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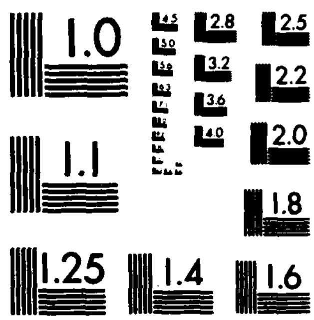

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A PROTON MAGNETOMETER SURVEY OF BORROW AREAS ALONG CUT-OFF LAKE: L-246

Prepared by

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Conducted for

U.S. Army, Corps of Engineers
Kansas City District
Kansas City, Missouri

under

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PREFACE

This magnetometer survey was conducted after a cultural resources survey of the area (Cooley and Fuller, 1976) revealed the possibility of sunken steamboats in the area of Stage I construction. Because of this, two borrow areas unstipulated and unsurveyed at the time of the cultural resources survey were surveyed using a GEOMETRICS, digital readout, proton magnetometer. The project was under the general supervision of Dean A. Rosebery, Northeast Missouri State University, Kirksville, Missouri. Field work was conducted by Larry Grantham and Earl McMurry, both of Northeast Missouri State University. We wish to express our thanks to the Science Division of North-east Missouri State University for both equipment and general support. We also wish to thank the Corps of Engineers for making this project possible.

A number of people contributed to both the field work and to the analysis, some of whom deserve mention here. We would like to express our gratitude to E. Dederick Carrasco and Roger B. Boyd, both of whom contributed time in the field in order to get the project completed in the specified time limits. As it was necessary to change grid pattern size between the initial set up and the field work, additional personnel were necessary.

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ABSTRACT

A proton magnetometer survey of borrow areas along the north shore of Cut-Off Lake was performed using a GEOMETRICS proton precession magnetometer. The area was surveyed using a twenty-feet grid spacing with five-feet grid spacings in areas of interest. Magnetic anomalies were discovered, but most of these were associated with modern artifacts at the surface. Two anomalies at the eastern end of the borrow areas were investigated in greater detail with a grid spacing of five feet. The objects causing these anomalies are fairly shallow and are probably not very large. It appears highly improbable, based on historical and geomorphological evidence, that the area could contain evidence of buried steamboats. The observed anomalies lie above the level of the river, and it appears that these could not be part of buried steamboats. The anomalies lie on the bank of a dredged drainage channel and are buried under the spoil pile. It would appear that these anomalies are associated with the dredging of this drainage channel.

INTRODUCTION

Description and Objectives of Research

The L-246 levee unit consists of portions of the Missouri River floodplain from Brunswick, Missouri on the Grand River, eastward to the entrance of the new channel of the Chariton River with the Missouri River south of Dalton, Missouri. The Stage I construction consists of levee units on both sides of Palmer Creek from the Norfolk Western Railroad to Cut-Off Lake, the western and portions of the eastern edges of Cut-Off Lake, and both sides of Palmer Creek from Cut-Off Lake to Bushwhacker Bend on the present Missouri River (see Figure 1).

In June of 1977, Northeast Missouri State University entered into an agreement with the Corps of Engineers, Kansas City District (P.O. #DACW41-77-M-1327) to conduct a proton magnetometer survey of borrow areas along the northern shore of Cut-Off Lake. These borrow areas were situated between the proposed alignment of the northern lake closure levee and the northern shore of the lake (Figure 2). The rationale behind this survey was the fact that the cultural resources survey (Cooley and Fuller 1976) had indicated that several steamboat wrecks had occurred in the construction areas. Two wrecks had occurred in the immediate vicinity of Cut-Off Lake. The northern shore was believed to be a potentially sensitive area for the location of same.

The value of the remains of steamboat wrecks as important cultural resources has already been demonstrated (c.f. Petsche 1974, Switzer 1974). As Petsche (1974:2) has pointed out, the historical significance of the cargo may be considered as material culture captured in time, precisely dated, and representative of the mining technology and frontier economy of mid-19th century North America. The importance of these lies not only in the extreme amounts of data available from the cargo, but the fact that they result from a catastrophic incident with instant preservation of significant archaeological evidence. The cargo and the ship itself are responsible for not only filling out our view of life in the west and gold mining, but also the active system of trade and river boat life which dominated the means of transportation to the west during that period (Petsche 1974:2).

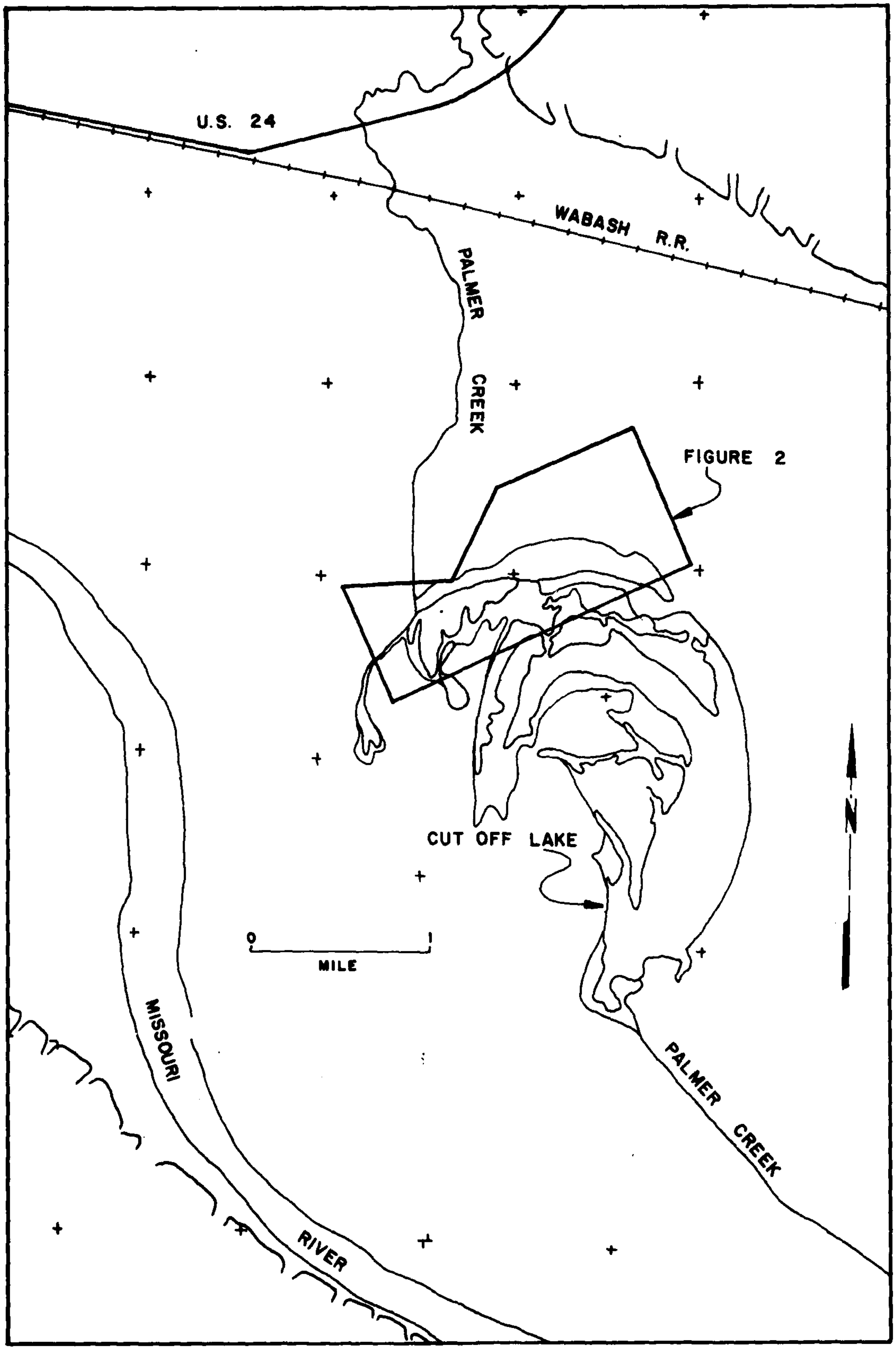
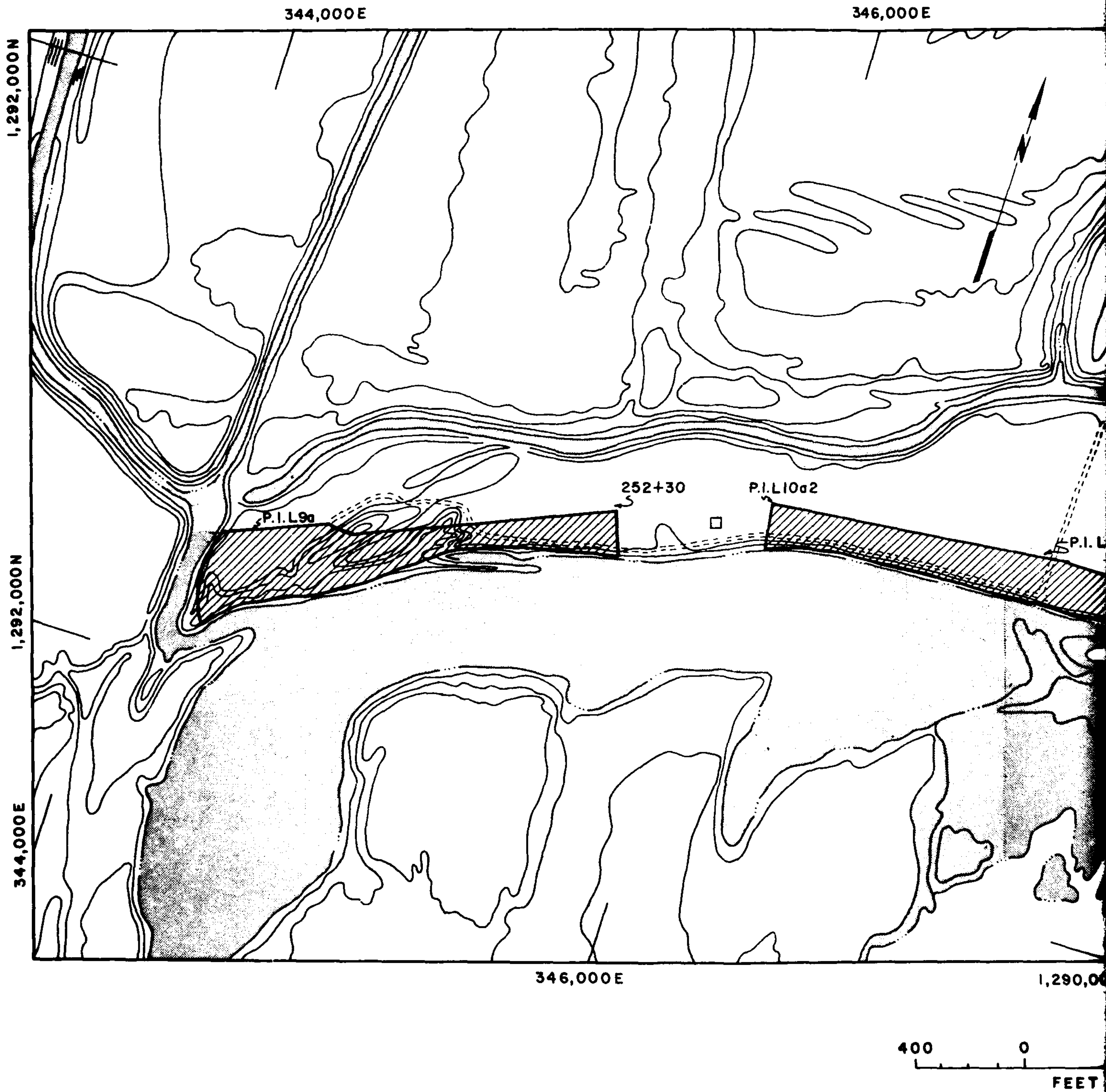


Figure 1. L-246. Project Area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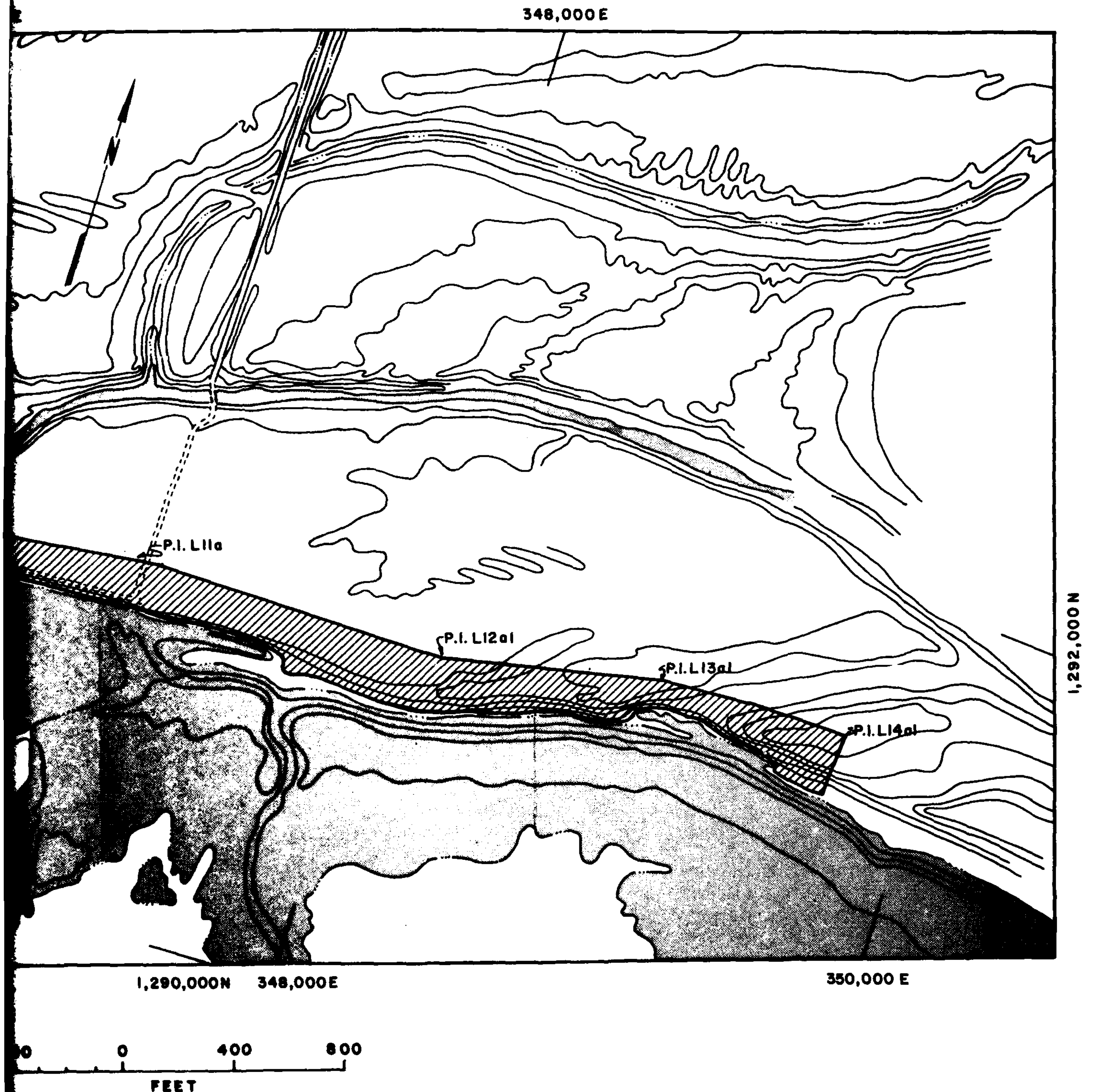

Figure 2. L-246. Borrow Areas, North Shore of Cut-Off Lake

Our objectives for this project were threefold. Our primary objective was to locate discernible magnetic anomalies in the borrow areas. The second objective was to discern whether anomalies encountered were steamboat wrecks or not through both analysis of field data and through literature research. Our third objective was more methodological in that we wished to expand the range of anyone's ability to identify steamboat wrecks, should one be located. To date, the Bertrand is our only example of a steamboat wreck located by magnetometer survey, and the Bertrand was loaded with a considerable quantity of ferromagnetic material. This is not true of all steamboats, particularly if the machinery was salvaged.

In attempting to determine what we would consider to be a pattern indicative of steamboat wrecks, we had very little background. To date, the Bertrand has been the only example of a steamboat wreck located by magnetometer survey. The Bertrand was bound for Montana Territory loaded with freight when it sank. We had little reason to expect that either of the two ships which sank in Bowling Green Bend were as heavily loaded. One was returning from Omaha, and the loss on the freight reported as $5,000. The George C. Wolf also was probably carrying little freight as the total loss claimed on the vessel was low. Thus, we did not anticipate a pattern completely similar to that of the Bertrand. The magnetometer survey of the area of the Bertrand indicated that low variation in total gamma values, even over the area of the wreck, were not uncommon. The total variation encountered from the greatest minimum to the surrounding field strength was less than 100 gamma. However, the area involved in the anomaly was greater than the total area of the ship. While we did not expect a large anomaly in total gamma, we did expect an anomaly indicative of a steamboat wreck to possess a fairly sizeable areal extent. Thus, we did expect an anomaly with the areal characteristics of the Bertrand (Petsche 1974) but did not necessarily expect similar values in total gamma differences.

Environmental Setting

The Missouri River, which flows just south of the project area drains most of the Northern Plains, and Cut-Off Lake and the entire project area lie within Quaternary alluvium deposited from the river. The project area lies between the confluence of the Grand

and Chariton Rivers with the Missouri River. These former two rivers drain most of northern Missouri and southern Iowa. Branson (1944:357) described the Missouri River plain as ranging from three to ten miles wide with the widest part from about 40 to 70 miles east of Kansas City. The river cuts in shales in this region and where it encountered Mississippian limestone on the boundary of Howard and Saline Counties, the valley narrow to about one-third of its upstream width. In the wide part of the valley it has the characteristics of late maturity but in the narrow part it is not at full maturity. This entrenched feature in the Lower Missouri Valley begins just east of the project area. The Missouri River occupies a relatively broad valley in the project area with moderate to well-defined valley definition. The valley is moderately to sharply incised into glacial till and loess as well as the underlying Pennsylvanian deposits. The valley of the Missouri River averages approximately 70-100 feet below the level of the uneroded remnants of the original level plain. Topography is level in the bottomlands to gently rolling in the uplands to the north. Drainage systems to the north of the project area in the uplands contain numerous and widely branching secondaries. Drainage patterns in the bottomlands lack the feature of branching secondaries. The average fall of the Missouri River in the project area is very slow, averaging less than two feet per mile.

The geology of the area is largely Quaternary geology. Nebraskan and Kansan till blanket the area, but depths are not great as compared with areas to the north. Glacial drift is covered by loessial deposits as great as ninety feet near the Missouri River valley. Both of these deposits are highly variable in thickness due to post depositional erosion. Bedrock exposures are not common but consist largely of Pennsylvanian deposits. These deposits consist of cyclical formations of sandstone, limestone, shales, coal, and clay. Mississippian age formations containing cherty limestones are located to both the east, west, and south of the project area. Alluvial deposits of sand and gravel are common in the valley, but silk- and clay-sized particles constitutes the bulk of the alluvial deposits within the project area. Sand is common only along the northern and eastern shores of the lake.

Soils of the area belong to the Leta, Gilliam, Waldron, Sarpy, Carr, Haynie, and Orrick soil series

(Scrivner and Decker 1967). These are calcareous soils indicating recent depositional history. Soils are defined by texture, and bottomland soil textures are derived mainly from their relative position in relation to water levels. Thus, soils with finer textures are deposited more slowly and are generally derived from lower relative positions.

Early Euro-American vegetation is illustrated by Cooley and Fuller (1976:Figure 5). Most of the bottomlands were forested except for areas where standing water or extremely wet conditions favored grasses. Most of the area to the north of Cut-Off Lake was in prairie at the time of the Government Land Office Surveys (GLO, 1816-1819). Upland prairie flora includes such grasses as big bluestem, Indian grass, wild rye, June grass, dropseed, switch grass, and side-oats grama (Kucera 1961). Upland forests included white oak, black oak, post oak, elm, walnut, hackberry, hickory, and maple (Grantham 1977). Bottomland forests included burr oak, cottonwood, elm, hackberry, hazel, hickory, lynn, pawpaw, red bud, walnut, and white oak (Cooley and Fuller 1976:32).

Prairie fauna included bison, elk, pronghorn antelope, black-tail rabbit, thirteen-lined ground squirrel, pocket gopher, coyote, badger, and the spotted skunk (Schwartz and Schwartz 1969). Fauna more common to the forested bottomlands include oppossum, woodchuck, red fox, striped skunk, white-tail deer, beaver, river otter, eastern fox squirrel, Franklin's ground squirrel, and eastern cottontail rabbit (Schwartz and Schwartz 1959).

SURVEY METHODS AND PROCEDURES

Field research was conducted during May of 1977. The methodology utilized, as outlined below, was designed largely to be a systematic survey of the borrow areas along the north shore of Cut-Off Lake for magnetic anomalies of sufficient magnitude to indicate the presence of buried steamboats. This survey was recommended based on the possible presence of buried steamboats indicated by the initial cultural resources survey (Cooley and Fuller 1976) and in consultation with other agencies. This survey was done in order to facilitate construction of the project. Thus, if project alternatives or mitigation actions were necessary based on adverse effects to significant cultural resources, these could be implemented as quickly as possible. The purpose was to provide an intensive survey of these borrow areas in order to provide an evaluatory mechanism prior to the actual construction. The project was designed to be intensive (i.e. as opposed to extensive). This was necessary based on the limitations placed by the Corps of Engineers on the area to be surveyed, and the area to be affected by actual land modification.

Methods

The use of magnetometers to search for objects or structures whose magnetic properties contrast with those of their surroundings is widely used in geophysics and archaeology. Aitken (1961) described the principles of operation of a proton procession magnetometer and how it is used in archaeological applications.

For this survey, a Geometrics G816 proton precession magnetometer was utilized. This instrument is capable of resolving differences in magnetic field strength of one gamma (10^{-5} gauss). The sensing bottle detector was supported on top of an eight foot monopod. This was high enough to avoid the magnetic effects of small metallic objects lying on the ground. Over 1750 observations were systematically taken on grid points spaced twenty feet apart for the main survey and five feet apart in more detailed studies of areas of special interest.

A map of the survey area appears in Figure 6. A twenty foot grid spacing was selected in order to survey all borrow areas in three days. It was believed that this spacing was more than sufficiently tight enough that a buried steamboat with the same magnetic characteristics as those shown by the Bertrand (Petsche 1974) could be detected. However, we did not have any guarantee at the outset of the project that any buried steamboats in the area would be magnetically similar to the Bertrand.

The topography consisted largely of flat farm fields which were under cultivation at the time of the survey. The entire borrow area was surveyed except for a small area to the south and east of Figures 7, 8 and 9. This area was so overgrown that establishment of any grid pattern was impossible. Excluding the area of the small relict stream channel which runs through this area, less than one percent of the borrow area was not surveyed.

The region to be surveyed was divided into square blocks 100 feet on a side. A transit was initially utilized, but it was quickly discovered that shooting in the squares required a considerably greater amount of time than did the actual survey of the blocks. The transit was then utilized to shoot in the northern edge of the blocks and the remainder of the blocks were laid out using tapes. Stakes were used as markers at twenty foot intervals along the edges of the squares. Using these stakes as guides, the twenty foot grid points on the interior of the squares were then found by pacing and using the markers as general guides. Up to four, 100 foot blocks were laid out at one time. The magnetic field strengths were measured at twenty foot intervals for the entire area designated before laying out a new block area. The measurement of four of these 100 foot blocks involved 126 observation points and could be completed in about twenty-five minutes by a three man team. In all cases, the establishment of the grid system required more time than the completion of the measurement of the points.

Temporal changes in the magnetic field were observed. However, these were so small (generally less than 2×10^{-6} gauss/min) over the time required to survey from one to four 100 feet blocks that it was unnecessary to correct the readings taken back to base station values. Thus, the contour lines in Figures 7 through 22 reflect the magnetic structure of the area represented in the figure alone.

PREVIOUS INVESTIGATIONS

Archaeology

Archaeological research in the Grand and Chariton riverine systems has been somewhat meager. Most of the work conducted to date has centered in the upper reaches of the river systems within reservoir projects (e.g. Shields 1966a, 1966b, Potter 1970, Graham 1977, Grantham 1977, Wheeler 1949, 1959, McKusick and Ries 1962, Hoffman 1966, Weichman 1976a, 1976b, Vehik 1971, and Chomko and Griffin 1975). The only archaeological projects in the Big Bend area centered on Hopewell and Oneota sites (Bray 1961, 1963, Chapman 1959, Henning 1970, Kay 1975, Leaf 1972, and McKinney 1954). The only projects conducted within the project area were associated with levee unit construction (Cole, Kaplan, Mori, and Wireman 1966 and Cooley and Fuller 1976).

The first of these two surveys in the project area (Cole, Kaplan, Mori, and Wireman 1966) recorded five archaeological sites along the Chariton River levee unit. Cooley and Fuller (1976) recorded five archaeological sites, two historic archaeological sites, and one historic architectural site in Stage I construction of Missouri River levee unit L-246.

History

Historical resources of the project area appear to be well covered by Cooley and Fuller. However, several additional comments on the potential historical resources of the area appear to be appropriate. This survey was initially prompted by Cooley and Fuller's (1976) notation that several steamboats had sunk in the area, and it was believed that the north shore of Cut-Off Lake was an area potentially sensitive to the discovery of these.

In order to find out more about the nature of the steamboats which had gone down in this bend of the river, McDonald (1926) was examined as a starting point. Two steamboat wrecks were known to have occurred in Bowling Green Bend (now Cut-Off Lake). These were the Waverly and the George C. Wolf. Both of these were fairly large steamboats.

The Waverly was the smaller of the two. It was a side-wheel steamboat, unlike the stern-wheel Bertrand. Its tonnage was rated as 452 tons, almost twice that of the Bertrand. Her length was 200 feet and beam was 34 feet. She was built at St. Louis, Missouri in 1866. She had two engines (17" x 5'), two boilers (22' x 44"), and allowed a working pressure of 131 pounds. She was owned by John P. Keiser, Thomas Raigan, and Thomas W. Rhea. The master was Captain Thomas W. Rhea. She struck a snag and sank in Bowling Green Bend on November 24, 1867, while en route from Omaha, Nebraska to St. Louis. The machinery was salvaged, but no apparent attempt was made to salvage anything else. The loss on the steamer was reported as $45,000 and $5,000 on the cargo. The nature of the cargo could not be determined. The steamer was part of the Fort Benton trade and made its first trip to Fort Benton, Montana Territory, in 1866, netting $50,000 in its first trip.

Considerably less is known about the George C. Wolf. She was a stern-wheel steamer, like the Bertrand, but her tonnage was rated as 533 tons (over twice the size of the Bertrand). Captain W. Crapster was ship master. She was sunk by a snag in Bowling Green Bend at Babler's wood yard on May 2, 1874. She was listed as a total loss, and the loss reported as $40,000.

Locating general areas where these steamboats went down proved to be impossible. However, several generalizations based on the pattern of river movement and commercialization on the river are possible. Both steamboats were sunk by snags. Snags tend to accumulate in areas where the river velocity has decreased. The river's velocity is lowest on the interiors of meanders and toward the edges on straight stretches. However, these are generally away from the main channel, and the incidence of snags in the main channel (although lower than away from it) claimed most of the steamboat victims. Thus, throughout most of Bowling Green bend, the main channel would be towards the outside of the bend.

No specific location was identified for Babler's wood yard. However, commercial ventures tended to be located where the channel velocity was not fast but where the channel approached the exterior banks (Figure 3). Thus, the location of both Nil Landing and Keytesville Landing are just prior to and just following the fastest velocity of the bend respectively. Thus, we might expect the George C. Wolf to have gone down near one of the landings. As Nil Landing appears to have been somewhat newer and more short-lived in nature, it would appear more likely that this steamboat went down near Keytesville Landing. If this is true, then the possible wreck noted by Cooley and Fuller (1976:63) from a local informant may represent the George C. Wolf.

Geomorphology

Several statements about the geomorphology of river meanders seem appropriate as this juncture. Sparks (1960:96) explaining the motion of a stream in meanders. The area of the deepest water in a meandering stream does not follow the median line of the stream but is deflected towards the concave banks and away from the convex banks. The tendency for a stream to continue to flow in a straight line results in a slight increase in the height of the surface on the outsides of the bends. This phenomenon results in a cross-channel movement being given to the stream. It appears to be started at the bottom layers, as these are flowing less rapidly than the upper layers and are more easily displaced. The flow across the bottom from the concave bank to the convex one is augmented by a return flow in the other direction on the surface. This motion is not at right angles to the current but possesses a downstream vector varying with the velocity of the stream. The result is a corkscrew motion which should tend to move material from the concave bank to the convex bank, assisting in the erosion of the outside and deposition on the inside of bends (Sparks 1960: 96-97). Thus, erosion is greatest on the three concave edges of the bend (Figure 4). There is a limit to the width of the meanders, depending on the size of the stream, a larger stream producing larger meanders. This limit on the width is probably caused by two main factors. As erosion occurs more rapidly on the three concave edges of the bend as the meander becomes larger the tendency is for the meander to break through into the next meander with the formation of a cut-off. Secondly, as meandering increases the length of a stream, it reduces its gradient and decreased its energy. The stream then ceases to be so effective an eroding agent (Sparks 1960:13-14).

All of these factors are amply demonstrated by Bowling Green Bend from 1819 to 1876 (Figure 5). Thus, the borrow areas along the north shore of Cut-Off Lake were in the most actively eroding areas in the bend up until the date of actual cut-off and fill (1879) The area thus would not appear potentially sensitive for the recovery of steamboat wrecks. Areas in which fill sequences on the convex edges of bends had begun would appear to be much more sensitive to the recovery of such wrecks. Fill sequences would have begun on the opposite edge of the bend from our survey.

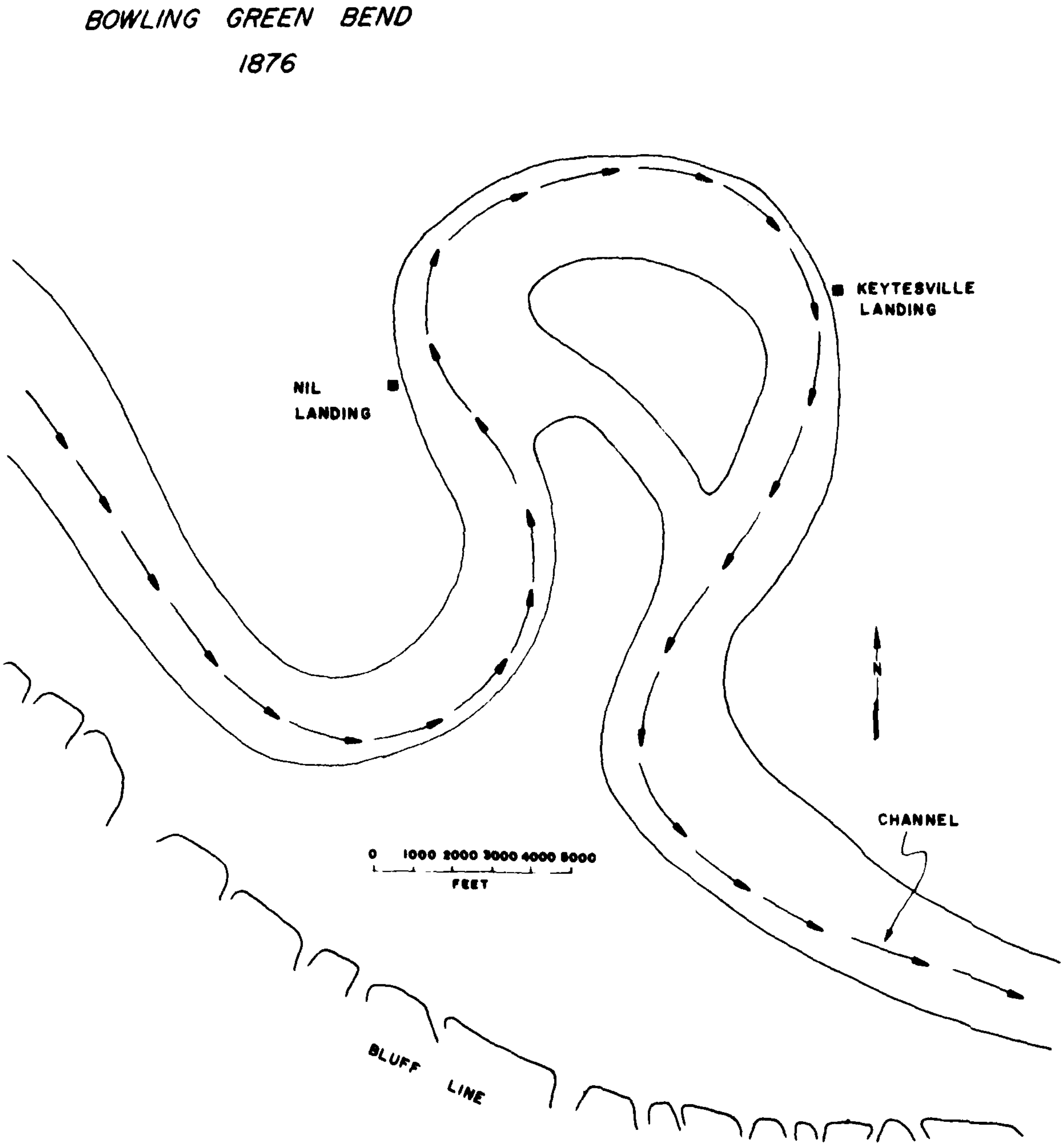

Figure 3. L-246. Location of Landings on Bowling Green Bend, 1876.

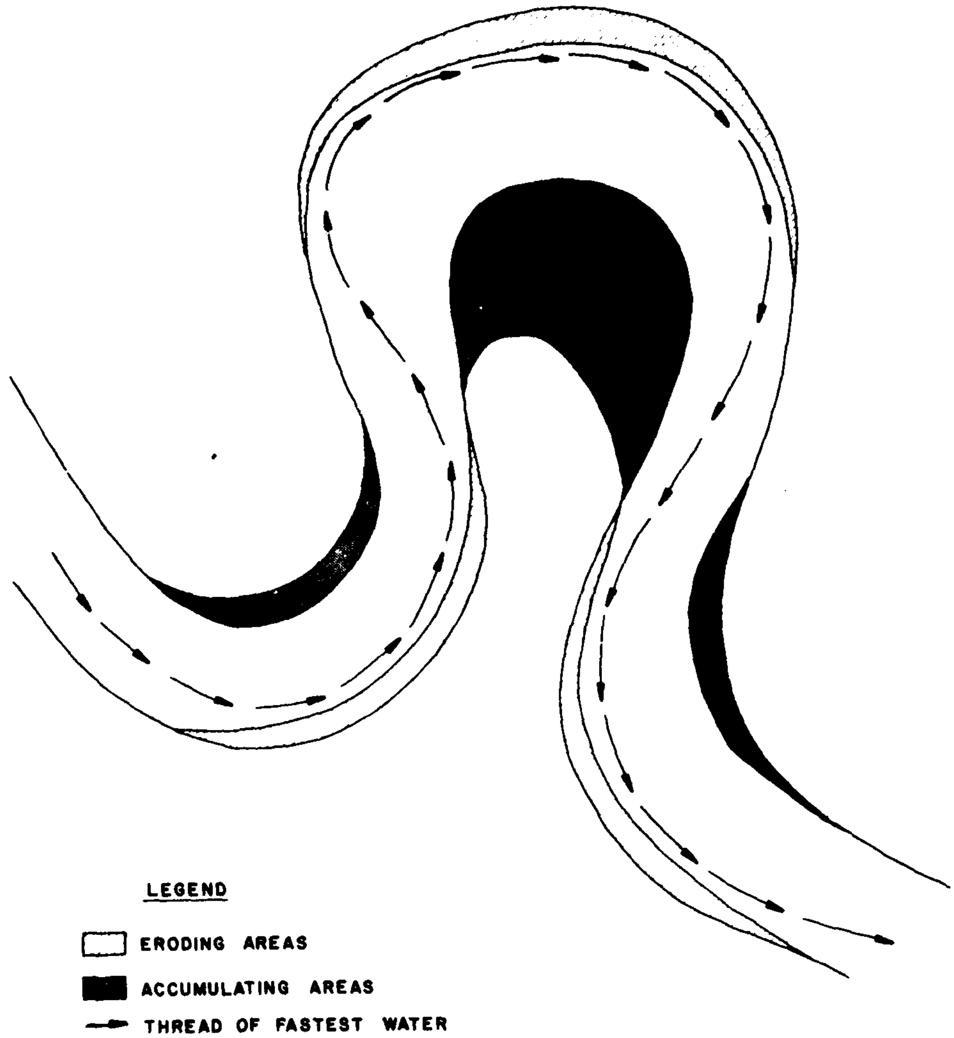

Figure 4. L-246. Generalized Model of Erosion and Movement in Meanders

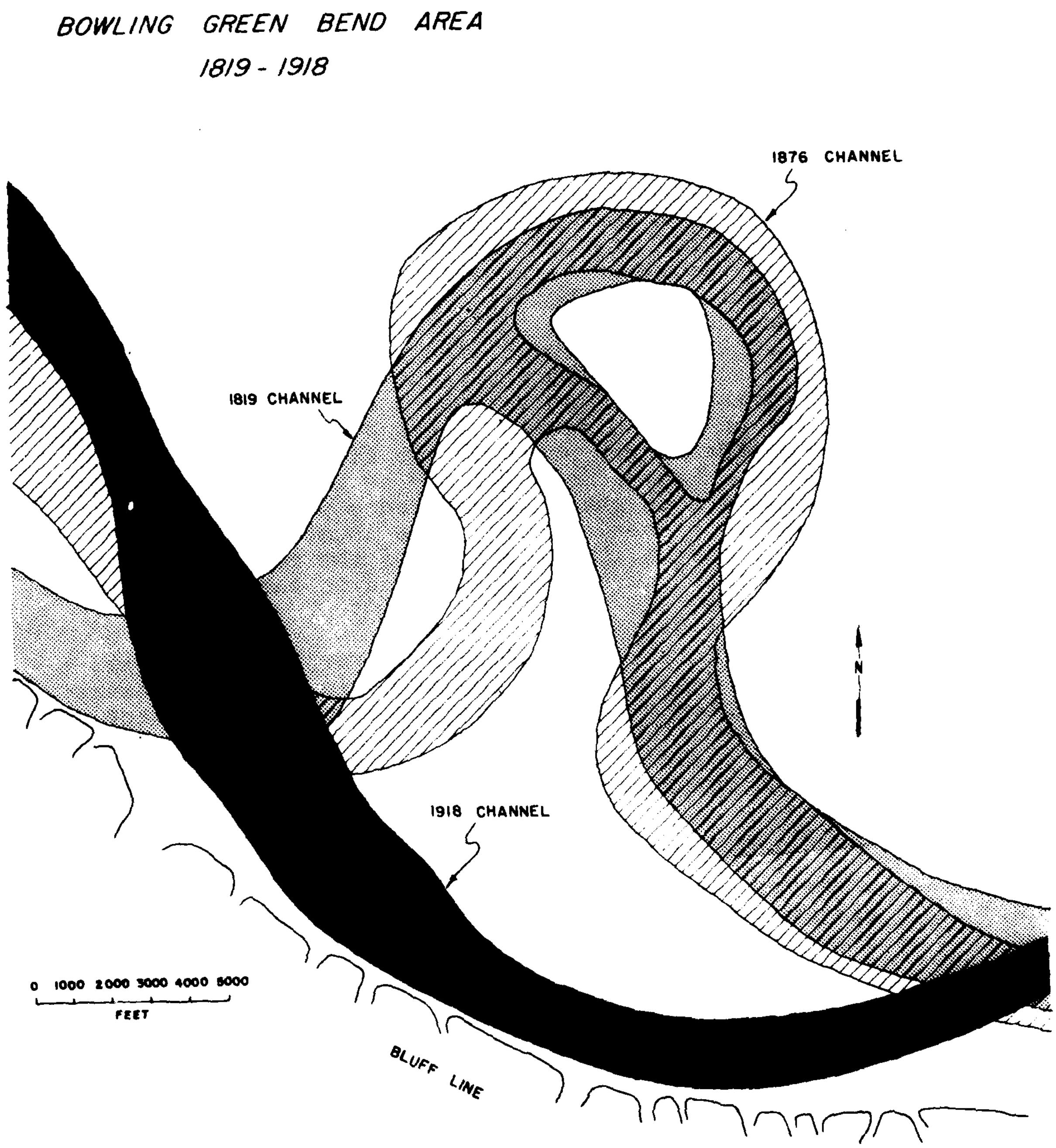

Figure 5. L-246. River Movements in Bowling Green Bend, 1819-1918

SURVEY RESULTS

Over 1750 observations were taken within the survey area (Figure 6). The raw data obtained is presented in Figures 7 through 22. The actual field strength (in Gamma = 10^{-5} gauss) at any grid point is found by adding the tabulated value to Base Field value given in the table heading. Block AV is the average of all the grid point values and SD is the standard deviation of a single observation. NO is the number of data points. "DATA IS" identifies the data according to the letter identification used as field book nomenclature. The contour lines are at ten gamma intervals. The locations of U.S. Army, Corps of Engineers metal survey posts are shown as black squares on each diagram. These are numbered as they were on the survey posts in the field, so that the location of any grid point may be located absolutely with respect to physical reference points and with respect to magnetic north. The location of surface features responsible for some of the magnetic anomalies seen in the figures is also given in each figure where appropriate.

An examination of Figures 7 through 20 reveals a regional trend in which the magnetic field increases toward approximately the southwest with a gradient of 13 ± 3 gamma/100 feet toward the south and 9 ± 2 gamma/100 feet toward the west. This is probably due to the magnetic characteristics of the basement rocks of the area.

Of more immediate interest is a discussion of the magnetic anomalies observed. In Table I, anomalies are located with respect to coordinates given in Figures 7 through 20. Pairs of numbers refer to a point on each figure where the first number is the distance in feet north or south of the 0 line and the second number is the distance in feet from the western edge of the borrow area.

Of all the anomalies in Table I, only those at 60S 2540E and 60S 4960E could not be attributed to observed magnetic objects. The anomaly at 60S 2540E appears to be attributable to an historic building. Thus the anomaly at 60S 4960E appears to be the only anomaly of interest.

In order to study the anomaly at 60S 4960E in greater detail, the area of the anomaly was gridded

TABLE I

OBSERVED MAGNETIC ANOMALIES

Figure	Location	Comments
7	10N 20E	COE Survey marker PIL-9A L146LT
10	0S 675E	Trash dumped in abondoned secondary stream channel to the west
11	100S 1500E	Large steel Butler Bin
	100S 1620E	Trash dumped along bank, large number of metal cans
12	80S 1740E	Trash dumped along bank, large number of metal cans
14	0S 2460E	COE Survey marker PC267 + 78.09 L246PC
	0S 2520E to 0S 2540E	COE Survey marker PIL-11A LT BK L246
	0S 2580E to 0S 2600E	COE Survey marker PT 269 + 12.75 UPC
	40S 2540E to 80S 2540E	Barbed wire and steel fence post in tree
	80S 2560E to 80S 2580E	Trash dumped along bank, large number of metal cans
15	100S 2600E	Trash dumped along bank, large number of metal cans
	0S 2600E	COE Survey marker PT 269 + 12.75 UPC

TABLE I (cont'd.)

Figure	Location	Comments
17	60S 3540E to 80S 3560E	Nothing on the surface near area where soil color and historic material suggests an historic building
	80S 3640E to 100S 3640E	COE Survey marker PIL-12-A
	80S 3740E	COE Survey marker PT 280 + 52.81 L246 LT
18	20S 4200E	COE Survey marker PC 285 + 08.98 L246 LT
	80S 4180E to 100S 4200E	Large metal object in old channel to the south
19	80S 4200E to 80S 4240E	continuation of above
20	0S 4720E	COE Survey marker PT 290 + 49.09 L246 LT
	0S 4860E	COE Survey marker PC 291 + 94.45 L246 LT
	20S 4940E to 20S 5000E	Small negative anomaly, unexplained
	60S 4940E to 60S 5000E	Large positive anomaly, unexplained

off in a rectangular area, and an additional 175 magnetic field determinations were taken with grid intervals of five feet and with the detector bottle located approximately four feet above the earth's surface. This area is illustrated in Figure 21, and the location of the two magnetic anomalies with respect to the survey markers is included.

The two magnetic anomalies are located by starting from survey marker PC 291 + 94.45. The smaller of the two anomalies is located 83 feet magnetic east and 67 feet magnetic south from the marker. The larger anomaly is located 120 feet magnetic east and 101 feet magnetic south of the marker.

The actual values found for the earth's magnetic field strength are given in Figure 21. The conventions used as titling information are the same as those used in Figures 7 through 20. A contour map with a contour interval of 100 gamma is superimposed on these values in Figure 21.

In order to illustrate these anomalies in greater detail, an attempt at a three dimensional representation of them appears in Figures 23 and 24. In Figure 23, the anomaly area is viewed from the west (viewer facing approximately magnetic east). All profiles are drawn to the same scale but have been offset vertically for clarity.

The data shown in Figures 20, 21, and 22 may be used to estimate the depth of burial of the objects responsible for its anomalies (Dobrin 1960:311). Since the precise "magnetic geometry" of the buried objects is unknown, it is impossible to predict exactly their depths of burial. However, application of standard "half-width" rules suggests that the larger anomaly is associated with an object(s) lying from about three to twelve feet below the surface, with the smaller anomaly produced by an object(s) lying from about one to five feet below the surface.

Both of these objects lie on the left bank of a drainage channel which enters from the north across an old terrace, crosses the old Palmer Creek channel, and enters into the northern bank of Cut-Off Lake. The bank in which the objects are buried is covered by a large spoil pile. As we did not reasonably expect a high potential for steamboat wrecks in the area and as both objects lie well above the level of the river, we expected that both objects were associated with the dredging of the drainage channel. The drainage channel appears to have been constructed in the late 1930's (Elmore 1977). As the channel ends at the bank of Cut-Off and these objects are apparently under the spoil pile, it is likely that these objects are associated with the construction of the drainage channel.

SUMMARY AND CONCLUSIONS

Time limits imposed by the Corps of Engineers on the field work aspect of this study dictated that the borrow areas along the north shore of Missouri River Levee Unit L-246 be surveyed at grid point spacings of twenty feet. This would be sufficiently small grid spacing to detect deeply buried objects whose magnetic qualities is reasonably strong. However, other objects of archaeological interest of smaller dimensions or lying nearer the surface may have been missed.

Magnetic anomalies were found by the study. Those which were not marked by observable surface features were marked by wooden lath markers with appropriate locational information. Most of these were associated with modern artifacts observed at the surface. Special attention was focused on two fairly large magnetic anomalies which were investigated in detail be a five foot grid spacing. The objects causing these anomalies are fairly shallow and are probably not very large.

It appears improbable, based on historical and geomorphological evidence, that the area could contain evidence of buried steamboats. The observed anomalies likewise appear to be above the level of the old channel. The anomalies lie on the bank of a drainage channel, and it appears that these anomalies are associated with the materials from the dredging of the drainage channel. It does not appear that any additional work relative to the magnetometer survey results is necessary. All of the anomalies noted are attributable to phenomena which do not appear to be related to historically significant events. It is suggested that the area of the project be allowed to proceed to the development level.

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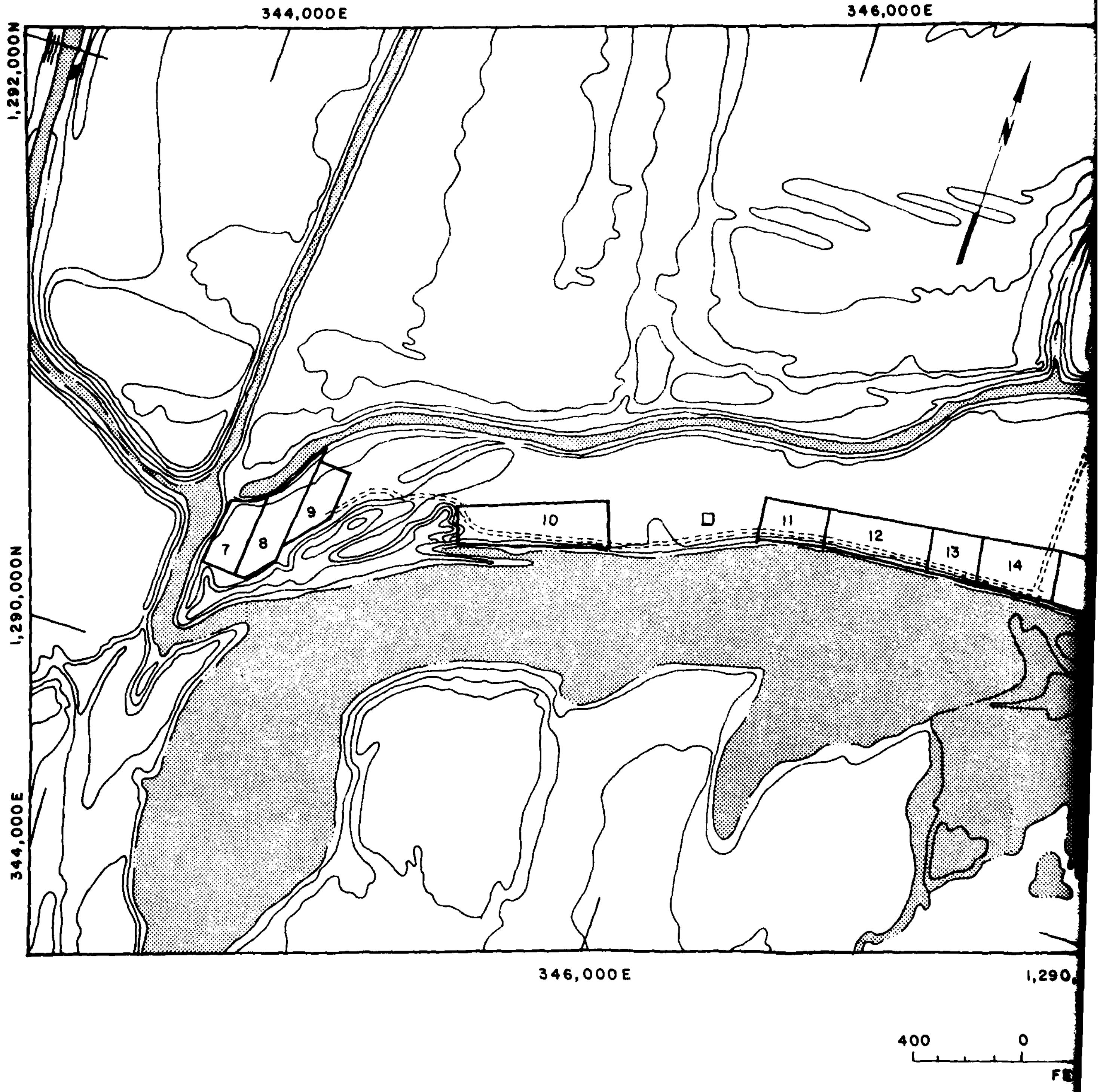

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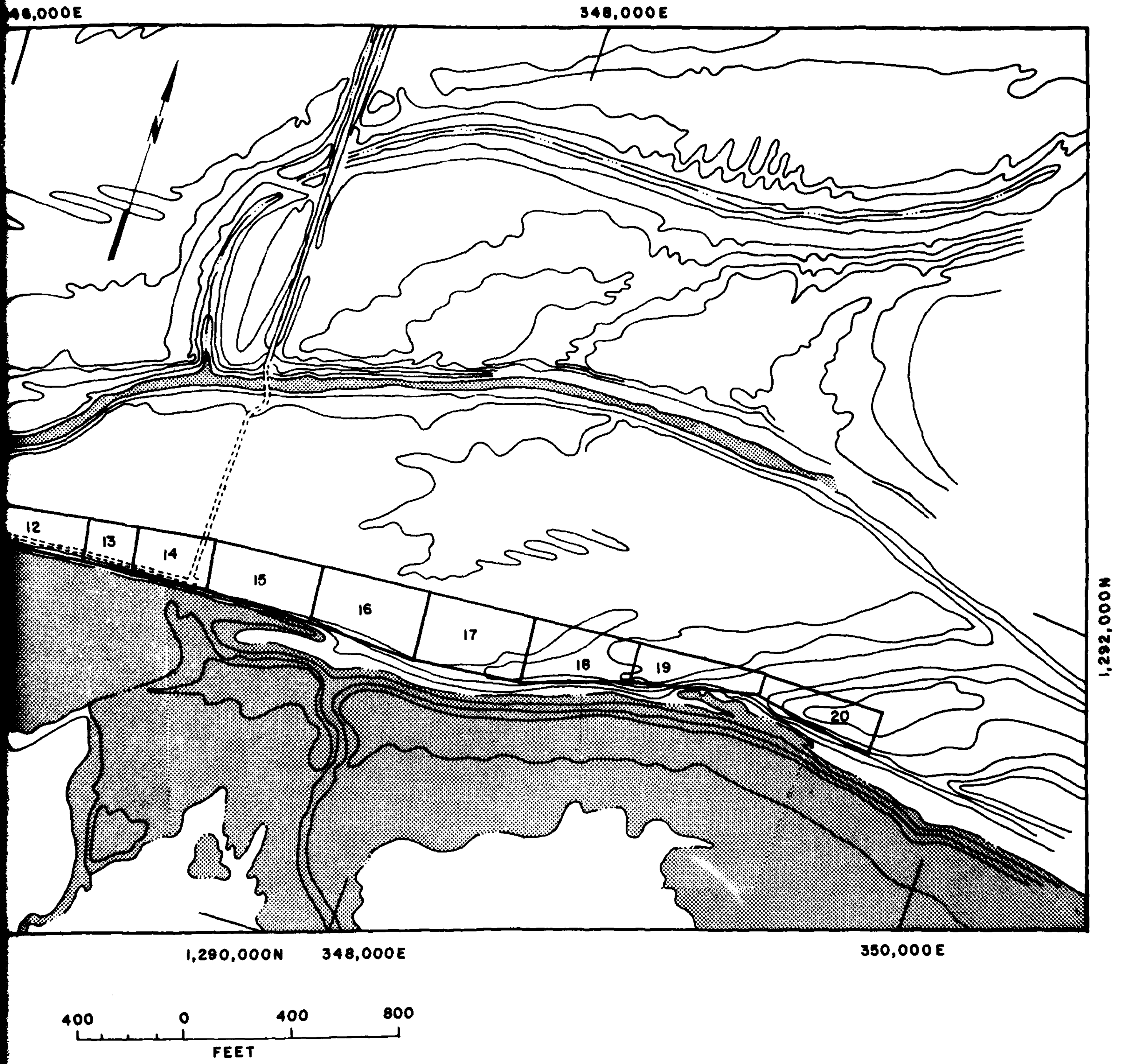

Figure 6. L-246. Proton magnetometer survey blocks.

FIGURE 7

BLOCK VALUES X 1: DATA IS A
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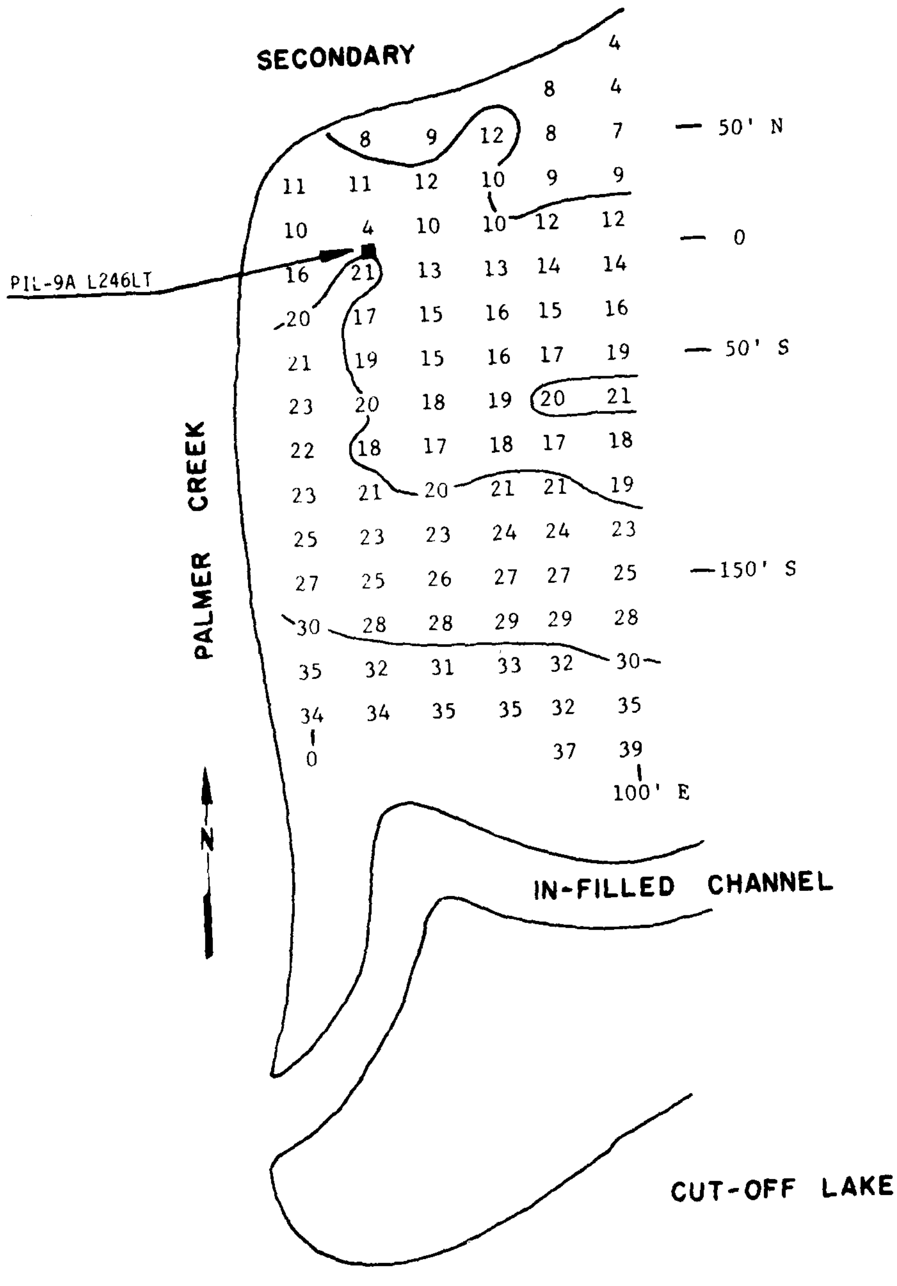

Figure 7. L-246. Block A

FIGURE 8

BLOCK VALUES X 1: DATA IS B
BASE FIELD = 54200.0 BLOCK AV = 40.3 SD = 35.5 NO = 115

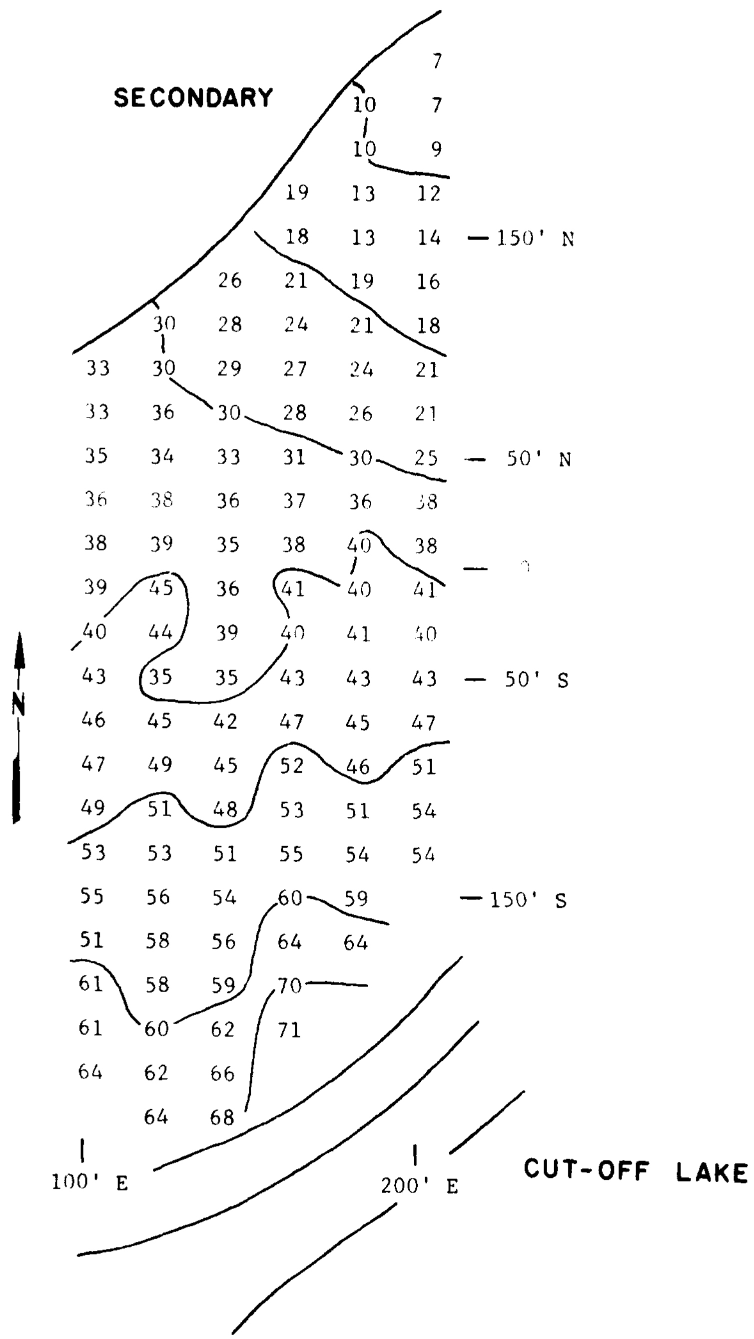

Figure 8. L-246. Block B

FIGURE 9

BLOCK VALUES X 1: DATA IS C

BASE FIELD = 57200.0 BLOCK AV = 13.0 SD = 10.2 NO = 53

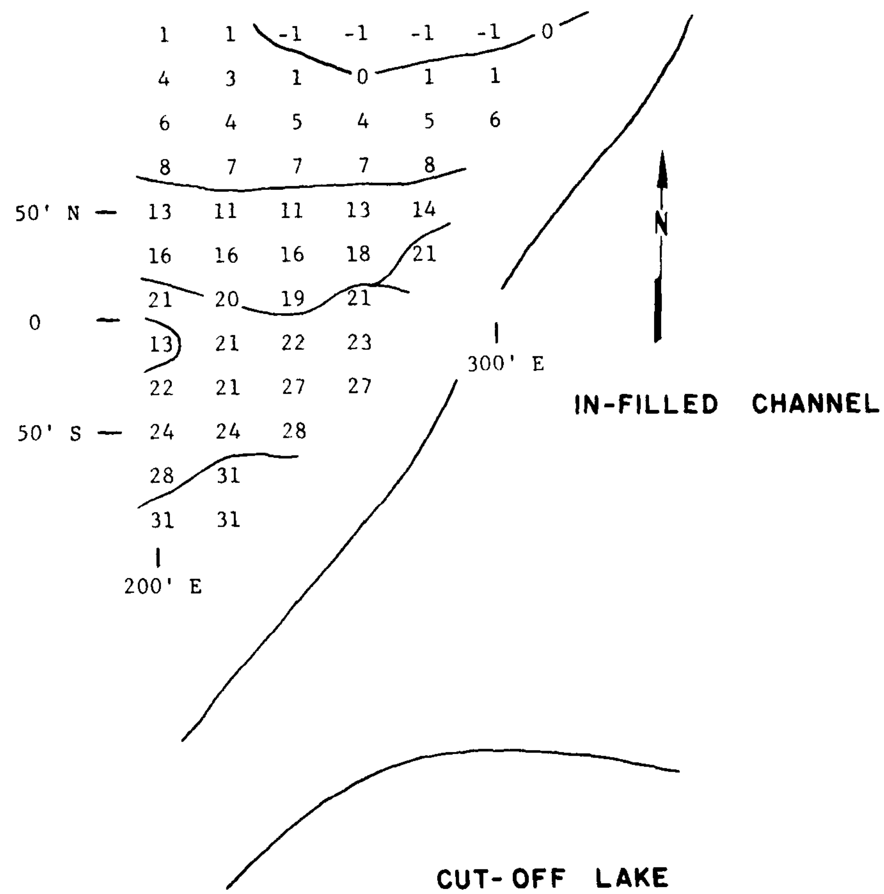

Figure 9. L-246. Block C

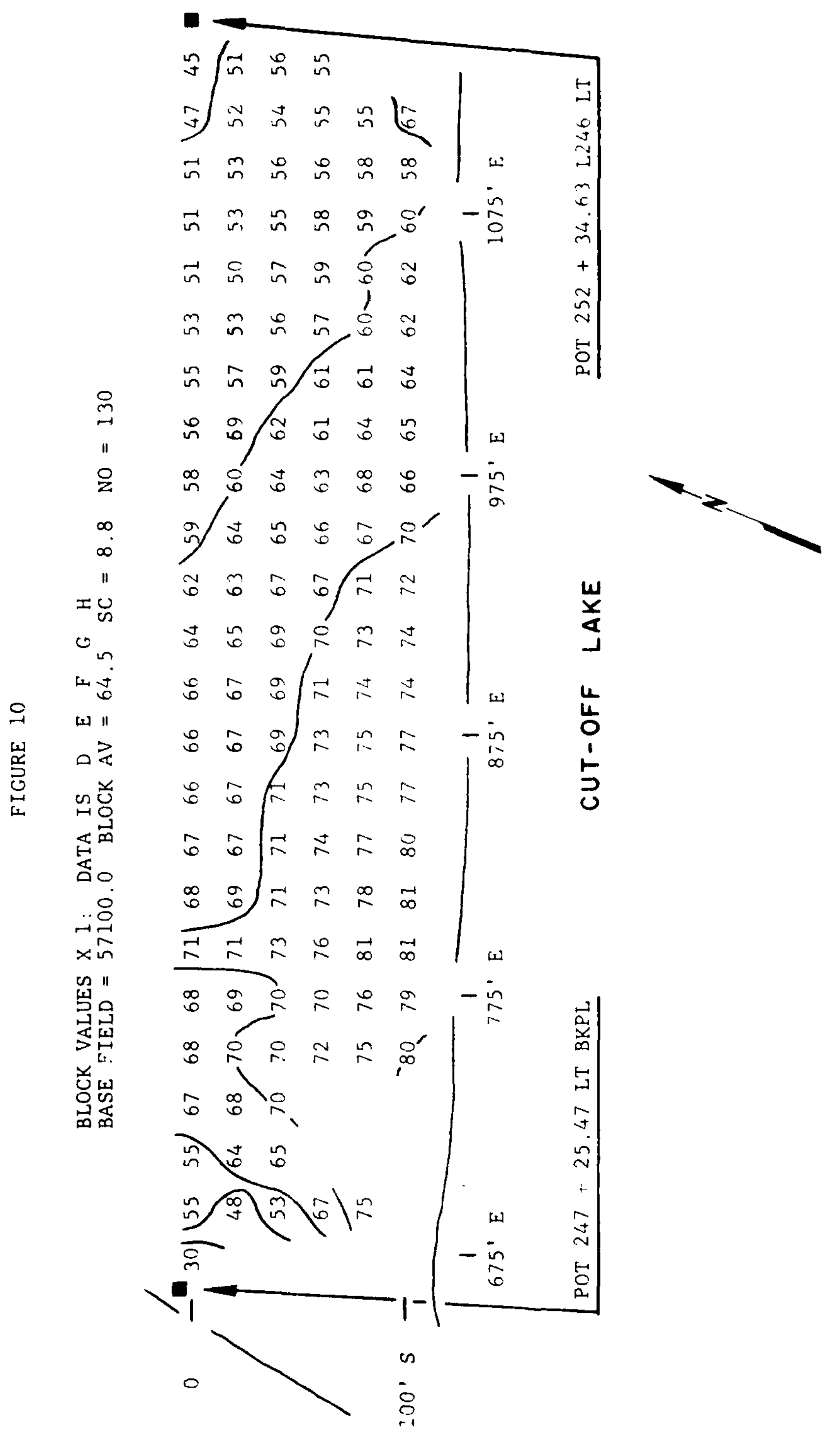

Figure 10. L-246. Blocks D,E,F,G,H

FIGURE 11

BLOCK VALUES X 1: DATA IS I J
BASE FIELD = 5700.0 BLOCK AV = 88.5 SC = 13.6 NO = 64

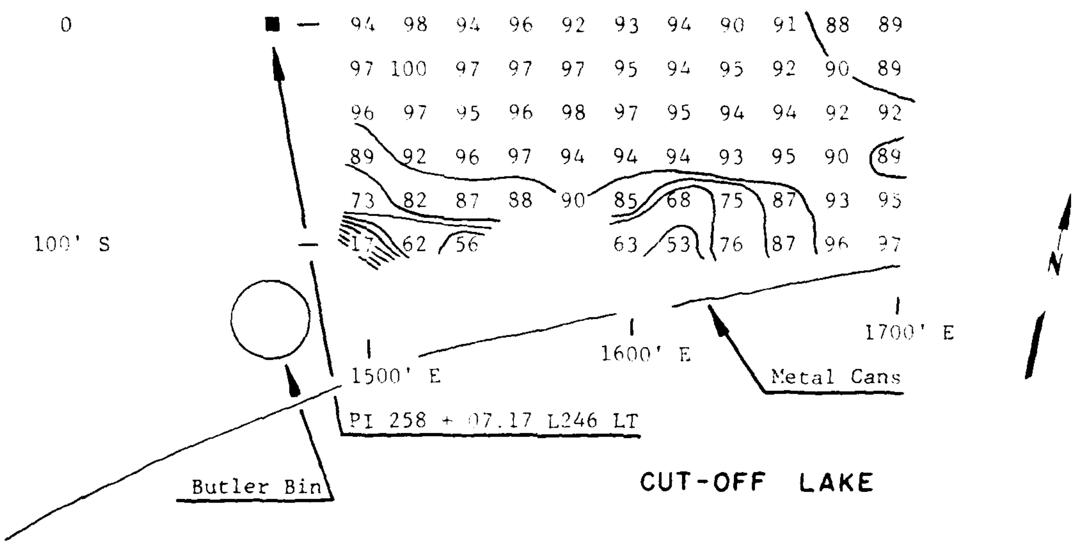

Figure 11. L-246. Blocks I,J

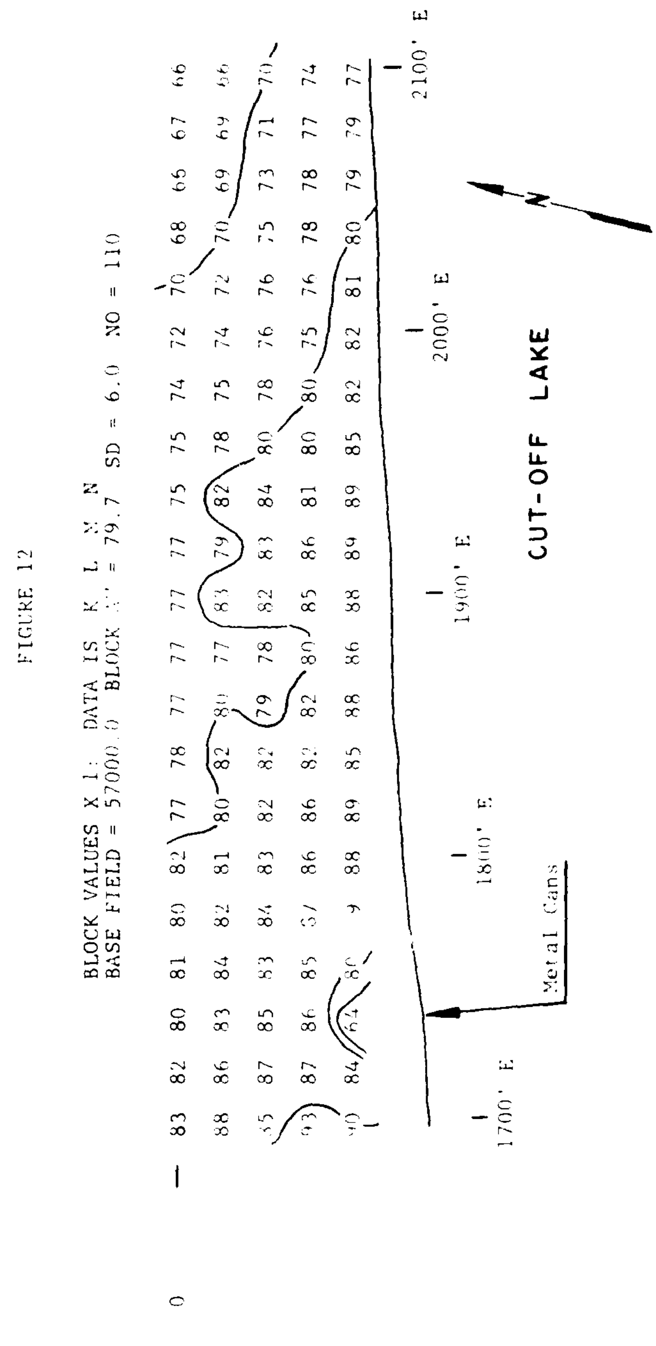

Figure 12. L-246. Blocks K,L,M,N

FIGURE 13

BLOCK VALUES X 1: DATA IS O P
BASE FIELD = 57000.0 BLOCK AV = 63.9 SC = 6.2 NO = 55

0	—	67	66	64	63	61	57	58	54	52	55	53
		68	66	66	65	64	61	59	56	55	57	54
		72	71	70	71	64	64	63	60	59	58	55
		77	71	70	68	66	66	67	63	62	61	59
		75	75	74	71	71	69	68	66	65	61	60

2100' E

2200' E

2300' E

N

CUT-OFF LAKE

Figure 13. L-246. Blocks O,P

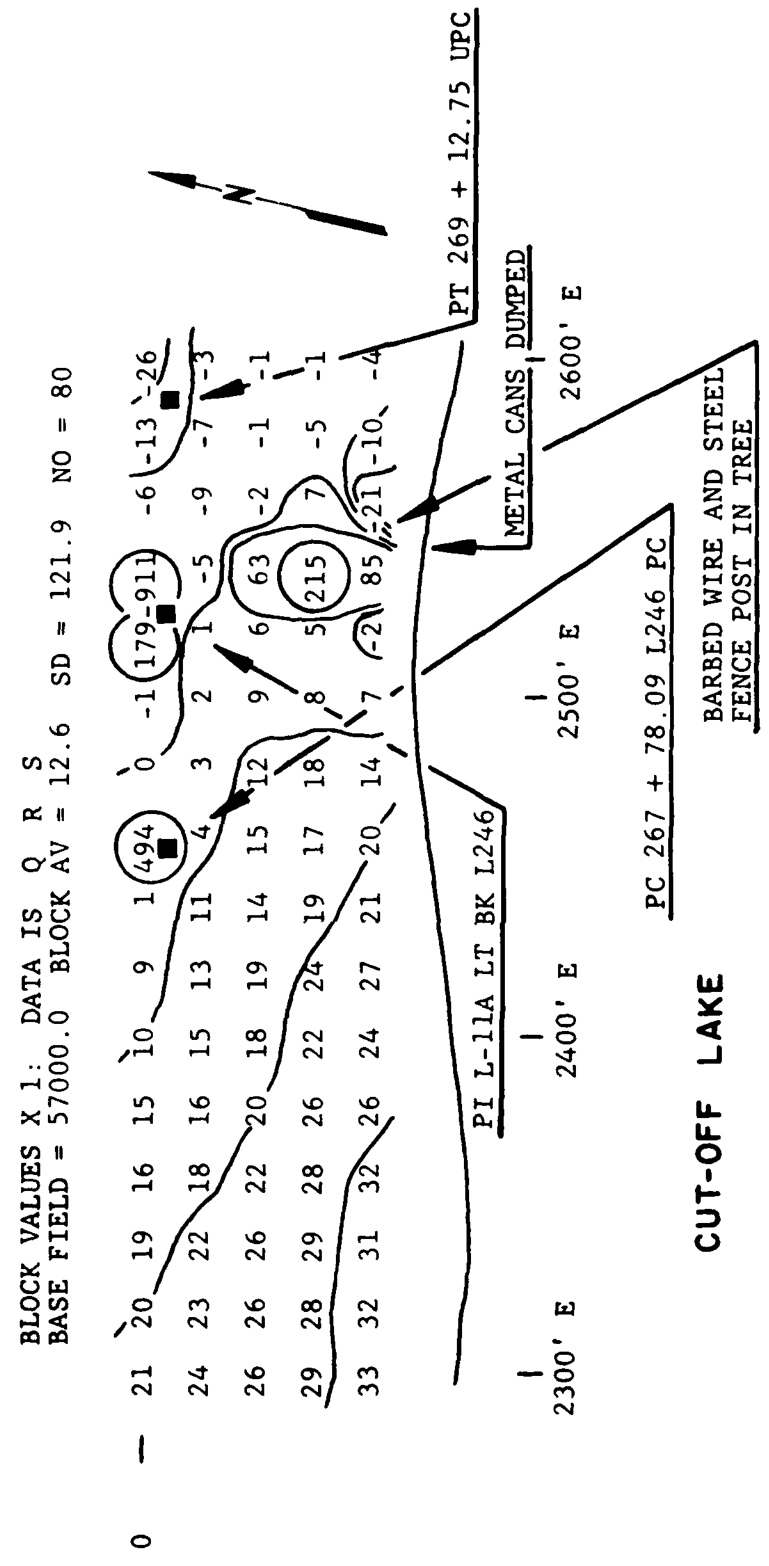

Figure 14. L-246. Blocks Q,R,S

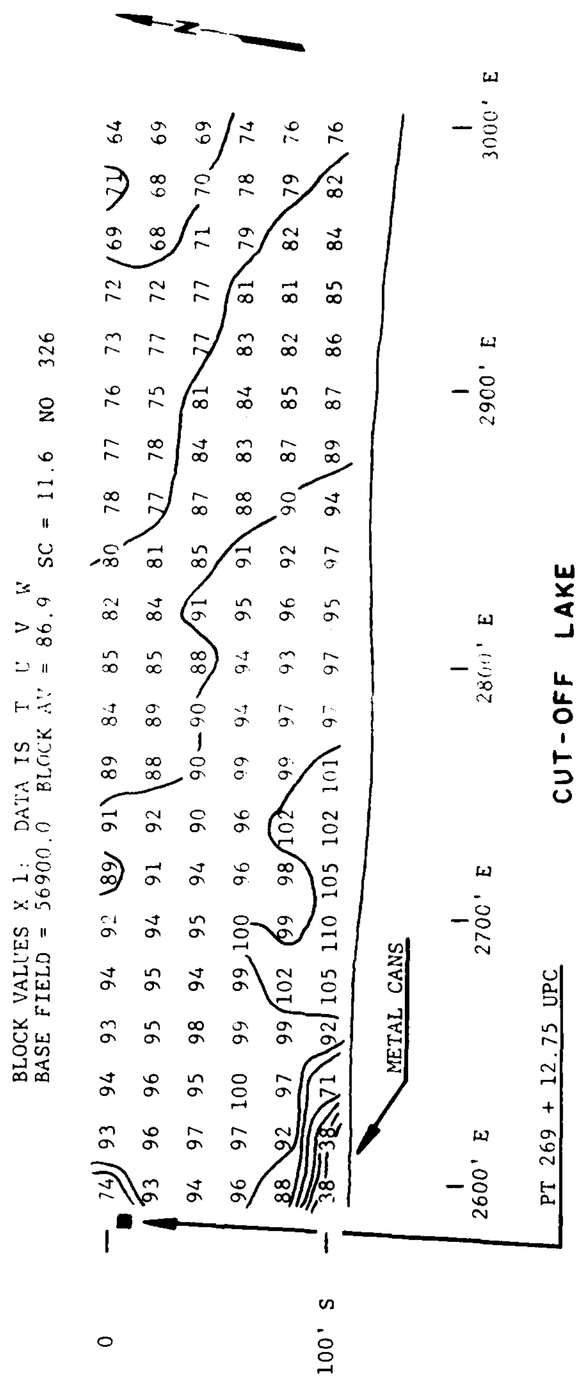

Figure 15. L-246. T,U,V,W

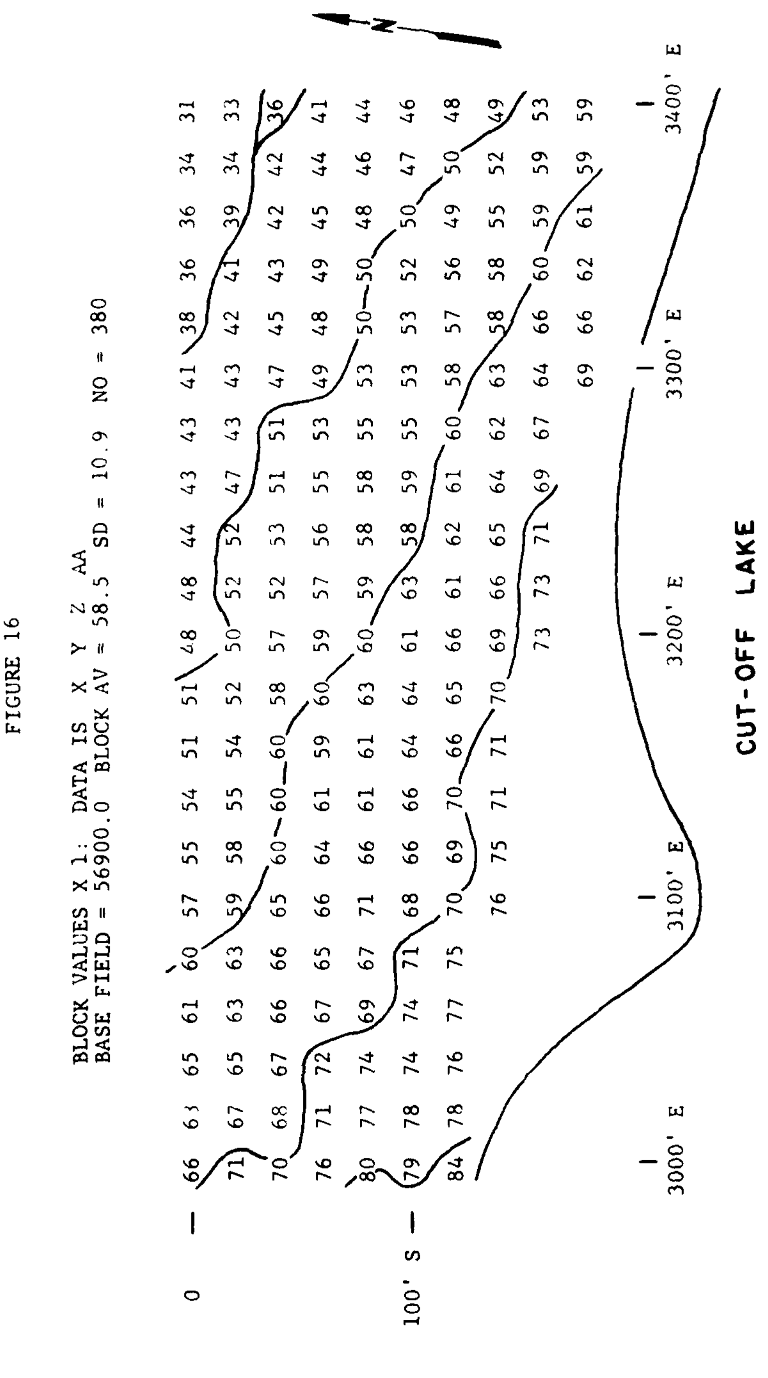

Figure 16. L-246. Blocks X,Y,Z,AA

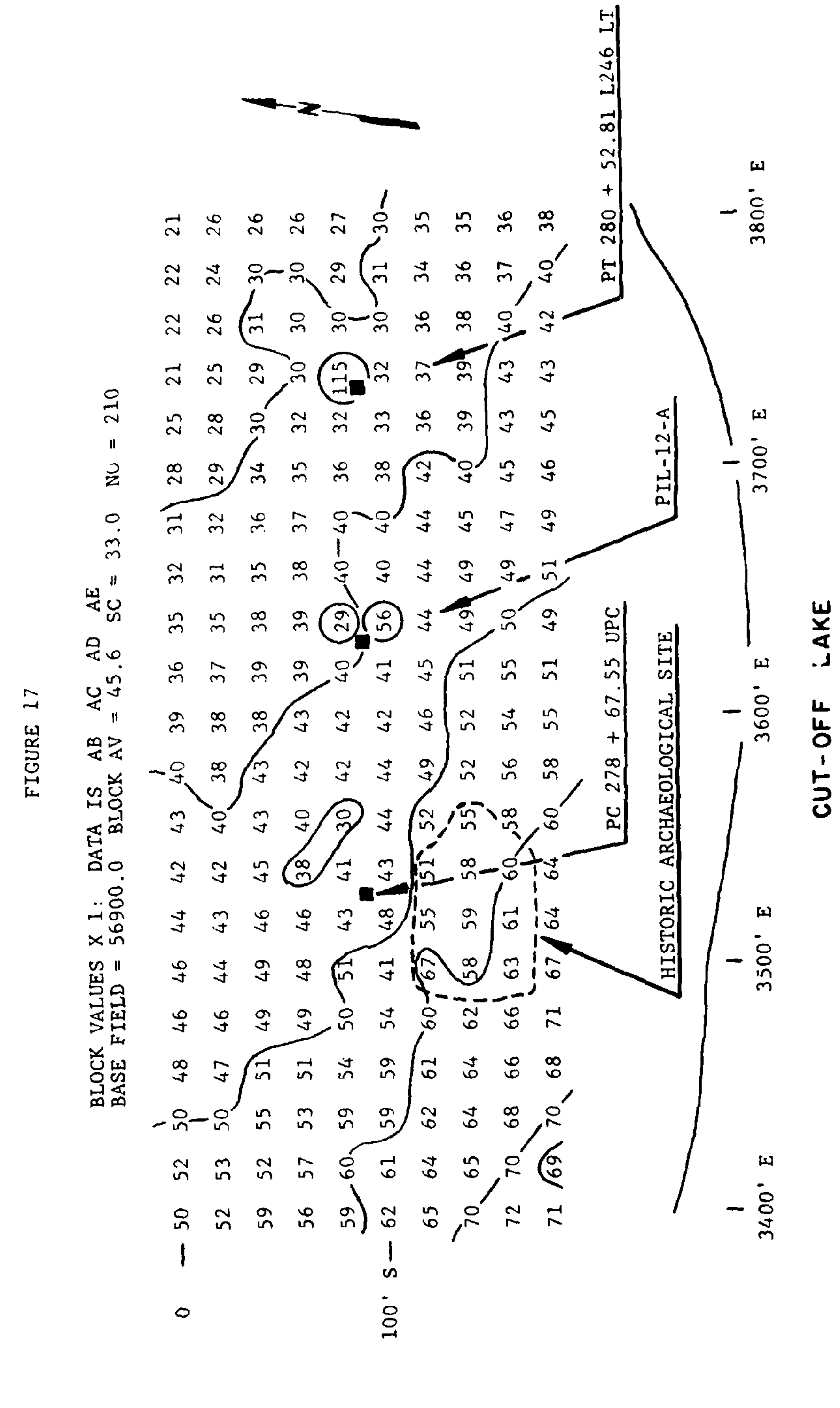

Figure 17. L-246. Blocks AB,AC,AD,AE

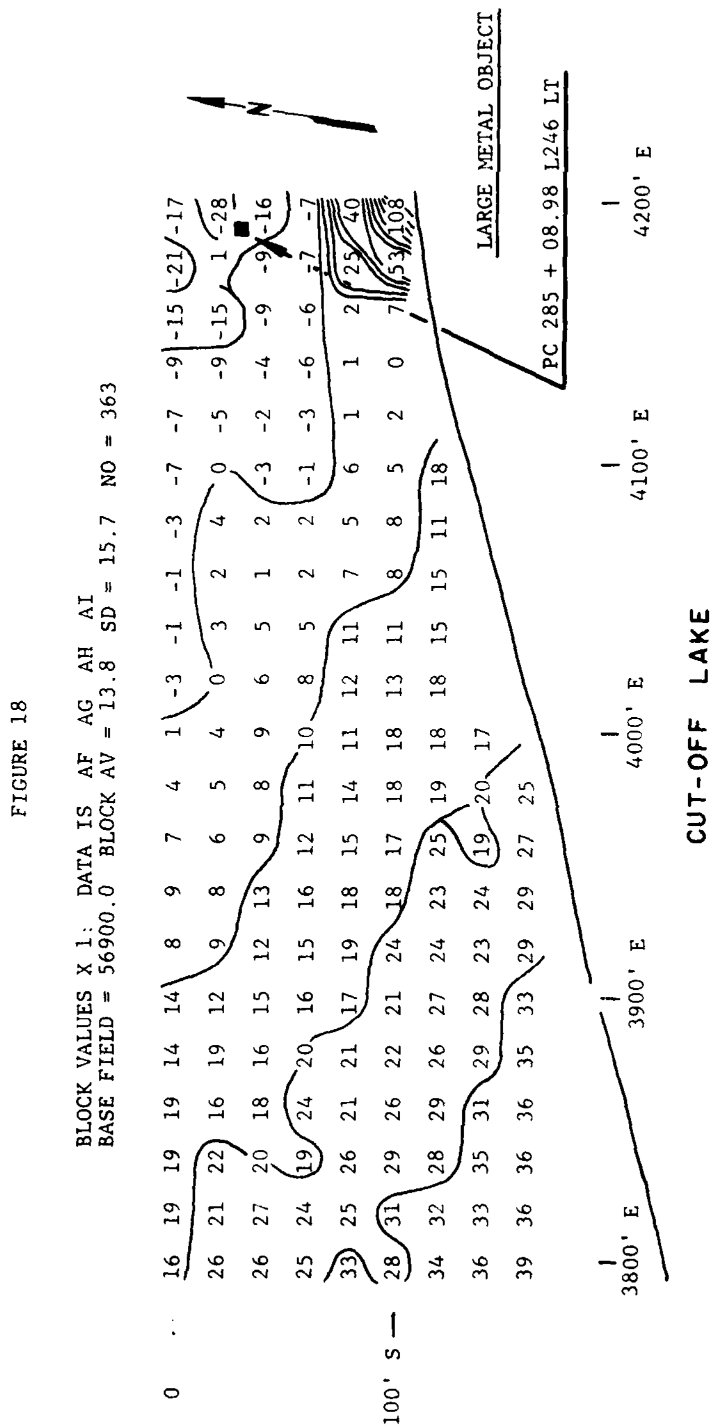

Figure 18. L-246. Blocks AF,AG,AH,AI

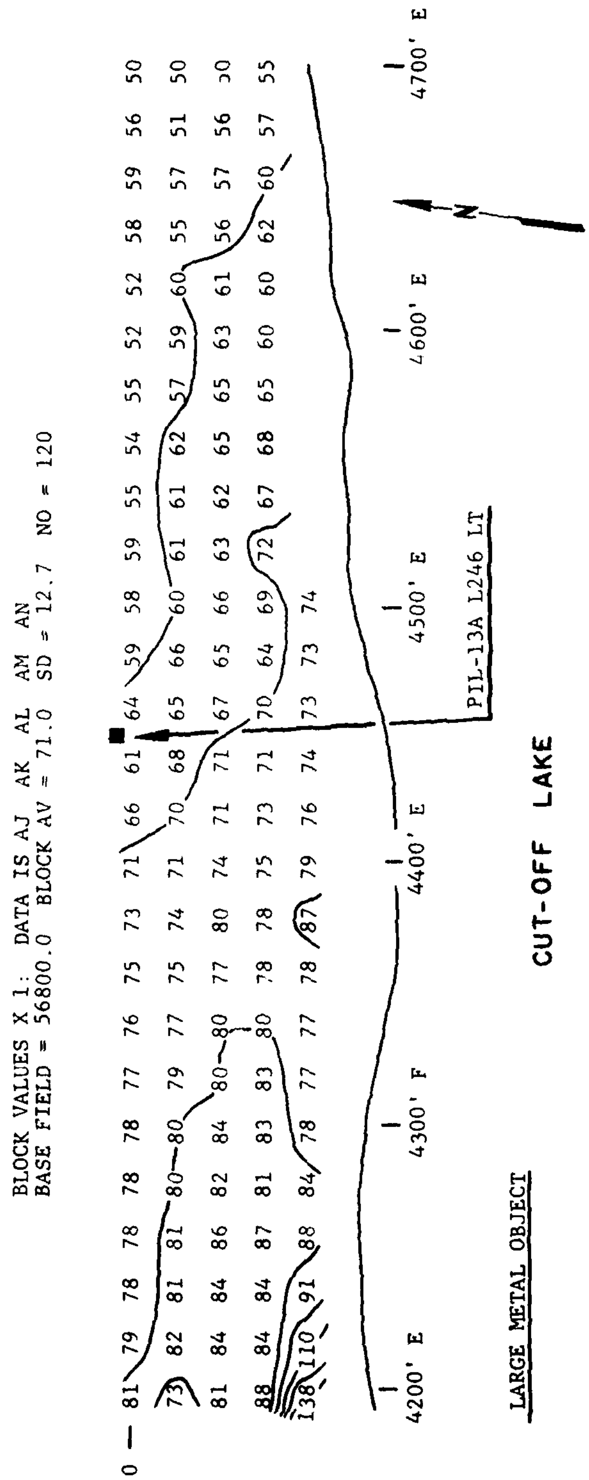

Figure 19. L-246. Blocks AJ,AK,AL,AM,AN

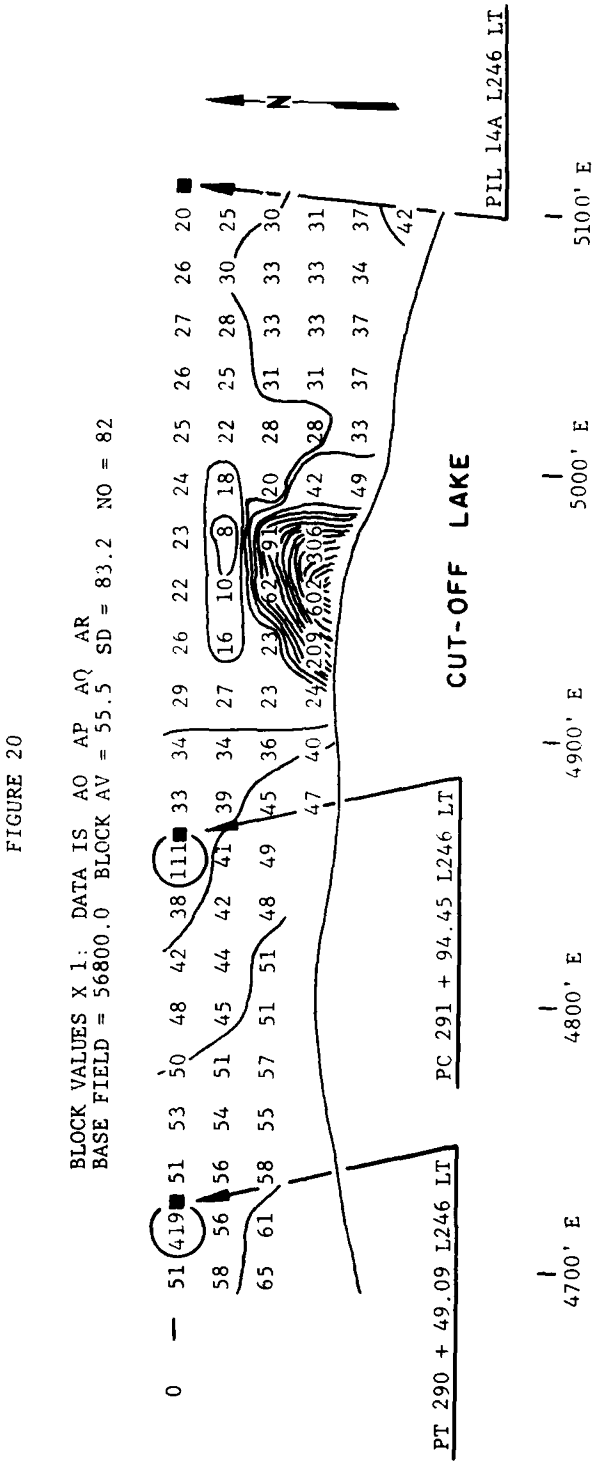

Figure 20. L-246. Blocks AO,AP,AQ,AR

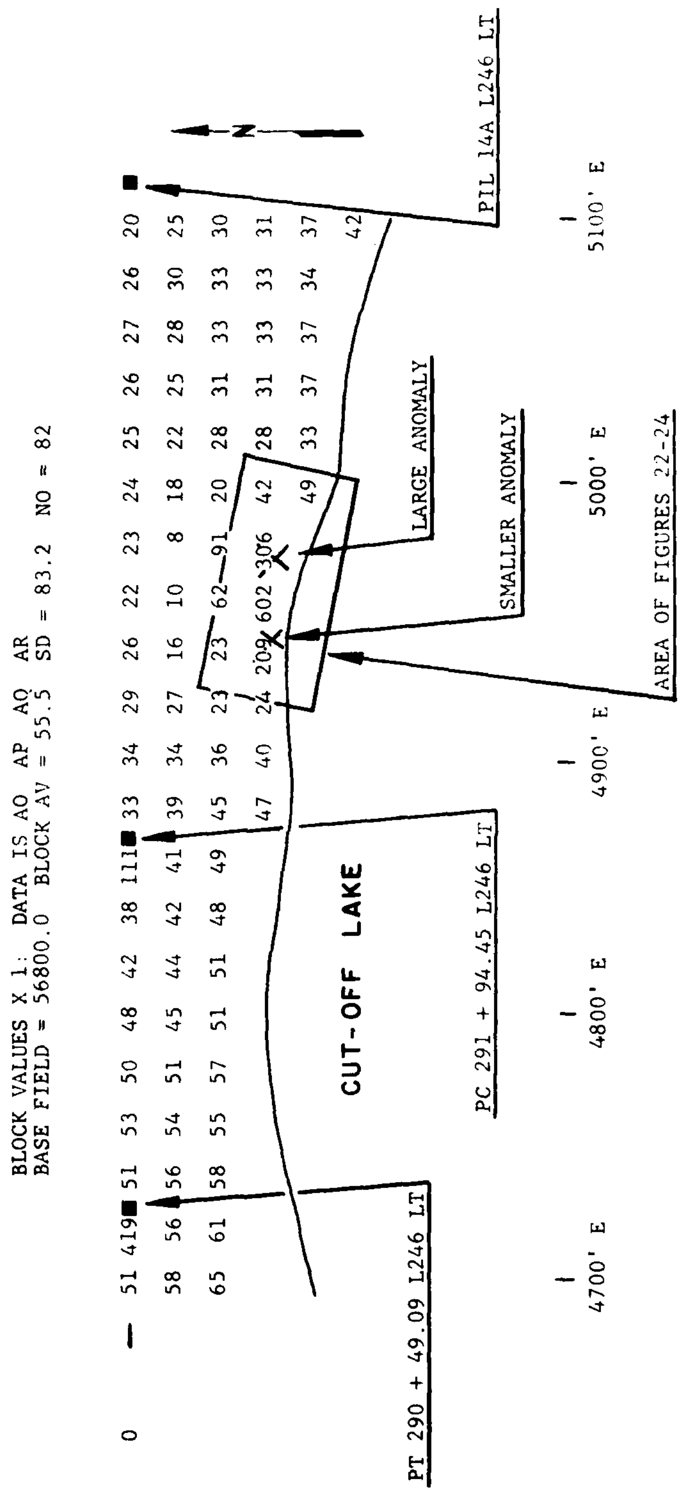

Figure 21. L-246. Blocks AO,AP,AQ,AR, and Location of Anomaly Areas

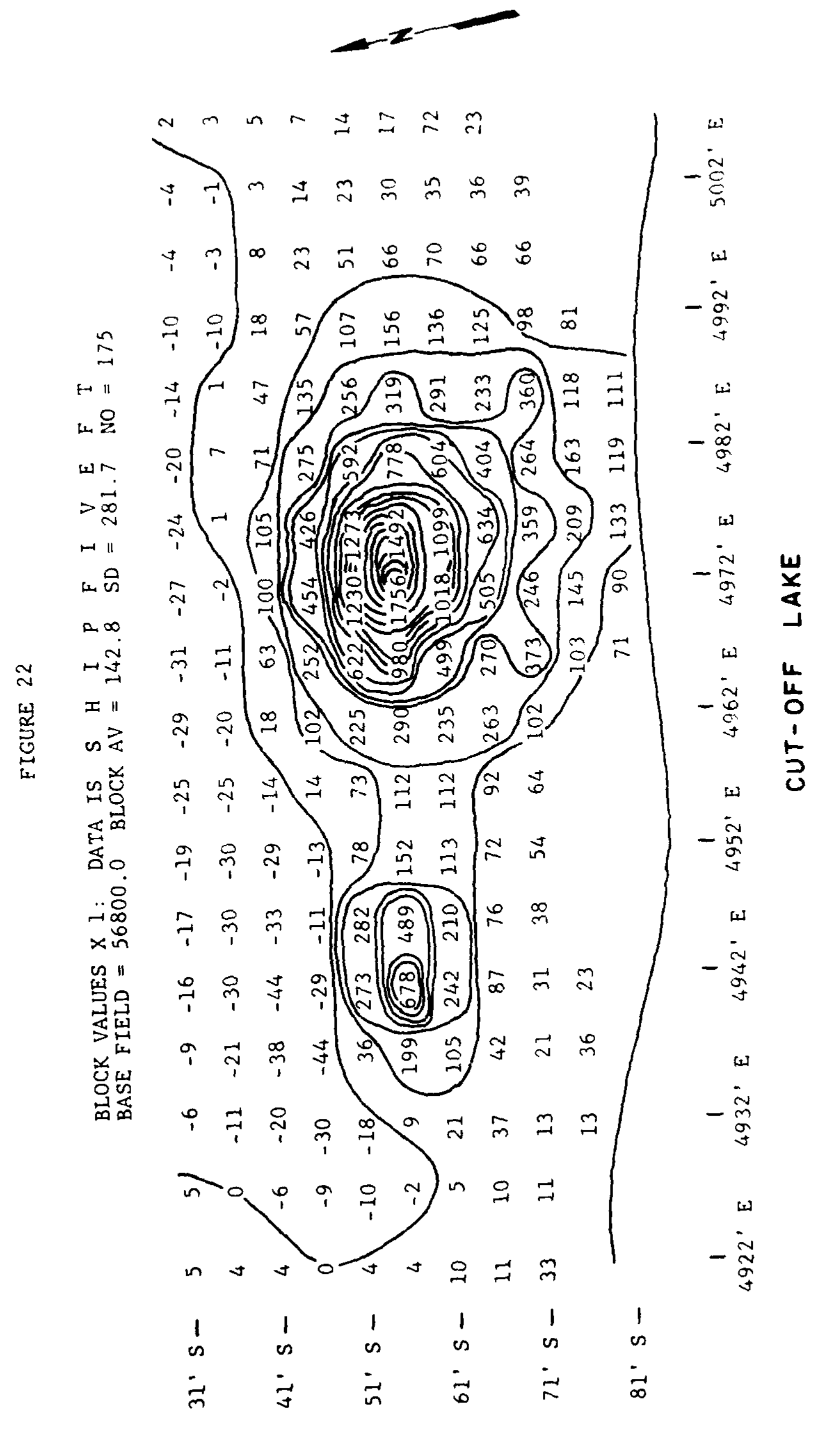

Figure 22. L-246. Anomaly grid values at 5-foot intervals with 100 gamma contour intervals

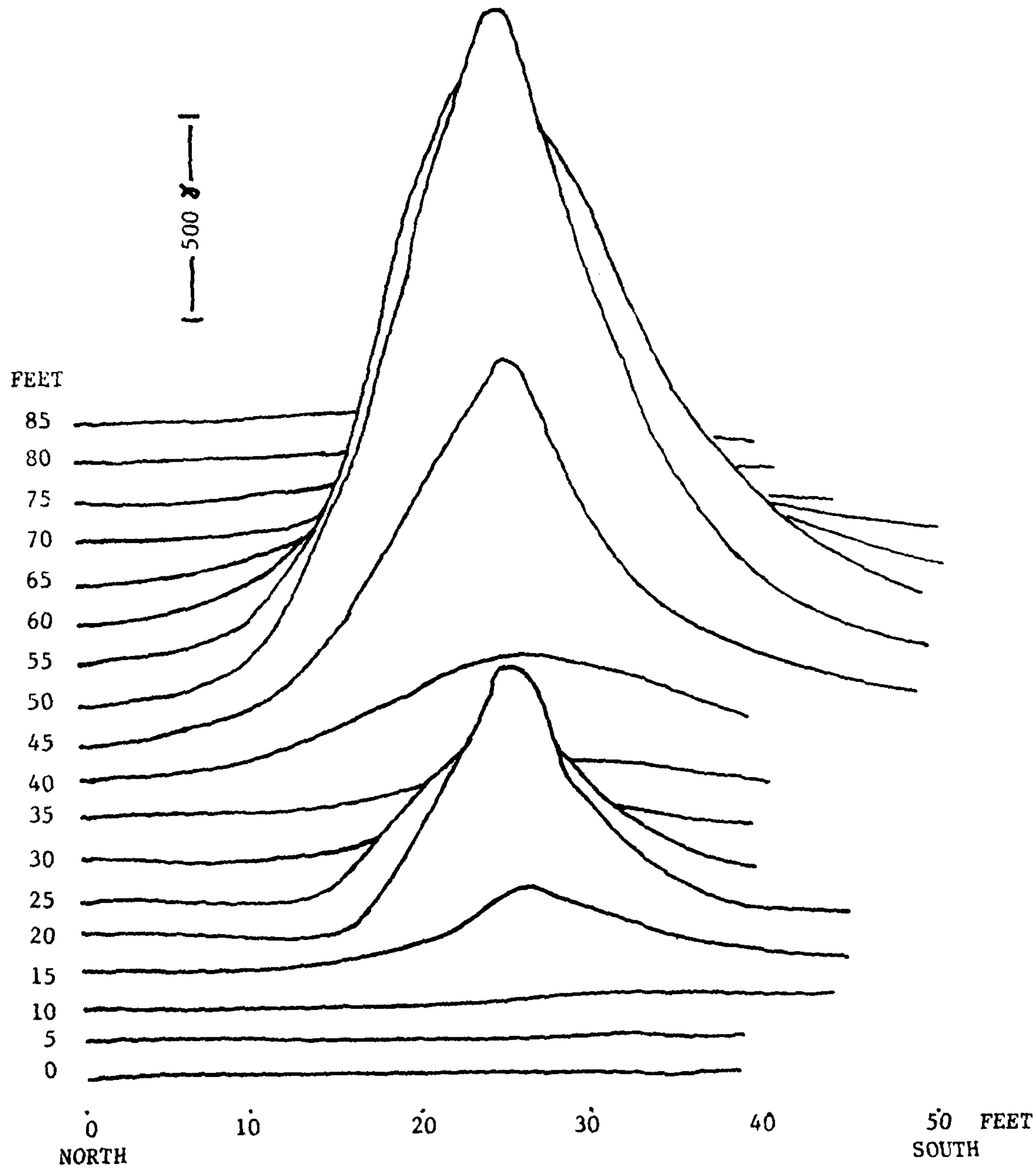

Figure 23. L-246. Visual representation of anomaly areas, viewer facing east

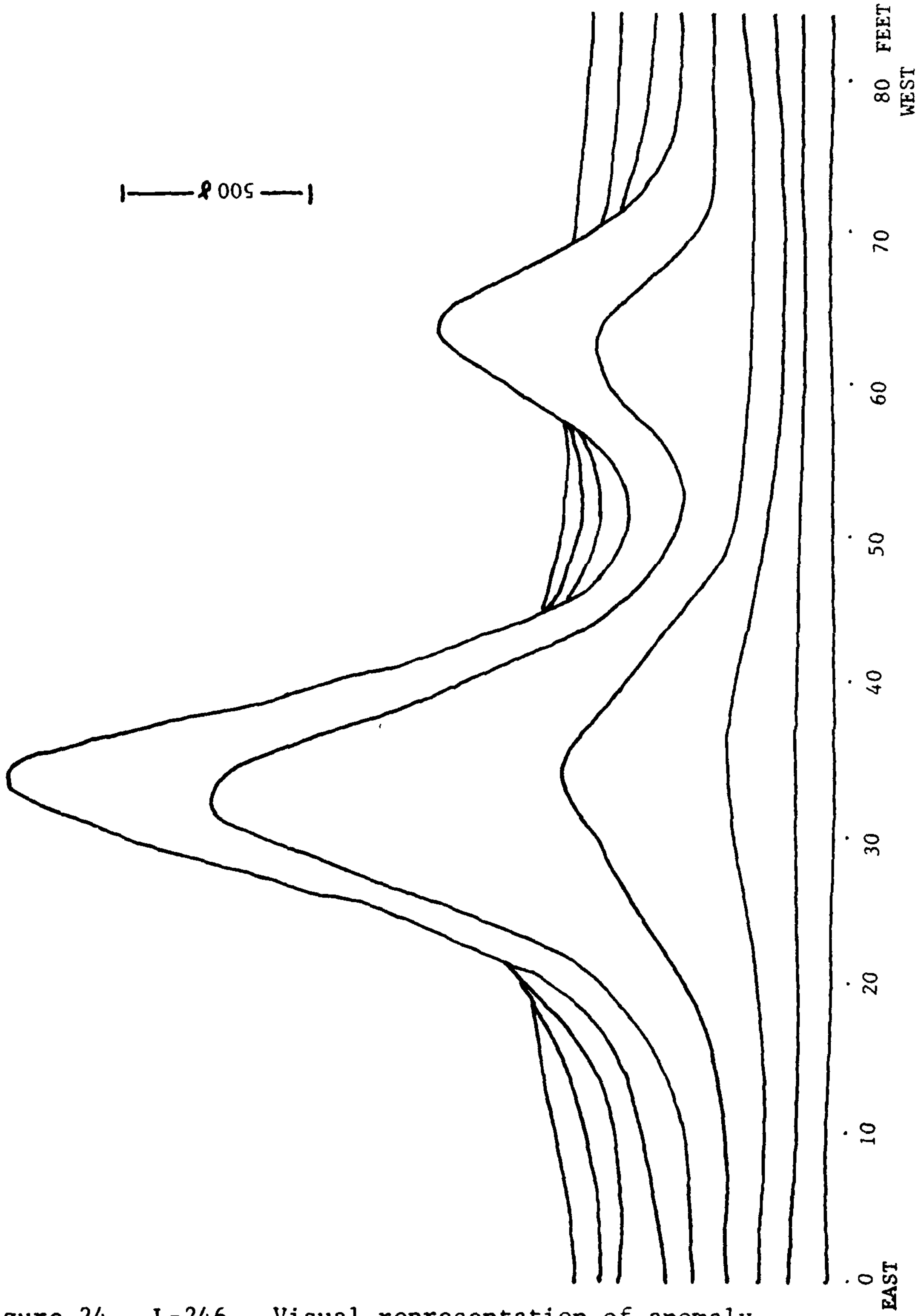

Figure 24. L-246. Visual representation of anomaly areas, viewer facing south

REVIEW COMMENTS

A draft version of this cultural resources survey report was sent to the following agencies and individuals for review of the merits and acceptability of the report. The comments which are pertinent to the final report are listed below together with the authors responses.

Missouri Department of Natural Resources, Division of Parks and Historic Preservation. Comment 1. In accordance with the Office of Historic Preservation's Guidelines for Contract Cultural Resource Survey Reports, a U.S.G.S. 7½ min. topographic map indicating all areas surveyed during this investigation must be included in the report. Also it is recommended that the location of any unexplained anomalies be clearly shown on this map.
Response: Agreed. Figure has been added.

Comment 2. Page 8, paragraph 2, line 7: "effected" should be "affected".
Response: Agreed. Changed accordingly.

Comment 3. Page 15, paragraph 4, lines 3-5: Anomaly #12 is attributed to an historic building. No further discussion is made about this anomaly. What will be the impact on this site? What, if any, is the significance of this historic structure? More discussion and evaluation is needed to clarify this point.
Response: This is a somewhat difficult point to deal with at this juncture. The anomaly is not in the area of historic scatter but is probably associated with it. The purpose of the study was to provide a proton magnetometer survey. A detailed description and discussion of the historic archaeological site appears to be aside from the main theme and detracts from the study. We have included an addendum to the report to address the topic. A more detailed description appears in the report of monitoring activities.

Comment 4. The report fails to provide the Corps and other appropriate state and federal agencies with any recommendations relative to buried historic resources within the project area. Is any further evaluation recommended? Although implied in the Summary and Conclusion section, specific recommendations and/or project clearance should be given. Also, as we feel that the present study is not totally conclusive, the Office of Historic Preservation recommends that in the event any cultural materials are encountered, work should cease immediately and our office notified at once.
Response: Agreed. Recommendations and project clearance have been added. As monitoring was already part of the project, it was not recommended. All of these have been amended.

U.S. Department of the Interior, National Park Service Mid-West Archaeological Center. Comment 1. The report is generally satisfactory.
Response: No comment required.

Comment 2. The twenty foot grid pattern is adequate for a survey to detect a buried steamboat with the same magnetic characteristics as the Bertrand.
Response: No comment required.

Comment 3. The depth estimation for the anomaly on Figure 15 may be too conservative.
Response: The depth estimates were felt to be adequate if we assume multiple objects are creating the anomaly. As we do not know the precise magnetic geometry, it was felt that this was a best estimate of the observed data.

Comment 4. The following topics should be clarified; more descriptive information is needed. The discussion of Petsche's Bertrand study (page 3) should be expanded. The study revealed that a relatively weak anomaly could be indicative of a steamboat. The total variation between readings directly over the ship and those away from the ship is not much more than 100 gamma and a difference of as little as 20 gamma is not uncommon. From Petsche's documentation, what magnetic values were then considered to be significant for this study.
Response: Agreed. We have substantially expanded this section in order to give more background data relative to the previous Bertrand study as well as to discuss what we considered to be significant values.

Comment 5. Spoil from dredging will create a different pattern than sedimentation materials or geologic features. If topographic information were included on the magnetic grids (Figures 2-15), differences in relief may help explain the nature of the anomalies.
Response: We believed that the magnetic grid maps were already sufficiently complex. Topographic information appears on Figure 1a. Although the figure was somewhat cluttered, we have attempted to resolve this.

Comment 6. Two of the grids, Figures 10 and 13, show anomalies in the corners. The gamma differences are similar to those in Petsche's study. What type or size cans caused the anomalies? Could it have been possible to move the metal cans out of the way and resurvey the area to determine if they were the only cause for the anomalies? Was any testing done beyond the gridded areas?
Response: The metal cans creating the anomaly in Figure 10 were dumped along the lake edge for approximately 50-60 feet, while the metal object creating the anomaly in Figure 13 was about boiler size but function could not be determined. It was not possible to move any of this material or survey beyond the gridded area as all of this was in Cut-Off Lake. Figures have been modified accordingly.

Comment 7. The area tested in Figure 18 could have been extended to the south to show if a monopole or a dipole were developing. The anomaly peaks at 1756 and rapidly drops to minus numbers to the north. The numbers begin to decrease to the south but the grid stops before we know what is happening. If the numbers level off creating a monopole, a natural (geologic) feature could be expected. If they decrease at the same rate as on the northern end, a metal object could be creating the anomaly.
Response: The grid was stopped at the edge of the lake. It was not possible to extend the grid to the south. The figure has been modified to reflect this.