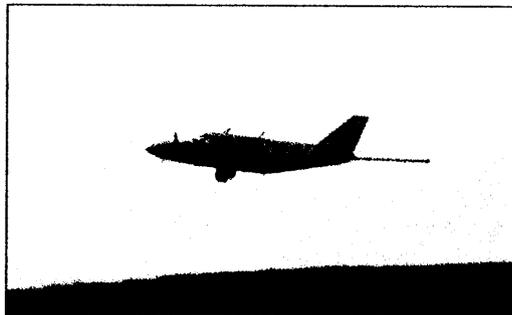


**Report on an Aeromagnetic Survey of the Missouri  
National Recreational River: Data Acquisition, Geophysical  
Processing, and Base Map Interpretation**

**US Army Corps of Engineers, Omaha  
Contract #DACW45-01-P-0267**

**Brian L. Molyneaux, PhD  
Principal Investigator**

**Prepared by  
Brian L. Molyneaux**



**Archaeology Laboratory**

**Cultural Resources Management Series  
Report #200128**



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## Abstract

The University of South Dakota Archaeology Laboratory, with the support of the Missouri River Institute, conducted an airborne magnetic survey of the Missouri National Recreational River for the US Army Corps of Engineers, Omaha District, (contract #DACW45-01-P-0267, supervised by Rebecca Latka, Project Manager, Missouri National Recreational River). The primary goal was to identify buried or submerged cultural resources along the past and present Missouri River channel.

The Principal Investigator was Brian Leigh Molyneaux, PhD. TerraQuest Ltd., Mississauga, Ontario, Canada, an international specialist in airborne geophysical surveys, acquired the total field magnetic data between November 27 and December 12, 2001. CGI Controlled Geophysics Inc., Thornhill, Ontario, Canada, processed the raw flight data. ENW Services, Denver, Colorado, geophysical consultant, contributed survey design, oversight, post-acquisition data processing, geophysical interpretation, and base map creation.

The results indicate that the Missouri River Valley has an active geomagnetic response suggesting significant variability in the basement geological units. Prominent features include numerous anomalies within a generally high geomagnetic background in the Yankton area, several northeasterly striking linear anomalies crossing the river valley at Vermillion and Burbank, South Dakota, and an isolated, large circular anomaly on the floodplain opposite Ponca State Park, Nebraska. ENW filtered out the response due to geology using a process that favored short-wavelength anomalies of a size and shape consistent with cultural sources then isolated a scatter of anomalies with reference to the flight path. The Archaeology Laboratory created a GIS for the project and conducted a base-map analysis of each anomaly. The base-maps consisted of a series of Corps of Engineers maps drawn in 1881, a series of Missouri River Commission maps drawn in 1892, the most recent USGS 7.5' Quadrangles (as DRGs), and the most recent digitized aerial photographs (DOQQ). Of the 119 anomalies isolated, 99 proved to be above-ground structures or features associated with extant farmsteads or agricultural activity, 12 were Priority A anomalies (primary targets for further investigation), and 8 were Priority B anomalies (less distinctive but still worthy of investigation).

The Archaeology Laboratory recommended that the 20 prioritized anomalies be ground truthed, to determine the nature of their sources.

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## 1. Introduction

The University of South Dakota Archaeology Laboratory (ARCHLAB), with the support of the Missouri River Institute, conducted an airborne magnetic survey of the Missouri National Recreational River (MNRR). The flight path extended from Yankton, South Dakota, to Ponca State Park, Nebraska (Figure 1). The US Army Corps of Engineers, Omaha District, funded the project (contract # DACW45-01-P-0267, supervised by Rebecca Latka, Project Manager, Missouri National Recreational River). The Principal Investigator was Brian Leigh Molyneaux, PhD, Director of the USD Archaeology Laboratory. TerraQuest Ltd., Mississauga, Ontario, Canada, an international specialist in airborne geophysical surveys, acquired the total field magnetic data between November 27 and December 12, 2001. CGI Controlled Geophysics Inc., Thornhill, Ontario, Canada, processed the raw flight data. ENW Services, Denver, Colorado, geophysical consultant, contributed survey design, oversight, post-acquisition data processing, geophysical interpretation, and base map creation.

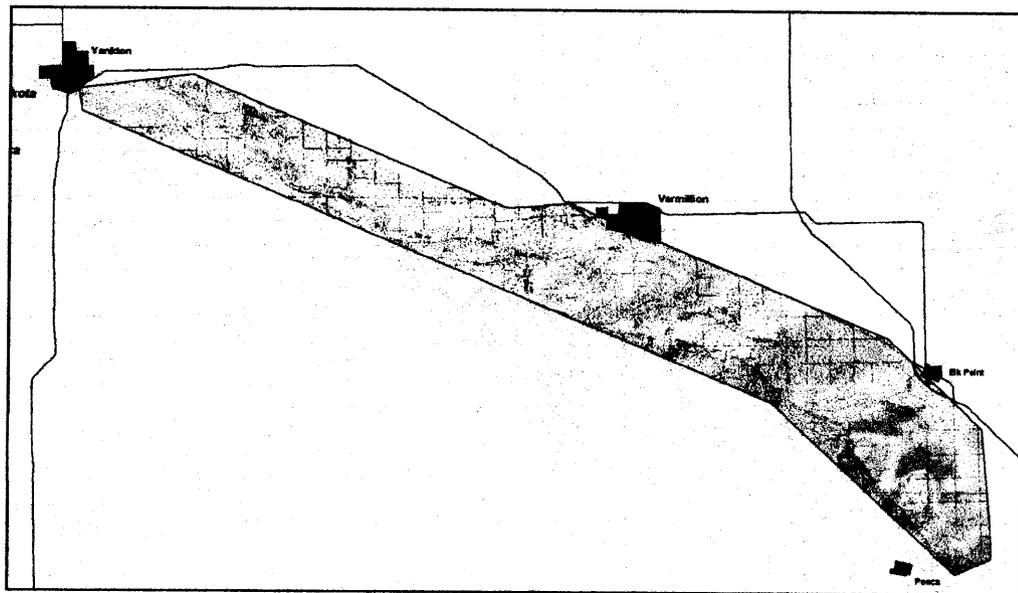


Figure 1 – Aeromagnetic survey area (Figure 1 in Bell & Corbett 2002)

The project report consists of three separate volumes. TerraQuest outlines its survey specifications and procedures in their operations report, entitled *High Sensitivity Magnetic Airborne Survey, Steamboat Project, South Dakota/Nebraska* (TerraQuest Ltd. 2002). ENW Services provides a geophysical interpretation of the magnetic data, accompanied by a set of maps, as detailed in their *Interpretation Report for the Missouri National Recreational River (MNRR) Aeromagnetic Survey in Southeastern South Dakota and Northeastern Nebraska* (Bell & Corbett 2002). The present report provides ARCHLAB's overview of the project and a cultural/historical interpretation of ENW's results.

The primary goal was the identification of buried or submerged cultural properties in the MNRR, for purposes of inventory, management and further research. The use of high-resolution aeromagnetics for the remote sensing of such cultural resources was a solution to the constraints of conventional land-based archaeological survey along the Missouri: the enormous cost of traversing a corridor approximately sixty (60) miles by 3 miles; and the problem of access to the corridor, which consists mainly of private landholdings.

ARCHLAB's expectations derived from conditions inherent in the magnetometer and data acquisition methods. A magnetometer measures ambient magnetic fields emanating from terrestrial forces, natural ferrous minerals or ferrous alloys found in cultural objects. The ability to delineate localized changes in the magnetic field due to cultural resources depends on the sensitivity of the instrument, the parameters of acquisition, the geometry and composition of the buried objects, and the intensity and orientation of the inducing magnetic field.

In general, the intensity of a magnetic anomaly increases with an increase in the mass of ferrous material or a decrease in distance between sensor and source. The airborne survey had a resolution that would potentially detect culturally derived ferrous masses larger than, for example, an automobile. This precluded detection of most prehistoric features, which tend to have relatively weak fields, but suits the potentially larger ferrous concentrations represented by steamboat wrecks, dumpsites and other accumulations of historic material.

Steamboats became a priority in this project because of the historic record of steamboat wrecks along this stretch of the Missouri (Chittenden 1897), the known location of a section of hull that is likely from the steamboat Western, which sank near Yankton in 1881 (Putz 1983), and examples on other parts of the river of successful steamboat excavations (e.g. Petsche 1974, Hawley 1997).

## 2. Research Design

The aeromagnetic survey of the Missouri National Recreational River was unique, in that its primary goal was to locate cultural, rather than natural, magnetic sources. It operated, therefore, without the comparative datasets and source signatures conventional to geophysical surveys. To compensate, ARCHLAB and ENW conceived the process of detection, interpretation and verification as a sequence of stages.

### Stage 1 – remote data acquisition and processing

1. data acquisition: an aerial Cesium magnetometer survey conducted in 100m transects at a mean terrain clearance of 80m.
2. geophysical processing: raw data processed to industry standards with minimal level corrections and noise filtration.
3. post-acquisition processing: enhancement of anomalies conforming to a predictive model through selective filtration.
4. analysis: identification of sources from the evidence on topographic maps and aerial photographs.

### Stage 2 – ground truthing

- 1) surface survey: on-the-ground examination of anomaly locations for source evidence.
- 2) magnetometry: implementation of a magnetic survey to determine the precise location and character of the anomaly; possible application of other geophysical methods (e.g. electromagnetic conductivity, soil resistivity, or ground penetrating radar to enhance subsurface imaging.
- 3) subsurface testing: auger bore holes testing to locate the anomaly source, identify the source material and, if possible, the object.
- 4) excavation: test units placed above the anomaly source and excavated to determine the nature of the object.

### Stage 3 – predictive model refinement

- 1) signal/source analysis: comparison of positively identified anomaly sources to the original magnetic signatures.
- 2) anomaly classification: identification of patterns in the magnetic signatures of similar objects.
- 3) model refinement: redefinition of potential cultural anomalies from the evidence provided by identified cultural sources.

### Stage 4 – reprocessing

- 1) reprocessing of the dataset, through enhanced filtration, to reflect changes in the predicted appearance of anomalies with cultural sources.
- 2) repetition of analytical stages for any newly selected anomalies.

In this research design, the MNRR survey was a Stage 1 project, as it covered data acquisition, geophysical processing, and base map interpretation. The Stage 1 results consisted of a dataset of target anomalies with geomagnetic signatures at the scale set by ENW Services in the initial processing. We must emphasize that these initial predictions were necessarily hypothetical; no dataset existed on which to base the judgments. During subsequent stages of analysis, these data can be refined, so that in future reprocessing of this aeromagnetic survey (i.e. Stage 4), or surveys of this type, a comparative dataset will exist.

## 3. Survey specifications

Survey specifications and procedures are outlined in the TerraQuest operations report, entitled *High Sensitivity Magnetic Airborne Survey, Steamboat Project, South Dakota/ Nebraska* (TerraQuest Ltd. 2002).

In brief, TerraQuest flew the aeromagnetic survey using a fixed-wing, twin-engine aircraft with a single cesium vapor magnetometer extending from the tail, GPS units for location control (aircraft and base station), a radar altimeter for terrain clearance and a barometric altimeter. Flight line traverses were 100 meters apart with orthogonal tie lines 2000 meters apart. They flew a total of 4531 line kilometers at 80 meters mean terrain clearance. Flight line geometry necessitated recording in some

upland areas outside the project corridor; ARCHLAB has retained and analyzed these data for their general research value.

Control Geophysics Inc. processed the raw data, applying minimal level corrections and noise filters so that short wavelength data characteristic of culturally derived anomalies would remain for enhancement in post-processing.

#### **4. Geophysical interpretation**

ENW Services provided a geophysical interpretation of the magnetic data, as detailed in their *Interpretation Report for the Missouri National Recreational River (MNRR) Aeromagnetic Survey in Southeast South Dakota and Northeast Nebraska* (Bell & Corbett 2002).

The protocol established in consultation with ARCHLAB was to process the data with filtration that would isolate and enhance anomalies with a shape and magnitude consistent with cultural, as opposed to natural, objects or features. This approach was somewhat problematic, in that there were no comparative magnetic data on the character of anomalies produced by buried steamboats. However, ENW reasonably predicted that cultural anomalies would have a distinct character – a short wavelength signal with a corresponding moderate-to-high amplitude, suggesting a relatively small, shallowly buried mass, as compared to the much broader magnetic field signature resulting from the background matrix of the basement rocks and sedimentary cap below the floodplain surface.

Furthermore, the subsequent identification of specific target features derived entirely from the physical characteristics of the anomalies. ENW analysts did not select features through qualitative assessments of landform position in relation to present or past river channels or above-ground cultural features visible on base maps or aerial photographs. While the subsequent dataset is populated with cultural anomalies identified, on inspection of USGS 7.5' quadrangles, with above-ground structures, the approach limited the possibility of selective bias in the geophysical interpretation.

#### **5. Results**

##### **Background geomagnetic data**

The initial processing of the raw dataset by ENW Services revealed an unexpectedly complex array of magnetic anomalies, which they suspected were deeply buried

geological formations below the Missouri River. While these data appeared to constitute noise with respect to the primary goals of the project, the identification of buried cultural resources, it was necessary to understand them in order to develop a filtering process that would remove this intense background while retaining the weaker cultural anomalies. With this in mind, ARCHLAB contacted the South Dakota Geological Survey. After initial consultation with the State Geologist, Derric Iles, their physical geologist, Kelli McCormick, examined the dataset and provided the following brief summary of her findings (McCormick 2002).

The South Dakota Geological Survey has found the new aeromagnetic data that the USD Archaeology Laboratory provided to be of great help in the interpretation of the geologic history of some of the oldest deeply buried rocks in the region. These new data compliment and enhance older ground magnetic data collected in the 1960s (e.g. Petsch 1962). This high-resolution data set, in part, covers an area south of the older data, allowing us to tentatively correlate old ( $\geq 1$  billion year old) magmatic intrusions from central Union County south beneath the Missouri River. These and other data suggest the existence of a relatively strong northeast-southwest structural trend in the deep basement rocks from Nebraska into South Dakota. They also support interpretations by previous workers (e.g. Klasner and King 1986; Van Schmus et al. 1989) that southeastern South Dakota overlies the margin of at least two "pieces" of continental craton (very old rocks, 1 to  $> 2.5$  billion years old, that form the core of the North American continent).

The South Dakota Geological Survey is currently drilling into and potentially obtaining core from a dome-shaped, strong aeromagnetic high identified from these new data. Although we have not yet intersected the source of the aeromagnetic anomaly, we have intersected Paleozoic rocks (between 240 and 580 million years old) that, in eastern South Dakota, are rare, and restricted to southern Union County. These rocks thicken into the Forest City Basin of Iowa and possibly into the Salina Basin, and directly overlie the older basement rocks discussed above. As very little is known about the distribution of these Paleozoic rocks in southeastern South Dakota, this drilling is providing further information concerning the age and spatial extent of these rocks in this region. By identifying the source of the strong, dome-shaped anomaly, we also hope to better define the margin between the two "pieces" of continental craton in this area.

The Geological Survey of South Dakota will provide the results to the COE and ARCHLAB at the completion of the work.

## Filtered magnetic data

For the interpretation of the anomalies derived from the filtered dataset, ARCHLAB established a GIS of the project area, consisting of DRGs derived from USGS 7.5' Series Quadrangles and DOQQs with similar coverage, and the table of UTM coordinates for the anomalies. We also consulted two historic map series: Map of the Missouri River (1879-81), produced by the Corps of Engineers; and Map of the Missouri River (1892-95), published by the Missouri River Commission. The relevant sheets date to 1881 and 1892, respectively. As these are not currently georeferenced, their use was limited to those anomalies with distinct geographical reference points.

The accuracy of anomaly locations is subject to several variables, including the nature of the magnetic field, the resolution of the data acquisition system (including the distance from the sensor, the ground distance between readings and the transect width), and any distortions in these locations projected on digitized topographic maps in a GIS. For the following interpretation, we assumed that the source would be within a radius of 100m from the projected map location. An actual location always requires ground level investigation.

Information significant to this project related to several key variables. First was the degree to which an anomaly had a size and shape consistent with an isolated cultural feature, as defined in the ENW model. ENW classified anomalies with the highest degree of conformity as having an "A priority" with respect to future ground truthing. They gave anomalies with somewhat less correspondence a "B priority". Second was the position of the anomaly in relation to modern or historic river channels. Proximity to the river – past or present – may indicate whether the anomaly is an object or feature associated with the river (e.g. a shipwreck, a flood or channel deposit, shoreline defenses, or a dumpsite) or with terrestrial activity unrelated to the river (e.g. a metal building or tank, a grouping of farm equipment or vehicles, or a dumpsite). Third was the possibility that some anomalies represented ephemeral sources moved subsequent to the data acquisition – for example, mobile irrigation units or large construction vehicles.

Given that the following analysis is map-based, with a possible location variation of up to 100 meters from the actual source, the interpretations are necessarily hypothetical. However, since the approach is contextual, involving an examination of the extant cultural features in the area of the anomaly, as well as the relation of the anomaly to the past and present Missouri River, we regard this evaluation as having an acceptable degree of confidence.

## Survey Block 1

### 1-1 Priority A

This anomaly is located on an old channel edge on Rush Island, downstream from Yankton (Figure 2). The surrounding land is a plowed field, with trees immediately to the north – presumably in an old channel that cannot be cultivated. No potential sources are visible on the DRG (USGS 7.5' Series, Menominee Quadrangle, Nebraska and South Dakota, 1968) or the DOQQ (Menominee, NW quadrant, 1993).

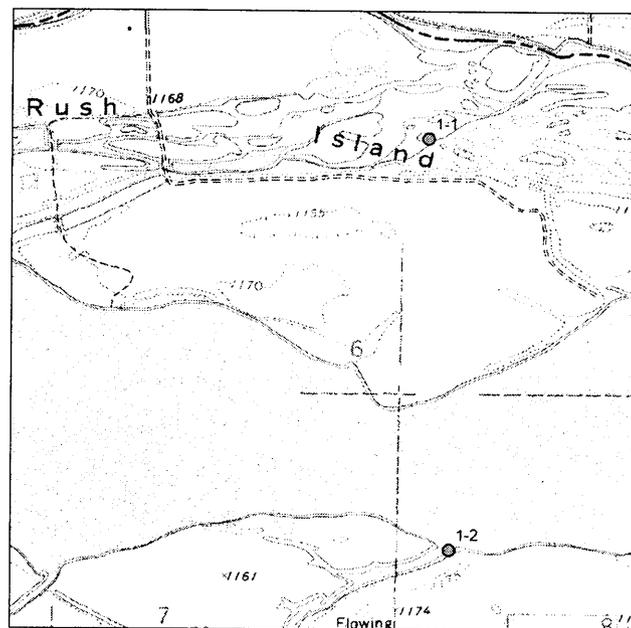


Figure 2 – Anomalies 1-1 and 1-2, extract from USGS 7.5' Series, Menominee Quadrangle, Nebraska and South Dakota, 1968.

On the Corps of Engineers map of 1881 (No. XXX in the Missouri River series) this feature is Elk Island (Figure 3). The anomaly appears to be on a large sandbar north of the main river channel. By 1894, as the Missouri River Commission map of 1894 (No. XXX) shows, two flood channels have cut through the island (Figure 4). The anomaly appears to be near the lower of these features. Given this information, it is possible that the source is a flood deposit associated with catastrophic breakup of the ice gorge at Yankton in the spring of 1881.

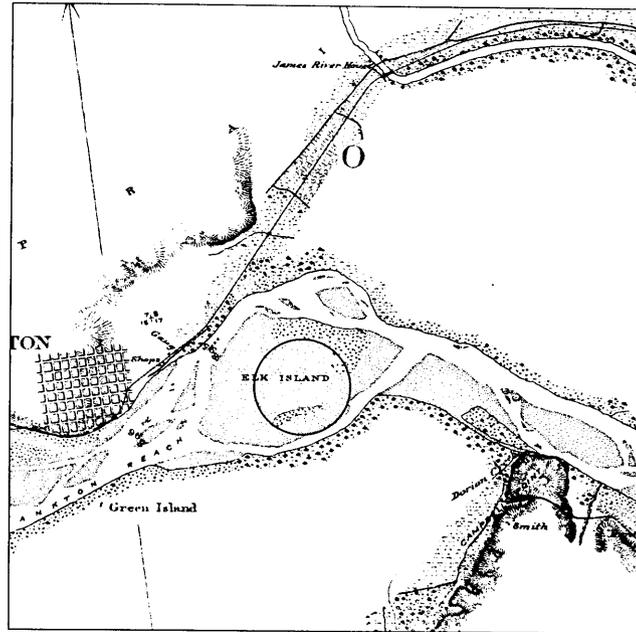


Figure 3 – Area of Anomaly 1-1, extract from *Map of the Missouri River*, XXX, Corps of Engineers, 1881



Figure 4 – Area of Anomaly 1-1, extract from *Map of the Missouri River*, XXX, Missouri River Commission, 1894

## 1-2 Priority B

This anomaly is located in an old channel remnant, partly under water, on the south shore of the Missouri, across from Rush Island (Figure 2). The narrow channel extends inland and then curves back toward the present river, suggesting that the land it encloses had an alluvial origin. It is also possible that the channel is an old outlet of Antelope Creek, which empties at present approximately 500 meters to the west. The historic maps show that the river meandered to the north in the late 19<sup>th</sup> century. No potential sources are visible on the DRG (USGS 7.5' Series, Menominee Quadrangle, Nebraska and South Dakota, 1968). The DOQQ (Menominee, NW quadrant, 1993) shows a row of small landholdings, with houses or other buildings, along the shoreline immediately south of the anomaly. In this setting, the source could possibly derive from either riverine or terrestrial activity.

### 1-3a, 1-3b Above-ground structures

These anomalies are located in a complex of farm buildings. No potential sources are visible on the DRG (USGS 7.5' Series, Menominee Quadrangle, Nebraska and South Dakota, 1968). However, the DOQQ (Menominee, NW quadrant, 1993) shows agricultural outbuildings (presumably metal) in both positions.

### 1-4 Above-ground structure

This anomaly is located in the middle of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, Menominee Quadrangle, Nebraska and South Dakota, 1968) and the DOQQ (Menominee, NW quadrant, 1993).

### 1-5a, 1-5b Above-ground features

These anomalies are located in a complex of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, Menominee Quadrangle, Nebraska and South Dakota, 1968) and the DOQQ (Menominee, NE quadrant, 1993).

### 1-6 Above-ground feature

This anomaly is located in the middle of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, Menominee Quadrangle, Nebraska and South Dakota, 1968) and the DOQQ (Menominee, NE quadrant, 1993).

## 1-7 Priority B

This anomaly is located above the river valley and outside the project area in a cultivated field near the town of St. Helena, Nebraska. No potential sources are visible on the DRG (USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Menominee, NW quadrant, 1993). The position of the anomaly indicates that the source derives from terrestrial activity.

## Survey Block 2

### 2-1 Above-ground structure

This anomaly is located in the middle of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Saint Helena, NW quadrant, 1993).

### 2-2 Above-ground structure

This anomaly is located in the middle of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Saint Helena, NW quadrant, 1993).

### 2-3 Above-ground structure

This anomaly is located in the middle of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Saint Helena, NE quadrant, 1993).

### 2-4 Above-ground structure

This anomaly is located in the middle of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Saint Helena, NE quadrant, 1993).

### 2-5 Above-ground structure

This anomaly is located in the middle of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Saint Helena, NE quadrant, 1993).

## 2-6 Priority A

This anomaly is located on an old Missouri channel edge (Figure 5). Terrace remnants inland indicate that the river once meandered here to the north. The land to the south is alluvial. The land at the source is a boundary between agricultural land and waste ground adjacent to the channel remnant. The historic maps suggest that this location was close to the shoreline in the late 19<sup>th</sup> century. No potential sources are visible on the DRG (USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Saint Helena, SE quadrant, 1993). In this setting, the source could possibly derive from either riverine or terrestrial activity.

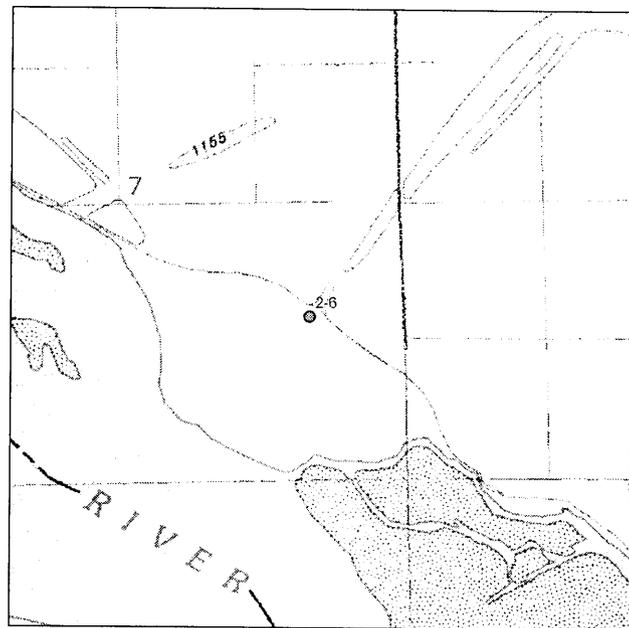


Figure 5 – Anomaly 2-6, extract from USGS 7.5' Series, St. Helena Quadrangle, Nebraska and South Dakota, 1994

## Survey Block 3

### 3-1 Above-ground feature

This anomaly is located in the Missouri floodplain in the shelterbelt adjacent to a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Saint Helena, SE quadrant, 1993).

### 3-2 Above-ground structure

This anomaly is located in the Missouri floodplain over one of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Saint Helena, SE quadrant, 1993).

### 3-3 Above-ground structure

This anomaly is located in the Missouri floodplain at the edge of a group of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-4 Above-ground structure

This anomaly is located in the Missouri floodplain at a cluster of farmstead buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-5 Priority A

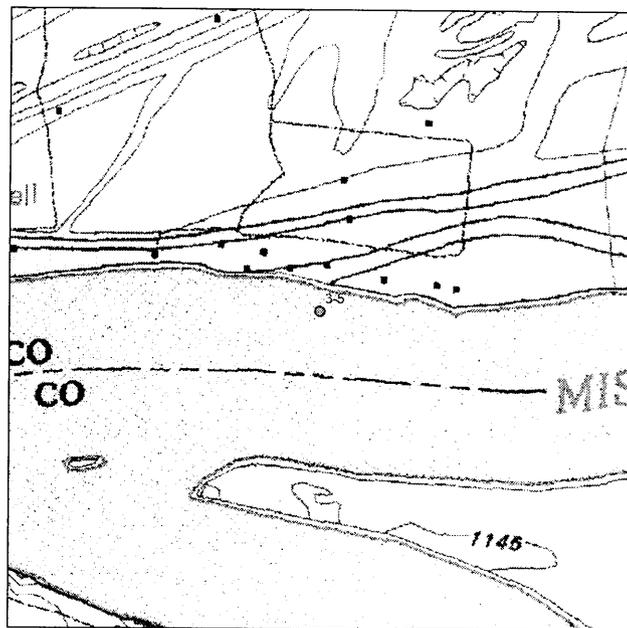


Figure 6 – Anomaly 3-5, extract from USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994

This anomaly is located in the present Missouri river channel, off the northern shore, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993) (Figure 6). The historic maps suggest that this location may have been on or near the shoreline in the late 19<sup>th</sup> century. In this setting, the source probably derives from riverine activity.

### 3-6 Above-ground structure

This anomaly is located over Bergen Lutheran Church, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-7 Above-ground structure

This anomaly is located over a small group of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-8 Above-ground structure

This anomaly is located within a small farmstead, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-9 Above-ground structure

This anomaly is located within a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-10 Above-ground structure

This anomaly is located within a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SE quadrant, 1993).

### 3-11 Above-ground structure

This anomaly is located within a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SE quadrant, 1993).

### 3-12 Above-ground structure

This anomaly is located within a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SE quadrant, 1993).

### 3-13 Priority A

This anomaly is located on the present Missouri shoreline, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SE quadrant, 1993) (Figure 7). The historic maps show the river in roughly the same place in the late 19<sup>th</sup> century. The source is west of a row of small landholdings. In this setting, the source probably derives from riverine activity.

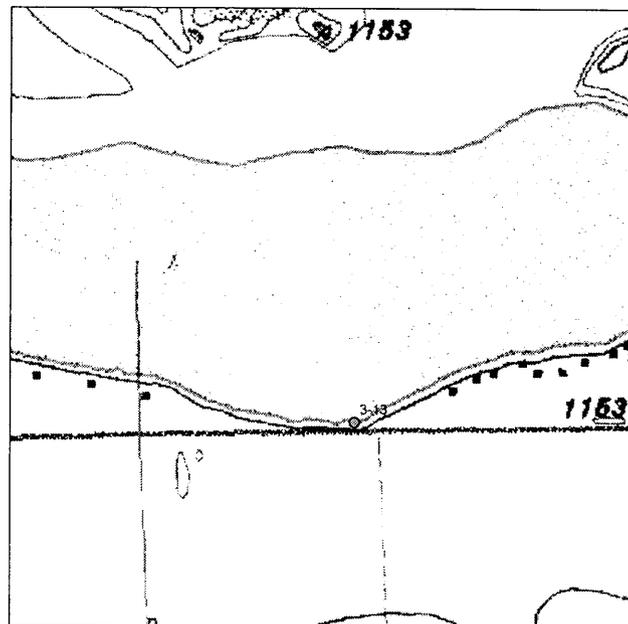


Figure 7 – Anomaly 3-13, extract from USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994

### 3-14 Above-ground structure

This anomaly is located over a large farm building, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SE quadrant, 1993).

### 3-15a Priority B

This anomaly is located on the margin of a paved highway, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993) (Figure 8). In this setting, the source likely derives from terrestrial activity, possibly related to the farmstead to the north. While there are a number of terraces in this area, marking previous meanders, the historic maps show that this was dry land in the late 19<sup>th</sup> century.

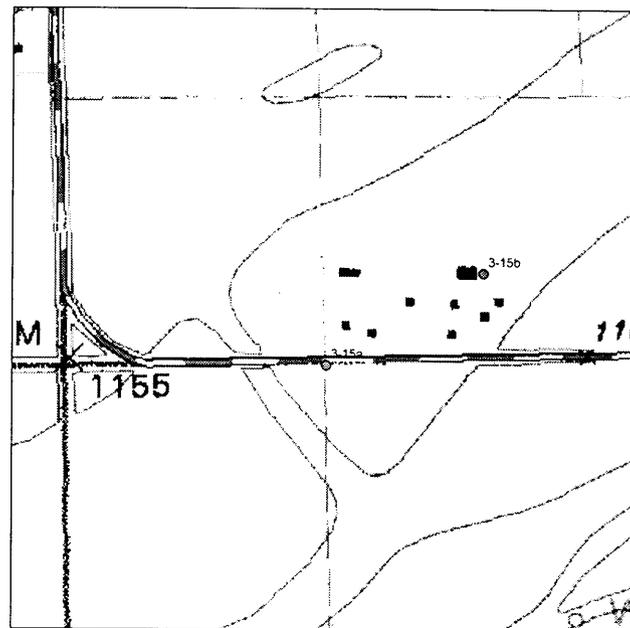


Figure 8 – Anomaly 3-15a, extract from USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994

### 3-15b Above-ground structure

This anomaly is located over a large farm building, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-16 Priority B

This anomaly is located on the Missouri floodplain near the southern shore, along a drainage ditch with an adjacent road (Figure 9). The surrounding lands are cultivated. There are no structures visible on the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Meckling, SW quadrant, 1993).

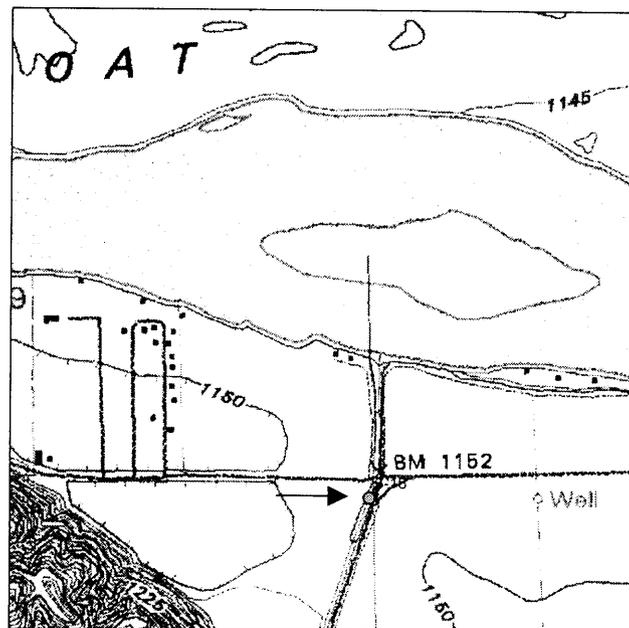


Figure 9 – Anomaly 3-16, extract from USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994

The historic maps show that this area was dry land in the late 19<sup>th</sup> century. On the 1881 map, the location was marked as Wiseman's Woodyard – one of the woodpiles established to service the steamboats in the 19<sup>th</sup> century (Figure 10). In this setting, the source could possibly derive from either riverine or terrestrial activity.

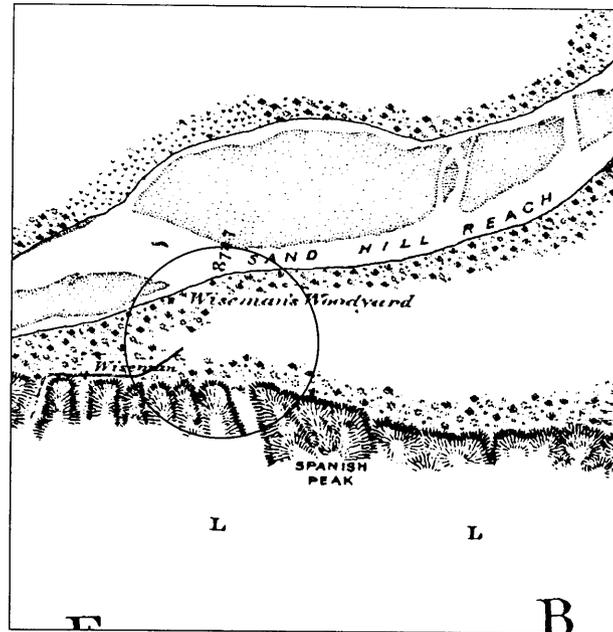


Figure 10 – Area of Anomaly 3-16, extract from *Map of the Missouri River*, XXIX, Corps of Engineers, 1881

### 3-17a, 3-17b Above-ground structures

These anomalies are located over buildings in a large farmstead, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-18 Above-ground structure

This anomaly is located over a large farm building, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SW quadrant, 1993).

### 3-19a, 3-19b Above-ground features

These anomalies are located on the margins of a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Meckling Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Meckling, SE quadrant, 1993).

### 3-20a, 3-20b Above-ground structures

These anomalies are located over buildings in a farmstead, as indicated on the DRG (USGS 7.5' Series, Obert Quadrangle, Nebraska, 1968).

## Survey Block 4

### 4-1 Above-ground structure

This anomaly is located over a large farm building, as indicated on both the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) and the DOQQ (Vermillion, SW quadrant, 1993).

### 4-2a, 4-2b Above-ground structures

These anomalies are located on farm buildings, as indicated on both the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) and the DOQQ (Vermillion, SW quadrant, 1993).

### 4-3 Above-ground structure

This anomaly is located over one of a cluster of buildings, as indicated on both the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) and the DOQQ (Vermillion, SW quadrant, 1993).

### 4-4 Priority A

This anomaly is located in a cultivated field east of a farmstead and south of the Vermillion River (Figure 11). No structures are visible on either the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) or the DOQQ (Vermillion, SW quadrant, 1993).

In this setting, the source likely derives from terrestrial activity. However, the source is also near terrace remnants marking old meanders of the Missouri River. The historic map of 1881 shows that this area was near the top of the large meander that once extended almost to the edge of the Missouri River bluffs at Vermillion (Figure 12). The ice gorge breakup earlier in 1881 caused the river to cut off this loop to the south and the meander became dry land.

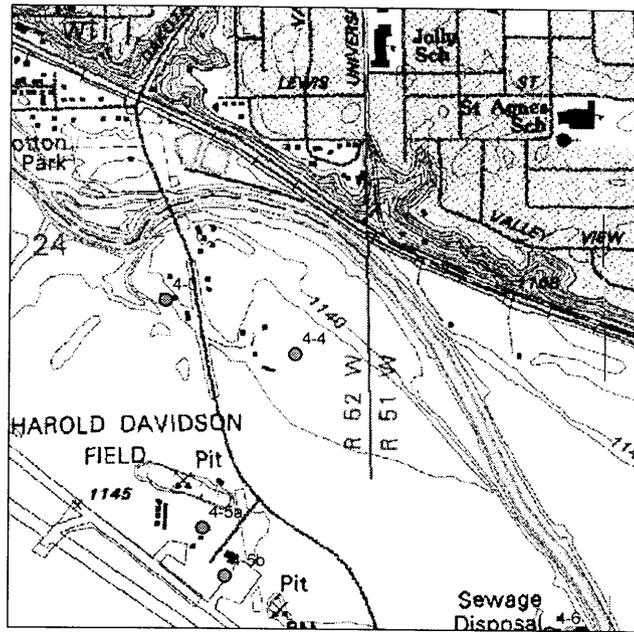


Figure 11 – Anomaly 4-4, extract from USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994

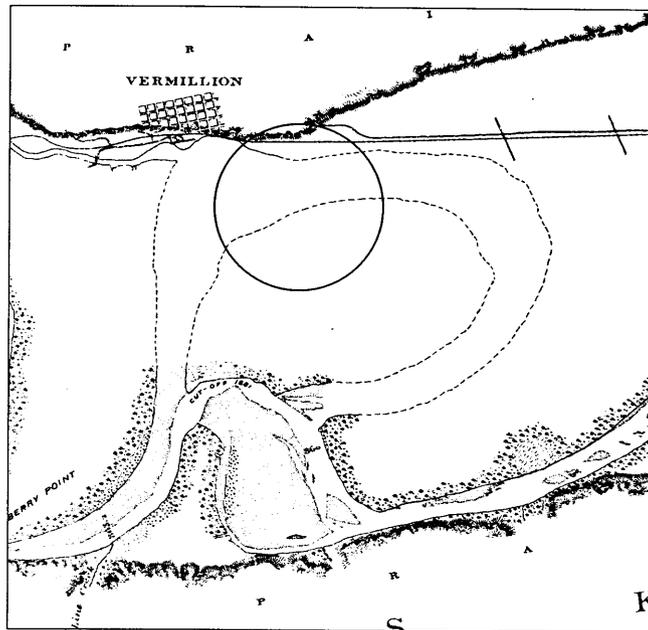


Figure 12 – Area of Anomaly 4-4, extract from *Map of the Missouri River, XXX, Corps of Engineers, 1881*

#### 4-5a, 4-5b Above-ground structures

These anomalies are located over buildings at Harold Davidson Field, the Vermillion airport, as shown on the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) and the DOQQ (Vermillion, SW quadrant, 1993).

#### 4-6 Above-ground structure

This anomaly is located over a building at the Vermillion Wastewater Treatment plant, as shown on the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) and the DOQQ (Vermillion, SW quadrant, 1993).

#### 4-7 Priority A

This anomaly is located in a cultivated field in an area of terrace remnants marking old meanders of the Missouri River (Figure 13). No structures are visible on either the DRG (USGS 7.5' Series, Maskell Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Maskell, NE quadrant, 1993).

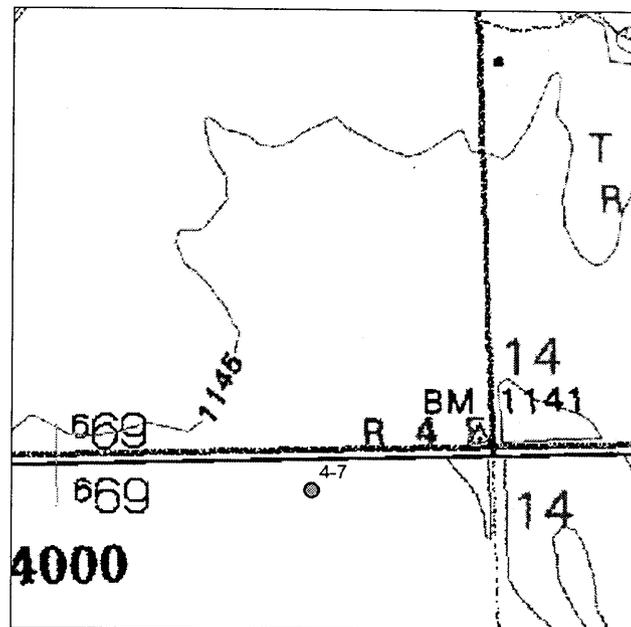


Figure 13 – Anomaly 4-7, extract from USGS 7.5' Series, Maskell Quadrangle, Nebraska and South Dakota, 1994

In this setting, the source likely derives from terrestrial activity. However, the source is also near terrace remnants marking old meanders of the Missouri River. The historic map of 1881 shows that this area was near the side of the large meander that once extended almost to the edge of the Missouri River bluffs at Vermillion (Figure 14). The ice gorge breakup earlier in 1881 caused the river to cut off this loop to the south and the meander became dry land.

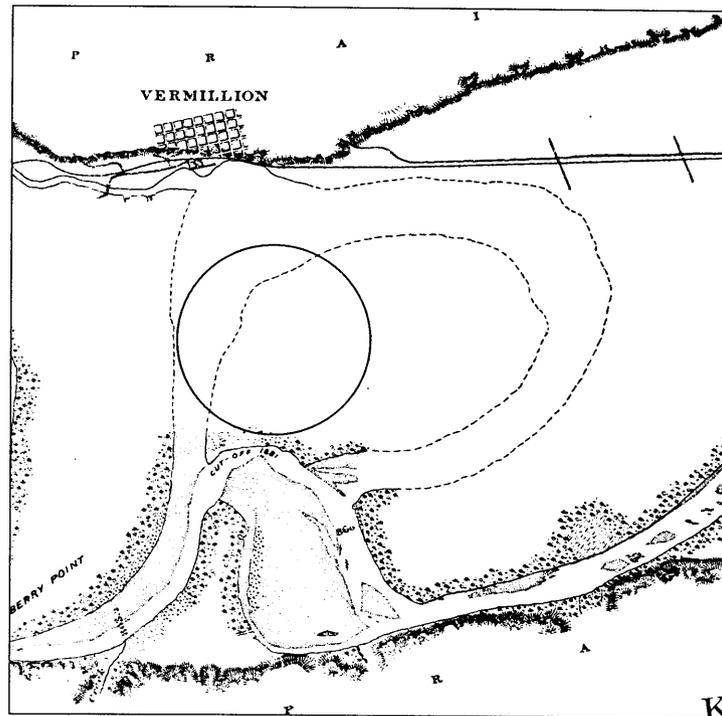


Figure 14 – Area of Anomaly 4-7, extract from *Map of the Missouri River*, XXX, Corps of Engineers, 1881

#### 4-8 Above-ground feature

This anomaly is located on the edge of a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Maskell Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Maskell, NW quadrant, 1993).

4-9 Priority A

This anomaly is located in the present Missouri River channel, off the eastern shore, as indicated on both the DRG (USGS 7.5' Series, Maskell Quadrangle, Nebraska and

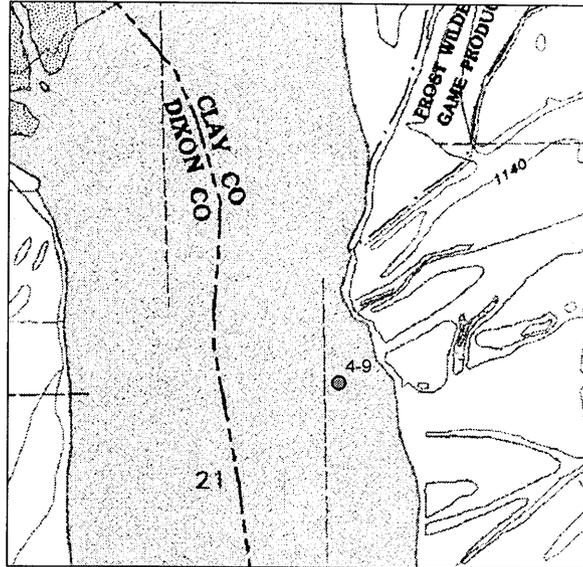


Figure 15 – Anomaly 4-9, extract from USGS 7.5' Series, Maskell Quadrangle, Nebraska and South Dakota, 1994

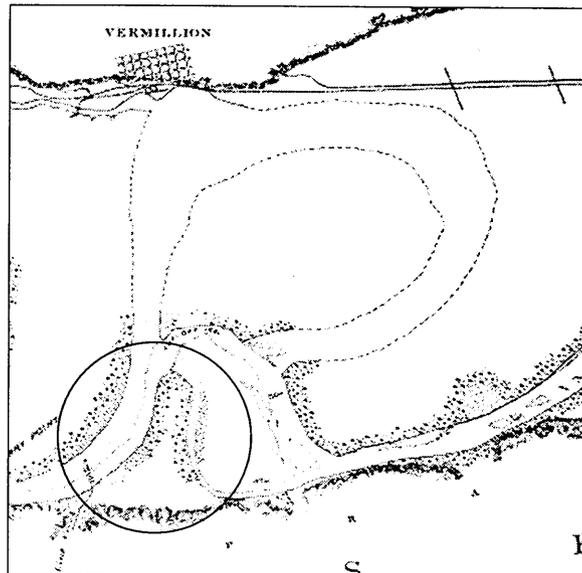


Figure 16 – Area of Anomaly 4-9, extract from *Map of the Missouri River, XXX, Corps of Engineers, 1881*

South Dakota, 1994) and the DOQQ (Maskell, NW quadrant, 1993) (Figure 15). The historic map of 1881 suggests that this location was possibly on dry land near the edge of the cut-off of 1881 (Figure 16).

#### 4-10 Priority A

This anomaly is located near the southern shoreline of the Missouri on a small creek that runs between several small landholdings with buildings (Figure 17). There is no visible structure on either the DRG (USGS 7.5' Series, Maskell Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Maskell, NW quadrant, 1993). In this setting, the source could derive from either riverine or terrestrial activity.

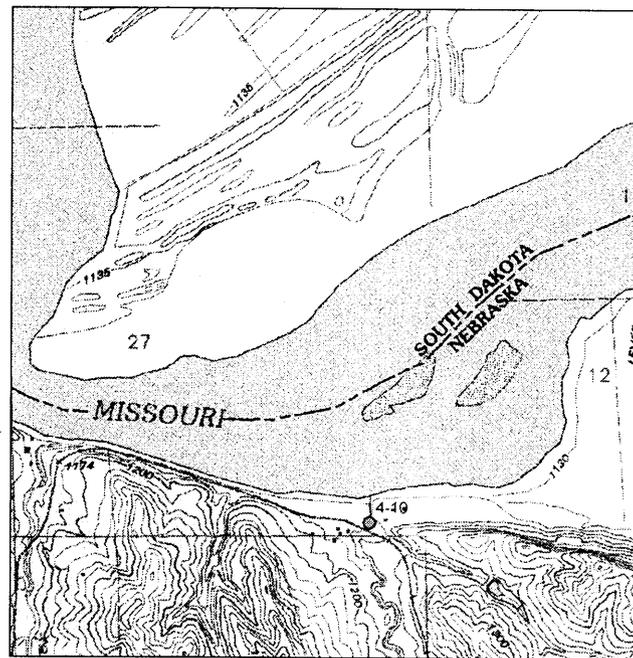


Figure 17 – Anomaly 4-10, extract from USGS 7.5' Series, Maskell Quadrangle, Nebraska and South Dakota, 1994

#### 4-11 Above-ground feature

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Maskell Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Maskell, NW quadrant, 1993).

#### 4-12 Above-ground feature

This anomaly is located on a railroad track. While no structures are visible on either the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) or the DOQQ (Vermillion, SE quadrant, 1993), the position of the anomaly strongly suggests an above-ground feature.

#### 4-13 Above-ground feature

This anomaly is located on a railroad track. While no structures are visible on either the DRG (USGS 7.5' Series, Vermillion Quadrangle, South Dakota and Nebraska, 1994) or the DOQQ (Vermillion, SE quadrant, 1993), the position of the anomaly strongly suggests an above-ground feature.

### Survey Block 5

#### 5-1 Above-ground structure

This anomaly is located above the river valley near the southern bluff edge in a complex of buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NW quadrant, 1993).

#### 5-2 Priority A

This anomaly is located near the Missouri River shoreline and adjacent to a farmstead (Figure 18). No structures are visible at the source on either the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Burbank, NW quadrant, 1993).

On the historic maps, this location is at the turn of the old Kate Sweeney bend, which is now dry land marked with series of terrace remnants extending towards the town of Burbank, South Dakota (Figure 19). In this setting, the source could derive from either riverine or terrestrial activity.

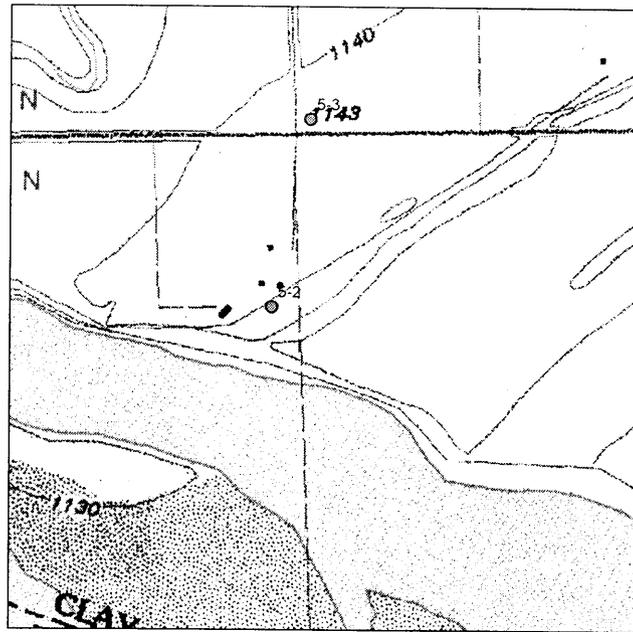


Figure 18 – Anomaly 5-2, extract from USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994

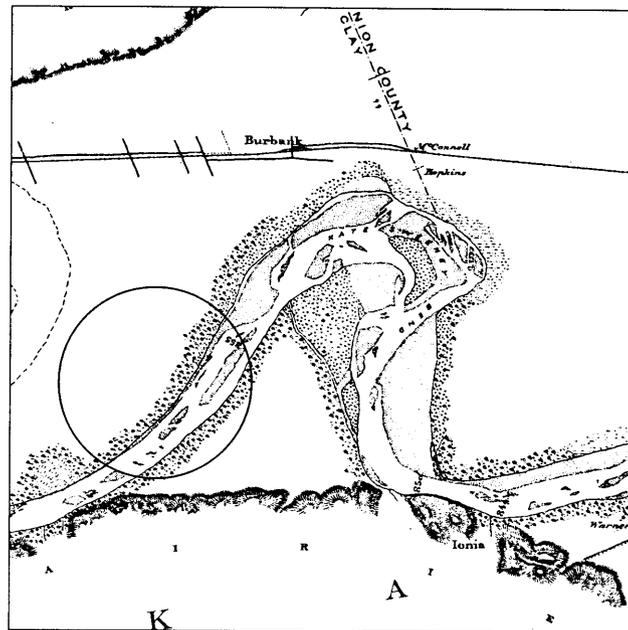


Figure 19 – Area of Anomaly 5-2, extract from *Map of the Missouri River*, XXX, Corps of Engineers, 1881

### 5-3 Above-ground structure

This anomaly marks a group of three metal silos, as indicated on the DOQQ (Burbank, NW quadrant, 1993).

### 5-4 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NW quadrant, 1993).

### 5-5 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Vermillion SE Quadrangle, South Dakota, 1969) and the DOQQ (Burbank, NW quadrant, 1993).

### 5-6 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

### 5-7 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

### 5-8 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

### 5-9 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

#### 5-10a, 5-10b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

#### 5-11 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

#### 5-12 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

#### 5-13 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

#### 5-14a, 5-14b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

#### 5-15a, 5-15b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, NE quadrant, 1993).

## 5-16 Priority A

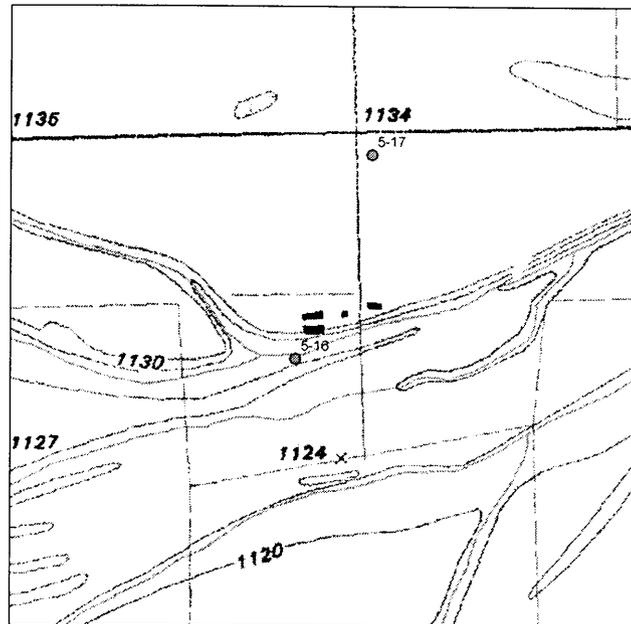


Figure 20 – Anomaly 5-16, extract from the USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994

This anomaly is located on cultivated land along the edge of an old Missouri shoreline, next to a farmstead (Figure 20). No structures are visible on either the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) or the DOQQ (Burbank, NE quadrant, 1993). The distance between the anomaly and the farmstead is within the margin of locational errors in the system, but the proximity of this source to an active river channel makes it possible that the source derives from riverine activity. The historic map of 1881 indicates that this was the active shoreline of the Missouri River in the late 19<sup>th</sup> century (Figure 21).

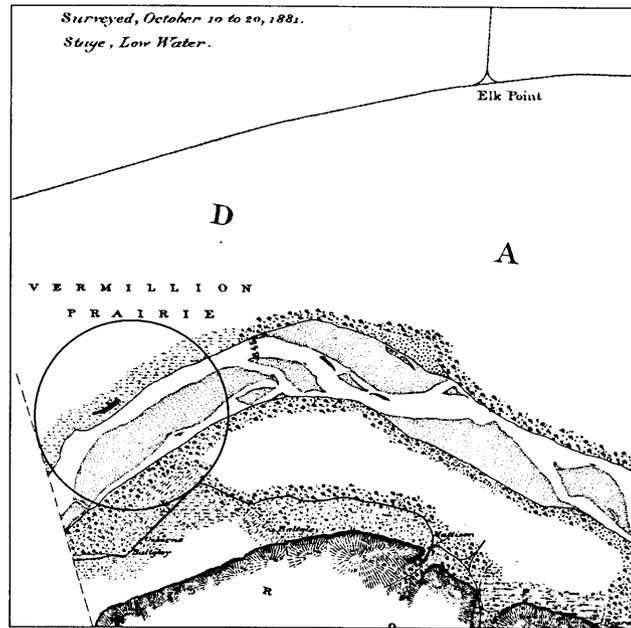


Figure 21 – Area of anomaly 5-16, extract from *Map of the Missouri River, XXIX, Corps of Engineers, 1881*

#### 5-17 Above-ground structure

This anomaly marks a group of metal silos, as indicated on the DOQQ (Burbank, NE quadrant, 1993).

#### 5-18 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, NW quadrant, 1993).

#### 5-19 Priority A

This anomaly is located at the edge of a paved road and railroad track (Figure 22). No structures are visible on either the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) or the DOQQ (Elk Point, NW quadrant, 1993). In this setting, the source likely derives from terrestrial activity.

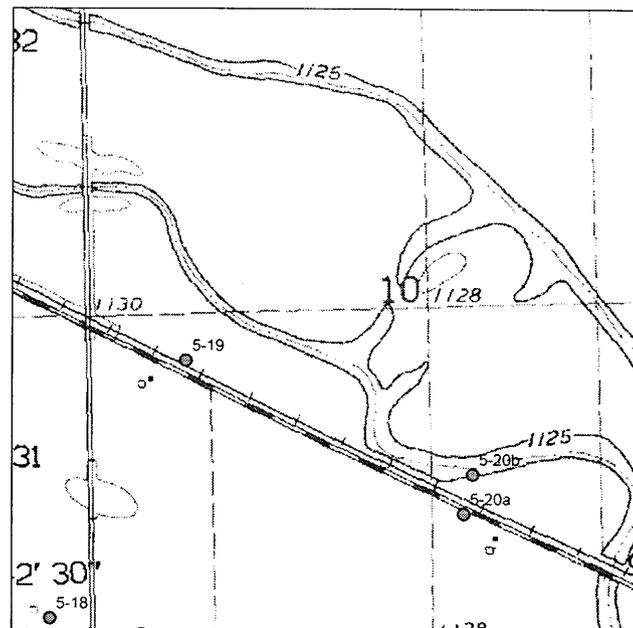


Figure 22 – Anomalies 5-19, 5-20a and 5-20b, extract from USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963

#### 5-20a Priority B

This anomaly is located at the edge of a paved road and railroad track (Figure 22). No structures are visible on either the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) or the DOQQ (Elk Point, NW quadrant, 1993). In this setting, the source likely derives from terrestrial activity.

#### 5-20b Priority B

This anomaly is located north of a paved road and railroad track, by an ephemeral creek (Figure 22). No structures are visible on either the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) or the DOQQ (Elk Point, NW quadrant, 1993). In this setting, the source likely derives from terrestrial activity.

#### 5-21 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, NW quadrant, 1993).

#### 5-22 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, NW quadrant, 1993).

#### 5-23 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, NW quadrant, 1993).

#### 5-24 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on the DOQQ (Elk Point, NW quadrant, 1993).

#### 5-25a, 5-25b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, NW quadrant, 1993).

#### 5-26 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, NW quadrant, 1993).

### **Survey Block 6**

#### 6-1a, 6-1b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, SE quadrant, 1993).

## 6-2 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, SE quadrant, 1993).

## 6-3 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Burbank, SE quadrant, 1993).

## 6-4a, 6-4b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRGs (USGS 7.5' Series, Burbank Quadrangle, Nebraska and South Dakota, 1994; Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Burbank, SE quadrant, 1993).

## 6-5 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SW quadrant, 1993).

## 6-6a, 6-6b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

## 6-7 Priority B

This anomaly is located in the present Missouri River channel, east of Ponca State Park, Nebraska, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993) (Figure 23). The historic maps show that the river channel was roughly in the same place in the late 19<sup>th</sup> century (Figure 24). In this setting, the source likely derives from riverine activity.

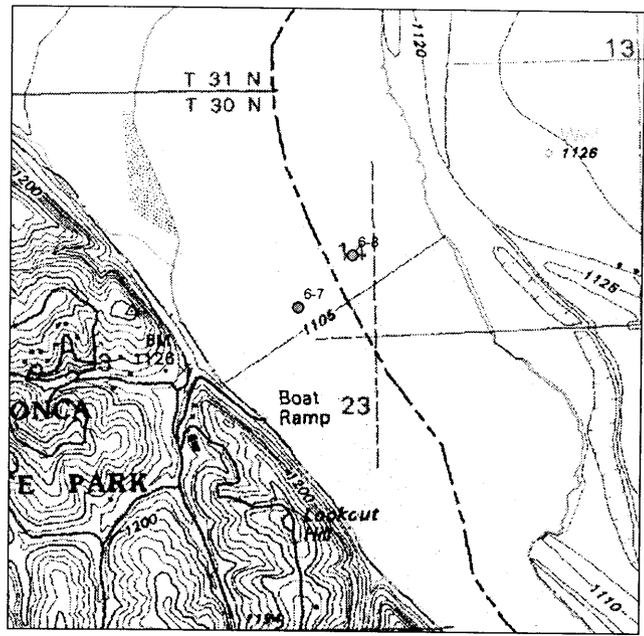


Figure 23 – Anomalies 6-7 and 6-8, extract from USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994

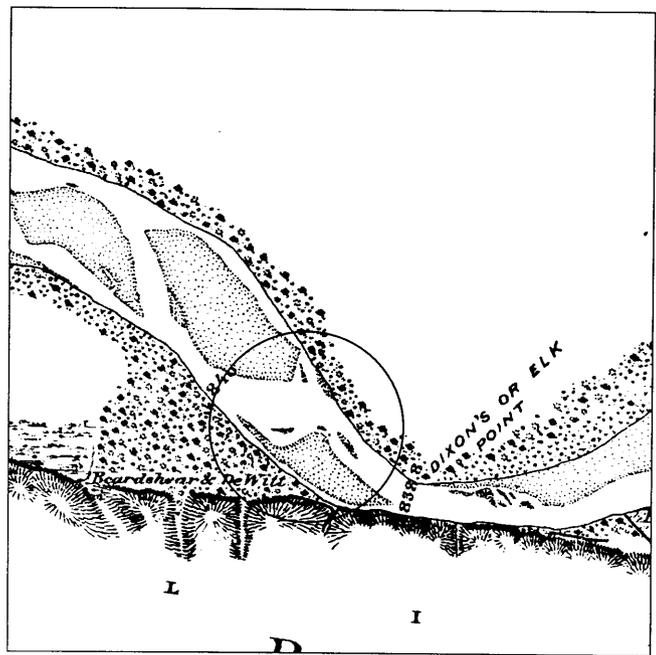


Figure 24 – Area of anomalies 6-7 and 6-8, extract from Map of the Missouri River, XXIX, Corps of Engineers, 1881

## 6-8 Priority B

This anomaly is located in the present Missouri River channel, east of Ponca State Park, Nebraska, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993) (Figure 23). The historic maps show that the river channel was roughly in the same place in the late 19<sup>th</sup> century (Figure 24). In this setting, the source likely derives from riverine activity.

## 6-9 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SW quadrant, 1993).

## 6-10a, 6-10b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SW quadrant, 1993).

## 6-11a, 6-11b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SW quadrant, 1993).

## 6-12a, 6-12b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

## 6-13a, 6-13b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

## 6-14a, 6-14b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

#### 6-15a, 6-15b Above-ground structures

These anomalies are located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

#### 6-16 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SE quadrant, 1993).

#### 6-17 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SE quadrant, 1993).

#### 6-18 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SE quadrant, 1993).

#### 6-19 Priority A

This anomaly is located in a cultivated field near a small farmstead in an area marked by old river channel remnants, as indicated on both the DRG (USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963) and the DOQQ (Elk Point, SE quadrant, 1993) (Figure 25). The historic maps show that this area was dry land in the late 19<sup>th</sup> century. In this setting, the source likely derives from terrestrial activity.

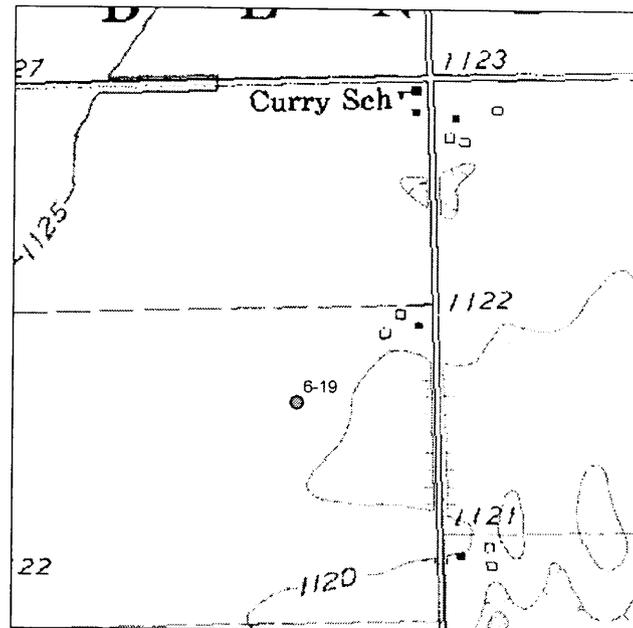


Figure 25 – Anomaly 6-19, extract from USGS 7.5' Series, Elk Point Quadrangle, South Dakota, Nebraska, Iowa, 1963

6-20 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

6-21 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

6-22 Above-ground structure

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

**6-23 Above-ground structure**

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

**6-24a Above-ground structure**

This anomaly is located in a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

**6-24b Above-ground structure**

This anomaly is located at a complex of farm buildings, as indicated on both the DRG (USGS 7.5' Series, Ponca Quadrangle, Nebraska and South Dakota, 1994) and the DOQQ (Ponca, NW quadrant, 1993).

**6. Spatial context of Priority A and B anomalies*****1. Underwater***

- 3-5 Priority A
- 4-9 Priority A
- 6-7 Priority B
- 6-8 Priority B

***2. Associated with the present Missouri River channel***

- 3-13 Priority A

***3. Associated with old Missouri River channels***

- 1-1 Priority A
- 1-2 Priority B
- 2-6 Priority A
- 5-2 Priority A

#### ***4. Possibly associated with old Missouri River channels***

3-15a Priority B  
3-16 Priority B  
4-4 Priority A  
4-7 Priority A  
4-10 Priority A  
5-16 Priority A

#### ***5. Probable land-based origin on the Missouri River floodplain***

5-19 Priority A  
5-20a Priority B  
5-20b Priority B  
6-19 Priority A

#### ***6. Uplands***

1-7 Priority B

### **7. Summary and Recommendations**

As outlined in the research design, a Stage 1 analysis provides the basic data for a set of magnetic anomalies that are hypothetically of cultural origin. ENW Services selected these targets from the raw data acquired during the aeromagnetic survey according to geophysical principals and analogies to previous non-cultural geophysical research. ARCHLAB then analyzed and interpreted the targets by reference to current and historic topographic base maps and aerial photographs. The results are as follows:

Above-ground structures: 99

Priority A anomalies: 12

Priority B anomalies: 8

While most targets turned out to be above-ground structures or features that are not germane to the goal of identifying the locations of potential steamboat wrecks or other buried cultural resources, this result is actually enormously valuable to the project. At the end of geophysical processing, all the anomaly sources were unknown; after map-based analysis, most of the anomalies can be associated with measurable structures or features. These data will feed into subsequent stages, allowing for a closer estimation of the magnetic signatures of cultural objects of all types in the landscape.

The Priority A and B anomalies remain unknown. These locations must now be ground-truthed (Stage 2) if the sources are to be identified. As four targets are in the present Missouri River channel and eleven, with varying degrees of confidence, may relate to older channels, the prospects for discovery of a steamboat wreck or other significant cultural feature remains promising.

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