AN ARCHEOLOGICAL ASSESSMENT OF KERR-MCGEE MANUFACTURING FACILITIES (SEQUOYAH AND CIMARRON FACILITIES), IN SEQUOYAH AND LOGAN COUNTIES

by

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INTRODUCTION

This report is in response to letters dated: 26 June, 9 July, and 11 July 1974, between Kerr-McGee Nuclear Corporation, Oklahoma City, and the Oklahoma Archaeological Survey, Norman. From this correspondence a preliminary assessment of potential archeological resources and possible ages of such resources was deemed necessary. This report is based on a review of available literature and a search through the Oklahoma Archaeological Survey site files.

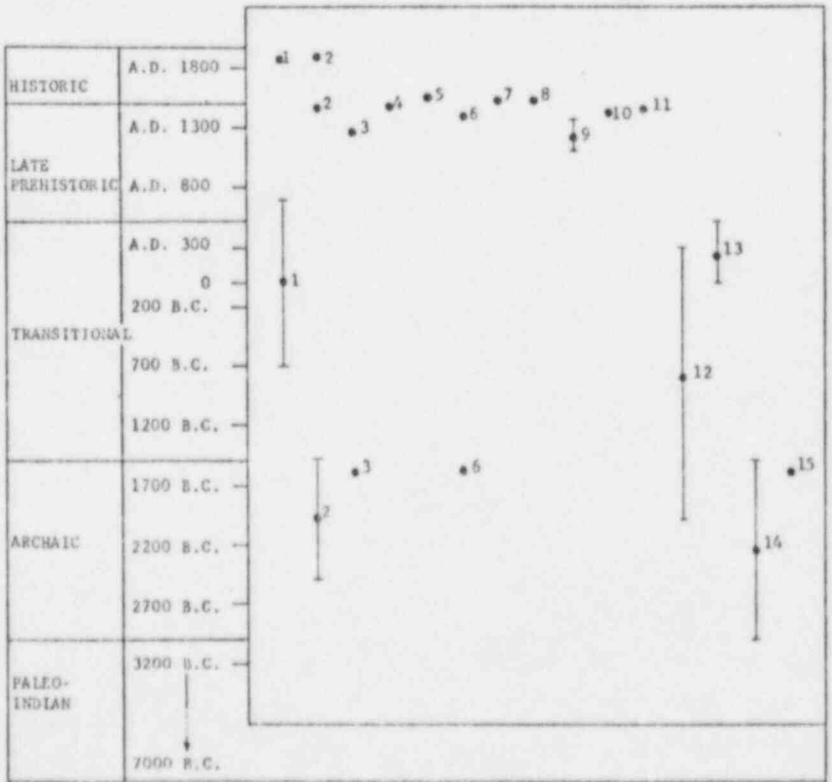
SEQUOYAH COUNTY

A number of archeological sites have been excavated and reports published for sites within a radial distance of 15 miles of the Sequoyah Facility. The majority of these sites were excavated by the Oklahoma River Basin Survey, Norman, during the period of 1966-1969, as a result of the impending construction of the Robert S. Kerr Reservoir (Short Mountain Reservoir) on the Arkansas River. Additional work was conducted in the immediate area during 1965-1966 on the Webbers Falls Lock and Dam Project (Schneider 1967; and Wyckoff and Barr 1967a), and the Tenkiller Ferry Lake area during the 1940's, and 1973 (Wenner 1948; and Neal 1974).

The following conceptual framework can be used for the Sequoyah Facility area (see Huffman, Cathey, and Humphrey 1963: 24-25; Wyckoff and Barr 1967a: 6; Israel 1969: 288; and Neal 1974: 5).

Occupation	Period
Paleo-Indian	7,000 B.C.-3,000 B.C.
Archaic	
Early (Grove Focus)	3,000 B.C.-2,250 B.C.
Middle (Grove Focus)	2,250 B.C.-1,750 B.C.
Late (Grove Focus)	1,750 B.C.-1,500 B.C.
Transitional (Woodland)	1,500 B.C.-A.D. 500
Late Prehistoric (Caddoan)	
Gibson Aspect	A.D. 500-A.D. 1200
Fulton Aspect	A.D. 1200-A.D. 1500
Historic	
Early	A.D. 1500-A.D. 1820
Late	A.D. 1820-to present

A tentative seriation of the reported archeological sites from within a 15 mile radius of the Sequoyah Facility is as follows:



(1) Dickson-Haraway site (Sq-40), Burton and Neal (1970)
(2) Harvey site (Sq-18), Burton (1971)
(3) Morris site (Ck-39), Bell and Dale (1953)
(4) Goff Shelter (Ms-46), Schneider (1967)
(5) Tyler site (Hs-11), Burton, Bastian, and Prewitt (1969)
(6) Cookson site (Ck-12), Israel (1969)
(7) Tyler-Rose site (Hs-24), Cartledge (1970)
(8) Sheffield site (Sq-22), Prewitt and Wood (1969)
(9) Fine site (Sq-13), Bighey (1969)
(10) Horton site (Sq-11), Wyckoff (1970)
(11) Cat Smith site (Ms-52), Wyckoff and Barr (1967b)
(12) McCulley site (Ms-50), Wyckoff and Barr (1967a)
(13) Wendtland site (Ms-53), Schneider (1967)
(14) Harkey-Bennett site (Sq-23), Burton and Stahl (1969)
(15) Tennison site (Ms-41), Schneider (1967)

Note: numbers appearing more than once represent multicomponent sites

For additional information on the sites the reader is referred to each specific report. A brief summation of previous work in the area would be as follows:

(1) Paleo-Indian: Characterized by small bands of hunting-gathering peoples who made distinctive dart points (spear points) and hunted various forms of extinct mammals such as the Imperial Mammoth and several forms of bison. No excavated sites are reported from the immediate area; however, some scattered surface finds of the dart points have been reported indicating that some activity has occurred in the region during this period.

(2) Archaic (Early, Middle, Late): Represented by small bands of hunting-gathering peoples; however, different styles of dart points and other tools help distinguish this period from the previous. Several sites from this period are recorded for the area: Tennison site (Schneider 1967); Wendtland site (Schneider 1967); McCulley site (Wyckoff and Barr 1967a); and Harkey-Bennett site (Burton and Stahl 1969).

(3) Transitional (Woodland): This period is characterized by the introduction of horticulture, pottery, and the bow and arrow, along with the construction of burned rock mounds. These new traits help set this period apart from the previous. Only one site assigned to this period is reported from the immediate area, the Wendtland site (Schneider 1967).

(4) Late Prehistoric: Extensive use of horticulture, the construction of large burial and temple mounds (during the earlier stages—Gibson Aspect), and semi-permanent villages or hamlets situated along the major river valleys, and a number of new tools, distinguishes this period from the others. During the later stages (Fulton Aspect) the construction of the large mounds is no longer practiced and new foreign elements or ideas occur in the area in the form of: bison scapula hoes and tibia digging sticks; bone rasps; thumbnail scrapers; diamond-shaped, alternate beveled knives; and small notched and unnotched triangular arrowpoints. A considerable amount of information is available for this period from the following published reports: Morris site (Bell and Dale 1953); Goff Shelter (Schneider 1967); McCulley site (Wyckoff and Barr 1967a); Cat Smith site (Wyckoff and Barr 1967b); Tyler site (Burton, Bastian, and Prewitt 1969); Fine site (Eighmy 1969); Cookson site (Israel 1969); Sheffield site (Prewitt and Wood 1969); Tyler-Rose site (Cartledge 1970); Dickson-Haraway site (Burton and Neal 1970); and Harvey site (Burton 1971).

Sites from this period can be expected to occur in the Sequoyah Facility location.

(5) Early and Late Historic: During this period a number of Indians were forceably removed from their homelands in the eastern United States and resettled in the study area. However, very little published information before 1860 is available for this period. Several reports containing some information are: the Dickson-Haraway site (Burton and Neal 1970); and the Harvey site (Burton 1971).

LOGAN COUNTY

Although considerable work has occurred along the Arkansas River Valley and other major drainages in the eastern one-half of Oklahoma, very little published information is available for the central portion of the State. The nearest published reports to the Cimarron Facility are: the Boss site, an Archaic burial reported for Oklahoma County (McWilliams 1969); the Nagle site, a Late Prehistoric burial ground also located in Oklahoma County (Shaeffer 1957); and a survey of Crutcho and Soldier Creeks in Oklahoma County (Lopez 1972). The Crutcho and Soldier Creeks survey recorded eight sites of the following possible periods: two Archaic sites; five Woodland and Late Prehistoric, multicomponent sites; and one unknown prehistoric site.

Although little published information is available for the central region of Oklahoma, this is a reflection of the amount of previous survey work conducted in the area, rather than a preference by prehistoric peoples for one region over the other.

A slightly different version of the conceptual framework proposed earlier is used for the Cimarron Facility area (see Bell and Baerreis 1951; Lopez 1972; and Bell 1973).

Occupation	Period
Paleo-Indian	12,000 B.C.-4,000 B.C.
Southern Plains Archaic	4,000 B.C.-A.D. 1
Plains Woodland	A.D. 1-A.D. 1000
Late Prehistoric	A.D. 1000-A.D. 1400
Early Historic	A.D. 1400-A.D. 1820
Late Historic	A.D. 1820-to present

Characteristics listed for the Paleo-Indian period are the same as earlier proposed for the Sequoyah Facility area; however, an earlier date can be suggested as earlier dart point types occur as surface finds in the western one-half of Oklahoma. Similar traits listed for the Archaic and

Woodland occupations occur in both areas; but, the length of occupation varies in each region. The Late Prehistoric occupation in the Cimarron Facility area appears to be a blend of traits from the eastern one-half of Oklahoma and the Southern Plains region (see McWilliams 1969; and Bell 1973). The Historic periods are similar; however, different Indian Nations and Tribes were established in each region. As it stands, much work still remains to be done before a clear understanding of the prehistoric occupation in the Cimarron Facility area can be formulated.

RECORDED SITES

The Oklahoma Archaeological Survey site files contain reports of 6 sites in Logan County and 52 sites in Sequoyah County. Again this difference in numbers is a reflection of the amount of previous survey work conducted in each county. The reported sites range in age from Paleo-Indian to Late Historic (7,000 B.C. to the present) with the following breakdown:

	Period	Number
Logan County	Archaic	2
	Late Prehistoric	1
	Unknown Prehistoric	3
Sequoyah County	Paleo-Indian	2
	Archaic	13
	Late Prehistoric	15
	Historic	1
	Unknown Prehistoric	21

RECOMMENDATION

No archeological sites were reported for the immediate areas affected by the two facilities (T16N; R2W; Sections: 1, 12, and 11 for the Cimarron Facility; and T12N; R21E; Sections: 15, 16, 23, 27, and 28 for the Sequoyah Facility). However, sites are reported from the surrounding areas and the probability of similar sites occurring on the Kerr-McGee properties is

considered high, as both facilities are located on high terraces overlooking major rivers (a situation considered to be a prime location for prehistoric utilization). Until an on foot surface survey has been conducted in the areas, important archeological resources are assumed to be affected by the two facilities. The amount of disturbance and the appropriate measures that could be taken, can be resolved only by a detailed field survey and follow-up report.

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LEAK IN RAFFINATE POND #2

Sequoyah Facility
Kerr-McGee Nuclear Corporation

All monitor wells surrounding the storage ponds were bailed dry on April 12 and subsequent liquid accumulation sampled on April 27 in accordance with the Sequoyah Facility Monitoring and Surveying Program. Sample results were received on May 13 for Well 2314 showing nitrate 160 ppm, uranium 10 ugm/l. Other wells showed normal results. The well was immediately checked, and the depth of liquid in the well had increased since bailing. The liquid was again removed, and a sample was taken during the bailing which confirmed the nitrate level. A sample was removed the following day, and the well again emptied. On May 15 the adjacent monitor wells were sampled with no significant variation from samples taken in April. A pattern analysis (see ER-Supp 2) was made on May 20 to confirm that the water composition was different than samples taken previously (see Fig 2). Sampling was continued each day until June 21 with the results as shown on Fig. 1. Level remained approximately constant since each sample removes about one gallon.

Several conferences were held during this period with technical personnel in the Oklahoma City office, geologists and soil engineers in other corporate divisions, during which it was decided that (1) an attempt would be made to flush 2314 to determine if accidental contamination had caused the increase in nitrate content, and (2) additional monitoring wells may be needed to determine the degree of dispersion.

On May 22, Well #2314 was filled and bailed four times with the water being thoroughly agitated. The resultant sample was extremely muddy and showed a large decrease in nitrate content but an increase in uranium content.

The results of all samples are shown on Fig. 1.

By May 25, it was evident that a leak from one of the raffinate ponds was finding its way into Well #2314 and additional monitor wells had to be drilled to determine the extent of distribution of the liquid leaking from the storage pond. After consultation with company geologists, 10 monitor wells (M Series) were drilled as shown on the sketch, Revision 2, commencing on June 30. These wells were drilled by an air-driven rotary drill to a maximum depth of approximately 20 ft. into a strata of blue-gray impervious shale. All wells were dry at the time of drilling, soil samples were taken from each of the strata intercepted by the drill. Uranium contents in the strata varied from .1 to 1.0 ugm/gm with a relatively uniform distribution throughout the depth of the well. Nitrate content was undetectable at the detection limit of 5 ugm/gm. From these wells, it was concluded that no pond liquid had reached this point and initial results from samples taken on June 17 did not demonstrate the presence of excessive nitrate. M series wells are 8" holes cased with 6" plastic pipe to approximately 18" above grade. With this conclusion, it was decided to drill additional test wells (T Series, Fig. 3) closer to the pond which was done on June 12. By June 14, all of these additional wells were moist. A moisture layer was observed at approximately the 25' level. The T wells are uncased 8" holes with a 9" diam. sleeve at the surface. By June 17, a small amount of liquid had collected, and samples were taken and analyzed. It was immediately evident from nitrate concentrations that the well approximately 2' northwest of 2314 (T-3) was intercepting approximately the same leak because of the nitrate level found. All other well samples were negative.

The plant was closed for its normal two-week vacation period June 22 and reopened on July 9. During this shutdown period,

only the T wells and 2314 were sampled. Subsequent to startup on July 9, all monitor wells have been sampled regularly each week. The sampling results for 2314 are shown on Figure 1 while the results on the monitor wells are summarized on Table I.

By the examination of Figure 1 and Table I, it is concluded that high nitrate liquid from the raffinate ponds is leaking into monitor well 2314 and into T-3. An attempt was made to determine the rate of the leakage, assuming that it all appears in 2314. The rate based upon the indicated periods are given below:

4/12 to 5/13	1.03 gal/da.
6/21 to 7/2	.54 gal/da.
7/23 to 7/30	.28 gal/da.
6/21 to 7/30 (cum)	.43 gal/da.

As can be seen from Table I the rate into the monitor wells varies from insignificant for the M series to .25 gal/da., while the T wells vary from .15 to .39 gal/da. During this same test period, rainfall for the area totaled 1.19 in. as shown in Table II.

In the three month period since the leak was first determined, it has been demonstrated that the (1) nitrate contamination does not result from an accidental contamination of the 2314, (2) the leakage is confined to a very narrow, less than 30' wide, section approximately in the middle of the south side of raffinate pond #2, (3) no progression of the fluid front beyond 2314 has been measured, (4) the quantity of rainfall received has resulted in the new monitoring wells receiving approximately .25 gallon of fluid a day from the groundwater

Leakage from the bottom of storage ponds is not an unusual phenomena and can normally be controlled by one of several techniques:

1. A common technique is the addition of material to the pond that would result in plugging the leak from the inside.

Bentonnite clay is often chosen because of its bulkiness and ready tendency to pack. However, bentonite must be restricted to the use of very acid ponds and works best in a solution of approximately 3 pH.

2. Some waste ponds have leaked in such a fashion that the water leaking from the pond can be trapped by construction of a trench and sump at the appropriate level and permitting the leak to accumulate in the sump prior to pumping back into the pond. It would appear that such a procedure would be appropriate for the current problem. The pond is underlaid with a tight strata of shale that extends in an unbroken fashion over the entire area at a depth of approximately 25 ft. The leak is relatively slow by all indications thus far. Sufficient additional wells have been installed to make it possible to measure the effectiveness of the intercept sump.

3. Curtain grouting by a solution of cement, water and soil is also a possible method of control that has been used with some success on water storage reservoirs. Success with waste ponds has been mixed since normally a salt of some description is present that may interfere with the cementing action depended upon to seal the leak. Some risk of enlarging the fissure due to placement pressure also exists.

Conclusion

From the observations described, it is concluded that:

1. A leak in raffinate pond #2 exists resulting in contamination of monitor well 2314 and T-3.
2. The leak has not spread and seems to be fairly well contained to the plane of the monitor well. Such a leak might exist from a fissure or a channel in the subsurface soil.
3. The rate of leakage does not demonstrate a serious threat to the environment.

4. In the event that the leakage rate increases or other wells begin to show that the liquid face has spread, the several methods of correction should be evaluated and installation commenced promptly of the most promising. Currently it is our plan to continue to monitor all of these wells by sampling weekly and determine the apparent leak rate on a monthly basis.

5. Current evaporation processes reduce the hydraulic head on the pond.

6. The raffinate treatment process shows success in the providing a permanent method of disposal.

TABLE I

New Monitor Well Data
6/15 - 7/30/74

Well	Gal. per da.	U ug/g	NO_3 ppm
M-1	--	--	--
2	.14	29	.3
3	.11	7	.8
4	.04	70	1.4
5	.25	8	.3
6	.30	56	.2
7	--	--	--
8	.004	7	.9
9	--	--	--
10	--	--	--
T-1	.27	28	1.1
2	.39	24	9.9
3	.15	33	423.
4	.26	21	.4
5	.28	23	.6

TABLE II

Rainfall

6/14	.04 in.
7/8	.81
7/17	.20
7/29	.14
	1.19 in.

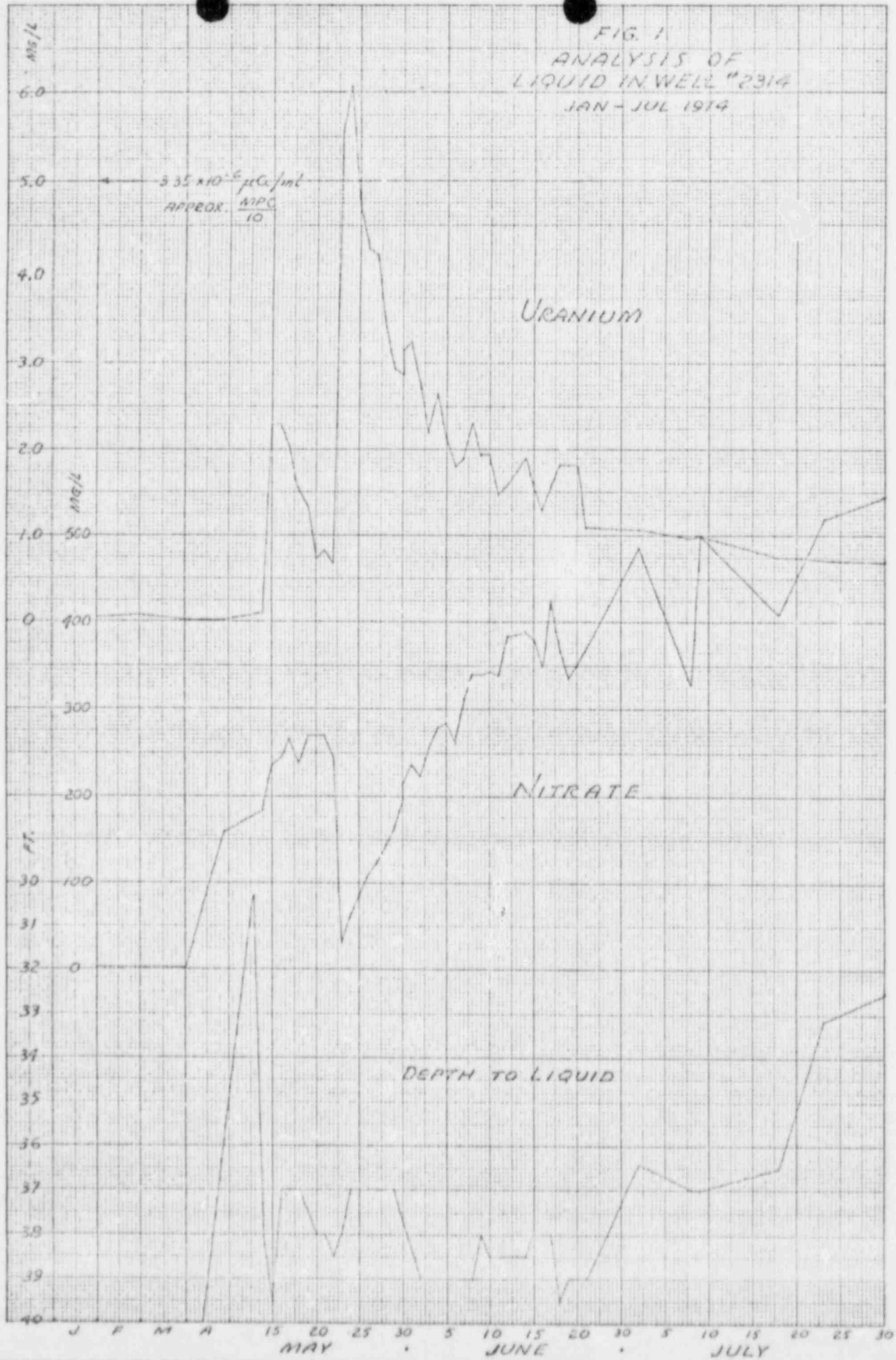


FIG. 1
ANALYSIS OF
LIQUID IN WELL #2314
JAN - JUL 1974

K+E 10 X 10 TO ½ INCH 46 1323
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

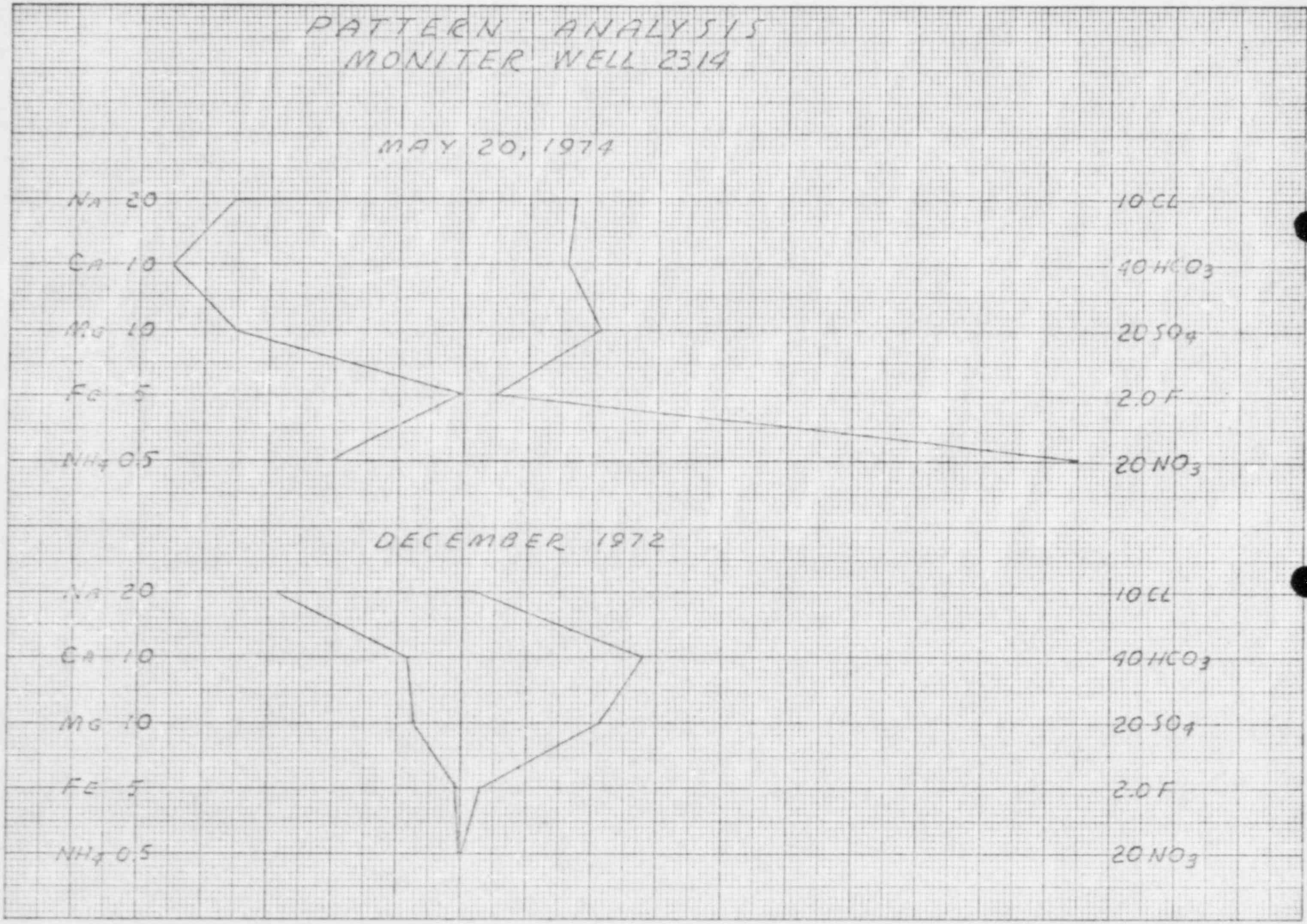


FIG. 2

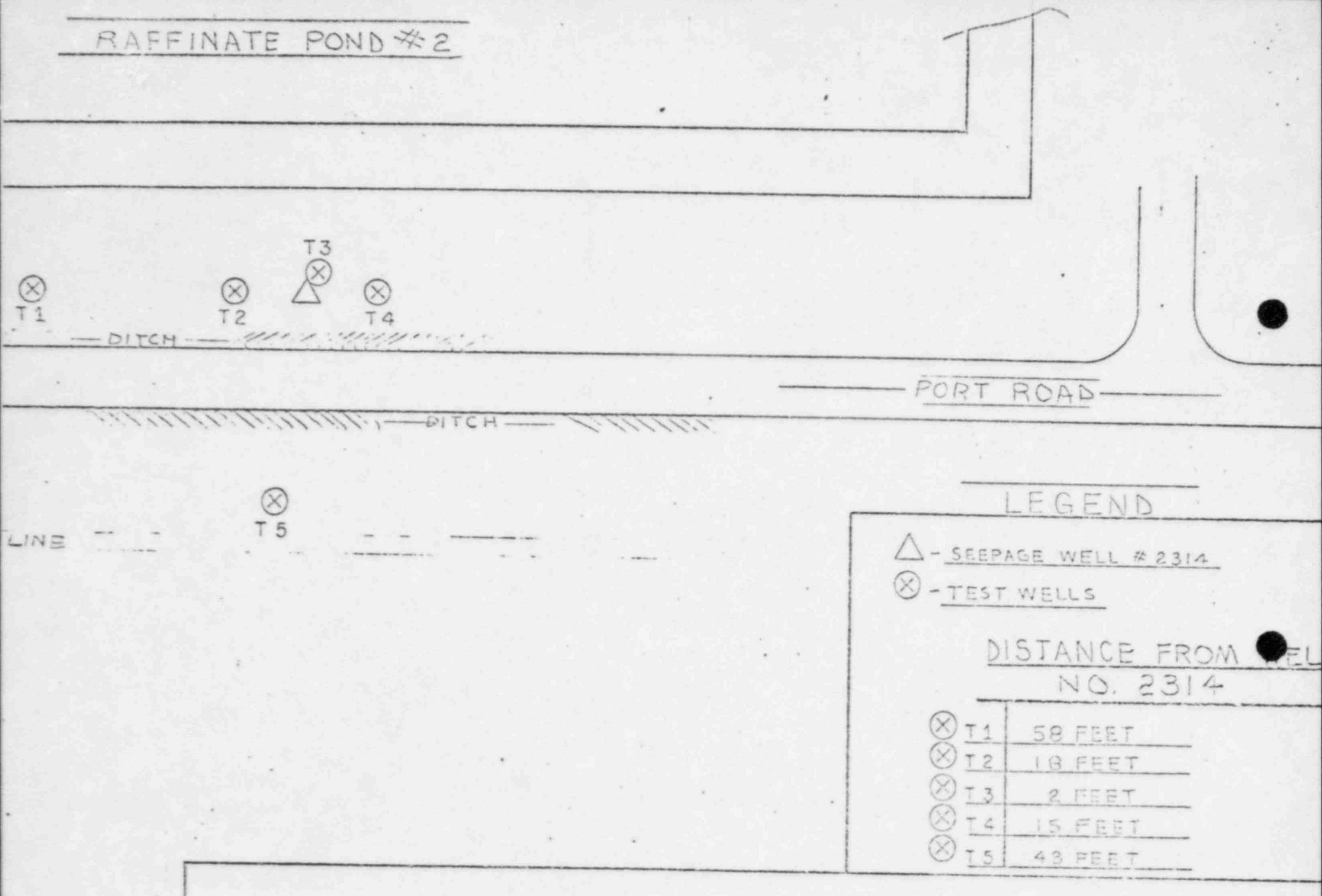
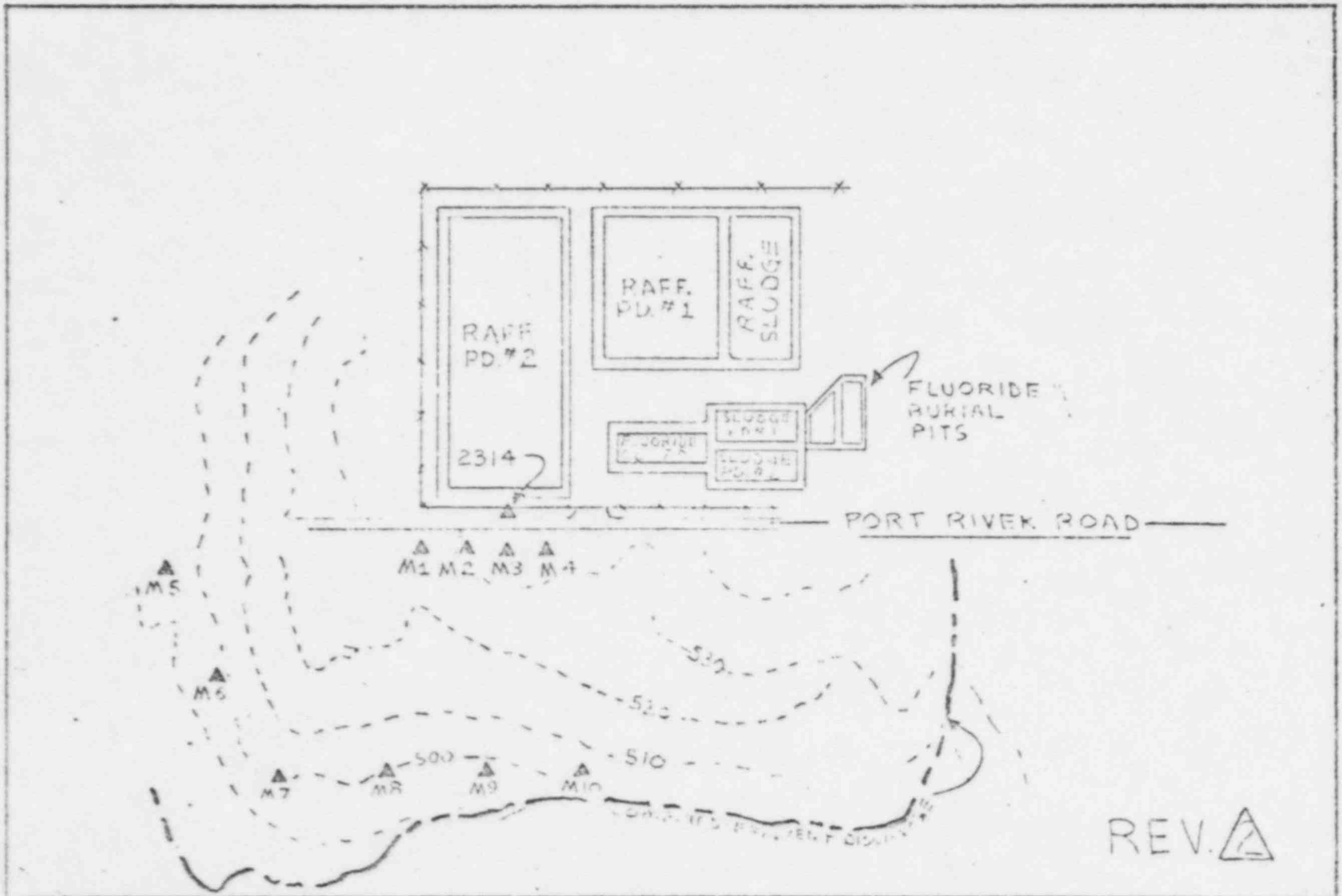


Figure 3

TEST WELLS FOR
RAFFINATE POND # 2



M▲ SEEPAGE MONITOR WELLS DRILLED 6-3-74

SCALE 1 IN. = 400 FT.

INTERIM REPORT
RAFFINATE TREATMENT TEST, 1974

In accordance with the request of Kerr-McGee Nuclear Corporation on February 20, 1974, the USAEC extended to 1974, Amendments #2 and 3 to License SUB-1010 by Amendment #5 dated April 25, 1974. During February and March, Kerr-McGee had discussed the feasibility of this test with Dr. Billy B. Tucker of Oklahoma State University, Department of Agronomy, and subsequently established in accordance with Amendments #2 and 3 the following program:

Establish four test plots immediately to the south of the plant within the area of the sprinkler system. These test plots would be treated separately, and all runoff sampled and measured. Grass would be harvested for yields of dry forage and analyzed for nitrogen and radionuclides regularly during the growing season.

As a result of this arrangement, the measurements would yield information on moisture flow, nitrogen distribution and distribution of radionuclides.

Subsequently the field was diked and proportional samplers constructed and installed. Dividing dikes were seeded and rolled in order to establish cover. It is planned to add fescue by planting in the fall to secure additional cool weather growth. This work was delayed by heavy spring rains and completed approximately July 1. As a result of these consultations and the construction work, four test plots were established and will be fertilized as follows:

1. Test plot at the north side of the area containing .74 acres. The total nitrogen to be applied from treated raw raffinate, approximately 1200 lbs. per acre for the growing season.

This application rate was selected since it is approximately 3 times that recommended for normal fertilization of bermuda grass or pasture in the Oklahoma area.

The treated raffinate would be applied at a rate of 350 gallons per acre each two weeks commencing July 12 and continue November 15.

2. Test plot lying immediately east of #1 contained .74 acres and would receive nitrogen from treated raw raffinate at a rate of 350 gallons each month commencing July 15.

3. Test plot #3 containing .74 acres was immediately east of #2 and would receive 100 gallons of commercial fertilizer solution prepared by dissolving 200 lbs. of commercial ammonium nitrate and would be applied at a rate of 400 lbs. per acre during the growing season on the same schedule as applied to #2.

4. Test plot #4 would be the control plot lying east of the road in the graded area immediately south of the plant and would receive no additional nitrate treatment during the growing season.

Spray nozzles on the fertilizer spreaders were altered to provide a courser, heavier spray than that of those used during 1973. Consequently, it is not expected to see the initial burned condition that was noted in 1973.

A batch of raw raffinate was treated commencing June 1 and approximately 12,000 gallons were prepared which

was sampled upon completion of treatment and subsequently out of each test batch distributed. As yet, all analyses are not complete due to some difficulties in the analytical laboratory with contaminated equipment. Sufficient samples have been successively completed, however, to demonstrate the bulk material assays:

pH	8.5
radium	1 pCi/l vs MPC - 30 pCi/l
uranium	.2 mg/l or 1.34×10^{-7} uci/ml vs the MPC 3×10^{-5} uCi/ml
thorium	approx. 50 pCi/l or 50×10^{-9} uCi/ml vs MPC 2×10^{-6} uCi/ml

We are thus assured that the material being distributed lies well below the MPC given in Table II, Appendix B, 10 CFR 20 (6/28/74).

Since the commencement of distribution, little precipitation has occurred in the Sequoyah area, and all growth has resulted from the addition of the fertilizer described above and artificial watering through the installed sprinkler system. Thus far no runoff from the test sites has occurred.

Grass growth is flourishing on all of the fertilized test sites with the apparently faster growth in the area of the greatest application.