to try to centrally locate it,

on where we might try to use the water. I cannot give you an exact location. I don't have a lease.

Q I think I can get it this way. This analysis that you are going to send me gives the location of the well from which it was taken?

A I'll have to check. I don't happen to have that information. It may be in the report. I'll have to glean through it. I didn't write the report myself, but I am sure they will certainly know where they got the water from. I will try to make it a point to tell you where it came from, if you so desire.

MR. IRBY: Good, that will take care of it.

MR. NUTTER: Any other questions? Mr. Durrett.

BY MR. DURRETT:

Q Mr. Carnahan, were you present this morning and did you hear Mr. Buckles' testimony in a previous waterflood case?

A Yes.

Q Did you hear him testify -- I believe he testified that in his opinion it was usually more desirable and more feasible to use salt water in waterflood operations if it was available in the area, reasonably available.

A I'll have to agree with him in principle, --

Q I would like to have your opinion on that, if you will.

A -- and maybe disagree a little bit, specifically. I'll agree with this point that he made, that usually a formation, a sand formation, has a higher permeability to salt water than it

does to fresh water. This is somewhat dependent upon the clay content of the sand itself. If it's a bentonitic type of sand, why, you are going to have a very serious permeability restriction due to the swelling of the clays, where you may end up where you can't inject anything. As far as we are concerned in particular here, we have run injectivity tests using cores selectively through this area, using Ogalala, Capitan Reef, and also Monument-San Andres water. We can find very little difference.

We couldn't account for it, maybe in just laboratory measurement in the actual permeability or the actual restriction that we have. We do not have or anticipate anything because we do not have a bentonitic or clay type sand here. What he's talking about, he may have -- I'm not familiar with the Langlie-Mattix Field and he may have more of a clay or a shaly problem there, and in his case it may be that he would definitely want to use salt water under those circumstances.

But to generally say that you would always want to use salt water to inject into a formation, this might be all right to say but then again, if you've got to pay for it and try to make any money out of doing it, then you are going to have to base what you use a little bit on economics. It doesn't make much sense to inject water to lose money, and you may be faced with that if you have to go a long distance to get a particular type of salt water to inject.

I will agree with him there is a reduction. This has

been noted in textbooks for years, that salt water will usually show a higher permeability to a given sand than fresh water will.

Q Let me ask you this question in connection with the costs of the water that you propose to use. Could you give us some estimate of what you think it's going to cost you to obtain the water you propose to use in this field?

A It might be a little difficult, actually, when you speak of cost, and I believe he mentioned a figure for his in the magnitude of one and a half cent per barrel, this would be a function of the quantity of water which you are going to use. Otherwise, if you are talking about using large volumes of water, you can end up processing it at a little cheaper rate than if you are going to have to operate one well to produce a small amount of water, which he was discussing there. Then the cost per barrel goes up because maybe he could put a little larger pumping unit on and cost him a little bit more money and produce a lot more water. He is restricted, he only needs so much water. I can't give you a cost per barrel if that's what you are looking for, as to what it's going to cost us per barrel to inject it.

I would say it is going to be considerably less than a cent and a half a barrel on a field-wide project, which we've discussed here, that we are contemplating to develop a source sufficient for all of these units, including the East Unit.

Q At any rate --

A Considerably lower than one and a half cents.

Q At any rate, you wouldn't consider it to be more than one and a half cents?

A No, I wouldn't.

Q I have one final question, Mr. Carnahan. In your exhibits or somewhere in our file, do we have the footage description of your proposed injection wells?

A The footage description?

Q Yes, or by unit or some way so we can describe the wells.

A Well, of course, I have them named over here and located here.

Q Locations?

A You mean particular location on each?

Q Yes, so if we approve this application we don't have to pick it off a map.

A In our application, we have the wells located as to section and unit; in a letter, I believe.

MR. MORRIS: That's correct, but we don't have it tied down to the name of the well.

A You mean the numbering system?

Q (By Mr. Durrett) Yes.

A Well, we are in the process right now of deciding which numbering system we are going to use. I think, this is my opinion, but I think this is what we are going to use. It will be something in the neighborhood, like the wells located in Section 22;

then starting with the same sequence, by which we currently alphabetically number the proration units, we will use the numbers one through equivalent of letter "P". The well will be designated,-- for instance, the Shell Rushing Well No. 2, which is an indicated injection well, will be designated as 22-2.

MR. MORRIS: Mr. Durrett, if you just want the unit and section of the wells as listed on Exhibit 5, well, I'll be glad to sit down and furnish you a list of the name of each well and the unit and the section in which it's located.

MR. DURRETT: Thank you, Mr.Morris. That will be completely adequate, I believe.

MR. NUTTER: Are there any other questions of Mr. Carnahan? He may be excused.

(Witness excused.)

MR. NUTTER: Do you have anything further, Mr. Morris?

MR. MORRIS: I would like to make one brief statement. In case we could possibly have left any confusion in the record as to what we intend to do on putting the wells on injection in this unit area, if approved, Shell would intend to place all of the wells on injection as soon as possible. We are not proposing this as a two-stage flood in any sense. The testimony given by Mr. Carnahan concerning the limited flood that might be initiated in the northern part of this unit would be merely a stop-gap and very temporary measure to just get this waterflood project going; but with the full intention of putting the whole, all of these

injection wells on injection just as soon as possible.

MR. NUTTER: I understand. Mr. Carnahan, one other question. You mentioned that some of these tracts had not been committed yet, and you gave a breakdown by whether they were State tracts or Fee tracts and so forth. Would you identify the tracts that have not been committed?

MR. CARNAHAN: Just one minute here. Of the three tracts that have not been committed, they amount to 160 acres, being the Sanford Union State lease, which is an 80-acre lease located in Section 15.

MR. NUTTER: That has an injection well on it?

MR. CARNAHAN: That has an injection well on it. The Colton Texaco Moran lease, which is located in Section 22, that is a Fee 40-acre lease; and the Colton Gulf State lease,which is located -- the only well located in Section 23, which is a 40-acre State lease.

MR. NUTTER: And it's not an injection well, it would be a producer, right?

MR. CARNAHAN: It is a producer, right.

MR. NUTTER: So of all the acreage which has not been committed, you have two tracts with injection wells on them but it just so happens that each of those tracts is an edge tract or an edge injection well?

MR. CARNAHAN: That is very true.

MR. NUTTER: And you don't have any holes in the pattern

itself?

MR. CARNAHAN: We are not a bit worried if those don't come in. It's not going to be any detriment anyway to the unit, as far as we are concerned.

MR. NUTTER: Thank you. Did you have anything further, Mr. Morris?

MR. MORRIS: That's all I have.

MR. NUTTER: Does anyone have anything they wish to offer in Cases 2850 and 2851? We will take the Cases under advisement.

* * *

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

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

WITNESS my Hand and Seal this 25th day of August, 1963.

Ada Dearnley
NOTARY PUBLIC

My Commission Expires:

June 19, 1967.

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. ..... heard by me on ..... 19.....

..... Examiner
New Mexico Oil Conservation Commission

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
July 10, 1963

EXAMINER HEARING

IN THE MATTER OF:

Application of Shell Oil Company for a unit agreement, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the East Pearl-Queen Unit Area comprising 2440 acres of State and Fee lands in Township 19 South, Range 35 East, Lea County, New Mexico. CASE 2850

IN THE MATTER OF:

Application of Shell Oil Company for a water-flood project, Lea County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a waterflood project on its East Pearl Queen Unit by the injection of water into the Queen formation through 29 wells in Sections 15, 21, 22, 26, 27, 34 and 35, Township 19 South, Range 35 East, Lea County, New Mexico. CASE 2851

BEFORE: Elvis A. Utz, Examiner

TRANSCRIPT OF HEARING

MR. UTZ: The hearing will come to order, please. The first case on the docket will be 2850. Application of Shell Oil Company for a unit agreement, Lea County, New Mexico.

MR. DURRETT: If the Examiner please, this case, I would like to move that it be continued until the 24th, the Examiner Hearing to be held on the 24th. Mr. Dick Morris, the

counsel for the Applicant, has contacted me concerning this case and they would like to put it on in conjunction with Case 2851, and there is an error in the ad in that case so they would like to re-advertise and continue both cases to the 24th.

MR. UTZ: 2850, as well as Case 2851, will be continued to July 24th Examiner Hearing.

* * * *

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

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

WITNESS my Hand and Seal this 16th day of July, 1963.

Ada Dearnley
NOTARY PUBLIC

My Commission Expires:

June 19, 1967.

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 2851, heard by me on July 10, 1963.

Examiner
New Mexico Oil Conservation Commission

EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO
INJECTION WELL DETAIL
PART II
INJECTION TUBING, PACKERS, AND PERFORATIONS

		Upper Injection Interval				Lower Injection Interval			
	Type Injection Well	Gross Perforated Interval	Tubing Size* - Depth	Packer Type	Packer Depth	Gross Perforated Interval	Tubing Size* - Depth	Packer Type	Packer Depth
Sanford-Union State 1	Single	Injection into lower interval only.				4862-4870	2.375 - 4800	RS w/HH	4800
Shell-McIntosh B-1	Single	Injection into lower interval only.				4762-4851	2.375 - 4700	RS w/HH	4700
Shell-McIntosh B-3	Single	Injection into lower interval only.				4853-4887	1.9 - 4800	Permanent	4800
Shell-Signal State 1	Single	Injection into lower interval only.				4804-4844	2.375 - 4750	RS w/HH	4750
Shell-Rushing 2	Single	Injection into lower interval only.				4810-4842	2.375 - 4750	RS w/HH	4750
Colton-Texaco Moran 2	Single	Injection into lower interval only.				4838-4842	2.375 - 4800	RS w/HH	4800
Collier-State 1	Single	Injection into lower interval only.				4774-4861	2.375 - 4750	RS w/HH	4750
Shell-Kimberlin 2	Single	4658-4860	2.375 - 4600	RS w/HH	4600	4808-4856	Commingled Injection		
Shell-Kimberlin 4	Single	4657-4658	2.375 - 4600	RS w/HH	4600	4772-4846	Commingled Injection		
Shell-McIntosh D-1	Dual	4661-4671	1.90 - 4600	RD w/HH	4600	4776-4873	1.90 - 4700	Permanent	4700
Shell-McIntosh E-1	Dual	4743-4749	1.315 - 4700	RD w/HH	4700	4914-4920	2.375 - 4800	Permanent	4800
Shell-McIntosh C-1	Dual	4700-4704	1.315 - 4650	RD w/HH	4650	4810-4877	2.375 - 4750	Permanent	4750
Shell-McIntosh C-4	Dual	4691-4703	1.9 - 4650	RD w/HH	4650	4804-4889	1.9 - 4750	Permanent	4750
Shell-McIntosh 1	Dual	4656-4670	1.9 - 4600	RD w/HH	4600	4856-4870	1.9 - 4800	Permanent	4800
Shell-McIntosh 3	Single	4708-4716	2.375 - 4650	RS w/HH	4650	Injection into upper interval only.			
Shell-State PB-1	Dual	4698-4700	2.375 - 4650	RD w/HH	4650	4799-4856	1.315 - 4750	Permanent	4750
Shell-Hooper 2	Dual	4677-4684	1.315 - 4650	RD w/HH	4650	4781-4874	2.375 - 4750	Permanent	4750
Shell-Allen Estate A-1	Single	4701-4706	2.375 - 4650	RS w/HH	4650	4810-4870	Commingled Injection		
Shell-Record 1	Dual	4687-4696	1.315 - 4650	RD w/HH	4650	4815-4849	2.375 - 4750	Permanent	4750
Shell-Allen Estate 1	Dual	4712-4724	1.9 - 4650	RD w/HH	4650	4819-4890	1.9 - 4750	Permanent	4750
Shell-Allen Estate 3	Single	Injection into lower interval only.				4880-4885	2.875 - 4870	Tension Set	Hookwall
Shell-State PA-2	Dual	4742	2.375 - 4700	RD w/HH	4700	4859-4915	1.315 - 4800	Permanent	4800
Shell-State PD-1	Dual	4750-4756	1.9 - 4700	RD w/HH	4700	4879-4965	1.9 - 4800	Permanent	4800
Shell-State PD-3	Dual	4762-4768	1.9 - 4700	RD w/HH	4700	4838-4975	1.9 - 4850	Permanent	4850
Shell-State PC-2	Dual	4754-4758	1.9 - 4700	RD w/HH	4700	4872-4953	1.9 - 4850	Permanent	4850
Shell-State PE-1	Dual	4738-4745	1.9 - 4700	RD w/HH	4700	4879-4944	1.9 - 4850	Permanent	4850
Shell-State PE-2	Dual	4735-4742	1.315 - 4700	RD w/HH	4700	4869-4893	2.375 - 4800	Permanent	4800
Shell-State PF-1	Dual	4744-4750	1.9 - 4700	RD w/HH	4700	4896-4958	1.9 - 4800	Permanent	4850
Gulf-State AR-2	Dual	4786-4788	1.315 - 4750	RD w/HH	4750	4912-4984	1.9 - 4850	Permanent	4850
Mid-Tex - Gulf State 1	Dual	4745-4752	1.9 - 4700	RD w/HH	4700	4954-4967	1.9 - 4800	Permanent	4900
Shell-State PG-1	Dual	4753-4760	1.9 - 4700	RD w/HH	4700	4900-4962	1.9 - 4800	Permanent	4850

*Tubing outside diameter.
RD w/HH - Retrievable dual with hydraulic holddown similar to Baker Model K.
RS w/HH - Retrievable single with hydraulic holddown similar to Baker Model R.
Permanent - Drillable packer similar to Baker Model D.

EAST PEARL QUEEN UNIT

WATERFLOOD STUDY

PEARL QUEEN FIELD
LEA COUNTY, NEW MEXICO

NOVEMBER 1962

TABLE OF CONTENTS

INTRODUCTION

The Pearl Queen Field is located 20 miles southwest of Hobbs in central Lea County, New Mexico. Presently the field encompasses an areal extent of some 5,600 acres with the production being from a series of Queen sands at an average depth of approximately 4,800 feet.

The field was discovered in December 1956 with the completion of the Shell-Hooper No. 1. Development has continued to the present with a total of 144 completions effected by the end of August 1962. Current drilling activity is confined to the northeast section of the field where production has been established from a new lower Queen sand interval not found to be productive in the main portion of the Pearl Queen Field.

In June 1962 a meeting of all the Pearl Queen Field Operators was held in Roswell, New Mexico, to discuss plans for initiating a waterflood project. It was agreed that in view of the field's advanced stage of depletion an engineering study should be conducted to determine the feasibility of a waterflood project. The field operators also recommended that the field be subdivided into three units (East, West, and South) in order to facilitate the engineering study and subsequent operations. Figure 1 is a map of the Pearl Queen Field showing the proposed unit subdivisions of the field.

The engineering study herein contained was limited to the area comprising the East Pearl Queen Unit. Some core and well control data from wells outside the East Unit were utilized to complete this study.

CONCLUSIONS

1. A waterflood of the main Queen sand interval in the East Pearl Queen Unit should provide an economically attractive secondary recovery project.
2. Primary recovery in the East Unit will amount to 2,192,000 stock tank barrels, or 10.16 per cent of the original oil in place.
3. Ultimate recovery after waterflood should be approximately 6,780,000 stock tank barrels, or 31.44 per cent of the original oil in place.
4. The waterflood project in the East Unit should recover an additional 4,588,000 barrels of oil with a profit of $7,300,000 or 802 per cent of a $910,000 capital investment.

RECOMMENDATIONS

1. Take necessary steps to unitize the main Queen sand section in the east half of the Pearl Queen Field as delineated in Figure 1.
2. Initiate a cooperative 5-spot pattern waterflood with the West Unit as soon as unitization is completed.
3. Should unitization of the East Unit precede that of the West Unit, consider initiating a Zone IV flood using the same 5-spot pattern and enlarge to a full-scale flood when a field-wide project can be commenced.
4. Conduct a joint study with the West Unit to find an adequate water supply for flood operations.

DISCUSSION

Geology

Production in the Pearl Queen Field is from a series of sands in the Queen (Middle Whitehorse) member, Guadalupe series of the upper Permian. The Queen sand interval which is productive throughout the main part of the Pearl Field comprises approximately 200 feet of gross section. This interval can be divided into four distinct sands or groups of sands which have been designated as Zones I through IV. Zones II and III have been further subdivided into A and B sands. These four zones are considered the main Queen sand interval.

Lithologically, the productive interval is a series of fine-grained, gray, dolomitic and anhydritic sandstones interbedded with tan anhydritic dolomite and anhydrite. Although the various sand zones are correlative over the entire Pearl Queen Field, porosity development is quite erratic with rapid changes noted from one well to the next. Deterioration of porosity is primarily due to cementation.

The main oil accumulation in the Queen sands is controlled by a combination stratigraphic-structural trap. Trapping is afforded by porosity deterioration on the north or up-dip edge of a relatively gentle southwesterly sloping feature. Water levels provide the down-dip productive limits. Laterally, the field is bounded by porosity deterioration to the east and by water levels to the south and west where the productive sands are structurally low.

The structure of the four main Queen sand zones within the East Unit are depicted by Figures 2 through 5. The indicated water levels in Zones I and IV were determined from log analyses and production test data. A water level of 1064

feet subsea provides the down-dip productive limits of Zone I. The Zone IV water level is indicated at 1125 feet subsea which, as can be seen, confines the productive limits of this zone to within the boundaries of the East Unit. The water levels in Zones II and III are not shown as they do not occur within the boundaries of the East Unit.

The correlative nature of the main Queen sands is shown by two east-west cross-sections, A-A' and B-B', Figures 14 and 15, and one north-south cross-section, C-C', Figure 16. The index to these cross-sections is shown in Figure 13.

As previously mentioned, current development is confined to the northeast section of the field which is to the east of the proposed waterflood unit. In this area a lower Queen sand (designated Zone V) has been proven productive while the main Queen sand interval is not of reservoir quality. Zone V is found approximately 80-100 feet below Zone IV, which is the lowest Queen zone found to be productive in the main part of the Pearl Queen Field. Within the boundaries of the East Unit eight wells have penetrated Zone V. Only the Colton-Texaco Moran No. 2 has found Zone V to be productive; however, the Colton-Gulf State No. 1 has good porosity development indicated by log analysis. The other six wells have either condemned Zone V by production test or log analysis. Cross-section A-A', Figure 14, depicts the Zone V correlation in respect to the main Queen sand interval (Zones I through IV).

Reservoir Characteristics

The four sand zones comprising the main pay interval are considered separate reservoirs and each is producing under solution gas drive and fluid expansion.

The average reservoir porosity, as determined from log analyses, is 15.1 per cent. A cut-off porosity of ten per cent was utilized in determining net pay. This cut-off porosity was based on an analysis of the statistical capillary

pressure and average core permeability data presented in Graph 1, Figure 19, and well completion experience which has indicated conclusively that sands with less than ten per cent log porosity are non-productive. The indicated average permeability of a 15.1 per cent porosity rock is 12 md. with the range of average permeabilities in ten per cent porosity rock and greater being 1 to 140 md.

Core analysis data used in this report were from 14 wells. Capillary pressure measurements were run on three of these cores. The capillary pressure data presented in Graph 1, Figure 19, are considered to be a valid representation of the average capillary properties of the main Queen sand interval.

The average water saturation from log analysis versus porosity is presented in Graph 2, Figure 19. The connate water saturation of a 15.1 per cent porosity rock is indicated to be 35 per cent. This value was used in subsequent volumetric calculations. The corresponding irreducible water saturation as indicated by the 62 atm. curve is 21 per cent. This may account for the free water production in areas of the field considerably above oil-water contacts.

The mobile oil factor, expressed as a per cent of the total oil in place, is presented in Graph 3, Figure 19. The mobile oil factor represents that portion of the total void space occupied by hydrocarbons that actively contributes to production. The mobile oil factors at various porosity values were obtained by dividing the percentage of 0-5 atm. pores (recoverable oil) by the corresponding oil saturations expressed as a per cent. The oil saturations (1 - water saturation) were determined from the water saturation versus porosity plot presented in Graph 2, Figure 19. It was thus determined that 68 per cent of the total oil saturation contained in the average reservoir rock (15.1% porosity) is mobile oil and therefore considered recoverable. The mobile oil saturation would be 44 per cent with the resulting residual oil saturation after waterflood being 21 per cent. This residual oil saturation appears to be in agreement with the range of residual oil

saturations measured in the core analyses. A sample calculation of the residual oil saturation after waterflood is present in Table VII.

Available bottom hole pressure data in the Pearl Queen Field are limited to surveys run by Shell Oil Company in wells located predominately in the north-half of the proposed East Unit. The lack of field-wide pressure data is attributed to the fact that most wells were pumping completions with the remaining wells experiencing only a short flowing life. Shell has run build-up pressure surveys in 15 wells with six of these wells equipped with offset well heads to enable the taking of bottom hole pressure measurements without pulling rods and pump. Routine pressure surveys have been conducted in these six wells throughout their producing life. An analysis of the available pressure data indicated that the original reservoir pressure was 1776 psi with the bubble point pressure being approximately 1400 psi at the reservoir temperature of 100° F. The predicted reservoir pressure performance of the East Unit, shown in Figure 17, was based on this analysis utilizing the estimated primary ultimate recovery as indicated from the production performance history, Figure 20.

A recombined P.V.T. analysis was performed using samples of separator liquid and vapor collected from the Shell-State PF No. 1 in January 1961. The separator products were recombined so that the resulting mixture would have a bubble point pressure of 1400 psi at 100° F. Differential liberation of the recombined sample indicated a formation volume factor of 1.176 at the original reservoir pressure of 1776 psi and 1.180 at the saturation or bubble point pressure of 1400 psi. Figure 18 presents the formation volume factors as determined from the P.V.T. analysis.

Determination of Original Oil in Place

The determination of original oil in place was based on volumetric data obtained from the quality isopachous maps presented in Figures 6 through 11. Individual quality isopachous maps were constructed for each of the sand zones. These maps were contoured on the factor of per cent porosity multiplied by net feet of pay as determined from log analyses.

The reservoir pore volume expressed in acre-porosity-feet of net pay was determined by planimetering each of the six quality isopachous maps. Tables II, III, and IV are tabulations by operator, lease, and zone of the acre-porosity-feet of net pay presently open to production, not open to production but considered productive in the well bore, and not productive in well bore but considered productive within lease boundary, respectively. Table V is a summary tabulation of total productive acre-porosity-feet of net pay by operator and lease. Table VI is a summary tabulation of acre-porosity-feet by zone.

The total productive reservoir pore volume was determined to be 5,028.99 acre-porosity-feet. Based on the average water saturation of 35 per cent and a formation volume factor at original conditions of 1.176, the original oil in place was found to be 21,565,000 stock tank barrels. Table VII presents the volumetric calculation of the original oil in place.

Determination of Ultimate Primary Recovery

The ultimate primary recovery of the East Unit is estimated to be 2,192,000 barrels of oil or 10.16 per cent of the original oil in place. This estimate was based on an exponential or constant percentage decline of future production to an economic limit of 3,300 barrels of oil per month (55 wells x 60 barrels per month). Oil production history, including predicted performance by primary depletion, is presented by Graph 20.

Waterflood Pattern and Injection Plans

A five-spot flood pattern, as illustrated in Figure 12, is recommended for this project. As can be seen from the quality isopachous maps, Figures 6 through 11, there is considerable variation in the sand quality within the individual zones. Also, the sand zones are not all productive throughout the unit area with Zone IV being limited to the north area and Zones II B and III B being limited primarily to the south area. For these reasons the five-spot is considered the best pattern to obtain adequate areal sweep in all sand zones.

The effective injection of water into more than one sand zone through a common injection well is considered somewhat of a problem. Due to the relatively small separations (3-10 feet) between Zones II A through IV, the completion fracture stimulations may not have effectively treated all perforated zones. Initially the bulk of the injected water will preferentially enter those zones which were effectively treated at completion; however, after fill up it is anticipated that the per zone injectivity will more nearly approach original permeability-capacity relationships.

Dual injection equipment has been provided for 22 of the 31 injection wells in order to segregate Zone I from the lower sand zones. Zone I is the most uniform and continuous sand in the main Queen sand section. Stratigraphically, it is separated from the lower zones by approximately 100 feet of section comprised primarily of dense anhydrite and anhydritic dolomite. Zone I contains 38.46 per cent of the total productive acre-porosity-feet in the East Unit. This zone by itself would be an attractive flood prospect and will probably contribute more than 40 per cent of the total oil recovered by waterflood. Controlled injection into Zone I should provide added assurance of a successful flood.

Prediction of Waterflood Performance

An empirical method of predicting waterflood performance has been used in this study. Several analytical methods were considered; however, all involved the basic assumption that a series of homogeneous layers of different permeability, derived from a grouping of core analysis data, would represent the average injection well. Due to the plan of segregated injection and the variations in the productive areas of the various sand zones, it would be difficult if not impossible to approximate an average injection well by this method. It was therefore concluded that an empirical method, based on the average known performance of many waterfloods, would yield the most satisfactory performance prediction.

The recoverable oil by waterflocd was determined from a volumetric calculation assuming that 40 per cent of the mobile oil in place at the time of flood initiation would be recovered. As shown in Table VII, the estimated recoverable oil by waterflood is 4,952,000 stock tank barrels. This represents an increase in recovery due to waterflood operations of 4,588,000 stock tank barrels or approximately 2.1 times the primary ultimate. The recovery after waterflood will be 31.44 per cent of the original oil in place compared with a 10.16 per cent primary recovery efficiency.

The cumulative water injected at the project economic limit is estimated to be approximately 50 million barrels or 1.27 pore volumes assuming the injection of ten barrels of water per barrel of oil produced under waterflood operation. An injection rate of 300 barrels of water per day per injection well is anticipated based on the injection history of the Shell-Allen Estate No. 3 Salt Water Disposal Well. This well is currently disposing of approximately 300 barrels of water per day into a lower water-bearing Queen sand zone at surface injection pressures of 1,800 to 1,900 psi. The total make-up water required for this project is estimated to be 15 million barrels or 30 per cent of the total injected water assuming the recycling of produced water.

Figure 20 illustrates the predicted performance of the East Unit waterflood project. It is estimated that fill-up will require 12 months of injection predicated on an average injection rate of 283,000 barrels of water per month and an initial gas saturation of 8.7 per cent. The first oil response should occur seven months after the start of injection or at 60 per cent fill-up. The top unit allowable oil production rate will be 71,500 barrels per month with a basic waterflood allowable of 42 barrels per day per well. The total project life of 15 years is based on maintaining an injection rate of 283,000 barrels of water per month except after fill-up when injection rates will be reduced for an estimated one-year period in order to balance injected and produced fluids.

Water Sources and Requirements

The initial daily water requirement for the East Unit will be 9,300 barrels based on a water injection rate of 300 barrels per day per well and a total of 31 injection wells. Combined water requirements for the East and West Units, which by necessity will have to be operated on a cooperative basis, are estimated to be approximately 19,000 barrels per day. During the life of the project the reinjection of produced water will reduce the make-up requirements necessary to maintain constant injection rates.

Since the development of a common source or sources of water for both units should have certain economic advantages, it is felt that a combined effort by the East and West Unit operators should be made to find and develop an adequate water source for flood operations in both units.

A cursory evaluation of water sources in the Pearl area indicates the following possibilities:

1. Shallow Water Sands - The Ogallala (100-200 feet) has been found to be productive of fresh water in the volumes required for drilling activity, but

it is doubtful that the sustained capacity of these sands could provide any more than a fraction of the total water requirement. The Santa Rosa (900-1300 feet) has not been tested; however, log evaluation indicates approximately 200 feet of sand with a porosity of 6-10 per cent and a water salinity of 2000-3000 ppm. Since both C. W. Trainer and Gulf Oil Corporation hold water leases in this area, it is felt that the Santa Rosa source merits further investigation.

2. Disposal Water From the Vacuum South Devonian Field - The field operators are presently considering SWD facilities. It is estimated that approximately 10,000 barrels per day will ultimately be available from the field. Since this amount would represent only one-half of the total water requirements, it would have to be supplemented from some other source. The pipe line cost to transport this water is estimated to be $60,000.

3. Eunice-Monument-Eumont SWD System - Total flood water requirements could be obtained from this SWD system. Present and anticipated future water disposal in this field is in excess of the estimated requirements. At this time the Eunice-Monument-Eumont SWD System appears to be the only adequate source of water available in the Pearl area. The estimated cost to provide a gathering line and a pump station to transport 19,000 barrels per day is $220,000. This source has been used in the economic analysis of waterflooding with the East Unit's share being approximately 50 per cent or $110,000.

Development Cost

The ultimate waterflood development cost for the East Unit is estimated to be $910,000. A capital investment of $731,000 will be required to initiate this project with a subsequent investment of $179,000 providing high capacity lifting equipment during the second and third years. A summary of the estimated development costs using disposal water from the Eunice-Monument-Eumont SWD system is as follows:

Item	Amount
Convert 31 wells to injection status	$269,000
Additional perforating and stimulation (producers & injectors)	70,000
Provide high capacity pumping equipment	179,000
Water Injection Plant	85,000
Water distribution system	102,000
Tank batteries, gathering and test facilities, LACT	64,000
Water supply line and pump station	110,000
Contingencies	31,000
Total Investment	$910,000

Economics

The economics of the East Unit waterflood are summarized in Table VIII. Tables IX and X present profitability analyses for continued primary depletion and waterflood operation, respectively. The total capital investment for the waterflood project is estimated to be $910,000 with an initial investment of $731,000. An additional 4,588,000 barrels of oil should be recovered by waterflood operations. The net increase in profit is $7,300,000 or 802% of the total capital investment. Payout is estimated to be 1.2 years.

Unitization

Unitization of the area included within the boundaries of the proposed East Unit shown in Figure 1 will provide the initial step toward field-wide unitization and the subsequent initiation of full scale waterflood operations. The unitized interval should include the Queen formation down to the top of Zone V. Since this zone is currently being developed outside the proposed unit boundary and isn't considered floodable within the unit, the exclusion of Zone V should facilitate unitization. At the time of unitization those wells producing from Zone V which are to be included within the East Unit can be given primary credit for any anticipated loss in production.

Table XI is a tabulation of potential unitization parameters. Ultimate recovery and remaining primary reserves by lease have not been included as possible parameters due to the lack of sufficient data to accurately predict these values. Acre-porosity-feet was included as a potential unitization parameter since this value should represent the relative secondary potential of each lease within the unit. It was originally thought that this parameter could also be used in determining the magnitude of the primary ultimate recovery from each lease; however, a comparison of the relative current capacity, cumulative production, and acre-porosity-feet by lease indicates that in some cases offset drainage has apparently taken place. Therefore, the use of the acre-porosity-feet parameter should be limited to the secondary phase of unitization if a split formula is used.

TABLE I
BASIC DATA
EAST PEARL QUEEN UNIT

Average Porosity (%)	15.1
Average Connate Water Saturation (%)	35
Range of Average Permeabilities in Productive Zones (md.)	1-140
Average Permeability (md.)	12
Original Formation Volume Factor	1.176
Estimated Formation Volume Factor at Start of Water Injection (1-1-64)	1.114
Acre-Porosity-Feet of Net Pay	5,028.99
Original Oil-in-Place (MMSTB)	21.565
Mobile Oil Saturation (%)	44
Oil Saturation After Primary (%)	54
Oil Saturation After Waterflood (%)	21
Ultimate Primary Recovery (MMSTB)	2.192
Primary Recovery Efficiency (%)	10.16
Estimated Cumulative Production at Start of Water Injection (MMSTB)	1.828
Waterflood Efficiency (%)	40
Combined Ultimate Recovery - Primary and Secondary (MMSTB)	6.780
Increased Recovery Due to Waterflood (MMSTB)	4.588
Recovery Efficiency After Waterflood (%)	31.44

TABLE II
TABULATION OF ACRE-POROSITY-FEET OF
NET PAY PRESENTLY OPEN TO PRODUCTION
EAST PEARL QUEEN UNIT

Operator	Lease	Acre-Porosity-Feet of Net Pay by Zone I	II A	II B	III A	III B	IV	Totals
Cabot	State G	82.40	37.51	0	0	0	0	119.91
Collier	State	0	0	0	8.81	0	0	8.81
Colton	Gulf State	0	0	0	0	0	5.39	5.39
	Texaco-Moran	0	0	0	0	0	18.55	18.55
	Subtotal	0	0	0	0	0	23.94	23.94
Gulf	State AR	34.95	119.58	0	99.55	0	0	254.08
Mid-Tex	Gulf-State	0	0	0	57.30	6.65	0	63.95
Sanford	Union-State	0	0	0	11.29	0	55.58	66.87
Trainer	Rushing	0	0	0	22.79	0	55.58	78.37
	Signal-State	0	0	0	0	0	127.09	127.09
	Subtotal	0	0	0	22.79	0	182.67	205.46
Shell	Allen Estate	123.25	12.00	0	101.84	0	0	237.09
	Allen Estate A	13.58	1.69	0	41.72	0	0	56.99
	Hooper	67.51	42.52	0	24.70	0	0	134.73
	Kimberlin	16.19	51.40	0	59.78	4.01	164.47	295.85
	McIntosh	240.61	4.08	0	0	0	52.83	297.52
	McIntosh A	36.07	0	0	21.87	0	78.51	136.45
	McIntosh B	0	6.00	0	37.75	0	119.45	163.20
	McIntosh C	314.81	53.71	0	46.50	0	0	415.02
	McIntosh D	59.26	0	0	33.25	0	61.97	154.48
	McIntosh E	16.79	0	0	18.29	0	0	35.08
	Record	0	0	0	0	0	0	0
	Record A	21.21	3.53	0	43.59	0	0	68.33
	State PA	118.93	2.95	2.45	0	0	0	124.33
	State PB	69.17	10.05	0	34.78	0	31.70	145.70
	State PC	130.88	30.16	0.84	14.78	13.37	0	190.03
	State PD	154.84	142.20	8.00	165.02	0	0	470.06
	State PE	66.72	0	0	0	21.27	0	87.99
	State PF	104.21	12.00	10.00	31.47	0	0	157.68
	State PG	97.49	0	0	0	0	0	97.49
	Subtotal	1,651.52	372.29	21.29	675.34	38.65	508.93	3,268.02
Unit Totals		1,768.87	529.38	21.29	875.08	45.30	771.12	4,011.04

TABLE III
TABULATION OF ACRE-POROSITY-FEET OF NET PAY NOT OPEN TO PRODUCTION BUT CONSIDERED PRODUCTIVE IN WELL BORE
EAST PEARL QUEEN UNIT

Operator	Lease	Acre-Porosity-Feet of Net Pay by Zone I	II A	II B	III A	III B	IV	Totals
Cabot	State G	0	0	0	0	0	0	0
Collier	State	0	0	0	0	0	0	0
Colton	Gulf State	0	0	0	0	0	0	0
	Texaco-Moran	0	0	0	0	0	0	0
	Subtotal	0	0	0	0	0	0	0
Gulf	State AR	0	0	33.27	0	0	0	33.27
Mid-Tex	Gulf-State	55.82	27.77	8.74	0	5.74	0	98.07
Sanford	Union-State	0	0	0	0	1.17	0	1.17
Trainer	Rushing	0	0	0	25.61	0	0	25.61
	Signal-State	17.11	0	0	33.91	19.49	0	70.51
	Subtotal	17.11	0	0	59.52	19.49	0	96.12
Shell	Allen Estate	0	12.00	0	0	7.73	0	19.73
	Allen Est. (DH)	0	0	0	0	0	0	0
	Allen Est. A	0	0	0	0	0	0	0
	Hooper	0	0	0	46.68	0	0	46.68
	Kimberlin	12.23	0	0	19.83	7.11	0	39.17
	McIntosh	0	0	0	0	0	0	0
	McIntosh A	0	4.53	0	0	0	0	4.53
	McIntosh B	3.94	0	0	7.32	0	0	11.26
	McIntosh C	0	14.84	0	26.04	23.36	0	64.24
	McIntosh D	0	4.97	0	25.18	4.78	0	34.93
	McIntosh E	0	0	0	0	0	0	0
	Record (DH)	18.58	4.39	0	13.13	0	0	36.10
	Record A	0	0	0	0	0	0	0
	State PA	0	10.20	0	21.90	0	0	32.10
	State PB	0	0	0	0	0	0	0
	State PC	0	0	4.16	18.88	19.28	0	42.32
	State PD	0	37.46	19.81	14.80	24.65	0	96.72
	State PE	0	7.73	0	7.44	0	0	15.17
	State PE (DH)	17.60	12.00	3.12	0	0	0	32.72
	State PF	0	12.00	3.60	11.17	15.23	0	42.00
	State PG	0	12.00	3.37	22.81	15.13	0	53.31
	Subtotal	52.35	132.12	34.06	235.18	117.27	0	570.98
Unit Totals		125.28	159.89	76.07	294.70	143.67	0	799.61

DH - 40-Acre Dry Hole Unit

TABLE IV

TABULATION OF ACRE-POROSITY-FEET OF NET PAY NOT PRODUCTIVE IN WELL BORE BUT CONSIDERED PRODUCTIVE WITHIN LEASE BOUNDARY

EAST PEARL QUEEN UNIT

Operator	Lease	Acre-Porosity-Feet of Net Pay by Zone I	II A	II B	III A	III B	IV	Totals
Cabot	State G	0	0	2.18	0.59	0	0	2.77
Collier	State	1.60	7.47	0	0	0.02	0	9.09
	State (UD)	0.26	0.93	0	3.84	0.01	13.54	18.58
	Subtotal	1.86	8.40	0	3.84	0.03	13.54	27.67
Colton	Gulf-State	0	0	0	0	0	0	0
	Texaco-Moran	0	0	0	3.71	0	0	3.71
	Subtotal	0	0	0	3.71	0	0	3.71
Gulf	State AR	0	0	15.12	0	2.82	0	17.94
Mid-Tex	Gulf-State	0	3.11	2.19	0	0	0	5.30
Sanford	Union-State	0	0	0	7.76	1.50	0	9.26
Trainer	Rushing	0	0	0	0	0.38	0	0.38
	Signal-State	0	0.16	0	0	0	0	0.16
	Subtotal	0	0.16	0	0	0.38	0	0.54
Shell	Allen Est.	0	3.56	0	0	0	0	3.56
	Allen Est. (DH)	10.55	0.26	0	9.97	0	0	20.78
	Allen Estate A	0	0	0	0	0	0	0
	Allen Est. A (UD)	4.62	1.53	0	6.35	0	0	12.50
	Hooper	0	0	0	0	0	3.30	3.30
	Kimberlin	1.49	13.40	0	0	0.80	0	15.69
	McIntosh	0	4.71	0.11	7.29	1.83	0	13.94
	McIntosh A	0	0	0	0	1.40	0	1.40
	McIntosh B	5.15	0.66	0	0	3.33	0	9.14
	McIntosh C	0	0	0	0	2.00	10.58	12.58
	McIntosh D	4.41	1.77	0	0	0.01	2.35	8.54
	McIntosh E	0	1.28	0	0	0	0	1.28
	Record (DH)	0	0	0	0	0	0	0
	Record A	0	0	0	0	0.30	0	0.30
	State PA	0	0	2.20	3.32	0.13	0	5.65
	State PB	0	10.73	0	0	0	0	10.73
	State PC	0	0	0	0	0	0	0
	State PD	11.81	0	0	0	9.45	0	21.26
	State PE	0	0	0.06	0	0	0	0.06
	State PE (DH)	0	0	0	1.81	2.99	0	4.80
	State PF	0	0	0	0	0	0	0
	State PG	0	3.46	2.18	0	0	0	5.64
	Subtotal	38.03	41.36	4.55	28.74	22.24	16.23	151.15
Unit Totals		39.89	53.03	24.04	44.64	26.97	29.77	218.34

DH - 40-Acre Dry Hole Unit
UD - 40-Acre Undrilled Unit

TABLE V
SUMMARY TABULATION OF
PRODUCTIVE ACRE-POROSITY-FEET
OF NET PAY BY OPERATOR AND LEASE
EAST PEARL QUEEN UNIT

Operator	Lease	Acre-Porosity-Feet of Net Pay: Open to Production	Not Open to Production	Not Present In Well Bore	Totals
Cabot	State G	119.91	0	2.77	122.68
Collier	State	8.81	0	9.09	17.90
	State (UD)	0	0	18.58	18.58
	Subtotal	8.81	0	27.67	36.48
Colton	Gulf-State	5.39	0	0	5.39
	Texaco-Moran	18.55	0	3.71	22.26
	Subtotal	23.94	0	3.71	27.65
Gulf	State AR	254.08	33.27	17.94	305.29
Mid-Tex	Gulf-State	63.95	98.07	5.30	167.32
Sanford	Union-State	66.87	1.17	9.26	77.30
Trainer	Rushing	78.37	25.61	0.38	104.36
	Signal-State	127.09	70.51	0.16	197.76
	Subtotal	205.46	96.12	0.54	302.12
Shell	Allen Est.	237.09	19.73	3.56	260.38
	Allen Est. (DH)	0	0	20.78	20.78
	Allen Est. A	56.99	0	0	56.99
	Allen Est. A (UD)	0	0	12.50	12.50
	Hooper	134.73	46.68	3.30	184.71
	Kimberlin	295.85	39.17	15.69	350.71
	McIntosh	297.52	0	13.94	311.46
	McIntosh A	136.45	4.53	1.40	142.38
	McIntosh B	163.20	11.26	9.14	183.60
	McIntosh C	415.02	64.24	12.58	491.84
	McIntosh D	154.48	34.93	8.54	197.95
	McIntosh E	35.08	0	1.28	36.36
	Record (DH)	0	36.10	0	36.10
	Record A	68.33	0	0.30	68.63
	State PA	124.33	32.10	5.65	162.08
	State PB	145.70	0	10.73	156.43
	State PC	190.03	42.32	0	232.35
	State PD	470.06	96.72	21.26	588.04
	State PE	87.99	15.17	0.06	103.22
	State PE (DH)	0	32.72	4.80	37.52
	State PF	157.68	42.00	0	199.68
	State PG	97.49	53.31	5.64	156.44
	Subtotal	3,268.02	570.98	151.15	3,990.15
Unit Totals		4,011.04	799.61	218.34	5,028.99

DH - 40-Acre Dry Hole Unit
UD - 40-Acre Undrilled Unit

TABLE VI
SUMMARY TABULATION OF PRODUCTIVE
ACRE-POROSITY-FEET OF NET PAY BY ZONE
EAST PEARL QUEEN UNIT

Zone	Acre-Porosity-Feet of Net Pay: Open to Production	Not Open to Production	Not Present In Well Bore	Zone Totals	% of Total Unit Acre-Porosity-Feet
I	1,768.87	125.28	39.89	1,934.04	38.46
II A	529.38	159.89	53.03	742.30	14.76
II B	21.29	76.07	24.04	121.40	2.41
III A	875.08	294.70	44.64	1,214.42	24.15
III B	45.30	143.67	26.97	215.94	4.29
IV	771.12	0	29.77	800.89	15.93
Unit Totals	4,011.04	799.61	218.34	5,028.99	100.00

TABLE VII
SAMPLE CALCULATIONS
EAST PEARL QUEEN UNIT

Residual Oil After Waterflood:

At 15.1 per cent porosity:

Mobile Oil Saturation = Mobile Oil Factor (from Graph 3, Fig. 19)
x Original Oil Saturation (from Graph 2, Fig. 19)
= 0.68 x (1-0.35) = 0.44

Residual Oil Saturation After Waterflood = Original Oil Saturation
- Mobile Oil Saturation = (1-0.35) - 0.44 = 0.21

Original Oil In Place:

$$OOIP\ (STB) = \frac{7758\ Ac\ \phi\ Ft\ (1-S_w)}{Boi} = \frac{7758 \times 5028.99\ (1-0.35)}{1.176} = 21,565,000\ STB$$

Oil Saturations:

At Primary Depletion:

$$S_o = B_o\left(\frac{1-S_w}{Boi} - \frac{N_p}{7758\ Ac\ \phi\ Ft}\right) = 1.088\left(\frac{1-0.35}{1.176} - \frac{2.192 \times 10^6}{7758 \times 5028.99}\right) = 0.540$$

At Start of Water Injection:

$$S_o = B_o\left(\frac{1-S_w}{Boi} - \frac{N_p}{7758\ Ac\ \phi\ Ft}\right) = 1.114\left(\frac{1-0.35}{1.176} - \frac{1.828 \times 10^6}{7758 \times 5028.99}\right) = 0.563$$

Recoverable Oil by Waterflood:

$$N_{wf} = \text{Waterflood Efficiency}\left[7758\ Ac\ \phi\ Ft\left(\frac{1-S_w}{Boi} - \frac{S_{or}}{Bo}\right) - N_p\right]$$

$$N_{wf} = 0.40\left[7758 \times 5028.99\left(\frac{1-0.35}{1.176} - \frac{0.21}{1.114}\right) - 1.828 \times 10^6\right] = 4,952,000\ STB$$

TABLE VIII
SUMMARY TABULATION OF
WATERFLOOD ECONOMICS
EAST PEARL QUEEN UNIT

Profitability Item	Continued Primary	Waterflood Project	Net Increase Due to Waterflood Operation
Gross Oil Production, (M) Bbls.	364	4,952	4,588
Value of Net Production, (M) $	930	12,301	11,371
Operating Costs, (M) $	433	2,668	2,235
Taxes & Insurance, (M) $	74	1,000	926
Capital Investment, (M) $	0	910	910
Total Expenditures, (M) $	507	4,578	4,071
Net Profit, (M) $	423	7,723	7,300
Per Cent Profit	-	-	802
Present Value Profit (@ 6%), (M) $	393	6,095	5,702
Per Cent Deferred Profit	-	-	641
Project Life, Yrs.	4	15	11
Pay Out Time, Yrs.	-	-	1.2

TABLE IX
PROFITABILITY ANALYSIS OF
CONTINUED PRIMARY DEPLETION
EAST PEARL QUEEN UNIT

Year	Gross Oil Production (M) Bbls.	Value of Net Prod.(1) (M) $	Expenditures (M) $				Net Profit (3) (M) $	Present Value of Net Profit Discounted at 6% (M) $
			Operating Costs	Taxes (2) & Insurance	Capital Investments	Total		
1964	140	358	110	28		138	220	212
1965	103	263	109	21		130	133	121
1966	70	179	108	14		122	57	49
1967	51	130	106	11	-	117	13	11
Totals	364	930	433	74	0	507	423	393

(1) Basic Royalty 12.5 Per Cent
(2) State and Local taxes
(3) Before Federal Income Tax

TABLE X
PROFITABILITY ANALYSIS OF
WATERFLOOD PROJECT
EAST PEARL QUEEN UNIT

Year	Gross Oil Production (M) Bbls.	Value of Net Prod.(1) (M) $	Expenditures (M) $ Operating Costs	Taxes(2) & Insurance	Capital Investments	Total	Net Profit(3) (M) $	Present Value of Net Profit Discounted at 6% (M) $
1964	415	1031	129	84	731	944	87	56
1965	858	2131	165	173	60	398	1733	1573
1966	858	2131	185	173	119	477	1654	1416
1967	706	1754	199	143		342	1412	1141
1968	468	1162	191	95		286	876	668
1969	311	773	185	63		248	525	378
1970	238	591	183	48		231	360	244
1971	208	517	181	42		223	294	188
1972	183	455	181	37		218	237	143
1973	162	402	180	33		213	189	108
1974	138	343	179	28		207	136	73
1975	123	305	178	25		203	102	52
1976	107	266	178	22		200	66	32
1977	93	231	177	17		194	37	17
1978	84	209	177	17		194	15	6
Totals	4,952	12,301	2,668	1,000	910	4,578	7,723	6,095

(1) Basic Royalty 12.5 Per Cent
(2) State and Local Taxes
(3) Before Federal Income Tax

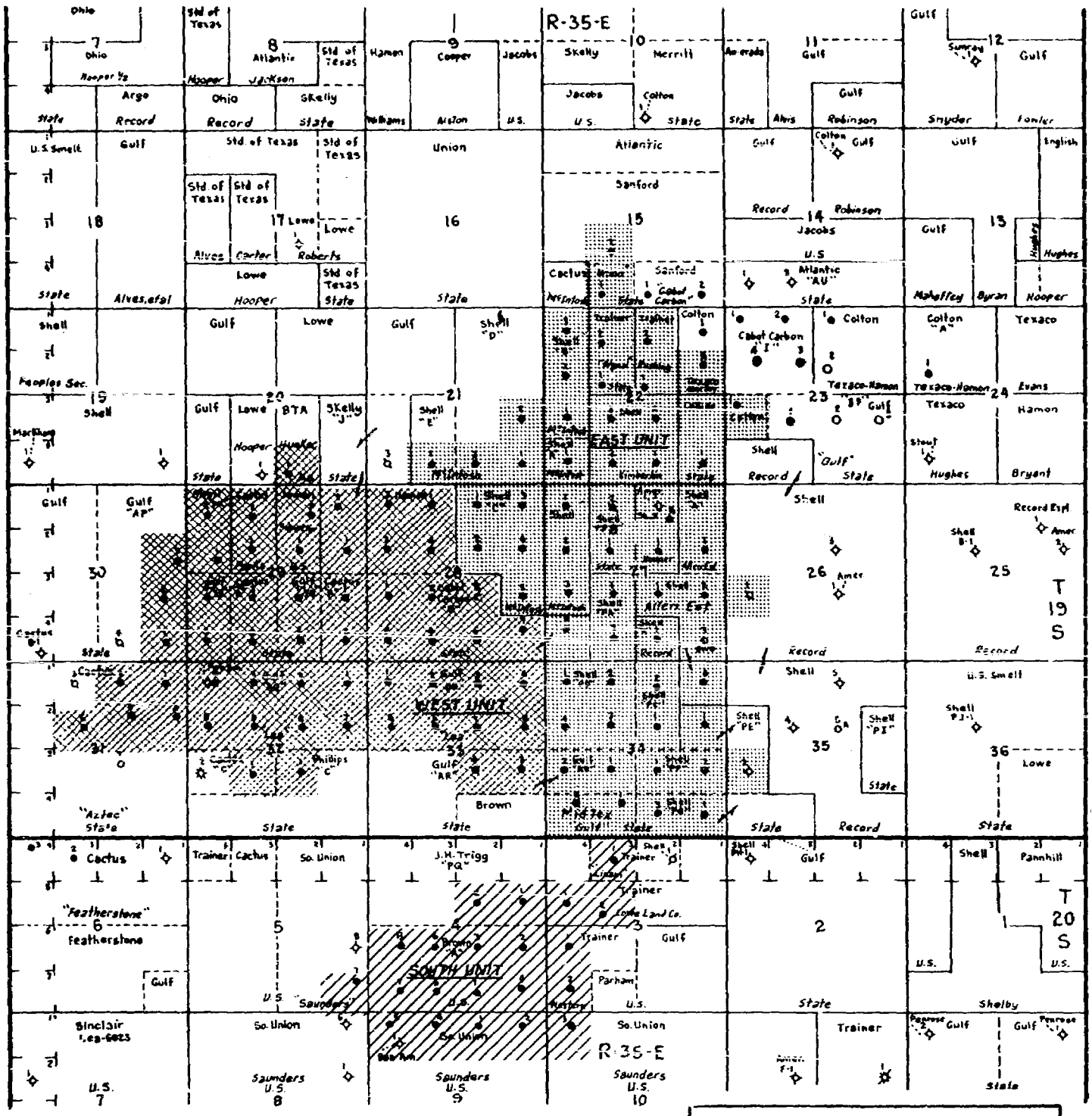
TABLE XI
POTENTIAL UNITIZATION PARAMETERS
EAST PEARL QUEEN UNIT

Operator & Lease	Statistics: Useable Wells	Statistics: Production June-Aug. 1962	Statistics: Cumulative Production (9-1-62)	Statistics: Total Acre-Porosity-Feet	Percentages: Useable Wells	Percentages: Production June-Aug. 1962	Percentages: Cumulative Production (9-1-62)	Percentages: Total Acre-Porosity-Feet
Cabot								
State "G"	1	1,335	36,646	122.68	1.7241	1.9519	2.3642	2.4395
Collier								
State	1	471	5,358	36.48	1.7241	0.6887	0.3457	0.7254
Colton								
Gulf-State	1	1,908	8,828	5.39	1.7242	2.7897	0.5695	0.1072
Texaco-Moran	1	2,278*	7,031*	22.26	1.7241	3.3307*	0.4535*	0.4426
Company Total	2	4,186*	15,859*	27.65	3.4483	6.1204*	1.0232*	0.5498
Gulf								
State "AR"	2	4,763	35,540	305.29	3.4483	6.9641	2.2929	6.0706
Mid-Tex								
Gulf-State	2	2,335	32,151	167.32	3.4483	3.4140	2.0742	3.3271
Sanford								
Union-State	2	1,196	19,315	77.30	3.4483	1.7487	1.2461	1.5371
Trainer								
Rushing	2	2,090	33,522	104.36	3.4483	3.0558	2.1627	2.0752
Signal-State	2	3,315	59,876	197.76	3.4483	4.8469	3.8629	3.9324
Company Total	4	5,405	93,398	302.12	6.8966	7.9027	6.0256	6.0076

*Production from Zone V is included in these values.

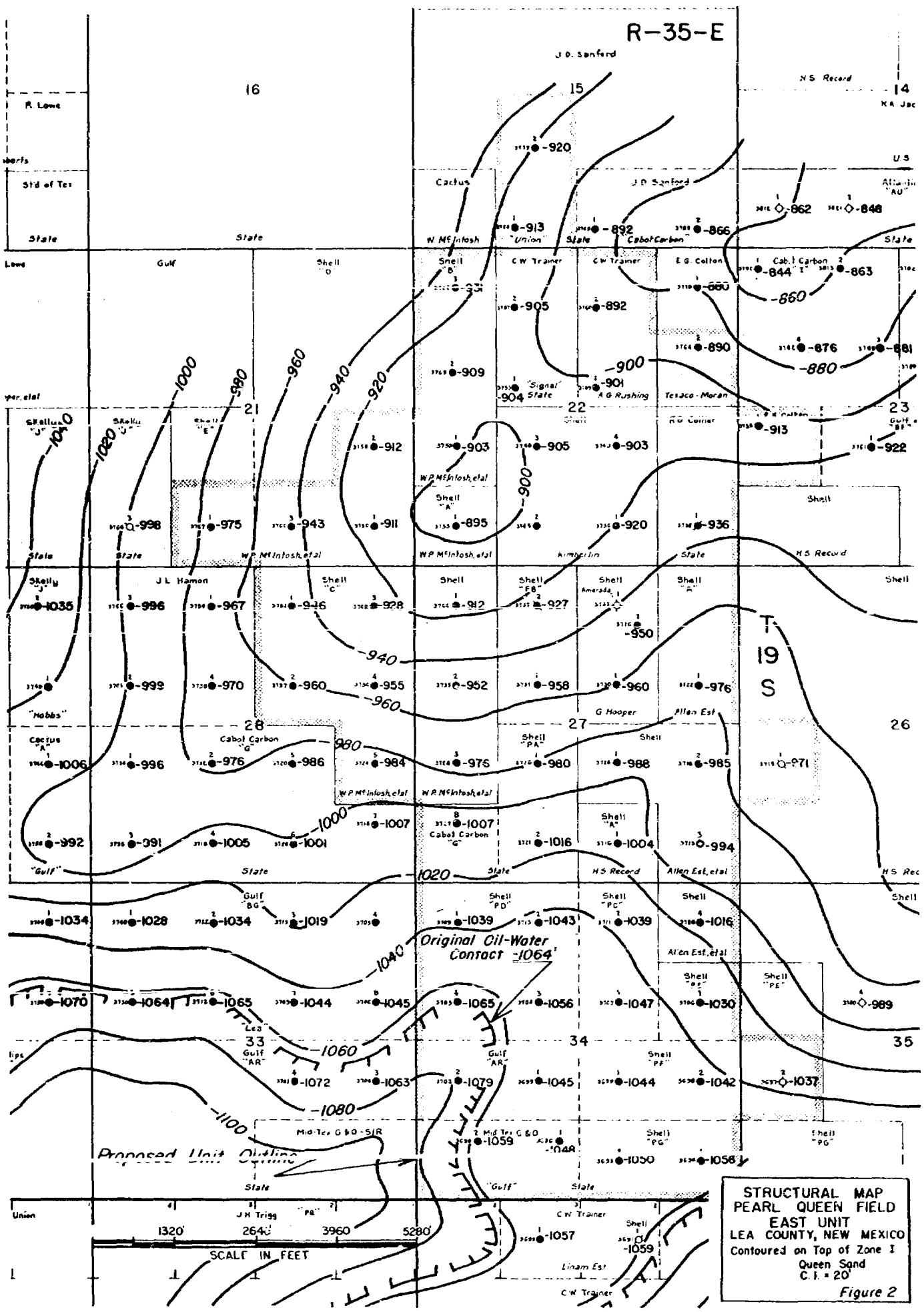
TABLE XI (CONTINUED)
POTENTIAL UNITIZATION PARAMETERS
EAST PEARL QUEEN UNIT

Operator & Lease	Statistics: Useable Wells	Production June-Aug. 1962	Cumulative Production (9-1-62)	Total Acre-Porosity-Feet	Percentages: Useable Wells	Production June-Aug. 1962	Cumulative Production (9-1-62)	Total Acre-Porosity-Feet
Shell								
Allen Estate	4	5,521	137,715	281.16	6.8966	8.0723	8.8848	5.5908
Allen Estate "A"	1	1,567	48,110	69.49	1.7241	2.2911	3.1039	1.3818
Hooper	2	377	42,264	184.71	3.4483	0.5512	2.7267	3.6729
Kimberlin	4	1,912	124,574	350.71	6.8966	2.7956	8.0370	6.9738
McIntosh	3	1,910	108,768	311.46	5.1724	2.7926	7.0172	6.1933
McIntosh "A"	1	1,029	47,365	142.38	1.7241	1.5045	3.0558	2.8312
McIntosh "B"	3	1,552	77,066	183.60	5.1724	2.2692	4.9720	3.6508
McIntosh "C"	5	4,308	161,820	491.84	8.6207	6.2988	10.4399	9.7801
McIntosh "D"	3	888	50,631	197.95	5.1724	1.2984	3.2665	3.9362
McIntosh "E"	1	283	13,927	36.36	1.7241	0.4138	0.8985	0.7230
Record	1	-	-	36.10	1.7241	-	-	0.7178
Record "A"	1	1,445	50,388	68.63	1.7241	2.1128	3.2508	1.3647
State "PA"	2	1,324	69,703	162.08	3.4483	1.9358	4.4969	3.2229
State "PB"	2	359	50,902	156.43	3.4483	0.5249	3.2840	3.1106
State "PC"	2	4,312	57,190	232.35	3.4483	6.3047	3.6897	4.6202
State "PD"	4	10,224	134,848	588.04	6.8966	14.9487	8.6998	11.6930
State "PE"	1	2,834	30,517	140.74	1.7241	4.1436	1.9688	2.7986
State "PF"	2	4,763	53,964	199.68	3.4483	6.9641	3.4815	3.9706
State "PG"	2	4,095	51,992	156.44	3.4482	5.9874	3.3543	3.1107
Company Total	44	48,703	1,311,744	3,990.15	75.8620	71.2095	84.6281	79.3430
Unit Totals	58	68,394	1,550,011	5,028.99	100.0000	100.0000	100.0000	100.0000



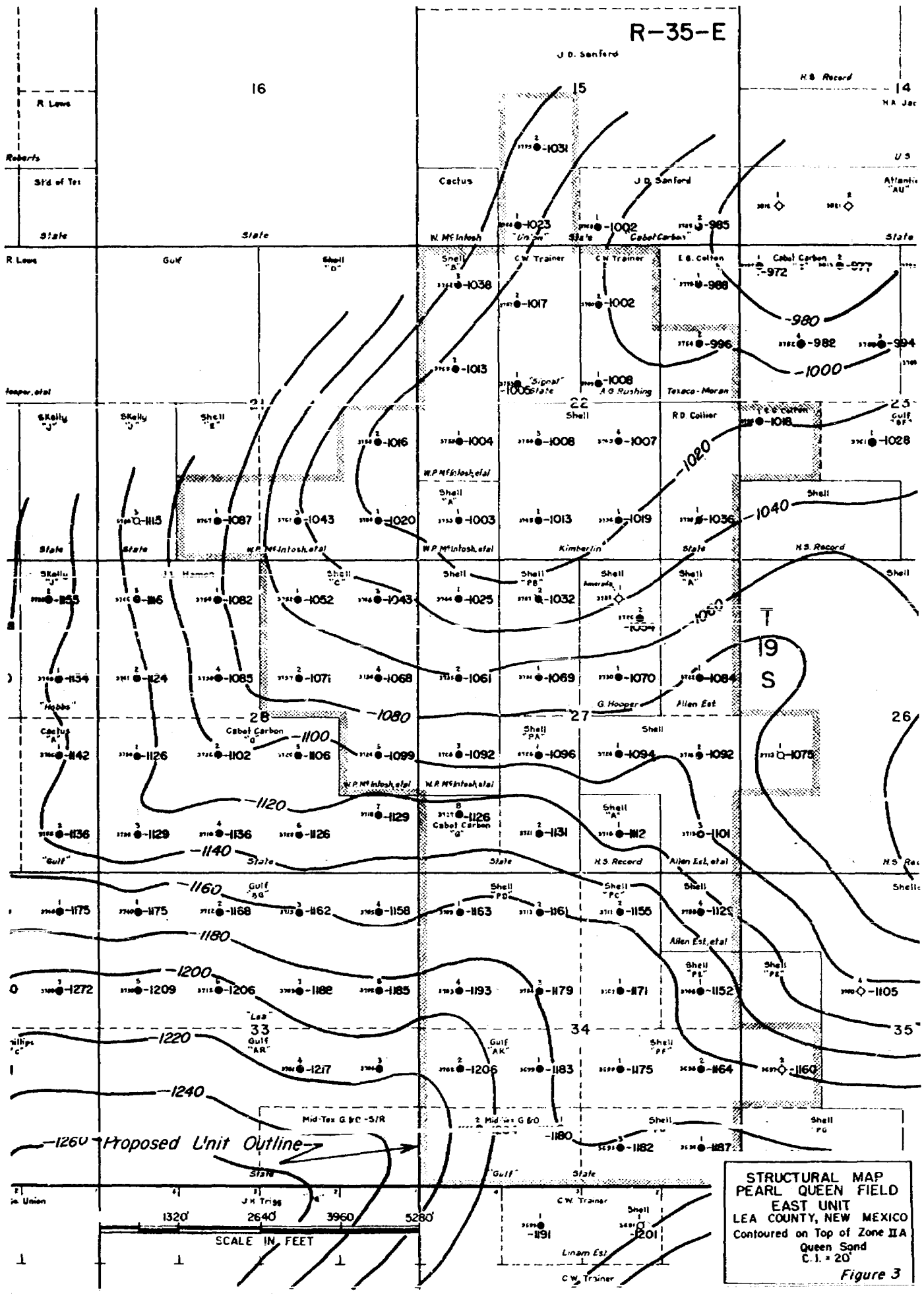
Pearl Queen Field
Lea County, New Mexico
Proposed Unit Subdivisions
Scale: 1" = 4000'

Figure 1



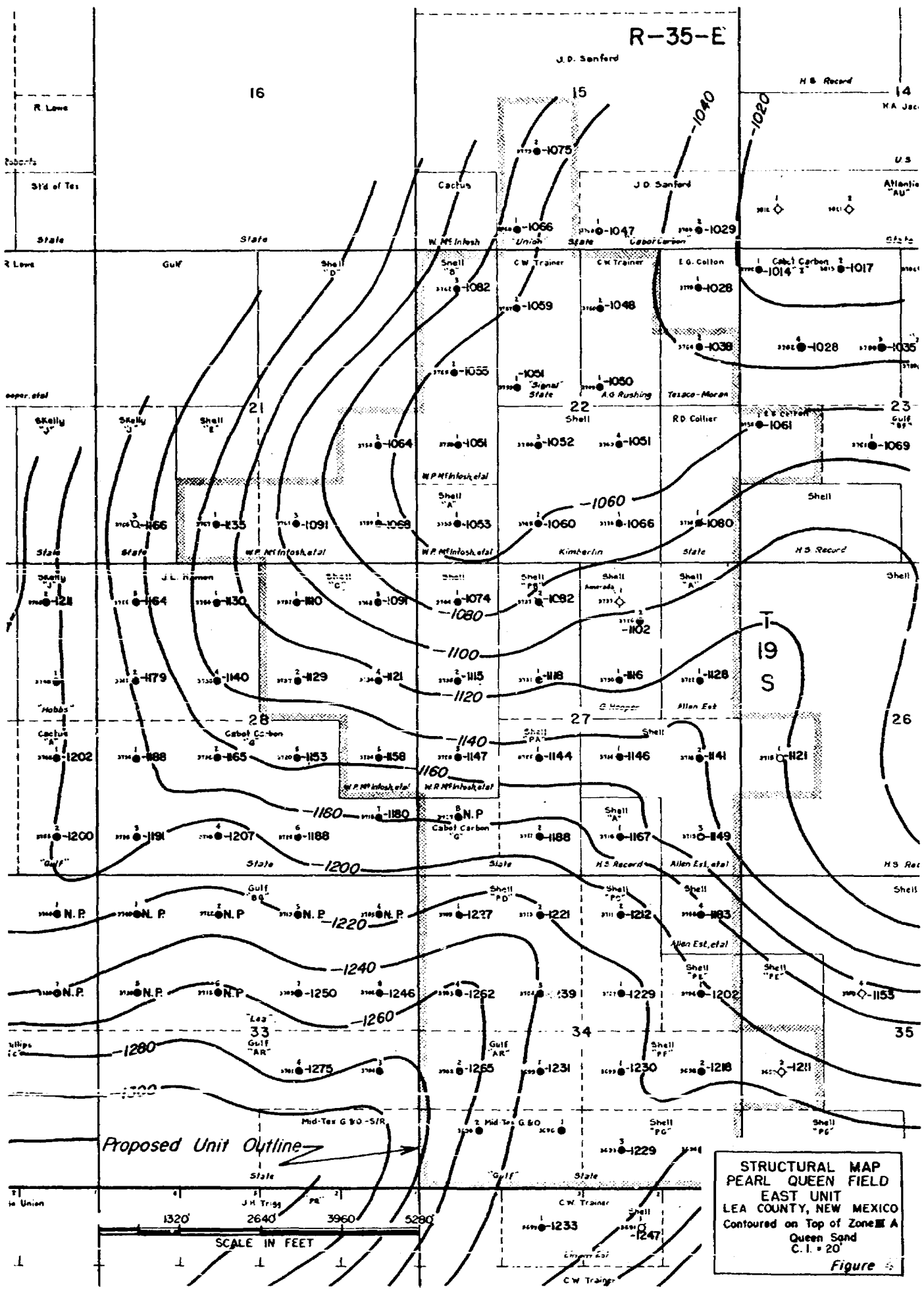
STRUCTURAL MAP
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Contoured on Top of Zone I
Queen Sand
C. I. = 20'

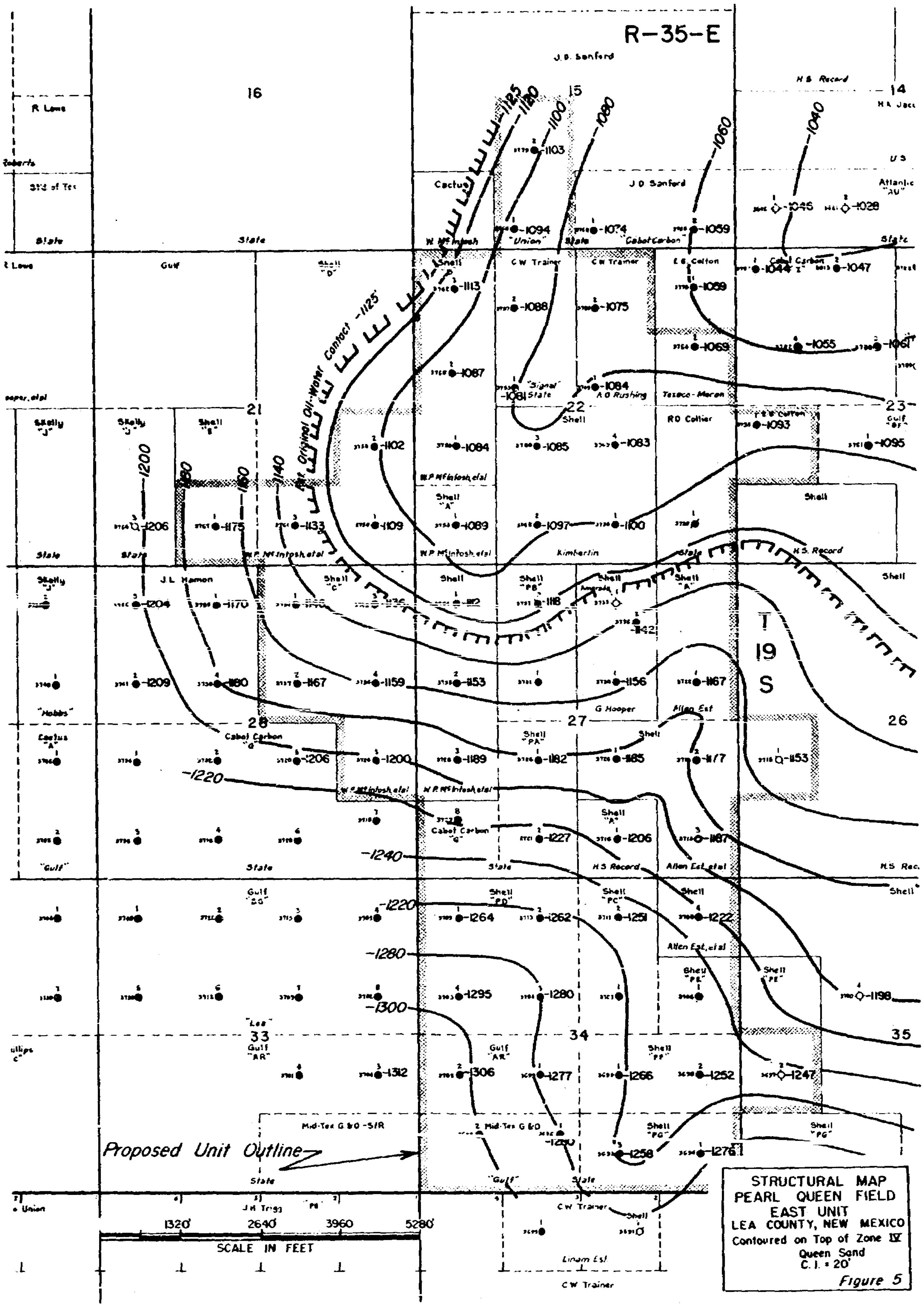
Figure 2



STRUCTURAL MAP
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Contoured on Top of Zone IIA
Queen Sand
C.I. = 20'

Figure 3


R-35-E
16
15
14
21
22
23
28
27
26
33
34
35
19 S
-1020
-1040
-1060
-1080
-1100
-1120
-1140
-1160
-1180
-1200
-1220
-1240
-1260
-1280
-1300
Proposed Unit Outline
1320'
2640'
3960'
5280'
SCALE IN FEET
STRUCTURAL MAP
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Contoured on Top of Zone III A
Queen Sand
C.I. = 20'
Figure



STRUCTURAL MAP
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Contoured on Top of Zone IV
Queen Sand
C.I. = 20'
Figure 5

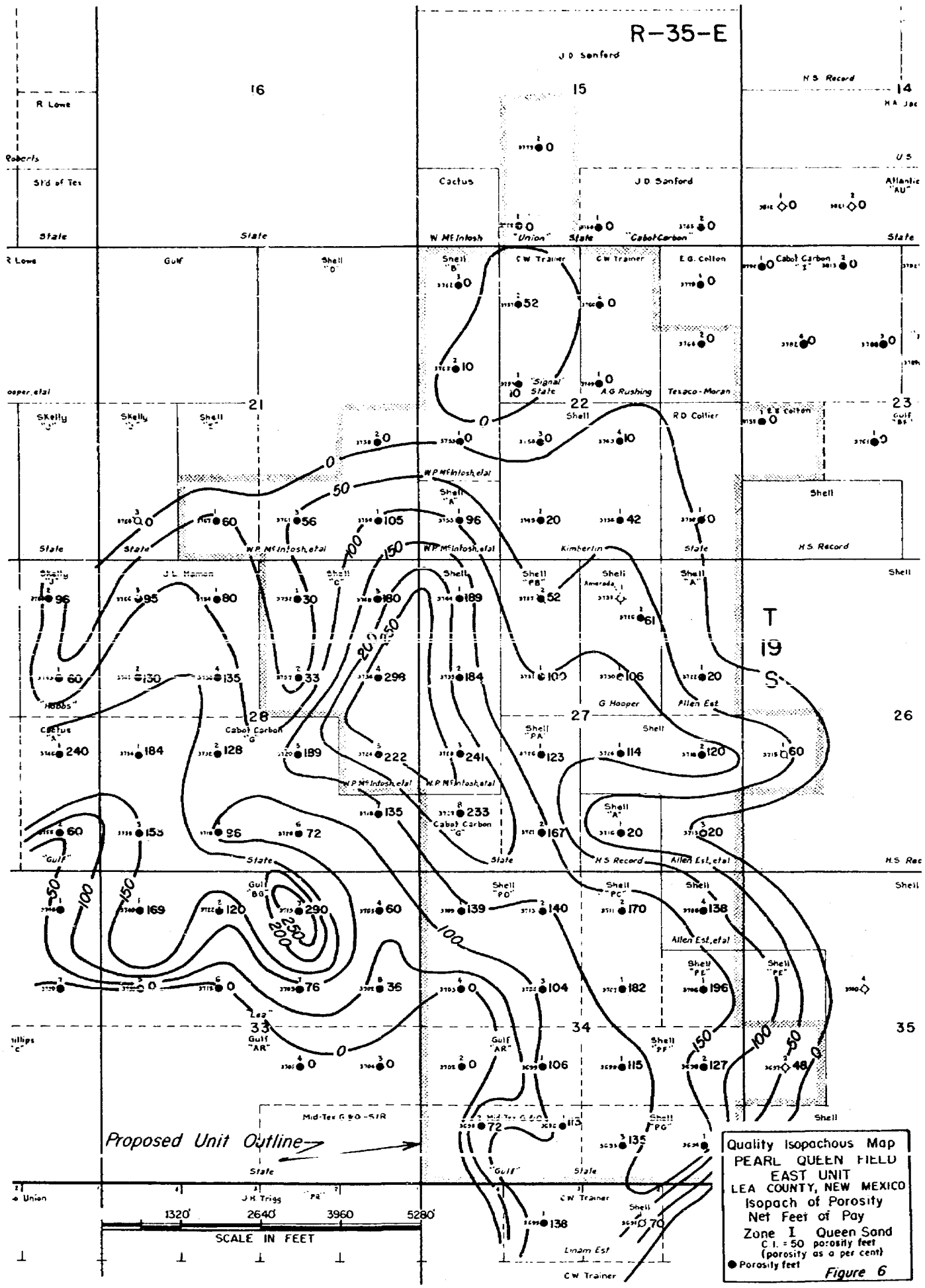
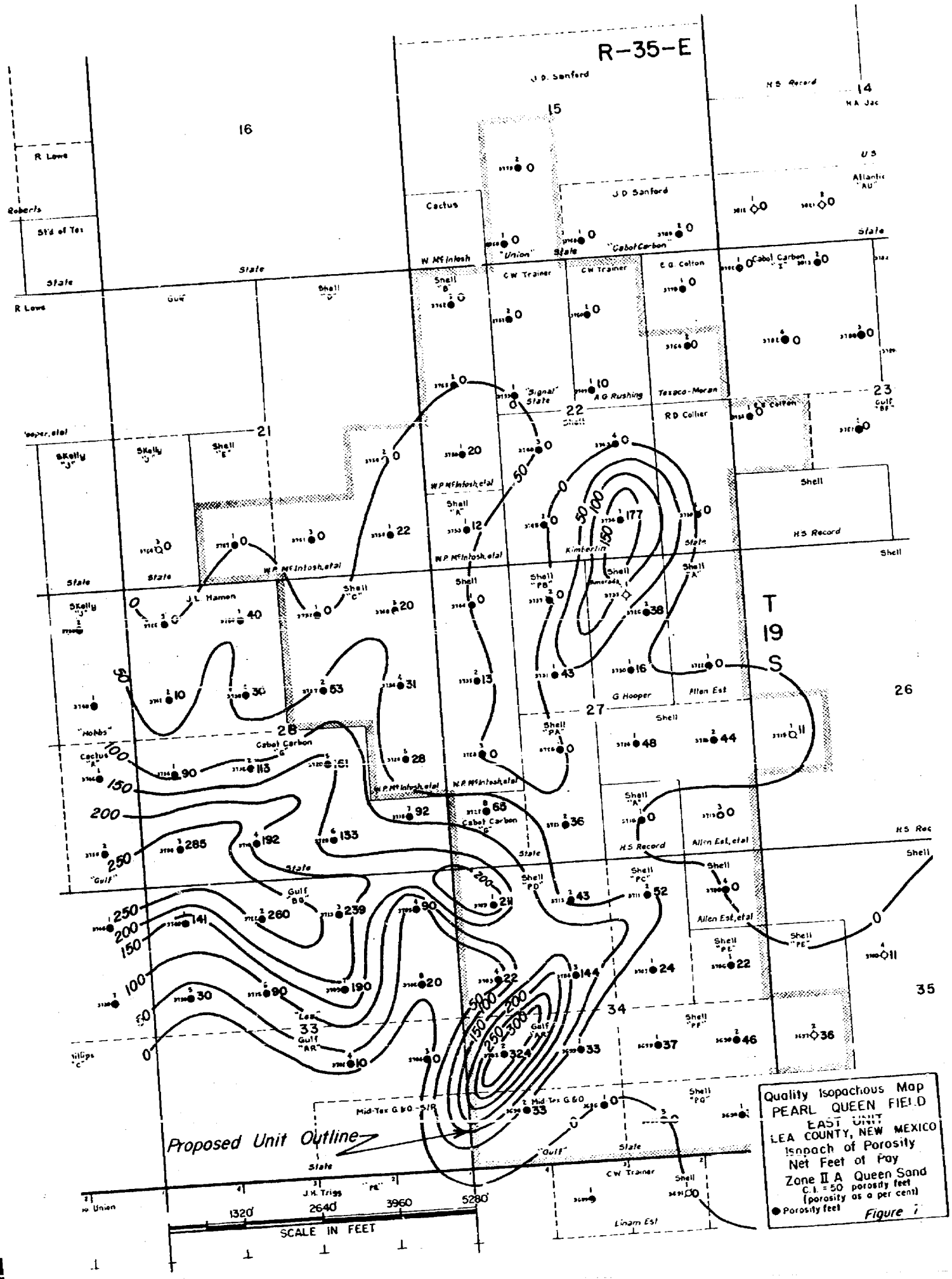
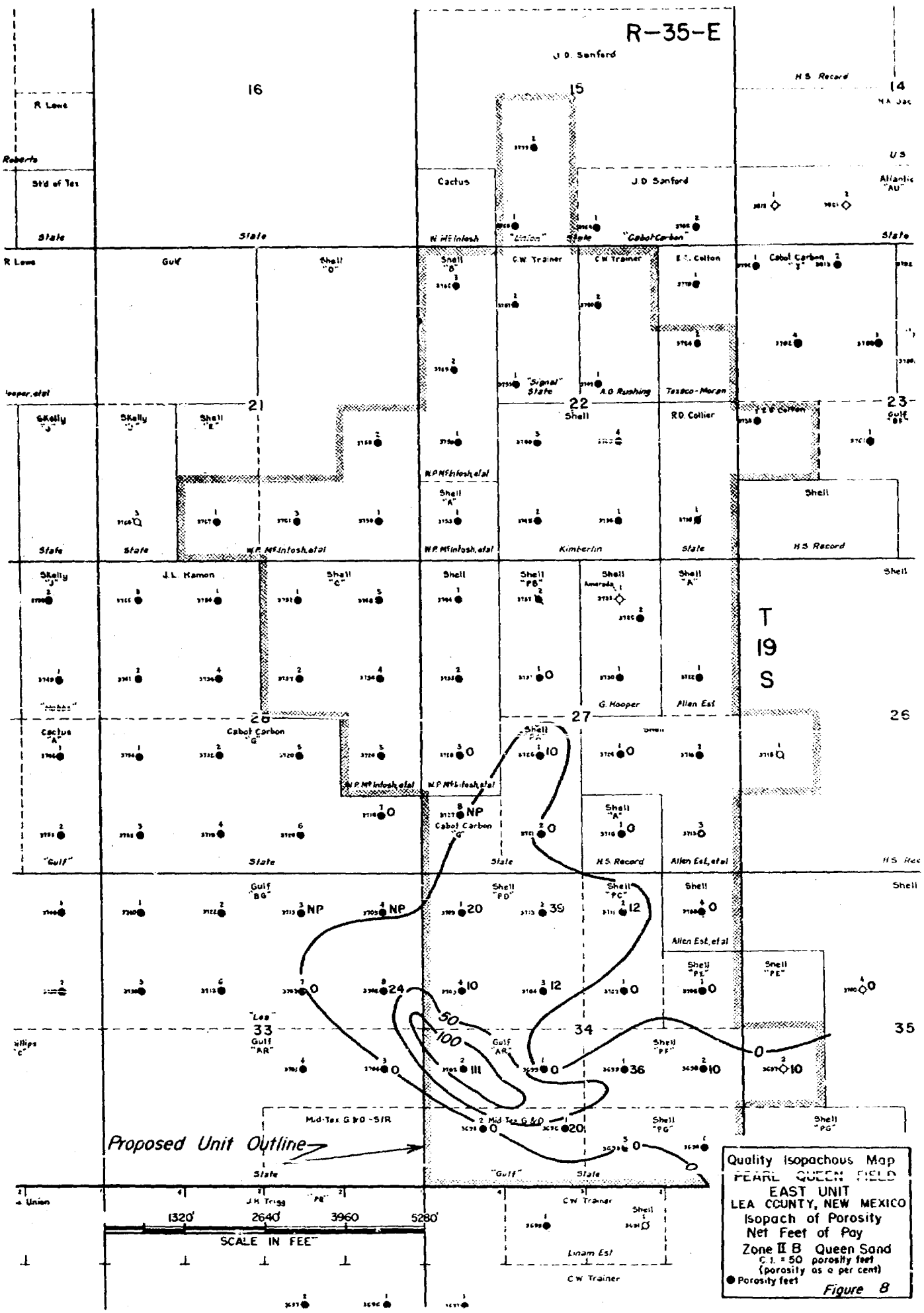

R-35-E
T 19 S
16
15
14
21
22
23
28
27
26
33
34
35
J D Sanford
H S Record
R Lowe
Roberts
Std of Tex
Cactus
J D Sanford
Atlantic "AU"
State
W McIntosh
"Union"
"Cabot Carbon"
Gulf
Shell "D"
Shell "B"
C W Trainer
E G Colton
Cabot Carbon "I"
"Signal" State
A G Rushing
Texaco-Moran
Skelly "J"
Skelly "I"
Shell "C"
Shell
R D Collier
Gulf "BK"
W P McIntosh, etal
Shell "A"
Kimberlin
J L Hamon
Shell "C"
Shell "FB"
Shell Amerada
Shell "A"
Hobbs
Cactus "A"
Cabot Carbon "G"
G Hooper
Allen Est
Shell "PA"
Shell "A"
Gulf "BG"
Shell "PD"
Shell "PC"
Shell "PE"
Allen Est, etal
Lea
Gulf "AR"
Shell "PF"
Shell "PG"
Mid-Tex G & O -STR
Proposed Unit Outline
J H Trigg "P2"
Union
Linam Est
0
50
100
150
200
250
1320'
2640'
3960'
5280'
SCALE IN FEET
Quality Isopachous Map
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Isopach of Porosity
Net Feet of Pay
Zone I Queen Sand
C.I. = 50 porosity feet
(porosity as a per cent)
● Porosity feet

Figure 6



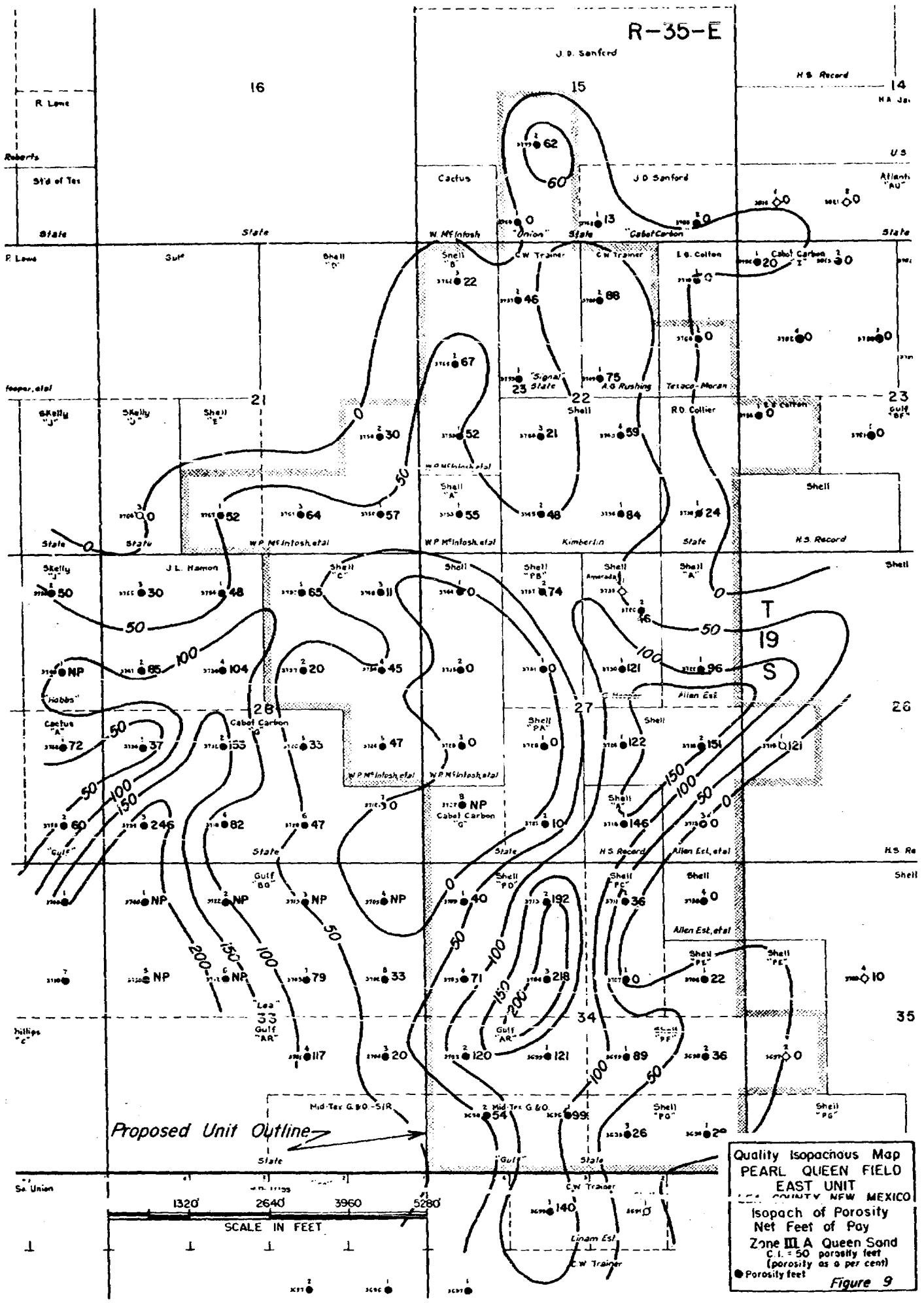
Quality Isopachous Map
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Isopach of Porosity
Net Feet of Pay
Zone II A Queen Sand
C.I. = 50 porosity feet
(porosity as a per cent)
● Porosity feet

Figure 1



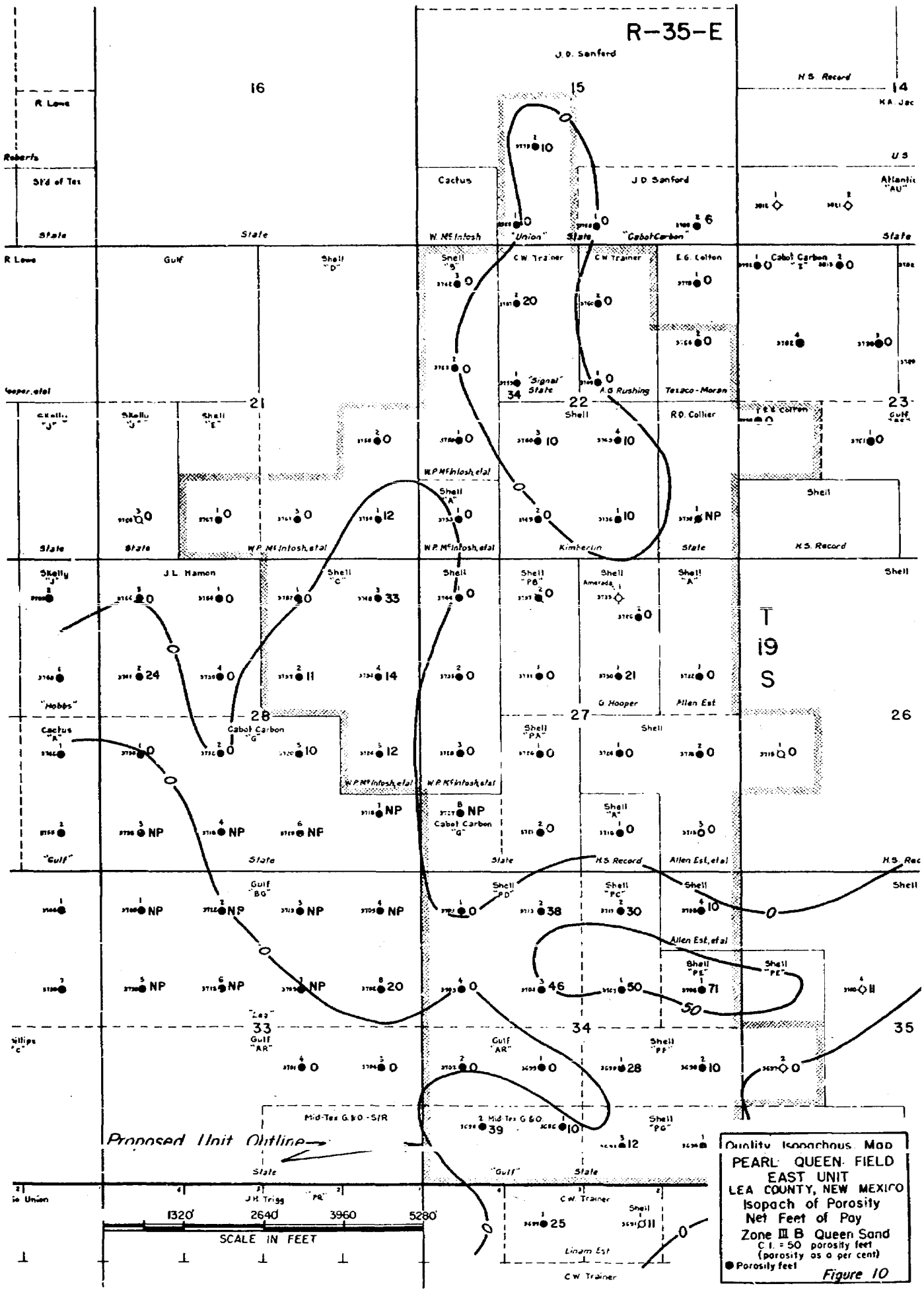
Quality Isopachous Map
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Isopach of Porosity
Net Feet of Pay
Zone II B Queen Sand
C.I. = 50 porosity feet
(porosity as a per cent)
● Porosity feet

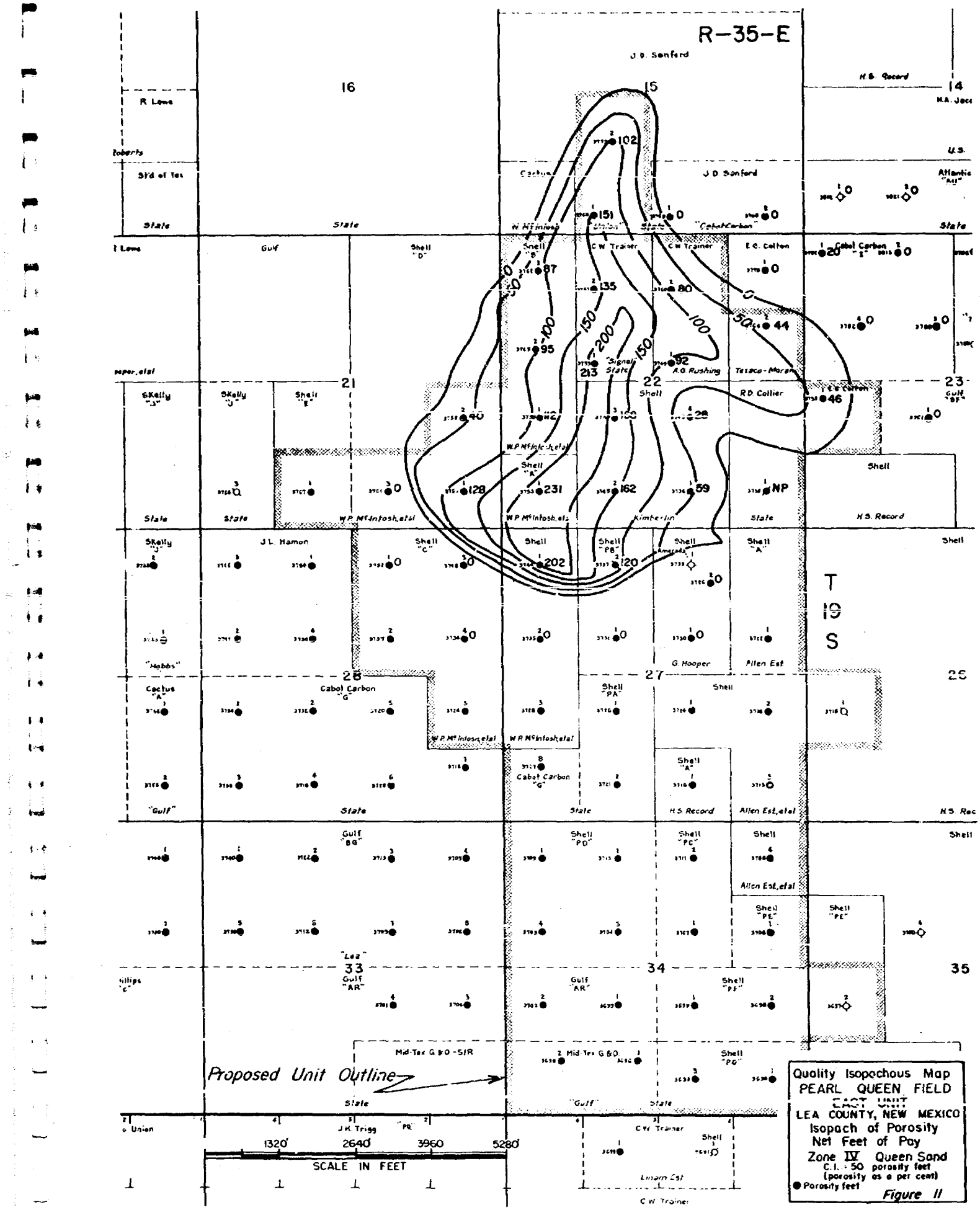
Figure 8



Quality Isopachous Map
PEARL QUEEN FIELD
EAST UNIT
[illegible] COUNTY NEW MEXICO
Isopach of Porosity
Net Feet of Pay
Zone III A Queen Sand
C.I. = 50 porosity feet
(porosity as a per cent)
● Porosity feet

Figure 9


R-35-E
T 19 S
16
15
14
21
22
23
28
27
26
33
34
35
J. D. Sanford
H.S. Record
R. Lowe
Roberts
Std of Tex
State
Cactus
W. McIntosh
"Union"
J D Sanford
"Cabot Carbon"
Atlantic "AU"
Gulf
Shell "D"
Shell "S"
C.W. Trainer
E.G. Colton
Cabot Carbon "E"
"Signal" State
A.G. Rushing
Texaco-Moran
R.O. Collier
Gulf "AS"
Skelly "J"
Shell "E"
W.P. McIntosh, et al
Shell "A"
Kimberlin
J.L. Hamon
Shell "C"
Shell "PB"
Amerada
G. Hooper
Allen Est
"Hobbs"
Cactus "A"
Cabot Carbon "G"
Shell "PA"
Gulf "BG"
Shell "PD"
Shell "PC"
Allen Est, et al
Shell "PE"
"Lea"
Gulf "AR"
Shell "PF"
Shell "PG"
Mid-Tex G&O - S/R
J.H. Trigg
"PQ"
C.W. Trainer
Linam Est
Proposed Unit Outline
1320'
2640'
3960
5280'
SCALE IN FEET
Quality Isopachous Map
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Isopach of Porosity
Net Feet of Pay
Zone III B Queen Sand
C.I. = 50 porosity feet
(porosity as a per cent)
Porosity feet
Figure 10



Quality Isopachous Map
PEARL QUEEN FIELD
EAST UNIT
LEA COUNTY, NEW MEXICO
Isopach of Porosity
Net Feet of Pay
Zone IV Queen Sand
C.I. = 50 porosity feet
(porosity as a per cent)
● Porosity feet

Figure II

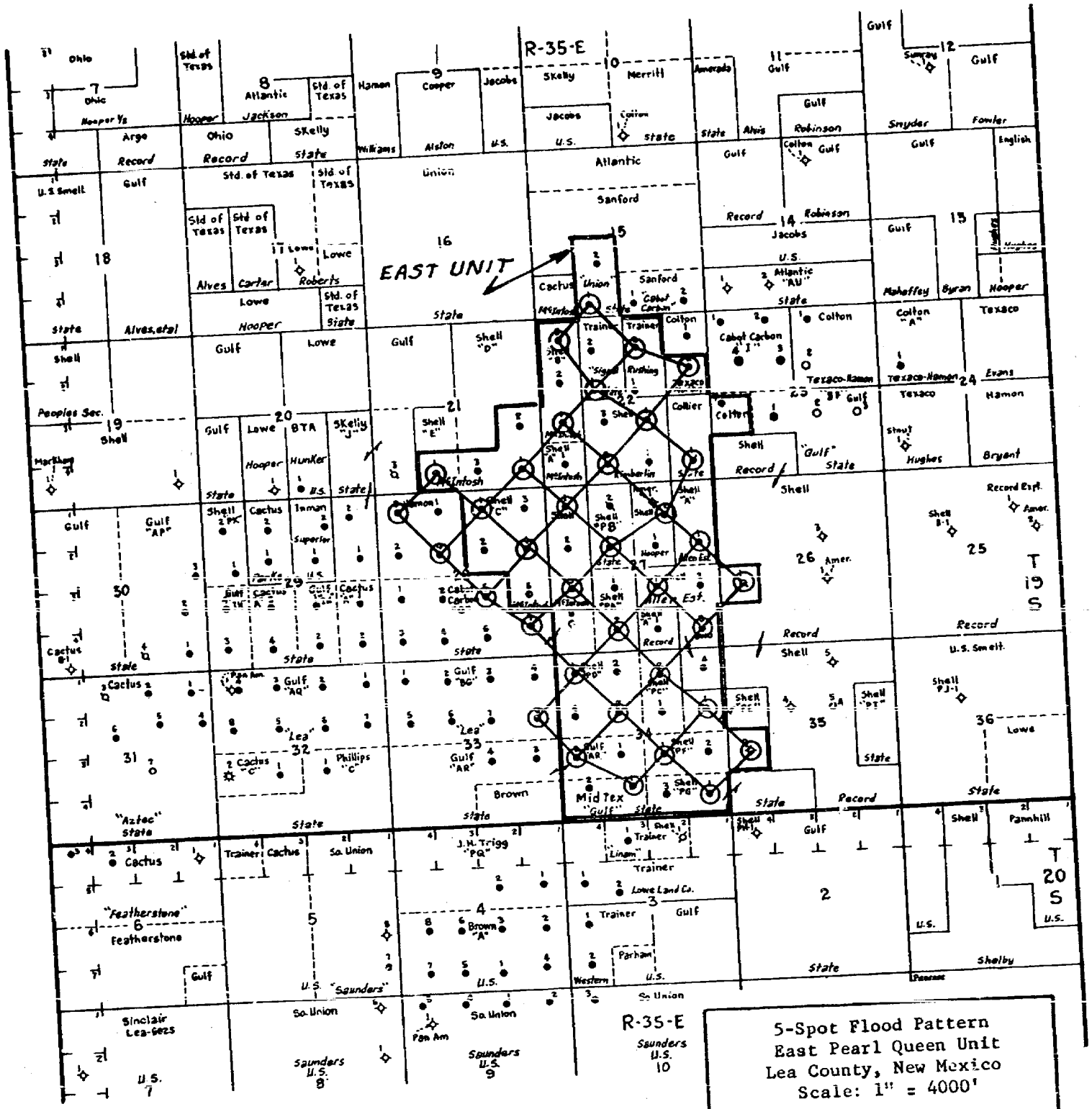
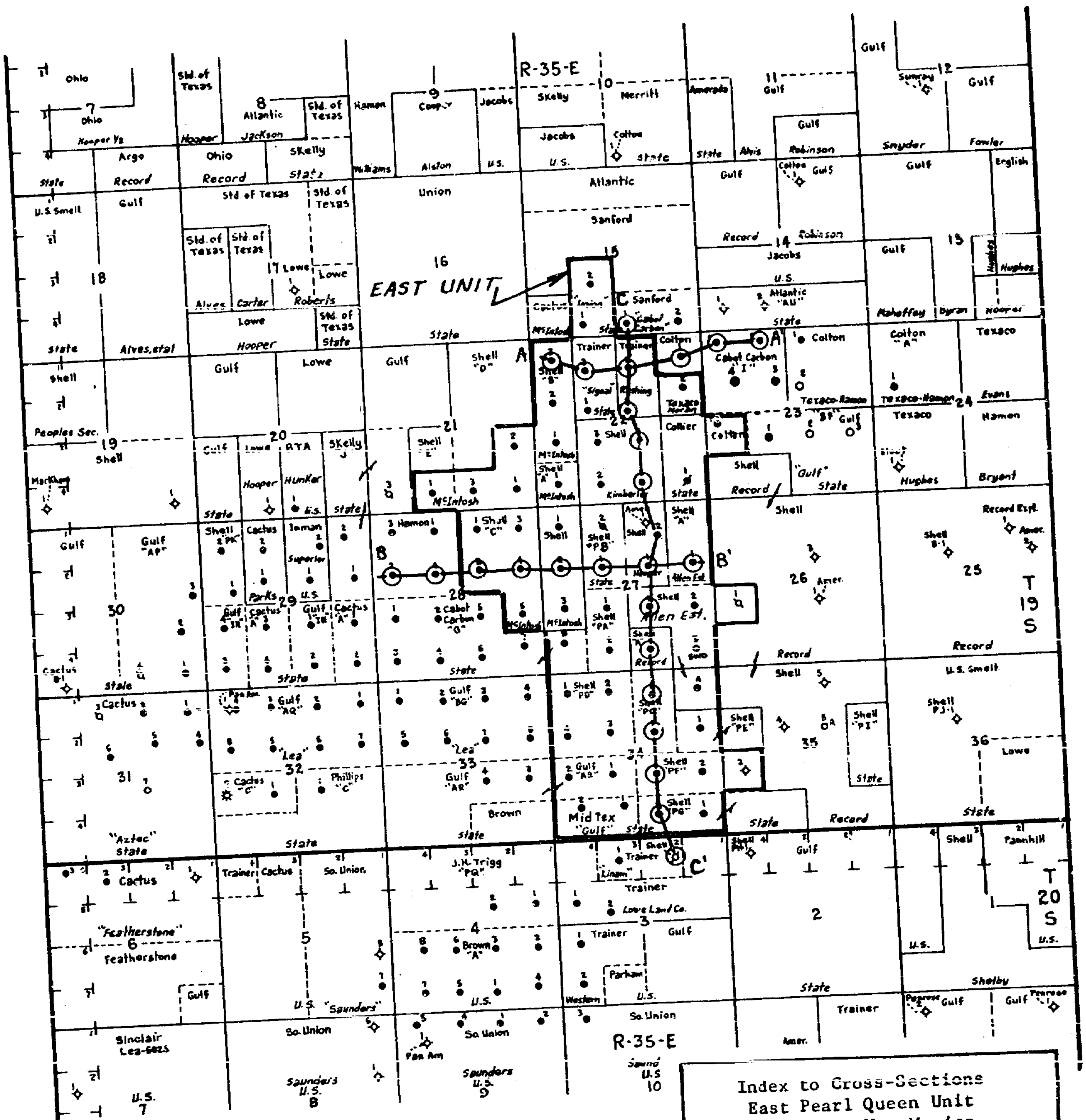
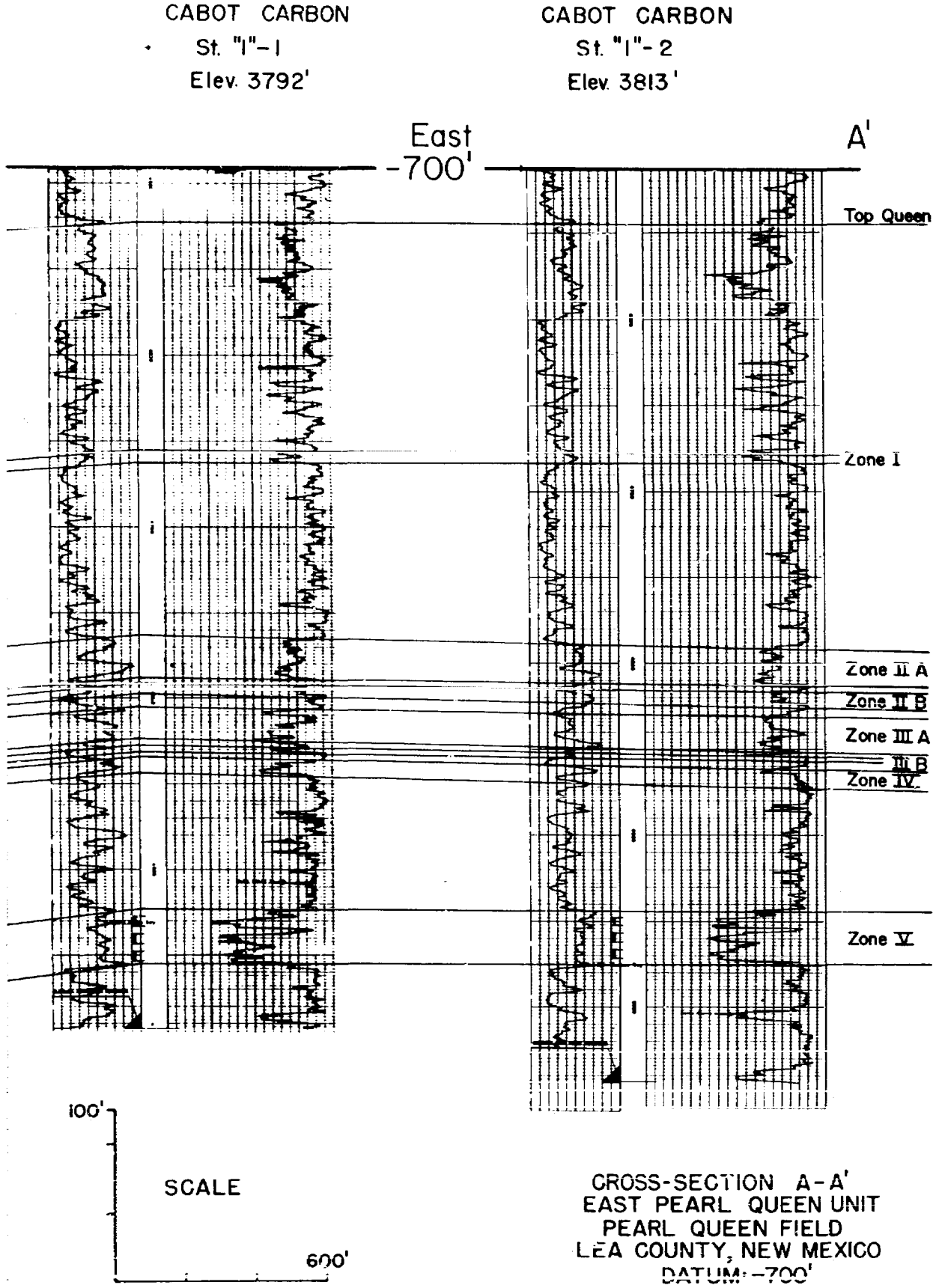

R-35-E
EAST UNIT
R-35-E
T 19 S
T 20 S
5-Spot Flood Pattern
East Pearl Queen Unit
Lea County, New Mexico
Scale: 1" = 4000'
Producing Well
Water Injection Well

Figure 12



Index to Cross-Sections
East Pearl Queen Unit
Lea County, New Mexico
Scale: 1" = 4000'
◉ Wells on Cross Sections

Figure 13



CROSS-SECTION A-A'
EAST PEARL QUEEN UNIT
PEARL QUEEN FIELD
LEA COUNTY, NEW MEXICO
DATUM: -700'

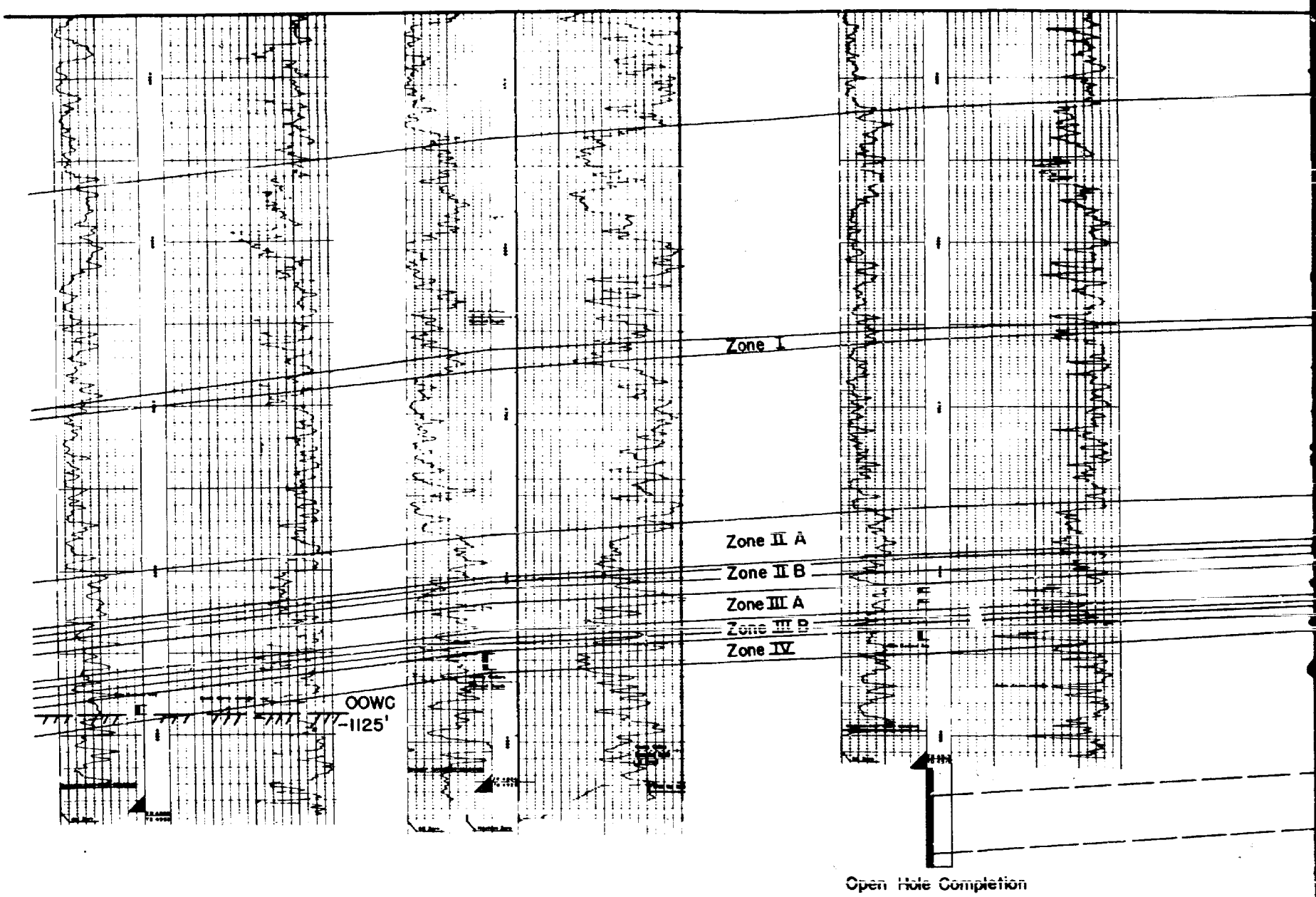
Figure 14

SHELL
McIntosh "B"-3
Elev. 3762'

TRAINER
St."Signal" 2
Elev. 3757'

TRAINER
Rushing 2
Elev. 3760'

A West



Open Hole Completion

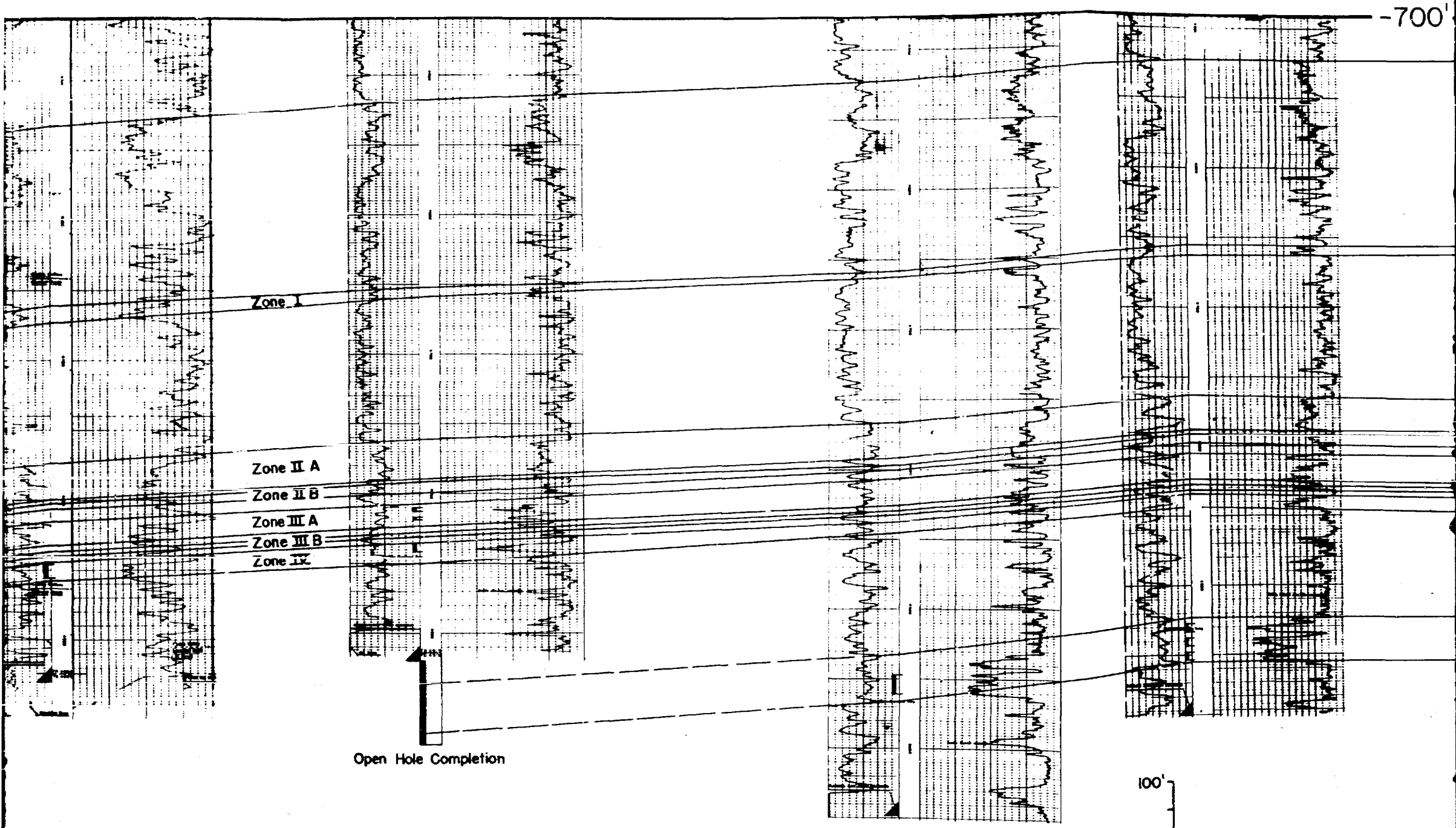
TRAINER
St. "Signal" 2
Elev. 3757'

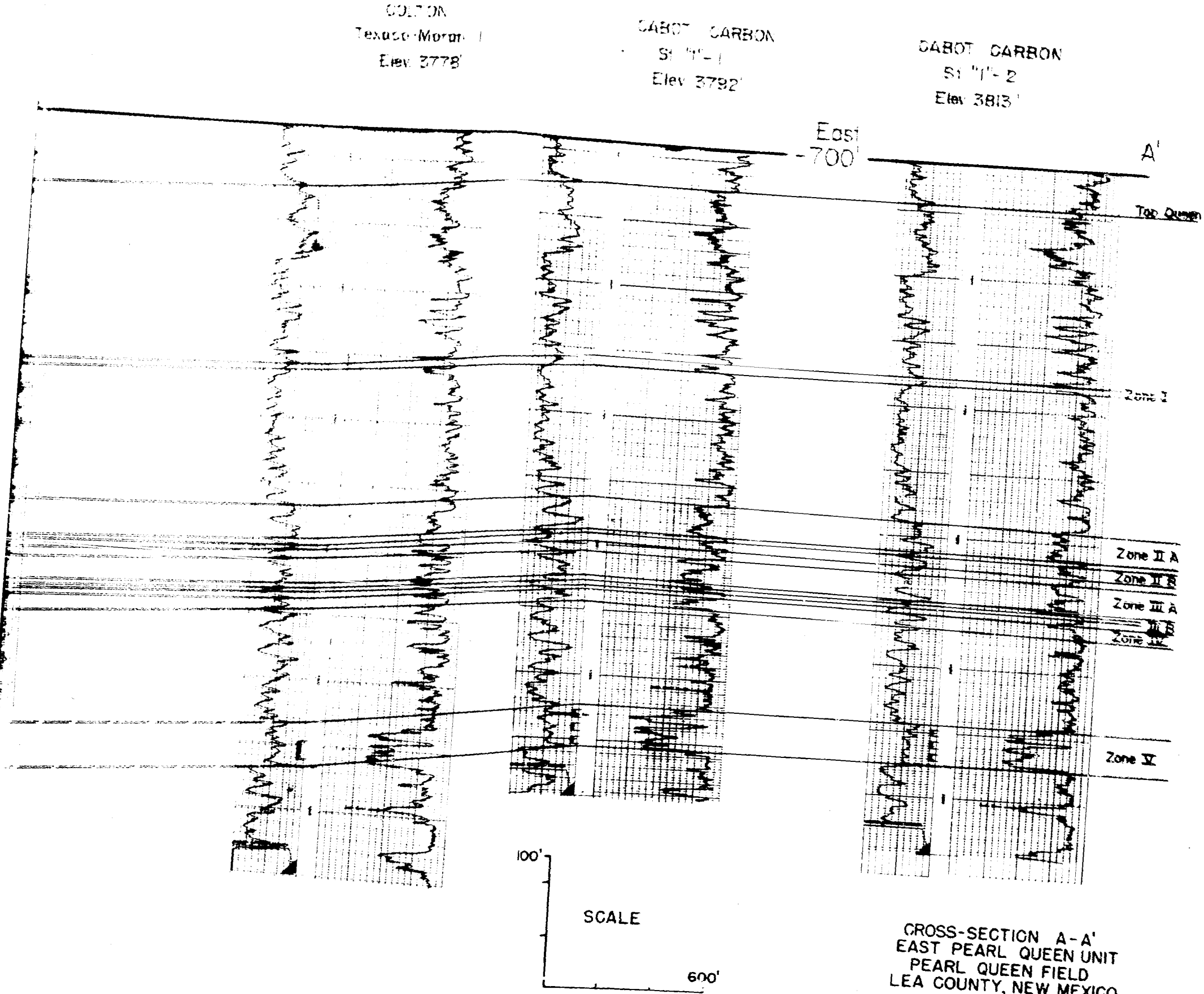
TRAINER
Rushing 2
Elev. 3760'

COLTON
Texaco-Moran 1
Elev. 3778'

CABOT CARBON
St. "I"-1
Elev. 3792'

East
-700'





CROSS-SECTION A-A'
EAST PEARL QUEEN UNIT
PEARL QUEEN FIELD
LEA COUNTY, NEW MEXICO
DATUM: -700'

Figure 14

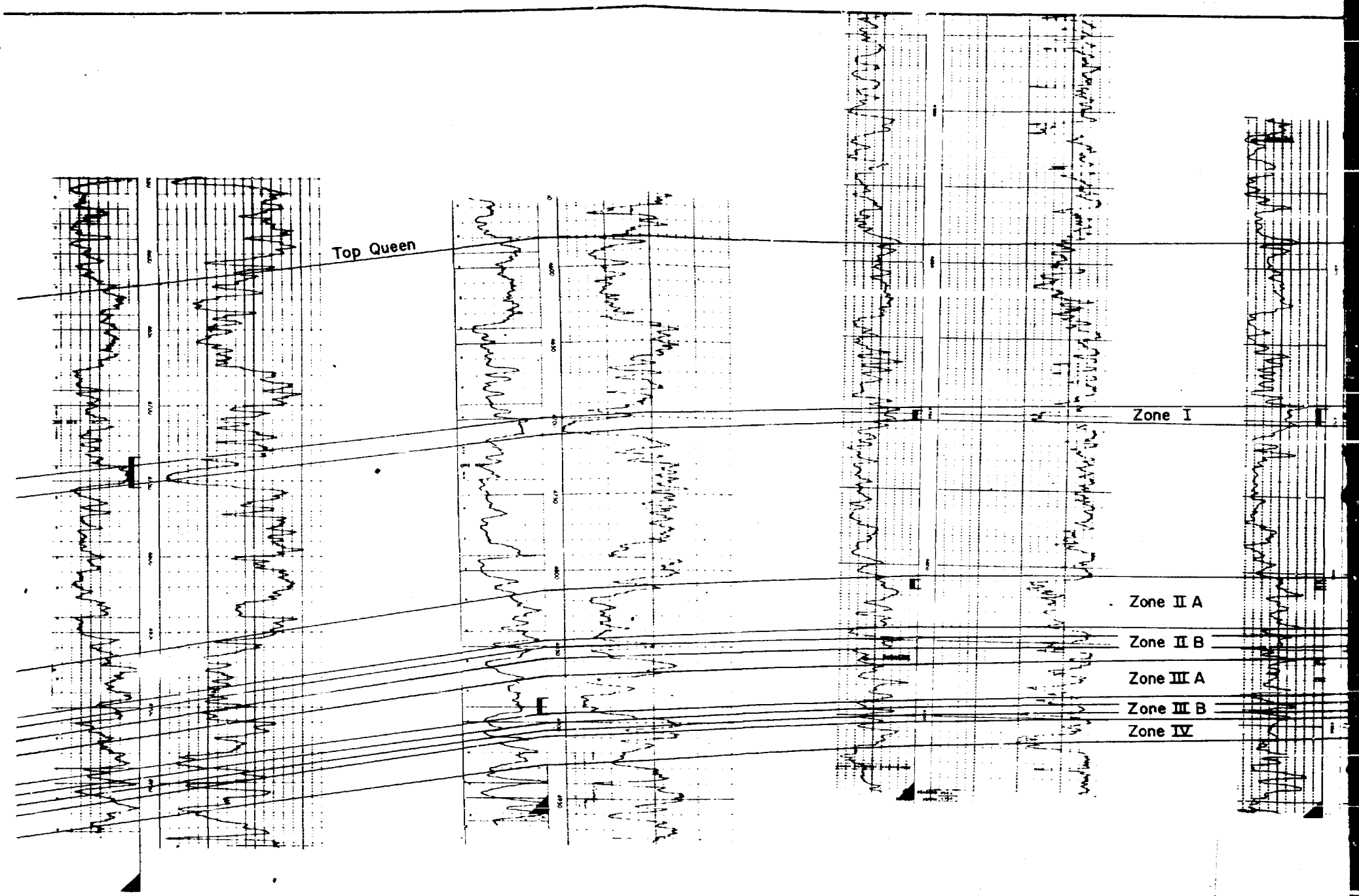
J. L. HAMON
St. 2
Elev. 3741'

J. L. HAMON
St. 4
Elev. 3730'

SHELL
McIntosh "C"-2
Elev. 3737'

Mc

B West

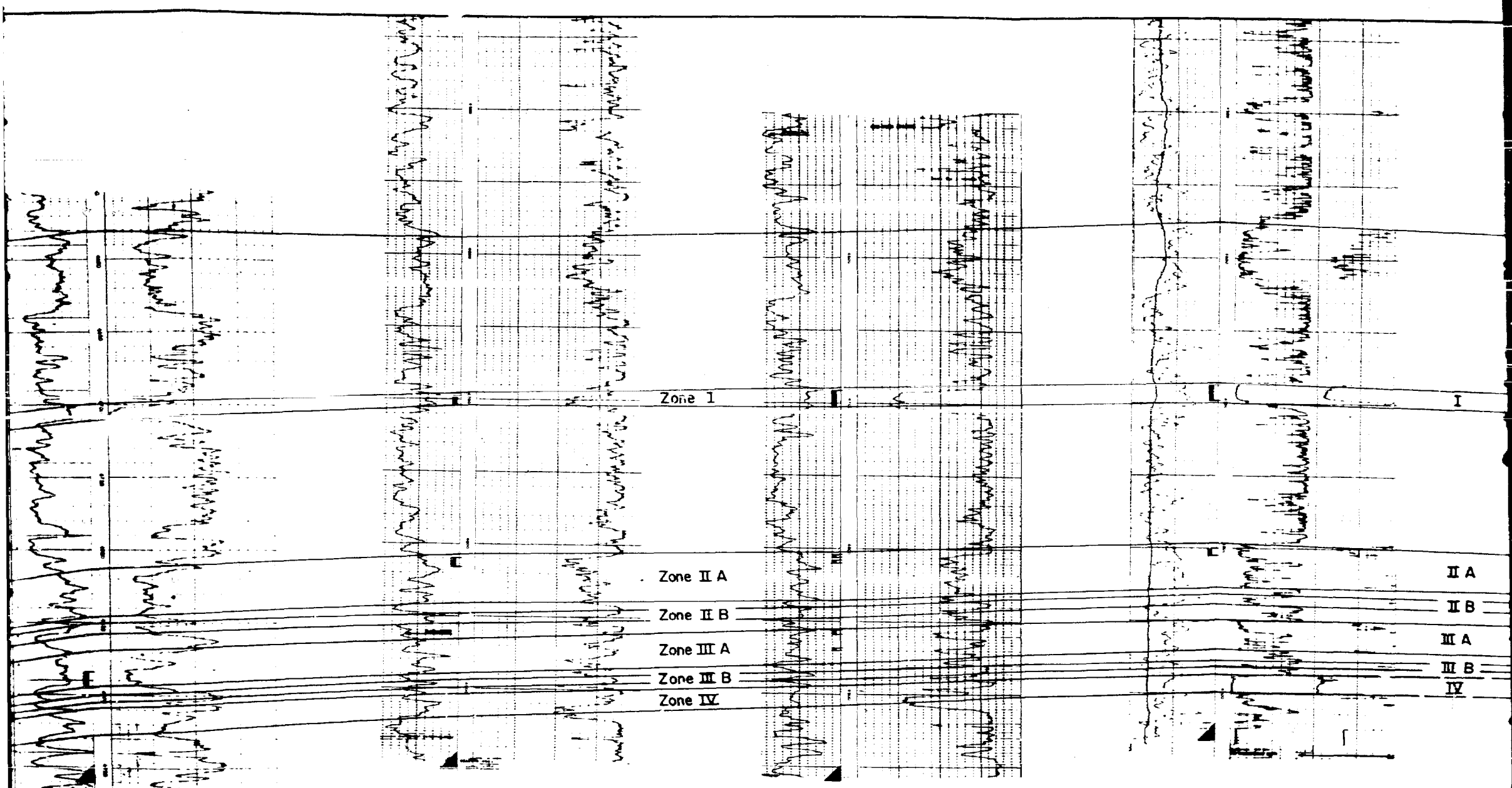


J. L. HAMON
St. 4
Elev. 3730'

SHELL
McIntosh "C"-2
Elev. 3737'

SHELL
McIntosh "C"-4
Elev. 3734'

SHELL
McIntosh 2
Elev. 3737'

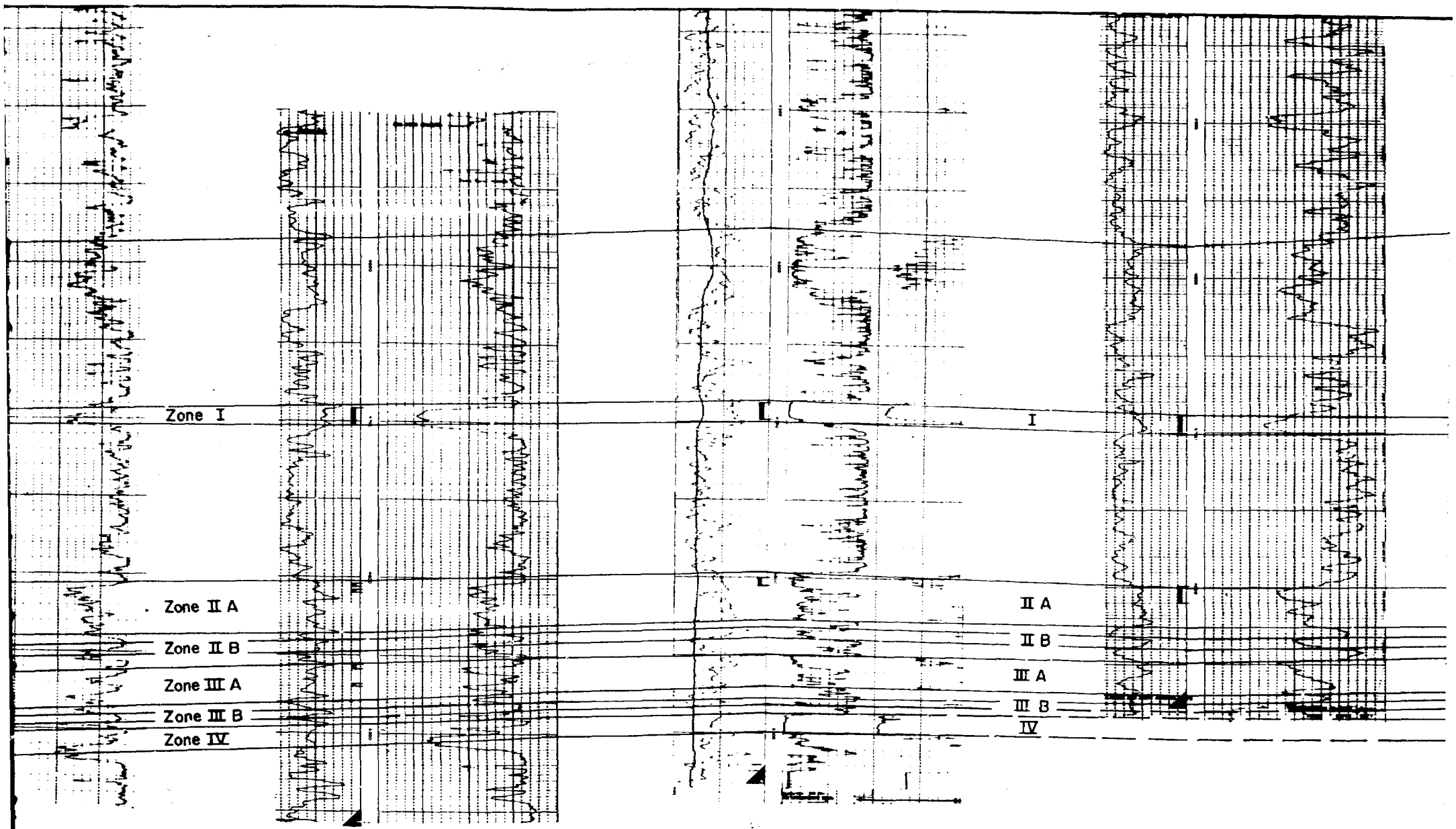


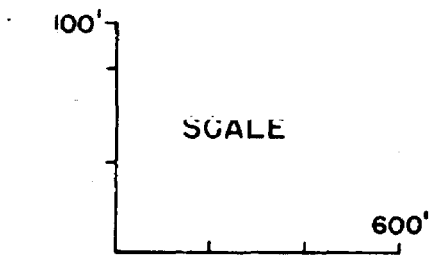
ELL
h "C"-2
' 3737'

SHELL
McIntosh "C"-4
Elev. 3734'

SHELL
McIntosh 2
Elev. 3737'

SHELL
St. "PB"-1
Elev. 3731'





SHELL
McIntosh 2
Elev. 3737'

SHELL
St. "PB"-1
Elev. 3731'

SHELL
Hooper 1
Elev. 3730'

SHELL
Allen Est. 1
Elev. 3722

East

700'

Top Queen

I

II A

II B

III A

III B

IV

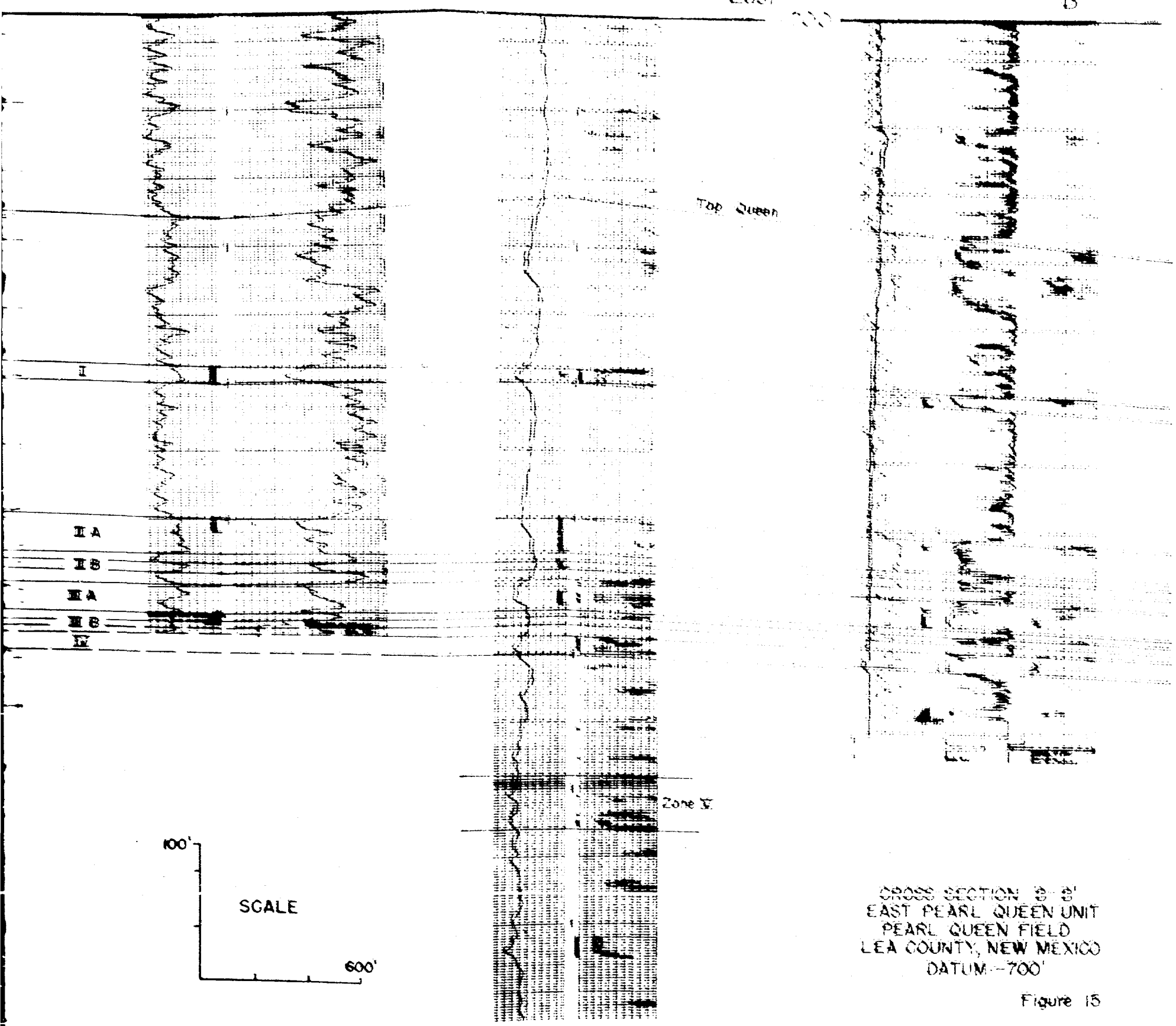
Zone V

100'

SCALE

600'

CROSS-SECTION
EAST PEARL QU
PEARL QUEEN
LEA COUNTY, NEW
DATUM: -7



CROSS SECTION B - B'
EAST PEARL QUEEN UNIT
PEARL QUEEN FIELD
LEA COUNTY, NEW MEXICO
DATUM --700'

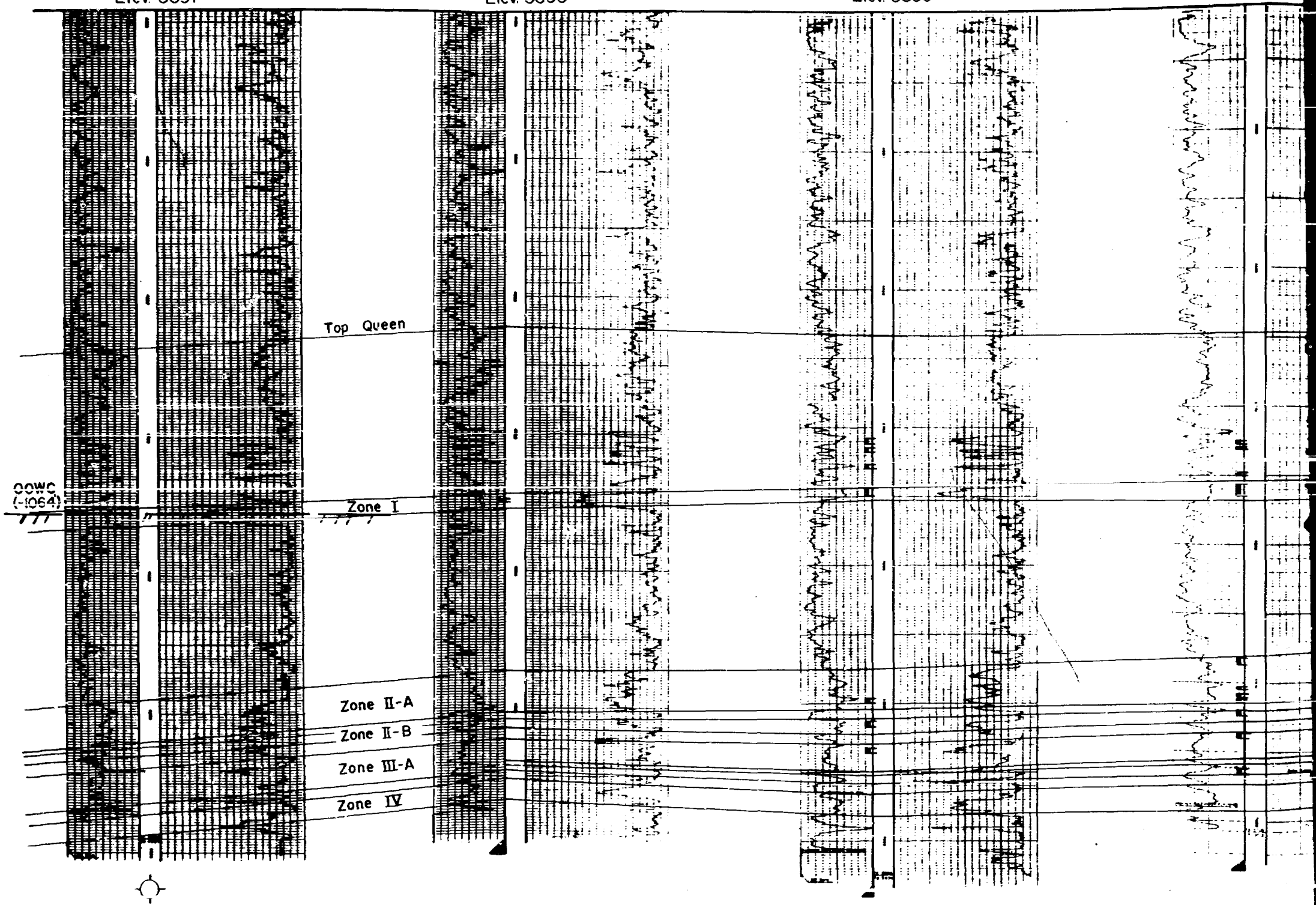
Figure 15

C' SHELL Linam Est. 1 Elev. 3691' South

SHELL St. "PG" 3 Elev. 3693'

SHELL St. "PF" 1 Elev. 3699'

SHEL St. "PC" Elev. 37

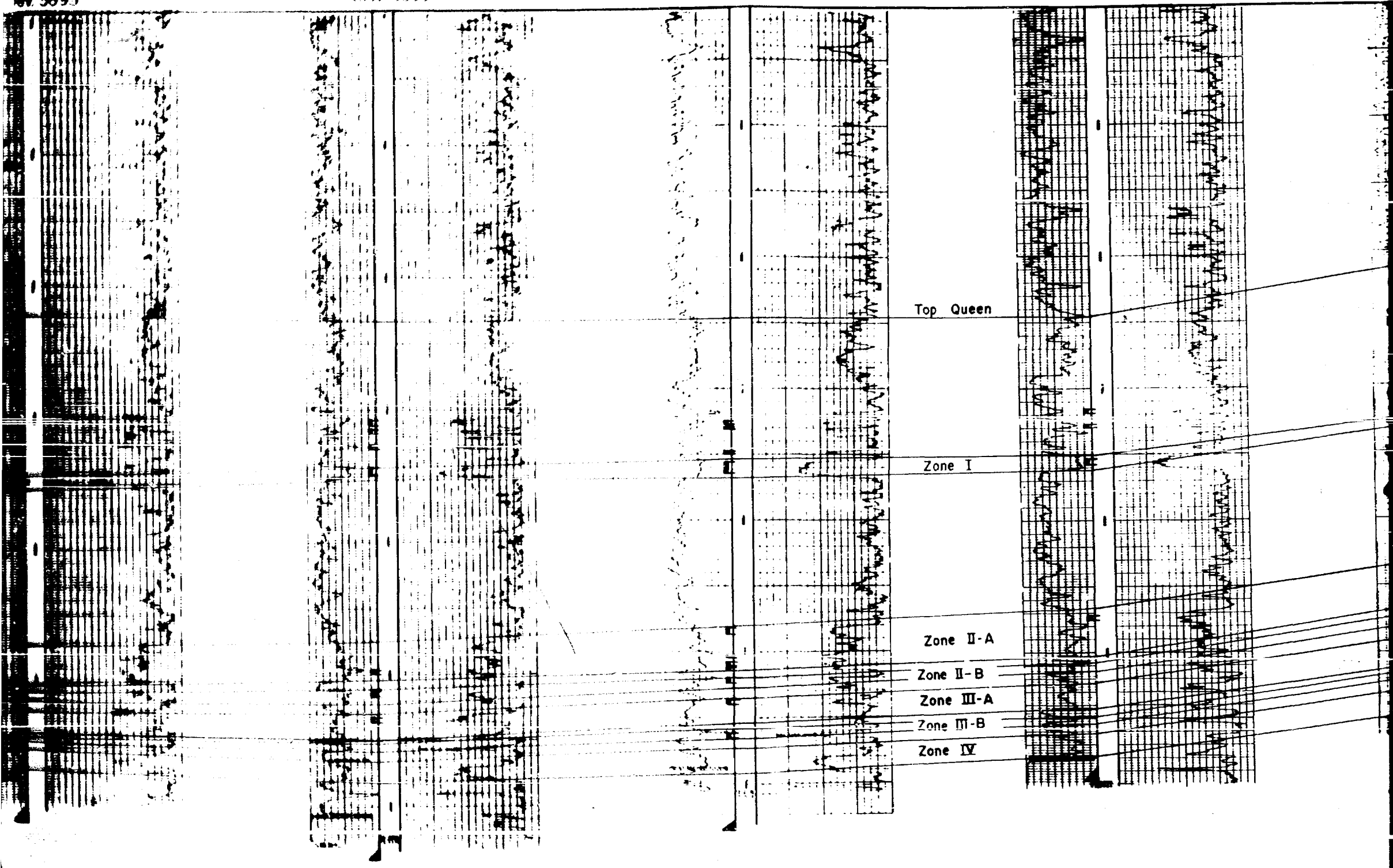


SHELL
"PB" 3
KB. 3695

SHELL
St. "PF" 1
Elev. 3693

SHELL
St. "PC" 1
Elev. 3707'

SHELL
St. "PC" 2
Elev. 3711'

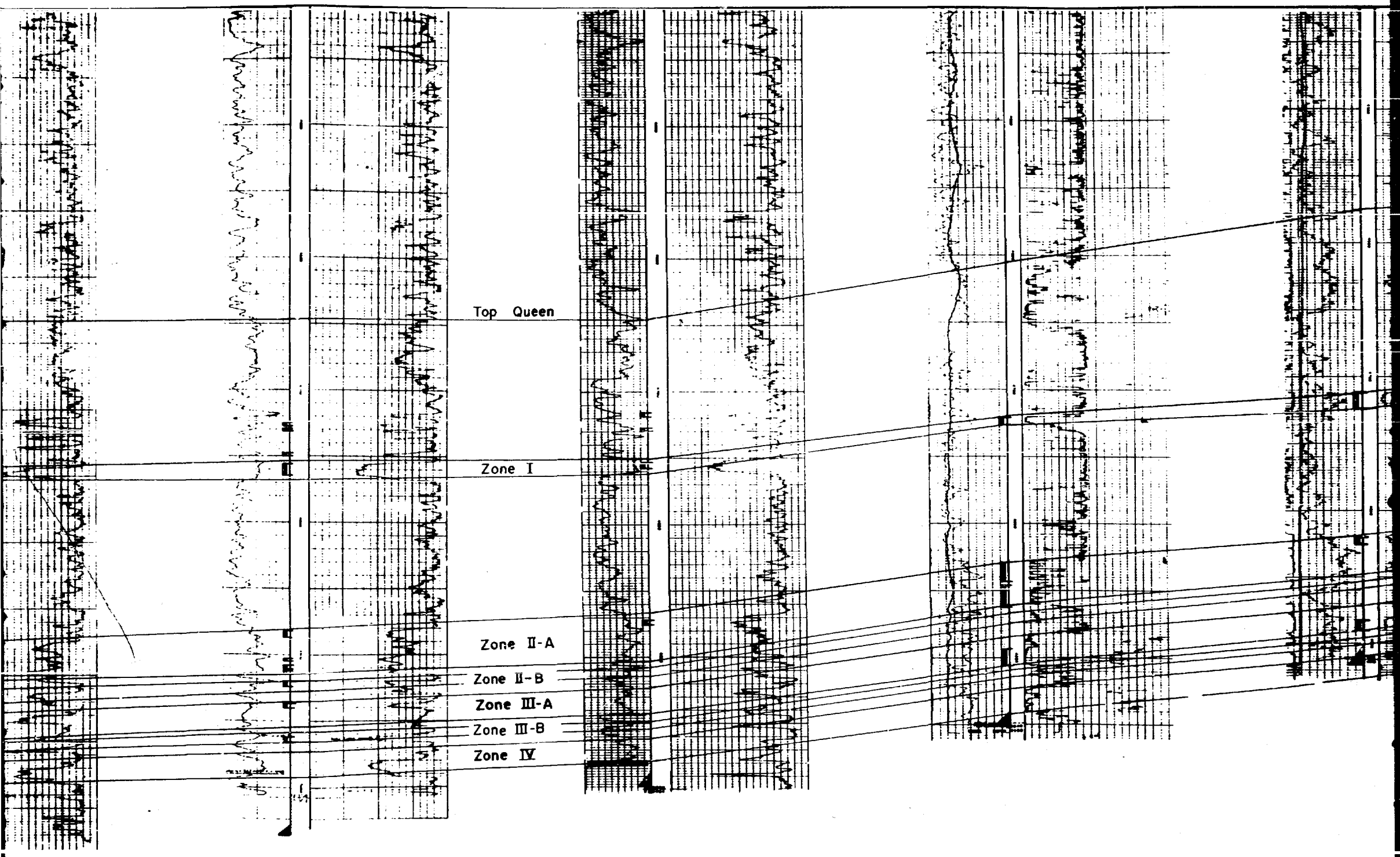


SHELL
St. "PC" 1
Elev. 3707'

SHELL
St. "PC" 2
Elev. 3711'

SHELL
Record "A"-1
Elev. 3716'

SHEL
Allen E
Elev. 37



SHELL
Record "A" 1
Elev. 3716'

SHELL
Allen Est. 1
Elev. 3724'

SHELL
Hooper 1
Elev. 3730'

Top Queen

II-A
II-B
III-A
III-B
IV

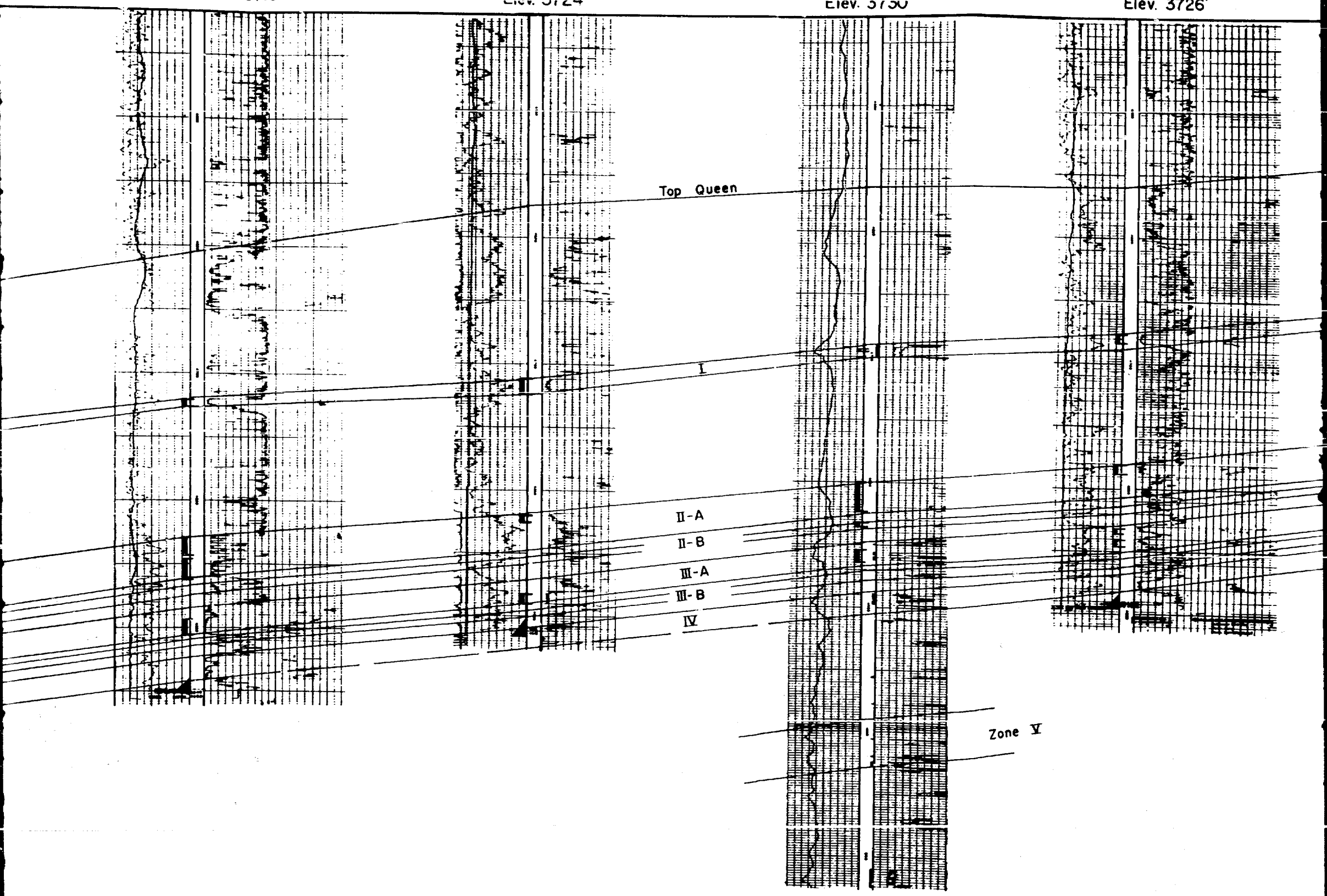
Csg at 13,824'

SHELL
Record "A"-1
Elev. 3716'

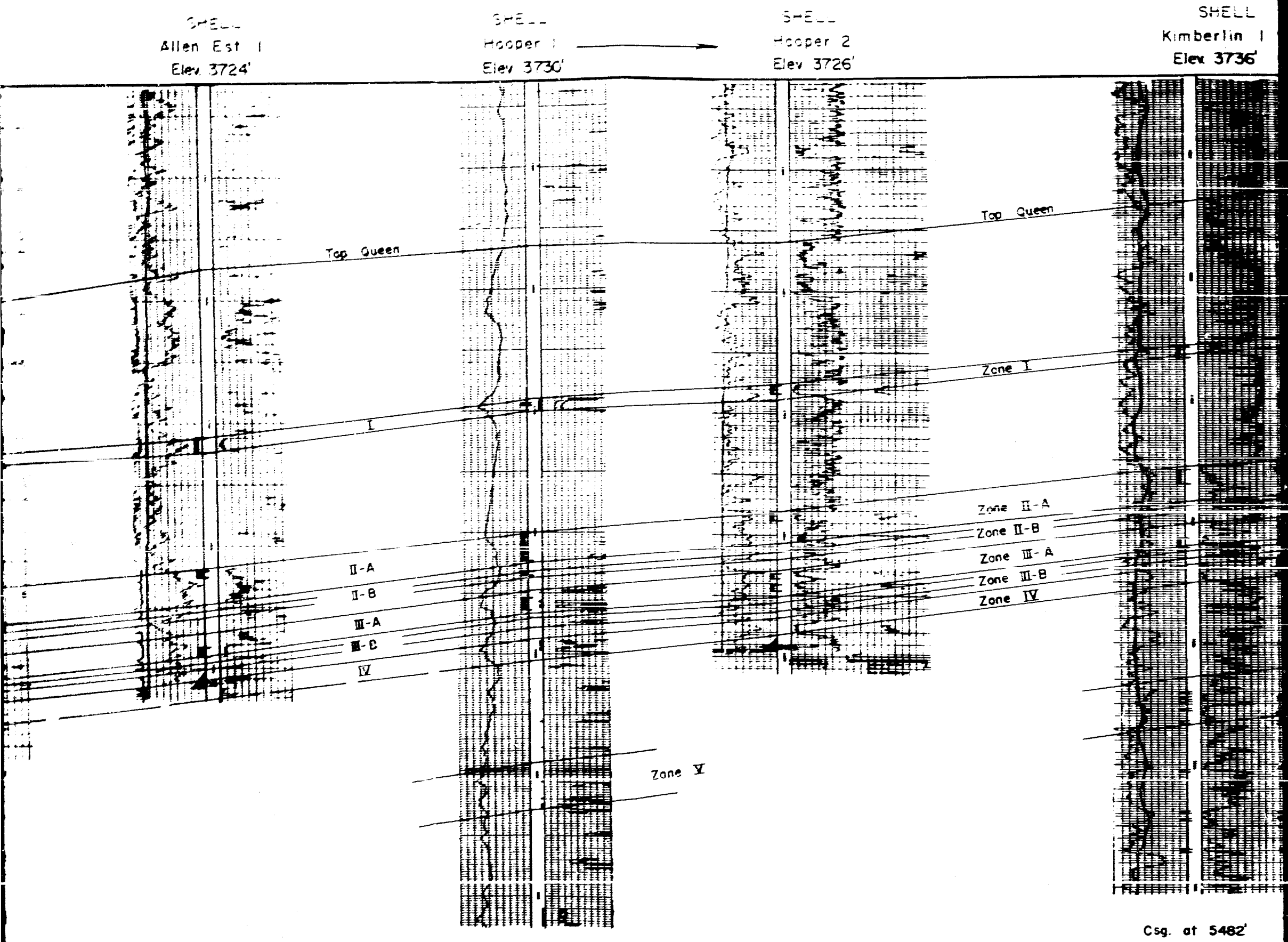
SHELL
Allen Est. 1
Elev. 3724'

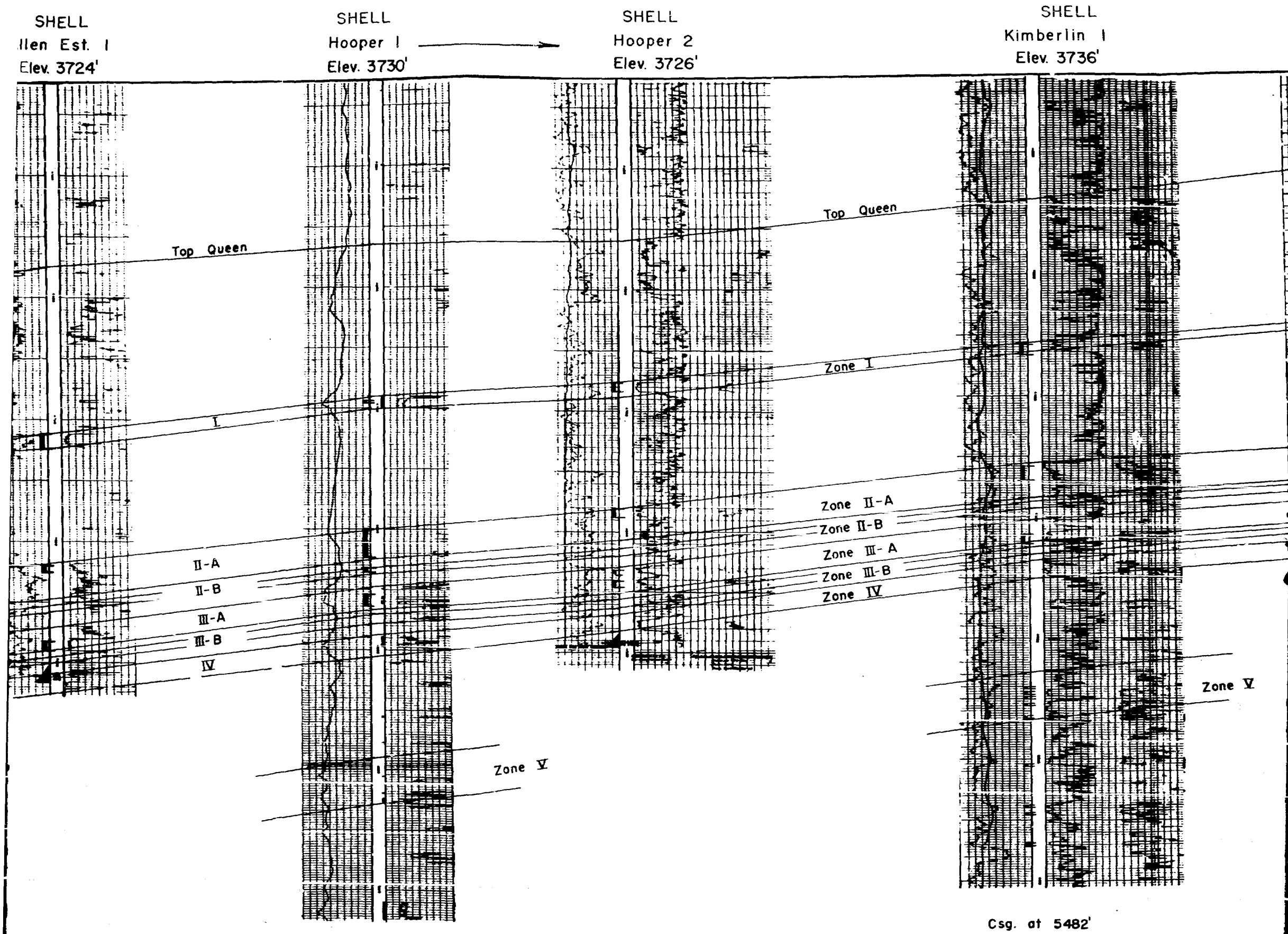
SHELL
Hooper 1
Elev. 3730'

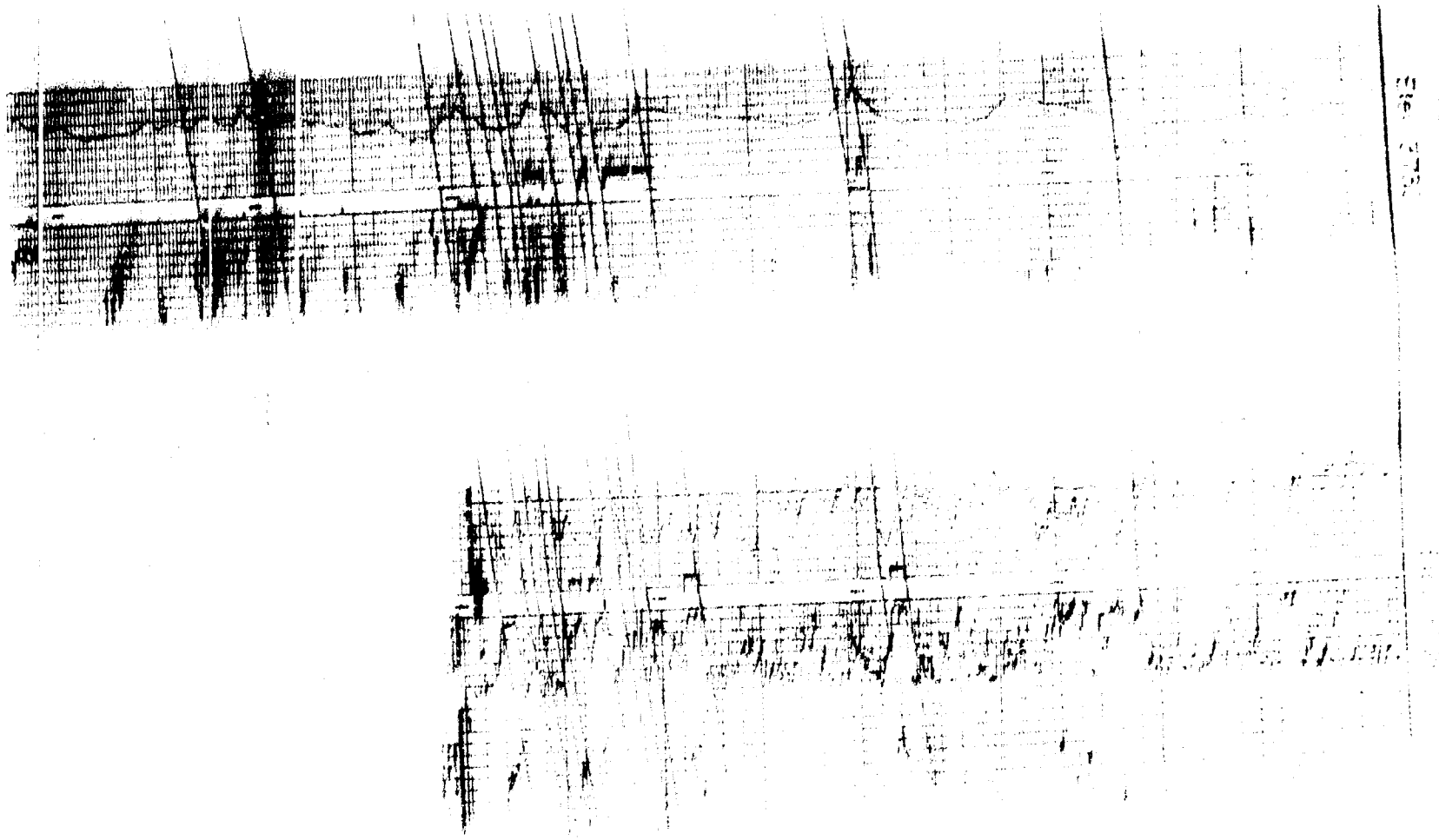
SHELL
Hooper 2
Elev. 3726'



Csg. at 13,824'


SHELL
Allen Est 1
Elev. 3724'
SHELL
Hooper 1
Elev 3730'
SHELL
Hooper 2
Elev 3726'
SHELL
Kimberlin 1
Elev 3736'
Top Queen
Top Queen
Zone I
I
II-A
II-B
III-A
III-B
IV
Zone II-A
Zone II-B
Zone III-A
Zone III-B
Zone IV
Zone V
Csg. at 13,824'
Csg. at 5482'


SHELL
llen Est. 1
Elev. 3724'
SHELL
Hooper 1
Elev. 3730'
SHELL
Hooper 2
Elev. 3726'
SHELL
Kimberlin 1
Elev. 3736'
Top Queen
I
II-A
II-B
III-A
III-B
IV
Zone V
Top Queen
Zone I
Zone II-A
Zone II-B
Zone III-A
Zone III-B
Zone IV
Zone V
Csg. at 13,824'
Csg. at 5482'

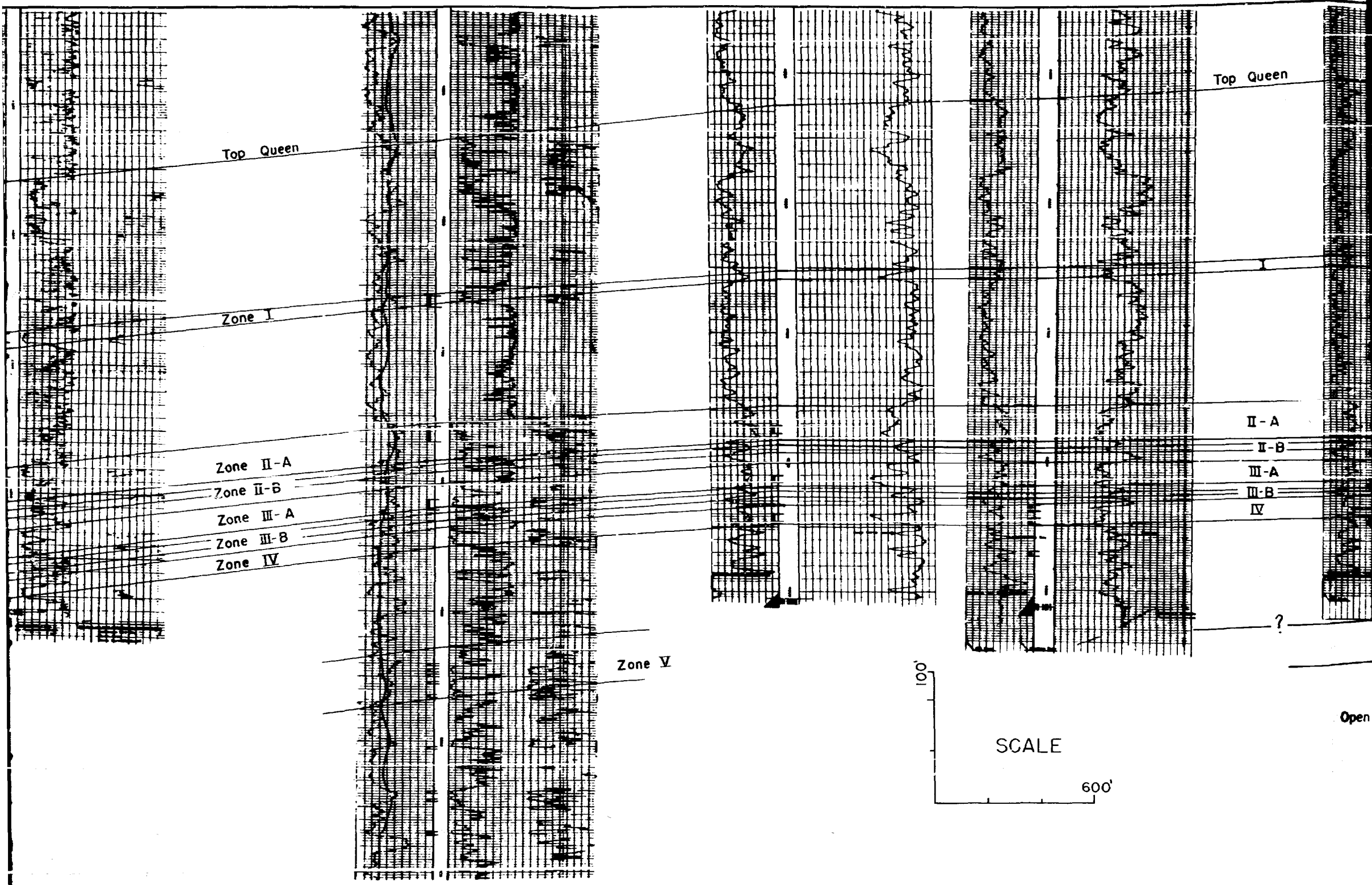


SHELL
Hooper 2
Elev. 3726'

SHELL
Kimberlin 1
Elev. 3736'

SHELL
Kimberlin 4
Elev. 3749'

TRAINER
Rushing 1
Elev. 3749'



Csg. at 5482'

SHELL
Kimberlin 1
Elev. 3736'

SHELL
Kimberlin 4
Elev. 3749'

TRAINER
Rushing 1
Elev. 3749'

TRAINER
Rushing 2
Elev. 3760'

North

700'

SAN
St. "Cabo
Elev.

Top Queen

II-A

II-B

III-A

III-B

IV

Zone V

?

?

100

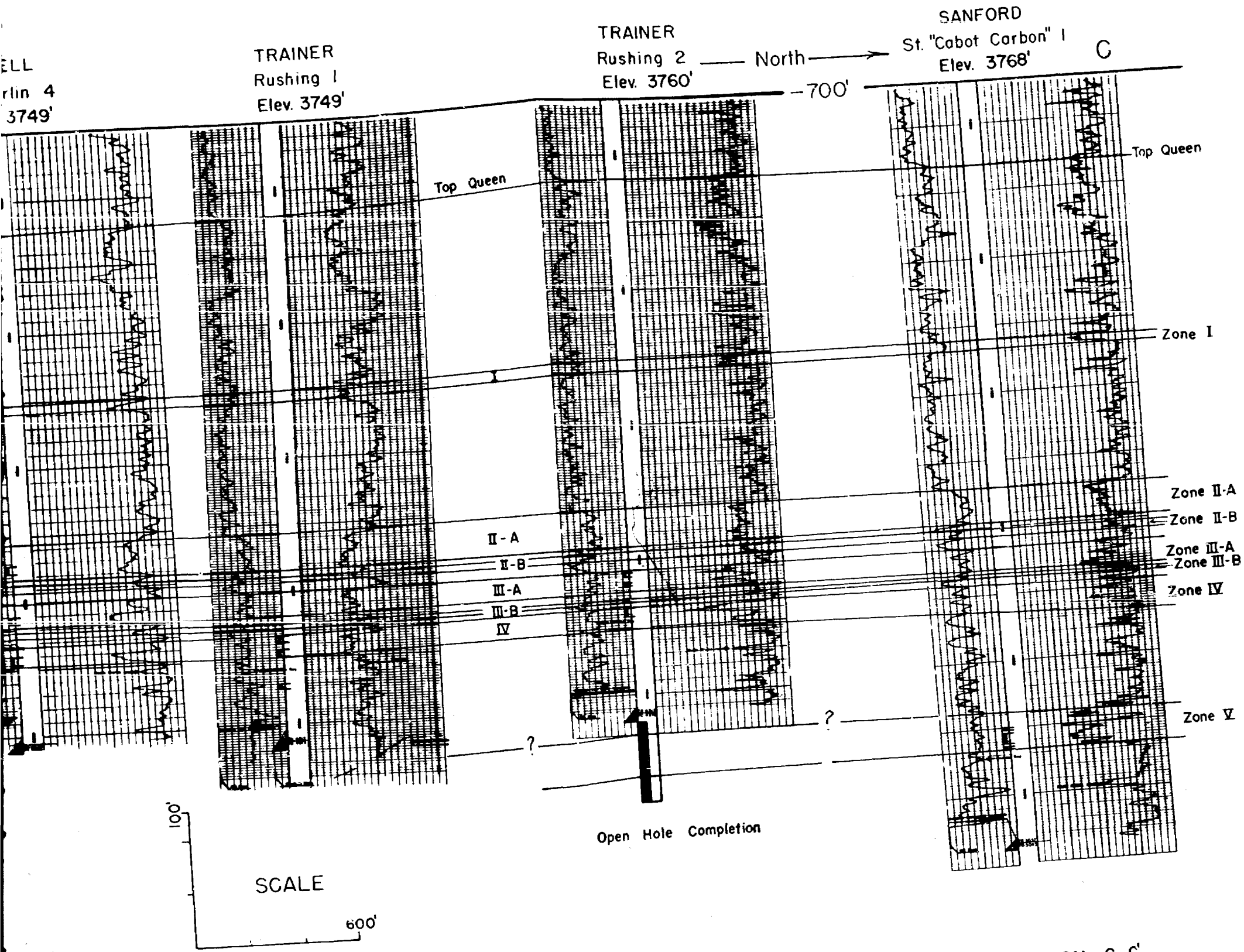
SCALE

600'

Open Hole Completion

Csg. at 5482'

CROSS S
EAST PEAR
PEARL QU
LEA COUNT
Dat

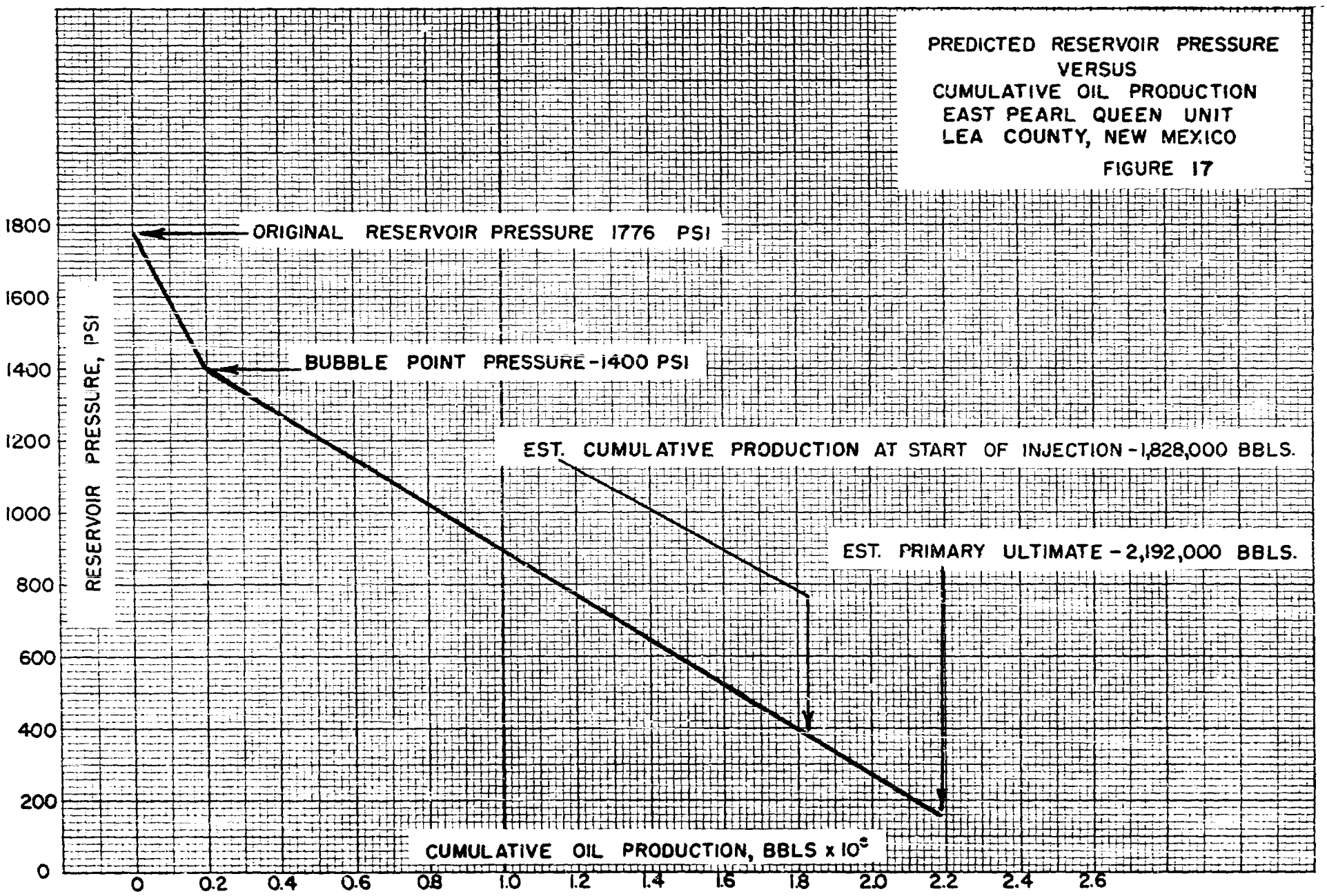


CROSS SECTION C-C'
EAST PEARL QUEEN UNIT
PEARL QUEEN FIELD
LEA COUNTY, NEW MEXICO
Datum: -700'

Figure 16

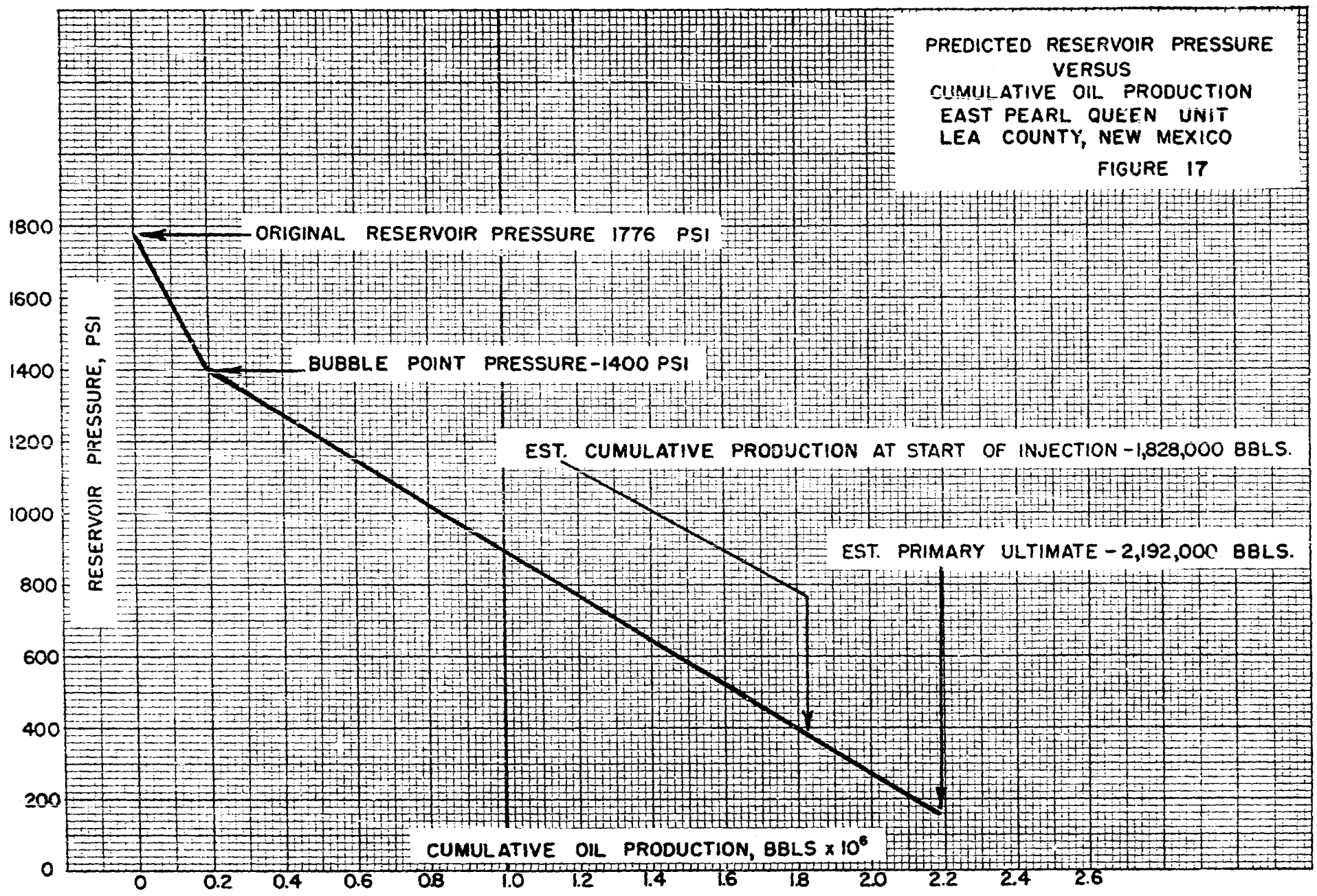
PREDICTED RESERVOIR PRESSURE
VERSUS
CUMULATIVE OIL PRODUCTION
EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO

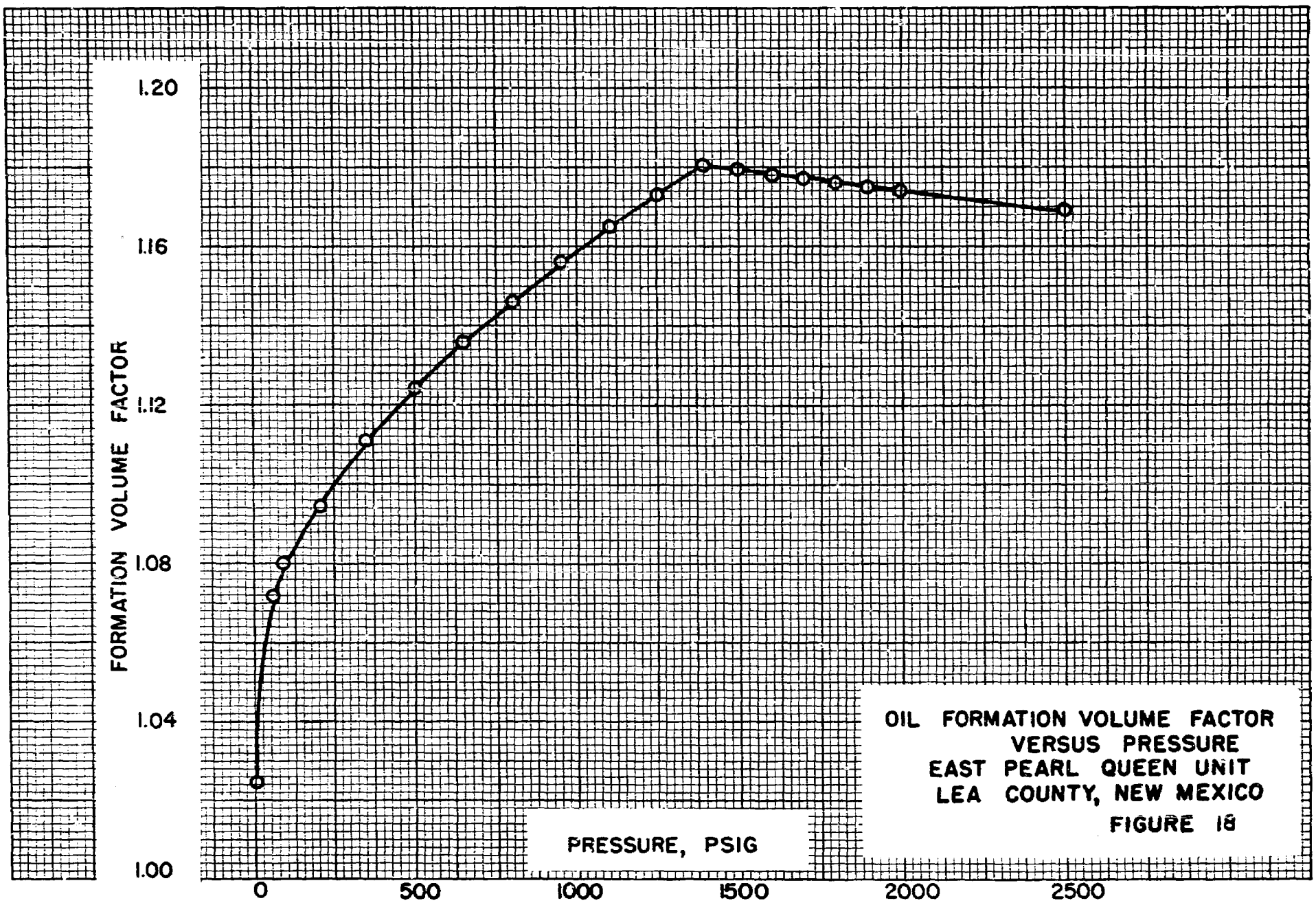
FIGURE 17



PREDICTED RESERVOIR PRESSURE
VERSUS
CUMULATIVE OIL PRODUCTION
EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO

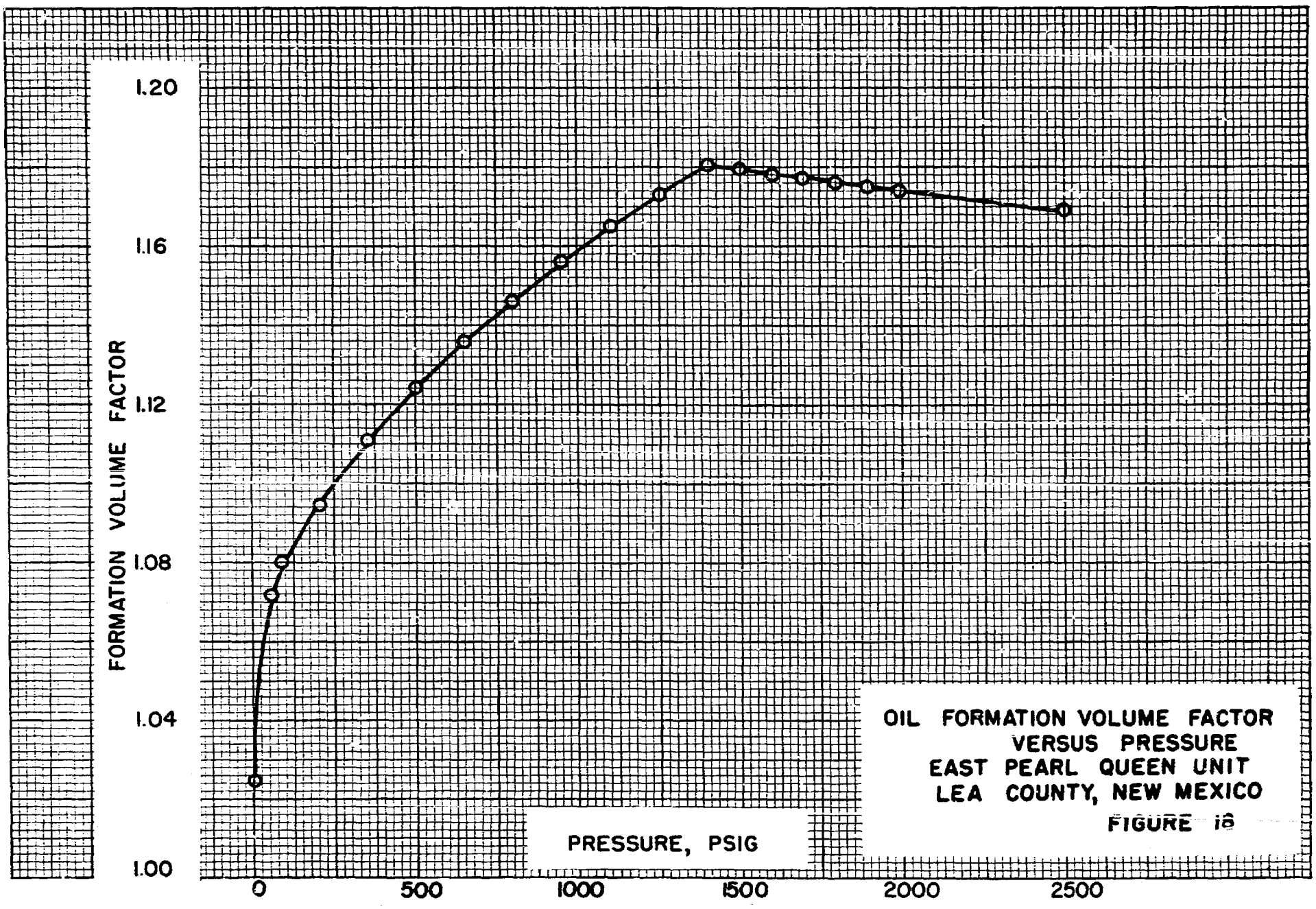
FIGURE 17





OIL FORMATION VOLUME FACTOR
VERSUS PRESSURE
EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO

FIGURE 18



OIL FORMATION VOLUME FACTOR
VERSUS PRESSURE
EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO

FIGURE 16

GRAPHICAL PRESENTATION OF CAPILLARY PRESSURE
AND LOG ANALYSIS DATA WITH A MOBILE OIL DETERMINATION
EAST PEARL QUEEN UNIT

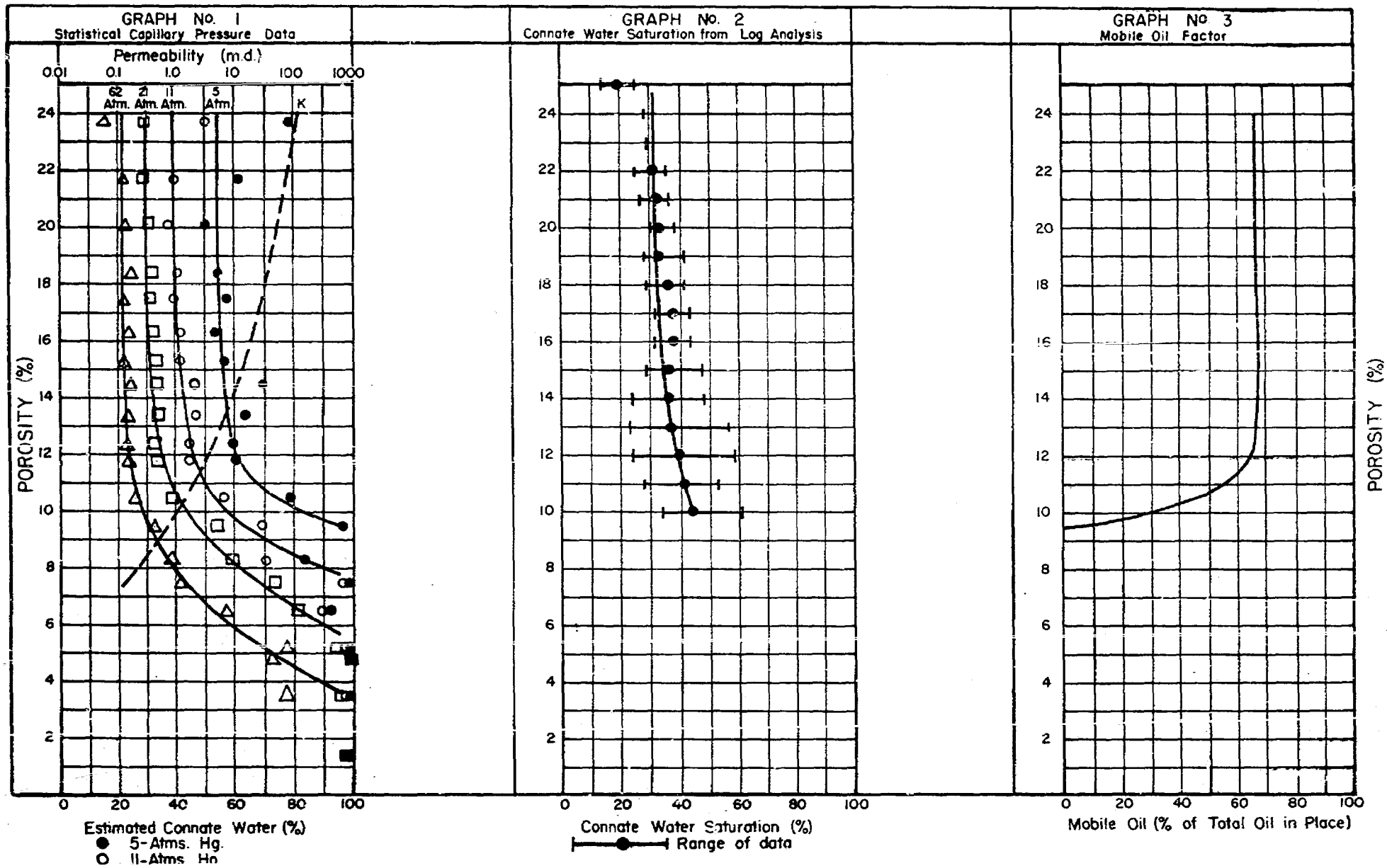
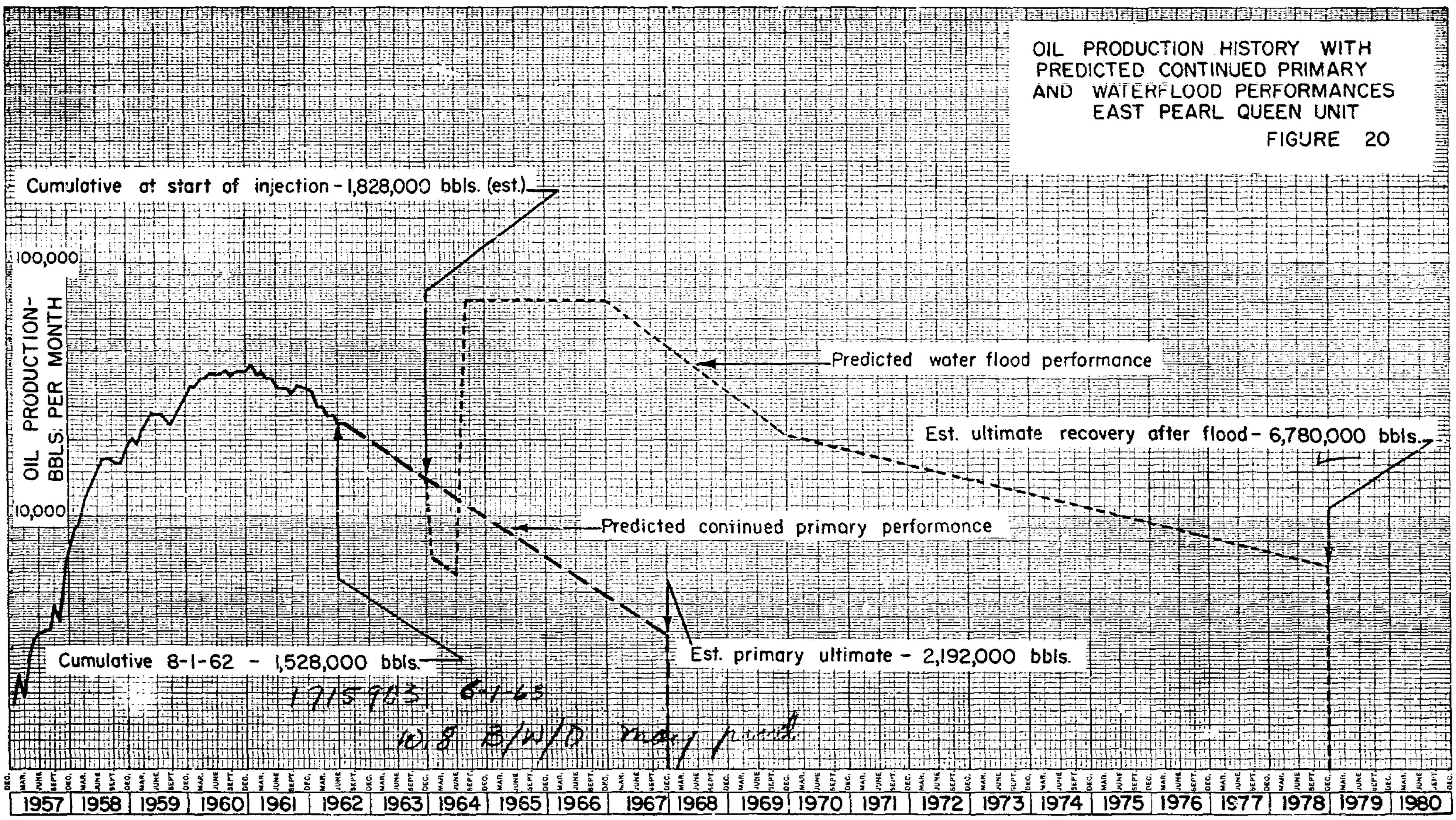
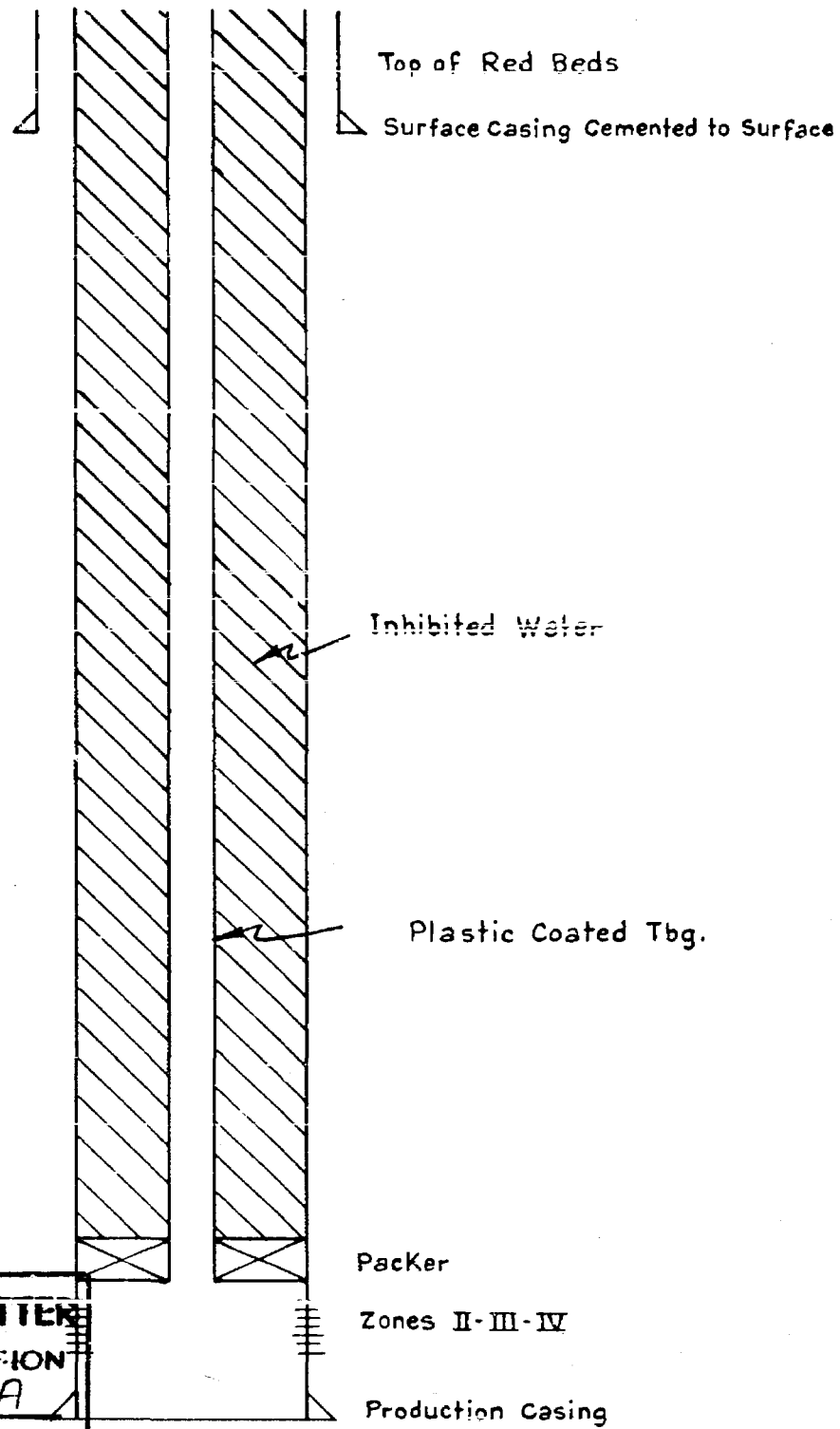


FIGURE 19



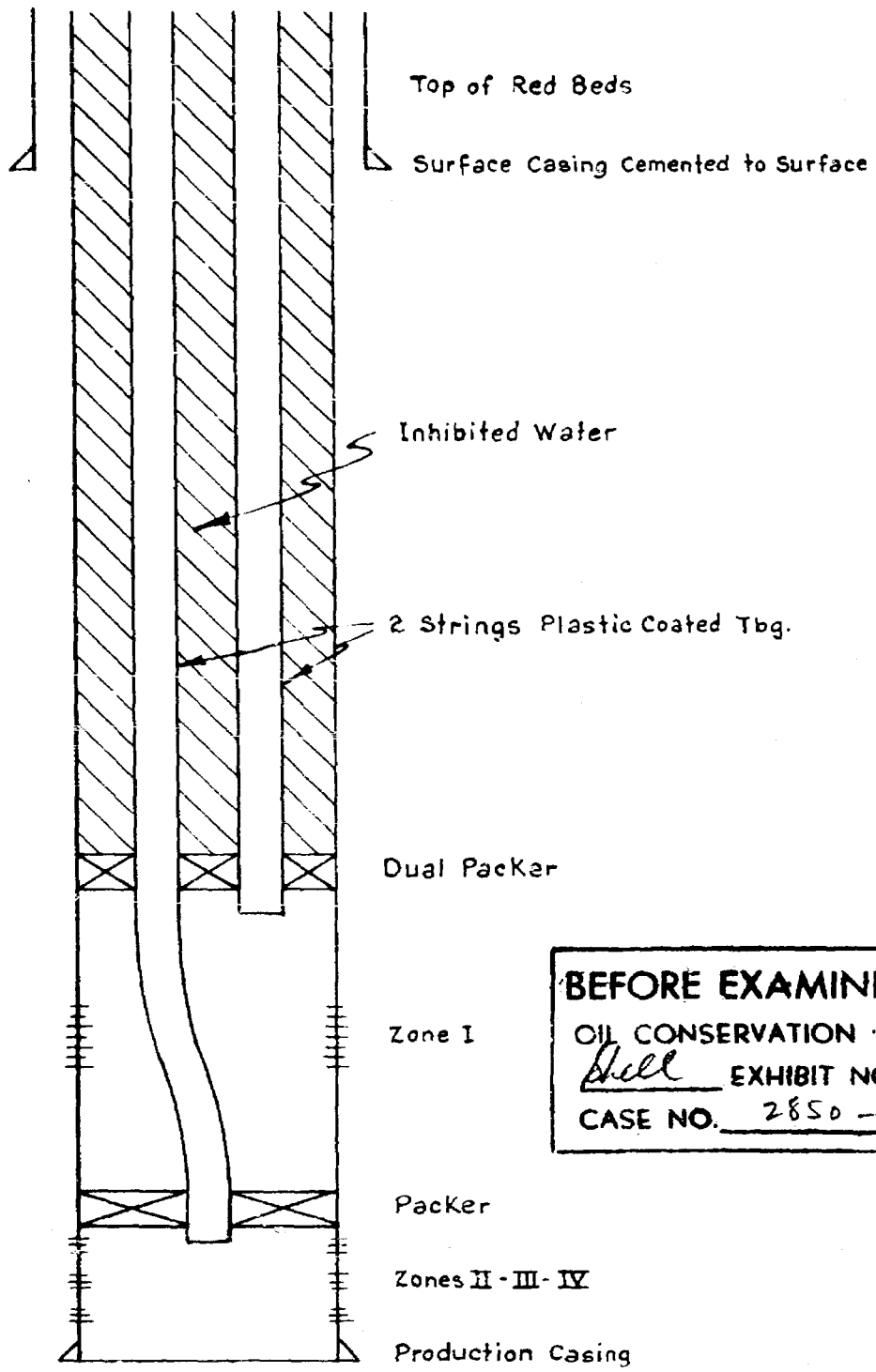
OIL PRODUCTION HISTORY WITH PREDICTED CONTINUED PRIMARY AND WATERFLOOD PERFORMANCES EAST PEARL QUEEN UNIT
FIGURE 20
Cumulative at start of injection - 1,828,000 bbls. (est.)
OIL PRODUCTION-BBLS. PER MONTH
100,000
10,000
Predicted water flood performance
Est. ultimate recovery after flood - 6,780,000 bbls.
Predicted continued primary performance
Cumulative 8-1-62 - 1,528,000 bbls.
Est. primary ultimate - 2,192,000 bbls.
1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980

EAST PEARL QUEEN UNIT
Lea County, N. Mex.
DIAGRAMMATIC SKETCH OF SINGLE INJECTION WELL

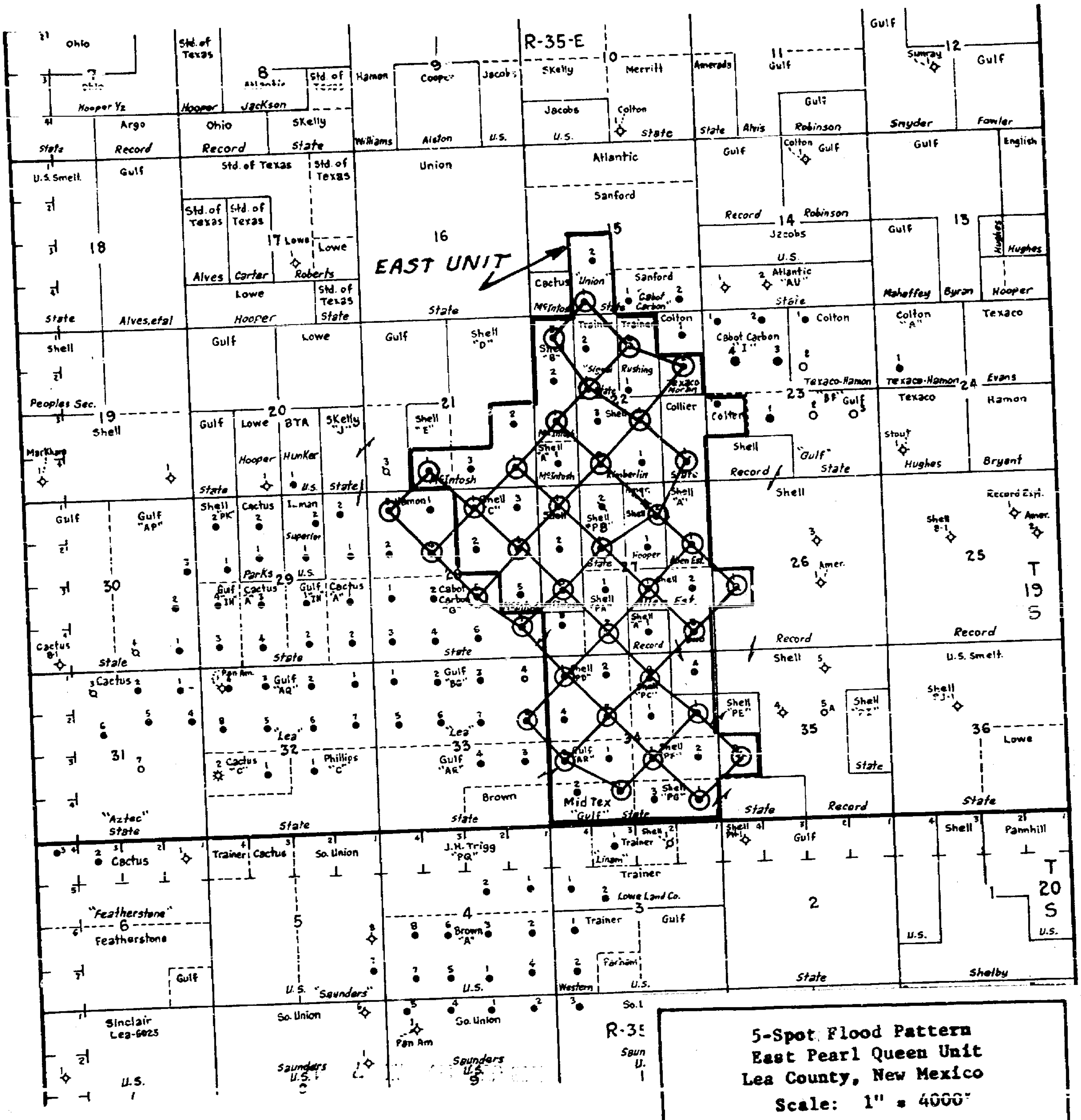


BEFORE EXAMINER NUTTER
OIL CONSERVATION COMMISSION
Shell EXHIBIT NO. 4-A
CASE NO. 2850-2851

EAST PEARL QUEEN UNIT
Lea County, N. Mex.
DIAGRAMMATIC SKETCH OF DUAL INJECTION WELL



BEFORE EXAMINER NUTTER
OIL CONSERVATION COMMISSION
Dull EXHIBIT NO. 4-B
CASE NO. 2850 - 2851

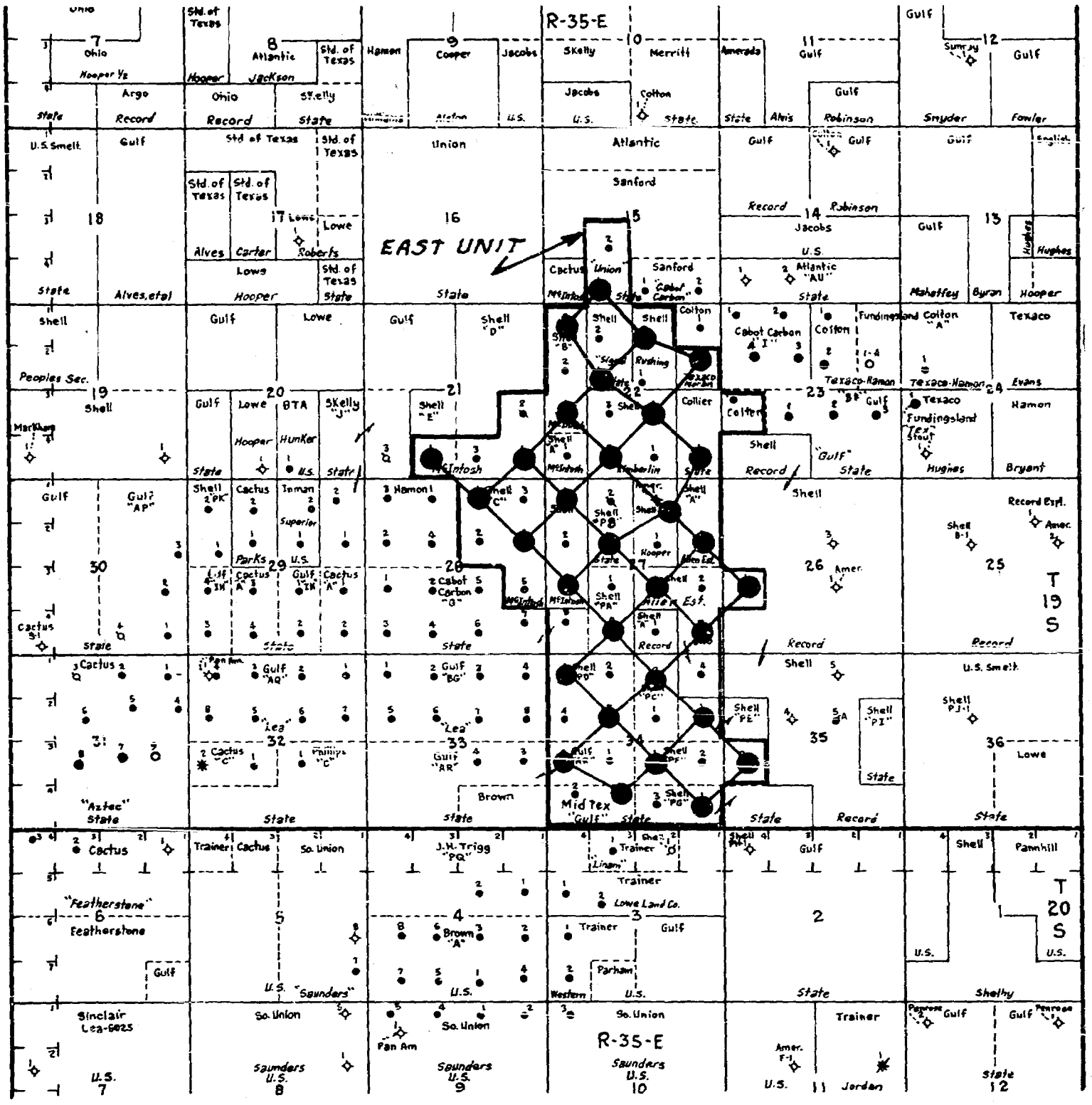


5-Spot Flood Pattern
East Pearl Queen Unit
Lea County, New Mexico
Scale: 1" = 4000'

● Producing Well

◉ Water Injection Well

Figure 12



EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO
Scale: 1" = 4000'

LEGEND

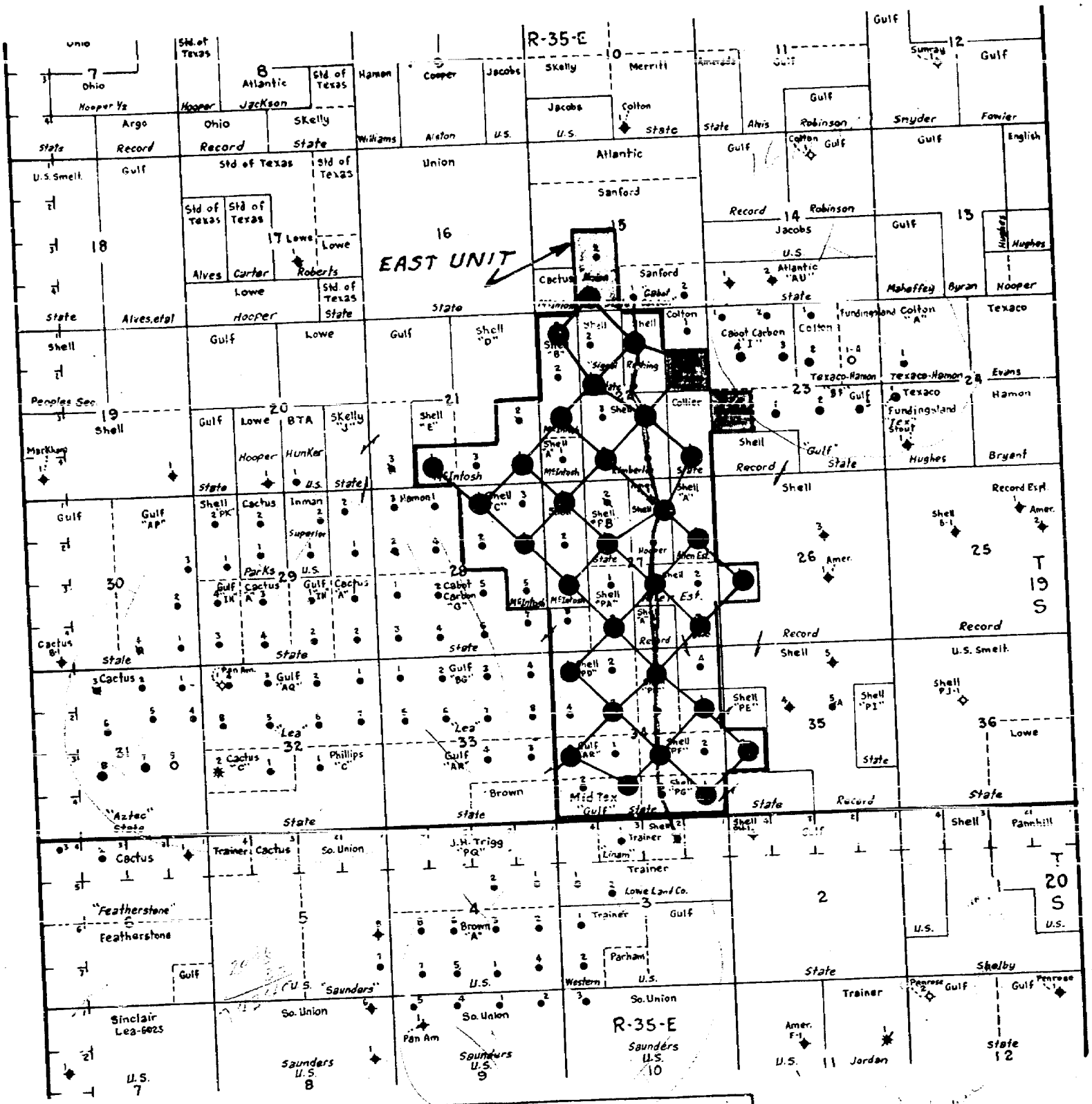
- Queen Producer
- A Atoka Producer
- Queen Gas Producer
- Injection Well-Ducl
- Drilling Well
- Injection Well-Single

EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO
INJECTION WELL DETAIL
PART I
CASING AND CEMENT

Injection Well	Surface Casing Size In.	Depth Ft.	Cement Sx.	Top Cement Ft.	Production Casing Size In.	Depth Ft.	Cement Sx.	Top Cement Ft.
Sanford-Union State 1	8 5/8	178	175	Surface (E)	5 1/2	5012	150	4150 (E)
Shell-McIntosh B-1	8 5/8	296	300	Surface (V)	5 1/2	4880	700	Surface (V)
Shell-McIntosh B-3	8 5/8	106	85	Surface (V)	2 7/8	4947	200	4100 (E)
Shell-Signal State 1	8 5/8	102	42	Surface (E)	4 1/2	4918	200	3760 (E)
Shell-Rushing 2	8 5/8	100	85	Surface (E)	4 1/2	4920	150	4050 (E)
Colton-Texaco Moran 2	8 5/8	192	100	Surface (E)	4 1/2	5087	150	4220 (E)
Collier-State 1	10 3/4	344	250	Surface (E)	5 1/2	4850	1200	Surface (E)
Shell-Kimberlin 2	9 5/8	301	300	Surface (V)	5 1/2	4904	700	860 (E)
Shell-Kimberlin 4	8 5/8	98	80	Surface (V)	5 1/2	4906	200	3750 (E)
Shell-McIntosh D-1	8 5/8	309	350	Surface (V)	5 1/2	4922	700	Surface (V)
Shell-McIntosh E-1	9 5/8	306	300	Surface (V)	5 1/2	4962	700	Surface (V)
Shell-McIntosh C-1	8 5/8	298	300	Surface (V)	5 1/2	4949	700	Surface (V)
Shell-McIntosh C-4	8 5/8	172	150	Surface (V)	5 1/2	4960	200	3800 (E)
Shell-McIntosh 1	8 5/8	306	300	Surface (V)	5 1/2	4885	700	Surface (V)
Shell-McIntosh 3	8 5/8	113	100	Surface (V)	5 1/2	5065	200	3910 (E)
Shell-State PB-1	9 5/8	304	300	Surface (V)	5 1/2	4878	800	2725 (S)
Shell-Hooper 2	8 5/8	312	300	Surface (V)	5 1/2	4895	700	Surface (V)
Shell-Allen Est. A-1	9 5/8	309	300	Surface (V)	5 1/2	4940	700	900 (E)
Shell-Record 1	8 5/8	325	300	Surface (V)	5 1/2	4918	700	880 (E)
Shell-Allen Est. 1	8 5/8	380	350	Surface (V)	5 1/2	4916	900	Surface (V)
Shell-Allen Est. 3	8 5/8	96	100	Surface (V)	5 1/2	4900	400	2580 (E)
Shell-State PA-2	8 5/8	110	100	Surface (V)	5 1/2	5024	200	3860 (E)
Shell-State PD-1	8 5/8	230	125	Surface (E)	5 1/2	5034	200	3870 (E)
Shell-State PD-3	8 5/8	141	100	Surface (V)	5 1/2	5046	200	3890 (E)
Shell-State PC-2	8 5/8	110	85	Surface (V)	5 1/2	4998	200	3840 (E)
Shell-State PE-1	8 5/8	108	85	Surface (V)	5 1/2	4985	200	3830 (E)
Shell-State PE-2	8 5/8	94	85	Surface (V)	5 1/2	4987	250	3550 (E)
Shell- State PF-1	9 5/8	106	85	Surface (V)	5 1/2	5037	200	3880 (E)
Gulf-State AR-2	8 5/8	136	100	Surface (E)	4 1/2	5051	275	3060 (E)
Mid-Tex - Gulf State 1	8 5/8	241	125	Surface (E)	5 1/2	5000	300	3270 (E)
Shell-State PG-1	8 5/8	108	85	Surface (V)	5 1/2	5019	200	3860 (E)

(E) Estimated
(V) Visual
(S) Survey

BEFORE EXAMINER NUTTER
OIL CONSERVATION COMMISSION
Applicant EXHIBIT NO. 5-A
CASE NO. 2550-2551



BEFORE EXAMINER NUTTER
OIL CONSERVATION COMMISSION
Shell EXHIBIT NO. 1
CASE NO. 2856 - 2951

EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO
Scale: 1" = 4000'

LEGEND
- Queen Producer
- A Atoka Producer
- Queen Gas Producer
- Injection Well - Dual
- Drilling Well
- Injection Well - Single

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. 2851
Order No. R-2538

APPLICATION OF SHELL OIL COMPANY
FOR A WATERFLOOD PROJECT, LEA
COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on July 24, 1963, at Santa Fe, New Mexico, before Daniel S. Nutter, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this 7th day of August, 1963, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Daniel S. Nutter, and being fully advised in the premises,

FINDS:

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

(2) That the East Pearl-Queen Unit Agreement has been approved by the Commission by Order No. R-2537; that the East Pearl-Queen Unit Area comprises 2,440 acres, more or less of State and Fee lands in Township 19 South, Range 35 East, NMPM, Lea County, New Mexico, as more fully described in said order.

(3) That the applicant, Shell Oil Company, seeks permission to institute a waterflood project on its East Pearl-Queen Unit by the injection of water into the Queen formation through 31 wells located within said unit area.

(4) That the wells in the project area are in an advanced state of depletion and should properly be classified as "stripper" wells.

(5) That the proposed waterflood project is in the interest of conservation and should result in recovery of otherwise unrecoverable oil, thereby preventing waste.

(6) That the subject application should be approved and the project should be governed by the provisions of Rule 701 of the Commission Rules and Regulations.

IT IS THEREFORE ORDERED:

(1) That the applicant, Shell Oil Company, is hereby authorized to institute a waterflood project in the East Pearl-Queen Unit Area, Lea County, New Mexico, by the injection of water into the Queen formation through the following-described 31 wells in Township 19 South, Range 35 East, NMPM, Lea County, New Mexico:

Well	Unit	Section
Sanford-Union State 1	M	15
Shell-McIntosh E-1	N	21
Shell-McIntosh D-1	P	21
Shell-Rushing 2	B	22
Shell-McIntosh B-3	D	22
Shell-Signal State 1	F	22
Colton-Texaco Moran 2	H	22
Shell-Kimberlin 4	J	22
Shell-McIntosh B-1	L	22
Shell-Kimberlin 2	M	22
Collier-State 1	P	22
Shell-Record 1	L	26
Shell-Hooper 2	B	27
Shell-McIntosh 1	D	27
Shell-State PB-1	F	27
Shell-Allen Est. A-1	H	27
Shell-Allen Est. 1	J	27
Shell-McIntosh 3	L	27
Shell-State PA-2	N	27
Shell-Allen Est. 3	P	27
Shell-McIntosh C-1	B	28
Shell-McIntosh C-4	H	28
Shell-State PC-2	B	34
Shell-State PD-1	D	34
Shell State PD-3	F	34
Shell-State PE-1	H	34
Shell-State PF-1	J	34
Gulf-State AR-2	L	34
Mid-Tex - Gulf State 1	M	34
Shell-State PG-1	P	34
Shell-State PE-2	L	35

(2) That the subject waterflood project shall be governed by the provisions of Rule 701 of the Commission Rules and Regulations, including the allowable provisions thereof, and including the provisions with respect to expansion of the waterflood project.

(3) That monthly progress reports of the waterflood project herein authorized shall be submitted to the Commission in accordance with Rules 704 and 1119 of the Commission Rules and Regulations.

(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

Jack M. Campbell
JACK M. CAMPBELL, Chairman

E. S. Walker
E. S. WALKER, Member

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

esr/

EAST PEARL QUEEN UNIT
LEA COUNTY, NEW MEXICO
CASING AND CEMENTING DETAIL IN PROPOSED INJECTION WELLS

Injection Well	Surface Casing			Production Casing			Approximate Depth Inj. Interval Top
	Size In.	Depth Ft.	Cement Sx.	Top Cement Ft.	Size In.	Depth Ft.	Cement Sx.	Top Cement Ft.	Ft.
Sanford-Union State 1	8 5/8	178	175	Surface (E)	5 1/2	5012	150	4150 (E)	4862
Shell-McIntosh B-1	8 5/8	296	300	Surface (V)	5 1/2	4880	700	Surface (V)	4757
Shell-McIntosh B-3	8 5/8	106	85	Surface (V)	2 7/8	4947	200	4100 (E)	4844
Shell-Signal State 1	8 5/8	102	42	Surface (E)	4 1/2	4918	200	3760 (E)	4804
Shell-Rushing 2	8 5/8	100	85	Surface (E)	4 1/2	4920	150	4050 (E)	4808
Colton-Texaco Moran 2	8 5/8	192	100	Surface (E)	4 1/2	5087	150	4220 (E)	4833
Collier-State 1	10 3/4	344	250	Surface (E)	5 1/2	4850	1200	Surface (E)	4818
Shell-Kimberlin 2	9 5/8	301	300	Surface (V)	5 1/2	4904	700	860 (E)	4652
Shell-Kimberlin 4	8 5/8	98	80	Surface (V)	5 1/2	4906	200	3750 (E)	4652
Shell-McIntosh D-1	8 5/8	309	350	Surface (V)	5 1/2	4922	700	Surface (V)	4661
Shell-McIntosh E-1	9 5/8	306	300	Surface (V)	5 1/2	4962	700	Surface (V)	4742
Shell-McIntosh C-1	8 5/8	298	300	Surface (V)	5 1/2	4949	700	Surface (V)	4698
Shell-McIntosh C-4	8 5/8	172	150	Surface (V)	5 1/2	4960	200	3800 (E)	4689
Shell-McIntosh 1	8 5/8	306	300	Surface (V)	5 1/2	4885	700	Surface (V)	4656
Shell-McIntosh 3	8 5/8	113	100	Surface (V)	5 1/2	5065	200	3910 (E)	4704
Shell-State PB-1	9 5/8	304	300	Surface (V)	5 1/2	4878	800	2725 (S)	4689
Shell-Hooper 2	8 5/8	312	300	Surface (V)	5 1/2	4895	700	Surface (V)	4676
Shell-Allen Est. A-1	9 5/8	309	300	Surface (V)	5 1/2	4940	700	900 (E)	4720
Shell-Record 1	8 5/8	325	300	Surface (V)	5 1/2	4918	700	880 (E)	4686
Shell-Allen Est. 1	8 5/8	380	350	Surface (V)	5 1/2	4916	900	Surface (V)	4712
Shell-Allen Est. 3	8 5/8	96	100	Surface (V)	5 1/2	4900	400	2580 (E)	4862
Shell-State PA-2	8 5/8	110	100	Surface (V)	5 1/2	5024	200	3860 (E)	4737
Shell-State PD-1	8 5/8	230	125	Surface (E)	5 1/2	5034	200	3870 (E)	4748
Shell-State PD-3	8 5/8	141	100	Surface (V)	5 1/2	5046	200	3890 (E)	4760
Shell-State PC-2	8 5/8	110	85	Surface (V)	5 1/2	4998	200	3840 (E)	4750
Shell-State PE-1	8 5/8	108	85	Surface (V)	5 1/2	4985	200	3830 (E)	4736
Shell-State PE-2	8 5/8	94	85	Surface (V)	5 1/2	4987	250	3550 (E)	4734
Shell-State PF-1	9 5/8	106	85	Surface (V)	5 1/2	5037	200	3880 (E)	4743
Gulf-State AR-2	8 5/8	136	100	Surface (E)	5 1/2	5031	275	3060 (E)	4781
Mid-Tex - Gulf State 1	8 5/8	241	125	Surface (E)	4 1/2	5000	300	3270 (E)	4744
Shell-State PG-1	8 5/8	108	85	Surface (V)	5 1/2	5019	200	3860 (E)	4750

(E) Estimated
(V) Visual
(S) Survey

DRAFT

JMD/esr

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. 2851

Order No. R- 2538

APPLICATION OF SHELL OIL COMPANY
FOR A WATERFLOOD PROJECT, LEA
COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on July 24, 1963, at Santa Fe, New Mexico, before Daniel S. Nutter, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this _____ day of ~~July~~ Aug, 1963, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Daniel S. Nutter, and being fully advised in the premises,

FINDS:

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

(2) That the East Pearl-Queen Unit Agreement has been approved by the Commission by Order No. R-2537; that the East Pearl-Queen Unit Area comprises 2,440 acres, more or less, of State and Fee lands in Township 19 South, Range 35 East, NMPM, Lea County, New Mexico, as more fully described in said order.

(3) That the applicant, Shell Oil Company, seeks permission to institute a waterflood project on its East Pearl-Queen Unit by the injection of water into the Queen formation through 31 wells located within said unit area.

(4) That the wells in the project area are in an advanced state of depletion and should properly be classified as "stripper"

(5) That the proposed waterflood project is in the interest of conservation and should result in recovery of otherwise unrecoverable oil, thereby preventing waste.

(6) That the subject application should be approved and the project should be governed by the provisions of Rule 701 of the Commission Rules and Regulations.

IT IS THEREFORE ORDERED:

(1) That the applicant, Shell Oil Company, is hereby authorized to institute a waterflood project in the East Pearl-Queen Unit Area, Lea County, New Mexico, by the injection of water into the Queen formation through the following-described 31 wells in Township 19 South, Range 35 East, NMPM, Lea County, New Mexico:

Sanford-Union State 1, Unit N, Sec. 15
Shell-McIntosh E-1, Unit N, Sec. 21
Shell-McIntosh D-1, Unit P, Sec. 21
Shell-Rushing 2, Unit B, Sec. 22
Shell-McIntosh B-3, Unit D, Sec. 22
Shell-Signal State 1, Unit F, Sec. 22
Colton-Texaco Moran 2, Unit H, Sec. 22
Shell-Kimberlin 4, Unit J, Sec. 22
Shell-McIntosh B-1, Unit L., Sec. 22
Shell-Kimberlin 2, Unit N, Sec. 22
Collier-State 1, Unit P, Sec. 22
Shell-Record 1, Unit L, Sec. 26
Shell-Hooper 2, Unit B, Sec. 27
Shell-McIntosh 1, Unit D, Sec. 27
Shell-State PB-1, Unit F, Sec. 27
Shell-Allen Est. A-1, Unit H, Sec. 27
Shell-Allen Est. 1, Unit J, Sec. 27
Shell-McIntosh 3, Unit L, Sec. 27
Shell-State PA-2, Unit N, Sec. 27
Shell-Allen Est. 3, Unit P, Sec. 27
Shell-McIntosh C-1, Unit B, Sec. 28
Shell-McIntosh C-4, Unit H, Sec. 28
Shell-State PC-2, Unit B, Sec. 34
Shell-State PD-1, Unit D, Sec. 34
Shell-State PD-3, Unit F, Sec. 34
Shell-State PE-1, Unit H, Sec. 34

Shell-State PF-1, Unit J, Sec. 34
Gulf-State AR-2, Unit L, Sec. 34
Mid-Tex - Gulf State 1, Unit N, Sec. 34
Shell-State PG-1, Unit P, Sec. 34
Shell-State PE-2, Unit L, Sec. 35

(2) That the subject waterflood project shall be governed by the provisions of Rule 701 of the Commission Rules and Regulations, including the allowable provisions thereof, and including the provisions with respect to expansion of the waterflood project.

(3) That monthly progress reports of the waterflood project herein authorized shall be submitted to the Commission in accordance with Rules 704 and 1119 of the Commission Rules and Regulations.

(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.

No. 21-63

DOCKET: EXAMINER HEARING - WEDNESDAY - JULY 24, 1963

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

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

CASE 2864: Application of Midwest Oil Corporation for a unit agreement, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the Custer Mountain Unit Area comprising 11,523.68 acres of State, Federal and Fee lands in Township 24 South, Range 35 East, Lea County, New Mexico.

CASE 2865: Application of Humble Oil & Refining Company for a pressure maintenance project, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a pressure maintenance project in the Gallup formation underlying its Navajo "G" lease in Sections 1, 2, 11 and 12, Township 31 North, Range 17 West, San Juan County, New Mexico. Initial injection will be through applicant's Well No. 16 located in Unit G of said Section 1. Applicant further seeks the promulgation of special rules governing the operation of said project.

CASE 2866: Application of Humble Oil & Refining Company for a dual completion, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the dual completion (combination) of its State "BV" Well No. 1, located in Unit A of Section 18, Township 18 South, Range 35 East, Lea County, New Mexico, to produce oil from the Bone Springs and Devonian formations through parallel strings of 2 7/8 inch casing and 4 1/2 inch casing cemented in a common well bore.

CASE 2867: Application of George L. Buckles Company for a waterflood project, Lea County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a waterflood project in the Langlie-Mattix Pool by the injection of water into the Queen formation through nine wells on its Knight lease comprising the E/2 SE/4 of Section 21, W/2 SW/4 of Section 22, Township 24 South, Range 37 East, Lea County, New Mexico.

CASE 2868: Application of Continental Oil Company for a non-standard oil proration unit, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of a 48.99-acre non-standard oil proration unit comprising Lots 2 and 3, Section 31, Township 26 South, Range 32 East, North Mason-Delaware Pool, Lea County, New Mexico, to be dedicated to its Russell Federal 31 Well No. 1, located in Lot 3 of said Section 31.

CASE 2841: (Cont'd from June 26,1963) Application of Shell Oil Company for an unorthodox location, Lea County, New Mexico. Applicant, in the above-styled cause, seeks permission to drill its Middleton Federal Well No. B-1 at an unorthodox location 660 feet from the North and West lines of Section 31, Township 19 South, Range 32 East, Lusk-Morrow Gas Pool, Lea County, New Mexico.

(Continued from July 10, 1963 examiner hearing)

CASE 2850: Application of Shell Oil Company for a unit agreement, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the East Pearl-Queen Unit Area comprising 2440 acres of State and Fee lands in Township 19 South, Range 35 East, Lea County, New Mexico.

CASE 2851: (Continued from July 10, 1963 examiner hearing and readvertised)

Application of Shell Oil Company for a waterflood project, Lea County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a waterflood project on its East Pearl Queen Unit by the injection of water into the Queen formation through 31 wells in Sections 15, 21, 22, 26, 27, 28, 34, and 35, Township 19 South, Range 35 East, Lea County, New Mexico.

CASE 2869: Application of Marathon Oil Company for a dual completion, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the dual completion (conventional) of its State Warn A/c 3 Well No. 5, located in Unit H of Section 33, Township 17 South, Range 35 East, Lea County, New Mexico, to produce from the Vacuum-Abo Reef Pool and either an undesignated Blinebry or Glorieta pool through parallel strings of 2 1/16" OD tubing.

CASE 2870: Application of J. Gregory Merrion & Associates for compulsory pooling, Rio Arriba County, New Mexico. Applicant, in the above-styled cause, seeks an order force-pooling all mineral irterests in the Basin-Dakota Gas Pool underlying the S/2 of Section 34, Township 25 North, Range 6 West, Rio Arriba County, New Mexico.

No. 21-63

DOCKET: EXAMINER HEARING - WEDNESDAY - JULY 24, 1963

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

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

CASE 2864: Application of Midwest Oil Corporation for a unit agreement, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the Custer Mountain Unit Area comprising 11,523.68 acres of State, Federal and Fee lands in Township 24 South, Range 35 East, Lea County, New Mexico.

CASE 2865: Application of Humble Oil & Refining Company for a pressure maintenance project, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a pressure maintenance project in the Gallup formation underlying its Navajo "G" lease in Sections 1, 2, 11 and 12, Township 31 North, Range 17 West, San Juan County, New Mexico. Initial injection will be through applicant's Well No. 16 located in Unit G of said Section 1. Applicant further seeks the promulgation of special rules governing the operation of said project.

CASE 2866: Application of Humble Oil & Refining Company for a dual completion, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of the dual completion (combination) of its State "BV" Well No. 1, located in Unit A of Section 18, Township 18 South, Range 35 East, Lea County, New Mexico, to produce oil from the Bone Springs and Devonian formations through parallel strings of 2 7/8 inch casing and 4 1/2 inch casing cemented in a common well bore.

CASE 2867: Application of George L. Buckles Company for a waterflood project, Lea County, New Mexico. Applicant, in the above-styled cause, seeks authority to institute a waterflood project in the Langlie-Mattix Pool by the injection of water into the Queen formation through nine wells on its Knight lease comprising the E/2 SE/4 of Section 21, W/2 SW/4 of Section 22, Township 24 South, Range 37 East, Lea County, New Mexico.

CASE 2868: Application of Continental Oil Company for a non-standard oil proration unit, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of a 48.99-acre non-standard oil proration unit comprising Lots 2 and 3, Section 31, Township 26 South, Range 32 East, North Mason-Delaware Pool, Lea County, New Mexico, to be dedicated to its Russell Federal 31 Well No. 1, located in Lot 3 of said Section 31.

CASE 2841: (Cont'd from June 26,1963) Application of Shell Oil Company for an unorthodox location, Lea County, New Mexico. Applicant, in the above-styled cause, seeks permission to drill its Middleton Federal Well No. B-1 at an unorthodox location 660 feet from the North and West lines of Section 31, Township 19 South, Range 32 East, Lusk-Morrow Gas Pool, Lea County, New Mexico.

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

APPLICATION OF SHELL OIL COMPANY FOR APPROVAL OF THE EAST PEARL-QUEEN UNIT AGREEMENT, LEA COUNTY, NEW MEXICO.

No. 2850

APPLICATION

Comes now Shell Oil Company by its attorneys and applies to the New Mexico Oil Conservation Commission for approval of the East Pearl-Queen Unit Agreement, Lea County, New Mexico, and in support of its application states:

1. That the proposed East Pearl-Queen Unit comprises 2440 acres of State and fee lands located in Township 19 South, Range 35 East, Lea County, New Mexico, as follows:

Section 15:	E/2 SW/4
Section 21:	E/2 SE/4, SW/4 SE/4, SE/4 SW/4
Section 22:	W/2, SE/4, S/2 NE/4, NW/4 NE/4
Section 23:	NW/4 SW/4
Section 26:	NW/4 SW/4
Section 27:	All
Section 28:	NE/4, NE/4 SE/4
Section 34:	All
Section 35:	NW/4 SW/4

2. That a secondary recovery project will be operated within the proposed unit area which project is the subject of a companion application.

3. That the operation of the subject acreage and of the said secondary recovery project as a unit pursuant to the East Pearl-Queen Unit Agreement will prevent waste and protect correlative rights.

WHEREFORE, it is requested that the application be set for hearing before the Commission or one of its examiners, and the Commission enter its order approving the East Pearl-Queen Unit Agreement.

SETH, MONTGOMERY, FEDERICI & ANDREWS

By: Richard S. Morris
Attorneys for Shell Oil Company

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

APPLICATION OF SHELL OIL COMPANY
FOR APPROVAL OF A WATER FLOOD
PROJECT, LEA COUNTY, NEW MEXICO.

No. 2851

APPLICATION

Comes now Shell Oil Company by its attorneys and applies to the New Mexico Oil Conservation Commission for approval of a water flood project to be instituted in the East Pearl-Queen Unit area, Lea County, New Mexico, and in support of its application states:

1. That the approval of the East Pearl-Queen Unit Agreement is being sought by Shell Oil Company in a companion application; said unit contains 2440 acres of State and fee lands located in Township 19 South, Range 35 East, Lea County, New Mexico, and is more completely described in said application.

2. That Shell Oil Company as operator of the East Pearl-Queen Unit proposes to institute a water flood project in the East Pearl-Queen Unit area by the injection of water into the Queen Formation through ~~twenty-nine~~ 31 injection wells located within said unit as follows:

Section 15: Unit N
Section 21: Units N, P
Section 22: Units B, D, F, H, J, L, N, P
Section 26: Unit L
Section 27: Units B, D, F, H, J, L, N, P
Section 34: Units B, D, F, H, J, L, N, P
Section 35: Unit L
Section 28: Units B + H

3. That the wells within the East Pearl-Queen Unit area are in an advanced stage of depletion and should properly be considered as "stripper" wells.

4. That approval of the application will result in increased recovery of oil and will prevent waste. Correlative rights will be protected by operation of the project as a unit.

Dick Dixon called Div Operations 6/28/63

DOCKET MAILED
Date 7/12/63

DOCKET MAILED
Date 6/28/63
JL

5. The proposed water flood project will be operated pursuant to the provisions of Rule 701 of the Commission's Rules and Regulations.

WHEREFORE, it is requested that this application be set for hearing before the Commission or one of its examiners, and that the Commission enter its order approving the water flood project as set forth in this application.

SETH, MONTGOMERY, FEDERICI & ANDREWS

By Richard E. Morris
Attorneys for Shell Oil Company

cc: Mr. Frank Irby
OCC - Hobbs, N.M.

OIL CONSERVATION COMMISSION
P. O. BOX 871
SANTA FE, NEW MEXICO

August 7, 1963

Mr. Richard S. Morris
Seth, Montgomery, Federici & Andrews
Attorneys at Law
Post Office Box 828
Santa Fe, New Mexico

Dear Mr. Morris:

Enclosed herewith is Commission Order No. R-2538, entered in Case No. 2851, approving the Shell Oil Company's East Pearl Queen Unit Waterflood Project.

According to our calculations, when all of the authorized injection wells have been placed on active injection, the maximum allowable which this project will be eligible to receive under the provisions of Rule 701-B-3 is 2478 barrels per day.

Please report any error in this calculated maximum allowable immediately, both to the Santa Fe Office of the Commission and the appropriate district proration office.

In order that the allowable assigned to the project may be kept current, and in order that the operator may fully benefit from the allowable provisions of Rule 701, it behooves him to promptly notify both of the aforementioned Commission offices by letter of any change in the status of wells in the project area, i. e., when active injection commences, when additional injection or producing wells are drilled, when additional wells are acquired through purchase or unitization, when wells have received a response to water injection, etc.

Your cooperation in keeping the Commission so informed as to the status of the project and the wells therein will be appreciated.

Very truly yours,

A. L. PORTER, Jr.
Secretary-Director

ALP/ir
Enclosure

SHELL OIL COMPANY

P. O. Box 1858
Roswell, New Mexico

July 1, 1963

Case 2851

Subject: East Pearl Queen Unit Waterflood
Lea County, New Mexico

Mr. D. S. Nutter
New Mexico Oil Conservation Commission
P. O. Box 871
Santa Fe, New Mexico

Dear Mr. Nutter:

Reference is made to your recent conversation with Mr. G. G. Carnahan and our attorney, Mr. R. S. Morris, concerning the scheduled July 10 hearing on the East Pearl Queen Unit Waterflood.

At this meeting copies of all the logs of the proposed injection wells were furnished to you with the exception of one log being the Collier-State No. 1. Enclosed is the log of the subject well. This set of logs will be used as an exhibit in the forthcoming hearing.

We want to thank you for your time in discussing with us the referenced waterflood hearing.

Yours very truly,

R. L. Rankin

R. L. Rankin
Division Production Manager

Enclosure

cc: Mr. R. S. Morris
P. O. Box 828
Santa Fe, New Mexico

DOCKET MAILED
Date 7/12/63