U.S. Army Corps
of Engineers
Missouri River Division

Volume 7F: Environmental Studies

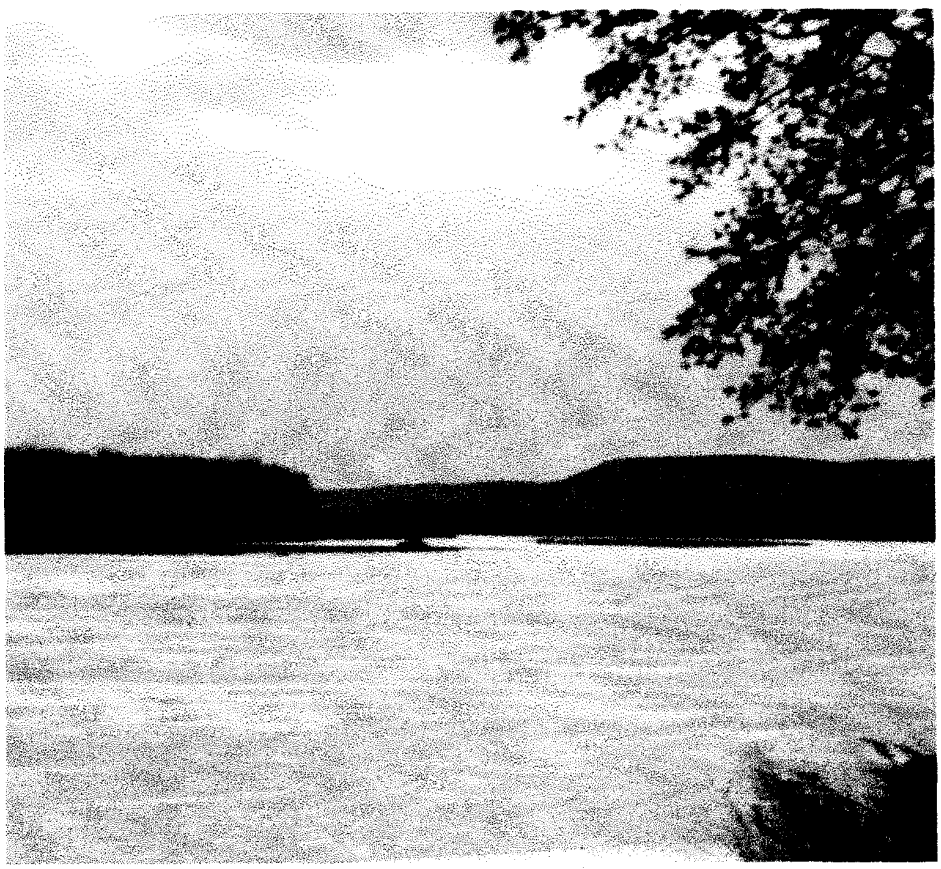
Wetland and Riparian

- Main Report
- Appendix A – Field and Mapping Methods
- Appendix B – Plant and Wildlife Species and Study Site Descriptions

Master Water Control Manual

MISSOURI RIVER

Review and Update



July 1994

Volume 1: Alternatives Evaluation Report

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Volume 7H: Environmental Studies
- Least Tern and Piping Plover
- Historic Properties
- Mississippi River Environment

Volume 8: Economic Impacts Model
Environmental Impacts Model

Volume 9: Socioeconomic Studies

Overview Discussion on the Reports that Were Prepared Summarizing the Supporting Technical Analyses for the Study

The Environmental Impact Statement (EIS) that was prepared for the Missouri River Master Water Control Manual Review and Update Study contains data that were generated by three primary models: (1) the Long Range Study (LRS) Model that computed the hydrology and other necessary data for subsequent analyses, 2) the Economic Impacts Model that computed the economic effects of the various alternatives, and 3) the Environmental Impacts Model that computed the environmental effects of the various alternatives. Numerous studies were conducted to provide the inputs to these models that allowed them to compute the effects of the alternatives. Detailed information on the development of the three models and their output was documented in reports prepared throughout the study. These reports were reproduced as technical reports supporting the EIS.

The inside cover of this document contains a listing of these technical reports. These reports are numbered from Volume 1 through Volume 9. The following synopses provide a brief overview of the volumes.

Volume 1 Contains output data from the three models on the array of alternatives considered for the draft EIS. It also discusses the data and the results of the analyses of these data.

Volume 2 Provides information on the LRS Model and summarizes some of the analyses that were done on the output data to demonstrate the model's capabilities and data analysis.

Volume 3 Consists of three reports reproduced in two separately bound volumes that summarize the results of analyses to determine the low-flow requirements for the uses relying on the Missouri River downstream from Gavins Point Dam.

Volume 4 Summarizes the hydraulic studies conducted on the river reaches upstream from Gavins Point Dam where daily peaking of the hydropower generators results in stage fluctuations throughout the day.

Volume 5 Contains a compilation of existing data on Missouri River aggradation, degradation, and water quality.

Volume 6 Consists of five separately bound volumes that summarize the data acquisition efforts, the analysis of these data to develop the various parts of the Economic Impacts Model, and the economic effects of some of the alternatives. The last of these bound volumes (Volume 6E) summarizes the Missouri River basin Multi-Regional Input-Output (MRIO) Model that was used to compute the total regional economic effects of some of the alternatives using output from the Economic Impacts Model.

Volume 7 Consists of eight separately bound volumes (19 documents) that summarize the data acquisition efforts, the analysis of these data, and the development of numerous computer models. These models computed the relationships used in the Environmental Impacts Model and provided the results of the model runs for some of the resources evaluated.

Volume 8 Consists of two reports: one on the Economic Impacts Model and one on the Environmental Impacts Model. These two reports provide some insight as to how the models are set up and how they work.

Volume 9 Summarizes background socioeconomic data on various subregions in the United States and provides more detailed information on the subregions within the Missouri River basin. This volume also summarizes the results of the socioeconomic analysis of a small sample set of alternatives from the large array of alternatives considered for the draft EIS.

Readers of the EIS are referred to these technical reports for details on the studies that were conducted in support of the EIS. These documents are referenced in the EIS whenever the information or data being presented is supported by these technical reports. A variety of organizations prepared these reports and their different formats reflect this diversity. Also, these reports are intended for a technically-oriented audience rather than the public.

At the front of each of these reports is a brief summary of the content of the report containing more detail than provided above. This summary is to help in selecting the appropriate report from the numerous volumes listed.

Missouri River Master Water Control Manual

Review and Update Study

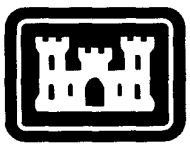
Volume 7F: Environmental Studies

Wetland and Riparian

Technical Report •

Appendix A – Field and Mapping Methods •

Appendix B – Plant and Wildlife Species Study •
Site Descriptions



U.S. Army Corps
of Engineers
Missouri River Division

July 1994

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Wetland and Riparian Main Report

Missouri River Master Water Control Manual

Review and Update Study

Volume 7F: Environmental Studies
Wetland and Riparian
Main Report

Wetlands and riparian areas are significant resources along the Missouri River, providing important fish and wildlife habitat. These resources required evaluation as part of the review and update of the Missouri River Water Control Master Manual. This review and update process included: (1) a field and mapping exercise to estimate the amount and types of wetland/riparian resources along the river and in reservoir deltas; (2) development of a model that would simulate annual changes in the acreage of wetland/riparian resources as a function of Missouri River flows and lake levels; and (3) application of the model to evaluate the effects of the alternative water control plans on wetlands/riparian resources.

Wetlands and riparian habitats along the Missouri River between the Fort Peck Lake delta in Montana and St. Louis, Missouri were inventoried, field investigated, and mapped in 1991. Results indicate that the deltas and riverine reaches of this 1,900-mile stretch of river support approximately 112,500 acres of wetlands. This same area contains about 911,582 of non-wetland riparian vegetation, including agricultural lands.

To evaluate the relative effects of water control plan alternatives on wetlands and riparian vegetation along the Missouri River, a computer model was developed to simulate changes in the resource type and acreage as a function of various hydrology and vegetation response factors. The assumption underlying this model is that the quantity of wetland and riparian vegetation is related to three main factors: (1) water surface elevation; (2) frequency, duration, and depth of inundation; and (3) successional processes.

The overall process of developing the wetlands/riparian resource model involved three steps: (1) determining hydrologic response and succession for the wetlands and riparian vegetation along the Missouri River; (2) integrating this information with monthly hydrology data; and (3) creating an accounting program to track changes in acreage over a 93-year simulation period. Consequently, the wetland/riparian model consists of three major components—ecological, hydrological, and accounting—with operations that are performed sequentially for each year of simulation for each water control plan alternative.

Input to the model included data on acreage, elevation, and wetland/riparian type obtained during the field and mapping process and monthly hydrological data for a given alternative. The results provided an estimate of the effects of that alternative on each wetland/riparian type for the entire river. Output from the wetland/riparian model was then used to compare the effects of various alternative water control plans on these resources along the Missouri River.

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LIST OF ABBREVIATIONS AND ACRONYMS

cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
EIS	Environmental Impact Statement
GIS	Geographic Information System
LRS	Long Range Study
MRBC	Missouri River Basin Commission
NEPA	National Environmental Policy Act
NWI	National Wetland Inventory
POG	points of ground
RM	river mile
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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INTRODUCTION

The U.S. Army Corps of Engineers' (Corps) Master Water Control Manual (Master Manual) for operating the six multi-purpose reservoir projects on the mainstem Missouri River is currently being reviewed and updated. As part of this review, an Environmental Impact Statement (EIS) is being developed according to National Environmental Policy Act (NEPA) requirements. The EIS addresses the impacts of various water control plan alternatives, each representing different reservoir pool levels and releases on natural resources. This report supports the EIS and covers the following topics: (1) the wetland and riparian resources along the Missouri River downstream of the Fort Peck delta; (2) the development of a wetland and riparian resource model, which is a tool for relating changes in these resources to changes in river flow and reservoir levels; and (3) application of the model to the results of the Corps' Long Range Study (LRS) model to estimate impacts on wetlands and riparian resources from the water control plan alternatives. The following five sections in this introduction discuss: (1) the purpose and need for determining the effects of different alternatives on the wetlands and riparian resources along the Missouri River; (2) the study area; (3) the classification system used to characterize wetlands and riparian areas; (4) the general approach used to evaluate the water control plan alternatives on wetland and riparian resources; and (5) coordination with the Missouri River Subcommittee.

PURPOSE AND NEED

Prior to construction of the mainstem reservoir projects, the unregulated Missouri River had created a wide, active floodplain through the processes of erosion and deposition. The side channels, backwaters, and oxbows associated with the river provided habitat for emergent and scrub-shrub wetlands. The floodplain supported extensive stands of deciduous forest in various stages of succession (Wilson 1970). Periodic flooding removed the vegetation along the river channel, eroded banks, and occasionally inundated large portions of the floodplain (Wilson 1970). Sediment deposited by floods formed islands and sandbars that provided new sites for the establishment of willows (*Salix* spp.) and cottonwood (*Populus deltoides*) that dominated young forest stands along the entire river. Mature stands were dominated by green ash (*Fraxinus pennsylvanica*) along the upper reaches above Omaha, Nebraska and by a mixture of hardwoods, including American elm (*Ulmus americana*), silver maple (*Acer saccharinum*), sycamore (*Plantanus occidentalis*), hackberry (*Celtis occidentalis*), and mulberry (*Morus alba*) along the lower portions (Bragg and Tatschl 1977, Corps 1974).

Despite the effects of development and agriculture, the Missouri River floodplain currently supports significant stands of riparian forest and includes numerous old channels that have been cut off from the river and formed oxbow lakes. Within some reaches of the active river channel, the processes of erosion and deposition continue to create islands, sandbars, chutes, and backwaters that support a variety of wetlands. In addition, each lake associated with the six dams along the river has mainstem or side tributary deltas that support extensive wetland complexes. The wetlands along the river and in deltas serve many important functions including habitat for waterfowl, big game, furbearers, and other wildlife;

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fish breeding and foraging habitat; nutrient/sediment trapping; flood control; and recreation. Riparian forests serve as important wildlife habitat, timber sources, wind shelters for residences, and locations for recreational activities. Because of the importance of wetlands and riparian areas, particularly in the semi-arid Great Plains, Federal regulations and directives require that the Corps assess the impacts of different water control plan alternatives on these resources.

STUDY AREA

The Missouri River originates on the eastern slopes of the Rocky Mountains in Montana and flows 2,341 miles through Montana, North Dakota, South Dakota, Iowa, Nebraska, Kansas, and Missouri to its confluence with the Mississippi River near St. Louis, Missouri (Figure 1). The Missouri River is the second longest river in the United States and its basin drains approximately 529,350 square miles. The primary tributaries are the Yellowstone, Platte, and Kansas rivers.

The Corps completed six dams on the mainstem Missouri River between 1938 and 1964 for flood control, hydroelectric power production, navigation, irrigation, and water supply. The three most upstream dams, Fort Peck, Garrison, and Oahe, occur at river miles (RM) 1771, 1390, and 1072, respectively, and impound approximately 540 miles of the river from eastern Montana to South Dakota. The gross storage capacity of the lakes associated with these dams is about 62.3 million acre-feet, or roughly three times the annual inflow to this reach. Inflow comes primarily from snow melt in the Rocky Mountains and the Great Plains. The lower three dams, Big Bend (RM 987), Fort Randall (RM 880), and Gavins Point (RM 811), impound approximately 220 miles of river in South Dakota and Nebraska. Their gross storage is about 6.8 million acre-feet. Inflows to the lakes behind these three dams are controlled to a large degree by the releases from the upper three dams; tributaries contribute only a small portion.

River reaches of varying lengths exist below each of the dams except Big Bend Dam. Upstream of Ponca, Nebraska, the river channel has been altered only slightly by bank stabilization projects. Two separate river reaches, one between Fort Randall and Gavins Point dams, and the other between Gavins Point Dam and Ponca, are designated as National Recreational Rivers. However, the Missouri River from Ponca downstream to its mouth near St. Louis has been altered by the completion of the Missouri River Bank Stabilization and Navigation Project. In this 754-mile reach, the river channel has been altered from a wide, meandering-to-braided form to one that is narrow and gently sinuous.

The study area for the wetland/riparian analyses for the Missouri River Master Manual EIS extends from the Fort Peck Lake delta downstream to the mouth at St. Louis, approximately 1,900 river miles. This area includes the following:

- the deltas of Fort Peck Lake, Lake Sakakawea, Lake Oahe, and Lewis and Clark Lake;

- the riverine reaches downstream of Fort Peck, Garrison, and Fort Randall;

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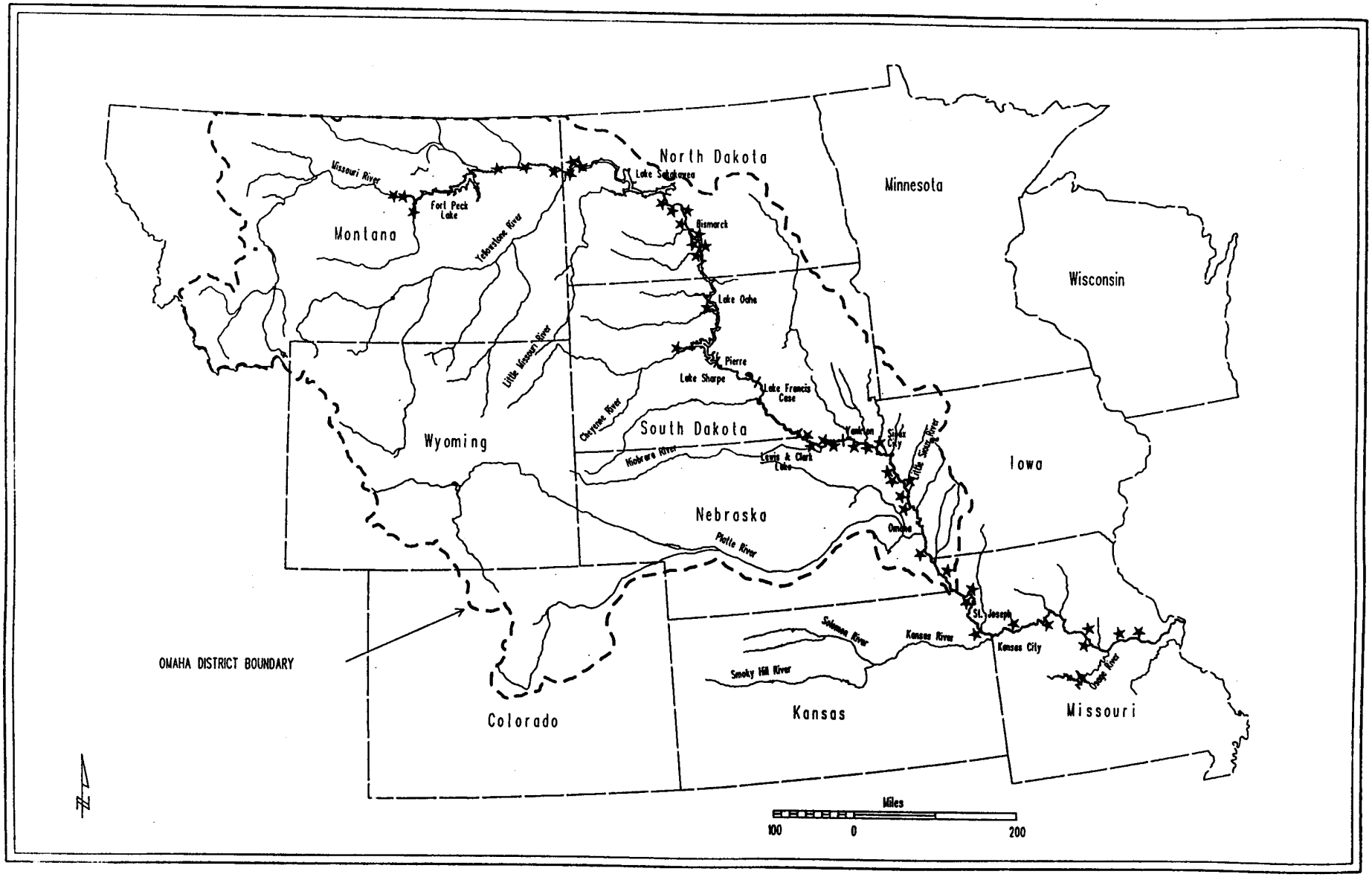

Figure 1. Study area. Stars denote approximate location of wetland study areas.

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- the entire river from Gavins Point Dam downstream to St. Louis; and

- the floodplain associated with the deltas and riverine reaches.

The elevations in the study area range from approximately 2,236 feet above mean sea level (msl) at Fort Peck to less than 500 feet msl near the mouth. Thornwaite (1948) described the climate of the Missouri River Basin as dry subhumid mesothermal, but it is extremely variable reflecting the extensive area, the wide range in elevations, and the Missouri River Basin's location in the central portion of North America. This climatic variation occurs both seasonally and yearly, as evidenced by the several periods of drought. Average annual precipitation ranges from 8 to 40 inches (Corps 1991).

For the purpose of the Master Manual EIS, the study area was divided into two main sections, based on climate and physiography: the upper river and the lower river. The upper river extends from the Fort Peck delta in central Montana to Ponca, just upstream from Sioux City, Iowa. This reach encompasses the ponderosa pine, prairie, and plains grassland ecosystems defined by the USDA Forest Service (1977). Natural upland vegetation consists primarily of grasslands. The climate along the upper river is characterized by cold winters with variable amounts of snowfall (30 to 50 inches) and hot dry summers (Corps 1991). Average temperatures at Fort Peck range from 12°F in January to 72°F in July (NOAA 1990). The growing season in the upper basin is relatively short, extending from late May to early September (NOAA 1990). Near Sioux City, average temperatures range from about 20°F in January to 75°F in August (NOAA 1990). The growing season in this region is from late April-early May to late September-early October. The upper river contains all six of the Corps' reservoirs and five riverine reaches including: Fort Peck Dam to Lake Sakakawea; Garrison Dam to Lake Oahe; Oahe Dam to Lake Sharpe; Fort Randall Dam to Lewis and Clark Lake; and Gavins Point Dam to Ponca, Nebraska (unchannelized reach).

The lower river extends from Ponca to St. Louis and lies within the plains grassland and oak-hickory forest ecosystems. The northern portion of the lower river is characterized by grasslands (USDA 1977). As the river turns east, rolling hills forested with oak, hickory, and maple predominate the landscape. The climate along the lower river is more mild; temperatures average 28°F in January and 79°F in July, with the growing season extending from early April to late October-early November (NOAA 1990). The lower river has no reservoirs and is divided into three river reaches: Ponca to Omaha, Nebraska; Omaha to St. Joseph, Missouri; and St. Joseph to St. Louis.

The Federal government owns lands surrounding each of the reservoirs. These lands are mostly administered by the Corps, but large tracts are leased to state and Federal fish and wildlife agencies for management. In Montana, the U.S. Fish and Wildlife Service (USFWS) operates the large Charles M. Russell National Wildlife Refuge, which includes holdings along the upper end of Fort Peck Lake. USFWS also manages Lake Audubon near Garrison Dam and owns and operates two large areas downstream of the mainstem dams: the DeSoto Bend, and Squaw Creek National Wildlife refuges. The U.S. National Park Service manages several National Historic Sites along the river in North Dakota and has

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management responsibilities, along with the Corps, for two nationally designated recreational river reaches along the Missouri River: Fort Randall Dam to Running Water and Gavins Point Dam to Ponca. Several Native American tribes have jurisdiction adjoining Federal lands along Lake Sakakawea and Lake Oahe.

Lands adjoining riverine reaches tend to be intensively farmed or grazed and are mostly in private ownership. However, tribal lands exist along the river below Fort Peck, Fort Randall, and Gavin Point dams, and state fish and wildlife or natural resource agencies own and/or manage many tracts of land along the middle and lower river for recreation or fish and wildlife habitat. A few smaller river-front areas are owned and operated by city or county governments for recreational access to the river.

WETLAND AND RIPARIAN RESOURCE CLASSIFICATION SYSTEM

This section describes the classification system used to define the different types of wetland and riparian resources along the Missouri River.

Wetland Types

The USFWS's wetlands classification system, commonly referred to as the Cowardin System (Cowardin et al. 1979), was used as the conceptual basis for defining and mapping the wetlands along the Missouri River. According to Cowardin et al. (1979),

> "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soils; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some point during the growing season."

Conversely, lands that are permanently flooded are defined as deepwater habitats (Cowardin et al. 1979). Deepwater habitats are lands that are generally covered with water that is too deep to support emergent vegetation. These areas may support aquatic plants, but water, not soil, is considered the principal medium (Cowardin et al. 1979).

Within these broad definitions for wetlands and deepwater habitats, Cowardin et al. (1979) described five different systems, each characterized by similar hydrologic, geomorphologic, chemical, or biological factors. These five systems are the following: (1) palustrine, (2) lacustrine, (3) riverine, (4) estuarine, and (5) marine (Cowardin et al. 1979). Each system is hierarchical and subdivided into subsystems, classes, subclasses, and dominance types. Wetland and deepwater types are defined, at a minimum, by system and class. Classes describe the appearance of vegetation or substrate/physiography (e.g., forested, rocky shore). Classes are further refined by modifiers that represent vegetation,

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soil, hydrology, and water chemistry (Cowardin et al. 1979). This system is used by the USFWS in the National Wetlands Inventory (NWI).

Three different wetland and deepwater systems occur along the Missouri River (Table 1): palustrine, lacustrine (lake), and riverine (river): Each of these systems contain two to five classes applicable to the vegetation or substrate/physiography in the study area (Table 1). Four of the hydrology modifiers defined by the Cowardin System are appropriate to the various water regimes in the study area. The hydrology modifiers were further refined for this analysis according to the definitions of Mitsch and Gosselink (1986).

Based on the definitions of wetland/deepwater system, class, and hydrology, 11 palustrine types, 3 lacustrine types, and 3 riverine types were selected for mapping along the Missouri River (Table 2). All palustrine types are considered wetlands and include those areas traditionally called wetlands, such as marshes, swamps, and bogs (Cowardin et al. 1979). Palustrine wetlands usually support vegetation; along the Missouri River the most common types are forest, scrub-shrub, emergent, and aquatic bed (Table 2). Lacustrine and riverine types include both wetlands and deepwater habitats. The two wetland types, lacustrine unconsolidated shore and riverine unconsolidated shore, include open shorelines and flats along lakes, reservoirs, and rivers that are exposed to frequent water fluctuations. Unconsolidated shore wetlands are typically transitional but may support some vegetation, usually pioneering plants that are mesophytic. The deepwater habitats, lacustrine unconsolidated bottom and riverine unconsolidated bottom, are areas that are usually permanently flooded such as reservoirs, lakes, and river channels. These habitats were mapped for the Missouri River deltas and riverine reaches because they potentially convert to wetlands under drought conditions and provide a means for estimating the amount of open water in the study area.

Riparian Types

In general, riparian vegetation refers to the plant communities, both upland and wetland, growing within the floodplain of a stream or river. In this study, the term riparian applies specifically to the upland, or non-wetland, component of the Missouri River floodplain. Upland plant communities do not meet the vegetation, hydrology, or soils criteria that define wetlands. Typically occurring at higher elevations than wetlands, riparian communities are characterized by soils that are drier and better drained, and occasional intermittent flooding. Intermittent flooding is defined as inundation or saturation for less than 2 percent of the growing season for 1 to 10 years out of every 100 years (Mitsch and Gosselink 1986).

The vegetation in riparian areas is usually transitional, including plants found in both upland and wetland communities. Cottonwood, box elder (*Acer negundo*), and green ash are probably the most common species in the riparian forests and shrublands along the river, although other tree species such as silver maple, sycamore, mulberry and elm (*Ulmus* spp.) are prevalent downstream of Kansas City, Missouri. Three riparian vegetation types were identified along the Missouri River (Table 2). Some areas of cropland were included in the riparian grassland type; major crops are small grains, corn, and alfalfa.

EXHIBIT 690 022022

Table 1. System, class, and hydrology definitions for Missouri River wetlands and deepwater habitats. 1 of 2

System:	**Palustrine (P)** All nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent lichens, or mosses. Also includes wetlands lacking vegetation but less than 20 acres in size with water depths less than 6 feet.
	Riverine (R) All wetlands and deep water areas contained within a channel except those dominated by trees, shrubs, persistent emergents, emergent lichens, or mosses. Associated with flowing water.
	Lacustrine (L) All wetlands and deep water areas contained in a basin and meeting the following criteria: 1) situated in a topographic depression or dammed river channel; 2) lacking trees, shrubs, persistent emergents, emergent lichens, or mosses with greater than 30 percent aereal coverage; and 3) total area exceeds 20 acres.
Classes:	**Forested (FO)** Characterized by woody vegetation greater than 20 feet tall.
	Scrub-Shrub (SS) Dominated by woody vegetation less than 20 feet tall.
	Emergent (EM) Dominated by emergent herbaceous plants, either persistent or nonpersistent.
	Aquatic Bed (AB) Dominated by plants that grow on or below the surface of the water.
	Unconsolidated Shore (US) Characterized by: 1) unconsolidated substrates with less than 75 percent areal coverage of stones, boulders, or bedrock; 2) less than 30 percent areal coverage of vegetation other than pioneering plants; and 3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded. Unconsolidated shores with greater than 30 percent cover of pioneer plants are designated as unconsolidated shore, vegetated (US5).
	Unconsolidated Bottom (UB) All wetland and deep water areas with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent. Water regimes include permanently flooded, intermittently exposed, and semipermanently flooded.
Water Regime:	**Open Water (H):** Water covers the area throughout the year except during an extreme drought. This category represents a combination of the "permanently flooded" and "intermittently exposed" hydrology definitions from the Cowardin System. For the Missouri River, open water was defined to include those areas without vegetation that were flooded at the time of sampling or on the date that the aerial photographs were taken. Open water areas are shallow and may support a variety of aquatic and semi-aquatic plants. Areas flooded with greater than 6 feet of water usually do not support vegetation and are not considered wetlands. These areas are classified as deepwater habitats.

EXHIBIT 690 022023

Table 1. System, class, and hydrology definitions for Missouri River wetlands and deepwater habitats. 2 of 2

Semipermanently Flooded (F)
Surface water persists for most of the growing season in most years. When surface water is absent, the water table is typically at or very near the surface. More specifically, semipermanently flooded is defined as inundation or saturation for greater than 25 percent of the growing season, for at least 51 out of every 100 years.

Semipermanently flooded areas are generally dominated by obligate wetland plants such as cattails. Obligate wetland plants almost always (>99 percent) occur in semipermanently flooded wetlands.

Seasonally Flooded (C)
Surface water is present for extended periods during the growing season but absent by the end of the growing season in most years. When surface water is absent, the water table is often near the surface. More specifically, seasonally flooded is defined as inundation or saturation for 12.5 to 25 percent of the growing season, for at least 51 out of every 100 years.

Seasonally flooded areas usually contain a mix of obligate and facultative wetland plants; a few facultative plants may occur as well. Facultative wetland plants usually occur (67 to 99 percent) in wetlands but are occasionally found in uplands. Facultative plants are equally likely to occur in wetlands or uplands.

Temporarily Flooded (A)
Surface water is present for brief periods during the growing season in most years, but the water table usually lies well below the soil surface for most of the season. More specifically, temporarily flooded is defined as inundation or saturation for 2 to 12.5 percent of the growing season, for at least 11 to 50 out of every 100 years.

Temporarily flooded areas generally support facultative wetland plants as well as facultative plants and, in some years, may include plants usually restricted to upland locations.

Sources: Cowardin et al. 1979; Mitsch and Gosselink 1986; Reed 1988

Table 2. Missouri River wetland, deepwater, and riparian types.

Wetlands

Palustrine Types

- Palustrine Emergent, Semipermanently Flooded (PEMF)
- Palustrine Emergent, Seasonally Flooded (PEMC)
- Palustrine Emergent, Temporarily Flooded (PEMA)[1/]
- Palustrine Scrub-Shrub, Seasonally Flooded (PSSC)
- Palustrine Scrub-Shrub, Temporarily Flooded (PSSA)
- Palustrine Forest, Seasonally Flooded (PFOC)
- Palustrine Forest, Temporarily Flooded (PFOA)
- Palustrine Aquatic Bed (PABH)[2/]
- Palustrine Unconsolidated Shore (PUS)[3/]
- Palustrine Unconsolidated Shore, Vegetated (PUS5)[3/]
- Palustrine Unconsolidated Bottom (PUBH)[2/]

Riverine Types

- Riverine Unconsolidated Shore (RUS)
- Riverine Unconsolidated Shore, Vegetated (RUS5)

Lacustrine Types

- Lacustrine Unconsolidated Shore (LUS)
- Lacustrine Unconsolidated Shore, Vegetated (LUS5)[1/]

Deepwater Habitats

- Riverine Unconsolidated Bottom (RUBH)
- Lacustrine Unconsolidated Bottom (LUBH)

Riparian Types

- Riparian Grassland[1/]
- Riparian Shrubland
- Riparian Forest

1/ These types include some agricultural lands.
2/ These shallow water types were mapped but represented a small amount of acreage. For reporting purposes, they were combined with LUBH.
3/ These types were mapped but were combined with LUS and LUS5, respectively, for summarization.

EXHIBIT 690 022025

GENERAL APPROACH

The general approach to resource impact assessment typically includes three major steps: (1) characterize existing conditions; (2) develop methods or tools (such as models) to estimate the impacts; and (3) apply the methods to compare the impacts of the alternatives under consideration. Application of these steps to the analysis of impacts from the various water control plan alternatives on wetland and riparian resources along the Missouri River is described below and diagrammed in Figure 2.

Characterization of Existing Conditions

Documenting the extent, condition, and types of existing wetlands and riparian resources in the study area was a prerequisite to evaluating the effects on these resources resulting from changes in water management. Characterizing the existing Missouri River floodplain environment involved four major tasks: (1) review of existing maps and acreage data; (2) additional mapping using recent aerial photography followed by field verification; (3) development of a database of wetland and riparian acreages; and (4) quantitative field surveys. The first three tasks resulted in acreage estimates of the wetland and riparian resources, by type, potentially affected by the water control plan alternatives. The fourth task provided data on species composition, condition, and the elevational distribution of these resources.

Existing Maps and Databases. Two existing databases covering major portions of the study area were reviewed: the USFWS's NWI, and the Missouri River Basin Commission (MRBC) maps. The NWI covers most of the United States (1:24,000 scale), but at the time of mapping, had not been completed for extensive areas in the central portion of the country. Areas along the Missouri River not yet mapped included Lake Oahe, Lake Sharpe, the entire riverine/reservoir system in Montana, and parts of the river downstream of Sioux City. Use of the NWI maps for this project was also limited by other factors: (1) exclusion of riparian areas not classified as wetland; (2) derivation, in many instances, from relatively out-dated aerial photography (1979); (3) no coverage of reservoir areas below the high water mark, resulting in the exclusion of wetlands that have developed in the deltas; and (4) no acreage summaries.

The MRBC inventoried wetlands as well as non-wetland riparian areas along the Missouri River from Ponca to St. Louis (lower river). All of the MRBC mapping was based on aerial photographs taken in 1979. Each of the maps (1:24,000 scale) included a summary of the amounts of various wetland and riparian types by map and county.

Mapping. The purpose of additional mapping of wetlands and riparian areas on aerial photographs was to fill the gaps in the existing mapped data and to develop a method for updating NWI and MRBC maps to 1991 conditions. True-color aerial photography taken in 1990 and 1991 provided the basis for updating and supplementing the mapping for reaches upstream of Ponca (upper river). Mapping the lower river was based on a combination of true-color and black and white aerial photographs (1:24,000 scale) taken in 1985 and 1986.

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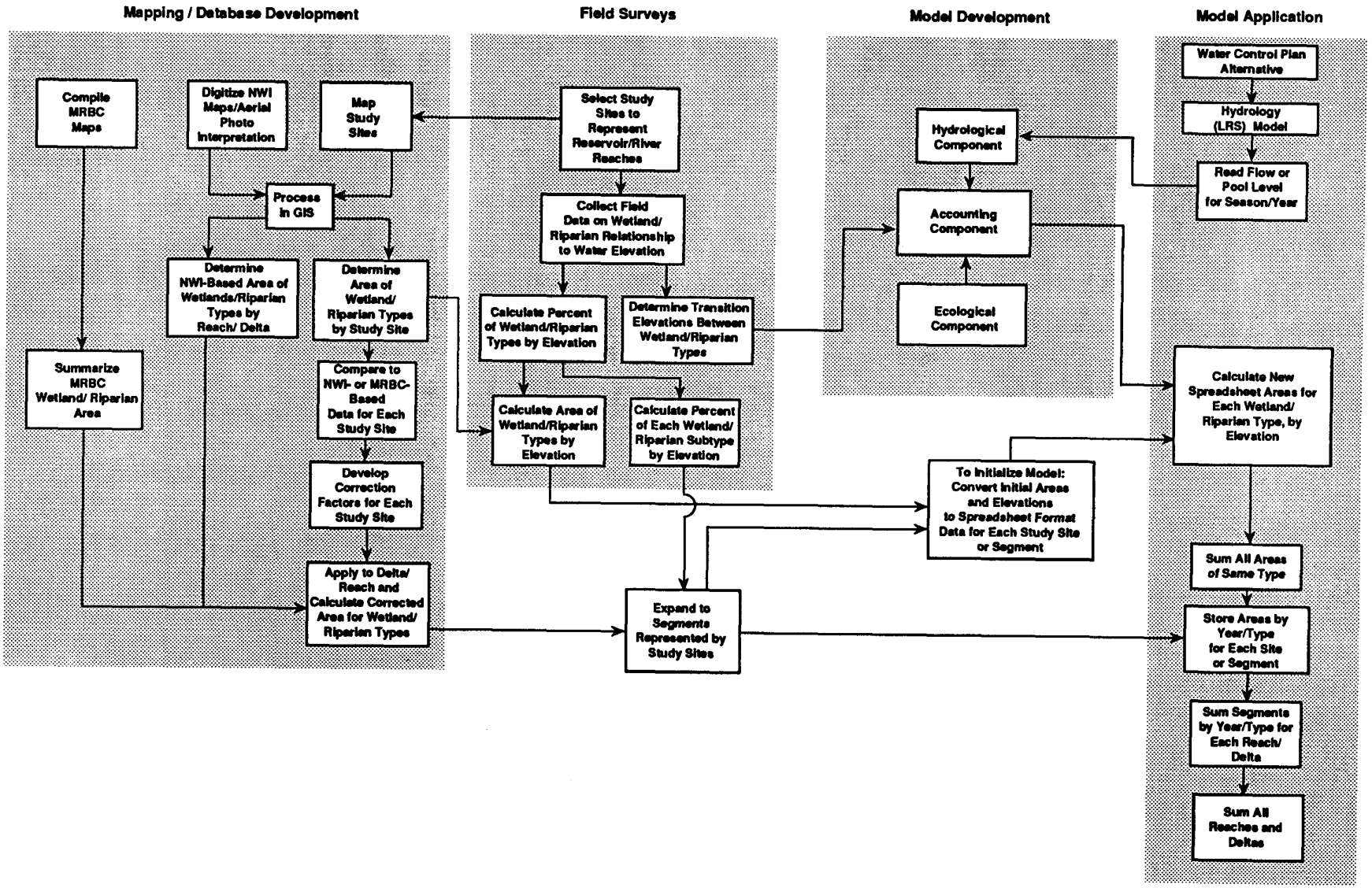

Figure 2. General approach to analysis of impacts from water control plan alternatives on wetland and riparian resources along the Missouri River.

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Ground truthing of the additional mapping on aerial photographs was conducted in 1991 in conjunction with the field surveys described below. Details on the specific methodologies used for photo interpretation, mapping, and ground truthing are described in Appendix A.

Database Development. Because of the large size of the study area and the need to simulate changes in wetland and riparian areas as a function of alternative water control plans, a database of acreages for these resources was created. For the upper river, a Geographic Information System (GIS) was used to develop the database from existing NWI maps and from supplemental mapping on recent aerial photographs (1990 and 1991). The GIS stores spatial information in computerized format and facilitates retrieval, calculation, and summarization of acreages for any given combination of resource categories or river reach. This database included all wetlands and riparian vegetation within the high bluffs bordering the floodplain. For the lower river, the database was developed from the MRBC maps and was constructed using a database management program (see Appendix A for details of database development). The database included all wetlands, riparian vegetation, and agricultural lands in the 100-year floodplain.

Field Surveys. Field investigations were conducted to determine the relationship between wetland and riparian types and water surface elevation and to obtain information on species composition and condition of various types along the river. A total of 42 study sites located between the Fort Peck Lake delta and St. Louis were selected for intensive field investigation (see Figure 1; Appendix A, Figure A-1). The sites were selected based on the following five criteria: (1) presence of wetland and riparian types representative of a given reach or delta (as opposed to amount or quality); (2) occurrence of hydrology representative of a given reach or delta; (3) proximity to at least one elevational control point, such as a U.S. Geological Survey (USGS) monument, one of the monuments erected by the Corps along the river for sediment range measurement, or one of the Corps' gaging stations; (4) location in a riverine reach or delta that would be affected by the various water control plan alternatives; and (5) accessible by car or boat. A total of 16 sites were selected along the lower river, and 26 sites were selected in the deltas and riverine reaches of the upper river (see Figure 1).

Field investigations were conducted at the 42 sites between early May and late October, 1991. At each site, the mapping on aerial photographs was verified and then used to locate one to five transects that would maximize the number of discrete wetland and riparian types intersected. Along each transect, the elevation of each transition from one wetland or riparian type to another was recorded, along with observations of species composition, soils, hydrology, and horizontal distance along the transect. Similar information was recorded at points where slope or aspect changed abruptly. All vertical and horizontal data were referenced to the elevational control point (USGS monument, sediment range marker) using standard electronic surveying equipment (a Leitz total station and rod with a prism). Details on field investigation methods are presented in Appendix A. Field investigations reflected 1987-1991 drought conditions and do not necessarily represent mean conditions.

Data collected from the field investigations at each site were entered into a computerized database. A topographic interpolation program was then run to assign elevations at 2-foot (linear) intervals between sampled points along each transect. The output

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from this program provided the distribution of each wetland and riparian type by elevation for each of 39 sites (three sites were omitted because of lack of a direct connection to river hydrology). For example, if field sampling and interpolation at a given site resulted in 500 elevational points in emergent wetlands, and 100 of these fell between 1,600 and 1,600.5 feet msl, then 20 percent of emergent wetland acreage at the entire site was assigned to this elevation band. The distribution information was then applied to the database of wetland/riparian acreage for that site to estimate the acreage of each type by elevation. Data for each site are presented in Appendix B.

Model Development

The wetland and riparian resource model can be considered a conceptual tool that relates changes in the amounts of these resources to changes in Missouri River flows and lake levels. The assumption underlying the development of this model is that the amount or extent of wetlands and riparian resources is related to three factors: (1) water surface elevation, as related to reservoir levels or river stage/discharge patterns; (2) frequency/ duration/depth of inundation or drying; and (3) successional processes related to establishment and persistence of various wetland and riparian vegetation. The purpose of the wetland and riparian resource model is to generate an annual estimate or index of acreage associated with reservoir levels and river stages, as defined by the water control plan alternatives, for the Missouri River between the Fort Peck Lake delta and St. Louis.

The overall process of model development for wetland and riparian resources involved three steps: (1) determining flood tolerance and succession for these communities along the Missouri River; (2) integrating this information with monthly hydrology data over the May through August growing period; and (3) creating an accounting program to track changes in acreage over a 93-year simulation period. Consequently, the wetland and riparian resource model includes three components: ecological, hydrological, and accounting. The ecological component consists of a set of "rules" that determine acreage shifts between wetland and riparian types as function of succession and flood tolerance. The hydrological component consists of data from the LRS model and determines water surface elevations on a monthly basis. The integration of hydrologic data with the ecological rules is achieved through a series of iterative calculations performed by a computer program. The accounting component tracks acreage of each wetland and riparian type as these resources respond to changes in hydrology over the simulation period.

Application of the Model

The purpose of the wetland/riparian resource model is to estimate the acreage of these resources for the entire river, as a function of hydrology, for each of the water control plan alternatives. Consequently, the model could not simply use the acreage and elevational distribution of wetland/riparian types determined during the 1991 field investigations at each of 39 wetland study sites as initial conditions (Figure 2). Instead, the data from each of the wetland study sites were extrapolated to represent larger areas of the river or delta in which they occur. These larger areas, designated as "segments," were used as initial conditions for

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the model. Results from each segment are then summed to obtain an estimate of the acreage of wetland and riparian resources in the reach or delta, followed by summation of reaches and deltas over the entire river. Thus, results can be displayed by study site, segment, riverine reach or delta, upper river, lower river, or the entire river. Results can also be displayed by each wetland and riparian type, but because of the large number of water control plan alternatives analyzed, types were aggregated into palustrine wetland and riparian forest and shrub totals.

COORDINATION AND AGENCY ASSISTANCE

A wetlands advisory group representing the Missouri River Environmental Subcommittee was established to provide study scoping assistance and technical oversight and review functions during the course of the study. Specific functions included: (1) assistance in identifying and selecting representative wetland study sites along the river; (2) assistance in field studies; (3) technical review of initial drafts of the wetland and riparian resource model; (4) suggestions for other measures of wetland and riparian resources; and (5) technical review of wetland study site maps and initial model outputs for study sites and segments.

The wetlands advisory group was comprised of the following individuals and agencies:

Jeff Herbert	Montana Department of Fish, Wildlife, and Parks
Greg Power	North Dakota Game and Fish Department
Cliff Stone	South Dakota Department of Game, Fish, and Parks
Larry Hesse	Nebraska Game and Parks Commission
Bob Moore	Iowa Department of Natural Resources
Steve Adams	Kansas Fish and Game Commission
Dave Carlson	U.S. Fish and Wildlife Service, Grand Island, Nebraska
Roger Collins	U.S. Fish and Wildlife Service, Bismarck, North Dakota
Make LeValley	U.S. Fish and Wildlife Service, Columbia, Missouri
Kathy Tortorici	Region VII, U.S. EPA
Roxanne DiLaura	Region VII, U.S. EPA
Brenda Schilf	Missouri Basin Tribes
Don Becker	Corps of Engineers, Omaha, Nebraska

Four meetings were held during the course of the wetlands study. A site identification meeting was held in Pierre, South Dakota, in April 1991, followed by additional site identification work and field work scoping at the Corps District Office in May 1991. In 1992, study progress and review meetings were all held at the Missouri River Division in Omaha.

Additional assistance in locating and evaluating study sites was provided by the Kansas City District of the Corps, St. Joseph Levee District, Lake Contrary Development Association, Fort Leavenworth Military Reservation, and Beverly-Farley Levee District. Mr. Chuck Elliott, coordinator for the USFWS's NWI Program, helped make available the NWI maps and digitized data for the Missouri River.

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Many other individuals, too numerous to mention, provided assistance during various study phases. These included acquisition of aerial photography, site photo-interpretation and mapping, field surveys, processing of field data, preparation of hydrological data, model development, computer programming, and report development and technical review.

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DESCRIPTION OF EXISTING WETLAND AND RIPARIAN RESOURCES

Based on the results of the field investigations, mapping, and inventory conducted in 1991, approximately 112,595 acres of palustrine wetlands occur in the study area along the 1,893 miles of the Missouri River between the Fort Peck Lake delta and St. Louis (Table 3). This same area contains about 192,548 acres of non-wetland riparian vegetation in the floodplain (Table 3) and more than 719,000 acres of agricultural land (Table 4). This section describes the existing wetland and riparian resources in the study area, by river reach and delta. Acreage summaries, maps, and descriptions for the 42 sites sampled during the field investigations are provided in Appendix B.

UPPER RIVER

The 1,139-mile upper river extends from the Fort Peck Lake delta (RM 1893) to Ponca (RM 754). It includes all of the Corps' reservoirs on the mainstem of the Missouri River and five riverine reaches. About 306,022 acres of floodplain and aquatic habitat were mapped along the upper river. The upper river represents 55 percent of the total acreage mapped along the Missouri River and supports about 73 percent of the palustrine wetlands and 36 percent of the riparian resources inventoried along the entire river, as determined from 1991 field and mapping efforts (Table 3).

Reservoir Deltas

Deltas have formed at the upstream end of each of the six mainstem reservoirs where water velocity decreases and suspended particulates settle. Reservoir pool elevations, through their influence on velocities of river inflows, determine the location and pattern of sediment deposits. High pools result in deposition of sediments in the upper delta areas, while low pools allow the sediments to be deposited in lower delta areas. Deltas of the upper three reservoirs, Fort Peck Lake, Lake Sakakawea, and Lake Oahe, are extensive and their water levels would be significantly affected by the various water control plan alternatives. The pool levels of the lower three reservoirs, Lake Sharpe, Lake Francis Case, and Lewis and Clark Lake, are expected to fluctuate much less. In addition, with the exception of Lewis and Clark Lake, fewer wetlands also exist in these lakes (Corps 1989). Consequently, field investigations focused on the deltas of the upper three reservoirs and the Lewis and Clark Lake delta. Information from Corps reports is used to describe the resources associated with the Lake Sharpe and Lake Francis Case deltas, but acreage values were not included in Table 3 or used in the wetland and riparian resource model.

About 176,457 acres of aquatic and floodplain habitat were mapped in association with the deltas of Fort Peck Lake, Lake Sakakawea, Lake Oahe, and Lewis and Clark Lake (Table 3). These four deltas contain 53 percent of the palustrine wetland acreage inventoried along the entire river and 71 percent of the amount inventoried along the upper river (Figures 3 and 4). Delta wetlands generally expand during drought periods, colonizing sediments exposed by receding water levels. Missouri River deltas typically support fewer

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Table 3. Acreages of wetland and riparian resources in the Missouri River study area. 1/

Missouri River Segments	PEMF	PEMC	PEMA 2/	PSSC	PSSA	PFOC	PFOA	Palustrine Wetland Subtotal	RF	RS	RG 2/	Riparian Subtotal	RUBH 3/, 6/	LUBH 4/	Surface Water Subtotal	R/LUS(5) 2/, 5/ (Shoreline)	Total
Sevenmile Creek	41	236	412	1,839	1,088	0	692	4,308	112	25	1	138	803	41	844	230	5,520
C.K. Creek	15	577	951	2,064	108	0	234	3,949	0	0	4	4	0	2,092	2,092	1,103	7,148
Musselshell River	216	912	1,173	912	825	0	89	4,127	12	227	29	268	0	4,803	4,803	1,504	10,702
Fort Peck Lake Delta	272	1,725	2,536	4,815	2,021	0	1,015	12,384	124	252	34	410	803	6,936	7,739	2,837	23,370
Wolf Point/Skinner's Island	1,347	1,461	1,403	726	2,190	1	456	7,584	8,641	1,995	1,668	12,304	8,552	252	8,804	1,213	29,905
Snowden	224	1,783	546	476	1,296	5	36	4,366	4,804	758	2,799	8,361	6,197	65	6,262	479	19,468
Fort Peck Dam to Lake Sakakawea Delta	1,571	3,244	1,949	1,202	3,486	6	492	11,950	13,445	2,753	4,467	20,665	14,749	317	15,066	1,692	49,373
Trenton Bottoms	284	429	2	1,253	393	7	1,368	3,736	592	53	1,091	1,736	1,079	1,191	2,270	428	8,170
Lewis and Clark	405	1,173	2,071	1,030	1,099	94	443	6,315	208	17	1,358	1,583	0	1,784	1,784	4,421	14,103
Williston Lagoon	533	3,658	4	5,381	22	1,208	18	10,824	6	1	27	34	0	3,002	3,002	3,423	17,283
Lake Sakakawea Delta	1,222	5,260	2,077	7,664	1,514	1,309	1,829	20,875	806	71	2,476	3,353	1,079	5,977	7,056	8,272	39,556
Stanton	67	125	239	2	128	3	199	763	5,640	0	2,770	8,410	2,425	543	2,968	1,482	13,623
Washburn	136	203	413	5	248	23	26	1,054	3,293	272	2,325	5,890	2,990	96	3,086	1,797	11,827
Square Butte	111	153	396	3	198	12	35	908	137	244	1,309	1,690	2,869	31	2,900	1,755	7,253
I-94	60	77	163	37	92	1	17	447	669	37	569	1,275	1,369	52	1,421	674	3,817
Garrison Dam to Lake Oahe Delta	374	558	1,211	47	666	39	277	3,172	9,739	553	6,973	17,265	9,653	722	10,375	5,708	36,520
Sibley Park	92	559	1,663	100	29	0	17	2,460	3,438	30	209	3,677	1,170	10	1,180	611	7,928
Kimball/Graner/McLean	378	1,082	2,522	238	419	81	243	4,963	4,638	68	920	5,626	744	811	1,555	875	13,019
Glencoe/Carlson	337	1,077	820	876	482	4	46	3,642	1,614	205	321	2,140	0	2,117	2,117	7,150	15,049
Cannonball River	530	234	194	416	694	0	40	2,108	117	1	1,857	1,975	1,838	11,402	13,240	18,218	35,541
Moreau River	0	310	56	1,797	166	0	104	2,433	60	0	161	221	106	9,003	9,109	3,984	15,747
Cheyenne River	0	90	0	1,619	13	381	0	2,103	0	0	5	5	213	1,620	1,833	3,224	7,165
Lake Oahe Deltas	1,337	3,352	5,255	5,046	1,803	466	450	17,709	9,867	304	3,473	13,644	4,071	24,963	29,034	34,062	94,449
Greenwood	285	405	239	95	49	0	802	1,875	3,854	15	545	4,414	5,380	39	5,419	131	11,839
Verdel/Choteau	338	371	44	227	83	19	68	1,150	682	181	19	882	2,029	7	2,036	166	4,234
Fort Randall Dam to Lewis and Clark Lake Delta	623	776	283	322	132	19	870	3,025	4,536	196	564	5,296	7,409	46	7,455	297	16,073
Niobrara	853	661	7	391	0	172	29	2,113	165	3	111	279	0	2,747	2,747	39	5,178
Bazille Creek	1,164	4,086	10	661	10	33	87	6,051	1,262	130	338	1,730	0	5,280	5,280	843	13,904
Lewis and Clark Lake Delta	2,017	4,747	17	1,052	10	205	116	8,164	1,427	133	449	2,009	0	8,027	8,027	882	19,082
Myron Grove	278	269	388	493	289	2	89	1,808	2,202	448	1,288	3,938	7,286	216	7,502	338	13,586
Mulberry Point	554	244	255	542	373	28	65	2,061	1,082	27	123	1,232	4,775	46	4,821	138	8,252
Elk Point	153	166	154	470	350	0	3	1,296	665	399	184	1,248	3,096	52	3,148	69	5,761
Gavins Point Dam to Ponca	985	679	797	1,585	1,012	30	157	5,165	3,949	874	1,595	6,418	15,157	314	15,471	545	27,599
Upper River Subtotal	8,401	20,341	14,125	21,653	10,644	2,074	5,206	82,444	43,893	5,136	20,031	69,060	52,921	47,302	100,223	54,295	306,022

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Table 3. Acreages of wetland and riparian resources in the Missouri River study area. 1/

Missouri River Segments	PEMF	PEMC	PEMA 2/	PSSC	PSSA	PFOC	PFOA	Palustrine Wetland Subtotal	RF	RS	RG 2/	Riparian Subtotal	RUBH 3/, 6/	LUBH 4/	Surface Water Subtotal	R/LUS(5) 2/, 5/ (Shoreline)	Total
Winnebago	148	1,599	113	652	887	13	103	3,515	4,812	532	1,169	6,513	3,404	309	3,713	187	13,928
Tieville Lake	52	469	32	186	249	4	28	1,020	1,653	179	252	2,084	1,017	122	1,139	59	4,302
Louisville	56	523	35	209	275	5	32	1,133	1,864	200	271	2,335	1,261	133	1,394	84	4,946
Bullard Bend	47	526	30	197	248	5	31	1,084	2,248	234	280	2,762	1,281	120	1,401	134	5,381
California	139	1,583	68	548	630	16	110	3,093	8,967	898	11,929	21,794	4,878	406	5,284	522	30,692
Ponca to Omaha	**442**	**4,700**	**278**	**1,790**	**2,289**	**43**	**303**	**9,845**	**19,544**	**2,042**	**13,901**	**35,487**	**11,841**	**1,090**	**12,931**	**986**	**59,250**
Otoe-Hamburg	93	1,068	51	404	471	10	86	2,182	5,741	577	11,452	17,770	4,281	266	4,547	296	24,795
Lincoln Bend	87	1,051	51	316	399	9	45	1,958	4,171	424	370	4,965	4,143	238	4,381	402	11,706
Worthwine Island	113	1,570	62	440	513	14	62	2,773	6,421	637	601	7,659	8,385	353	8,738	812	19,982
Omaha to St. Joseph	**293**	**3,689**	**163**	**1,160**	**1,383**	**33**	**192**	**6,913**	**16,333**	**1,638**	**12,423**	**30,394**	**16,809**	**857**	**17,666**	**1,510**	**56,483**
Jackass Bend	812	500	81	139	222	2,210	666	4,630	13,240	21	1,009	14,270	14,984	738	15,722	651	35,272
Overton Bottoms	574	380	76	136	193	1,632	602	3,592	12,488	20	1,060	13,568	12,730	529	13,259	975	31,395
Eagle Bluff	23	49	15	18	37	267	125	534	2,362	4	144	2,510	4,932	21	4,953	435	8,433
Morrison Bend	34	75	32	25	62	347	238	813	5,203	9	273	5,485	6,696	33	6,729	539	13,566
Berger Bend	50	83	30	38	61	450	222	933	4,945	8	219	5,172	6,086	46	6,132	312	12,549
Howell Island	299	283	94	97	183	1,254	681	2,890	15,487	25	1,090	16,602	11,626	277	11,903	830	32,225
St. Joseph to St. Louis	**1,793**	**1,370**	**327**	**452**	**758**	**6,159**	**2,533**	**13,393**	**53,725**	**87**	**3,795**	**57,607**	**57,854**	**1,644**	**58,698**	**3,742**	**133,440**
Lower River Subtotal	**2,529**	**9,758**	**768**	**3,402**	**4,431**	**6,235**	**3,029**	**30,151**	**89,602**	**3,767**	**30,119**	**123,488**	**85,704**	**3,592**	**89,296**	**6,238**	**249,173**
Total	**10,930**	**30,099**	**14,893**	**25,055**	**15,075**	**8,309**	**8,235**	**112,595**	**133,495**	**8,903**	**50,150**	**192,548**	**138,625**	**50,894**	**189,519**	**60,533**	**555,195**

1/ See text for definitions of wetland and riparian types and study area boundary. This table does not include Lake Sharpe or Lake Francis Case because their deltas are not expected to be affected by the water control plan alternatives. In addition, the short (5 mile) riverine reach between Oahe Dam and Lake Sharpe is not included because this area supports few wetlands

2/ Includes small amounts of agricultural lands.

3/ RUBH includes river surface area.

4/ LUBH includes the reservoir surface area in deltas only, as well as aquatic bed wetlands and oxbow lakes along the river and in deltas.

5/ R/LUS(5) includes bare and vegetated unconsolidated shore.

6/ RUBH acres in delta segments represent the portion of the segment that is above the mean reservoir pool elevation and, therefore, exhibits more riverine characteristics.

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Table 4. Acreage of agricultural lands mapped in the Missouri River segments. Page 1 of 2

Missouri River Segment	Acres of Agricultural Lands
Sevenmile Creek	0
C.K. Creek	0
Musselshell River	0
Fort Peck Lake Delta	**0**
Wolf Point/Skinner's Island	0
Snowden	0
Fort Peck Dam to Lake Sakakawea Delta	**0**
Trenton Bottoms	144
Lewis and Clark	0
Williston Lagoon	0
Lake Sakakawea Delta	**144**
Stanton	729
Washburn	2,892
Square Butte	2,716
I-94	67
Garrison Dam to Lake Oahe Delta	**6,404**
Sibley Park	0
Kimball/Graner/McLean	1,303
Glencoe/Carlson	29
Cannonball River	0
Moreau River	0
Cheyenne River	0
Lake Oahe Delta	**1,332**
Greenwood	0
Verdel/Choteau	0
Fort Randall Dam to Lewis and Clark Lake Delta	**0**
Niobrara	329
Bazille Creek	64
Lewis and Clark Lake Delta	**393**
Myron Grove	0
Mulberry Point	0
Elk Point	0
Gavins Point to Ponca	**0**
UPPER RIVER TOTAL[1/]	8,273
Winnebago Bend	11,149

Table 4. Acreage of agricultural lands mapped in the Missouri River segments. Page 2 of 2

Missouri River Segment	Acres of Agricultural Lands
Tieville Lake	9,022
Louisville Bend	11,948
Bullard Bend	12,133
California Bend	33,200
Ponca to Omaha	**77,452**
Otoe-Hamburg	9,982
Lincoln Bend	52,044
Worthwine Island	69,258
Omaha to St. Joseph	**131,284**
Jackass Bend	177,389
Overton Bottoms	167,838
Eagle Bluff	21,885
Morrison Bend	37,363
Berger Bend	32,657
Howell Island	64,364
St. Joseph to St. Louis	**501,496**
LOWER RIVER TOTAL[2/]	710,232
MISSOURI RIVER TOTAL	718,505

1/ There was no database of agricultural lands for the upper river and mapping was limited by the aerial photography which was focused on the river. Estimates for the upper river are based on the amount of agricultural land actually mapped for each site on aerial photography. Estimates do not accurately reflect the amount of cropland along the upper river.

2/ Acreage of agricultural land along the lower river was available from the MRBC maps for 1979 and was adjusted to 1991 conditions based on field mapping. Estimates are thus a reasonable approximation of the amount of cropland in the 100-year floodplain in 1991.

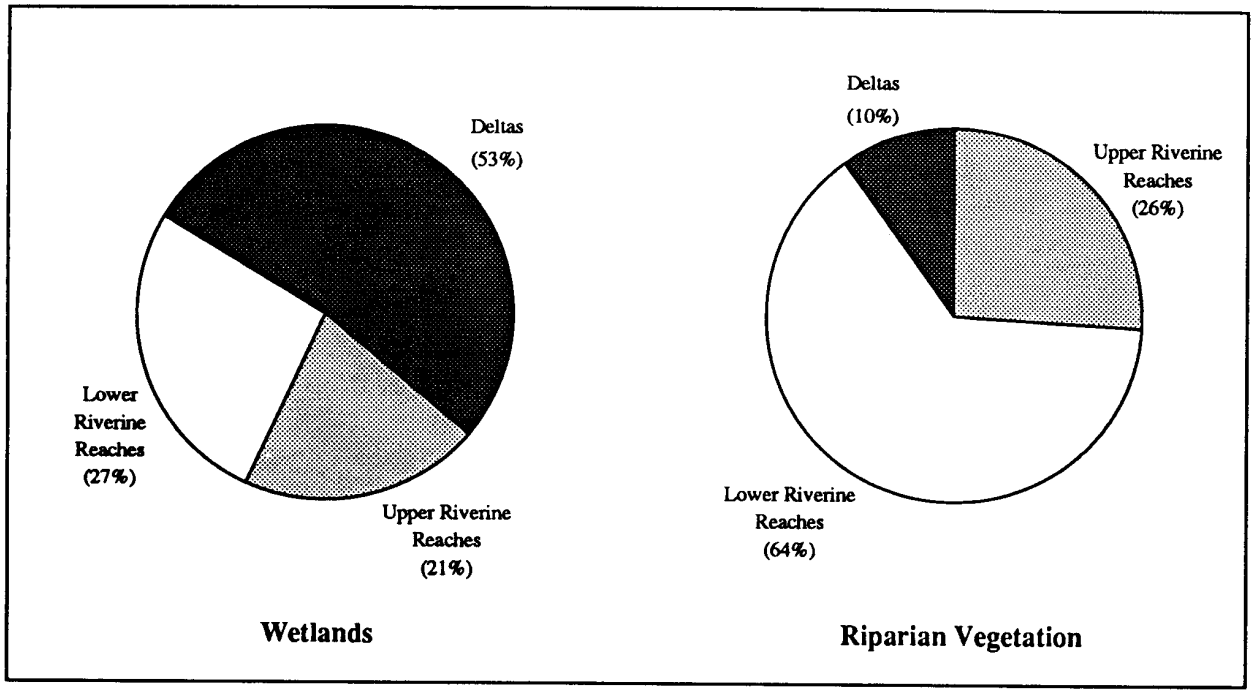

Figure 3. Distribution of palustrine wetlands and riparian areas in deltas and riverine reaches along the Missouri River.

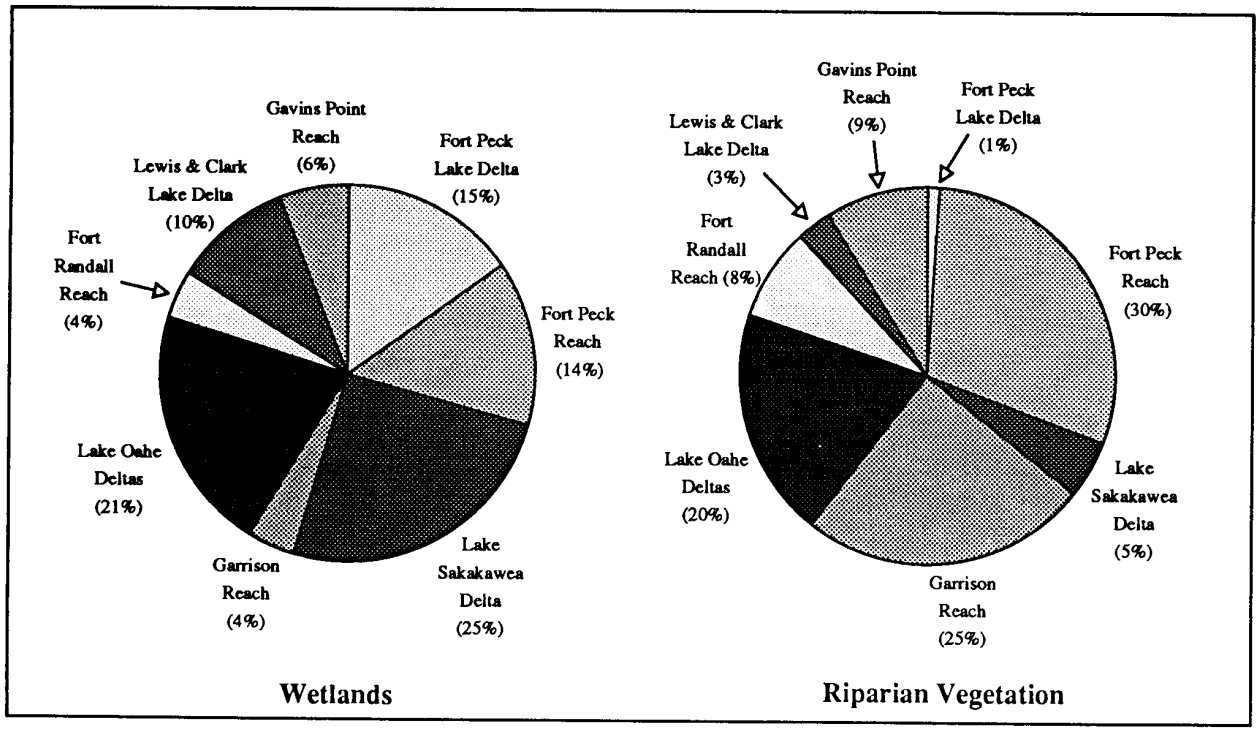

Figure 4. Distribution of palustrine wetlands and riparian areas, by delta and reach, along the upper Missouri River.

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palustrine wetland types than riverine reaches primarily because fluctuating water levels preclude the establishment of trees and species that are intolerant of long periods of inundation. Similarly, development of riparian vegetation in most Missouri River deltas is limited because delta wetlands encompass large portions of the adjacent floodplain, which restricts the amount of drier habitat avoidable for the establishment of vegetation intolerant of inundation. Deltas support only 10 percent of the acreage of riparian vegetation inventoried along the entire river in 1991 and 28 percent of the amount along the upper river (Figures 3 and 4).

Fort Peck Lake Delta. Fort Peck Lake is located in eastern Montana, behind Fort Peck Dam at RM 1771. The furthest upstream of the Corps' Missouri River dams, this project has an average annual inflow is 10,200 cubic feet per second (cfs) (Corps 1991). Its normal minimum operating pool is 2,234 feet msl, but during the 1988-1992 drought, the pool elevation fell to between 2,210 and 2,220 feet msl. The Fort Peck Lake delta is about 26 miles long, extending from just upstream of Seven-mile Creek (RM 1893) to the confluence of the Musselshell River (RM 1867). The Missouri and Musselshell rivers carry an estimated 17,700 acre-feet of sediments into the delta each year (Corps 1991).

As mapped from 1990 aerial photographs, 53 percent of the Fort Peck Lake delta is palustrine wetland, 33 percent is deepwater habitat, 12 percent is unconsolidated shore, and 2 percent is riparian vegetation (Table 3). The Fort Peck Lake delta supports about 11 percent of the palustrine wetland acreage mapped along the entire river and a negligible portion of the riparian vegetation (Figure 5).

The majority of palustrine wetland acreage in the Fort Peck Lake delta consists of seasonally flooded palustrine scrub-shrub (PSSC) (39 percent) and temporarily flooded palustrine emergent (PEMA) wetlands (20 percent) (Table 3). The palustrine emergent, semi-permanently flooded (PEMF) type is uncommon (2 percent), limited to the lower portion of the delta in the vicinity of the Musselshell River. Delta stands of PSSC are characterized by dense thickets of young sandbar willow (*Salix interior*) with virtually no understory. Many of the areas supporting PSSC wetlands in 1991 would be inundated under normal operating conditions. However, sandbar willow is quick to colonize exposed mudflats that retain sufficient moisture for germination but remain unflooded for the rest of the first growing season (Barnes 1985, Noble 1979, Wilson 1970). PEMA wetlands support a variety of grasses and forbs, primarily western wheatgrass (*Agropyron smithii*) and Canada thistle (*Cirsium arvense*). River bulrush (*Scirpus fluviatilis*), spike-rushes (*Eleocharis* spp.), and rushes (*Juncus* spp.) dominate the PEMF wetlands.

During 1991 field investigations, the Fort Peck Lake pool elevation was approximately 14 feet below the minimum normal operating level (base of annual flood control). Consequently, large areas of vegetated lacustrine unconsolidated shore (LUS5) are common, particularly in lower portions of the delta, near the Musselshell River. These areas generally support a mixture of weedy, mesic species, including cocklebur (*Xanthium strumarium*), kochia (*Kochia* sp.), horseweed (*Conyza canadensis*), barnyard grass (*Echinochloa* sp.), witchgrass (*Panicum capillare*), and foxtail barley (*Hordeum jubatum*). Unvegetated lacustrine unconsolidated shore (LUS) areas occur most frequently in the more recently

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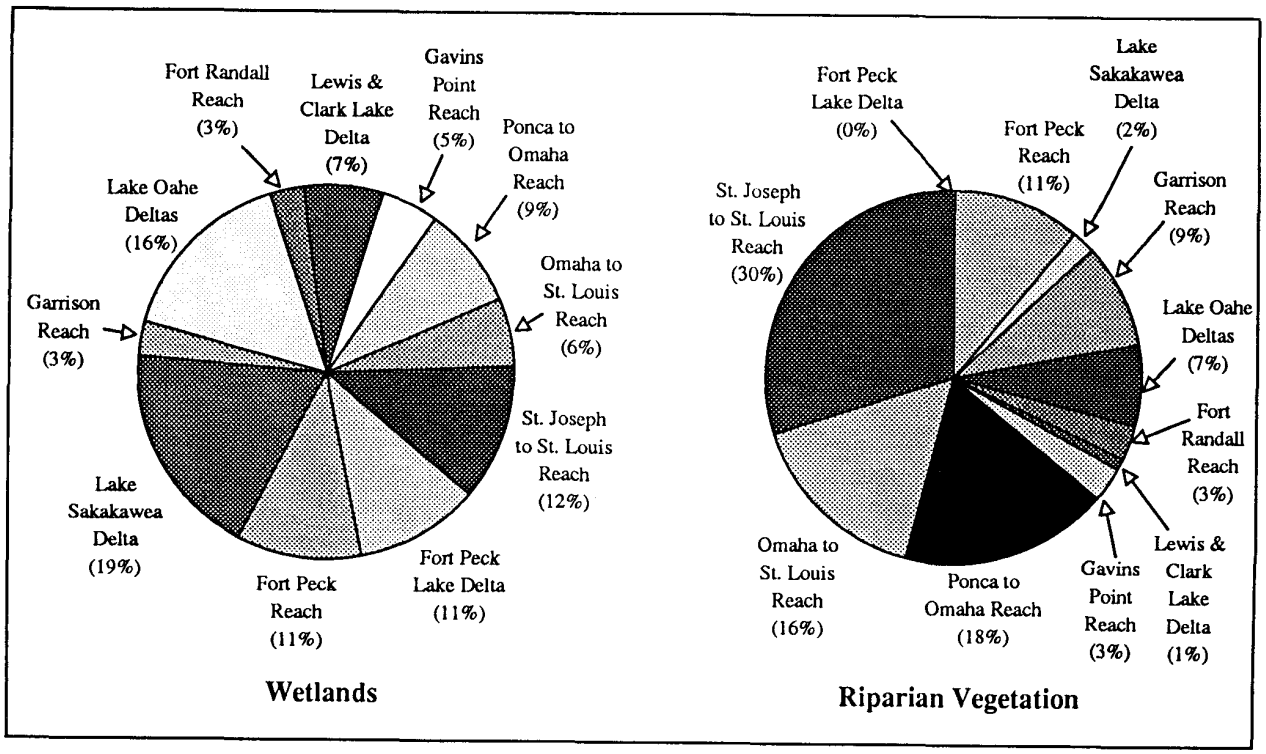

Figure 5. Distribution of palustrine wetlands and riparian areas, by delta and reach, along the Missouri River.

exposed upstream portions of the delta and consist of large expanses of viscous silty clay, locally known as "gumbo."

Riparian vegetation is generally restricted to the extreme upper portion of the Fort Peck Lake delta, where the floodplain widens and is less frequently subjected to prolonged periods of inundation. Over 60 percent of the riparian area in the Fort Peck Lake delta consists of riparian shrublands (Table 3). These stands appear to be an extension of the riparian forests and shrublands that dominant nearly half of the floodplain adjacent to the river upstream of the delta. Riparian forests and shrublands are dominated by cottonwood, but peachleaf willow (*Salix amygdaloides*) is also common.

Lake Sakakawea Delta. Lake Sakakawea is located in western North Dakota behind Garrison Dam at RM 1390. It is the largest of the Corps' Missouri River reservoirs and has an average annual inflow of 25,600 cfs, with 55 percent attributable to the Yellowstone River (Corps 1989). The normal minimum operating pool is 1,837 feet msl, but during the 1988-1992 drought, pool elevation fell to between 1,820 and 1,829 feet msl (Corps 1991). The mapped portion of the Lake Sakakawea delta extends from the Trenton Bottoms area (RM 1573) downstream to just beyond Raum's Landing (RM 1535). Approximately 31,000 acre-feet of sediment settle in the delta each year, nearly double the inflow to the Fort Peck Lake delta (Corps 1991). A Federal levee system protects portions of the town of Williston, North Dakota, located on the north shore of the delta, from rising water. Large areas of

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cropland, especially in the upper delta near Trenton Bottoms, are converting to wetlands as a result of aggradation (Corps 1989).

As mapped from 1990 aerial photographs, 53 percent of the Lake Sakakawea delta is palustrine wetland, about 21 percent is unconsolidated shore, 18 percent is deepwater habitat, and about 9 percent is riparian vegetation (Table 3). The Lake Sakakawea delta supports more wetland acreage than any other delta or reach along the Missouri River, about 19 percent of the amount mapped for the entire river (Figure 5). Conversely, riparian vegetation in the delta represents less than 2 percent of the amount mapped along the river (Figure 5). Much of the riparian habitat associated with the delta has been converted to cropland (Table 4).

PSSC wetlands account for about one-third of the palustrine wetland acreage in the Sakakawea delta, followed by the palustrine emergent, seasonally flooded (PEMC) type which accounts for about one quarter (Table 3). The least common type, PEMF (6 percent of the delta), tends to develop in old backwater areas, ponds, and side channels that have been cut off from the main channel. As at Fort Peck Lake, PSSC wetlands in the Lake Sakakawea delta consist of dense stands of sandbar willow that have colonized mudflats exposed by the drought of the last several years. PEMC wetlands are composed primarily of common reed (*Phragmites australis*), slough sedge (*Carex atherodes*), and reed canarygrass (*Phalaris arundinacea*). PEMF wetlands are typically mono-cultures of narrow-leaved cattail (*Typha angustifolia*).

During the 1991 field investigations, the Lake Sakakawea pool elevation was approximately 1,829 feet msl, approximately 9 feet below the normal minimum operating level. The reservoir was at 1,829 feet msl or lower for the several years (Corps 1991). Large, nearly monotypic stands of PSSC were observed from Raum's Landing downstream for 8 miles. Beyond this point, expansive areas of recently exposed sediments (LUS and LUS5) extended downstream. Areas of LUS5 typically support a mixture of species similar to those found on mudflats in the Fort Peck Lake delta. At the upper end of the Lake Sakakawea delta (above Highway 85), areas of LUS and LUS5 were typically limited to oxbows cut off from the main reservoir or side channels.

Riparian vegetation occurs throughout the Lake Sakakawea delta, generally on small ridges of higher ground surrounded by wetlands. Most riparian areas consist primarily of riparian grasslands (Table 3), frequently dominated by Kentucky blue grass (*Poa pratensis*), quackgrass (*Agropyron repens*), crested wheatgrass (*A. cristatum*), and smooth brome (*Bromus inermis*). Cottonwoods dominate riparian forest stands and rough leaved dogwood (*Cornus drummondii*) is a common understory species. The largest riparian forest stands occur at the Lewis and Clark and Trenton Bottoms wildlife refuges.

Lake Oahe Deltas. Lake Oahe is located in north central South Dakota and south central North Dakota behind Oahe Dam at RM 1072. The second largest of the Corps' Missouri River reservoirs, this project has an average annual inflow of 28,900 cfs, most of which represents releases from Garrison Dam (Corps 1989). The normal minimum operating pool elevation is 1,607.5 feet msl but during the 1988-1992 drought, the pool elevation was been maintained between 1,588 and 1,595 feet msl (Corps 1991). The Lake Oahe delta

extends from just downstream of Bismarck, North Dakota (RM 1306) to Fort Yates near the North Dakota-South Dakota border (RM 1242). Sediment inflow to the Oahe delta is 23,000 acre-feet per year. Because neither the mainstem river below Garrison Dam nor the tributaries upstream of Lake Oahe carry significant amounts of sediment, input of sediments into the Lake Oahe delta is much lower than at Lake Sakakawea. Included within the mainstem delta is the Cannonball River delta, a tributary entering Lake Oahe at RM 1270. Two other major tributaries, the Moreau and Cheyenne rivers, flow into the west side of Lake Oahe, and have associated deltas. All the deltas are grouped together for purposes of the following discussion.

As mapped from 1990 aerial photographs, 36 percent of the area covered by the 4 Lake Oahe deltas is unconsolidated shoreline, 31 percent is deepwater habitat, 19 percent is palustrine wetland, and 14 percent is riparian vegetation (Table 3). The Lake Oahe deltas support nearly as much palustrine wetland acreage as does the Lake Sakakawea delta, about 16 percent of the amount mapped along the entire river (Figure 5). Over 70 percent of the riparian vegetation mapped in all of the Missouri River deltas is associated with the Lake Oahe deltas but this amount represents only 7 percent of the riparian vegetation inventoried along the entire river (Figures 4 and 5).

Palustrine wetlands and riparian vegetation are most prevalent in the upper portion of the mainstem Lake Oahe delta, from Schmidt Bottom (RM 1301) to Carlson Bottom (RM 1282). The river channel through this area is wide and meandering and has created a number of old oxbows, such as Carlson (RM 1283) and Wilde (RM 1278) lakes, that support extensive palustrine wetland complexes. The Missouri River typically floods these areas approximately every 5 years (Corps 1989). From Fort Rice (RM 1275) to Fort Yates, the mainstem delta largely consists of drawdown zones dominated by weedy annuals. Little wetland or woody vegetation establishes or persists in the lower portions of the mainstem or tributary deltas because of frequent flooding and higher sedimentation rates.

PEMA and PSSC wetlands are the most common types in the Lake Oahe deltas, where they respectively comprise about 30 and 28 percent of total palustrine wetland area (Table 3). Seasonally and temporarily flooded palustrine forests (PFOC and PFOA, respectively), which occur primarily in the upper portion of the delta, are less common (3 percent each). PEMF wetlands occur throughout the upper portion of the mainstem delta where they are generally confined to the margins of old backwater channels and Glencore, Carlson, and Wilde Lakes. PSSC wetlands in the Lake Oahe deltas include dense stands of sandbar willow, but indigo bush (*Amorpha fruticosa*) and peachleaf willow are also common. As at Fort Peck Lake and Lake Sakakawea, many of the PSSC wetlands in the Lake Oahe deltas appear to have colonized mudflats exposed by the lower water levels caused by the drought of the last several years. PEMA wetlands commonly include prairie cordgrass (*Spartina pectinata*), quackgrass, sedge (*Carex* sp.), Canada thistle, and redtop (*Agrostis alba*). Many of the PEMA wetlands contain remnants of vegetation more common in seasonally flooded wetlands, and appear to be drying out and shifting to a more mesophytic flora. PFOC wetlands are dominated by sandbar and peachleaf willow; PFOA wetlands generally include cottonwood as well. Cattails (*Typha* spp.), river bulrush, soft-stem bulrush (*Scirpus validus*), spike-rushes, and smartweeds (*Polygonum* spp.) characterize stands of PEMF.

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During 1991 field investigations, the Lake Oahe pool elevation was approximately 1,591 feet msl, 16 feet below the normal minimum operating levels (Corps 1991). Consequently, LUS5 dominates large expanses of the deltas, particularly the lower portions that are infrequently exposed. These areas are characterized by weedy mesic species including sweet clover (*Melilotus* spp.), cocklebur, sow thistle (*Sonchus arvensis*), prickly lettuce (*Lactuca serriola*), beggar's tick (*Bidens* spp.), dock (*Rumex* sp.), and sunflower (*Helianthus* spp.). LUS occurs infrequently, primarily along the shoreline in the upper portions of the delta.

Riparian vegetation occurs throughout the mainstem Lake Oahe delta, but is rare on the tributary deltas. Over 70 percent of the riparian vegetation is forest and much of this type occurs in the upper mainstem delta, from Sibley Park to Carlson Bottoms. Many of these areas support stands of mature cottonwood trees, which are on ridges and higher ground at the margins of the delta.

Lake Sharpe Delta. Lake Sharpe, located in central South Dakota behind Big Bend Dam (RM 987), remains at a nearly constant pool elevation of 1,420 feet msl, even during drought (Corps 1991). Average annual flow into the reservoir is 28,900 cfs including flow from the Bad River (Corps 1989, 1991). Because Lake Sharpe is so close to Oahe Dam, it receives very little sediment inflow from the mainstem of the Missouri River. However, a delta formed by sediment from the Bad River, a major right-bank tributary, extends from Pierre, South Dakota (RM 1067) to the DeGray area (RM 1037). Total annual sediment inflow to this delta is 5,300 acre-feet (Corps 1991).

Most of the Lake Sharpe delta consists of shallow open water or seasonally flooded mudflats (Corps 1989). Palustrine wetlands are limited to Farm and LaFramboise islands and the mouths of the Bad River and several other tributaries including Medicine, Antelope, Medicine Knoll, and Mush creeks. About 430 acres of emergent wetlands (PEMF, PEMC, and PEMA) are present on Farm and LaFramboise islands, which are dominated by dense stands of common reed, cattail, and reed canarygrass (Corps 1989). Scrub-shrub wetlands (PSSC and PSSA) are few and also largely confined to portions of these islands. Aquatic bed wetlands appear to be increasing in the delta and within embayments or protected areas of the lake itself.

Lake Francis Case Delta. Lake Francis Case is located in southern South Dakota behind Fort Randall Dam (RM 888). Average annual flow into the reservoir is 30,000 cfs, including contributions from the White River (Corps 1989, 1991). The normal minimum operating pool is 1,350 feet msl, but Lake Francis Case is typically drawn down to an elevation of 1,337.5 feet msl every autumn to provide storage for high winter power releases from Oahe and Big Bend dams (Corps 1991). Because of the proximity of Big Bend Dam immediately upstream, Lake Francis Case receives very little sediment inflow from the mainstem of the Missouri River. However, a delta formed by sediment from the White River, a major right-bank tributary, extends approximately 15 miles up the White River valley (Corps 1989). Annual sediment inflow to the delta at the confluence of the White River with Lake Francis Case is 21,600 acre-feet (Corps 1991).

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The White River delta consists primarily of PEMF and PSSC wetlands dominated by species typically occurring in these types along other portions of the upper river (Corps 1989). Large areas of PFOC wetlands and riparian forests also occur within the delta. No estimates of wetland and riparian acreage have been reported for this delta.

Lewis and Clark Lake Delta. Lewis and Clark Lake, the smallest of the Missouri River reservoirs, is located on the Nebraska-South Dakota border behind Gavins Point Dam at RM 811. Lewis and Clark Lake levels typically fluctuate, on an annual basis, between 1,204.5 and 1,208 feet msl, even during drought (Corps 1989). Average annual flow into the reservoir is 32,000 cfs, including contributions from the Niobrara River (Corps 1989, 1991). The configuration of the Lewis and Clark Lake delta is affected by the reservoir pool elevation and sediment deposition patterns from the Niobrara River. The delta extends about 17 miles, from near Verdel, South Dakota (RM 850) to about 3 miles downstream of Springfield, South Dakota (RM 833). Delta wetlands upstream of Springfield, which include those at the mouth of the Niobrara River and Bazille Creek, are influenced primarily by river stage; those from Springfield downstream are controlled by pool elevation (Corps 1989). Annual sediment inflow is about 2,800 acre-feet, with 60 percent of this amount attributable to the Niobrara River (Corps 1989, 1991).

As mapped from 1990 aerial photographs, 43 percent of the Lewis and Clark Lake delta consists of palustrine wetlands, 42 percent is deepwater habitat, 11 percent is riparian vegetation, and 5 percent is unconsolidated shore (Table 3). The Lewis and Clark Lake delta supports only about 7 percent of the palustrine wetlands mapped along the entire river and less than 1 percent of the riparian vegetation (Figure 5).

In contrast to the other major Missouri River deltas, the Lewis and Clark Lake delta has numerous backwaters, ponds, and chutes that are characterized by a variety of palustrine emergent wetland types. PEMC wetlands are the most common type (58 percent), followed by the PEMF type (25 percent) (Table 3). Some aquatic bed wetlands also occur. Temporarily flooded palustrine wetlands, both emergent and scrub-shrub, are least common (comprising less than 1 percent each), occurring in only a few locations along the margins of the delta (Table 3).

A reconnaissance level survey in 1988 indicated that about one-third of the PEMF and PEMC wetlands in the Lewis and Clark/Niobrara River delta had been infested with purple loosestrife (*Lythrum salicaria*). This species readily invades freshwater wetlands and degrades valuable habitat used by waterfowl and furbearers. Currently, Lewis and Clark Lake serves as a barrier (partial) to downstream dispersal to the remainder of the Missouri River (Corps 1989). Delta areas not infested with purple loosestrife include extensive stands of PEMC wetlands that are dominated by reed canarygrass and common reed. PEMF wetlands are characterized by dense stands of hybrid (*Typha glauca*) and narrow-leaved cattail, which occur in the shallow waters associated with islands, backwaters, and side channels. Because cattails can germinate in several inches of water (Bedish 1967), the current operating regime for Lewis and Clark Lake, which involves spring drawdown and higher pool levels in July, is apparently conducive to the establishment of PEMF wetlands in the shallow waters (Corps 1989). This operating regime precludes the establishment of

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PSSC wetlands in many areas of the delta, probably because sandbar willow requires recently deposited sediments that remain unflooded for the duration of the summer.

LUS5 is uncommon in the Lewis and Clark Lake delta, because the reservoir is not subject to large annual drawdowns. Areas of LUS include several large new islands forming at the mouth of the Niobrara River. These islands and sediment studies by the Corps indicate that extensive aggradation has occurred in the Lewis and Clark Lake delta (Corps 1989). Additional evidence of recent aggradation is noticeable on several well established islands between the mouth of the Niobrara River and Bazille Creek, where cottonwoods have died and been replaced by stands of cattail and bulrush (*Scirpus* spp.).

Riparian vegetation occurs throughout the upper portion of the Lewis and Clark Lake delta. Over half of the riparian vegetation is forest (Table 3), occurring on large islands near the mouth of the Niobrara River and Bazille and Choteau creeks. Cottonwoods dominate these stands, with green ash, dogwood (*Cornus* spp.), and snowberry (*Symphoricarpos* sp.) typically comprising a shrub understory in mature stands. Scouring rush (*Equisetum hyemale*) is a frequent ground cover, particularly in stands with sandy soils.

Riverine Reaches

The upper river section of the study area includes four riverine reaches, one each below Fort Peck, Garrison, Fort Randall, and Gavins Point dams. A short riverine reach extends approximately 5 miles below Oahe Dam, but was not field investigated because it contains relatively few wetlands (Corps 1989).

Despite the presence of upstream dams, riverine reaches in the upper river are semi-braided and have retained many islands, backwaters, side channels, and associated wetlands. However, the dams have reduced sediment deposition in the reaches, resulting in degradation and greatly reduced rates of island and sandbar creation. Degradation tends to be greatest immediately downstream from each dam and has resulted in bank erosion, lower water tables, and reduced periodic flooding of wetlands and riparian areas. Lower water tables and reduced periodic flooding may be responsible for the observed significant decline in age-adjusted growth rates for elm, box elder, and green ash in riparian areas along some upper riverine reaches (Reily and Johnson 1982, Johnson et al. 1976). Although a significant reduction in growth has not been reported for cottonwood (Reily and Johnson 1982, Johnson et al. 1976), degradation might be at least partially responsible for the reduced vigor, branch loss, and high mortality observed in mature riparian cottonwood forests along upper riverine reaches. Although individual cottonwood trees can live up to 250 years (Johnson et al. 1976), the species is relatively short lived, remaining vigorous for 80 to 90 years under favorable conditions (Harlow et al. 1979, Van Haverbeke 1990). Less favorable moisture conditions resulting from reduced frequency of spring flooding and/or lowered water table are likely contributing to mortality and loss of vigor of mature trees already stressed by advanced age. In addition, because cottonwood requires a moist, bare substrate for establishment (Wilson 1970), reduced rates of island and sandbar creation have affected the regeneration of riparian forests. Consequently, cottonwood forest regeneration along upper riverine reaches is currently limited to narrow shoreline zones.

The four upper riverine reaches encompass about 129,565 acres of aquatic and floodplain habitat (Table 3). Riparian vegetation comprises 38 percent of this area, deep water habitats comprise 37 percent, palustrine wetlands comprise 18 percent, and unconsolidated shore comprises 6 percent. Upper riverine reaches represent about 23 percent of the study area and support about 21 and 26 percent of the palustrine wetlands and riparian vegetation, respectively, mapped along the entire river in 1991 (Figure 3).

Fort Peck Dam to Lake Sakakawea Delta. Riverine conditions extend from Fort Peck Dam (RM 1771) 198 miles downstream to Lake Sakakawea delta near Trenton Bottoms (RM 1573). The river drops from approximately 2,034 feet msl below the dam, to approximately 1,850 feet msl at the Lake Sakakawea delta (0.9 foot per river mile [ft/RM]). The Fort Peck reach meanders through dryland crop and grazing lands which lie within the native prairie grassland ecosystem (USDA Forest Service 1977). The river retains many of its numerous sandbars, islands, and side channels. Abandoned channels and several oxbow lakes still occur in the floodplain and bank erosion is noticeable. Upstream of Brockton, Montana (RM 1660) the floodplain averages about 4 miles wide, extending through rolling grasslands; downstream of this point the floodplain narrows to a 1-mile-wide valley surrounded by badlands. The Fort Peck Indian Reservation borders the river on the north side from just below the dam to the Big Muddy River; the remainder of the land is mostly privately owned.

The flow in the Fort Peck reach is regulated primarily by the releases from Fort Peck Dam, which normally range from approximately 6,000 to 13,000 cfs. Major tributaries include the Milk, Poplar, Big Muddy, and Yellowstone rivers, although the latter enters the Fort Peck reach just upstream of the Lake Sakakawea delta and influences only a short portion of the reach.

As mapped from selected 1990 aerial photographs, riparian vegetation comprises about 42 percent of the Fort Peck reach floodplain, deepwater habitat comprises about 31 percent, palustrine wetlands comprise about 24 percent, and unconsolidated shore comprises about 3 percent (Table 3). The Fort Peck reach is more than twice as long as any other upper riverine reach and supports about 11 percent of the palustrine wetland acreage mapped along the entire river and 30 percent of the riparian vegetation inventoried along the 1,139-mile upper river (Figures 4 and 5).

More than half of the palustrine wetlands in the Fort Peck reach are either PSSA (29 percent) or PEMC (27 percent) wetlands (Table 3). Most of the remainder are PEMA (16 percent) or PEMF (13 percent) wetlands; PFOC wetlands are rare (less than 1 percent) (Table 3). PEMC wetlands are extensive and dominated by reed canary grass and common reed. PSSA wetlands are characterized by mixed stands of cottonwood seedlings and willow. PEMA wetlands typically support a variety of grasses and forbs, including western wheatgrass and Canada thistle. PEMF wetlands are dominated by cattails and bulrushes and are generally found in old oxbows or along islands, side channels, and backwaters.

Vegetated and unvegetated riverine unconsolidated shores (RUS5 and RUS) are uncommon in the Fort Peck reach. When present, these areas mostly occur on the edges of

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islands and bars in the main channel, although some bare shorelines appear during periods of falling river stage.

Riparian vegetation occurs along the entire Fort Peck reach; over half is riparian forest (Table 3), which commonly lines both shores. Cottonwood currently dominates riparian forests, but green ash is considered the climax species in this area (Pfister and Batchelor n.d.). Most of the original floodplain vegetation has been cleared, particularly from lands more distant from the river banks. Riparian shrublands generally include cottonwood as well as snowberry, rose (*Rosa* spp.), and dogwood. Smooth brome typically dominates riparian grasslands.

Garrison Dam to Lake Oahe Delta. The riverine reach between Garrison Dam (RM 1390) and the Lake Oahe delta (RM 1306), referred to as the Garrison reach, is approximately 84 miles long. The river flows through prairie grassland ecosystems (USDA Forest Service 1977), dropping from an elevation of approximately 1,676 feet msl just below the dam, to about 1,615 feet msl at the delta (0.7 ft/RM). Within the floodplain, terraces form a complex of different landforms varying by as little as 3 feet above the river. The river is restricted to one main channel with very few side channels, old channels, or oxbow lakes. Land use along the upper portion, north of Bismarck, is mostly agricultural, except for the area around several coal-fired powerplants. Urban areas predominate in the downstream end of the reach, in the vicinity of Bismarck and Mandan, North Dakota.

The flows in the Garrison reach depend largely on releases from Garrison Dam, which range between 12,000 and 29,000 cfs. Two significant tributaries are the Knife River, near Stanton, North Dakota, and the Heart River, just upstream of the Lake Oahe delta and downstream of Mandan. The upper part of this reach is subject to large diurnal and seasonal variations in river stage due to the peaking operation of Garrison Dam and the pattern of releases throughout the year. Large seasonal and yearly variations in flow may also occur due to tributary inflows.

As mapped by the NWI and updated from 1990 aerial photographs, riparian vegetation comprises about 47 percent of the Garrison reach, deepwater habitat comprises about 28 percent, unconsolidated shore comprises about 16 percent, and palustrine wetlands comprise about 9 percent (Table 3). Wetlands in this reach represent only 3 percent of the amount mapped along the entire river (Figure 5). Although the Garrison reach is less than half the length of the Fort Peck reach, it supports nearly an equivalent acreage of riparian vegetation, about 25 percent of the amount mapped along the upper river (Figure 4).

PEMA wetlands comprise about 38 percent of palustrine wetland acreage in the Garrison reach. Other relatively common types are PSSA (21 percent) and PEMC (18 percent) (Table 3). PFOC and PSSC wetlands are the least common (1 percent each) (Table 3). PEMA wetlands support a mix of hydric and mesic species, including quackgrass, bluegrass, and mints (*Mentha* spp.). Cottonwood, indigo bush, and peachleaf willow characterize the PSSA type. Reed canary grass typically dominates the PEMC type, although slough sedge forms extensive stands in certain areas, particularly near Bismarck. The few PEMF wetlands occupy old, narrow side channels.

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In general, the Garrison reach supports proportionately fewer palustrine wetlands than any of the other upper riverine reaches. The large daily fluctuations in hydro peaking from Garrison Dam probably impede palustrine wetland establishment and survival, favoring greater acreage of RUS5 and RUS. The peaking operations may also affect ice dynamics in the river. Thus, ice scouring may also be an important factor in preventing emergent wetland vegetation from developing in the channel. The release pattern from Garrison Dam also causes scouring and erosion on large islands and bars; as a result, they support little or no vegetation. These areas are most apparent close to the dam and diminish downstream.

Riparian vegetation occurs along the entire Garrison reach, over half is riparian forest (Table 3), which commonly lines both shores of this reach. Cottonwood, slippery elm (*Ulmus fulva*), green ash, and box elder are the most common tree species on the floodplain (Johnson et al. 1976). Because the river meanders, the majority of the youngest stands occur on sediments deposited on point bars, while the older trees are found on established banks (Johnson 1992). Sandbar and peachleaf willow occur along with cottonwood on river sandbars. In general, the acreage of riparian forest in the upper Missouri River Basin has been drastically reduced since settlement and by construction of the Garrison Dam (Reily and Johnson 1982).

Oahe Dam to Lake Sharpe Delta. This short reach extends from Oahe Dam (RM 1072) 5 miles to Lake Sharpe (RM 1067) near the city of Pierre. Releases from Oahe Dam range from 15,000 to 38,000 cfs. Located in the prairie grassland ecosystem (USDA Forest Service 1977), this reach is relatively straight, confined to one channel, and bordered by narrow bands of riparian forest and grasslands. Wetlands of various types are limited to backwaters created by channel structures.

Fort Randall Dam to Lewis and Clark Lake Delta. The riverine reach between Fort Randall Dam (RM 880) and Lewis and Clark Lake delta (RM 844) extends approximately 36 miles, dropping from approximately 1,234 feet msl just below the dam, to approximately 1,205 feet msl at the delta (0.8 ft/rm). Referred to as the Fort Randall reach, it lies within the plains grassland ecosystem (USDA Forest Service 1977) and has been recently designated a National Recreational River. Steep banks, many in a state of active erosion, tend to restrict the river to one main channel with only a few side channels and backwaters. Agriculture dominates land use outside the floodplain. The Yankton Sioux Indian Reservation borders the north side of the river, from just below the dam to several miles upstream of the Lewis and Clark Lake delta.

The releases from Fort Randall Dam range from 12,000 to 38,000 cfs. High summer discharges (20,000 to 30,000 cfs) maintain navigation flows downstream. Although releases are peaked to maximize power generation, daily fluctuations are much less pronounced than in the Garrison reach. The Fort Randall reach receives no significant input from tributaries.

As mapped by the NWI and updated from 1990 aerial photographs, riparian vegetation comprises about 33 percent of the Fort Randall reach, deepwater habitat comprises about 47 percent, palustrine wetlands comprise about 19 percent, and unconsolidated shore comprises less than 2 percent (Table 3). The Fort Randall reach is a short riverine reach which

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supports only 3 percent of the wetlands and riparian vegetation mapped along the entire river (Figure 5).

Three-quarters of the palustrine wetland acreage in the Fort Randall reach is composed of the PFOA (29 percent), PEMC (26 percent), and PEMF (21 percent) types (Table 3). PFOC wetlands are the least common (less than 1 percent) (Table 3). PFOA wetlands are characterized by a mix of peachleaf willow and cottonwood, with some sandbar willow. PEMC wetlands support the typical mix of reed canarygrass and common reed. PEMF wetlands consist primarily of cattail, although softstem bulrush (*Scirpus validus*) is also a common component. PEMF wetlands occur in expansive, often low, areas associated with old channels and backwaters. Several of these areas near Greenwood were dry at the time of field observation, and based on examination of the residual vegetation, appear substantially less productive than in previous years, possibly as a result of channel degradation or drought. Areas of RUS5 and RUS occur infrequently in the Fort Randall reach, limited to a few sandbars, islands, and shorelines.

Nearly all of the riparian vegetation in this reach is forest (Table 3). Open areas are typically grazed or farmed. Riparian forests are dominated by cottonwood, but green ash, Russian olive (*Elaeagnus angustifolia*), slippery elm, and box elder also occur. The understory of mature cottonwood stands is typically sparse, consisting mainly of Kentucky bluegrass (*Poa pratensis*), smooth sumac (*Rhus glabra)*, smooth brome, scouring rush, eastern red cedar (*Juniperus virginiana*), rough leaved dogwood, prickly ash, poison ivy (*Toxicodendron rydbergii*), and Virginia creeper (*Parthenocissus quinquefolia*).

Gavins Point Dam to Ponca. The Missouri River between Gavins Point Dam (RM 811) and Ponca (RM 754) has been designated a National Recreational River. This 57-mile reach drops from approximately 1,162 feet msl just below the dam to approximately 1,100 feet msl at Ponca (1.1 ft/RM). The National Recreational River resembles a natural river more than any other reach because it has a wide, braided channel, and numerous islands, chutes, and backwaters. Nonetheless, this reach has been affected by channel degradation, which is most evident near Gavins Point Dam. The National Recreational River lies within the plains grassland ecosystem (USDA Forest Service 1977), but adjacent lands are intensively farmed.

Flows in the National Recreational River are regulated almost entirely by releases from Gavins Point Dam, which vary from 6,000 to 38,000 cfs. Flows in support of downstream navigation from March through November, range from 25,000 to 35,000 cfs. Releases during the non-navigation season range much lower, between 6,000 and 23,000 cfs (Corps 1991). Major tributaries in the reach are the James and Vermillion rivers.

As mapped by the NWI and updated from 1990 aerial photographs, deepwater habitat comprises about 56 percent of the National Recreational River, riparian vegetation comprises about 23 percent, palustrine wetlands comprise about 19 percent, and unconsolidated shore about 3 percent (Table 3). The National Recreational River is the second shortest riverine reach and supports only 5 percent of the wetland acreage mapped along the entire river and less than 3 percent of the riparian vegetation (Figure 5).

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About half of the palustrine wetland area in the National Recreational River is scrub-shrub (Table 3). PSSC wetlands (29 percent) are the most common wetland type, followed by PSSA wetlands (20 percent), and PEMF wetlands (19 percent) (Table 3). PFOC wetlands are the least common (less than 1 percent). PSSC wetlands are typified by dense stands of young sandbar willow. The less-frequently inundated PSSA type consists of a mix of sandbar willow, peachleaf willow, and cottonwood. PEMF wetlands support cattails and bulrushes and occur primarily in old channels and backwaters, and near islands. Areas of RUS5 and RUS occur along the entire National Recreational River, and are associated with sandbars, eroding banks, developing islands, and shorelines.

Over half of the riparian vegetation along the National Recreational River is forested (Table 3). However, the acreage of this type has been severely reduced by clearing for agriculture. Riparian forests are dominated by cottonwood, but green ash, slippery elm, eastern red cedar, Russian olive, mulberry, and box elder also occur. The typically sparse herbaceous stratum beneath mature cottonwood consists mostly of scouring rush, Kentucky bluegrass, and smooth brome. Riparian grasslands along the National Recreational River are dominated by Kentucky bluegrass, smooth brome and leafy spurge (*Euphorbia esula*), both invasive introduced species. Switchgrass (*Panicum virgatum*), goldenrod (*Solidago* spp.), asters (*Aster* spp.), evening primrose (*Oenothera* spp.), showy partridge pea (*Cassia fasciculata*), and marijuana (*Cannabis sativa*) are also common.

LOWER RIVER

The 754-mile lower river extends from Ponca (RM 754) to St. Louis (RM 0). The entire lower river is channelized to allow for navigation from St. Louis to Sioux City. Dikes and levees converted the broad, semi-braided, meandering river to a narrow, sinuous channel (Hallberg et al. 1979, Kallemeyn and Novotny 1977). This process resulted in the disappearance of nearly all islands, backwaters, and side channels. As a consequence of channel work and bed degradation, drainage has improved on the floodplain and the accreted lands have been reclaimed for agricultural purposes. Several oxbow lakes and isolated backwaters have been maintained by groundwater seepage, surface inflow, or pumping of ground or surface water.

The lower river is divided into three reaches: Ponca to Omaha; Omaha to St. Joseph; and St. Joseph to St. Louis. About 249,173 acres of palustrine wetland, riparian vegetation, and aquatic habitat were evaluated in the 100-year floodplain along the lower river (Table 3); much of the floodplain has been converted to cropland (Table 4). Although the lower river represents 45 percent of the total acreage mapped along the entire river, it supports only 27 percent of the palustrine wetlands inventoried in 1991 (Figure 3). Conversely, 64 percent of the riparian vegetation mapped along the entire Missouri River is found along the lower river (Figure 3).

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Ponca to Omaha

In the 144 miles between Ponca (RM 754) and Omaha (RM 610), the Missouri River drops from an elevation of approximately 1,100 feet msl to 960 feet msl (1.0 ft/RM). The Ponca to Omaha reach traverses the plains grassland ecosystem (USDA Forest Service 1977). Six large tracts of public land, mostly located in Iowa along bends in the river, are managed for wildlife. The surrounding 100-year floodplain is intensively farmed except at the downstream end of the reach, which is characterized by the urban developments of Omaha and Council Bluffs, Iowa. The Omaha and Winnebago Indian Reservations border the west side of the river between RM 695 and 715. Flows in the Ponca to Omaha reach are similar to those described for the National Recreational River. Major tributaries include the Big Sioux, Little Sioux, and Floyd rivers.

Based on the updated MRBC maps, riparian lands comprise about 60 percent of the Ponca to Omaha reach, deepwater habitat comprises about 22 percent, palustrine wetlands comprise about 17 percent, and unconsolidated shore comprises less than 2 percent (Table 3). The shortest of the three lower riverine reaches, the Ponca to Omaha reach supports 33 percent of the wetland acreage mapped along the lower river and 29 percent of the riparian area (Figure 6).

Almost half (48 percent) of the palustrine wetlands in the Ponca to Omaha reach are PEMC wetlands; most of the remaining palustrine wetlands are PSSA wetlands (23 percent). PFOC wetlands are the least common (less than 1 percent). PEMC wetlands are dominated by reed canarygrass or, less frequently, common reed. PSSA wetlands are characterized by peachleaf willow and cottonwood, with some sandbar willow. Most of the palustrine wetlands in the Ponca to Omaha reach are associated with the old bends and oxbows that have been cut off from the river by bank stabilization structures or levees, but are hydrologically maintained by groundwater seepage, surface inflow, or by groundwater or surface water pumping. The largest and most diverse wetland/riparian complexes occur at the wildlife areas managed by the Iowa Department of Natural Resources at Tieville Lake (RM 692), and Louisville (RM 683), Snyder/Winnebago (RM 709), and California (RM 650) bends. Desoto National Wildlife Refuge owned and managed by the USFWS, also has large wetland complexes. Areas of RUS5 and RUS are very uncommon in the Ponca to Omaha reach and are limited mainly to a few sandbars and shorelines associated with dike fields.

Most of the riparian habitat in the Ponca to Omaha reach has developed in areas that were originally part of the river channel but have filled in as a result of channelization. Many of these areas are now croplands (Table 4) but riparian vegetation generally borders much of the river. Approximately 55 percent of the riparian vegetation in the reach is currently forested and 39 percent is grassland (Table 3). The largest forest stands are associated with the wetland complexes in the wildlife management areas. Some additional acreage occurs as thin bands along the river. Riparian forests are generally even-aged stands dominated by cottonwood; stands less than 40 years old are almost exclusively cottonwood. However, cottonwoods reach maturity in about 45 years and rapidly decline after 70 years (Harlow et al. 1979). Decadent cottonwood stands are readily invaded by other species such as elm, green ash, Russian olive, box elder, red cedar, and mulberry (Wilson 1970).

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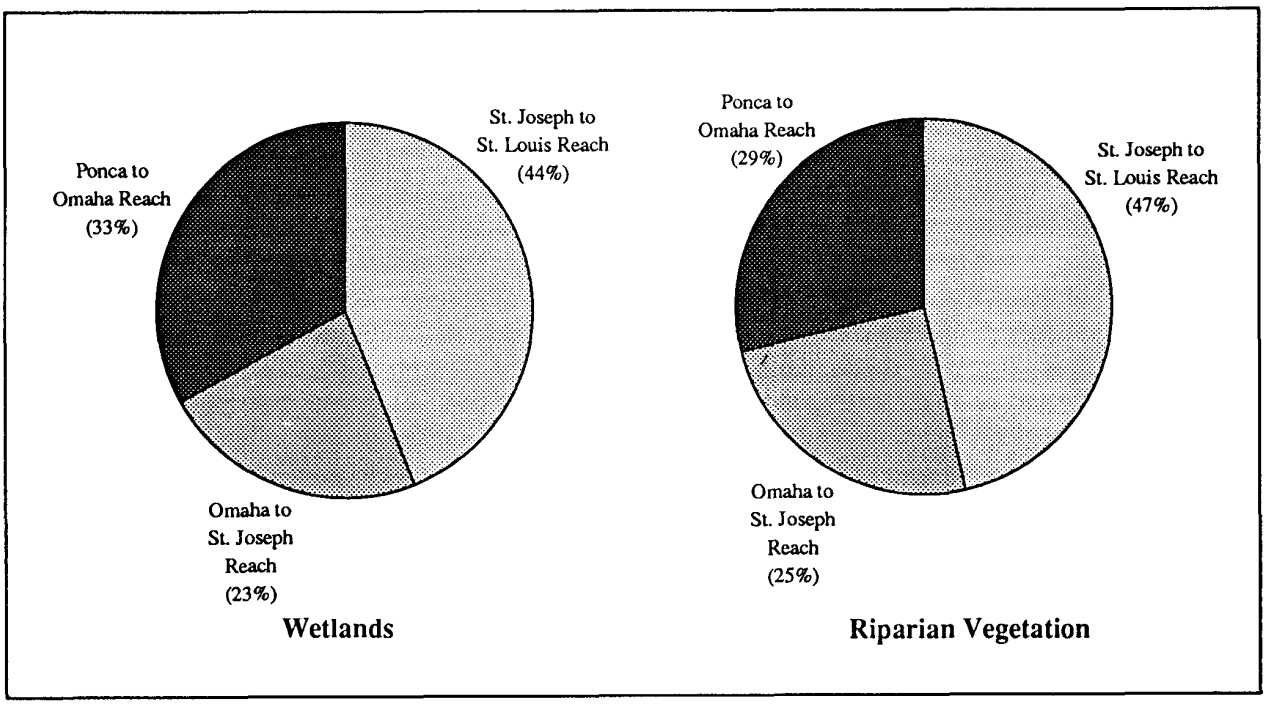

Figure 6. Distribution of palustrine wetlands and riparian areas, by reach, along the lower Missouri River.

Omaha to St. Joseph

In the 164 miles between Omaha (RM 610) and St. Joseph (RM 446), the Missouri River drops from an elevation of approximately 1,040 feet msl to 833 feet msl (1.3 ft/RM). This reach traverses lands that are transitional between the plains grassland and oak-hickory ecosystems (USDA Forest Service 1977). The channel along the entire reach has been modified and diked to accommodate navigation and flood control, resulting in the loss of aquatic habitats in marshes, oxbow lakes, and river backwater areas. The 100-year floodplain is intensively farmed (Table 4) except for areas of residential and industrial development in the vicinity of Nebraska City, Nebraska and St. Joseph. The Iowa Sac and Fox Indian Reservation borders the right bank of the river downstream of Rulo, Nebraska.

Releases from Gavins Point Dam and inflow from the Platte River and other tributaries account for most of the variability in flow in the Omaha to St. Joseph reach. Flooding is frequent in some areas, as a result of inflows from the Platte River and lower tributaries. During the navigation season, flows generally range from 25,000 to 60,000 cfs at Omaha and are slightly higher at Nebraska City (Corps 1991). Flows during the non-navigation season are much lower, typically below 20,000 cfs at Nebraska City (Corps 1991).

Based on the updated MRBC maps, riparian vegetation comprises about 54 percent of the acreage in the Omaha to St. Joseph reach, deepwater habitat comprises about 31 percent, palustrine wetlands comprise about 12 percent, and unconsolidated shore comprises 3 percent

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(Table 3). Although longer than the Ponca to Omaha reach, the Omaha to St. Joseph reach supports only 23 percent (versus 33 percent) of the wetland acreage mapped along the lower river (Figure 6). This reach contains 25 percent of the riparian vegetation inventoried along the lower river (Figure 6).

PEMC, PSSA, and PSSC types respectively comprise 53, 20, and 17 percent of the palustrine wetland acreage in the Omaha to St. Joseph reach. The least common type, PFOC, accounts for less than 1 percent (Table 3). Reed canarygrass dominates the PEMC wetlands, but sedges, rushes, and rice cutgrass (*Leersia oryzoides*) are also common. PSSA wetlands typically support a mix of black willow (*Salix nigra*), young cottonwood, and some sandbar willow. Most of the wetlands in the Omaha to St. Joseph reach are associated with the old bends and oxbows that have been cut off from the river by levees but remain wet because of pumping, groundwater seepage under levees, or surface inflows.

About 41 percent of the riparian lands in the Omaha to St. Joseph reach are grasslands; 54 percent are currently forested (Table 3). The largest stands of riparian forest occur in association with wetland complexes, but substantial acreage can be attributed to linear bands along the river banks. Forest stands are dominated by cottonwood, but green ash, sycamore, mulberry, elm, and box elder are also common.

St. Joseph to St. Louis

Between St. Joseph (RM 466) and St. Louis (RM 0), the Missouri River drops about 390 feet in elevation over 446 miles (0.8 ft/RM). This reach lies within the oak-hickory ecosystem (USDA Forest Service 1977). The entire reach has been channelized and diked for navigation and flood control; consequently, most of the old channels and oxbows behind the levees have been drained and converted to agricultural land. The surrounding floodplain is intensively farmed (Table 4) except for areas of residential and industrial development at Kansas City and Columbia, Missouri, and at St. Louis.

Flows in the St. Joseph to St. Louis reach are greatly influenced by inflows from the Platte, Kansas, Grand, Osage, and Gasconade rivers. Releases from Gavins Point Dam are less important in each successive downstream reach. Severe flooding occasionally occurs in this reach. During the navigation season, flows range from 35,000 to 70,000 cfs at Kansas City (Corps 1991). Flows during the non-navigation season are much lower, generally between 10,000 to 40,000 cfs at Kansas City (Corps 1991).

Based on the updated MRBC maps, riparian lands account for 43 percent of the acreage in the 100-year floodplain of the St. Joseph to St. Louis reach, deepwater habitat accounts for about 44 percent, palustrine wetlands account for about 10 percent, and unconsolidated shore accounts for 3 percent (Table 3). The St. Joseph to St. Louis reach is more than double the length of any other riverine reach and the floodplain and aquatic habitat mapped in this reach represents nearly one-quarter of the amount inventoried along the entire Missouri River (Table 3). Nonetheless, the St. Joseph to St. Louis reach supports only about 12 percent of the palustrine wetlands acreage mapped along the entire river, more than any other reach but less than several of the deltas (Figure 5). Approximately 30 percent of the

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riparian lands mapped along the entire river is found in the St. Joseph to St.Louis reach, far more than any other reach or delta area.

Differing markedly from other reaches, almost two-thirds of the palustrine wetland acreage in the St. Joseph to St. Louis reach is forested. PFOC wetlands comprise about 46 percent of the wetland acreage, and the PFOA type about 19 percent (Table 3). PEMF and PEMC types respectively represent about 13 and 10 percent (Table 3). PEMA wetlands are the least common (2 percent) (Table 3). As in other lower riverine reaches, PFOC wetlands are dominated by black willow. PFOA wetlands are characterized by black willow as well as silver maple and sycamore. PEMF wetlands, which tend to occupy shallow water in ponds located between the river and levees, are characterized by flatsedges (*Cyperus* spp.), smartweeds (*Polygonum* spp.) and, less commonly, cattails. PEMC wetlands in this reach support rice cutgrass and, less commonly, green bulrush (*Scirpus atrovirens*), skullcap (*Scutellaria* sp.), and smartweeds. Most of the wetlands in the St. Joseph to St. Louis reach are associated with islands or old bends and oxbows that have been cut off from the river by levees but remain wet. Many of these wetland complexes are wildlife or natural areas managed by the Missouri Department of Conservation. Since 1974, channel structures of the lower river have been modified in an attempt to restore side channels and backwater habitats.

About 93 percent of the riparian lands in the St. Joseph to St. Louis reach are forested (Table 3) and characterized by a mix of cottonwood, sycamore, box elder, dogwood, and mulberry (*Morus* spp.). The understory typically includes vines such as wild grape (*Vitis* sp.), and clematis (*Clematis* sp.). In many areas riparian forests and PFOA wetlands are very similar in terms of structure and under-story species composition and may be classified as either, depending on wet or dry conditions. One of the largest, most diverse, and undisturbed areas of riparian forest along the lower river, occurs at Fort Leavenworth, Kansas. This area includes many species that are now rarely seen along the lower Missouri River including pecan (*Carya illinoensis*), pawpaw (*Carica papaya*), Kentucky coffeetree (*Gymnocladus dioica*), and swamp chestnut oak (*Quercus michauxii*).

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DEVELOPMENT OF THE WETLAND AND RIPARIAN MODEL

The objective of developing a wetland/riparian resource model is to relate changes in the hydrologic regime of the Missouri River over time to alterations in the wetland and riparian communities along the river. The model would show how these resources change, in type and relative quantity, after exposure to a pattern of hydrologic events over a 93-year simulation period . The assumption underlying the development of this model is that the quantity and type of wetland/riparian resources is related to three factors: (1) water surface elevation as defined by reservoir levels or river stage/discharge patterns; (2) frequency, duration, and depth of inundation; and (3) successional processes related to establishment and persistence of various types of wetland and riparian vegetation.

The overall process of model development involved three steps: (1) determining the hydrologic and successional responses of wetland and riparian communities along the Missouri River; (2) integrating this information with monthly hydrology data; and (3) creating an accounting program to track changes in acreage over a 93-year simulation period. Consequently, the wetland/riparian resource model consists of three major components operated sequentially for each year of simulation (1898 through 1991) for each water control plan alternative. These three components follow:

- Ecological Component - Applies a set of hydrologic and successional rules that determine the response of wetland/riparian types to changes in hydrology;

- Hydrological Component - Translates the LRS output into mean and maximum monthly reservoir and river surface elevations (stage) to determine inundation/saturation duration and frequency for wetland and riparian areas; and

- Accounting Component - Consists of a sequence of data matrices that track the acreage of each wetland/riparian type, by elevation, for each year of the 93-year simulation period.

The following sections describe in detail these three major operational components. A fourth section describes the integration of the three components to generate an annual estimate of acreage associated with reservoir levels and river stages for the Missouri River, as defined by the water control plan alternatives.

ECOLOGICAL COMPONENT

The ecological component of the wetland/riparian resource model consists of the "rules" that determine the direction and extent of acreage changes between wetland/riparian type, as a function of succession or water surface elevation (either river stage or pool elevation). Ideally, the rules should account for all factors that influence the initial establishment and survival of various wetland/riparian types, including: (1) current plant community type (especially the dominant taxon) composition; (2) plant succession; (3) plant tolerance to flooding; (4) soil or substrate type; (5) sedimentation; (6) erosion; (7) scouring;

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(8) flood season, duration, and frequency; (9) seed bed composition; (10) topography; and (11) disturbance from wildlife, agriculture, or other factors. However, to simplify the modeling of long-term changes in vegetation distribution and abundance, four of the above factors were identified as the primary controls of wetland/riparian resources along the Missouri River: (1) current plant community; (2) plant succession; (3) plant tolerance to flooding and drying; and (4) inundation patterns, including season, duration, and frequency. Because the definitions of each wetland/riparian type largely determine plant community type, as well as inundation patterns (see Table 1), the rules developed for each type primarily reflect differences in flood/drought tolerance and successional patterns.

For the purpose of developing the rules for the ecological component, the flood and drought tolerance of dominant plant species for each wetland/riparian type was used to govern the conversion of a drier type to a wetter type or vice versa. For example, deep flooding over the entire growing season for 2 consecutive years eliminates all but the most water-tolerant plants, resulting in the conversion of a palustrine wetland type to a deep water habitat. Because of changes in species dominants, response rules developed for wetland types along the upper river were different from those along the lower river. In addition, it is assumed that plants are damaged more by inundation in a riverine reach because of scour and sediment deposition than if the plants were inundated in a reservoir with similar water levels and duration. Consequently, rule assumptions for wetlands in deltas and riverine reaches were also different.

Succession is defined as changes in the species composition of a community over time as it responds to and modifies the environment. Catastrophic events typically interrupt succession, either restarting the cycle or beginning at an earlier stage. When plants are protected from destructive hydrologic events, time and life history characteristics of the dominant species have the greatest influence on successional patterns. The successional changes that potentially occur in wetland/riparian communities in response to changes in hydrology are relatively complex (Figure 7). The complexity results in large part from the number of interactions between each possible vegetation type and various environmental conditions. Some wetland/riparian types are relatively insensitive to periodic changes in environmental conditions and remain stable for long periods. Other types change quickly in response to seemingly minor alterations in flood regime or soil moisture. For the purpose of developing rules for the ecological component, the life histories of dominant species and the flooding regimes generally associated with each wetland/riparian type (Table 5) determine the successional patterns for each type.

The following subsections highlight the flood tolerance and life history information for each of the wetland/riparian types. The assumptions derived from this information are then summarized and used to develop the rules for the ecological component. Appendix C provides the actual rules that were programmed into the ecological component of the wetland/riparian model. Wetlands in deltas and along upper and lower riverine reaches have different sets of rules.

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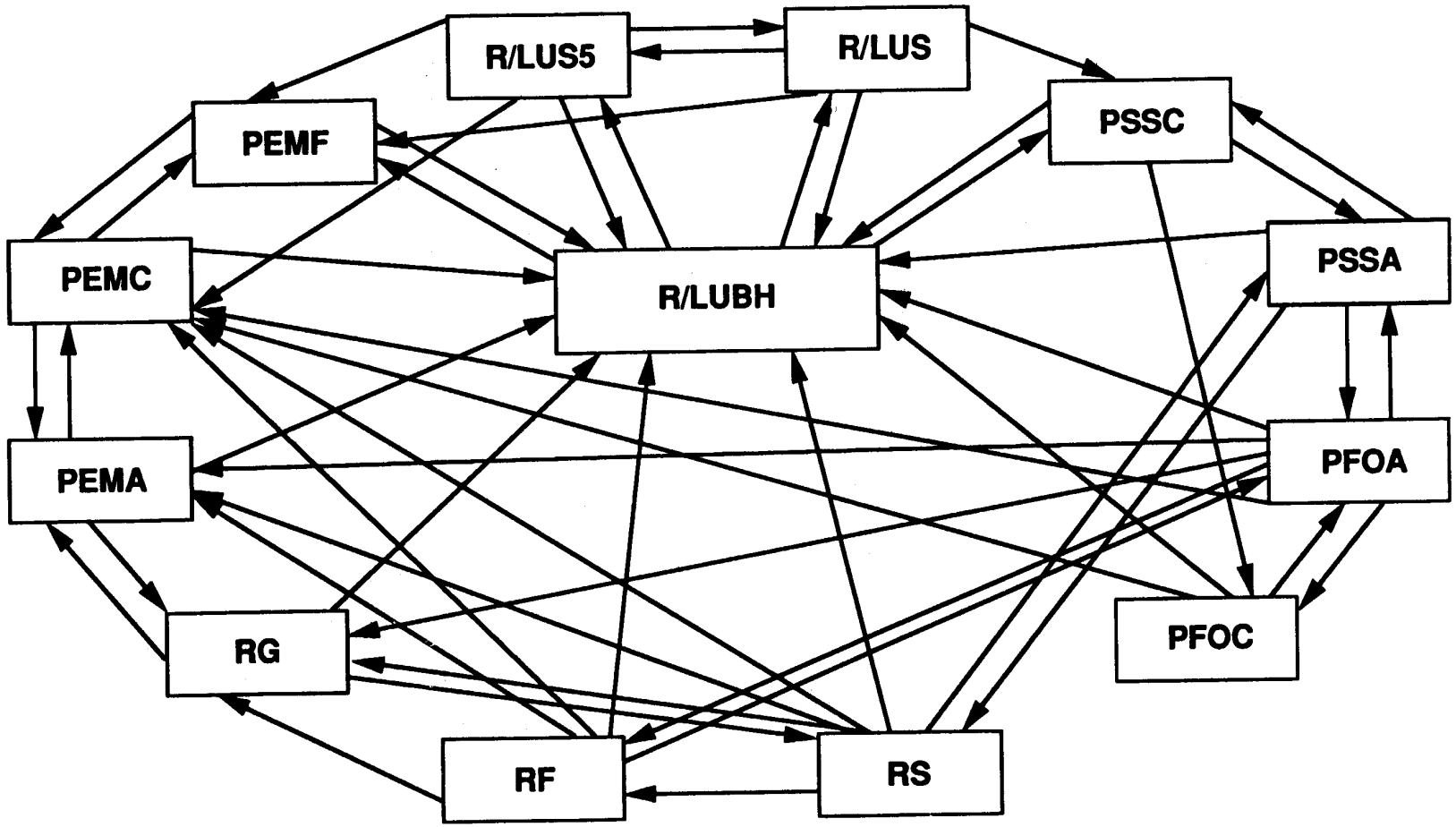

Figure 7. Successional diagram for wetland and riparian types along the Missouri River. Nomenclature for wetland types follows Cowardin et al. 1979.

Table 5. Dominant species, flood frequency, and flood duration for Missouri River wetland, deepwater, and riparian habitat types.

TYPE	DOMINANT SPECIES [1]	FLOOD/SATURATION DURATION [2],[4]	FLOOD/SATURATION FREQUENCY [3],[4]
PALUSTRINE TYPES			
Palustrine Emergent Semipermanently Flooded (PEMF)	Upper River: cattail (narrow-leaved, broad-leaved, hybrid), bulrush (soft-stem, hard-stem, river) Lower River: smartweed, flatsedge	More than 2 months per growing season	At least 1 year out of every 2 years
Palustrine Emergent Seasonally Flooded (PEMC)	Upper River: reed canarygrass, common reed, scouring rush, slough sedge Lower River: rice cutgrass, smartweed, foxtail, darkgreen bulrush, fox sedge	More than 1 month but less than 2 months per growing season	At least 1 year out of every 2 years
Palustrine Emergent Temporarily Flooded (PEMA)	Upper River: wheatgrasses, Canada thistle, sweet clover, scouring rush Lower River: annual sunflower, giant ragweed	At least 10 days during the growing season	At least 1 year out of every 10 years
Palustrine Scrub-Shrub Seasonally Flooded (PSSC)	Upper River: sandbar willow, peachleaf willow, indigo bush Lower River: sandbar willow, black willow	At least 1 month during the growing season	At least 1 year out of every 2 years
Palustrine Scrub-Shrub Temporarily Flooded (PSSA)	Upper River: sandbar willow, peachleaf willow, cottonwood Lower River: black willow, cottonwood	At least 10 days during the growing season	At least 1 year out of every 10 years
Palustrine Forest Seasonally Flooded (PFOC)	Upper River: peachleaf willow Lower River: black willow	At least 1 month during the growing season	At least 1 year out of every 2 years
Palustrine Forest Temporarily Flooded (PFOA)	Upper River: peachleaf willow, cottonwood Lower River: black willow, silver maple, cottonwood, sycamore	At least 10 days during the growing season	At least 1 year out of every 10 years
LACUSTRINE TYPES			
Lacustrine Unconsolidated Bottom, Permanently Flooded (LUBH)	none [5]	Continual	Every year

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Table 5. Dominant species, flood frequency, and flood duration for Missouri River wetland, deepwater, and riparian habitat types.

TYPE	DOMINANT SPECIES [1]	FLOOD/SATURATION DURATION [2],[4]	FLOOD/SATURATION FREQUENCY [3],[4]
Lacustrine Unconsolidated Shore, Seasonally Flooded (LUSC)	None	At least 1 month during the growing season	At least 1 year out of every 2 years
Lacustrine Unconsolidated Shore, Vegetated (LUS5)	Upper River: cocklebur, wild barley, sun flower, prickly lettuce, beggerstick, barnyard grass, dock, sweet clover	Variable	Variable
RIVERINE TYPES			
Riverine Unconsolidated Bottom, Permanently Flooded (RUBH)	None [5]	Continual	Every year
Riverine Unconsolidated Shore, Seasonally Flooded (RUSC)	None	At least 1 month during the growing season	At least 1 year out of every 2 years
Riverine Unconsolidated Shore, Vegetated (RUS5)	Cocklebur, wild barley, spikerush, beggerstick, sweet clover, cottonwood	Variable	Variable
RIPARIAN TYPES			
Riparian Grassland (RG)	Upper River: smooth brome, leafy spurge Lower River: Johnson grass, cassia	Generally less than 10 days per growing season	Less than once out of every 10 years to maintain; 2 or more consecutive years to convert to wetland
Riparian Scrub-Shrub (RS)	Upper River: cottonwood Lower River: cottonwood, snowberry, mulberry	Generally less than 10 days per growing season	Less than once out of every 10 years to maintain; 2 or more consecutive years to convert to wetland

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Table 5. Dominant species, flood frequency, and flood duration for Missouri River wetland, deepwater, and riparian habitat types.

TYPE	DOMINANT SPECIES [1/]	FLOOD/SATURATION DURATION[2/,4/]	FLOOD/SATURATION FREQUENCY[3/,4/]
Riparian Forest (RF)	Upper River: cottonwood, green ash, Russian olive, elm Lower River: cottonwood, mulberry, box elder	Generally less than 10 days per growing season	Less than once out of every 10 years to maintain; 2 or more consecutive years to convert to wetland

1/ The upper river extends from the Fort Peck Lake delta to Ponca; the lower river extends from Ponca to St. Louis.

2/ Based on a 4-month (May to August) growing season.

3/ Because sandy soils, which have a water retention capability of about 1 foot, the lowest of any soil, flood/saturation is defined as water within 1 foot or less of the surface (Novakowi and Gillham 1988).

4/ Flood frequency/duration definitions adapted from Mitsch and Gosselink (1986) to fit hydrological data available from the Corps' LRS model and simulation period.

5/ Most permanently flooded areas in the Missouri reservoirs and riverine reaches are inundated with greater than 6 feet of water and did not support vegetation. These areas (RUBH and LUBH) are classified as deepwater habitats.

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Palustrine Emergent Semipermanently Flooded Wetlands (PEMF)

Herbaceous plants that tolerate flooded or saturated soils during some or all of the growing season dominate semipermanently flooded wetlands (Cowardin et al. 1979). Many of these species are perennials that can reproduce by seed and/or vegetatively from rhizomes. The majority of the PEMF wetlands along the upper river consists mainly of narrow-leaved cattail. Other commonly occurring species include broad-leaved and hybrid cattails and river, softstem, and hardstem bulrushes (*Scirpus acutus*). PEMF wetlands along the lower river are rare and usually dominated by flat sedges and smartweeds.

Flood Tolerance. The flood tolerances of species that dominate PEMF wetlands are summarized as follows:

- Narrow-leaved cattail grows in water up to 3.6 feet (110 cm) deep but prefers depths of about 2.5 feet (80 cm) (Grace and Wetzel 1981). Narrow-leaved cattail is the most tolerant of cattail species to deep water (Harris and Marshall 1963).

- Broad-leaved cattail is found in depths up to 2.5 feet (80 cm), with optimal production occurring between 0.3 and 1.6 feet (10 to 50 cm) (Grace and Wetzel 1981).

- The tolerance of hybrid cattail to deep water is intermediate between that of broad-leaved and narrow-leaved cattail. Hybrid cattail is known to survive in water depths of 2 feet (61 cm) for more than 4 years (Harris and Marshall 1963).

- Cattails in Lake Sakakawea were eliminated after being inundated for 123 days (4.1 months) at depths up to 7.5 feet (230 cm); however, they regenerated the following year from underground rhizomes (Hoffman 1978). None of the cattail species along the Missouri River survive water depths greater than 3.3 feet (100 cm) when submerged for more than 2 years (Shay and Shay 1986).

- Softstem bulrush occurs in water up to 3.9 feet (120 cm) deep, but prefers depths less than 0.7 feet (20 cm) (Shay and Shay 1986). This species does not survive in water depths greater than 1.3 feet (38 cm) for more than 2 years (Harris and Marshall 1963).

- Hardstem bulrush is found in water depths up to 6.6 feet (200 cm); 0.5 to 1.5 feet (15 to 45 cm) is optimal. This species apparently tolerates stable water levels between 1.6 and 3.3 feet (50 to 100 cm) and will survive a 2-year flood (Shay and Shay 1986, Hoffman 1978). However, 1.6 feet (49 cm) of water kills seedlings (Merendino and Smith 1991).

- River bulrush is found in water depths greater than 3.3 feet (100 cm) (Hitchcock and Cronquist 1973).

- Water smartweed (*Polygonum punctation*) cannot survive more than 2 years of continuous flooding during the growing season (Miller 1973). However, it can

survive deep flooding for a single season and can fruit and flower in water depths up to 10 feet (305 cm) (Hall et al. 1946). Other smartweed species also seem tolerant of water up to 1 foot (30 cm) deep for at least 1 month during the growing season (Hall et al. 1973).

Life History. The following are major life history features relevant to the successional patterns of PEMF wetlands:

- Many wetland species are poor competitors that are frequently and quickly eliminated by more mesic plants under drying conditions (Hall et al. 1946). For example, cattail marshes occurring on coarse soils in the northern United States are invaded by weedy species, such as Canada thistle and sweet clovers (*Melilotus* spp.) during the second year of a dry period with no surface water (Harris and Marshall 1963). However, dense litter has been shown to retard the germination of other species in cattail stands (Polani and Johnson 1989). Cattail response to single-season drought includes reduced standing crop and flowering shoot density the following year with full recovery requiring about 2 years (Van der Valk and Davis 1980).

- Softstem, hardstem, and river bulrush can survive drawdown. However, softstem bulrush is a relatively short-lived perennial that persists only 2 to 3 years, even under optimal conditions (Shay and Shay 1986).

- Hardstem bulrush is a long-lived perennial and can persist for many years along shorelines after water levels have dropped (Shay and Shay 1986). River bulrush response to a single-season drought includes heavier, denser, and taller vegetative shoots the following year but lower flowering shoot density; flowering shoots recover in about 2 years (Van der Valk and Davis 1980). Field observations along the Missouri River suggest that more drought-tolerant species invade dry stands of hardstem and river bulrush over a 3- to 5-year period.

- Cattail and softstem bulrush can germinate in at least 6 inches (15 cm) of water (Keddy and Ellis 1985, Bedish 1967). Cattail seeds can germinate the same season they are produced (Hall et al. 1946).

- Periodic drawdowns appear to enable several emergent species to coexist in a community because of their different responses to disturbance. In prairie glacial marshes, habitat stability favors lower species diversity and monotypic stands (Van der Valk and Davis 1980).

- Establishment of emergents in a northern prairie marsh is favored by an early season drawdown (Harris and Marshall 1963). Early season drawdowns (May and June) allow perennials time to develop rhizomes capable of producing shoots under flooded conditions. Hardstem bulrush plants that establish under conditions of early season drawdown are capable of withstanding deeper flooding than plants that establish under a regime of late drawdown (Merendino and Smith 1991).

- The presence of existing vegetation inhibits seedling establishment because cattails are intolerant of shade and require bare soil for germination (Grace and Harrison 1986).

Rule Assumptions for PEMF Wetlands. Because the flood and drought tolerances of species dominating PEMF wetlands are essentially the same along the entire Missouri River, the rule assumptions for the upper and lower riverine models are the same. However, because emergent plants are relatively easy to uproot, the flood tolerance of PEMF wetlands along riverine stretches is expected to be less than that of similar wetlands in deltas. Consequently, the rule assumptions of PEMF wetlands are different for riverine areas and deltas. Based on flood tolerance and life history requirements of plants in PEMF wetlands, the following rules for the ecological component were defined:

- PEMF wetlands can replace RUBH, LUBH, and PEMC wetlands; however, they do not directly convert to scrub-shrub or forested wetlands because the dominant species in these types require bare mineral soil for germination.

- PEMF wetlands can arise from RUBH, LUBH, RUSC, and LUSC if these types experience drier conditions. PEMF wetlands can also replace PEMC wetlands that experience wetter conditions.

- Established PEMF wetlands in deltas can withstand 2 consecutive years of flooding at depths greater than 3.3 feet (100 cm). At the end of the second consecutive year, however, PEMF wetlands in deltas would convert to LUBH.

- Established PEMF wetlands along riverine stretches can withstand only 1 year of flooding depths greater than 3.3 feet (100 cm) due to water velocity/scouring effects. At the end of 1 season, PEMF wetlands in riverine stretches would convert to RUBH.

- PEMF wetlands can withstand 2 years of drought or drawdown, with water levels lower than the surface for the entire growing season. After the second year, PEMF wetlands are subject to invasion by weedy annuals and convert to PEMC.

- Conditions that favor the creation of PEMF wetlands from LUBH or RUBH include early season drawdown (May or June) to create shallow water (less than 6 inches) through July. Given this set of circumstances, new cattail and/or bulrush plants could likely survive August water depths up to 1 foot (30 cm) or dry conditions.

Palustrine Emergent Seasonally Flooded Wetlands (PEMC)

Seasonally flooded emergent wetlands are characterized by herbaceous plants that are generally tolerant of both flooding and drying during the growing season. Most of PEMC

wetlands along the upper river are dominated by reed canarygrass, common reed, and slough sedge. Along the lower river, rice cutgrass and smartweeds are the most common species.

Flood Tolerance. The flood tolerances of species that dominate PEMC wetlands are summarized as follows:

- Common reed readily tolerates water depths up to 1.6 feet (50 cm). A stand of common reed was observed in Lake Sakakawea in water about 3.3 feet (100 cm) deep that was present for most of the growing season (Hoffman 1978). However, 2 years of continual inundation greater than 3.3 feet (100 cm) kills all but the most vigorous clones, and 3 years of flooding at this depth eliminates it (Shay and Shay 1986).

- Reed canarygrass is a vigorous species that tolerates a wide range of conditions. At Lake Sakakawea, this species survived 106 days (3.5 months) of surface water, including 43 days (1.4 month) of complete inundation (Hoffman 1978). However, 3 years of continuous inundation greater than 3 feet (0.9 m) would probably eliminate reed canarygrass.

- Slough sedge begins to die when flooded with 2.5 to 3 feet (76 to 91 cm) of water in a single growing season. Higher water levels further decrease survival, and 2 years of continual flooding eliminates this species (Miller 1973). Flooding with 1 to 1.3 feet (30 to 40 cm) of water greatly reduces slough sedge in 3 years and eliminates it in 4 years (Harris and Marshall 1963).

- Optimal growth for rice cutgrass occurs under two different sets of conditions: (1) shallow flooding (1 to 2 inches [2 to 5 cm]) throughout the growing season; or (2) deep or shallow flooding until mid- or late growing season, then drawn down (Fredrickson and Taylor, 1982). Continual flooding for 2 years at depths greater than 1 to 2 feet would probably eliminate this species.

- Smartweed species found in PEMC wetlands appear tolerant of water up to at least 1 foot (30 cm) deep for some portion of the growing season (Hall et al. 1973).

Life History. Successional patterns of PEMC wetlands are summarized as follows:

- Common reed does not survive well in areas where the water table is more than 3.3 feet (100 cm) below the surface (Shay and Shay 1986).

- Field observations indicate that well-established stands of reed canarygrass can tolerate droughts of 3 to 5 years.

- Field observations indicate that rice cutgrass is relatively intolerant to drought over the course of the growing season. The productivity and cover of this species appeared greatly reduced in wetlands that had not experienced some

period of high water during the 1991 growing season. It seems likely that 3 years of drought would eliminate this species.

- Laboratory studies indicate reed canarygrass germinates poorly in standing water (Stanley and Hoffman 1975).

- Rice cutgrass requires wet soils for germination but does not tolerate surface water during this period (Fredrickson and Taylor 1982).

- Many species of smartweed require moist-to-wet conditions for germination but cannot withstand surface water (Hall et al. 1946).

Rule Assumptions for PEMC Wetlands. Because the flood and drought tolerances of species dominating PEMC wetlands are essentially the same along the entire Missouri River, the rule assumptions for the upper and lower riverine models are the same. However, because herbaceous plants are relatively easy to uproot, the flood tolerance of PEMC wetlands along riverine stretches is expected to be less than that of similar wetlands in deltas. Consequently, the rule assumptions of PEMC wetlands are different for riverine areas and deltas. The following rules for PEMC were developed from flood tolerance and life history requirements:

- PEMC wetlands can convert to RUBH, LUBH, PEMA, and PEMF. PEMC wetlands do not directly convert to scrub-shrub or forested wetlands because the dominant species in these types require bare mineral soil for germination.

- PEMC wetlands can arise from PEMF, PEMA, PFOC, and PFOA wetlands as well as from LUS5 and RUS5. Because most of the dominant plants in PEMC wetlands cannot tolerate standing water during germination, PEMC wetlands are unlikely to establish on exposed areas of RUBH, LUBH, RUSC, or LUSC because these types are usually flooded for much of the growing season.

- Established PEMC wetlands in deltas can withstand 2 consecutive years of flooding at depths greater than 3.3 feet (100 cm). At the end of the second consecutive year, PEMC converts to LUBH.

- Established PEMC wetlands along riverine stretches can withstand only 1 year of flooding depths greater than 3.3 feet (100 cm) due to water velocity/scouring effects. At the end of 1 season, PEMC wetlands in riverine stretches would convert to RUBH.

- Based on the hydrologic regime defined for seasonally flooded wetlands (see Table 1), PEMC wetlands would convert to PEMF wetlands after 2 years with 2 or more months of surface water during the growing season. Although most of the species that characterize PEMC wetlands tolerate long wet periods and may persist for several years, it is likely that emergent species more tolerant of flooding would begin to invade.

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- The drought tolerance of species dominating PEMC wetlands is variable. After the second year of a drought, some of the less drought-tolerant species, such as rice cutgrass, might begin to die. Common reed and reed canarygrass, however, might persist for several more years. Based on the hydrologic regime defined for seasonally flooded wetlands (see Table 2), PEMC wetlands convert to PEMA wetlands after 2 consecutive years of water more than 1 foot (30 cm) below the surface.

- Conditions that favor the creation of PEMC wetlands from LUS5 and RUS5 include early season flooding followed by saturated conditions in July and August. This hydrologic regime promotes the establishment of emergents such as rice cutgrass and reed canarygrass.

- Water levels within 2 feet (60 cm) of the surface over a period of 3 years will kill most trees in PFOA wetlands. Three years of surface water are required to kill the flood-tolerant willows that comprise most PFOC wetlands. Depending on the water regime in the third year, PEMC wetlands can become established.

Palustrine Emergent Temporarily Flooded Wetlands (PEMA)

Temporarily flooded emergent wetlands are dominated by a mixture of plants tolerant to occasional flooding during the growing season. Plants more typically found in uplands but better adapted to a wide range of conditions are also prevalent. The number of species represented in PEMA wetlands is typically higher than in other wetland types and the species composition is more variable, even within the same locale. Along the upper river, scouring rushes (*Equisetum* spp.), Canada thistle, sweet clovers, quackgrass, and western wheatgrass characterize PEMA wetlands. Along the lower river, giant ragweed (*Ambrosia trifida*) and sunflower are common in PEMA wetlands.

Flood Tolerance. The flood tolerances of species that dominate PEMA wetlands are summarized as follows:

- Quackgrass and western wheatgrass are relatively tolerant to flooding. At Lake Sakakawea, these species survived over 90 days (3 months) of surface water, including more than 60 days (2 months) of complete inundation (Hoffman 1978). Flooding of 1 to 2 feet (30 to 60 cm) for 1 growing season would probably eliminate quackgrass and western wheatgrass.

- Giant ragweed is killed by 30 days (1 month) of flooding during June to depths of 6 inches (15 cm) (Hall et al. 1946).

- Water horsetail (*Equisetum fluviatile*) is the only species in drained wetlands (in Sweden) that survives reflooding and water depths up to 6 feet (190 cm) (Sjoberg and Danell 1983).

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- Common plants in upland communities along a reservoir in Kentucky typically survive up to 10 days (0.3 month) of shallow flooding but die in deeper water (Hall et al. 1946). Consequently, it is likely that facultative upland species found in PEMA wetlands, such as Canada thistle and sweet clover, would die if submerged in water more than 1 foot deep (30 cm) for more than 10 days.

Life History. Successional patterns of PEMA wetlands are summarized as follows:

- Laboratory studies by Stanley and Hoffman (1975) indicate quackgrass readily germinates in standing water but western wheatgrass does not.

- Most species common to PEMA wetlands, such as giant ragweed, require dewatering to germinate (Hall et al. 1946).

Rule Assumptions for PEMA Wetlands. Because the flood and drought tolerance of species dominating PEMA wetlands is essentially the same along the entire Missouri River, the rule assumptions for the upper and lower riverine models are the same. In addition, because the herbaceous species that dominant PEMA wetlands in deltas and riverine reaches are relatively intolerant of flooding, the rule assumptions for PEMA wetlands in both these areas are the same as well. Based on flood tolerance and life history requirements, the following assumptions were incorporated into the rules for PEMA wetlands:

- PEMA wetlands can convert to RUBH, LUBH, PEMC, and RG. PEMA wetlands cannot directly convert to scrub-shrub or forested wetlands because the dominant species in these types require bare mineral soil for germination.

- PEMA wetlands can arise from PEMC wetlands that experience drier conditions or RG that experiences wetter conditions.

- Because many of the dominant plants in PEMA wetlands are upland species that are intolerant of more than a few weeks of saturated soils or inundation, PEMA wetlands are unlikely to arise directly from exposed RUBH, LUBH, RUSC, or LUSC.

- Continual flooding with water at least 1 foot (30 cm) deep throughout a single growing season eliminates the dominant species in PEMA wetlands and converts this type directly to RUBH or LUBH. Two consecutive years of continual surface water of any depth also converts this type to RUBH or RUBH.

- Based on the hydrologic regime defined for temporarily flooded wetlands (see Table 1), PEMA wetlands convert to PEMC wetlands after 2 years with 1 or more months of water within 1 foot of the surface during the growing season. Most of the species that characterize PEMA wetlands cannot withstand long wet periods, and they are gradually replaced by species more tolerant of flooding.

- Many of the plants that dominate PEMA wetlands are upland species that are relatively drought tolerant. Consequently, they most likely persist throughout dry

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periods. Based on the hydrologic regime defined for temporarily flooded wetlands (see Table 2), PEMA wetlands convert to RG after 6 consecutive years of water more than 1 foot below the surface.

Palustrine Scrub-Shrub Seasonally Flooded Wetlands (PSSC) and Palustrine Forest Seasonally Flooded Wetlands (PFOC).

Seasonally flooded scrub-shrub and/or forested wetlands consist of woody species that are tolerant of periodic flooding during the growing season. The majority of the PSSC wetlands along the upper river are dominated by sandbar willow. Peachleaf willow and indigo bush also occur, but are rarely dominant. PFOC wetlands generally consist of sandbar and/or peachleaf willow greater than 20 feet (6 m) tall. Sandbar willow and black willow dominate PSSC and PFOC wetlands along the lower river.

Flood Tolerance. The flood tolerances of species that dominate PSSC and PFOC wetlands are summarized as follows:

- Black willow is one of the most flood tolerant of all shrub and tree species (Green 1947, Hall and Smith 1955). This species can survive continuous inundation of more than 1 foot (30 cm) for at least 2 growing seasons (Moyle 1959). Other evidence suggests that black willow can survive up to 4 years of inundation to the root crown (Green 1947). Over the long term (greater than 8 years), black willow grows well in areas that are inundated, on average, less than 43 percent of the growing season (Hall and Smith 1955).

- Well-established sandbar willows are also very flood tolerant. Sandbar willow shrubs succumb to continual inundation by more than 2 feet (60 cm) of water for 3 to 4 years or greater than 1.5 feet (45 cm) for 5 years (Harris and Marshall 1963). Sandbar willow trees die from 2 years of flooding of the root crown (Green 1947).

- Shrub seedlings (1 to 2 years old) are not as tolerant to flooding as older individuals; one season of inundation to 0.8 foot (25 cm) severely stresses seedling sandbar willow and 2 years of water at this level kills them (Harris and Marshall 1963). Black willow seedlings survive 1 month of complete inundation under laboratory conditions (Hosner 1958). Black willow seedlings tolerate inundation for 45 percent of the growing season, but die when flooded for longer periods (Hall and Smith 1955).

- In general, mature trees are more susceptible to stress from flooding than immature trees or shrubs (Hall et al. 1946).

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Life History. Successional patterns of PSSC and PFOC wetlands are summarized as follows:

- Sandbar willow seeds require moist, bare, mineral soil for germination. Consequently, they are one of the first species to colonize newly formed point bars and islands (Barnes 1985, Noble 1979, Wilson 1970). Seeds deposited by receding flood waters germinate if the soil remains moist and no floods occur for several months (Barnes 1985). Once established, sandbar willow grows quickly, averaging 20 inches (50 cm) in height at the end of its first growing season (Dionigi et al. 1985). This species readily reproduces vegetatively from long, fiberlike roots (Barnes 1985). On a river island in Wisconsin, nearly 97 percent of the sandbar willow stems were judged to be clones (Barnes 1985). This adaptation enables sandbar willow to readily survive erosion, inundation, and scouring (Barnes 1985). Sandbar willow rarely exceeds 9.8 to 16 feet (3 to 5 m) in height, and starts to decline at about 35 years of age (Barnes 1985).

- Along the Missouri River in South Dakota, sandbar willow is generally the first species to colonize islands and point bars. Cottonwoods gradually invade this community through successful seedling establishment in bare areas. The willow/cottonwood type usually persists for about 15 years before the willow dies out and cottonwood dominates (Wilson 1970).

- The germination and establishment requirements of black willow are similar to those of sandbar willow. Black willow also requires bare mineral soil for germination and readily reproduces vegetatively. It grows quickly, averaging 46 inches (117 cm) in height by the end of its first growing season (Dionigi et al. 1985). This species averages 30 to 60 feet (9 to 18 m) at maturity and begins to decline within 30 to 50 years (Harlow et al. 1979).

Rule Assumptions for PSSC Wetlands. Because the flood tolerance of species dominating PSSC wetlands differs between the upper and lower river, the rule assumptions for the upper and lower riverine models are different. Similarly, because seedling PSSC are harder to establish along riverine reaches than in deltas, the rule assumptions for seedling PSSC are different for deltas and riverine reaches. However, because mature shrubs are difficult to uproot and can tolerate relatively high water velocities, the rule assumptions for established PSSC wetlands in deltas are the same as those for the upper river. The following rules for PSSC wetlands were developed from flood tolerance and life history requirements.

- PSSC wetlands can convert to RUBH, LUBH, PSSA, and PFOC. PSSC wetlands do not directly convert to emergent wetlands because willow is relatively flood tolerant. This species will die if continually inundated for relatively long periods, resulting in open water. In addition, most emergents are shade intolerant and are unable to germinate under the dense canopies that usually characterize most willow stands.

- Because willow requires bare mineral soil for germination, PSSC wetlands arise only from RUSC, LUSC, LUBH, and RUBH that are exposed during dry

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periods. Conditions that favor the creation of PSSC from these types include drawdown resulting in moist conditions without standing water from May or June through July. Given this set of circumstances, seedling willow could probably survive high water or dry conditions in August.

- Established PSSC wetlands along the upper river can withstand 2 consecutive years of flooding at depths greater than 2 feet (60 cm) throughout the growing season; conversion to either LUBH or RUBH occurs at the end of the second season of inundation.

- Established PSSC wetlands along the upper river can withstand 3 consecutive years of surface flooding to depths less than 2 feet (60 cm) throughout the growing season; conversion to either LUBH or RUBH occurs at the end of the third growing season of inundation.

- Established PSSC wetlands along the lower river can withstand 3 consecutive years of flooding at depths greater than 2 feet (60 cm) throughout the growing season; conversion to RUBH occurs at the end of the third season of inundation.

- Established PSSC wetlands along the lower river can withstand 4 consecutive years of surface flooding at depths less than 2 feet (60 cm) throughout the growing season; conversion to RUBH occurs at the end of the fourth season of inundation.

- Regardless of location along the river, PSSC wetlands will convert to RUBH or LUBH if shrubs are completely submerged for an entire growing season. On the basis of field observations and because shrubs in PSSC wetlands can range from 1 to 20 feet (30 to 600 cm) in height, 12 feet (365 cm) was used as the single-year flooding depth that would kill most shrubs within a single growing season.

- Three or more months of water depths over 1 foot (30 cm) kill stands of seedling PSSC wetlands in deltas. The area converts to LUBH, RUBH, LUSC, or RUSC.

- Three or more months of water depths over 0.5 foot (15 cm) kill stands of seedling PSSC wetlands along riverine stretches. The area converts to LUBH, RUBH, LUSC, or RUSC.

- Once established, willow is fairly drought tolerant and dominates PSSA as well as PSSC wetlands. Based on the hydrologic regime defined for seasonally flooded wetlands (see Table 1), PSSC wetlands convert to PSSA wetlands after 2 consecutive years with water more than 1 foot below the surface. Such conditions favor the growth of any cottonwood seedlings that have established.

- Seedling PSSC wetlands convert directly to PSSA wetlands if the water level remains more than 1 foot (30 cm) below the surface for the entire growing season.

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- Willows are a very fast growing species and it is expected that, under favorable conditions, PSSC wetlands convert to PFOC wetlands after approximately 10 years.

Rule Assumptions for PFOC Wetlands. Because the flood tolerance of species dominating PFOC wetlands differs between the upper and lower river, the rule assumptions for the upper and lower riverine models are different. Although trees can respond differently to flooding from flowing water instead of still water, timing, duration, and depth of flooding are probably the variables that most influence the effects of inundation. Consequently, the rule assumptions for PFOC wetlands in deltas are the same as those for PFOC wetlands along the upper river. The following rules for PFOC wetlands were developed from flood tolerance and life history requirements.

- PFOC wetlands can convert to PFOA, PEMC, RUBH, and LUBH. PFOC wetlands do not convert directly to PEMF wetlands because only long periods of inundation kill willow, and most emergents will not germinate under the canopy of dense shrubs and trees that often typifies forested wetlands.

- PFOC wetlands can arise from PSSC wetlands if willows grow to 20 feet (6 m) in height or from PFOA wetlands that experiences wetter conditions.

- Three consecutive years of persistent surface water during the growing season kill trees in established PFOC wetlands. If water depths are greater than 3.3 feet (107 cm) during the third year, PFOC wetlands convert to LUBH or RUBH. If water depths are between the surface and 3.3 feet (107 cm) deep, PFOC wetlands convert to PEMC wetlands.

- Based on the hydrologic regime defined for seasonally flooded wetlands (see Table 1), PFOC wetlands convert to PFOA wetlands after 2 consecutive years if the water table is more than 1 foot (30 cm) below the surface. In such cases, conditions favor cottonwood and other more mesic species.

- Peachleaf willow dominates the few forested wetlands along the upper reaches of the Missouri River. Although there is little information on the life history of peachleaf willow, it is assumed that this species, like other willows, is relatively short lived. As peachleaf willow declines, PFOC gradually converts to PEMC over 30 to 50 years. Assuming that it requires about 11 years for willows to reach tree size (1 year as seedlings plus 10 years as shrubs), PFOC wetlands along the upper Missouri convert to PEMC after 29 years.

- Black willow dominates most of the PFOC wetlands along the Missouri in the lower reach. Black willow begins to decline in 30 to 50 years but persists as long as there is occasional flooding with associated scouring or sediment deposition.

Palustrine Scrub-Shrub Temporarily Flooded Wetlands (PSSA) and Palustrine Forest Temporarily Flooded Wetlands (PFOA)

Temporarily flooded scrub-shrub and/or forested wetlands consist of woody species that are tolerant of occasional, short periods of inundation during the growing season as well as years without flooding. Well-established sandbar willow, peachleaf willow, and cottonwood dominate the majority of the PSSA and PFOA wetlands along the upper river. Sandbar willow, black willow, and cottonwood dominate PSSA wetlands along the lower river. Lower river PFOA wetlands include black willow as well as cottonwood, sycamore, and silver maple.

Flood Tolerance. The flood tolerances of black willow and sandbar willow have been described above. The flood tolerances of other species that dominate PSSA and PFOA wetlands are summarized as follows:

- The major factor in determining the flood tolerance of trees appears to be the location of the root crown compared to normal water levels. Increased water levels at a reservoir on the Mississippi River kills trees within the 2-foot (60 cm) contour above the normal water surface elevation, including cottonwood, green ash, black willow, and silver maple (Green 1947).

- Mature specimens of cottonwood and silver maple along a reservoir in Illinois survived and completed their annual growth cycle despite continuous inundation (to the base of the tree) for 189 days (6.3 months) (Bell and Johnson 1974). Both of these species were able to survive for 3 years when inundated to the root crown (Green 1947). Sycamore can apparently survive more than 150 days (5 months) of continuous inundation (Bell and Johnson 1974). Over the long term (greater than 8 years), cottonwood and sycamore grow well in areas that are inundated less than an average of 35 and 24 percent, respectively, of the growing season (Hall and Smith 1955).

- Seedlings are generally less tolerant of flooding than established trees. With the exception of black willow, seedlings cannot survive in areas inundated for most of the growing season (Hall and Smith 1955); 16 days of inundation killed cottonwood seedlings in laboratory studies (Hosner 1958). In field studies, one month (May to June) of inundation to 3 feet (90 cm) of water (Baker n.d.) killed about 75 percent of a sample of cottonwood seedlings. Silver maple seedlings survive up to 60 days (2 months) of continuous soil saturation, but the same soil moisture kills about one-quarter of the sycamore seedlings (Hosner and Boyce 1962).

Life History. The successional patterns of PSSA and PFOA wetlands are summarized as follows:

- Sandbar willow is more drought-tolerant than black willow because the smaller stomata of sandbar willow results in reduced moisture loss. Where the two species occur together, sandbar willow typically establishes on higher, more well-

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drained sites and black willow establishes on poorly drained low areas (Dionigi et al. 1985). Based on 1991 field observations of the regular occurrence of sandbar and black willow in riparian areas and temporarily flooded wetlands, it appears that well-established individuals of both species are relatively drought tolerant.

- Cottonwood is a pioneer species that quickly colonizes open, newly exposed shorelines. The seeds of this species are very delicate and require bare mineral soil with a constant supply of moisture for 14 days (0.5 month) to germinate (Wilson 1970). Seedlings grow slowly, but once established cottonwoods grow rapidly, often 5 feet (1.5 m) or more annually for the first 25 to 30 years (Harlow et al. 1979). This species is able to reproduce vegetatively for 20 to 25 years (Wilson 1970). Cottonwood can reach heights of 80 to 100 feet (24 to 30 m), with 3- to 4-foot diameters (0.9 to 1.2 m). It reaches maturity at 45 years and rapidly deteriorates after 70 years (Harlow et al. 1979). Along the Missouri River in South Dakota, cottonwood stands begin to deteriorate after about 50 years and become subject to invasion by other species (Wilson 1970).

- Sycamore also requires moist, bare soils in open areas for germination. This species can grow up to 8 feet (2.4 m) during its first growing season and commonly reaches 100 feet (30 m) at maturity. Although sycamore can live for 500 to 600 years, it is intolerant of competition. Consequently, it usually occurs in small, nearly pure stands that are quickly replaced by more shade-tolerant species (Harlow et al. 1979).

- Silver maple is more tolerant of shade and competition than cottonwood, sycamore, and willow. It is a fast growing tree that matures in about 125 years, to heights of 60 to 80 feet (18 to 24 m). Silver maple has brittle branches that easily break. Consequently, this species often deteriorates at a young age due to wood-destroying fungi (Harlow et al. 1979).

Rule Assumptions for PSSA Wetlands. Because species found in PSSA wetlands in deltas and along the entire Missouri River respond similarly to short-term flooding, the same rule assumptions apply to the entire river/delta system. Responses to long-term flooding differ between species in PSSA wetlands along the upper river versus the lower river; however, because long-term flooding first converts PSSA wetlands to PSSC wetlands, these differences are accounted for in the PSSC rule assumptions. Consequently, the rule assumptions for PSSA wetlands are the same for the upper riverine, lower riverine, and delta models. Based on flood tolerance and life history requirements, the following assumptions were incorporated into the rules for PSSA wetlands.

- PSSA wetlands can convert to RUBH, LUBH, PSSC, PFOA, and RS. PSSA wetlands do not directly convert to PEMF wetlands because willow and cottonwood mortality usually results from long periods of continual inundation. Also, most emergent species will not germinate under the dense canopy that typifies PSSA wetlands.

- PSSA wetlands can arise from PSSC wetlands that experience drier conditions or RS that experience wetter conditions.

- PSSA wetlands generally arise from PSSC wetlands because the requirements for the successful germination of cottonwood are similar to those of willow. Consequently, these two species often germinate side-by-side on the mineral soil found on newly exposed shorelines, creating seedling stands of PSSC. Based on the hydrologic regime defined for seasonally flooded wetlands, PSSA develops whenever the water level does not get within 1 foot (30 cm) of the surface for 2 consecutive growing seasons (see Table 1). If this situation occurs within the growing season following establishment, the seedling stand of PSSC wetland quickly converts into a PSSA wetland.

- Established PSSA wetlands convert to LUBH or RUBH if shrubs are completely submerged for the entire growing season.

- Once established, willow is fairly drought tolerant and dominates both PSSC and PSSA wetlands. Based on the hydrologic regime defined for temporarily flooded wetlands (see Table 2), PSSA wetlands convert to PSSC wetlands after 2 consecutive years of water within 1 foot (30 cm) of the surface for about 1 month. Such conditions are likely to stress cottonwood shrubs and favor the growth of willow.

- PSSA wetlands are maintained by short periods of saturation occasionally. Therefore, as long as the maximum water level is within 1 foot (30 cm) of the surface at least 1 month every 6 growing seasons, PSSA wetlands are maintained. Under drier hydrologic regimes, it is likely that more mesic species would invade and PSSA would convert to RS.

- Assuming a growth rate of approximately 1.6 feet (0.5 m) per year for cottonwood (Barnes 1985), PSSA wetlands would convert to PFOA wetlands within about 12 years.

Rule Assumptions for PFOA Wetlands. Because the flood and drought tolerance of species dominating PFOA wetlands is essentially the same along the entire Missouri River, the rule assumptions for the upper and lower riverine models are the same. Although trees can respond differently to flooding from flowing water instead of still water, timing, duration, and depth of flooding are probably the variables that most influence the effects of inundation. Consequently, the rule assumptions for PFOA wetlands in deltas are the same as those for PFOA wetlands along the river. Based on flood tolerance and life history requirements, the following assumptions were incorporated into the rules for PFOA wetlands:

- PFOA wetlands can convert to RF, PFOC, PEMC, RUSC, LUSC, RUS5, LUS5, RUBH, and LUBH. PFOA wetlands do not directly convert to PEMF wetlands because willow and cottonwood are usually only killed by long periods of inundation, and most emergents will not germinate under the dense canopy that often typifies forested wetlands.

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- PFOA wetlands arise from PSSA wetlands when shrubs grow to 20 feet (6 m). PFOA can also arise from PFOC wetlands that experience drier conditions, or RF that experiences wetter conditions.

- Mature cottonwood, silver maple, and sycamore trees are affected by anaerobic conditions in the root zone; 3 consecutive years of water within 1 foot (30 cm) of the surface causes mortality. The resultant vegetation type is dependent on hydrologic conditions, especially during the third year.

    - If water depths are between 1 foot (30 cm) below the surface and 1 foot (30 cm) deep, then PFOA wetlands converts to PEMC wetlands.

    - Mean water depths greater than 1 foot (30 cm) for the entire growing season during the third year results in LUBH or RUBH.

    - Water depths greater than 1 foot (30 cm) that persist through most of the third year growing season and then drop in July or August results in LUSC, RUSC, LUS5, or RUS5.

- Based on the hydrologic regime defined for seasonally flooded wetlands (see Table 1), PFOA wetlands convert to RF after 6 consecutive years of water more than 1 foot (30 cm) below the surface.

- One or more months with a mean water level within 1 foot (30 cm) of the surface for 2 consecutive years results in the conversion of PFOA wetlands to PFOC wetlands.

Riverine Unconsolidated Shore, Vegetated (RUS5) and Lacustrine Unconsolidated Shore, Vegetated (LUS5)

Unconsolidated vegetated shorelines are dominated by a mixture of pioneering species that readily colonize exposed mud and sand flats vegetated. Typically, these species are weedy mesophytes that are intolerant of flooding or soil saturation. Consequently, plants that characterize shorelines are usually annuals that are killed by rising water levels and do not persist into the next growing season (Cowardin et al. 1979). Large expanses of vegetated unconsolidated shoreline occur along the Missouri River, particularly in the drawdown zones of the three largest reservoirs. Shoreline species are similar along both the upper and lower river. The most common species include spikerush, cocklebur, beggar's tick, wild barley, horseweed, flat sedges, sweet clovers, and barnyard grass. Low densities of willow seedlings frequently intermix with annual herbaceous species along shorelines.

Flood Tolerance. The flood tolerances of species that dominate LUS5 and RUS5 wetlands are summarized as follows:

- Once established, both barnyard grass and beggar's tick can withstand shallow flooding to depths of 0.4 to 0.5 feet (15 to 20 cm), but are killed by deeper water (Fredrickson and Taylor 1982).

- Two or more weeks of inundation kill established cocklebur plants (Hall et al. 1946).

- Wild barley can survive 30 days (1 month) of flooding, but not 45 days (Hoffman 1978).

- Spikerush can survive 30 days (1 month) of complete inundation, but carp often uproot it in areas of slow water (Hall et al. 1946).

- Spring flooding for 10 to 14 days (0.3 to 0.5 month) kills mature sweet clover plants (Schumacher 1978).

Life History. Successional patterns of LUS5 and RUS5 are summarized as follows:

- Most of the annual grasses and forbs that colonize exposed shorelines and mudflats are somewhat tolerant of drought conditions, particularly later in the growing season (Fredrickson and Taylor 1982). However, most of these species require dewatering for germination (Hall et al. 1946).

- Barnyard grass and beggar's tick can germinate on exposed shorelines as late as mid-July (Fredrickson and Taylor 1982).

- Cocklebur requires about 5 to 10 days of dewatering before seedling emergence and germinates through mid-August (Fredrickson and Taylor 1982).

- Spikerush (*Eleocharis obtusa*) germinates late in the growing season (Fredrickson and Taylor 1982).

Rule Assumptions for LUS5 and RUS5. Because the flood and drought tolerance of species that dominate vegetated shorelines are similar along the entire Missouri River, the rule assumptions for RU55 and LU55 are the same in the upper and lower riverine models. Deltas, however, are more conducive to the establishment of PSSC wetlands along shorelines than riverine reaches. In delta areas, low densities of willow can eventually become dominant by spreading vegetatively. Along riverine reaches willows are less likely to spread because seedlings are often uprooted by high water levels late in the summer. Consequently, the rule assumptions for LUS5 differ from those for RUS5. Based on flood tolerance and life history requirements, the following assumptions were incorporated into the rules for vegetated unconsolidated shore types:

- LUS5 and RUS5 convert to PEMF, PEMC, PSSC, LUBH, and RUBH.

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- RUS5 and LUS5 can arise from RUBH, LUBH, LUSC, and RUSC. RUS5 and LUS5 can also be created from PFOA.

- Conditions that promote the establishment of weedy annuals on newly exposed shorelines include: (1) late season (July) drawdown followed by shallow reflooding (less than 6 inches) or saturation; (2) early season drawdown coupled with very dry conditions (water less than 1 foot below the surface) for the remainder of the growing season; and (3) dry conditions throughout the entire growing season. These hydrologic regimes also maintain LUS5 and RUS5.

- Saturated conditions throughout July favor the growth of willows. Flooding in August would kill weedy annuals and promote the establishment of PSSC on vegetated shorelines, particularly in deltas.

- LUS5 and RUS5 convert to PEMF wetlands if flooded to 6 inches (15 cm) for at least 2 consecutive months between May and July. Flooded conditions early in the growing season prevent the germination of the weedy annuals that typify vegetated unconsolidated shorelines, but promote the establishment of emergents such as bulrush and cattail. Flooded conditions in June and July also prevent the germination of willow seedlings.

- Early season flooding followed by saturated conditions in July and August promotes the establishment of emergents such as rice cutgrass and reed canarygrass, resulting in the conversion of LUS5 and RUS5 to PEMC.

- Continual flooding throughout the entire growing season converts LUS5 and RUS5 to LUBH and RUBH, respectively.

- Dry conditions in May, June, or July promote the germination of weedy annuals. If water depths increase to more than 6 inches (15 cm) later in the summer, these plants die, resulting in LUSC, RUSC, LUBH, or RUBH.

- Unfavorable physical and chemical properties of exposed soils can preclude the establishment of wetlands, resulting in LUS5 and RUS5.

Riverine Unconsolidated Shore, Unvegetated (RUS); Lacustrine Unconsolidated Shore, Unvegetated (LUS); Riverine Unconsolidated Bottom (RUBH); and Lacustrine Unconsolidated Bottom (LUBH)

The riverine stretches and reservoirs along the Missouri River are flooded most of the time, in all years, and are considered deepwater habitats. In general, both riverine and lacustrine unconsolidated bottom (RUBH and LUBH, respectively) types support little, if any, vegetation.

In addition to the unvegetated deepwater habitats, there are also miles of riverine and lacustrine unvegetated shoreline (RUSC and LUSC, respectively) along the Missouri River.

These types include mudflats and sandbars that support less than 30 percent vegetative cover because they are (1) only exposed for brief periods during the growing season, (2) scoured by ice and high water during the winter, or (3) subject to widely fluctuating water levels on a daily or weekly basis.

Rule Assumptions for RUBH, LUBH, RUSC, and LUSC. When unvegetated, unconsolidated shorelines or bottoms are exposed due to drawdown or drought, they can succeed to any one of several wetland types depending on the timing and duration of the dry period and seed bank composition. Because the flood and drought tolerance of species colonizing shorelines are similar along the entire Missouri River, the rule assumptions for the upper and lower riverine models are the same. However, because deltas appear to be more conducive to the establishment of PSCC wetlands, the rule assumptions for deltas differ from those for riverine reaches. Based on flood tolerance and life history requirements for various wetland plants, the following assumptions were incorporated into the rules for the unconsolidated shore and bottom types:

- LUSC, RUSC, LUBH, and RUBH can convert to PEMF, PSSC, LUS5, and RUS5. LUSC and RUSC convert to LUBH and RUBH, respectively, if flooded for the entire growing season. LUBH and RUBH convert to LUSC and RUSC, respectively, if exposed during the growing season and are not vegetated.

- LUSC and RUSC can arise from exposed and non-vegetated LUBH and RUBH, respectively. They can also arise from LUS5 and RUS5, respectively, if fluctuating water levels kill vegetation.

- RUBH and LUBH result when any wetland/riparian type is flooded long enough to kill the existing vegetation.

- Conditions that promote the establishment of LUS5 or RUS5 from LUSC, RUSC, LUBH, or RUBH include (1) late season (July) drawdown followed by shallow reflooding (less than 6 inches) or saturation; (2) early season drawdown coupled with very dry conditions (water less than 1 foot below the surface) for the remainder of the growing season; and (3) dry conditions throughout the entire growing season.

- LUSC, RUSC, LUBH, and RUBH convert to PEMF wetlands if saturated or flooded to 6 inches (15 cm) for at least 2 consecutive months between May and July. Flooded or saturated conditions early in the growing season prevent the germination of the weedy annuals that typify vegetated unconsolidated shorelines but promote the establishment of emergents such as bulrush and cattail.

- Early season flooding or dry conditions followed by saturated conditions throughout the remainder of the growing season promote the germination and establishment of willow and cottonwood seedlings, converting LUBH, RUBH, LUSC, and RUSC to PSSC wetlands.

Riparian Grasslands (RG)

Riparian grasslands are characterized by a mixture of upland grasses and forbs that can withstand brief periods of inundation during the growing season. The vegetation that dominates riparian grasslands often consists of weedy species that have resulted from grazing or agriculture. Smooth brome and leafy spurge, both introduced species, dominate riparian grasslands along the upper river. Other common species include Canada wildrye (*Elymus canadensis*), switchgrass, Kentucky bluegrass, quackgrass, western wheatgrass, crested wheatgrass, and showy partridge pea. Along the lower river, riparian grasslands are rare because most open land near the river is used for agriculture. Smooth brome, Canada wildrye, switchgrass, and Johnson grass (*Sorghum halepense*) characterize the few remaining areas of riparian grassland along the lower river.

Flood Tolerance. The flood tolerances of species that dominate RG areas are summarized as follows:

- Mature plants of smooth brome are killed by 24 to 28 days (0.8 to 0.9 month) of spring inundation and seedlings by 49 to 63 days (1.6 to 2.1 months) of flooding (Schumacher 1978).

- Switchgrass tolerates between 15 and 30 days (0.5 to 1 month) of flooding (Schumacher 1978).

- Wildrye survives between 20 and 45 days (0.7 to 1.5 month) of flooding (Schumacher 1978).

Life History. In general, the riparian grasslands along the river exist as small disturbed patches that are often maintained for grazing. Most are interspersed between shrublands and forest stands that provide a ready seed source for shrubs. Consequently, many of the riparian grasslands show evidence of invasion by shrubs, particularly green ash, snowberry, and dogwood. However, one of the most common species in riparian grasslands, smooth brome, is a rhizomatous perennial that can persist for a long period. Leafy spurge is also an aggressive species that is difficult to eradicate once established. Both of these species often persist in the understory of shrublands and forest stands.

Rule Assumptions for RG. Because the flood tolerances of species found in riparian grasslands are similar along the upper entire river, the rule assumptions for riparian grasslands are the same for the upper and lower river and delta models. The following rules for RG were developed from flood tolerance and life history requirements:

- RG can convert to PEMA, RS, LUBH, and RUBH, but RG can only arise from PEMA wetlands.

- Most of the plants found in RG are mesic species that are intolerant of flooding. Consequently, surface water throughout a single growing season converts RG to LUBH or RUBH.

- Based on the hydrologic regime defined for temporarily flooded wetlands (see Table 1), a single monthly peak water level within 1 foot (30 cm) of the surface for 2 consecutive years converts RG to PEMA wetlands.

- If RG persists for more than 10 years, shrubs are likely to invade, resulting in conversion to RS.

Riparian Shrublands (RS) and Riparian Forest (RF)

Riparian shrublands and forests generally include trees and shrubs found in both wetlands and uplands. All of these species must be able to tolerate at least intermittent flooding or soil saturation. In addition, many of the trees and shrubs may depend on the higher water table associated with the river. Along the upper river, cottonwood dominates areas of RS but willow, green ash, dogwood, Russian olive, and slippery elm also occur. Along the lower river common species include willow, dogwood, silver maple, sycamore, mulberry, box elder, and cottonwood.

There are two distinct types of riparian forests along the Missouri River: early and late successional. Cottonwood dominates early successional forests along the entire river. Later successional riparian forests along the upper river consist primarily of green ash and elm. Along the lower river, later successional forests consist of silver maple, mulberry, and box elder. In many areas along the lower river, PFOA wetlands and riparian forests are very similar in terms of structure and overstory species combination. The same area might be classified as a PFOA wetland or riparian forest, depending on wet or dry conditions.

Flood Tolerance. The flood tolerances of most of the common species in RS and RF were covered in other sections; additional information is presented below:

- Mature specimens of green ash survive and complete their annual growth cycle despite continuous inundation (to the base of the tree) for 90 days (3 months) (Bell and Johnson 1974). Established green ash trees survive 4 years of inundation to the root crown (Green 1947). Seedlings survive 60 days (2 months) of continuous soil saturation (Hosner and Boyce 1962).

- Established box elder withstands at least 150 days (5 months) of continuous flooding to the root crown during the growing season (Bell and Johnson 1974).

Life History. Information from the literature relevant to the successional patterns of RS and RF follows:

- Because cottonwood requires very specific conditions for germination, it generally occurs in even-aged stands. As the stand matures, more mesophytic and relatively shade-tolerant species such as green ash, elm, and box elder invade the understory. As the cottonwoods deteriorate after 50 to 70 years, these species begin to dominate the riparian forests along the upper river (Wilson 1970).

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Along the lower river, silver maple, green ash, box elder, and mulberry replace cottonwood (Vaudbel and Hoffman 1975).

- Once established, green ash is very tolerant of climatic extremes and will persist on dry sterile soils (Harlow et al. 1979).

- Box elder grows quickly but is relatively short lived. It usually establishes in moist sites, but is capable of growing in dry locations (Harlow et al. 1979).

Rule Assumptions for RS and RF. Because the flood tolerances of species found in riparian shrublands and forests are similar along the entire river, the rule assumptions for riparian grasslands are the same for the upper and lower river and delta models. Based on flood tolerance and life history requirements, the following assumptions were incorporated into the rules for RS and RF:

- RS can convert to PSSA wetlands and RF. RF can convert to PFOA wetlands. Both types can convert to PEMC, LUBH, and RUBH.

- RS can arise from PSSA wetlands and RG. Similarly, RF can arise from PFOA wetlands and RS.

- Established RS stands convert to LUBH or RUBH if shrubs are completely submerged for the entire growing season.

- Based on the hydrologic regime defined for temporarily flooded wetlands (see Table 1), short-duration flooding or saturation within 1 foot (30 cm) of the surface for 2 consecutive years converts RS to PSSA wetlands and RF to PFOA wetlands.

- If RS persists for more than 12 years, it converts to RF.

- Anaerobic conditions in the root zone affect shrubs and trees found in riparian stands. Three consecutive years of water within 1 foot (30 cm) of the surface kills trees and shrubs. The resultant vegetation type is dependent on hydrologic conditions, especially during the third year.

    - If water depths are between 1 foot (30 cm) below the surface and 1 foot (30 cm) deep, RS and RF convert to PEMC wetlands.

    - Mean water depths greater than 1 foot (30 cm) for the entire growing season during the third year result in LUBH or RUBH.

    - Water depths greater than 1 foot (30 cm) that persist through most of the third growing season and then drop in July or August result in LUSC, RUSC, LUS5, or RUS5.

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HYDROLOGICAL COMPONENT

The ecological rules summarized in the previous section relate changes in the acreage of wetland/riparian types to changes in water surface elevations that result from water control plan alternatives. Hydrological data are needed to determine water surface elevations as well as the duration and frequency with which they occur. An important constraint on the wetland/riparian resource model is its dependence on the LRS model to predict water surface elevations for different water control plan alternatives. The LRS model simulates end-of-month pool elevations for four reservoirs, but does not simulate river stage elevations for riverine locations. Instead, the LRS model predicts mean monthly flow at 16 points in riverine locations between Fort Peck Dam, Montana and Hermann, Missouri. Consequently, the hydrological component consists of a set of regression (or rating) curves developed by the Corps to translate LRS model flow data into corresponding water surface elevations.

Separate rating curves were developed for each of the wetland study sites to account for differences in water surface profile with varying flows. Bathymetric data and river width for the rating curves were provided by existing sediment range transects located at 1- to 5-mile intervals along the river. Channel stability was assumed to be constant for all water control plan alternatives so rating curves were not modified to reflect possible changes over the 93-year simulation period.

For wetland study sites located in deltas, where the hydrologic regime can shift from lacustrine to riverine as a function of reservoir level, a sequence of three curves was developed. Each of the three delta site rating curves is designed for a specified range of reservoir pool elevations. At wetland study sites located on the riverine reaches below Fort Peck, Garrison, and Fort Randall dams, rating curves reflect the frequent stage increases resulting from hydropower peaking. During a given month, the Corps implements different peaking patterns, depending on mean discharge at the dam. The releases cause repeated short-term elevated stages that progressively dissipate downstream of the dams. The frequency of peak releases, about once every 3 days, influences hydrology at sites experiencing peak-elevated flows. A separate simulation model, the Dynamic Flow Model, was used to determine the maximum river stages at a particular site resulting from a specified peaking pattern from the upstream dam. Rating curves were then constructed for these sites, depicting the maximum river stage associated with the peaking pattern for a given mean monthly flow (LRS model output).

As defined in the ecological component, temporarily flooded palustrine wetlands and riparian habitats are dependent on short-duration flooding or inundation (10 days; see Table 5) not monthly flows. For these types, the maximum peak monthly (not average monthly) flows were used to represent short-duration flooding or inundation. For delta wetland study sites, the higher of the two pool elevations occurring at the beginning (that is, the end of the preceding month) and end of a particular month is defined as the maximum for that month. For riverine sites, monthly maximum stage elevations are derived from the LRS model monthly mean flow. The relationship between monthly mean flow from the LRS model and monthly maximum elevation was determined by regressing historical daily maximum flows with historical monthly mean flows. The calculated monthly maximum flows were translated into elevations using the rating curves developed for each riverine

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wetland study site. The historical maximum flow data were obtained from the same 16 gauges at which the LRS model simulates monthly flow data.

ACCOUNTING COMPONENT

The accounting component of the wetlands/riparian resource model consists of a sequence of data matrices for each wetland study site that track the acreage of each wetland/riparian type, by elevation, for each of the 93 years included in the simulation period. The mechanics of the accounting component involves tracking the fate of discrete parcels of land termed "plots of ground", or POGs, within a given study site. An individual POG is initially defined as the sum of all of the field transect intercepts (both measured and interpolated) of a particular wetland/riparian type (for example, PEMA) occurring at a given elevation band (0.5-foot increments) at the given site. The distribution of POGs at the C.K. Creek study site, expressed in numbers of transect intersects, is shown in Table 6. At that site, the PEMA vegetation type was intercepted 518 times, distributed over 6 elevation bands, and is therefore represented in 1991 by 6 POGs. Prior to running the model, POG units were converted from transect intercepts to actual acres. If, for example, PEMA at elevation band 2240.5 is intercepted at 14 locations, and the total mapped acreage of PEMA at the C.K. Creek site is 2,026 acres, that particular POG represents 55 acres.

The initial distribution of POGs is important because it establishes the area available for wetland/riparian gains and losses. The initial distribution was determined from the 1991 mapping and field observations, and then adjusted using topographic maps, Corps bathymetry data (thalwegs), and aerial photographs. For example, even though the field survey transects did not extend more than a few feet into the river, POGs were added to the initial conditions table to extend to the river's deepest point (thalweg). The elevation decline from shore to thalweg was assumed even; the horizontal distance was measured from U.S. Geological Survey 7 1/2-minute quadrangles. A similar adjustment to total POGs was performed to extend transects up-gradient to the floodplain-upland interface, as inferred from aerial photography and the 7 1/2-minute quadrangles.

The model revises the distribution of POGs each year to reflect each year's hydrology and natural succession. For each site, the first spreadsheet in the accounting component represents the distribution of POGs in 1991, by elevation and wetland/riparian type, as determined from mapping and field investigations. In each successive year, the ecological and hydrological components of the model provide the basis for modifying the distribution of the POGs among wetland/riparian types. The total number of POGs per elevation band and the total area of each study site is fixed throughout the simulation period. POGs may move between wetland/riparian types (see Figure 3), but cannot be broken up into smaller units or shifted into different elevation bands. The new distribution of wetland/riparian types for each year is compiled in a separate spreadsheet by the accounting component of the model.

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Table 6. Example of matrix showing wetland, shoreline, riparian, and deepwater types by elevation class for the C.K. Creek site.[1/]

	Wetland/Riparian Types									
Elevation	PEMC	PEMA	RG	PSSC	PSSA	LUS	LUS5	PFOA	PEMF	LUBH
2234.0	0	0	0	0	0	0	0	0	0	1
2234.5	0	0	0	0	0	0	0	0	0	1
2235.0	0	0	0	0	0	0	0	0	0	1
2235.5	0	0	0	0	0	0	0	0	0	1
2236.0	0	0	0	0	0	0	0	0	0	1
2236.5	0	0	0	0	0	0	0	0	0	1
2237.0	0	0	0	0	0	0	0	0	0	1
2237.5	0	0	0	0	0	0	0	0	0	1
2238.0	0	0	0	0	0	0	0	0	0	1
2238.5	0	0	0	0	0	0	0	0	0	1
2239.0	0	0	0	0	0	227	78	0	227	1
2239.5	0	0	0	13	0	97	181	0	97	0
2240.0	64	0	0	331	0	214	36	0	214	0
2240.5	143	14	0	405	0	13	11	0	13	0
2241.0	2	156	0	152	6	1	0	0	1	0
2241.5	0	122	0	94	10	2	0	0	2	0
2242.0	0	177	2	65	18	0	0	0	0	0
2242.5	0	2	12	0	5	0	0	24	0	0
2243.0	0	47	8	0	0	0	0	0	0	0
2243.5	0	0	1	0	0	0	0	0	0	0
2244.0	0	0	1	0	0	0	0	0	0	0
2244.5	0	0	1	0	0	0	0	0	0	0
2245.0	0	0	1	0	0	0	0	0	0	0
2245.5	0	0	1	0	0	0	0	0	0	0
2246.0	0	0	1	0	0	0	0	0	0	0
TOTAL	209	518	28	1060	39	554	306	24	554	11

1/ Numbers are points intercepted along transect lines. Total number of intercepts in an elevation band for a given type represent a single POG. Matrix does not show entire distribution of elevations at the site; elevations extended from the THALWEG at 2230.5 to the 100-year floodplain elevation at 2250.0.

2/ Artificial distributions were assigned to wetland/riparian types that extended beyond the elevations sampled.

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INTEGRATION OF MODEL COMPONENTS

Integration of the ecological, hydrological, and accounting components of the wetland/riparian resource model is illustrated in Figure 8. The model performs the following steps for each water control plan alternative and growing season over the 93-year simulation period:

- The hydrological component of the model combines the monthly discharge and pool elevation output generated by the LRS model, with the rating curves for a given wetland study site, to determine the monthly mean and maximum water levels.

- These water level data are then compared to a matrix of the elevational distribution of each wetland/riparian type (as represented by POGs) at that site, as displayed by the accounting component.

- The ecological component of the model applies a set of rules that determine the flood tolerance and successional patterns for the wetland/riparian types represented at the site. For each river stage or pool elevation, the rules determine if the acreage of a given wetland/riparian type (1) remains unchanged, (2) decreases due to flooding over several seasons, (3) decreases due to drying for several seasons and conversion to another type, or (4) increases due to conversion from other types dependent on different water elevations.

- The output is stored in the accounting component as the annual simulated amount of each wetland/riparian type, by elevation, at the study site.

This process is repeated for each year of the simulation period. A summary program can then be used to generate the total acreage of each wetland/riparian type by year and the average over the simulation period.

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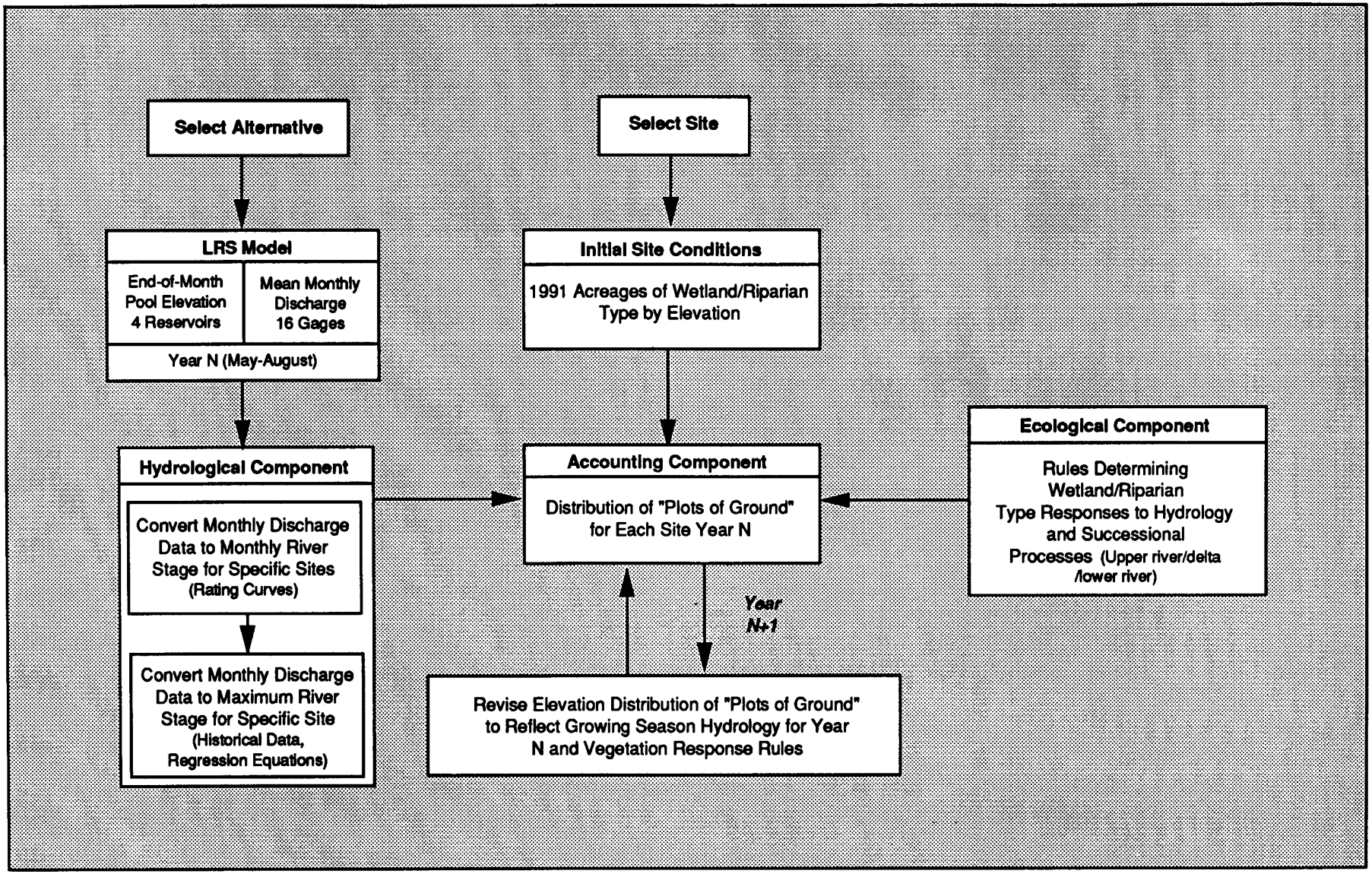

Figure 8. Flow chart illustrating the integration of the components for the wetland/riparian resource model.

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APPLICATION OF THE WETLAND/RIPARIAN RESOURCE MODEL

The wetland/riparian resource model is intended as a tool to evaluate the effects of alternative water control plans over a 93-year simulation period. The model is an appropriate tool for this type of exercise because it was designed to measure changes in wetland/riparian acreage as a function of hydrology. Results of model testing using 10 years of historical data at several sites on the lower river approximate current (1991) conditions (Appendix D). In addition, results from the model parallel those obtained from a flood duration analysis conducted at several wetland study sites (Appendix F). However, because the model lacks the ability to factor in erosion and deposition as well as local runoff and soil type, it cannot be considered adequate as a predictive tool for long-term site-specific planning.

This section describes the application of the wetland/riparian resource model to individual wetland study sites and the entire Missouri River. In addition, it discusses the selection of the specific wetland/riparian resource values to be used to evaluate and rank alternative water control plans.

APPLICATION TO STUDY SITES

Applying the wetland/riparian resource model to a given water control plan alternative and site produces matrices of the acreage of each wetland and riparian type, by elevation band, for each of the 93 years from 1898 to 1991. Table 7 shows a matrix generated for 1934 for the C.K. Creek site for an example alternative. For each alternative and site, the model also produces a summary matrix of the acreage of each wetland/riparian type by year (Table 8). This matrix also includes summary statistics for each type.

APPLICATION TO THE ENTIRE MISSOURI RIVER

Developing the wetland/riparian model focused on the 39 wetland study sites that were selected for field investigation. The impacts of each water control plan alternative, however, must be determined for wetland/riparian resources along the entire Missouri River. Individual sites range from several hundred acres to several thousand acres and vary in habitat quality; they cannot be simply added together to represent the entire river. To obtain a more complete picture of the entire river, each site is expanded to represent the adjacent "segment" of river using the following assumptions: (1) the hydrology of the segment is similar to the site; and (2) the wetland/riparian types in the segment have the same relative distribution to water surface elevation as they do at the site. The sum of the acreage of all 39 segments represents the total acreage of deepwater habitat, shore wetlands, palustrine wetlands, and riparian habitat in the deltas and riverine reaches of the Missouri River from the headwaters of Fort Peck Lake to St. Louis.

To run the model for river segments, the area of each wetland/riparian type in each segment was obtained from the GIS database constructed for the river (Table 3). For some

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Table 7. Example of wetland/riparian type distribution by elevation at C.K. Creek site in 1934, for an example alternative.

	Wetland/Riparian Types								
Elevation	PEMF	PEMC	PEMA	PSSC	RF	RG	LUS	LUS5	LUBH
2230.5	—	—	—	—	—	—	—	—	107.3
2231.0	—	—	—	—	—	—	—	—	107.3
2231.5	—	—	—	—	—	—	—	—	107.3
2232.0	—	—	—	—	—	—	—	—	107.3
2232.5	—	—	—	—	—	—	—	—	107.3
2233.0	—	—	—	—	—	—	—	—	107.3
2233.5	—	—	—	—	—	—	—	—	107.3
2234.0	—	—	—	—	—	—	—	—	107.3
2234.5	—	—	—	—	—	—	—	—	107.3
2235.0	—	—	—	—	—	—	—	—	107.3
2235.5	—	—	—	—	—	—	—	—	107.3
2236.0	—	—	—	—	—	—	—	—	107.3
2236.5	—	—	—	—	—	—	—	—	107.3
2237.0	—	—	—	—	—	—	—	—	107.3
2237.5	—	—	—	—	—	—	—	—	107.3
2238.0	—	—	—	—	—	—	—	—	107.3
2238.5	—	—	—	—	—	—	—	—	107.3
2239.0	—	—	—	—	—	—	6.2	—	476.5
2239.5	—	—	—	650.9	—	—	—	—	—
2240.0	1056.8	—	—	—	—	—	—	—	—
2240.5	1251.1	—	—	—	—	—	—	—	—
2241.0	—	—	—	604.9	—	—	—	—	—
2241.5	—	435.8	—	—	—	—	—	—	—
2242.0	—	—	—	—	—	—	—	501.5	—
2242.5	—	233.9	—	—	—	—	—	18.8	—
2243.0	—	—	—	—	—	—	—	87.1	—
2243.5	—	—	—	—	—	—	—	0.1	—
2244.0	—	—	0.1	—	—	—	—	—	—
2244.5	—	—	0.1	—	—	—	—	—	—
2245.0	—	—	0.1	—	—	—	—	—	—
2245.5	—	—	0.1	—	—	—	—	—	—
2246.0	—	—	0.1	—	—	—	—	—	—
2246.5	—	—	0.1	—	—	—	—	—	—
2247.0	—	—	0.1	—	—	—	—	—	—
2247.5	—	—	—	—	—	0.1	—	—	—
2248.0	—	—	—	—	—	0.1	—	—	—
2248.5	—	—	—	—	—	0.1	—	—	—
2249.0	—	—	—	—	—	0.1	—	—	—
2249.5	—	—	—	—	—	0.1	—	—	—
2250.0	—	—	—	—	0.1	—	—	—	—
Total	2307.9	669.7	0.8	1255.8	0.1	0.6	6.2	607.5	2299.7

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Table 8. Summary matrix for the C.K. Creek site for an example water control plan alternative.

	Wetland/Riparian Types (acres)													Palustrine Wetland	Riparian
Year	PEMF	PEMC	PEMA	PSSC	PSSA	PFOC	PFOA	RS	RF	RG	R/LUBH	R/LUS	R/LUS5	Total	Total
Init	15.0	577.1	950.5	2063.7	108.2	0.0	233.9	0.0	0.0	3.9	1930.5	301.5	963.9	3948.4	3.9
1898	15.0	577.1	89.9	0.0	108.2	0.0	233.9	0.0	0.0	1.5	6122.5	0.0	0.0	1024.1	1.5
1899	583.3	0.0	0.9	108.2	0.0	233.9	0.0	0.0	0.0	0.4	6221.4	0.0	0.0	926.3	0.4
1900	583.3	233.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.4	6178.5	151.0	0.1	818.1	0.4
1901	817.3	0.3	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.4	6242.3	87.1	0.0	818.3	0.4
1902	817.3	0.3	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.4	6223.5	105.9	0.0	818.3	0.4
1903	817.2	0.4	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.4	5722.0	607.4	0.0	818.3	0.4
1904	817.2	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	6242.3	87.2	0.0	818.2	0.4
1905	1252.9	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2956.8	1730.2	1206.9	1253.6	0.8
1906	1252.9	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.8	4687.0	1206.7	0.0	1253.7	0.8
1907	1252.9	0.3	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.7	5893.7	0.1	0.0	1253.6	0.8
1908	1070.7	0.3	0.6	0.0	0.0	0.0	0.0	0.1	0.0	0.1	6076.3	0.0	0.0	1071.6	0.2
1909	1070.7	0.3	0.6	0.0	0.0	0.0	0.0	0.1	0.0	0.1	6076.3	0.0	0.0	1071.6	0.2
1910	1070.7	0.3	0.6	0.1	0.0	0.0	0.0	0.1	0.0	0.1	5989.1	87.1	0.0	1071.7	0.2
1911	1070.6	0.4	0.6	0.1	0.0	0.0	0.0	0.1	0.0	0.1	2956.8	1912.7	1206.7	1071.7	0.2
1912	1070.6	0.4	0.6	0.0	0.0	0.0	0.0	0.1	0.0	0.1	5970.3	106.0	0.0	1071.6	0.2
1913	1071.0	0.2	0.4	0.0	0.0	0.0	0.0	0.1	0.0	0.1	6076.3	0.0	0.0	1071.6	0.2
1914	1071.0	0.2	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.2	6076.2	0.1	0.0	1071.5	0.3
1915	1071.0	0.2	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.2	6076.3	0.0	0.0	1071.5	0.3
1916	1071.0	0.2	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.2	6076.3	0.0	0.0	1071.5	0.3
1917	670.3	0.3	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	6477.1	0.0	0.0	670.8	0.3
1918	670.3	0.3	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	6477.1	0.0	0.0	670.8	0.3
1919	669.9	0.4	0.4	1133.5	0.0	0.0	0.0	0.0	0.1	0.2	1823.3	1056.8	2463.5	1804.3	0.3
1920	669.7	0.7	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1823.3	4653.7	0.1	670.8	0.3
1921	669.7	0.4	0.7	0.1	0.0	0.0	0.0	0.0	0.1	0.2	6389.9	87.1	0.0	670.9	0.3
1922	669.7	0.4	0.7	87.2	0.0	0.0	0.0	0.0	0.1	0.2	6389.9	0.0	0.0	757.9	0.3
1923	669.7	0.4	0.6	87.2	0.0	0.0	0.0	0.0	0.1	0.3	6371.1	18.8	0.0	757.8	0.4
1924	669.7	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.3	6389.9	87.2	0.0	670.6	0.4
1925	669.8	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.6	6477.1	0.0	0.0	670.4	0.7
1926	669.8	0.2	0.4	1056.8	0.0	0.0	0.0	0.0	0.1	0.6	2305.9	87.1	3027.3	1727.2	0.7
1927	669.8	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.6	6477.1	0.0	0.0	670.4	0.7
1928	670.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	6477.1	0.0	0.0	670.4	0.7
1929	670.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	6477.0	0.1	0.0	670.4	0.7
1930	1726.6	0.3	0.3	650.9	0.0	0.0	0.0	0.0	0.1	0.6	2305.9	0.0	2463.5	2378.1	0.7
1931	1056.8	670.0	0.4	650.9	0.0	0.0	0.0	0.0	0.1	0.6	2305.9	0.0	2463.5	2378.1	0.7
1932	1056.8	1920.9	0.7	1255.8	0.0	0.0	0.0	0.0	0.1	0.6	2305.9	0.0	607.5	4234.1	0.7
1933	1056.8	1920.9	0.7	1255.8	0.0	0.0	0.0	0.0	0.1	0.6	2305.9	18.8	588.7	4234.1	0.7
1934	2307.9	669.7	0.8	1255.8	0.0	0.0	0.0	0.0	0.1	0.6	2299.7	6.2	607.5	4234.1	0.7
1935	2307.9	435.8	234.7	1255.8	0.0	0.0	0.0	0.0	0.1	0.6	2305.9	0.0	607.5	4234.1	0.7
1936	2307.9	435.8	234.3	1255.8	0.0	0.0	0.0	0.0	0.1	0.9	2305.9	0.0	607.5	4233.8	1.0
1937	2307.9	435.8	234.3	1255.8	0.0	0.0	0.0	0.6	0.1	0.3	2305.9	0.0	607.5	4233.8	1.0
1938	2307.9	435.8	234.3	604.9	0.0	0.0	0.0	0.6	0.1	0.3	2305.9	1171.2	87.2	3582.9	1.0
1939	2743.7	233.9	0.4	604.9	0.0	0.0	0.0	0.6	0.1	0.3	2305.9	650.9	607.5	3582.9	1.0
1940	2743.7	233.9	0.4	1255.8	0.0	0.0	0.0	0.6	0.1	0.3	2305.9	0.0	607.5	4233.8	1.0
1941	2307.9	435.8	234.3	1255.8	0.0	0.0	0.0	0.6	0.1	0.3	2305.9	0.0	607.5	4233.8	1.0
1942	2307.9	435.8	234.3	1255.8	0.0	0.0	0.0	0.6	0.1	0.3	2305.9	0.0	607.5	4233.8	1.0
1943	2743.7	234.3	0.3	604.9	0.0	0.0	0.0	0.6	0.1	0.0	2305.9	650.9	607.5	3583.2	0.7
1944	2743.7	234.3	0.3	604.9	0.0	0.0	0.0	0.6	0.1	0.0	2956.8	0.0	607.5	3583.2	0.7
1945	2307.9	669.9	0.6	604.9	0.0	0.0	0.0	0.6	0.1	0.0	2305.9	650.9	607.5	3583.2	0.7
1946	2307.9	669.7	0.8	604.9	0.0	0.0	0.0	0.6	0.1	0.0	2305.9	650.9	607.5	3583.2	0.7
1947	2307.9	669.7	0.8	0.1	0.0	0.0	0.0	0.6	0.1	0.0	4082.0	87.1	0.0	2978.4	0.7
1948	2977.6	0.3	0.4	0.0	0.0	0.0	0.0	0.6	0.1	0.0	4169.1	0.1	0.0	2978.3	0.7
1949	2977.7	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.0	4082.0	87.1	0.0	2978.4	0.7
1950	2977.7	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.0	4169.1	0.0	0.0	2978.4	0.7
1951	1921.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	5225.9	0.0	0.0	1921.6	0.7

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Table 8. Summary matrix for the C.K. Creek site for an example water control plan alternative.

	Wetland/Riparian Types (acres)													Palustrine Wetland	Riparian
Year	PEMF	PEMC	PEMA	PSSC	PSSA	PFOC	PFOA	RS	RF	RG	R/LUBH	R/LUS	R/LUSS	Total	Total
1952	670.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6477.0	0.0	0.0	670.5	0.7
1953	670.2	0.3	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0	6371.1	105.9	0.0	671.0	0.2
1954	670.2	0.3	0.0	1856.0	0.0	0.0	0.4	0.0	0.2	0.0	4013.6	0.0	607.4	2527.0	0.2
1955	0.0	670.2	0.3	1856.0	0.0	0.0	0.4	0.0	0.2	0.0	2956.8	1056.8	607.4	2527.0	0.2
1956	0.0	670.2	0.3	1856.0	0.0	0.0	0.4	0.0	0.2	0.0	2956.8	0.0	1664.2	2527.0	0.2
1957	0.0	669.7	0.9	1856.0	0.0	0.0	0.4	0.0	0.2	0.0	2956.8	1056.8	607.4	2527.0	0.2
1958	0.0	669.7	0.9	1856.0	0.0	0.0	0.4	0.0	0.2	0.0	4013.6	0.0	607.4	2527.0	0.2
1959	0.0	669.7	0.9	1856.0	0.0	0.0	0.0	0.0	0.7	0.0	4013.6	18.8	588.6	2526.6	0.7
1960	0.0	669.7	0.9	2912.8	0.0	0.0	0.0	0.0	0.7	0.0	2305.9	0.0	1258.3	3583.4	0.7
1961	650.9	669.7	0.6	2912.8	0.0	0.0	0.0	0.0	0.7	0.3	2305.9	0.0	607.4	4233.9	1.0
1962	650.9	669.7	0.6	2912.8	0.0	0.0	0.0	0.0	0.7	0.3	2305.9	0.0	607.4	4233.9	1.0
1963	650.9	669.8	0.3	2912.8	0.0	0.0	0.0	0.0	0.7	0.4	2305.9	0.0	607.4	4233.8	1.1
1964	650.9	669.8	0.3	604.9	0.0	0.0	0.0	0.0	0.7	0.4	2305.9	2307.9	607.4	1925.9	1.1
1965	1320.5	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.1	5739.0	87.1	0.0	1321.3	0.8
1966	1407.6	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.1	4613.8	1125.2	0.0	1408.4	0.8
1967	1407.6	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.1	5218.7	520.3	0.0	1408.4	0.8
1968	1407.6	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.7	0.1	5218.7	520.3	0.0	1408.4	0.8
1969	1407.6	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.7	0.1	5739.0	0.0	0.0	1408.4	0.8
1970	757.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.1	6389.9	0.0	0.0	757.5	0.8
1971	757.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.1	6389.9	0.0	0.0	757.5	0.8
1972	321.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6825.6	0.0	0.0	321.9	0.7
1973	321.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.0	4013.6	2812.1	0.0	321.9	0.7
1974	321.1	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6806.8	18.8	0.0	321.9	0.7
1975	321.1	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6825.6	0.0	0.0	321.9	0.7
1976	321.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6825.6	0.0	0.0	321.9	0.7
1977	2029.3	0.2	0.0	1251.1	0.0	0.0	0.0	0.0	0.7	0.0	2305.9	0.0	1561.0	3280.6	0.7
1978	2029.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	5118.0	0.0	0.0	2029.5	0.7
1979	321.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6825.6	0.0	0.0	321.9	0.7
1980	321.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	5264.7	1561.0	0.0	321.9	0.7
1981	321.1	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.7	0.0	5264.7	1040.7	520.3	321.9	0.7
1982	321.1	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6305.3	520.3	0.0	321.9	0.7
1983	321.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6825.6	0.0	0.0	321.9	0.7
1984	321.2	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.0	6825.6	0.0	0.0	321.9	0.7
1985	2629.1	0.6	0.1	604.9	0.0	0.0	0.0	0.0	0.7	0.0	2956.8	0.0	956.0	3234.7	0.7
1986	2629.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.0	4517.7	0.0	0.0	2629.8	0.7
1987	2629.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.0	4517.7	0.0	0.0	2629.8	0.7
1988	3279.8	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.7	0.0	2305.9	0.0	1561.0	3280.6	0.7
1989	3563.7	321.1	0.8	0.0	0.0	0.0	0.0	0.0	0.7	0.0	2305.9	0.0	956.0	3885.6	0.7
1990	3563.7	321.0	0.8	0.0	0.0	0.0	0.0	0.0	0.7	0.1	2305.9	0.0	956.0	3885.5	0.8
1991	3563.7	756.7	0.8	0.0	0.0	0.0	0.0	0.0	0.7	0.1	2305.9	0.0	520.3	4321.2	0.8
1992	3563.7	756.7	0.6	0.0	0.0	0.0	0.0	0.0	0.7	0.3	2305.9	0.0	520.3	4321.0	1.0
1993	3563.7	756.7	0.6	0.0	0.0	0.0	0.0	0.0	0.7	0.3	2305.9	520.3	0.0	4321.0	1.0
MAX	3563.7	1920.9	234.7	2912.8	108.2	233.9	233.9	0.6	0.7	1.5	6825.6	4653.7	3027.3	4321.2	1.5
MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1823.3	0.0	0.0	321.9	0.2
MEAN	1312.7	220.7	16.0	457.9	1.1	2.4	2.5	0.1	0.3	0.2	4440.2	305.3	388.8	2013.2	0.6
SDEV	1010.5	371.4	57.4	770.8	11.0	23.9	23.9	0.2	0.3	0.3	1810.6	702.1	624.1	1411.1	0.3
10%	321.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2305.9	0.0	0.0	321.9	0.2
25%	650.9	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	2305.9	0.0	0.0	757.5	0.4
MED	1056.8	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.1	4517.7	0.0	0.0	1408.4	0.7
75%	2307.9	435.8	0.6	604.9	0.0	0.0	0.0	0.0	0.7	0.3	6223.5	105.9	607.5	3280.6	0.8
90%	2743.7	669.8	0.9	1255.8	0.0	0.0	0.0	0.6	0.7	0.6	6477.1	1056.8	956.0	4233.8	1.0

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segments, the areas of each type were modified to exclude wetlands and deepwater areas that were not affected by river hydrology. In addition, because much of the Missouri River floodplain has been converted to agriculture, the acreage of croplands in each segment (Table 4) was added to RG, which typically has a similar elevational distribution. The acreages of wetland/riparian types in each segment were then assigned the same relative elevational distribution as each type in the corresponding site.

Once the model is applied to all segments for a given alternative, the results from each segment are summed to obtain an estimate of the effects of that alternative on each wetland/riparian type along the entire river. Segments are also combined to represent deltas or reaches. The relationship between individual sites, segments, reaches/deltas, and upper and lower river is diagrammed in Figure 9. The two sites in the Lewis and Clark Lake delta were combined with those in the Fort Randall reach for modeling purposes. This combination was made because none of the water control plan alternatives is expected to influence Lewis and Clark Lake levels but changes in flow in the Fort Randall reach are likely to affect wetlands in the Lewis and Clark Lake delta.

SELECTION OF WETLAND AND RIPARIAN RESOURCE VALUES

Because it is difficult to rank the effects of alternative water control plans on seven palustrine wetland, four shore wetland, and three riparian types, some method of combining types into one or two resource values was needed. An attempt was made to use diversity indices to accomplish this task (Appendix E). The resource values generated by this approach, however, generally showed very little difference between alternatives. A comparison of wetland acreage data from a variety of water control plan alternatives demonstrated that acreage fluctuations in each reach and delta paralleled fluctuations in the hydrology modeled for the various alternatives. Consequently, it was decided to use the acreages represented by the 93-year mean of the sum of the seven palustrine wetland types (PEMF, PEMC, PEMA, PSSC, PSSA, PFOC, and PFOA). The shore wetland types were excluded from the wetland resource value because these types are typically transitional and do not support significant amounts of wetland vegetation. Similarly, the riparian resource value assumed the 93-year mean of the sum of two riparian types (RF and RS; RG was excluded because of the agricultural lands included in this type for modeling purposes). The information in Tables 9 and 10 is produced by the wetland/riparian resource model for a selected alternative water control plan alternative. These tables show the wetland/riparian resource values, by year, for the entire river, as well as for deltas, upper riverine reaches, and lower riverine reaches. In addition, the table presents the summary statistics for the resource values over the 93-year simulation period.

An additional method of evaluating the effects of alternative water control plans on palustrine wetlands was developed for use in conjunction with the resource values generated by the model. The backwater/chute analysis determines the effects of water control plan alternatives by evaluating the flood duration of representative backwaters and wetland complexes along the river. Alternatives that increase the duration of inundation were considered to improve these areas due to the historical pattern of insufficient water levels during the growing season. Details of this method are presented in Appendix F.

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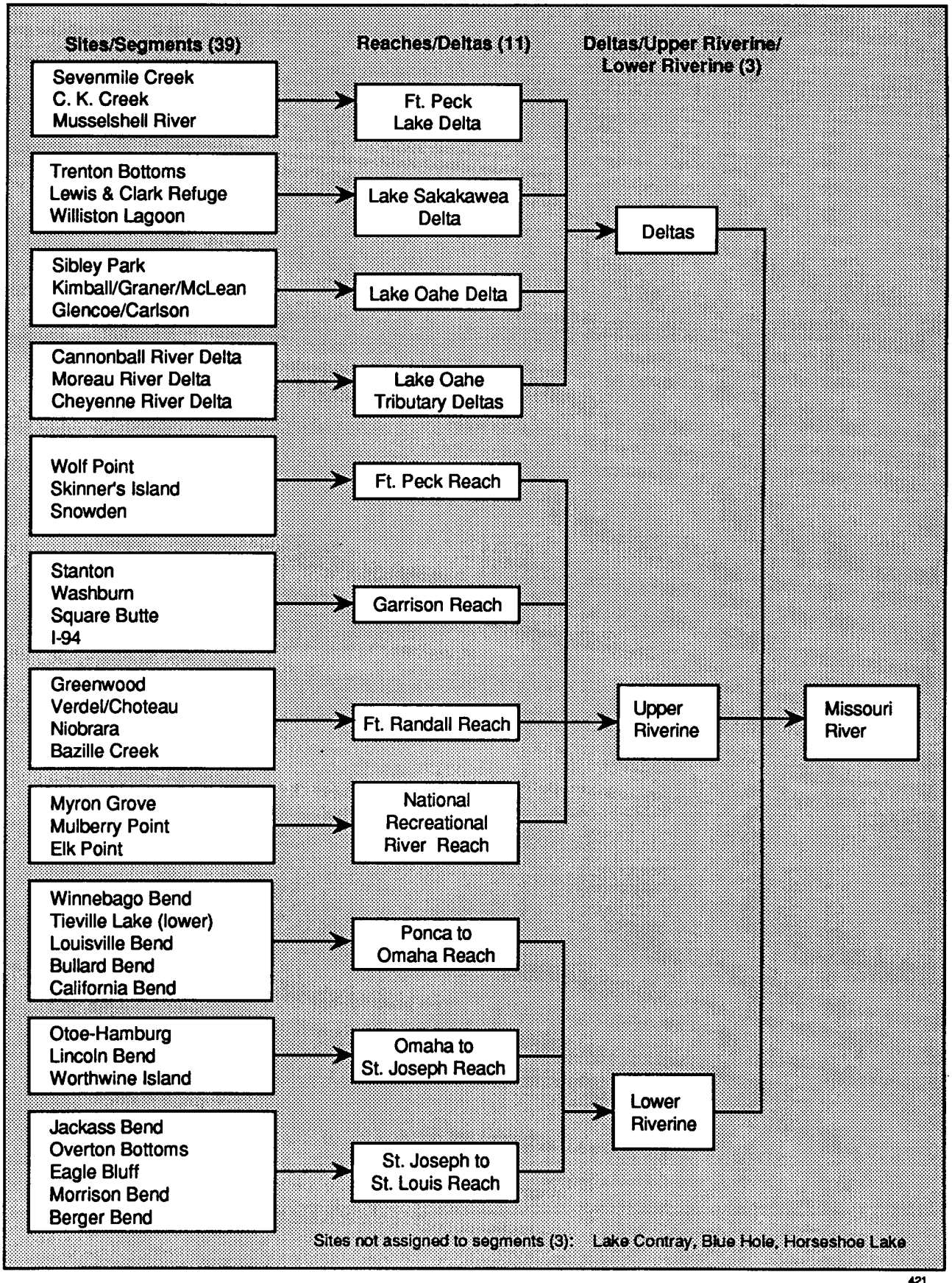

Figure 9. Schematic illustration of the segments, deltas, and reaches represented by each of the 39 study sites along the Missouri River.

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Table 9. Matrix of total palustrine wetlands, by year, for an example alternative.[1/]

Year	Total Wetlands (ac)	Delta Wetlands (ac)	Upper Riverine Wetlands (ac)	Lower Riverine Wetlands (ac)
1898	93,041.90	31,815.50	31,136.80	30,089.50
1899	128,237.60	30,119.20	40,416.20	57,702.30
1900	133,469.00	29,077.80	45,136.20	59,254.90
1901	135,395.60	30,341.90	45,475.70	59,578.00
1902	137,226.10	30,774.50	46,331.20	60,120.40
1903	166,705.10	32,480.40	46,235.70	87,989.00
1904	165,782.00	32,027.20	46,188.00	87,566.70
1905	167,924.80	33,472.10	47,111.80	87,341.00
1906	166,700.30	33,897.50	44,747.40	88,055.40
1907	161,253.20	32,510.30	42,065.60	86,677.30
1908	171,955.80	32,172.80	42,163.90	97,619.10
1909	168,889.60	31,802.60	41,657.10	95,429.90
1910	168,730.20	30,992.90	41,294.60	96,442.80
1911	179,923.20	33,813.70	44,816.40	101,293.10
1912	178,711.70	31,927.10	45,466.10	101,318.50
1913	172,905.10	30,196.90	43,396.00	99,312.20
1914	172,077.50	30,477.10	43,507.10	98,093.30
1915	167,513.80	30,263.70	43,560.80	93,689.30
1916	160,799.10	29,785.20	41,158.60	89,855.40
1917	168,164.90	28,718.80	46,750.30	92,695.70
1918	170,171.20	29,217.10	47,432.70	93,521.40
1919	178,704.30	34,811.10	49,492.50	94,400.70
1920	179,461.80	33,896.60	51,164.50	94,400.70
1921	181,463.40	33,527.80	53,585.80	94,349.80
1922	182,701.30	34,752.40	53,599.10	94,349.80
1923	162,495.50	37,011.30	48,055.30	77,428.90
1924	155,001.10	35,792.10	42,543.10	76,665.80
1925	146,887.10	32,257.40	41,079.00	73,550.80
1926	151,125.40	34,144.00	42,293.10	74,688.30
1927	143,835.20	30,723.10	39,151.60	73,960.50
1928	146,552.60	26,956.60	41,489.40	78,106.60
1929	148,109.40	27,073.50	42,252.50	78,783.50
1930	155,638.50	29,279.70	47,067.40	79,291.30
1931	160,872.90	31,302.00	49,502.10	80,068.70
1932	163,146.10	32,711.40	49,567.20	80,867.60
1933	163,224.80	33,029.60	49,567.20	80,628.00
1934	161,611.60	35,860.80	46,026.50	79,724.30
1935	157,057.30	36,537.10	46,677.00	73,843.30
1936	142,410.00	31,769.20	45,235.70	65,405.20
1937	145,679.80	30,880.80	48,799.30	65,999.70
1938	142,919.90	29,729.40	48,784.90	64,405.50
1939	141,471.10	29,290.30	48,119.30	64,061.50
1940	137,694.50	29,325.40	45,243.70	63,125.50
1941	116,998.70	28,961.20	45,211.80	42,825.70
1942	116,499.90	28,055.20	45,922.10	42,522.50
1943	134,359.80	28,211.40	45,875.20	60,273.20
1944	136,953.00	29,018.80	46,185.20	61,749.00
1945	139,034.70	26,124.00	45,215.70	67,694.90
1946	139,595.30	26,723.00	45,041.50	67,830.80
1947	139,453.00	26,290.10	45,405.20	67,757.70
1948	142,308.70	27,361.30	46,307.10	68,640.30
1949	141,363.60	27,383.40	45,387.90	68,592.40
1950	142,160.90	28,386.10	45,356.00	68,418.80
1951	152,040.70	29,142.20	48,319.80	74,578.70

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Table 9. Matrix of total palustrine wetlands, by year, for an example alternative (continued).

Year	Total Wetlands (ac)	Delta Wetlands (ac)	Upper Riverine Wetlands (ac)	Lower Riverine Wetlands (ac)
1952	159,867.80	28,507.70	48,094.50	83,265.60
1953	164,924.50	28,949.90	52,040.60	83,934.00
1954	169,258.80	32,567.90	52,451.60	84,239.30
1955	171,525.90	33,449.80	53,762.20	84,314.00
1956	173,146.80	34,159.90	53,427.40	85,559.50
1957	172,267.00	35,696.80	53,427.40	83,142.90
1958	157,835.50	34,275.40	52,205.90	71,354.20
1959	150,038.70	34,131.10	47,208.90	68,698.70
1960	148,063.80	37,094.30	47,285.40	63,684.00
1961	141,381.00	35,476.50	44,012.00	61,892.50
1962	135,696.30	32,281.70	42,701.80	60,712.80
1963	131,008.20	29,949.20	40,791.80	60,267.30
1964	125,525.20	26,912.20	40,406.30	58,206.60
1965	123,471.20	24,855.90	40,518.50	58,096.90
1966	122,471.20	23,716.40	40,756.80	57,998.00
1967	129,395.30	26,986.80	43,408.00	59,000.50
1968	133,340.80	28,803.20	45,410.50	59,127.00
1969	132,166.20	28,540.90	44,124.40	59,501.00
1970	143,547.00	30,795.20	45,201.20	67,550.50
1971	142,501.60	30,845.90	45,539.10	66,116.60
1972	152,575.00	32,127.30	46,291.50	74,156.20
1973	153,508.40	32,320.70	47,353.40	73,834.40
1974	158,876.10	33,467.00	49,874.50	75,534.60
1975	155,222.90	32,009.80	48,002.20	75,210.90
1976	162,911.80	32,123.40	54,428.90	76,359.50
1977	167,944.50	35,952.30	55,403.40	76,588.90
1978	164,150.50	33,180.00	54,886.70	76,083.80
1979	163,223.40	31,337.70	54,953.90	76,931.80
1980	163,225.90	31,946.40	54,979.70	76,299.80
1981	163,548.00	32,254.20	55,415.50	75,878.20
1982	165,160.70	32,245.30	55,530.20	77,385.20
1983	173,697.10	32,437.00	55,530.20	85,729.80
1984	175,320.30	31,719.30	55,335.60	88,265.50
1985	172,343.30	35,493.60	47,912.80	88,936.90
1986	170,940.80	34,398.70	47,429.10	89,113.00
1987	172,682.40	37,725.10	45,075.60	89,881.60
1988	174,671.60	38,628.10	45,442.90	90,600.70
1989	174,840.10	40,295.90	43,032.90	91,511.40
1990	165,863.60	41,477.00	43,079.10	81,307.50
1991	165,249.70	40,863.10	43,079.10	81,307.50
1992	157,665.70	43,095.40	43,000.80	71,569.50
1993	156,915.70	41,062.20	45,386.80	70,466.70
Mean	15,4610	31,940	46,600	76,070
Min.	9,3040	23,720	31,140	30,090
Max.	18,2700	43,100	55,530	101,320
StdD	17,470	3,690	4,540	13,910
10%	131,360	27,160	41,200	59,170
25%	141,400	29,160	43,400	65,550
50%	157,360	31,810	45,510	75,980
75%	167,310	33,510	48,110	85,690
90%	172,580	35,760	53,430	93,270

1/ Includes subtotals for deltas and upper and lower riverine reaches and summary statistics.

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Table 10. Matrix of total riparian habitat, by year, for an example alternative.[1/]

Year	Total Riparian Area (ac)	Delta Riparian Area (ac)	Upper Riverine Riparian Area (ac)	Lower Riverine Riparian Area (ac)
1898	142,237.80	11,289.10	37,584.70	93,364.00
1899	105,857.20	7,796.30	30,807.80	67,253.20
1900	105,009.70	7,796.30	29,960.30	67,253.20
1901	105,009.70	7,796.30	29,960.30	67,253.20
1902	105,009.70	7,796.30	29,960.30	67,253.20
1903	79,211.20	7,796.30	30,576.70	40,838.20
1904	78,773.70	7,805.10	30,671.40	40,297.20
1905	80,018.00	8,100.50	31,578.40	40,339.10
1906	81,474.20	8,100.50	33,034.60	40,339.10
1907	94,567.60	9,945.30	41,757.40	42,864.90
1908	81,590.80	8,431.60	40,017.00	33,142.20
1909	81,444.90	8,431.60	39,871.10	33,142.20
1910	81,378.10	8,364.70	39,871.10	33,142.20
1911	81,378.10	8,364.70	39,871.10	33,142.20
1912	81,378.10	8,364.70	39,871.10	33,142.20
1913	81,692.70	8,301.50	40,171.70	33,219.50
1914	82,664.00	8,307.50	40,171.70	34,184.90
1915	86,770.00	8,307.50	40,371.50	38,091.10
1916	86,770.00	8,307.50	40,371.50	38,091.10
1917	80,327.30	8,114.80	36,575.20	35,637.20
1918	80,327.30	8,114.80	36,575.20	35,637.20
1919	80,327.30	8,114.80	36,575.20	35,637.20
1920	80,327.30	8,114.80	36,575.20	35,637.20
1921	80,681.90	8,118.60	36,575.20	35,988.10
1922	80,681.90	8,118.60	36,575.20	35,988.10
1923	100,784.10	8,286.50	40,375.40	52,122.20
1924	101,876.70	8,525.50	41,150.30	52,201.00
1925	105,832.90	8,806.90	41,940.60	55,085.50
1926	106,633.90	9,385.00	42,007.90	55,241.10
1927	106,670.40	9,385.00	42,007.90	55,277.50
1928	100,870.60	8,790.00	40,382.40	51,698.20
1929	100,142.50	8,790.00	40,382.40	50,970.10
1930	100,142.50	8,790.00	40,382.40	50,970.10
1931	100,156.00	8,800.00	40,382.40	50,973.50
1932	100,156.00	8,800.00	40,382.40	50,973.50
1933	101,412.90	9,431.90	40,382.40	51,598.60
1934	107,616.30	10,058.10	42,360.60	55,197.60
1935	111,761.40	10,242.10	42,493.40	59,025.80
1936	119,691.50	11,241.40	43,117.20	65,332.80
1937	125,046.50	13,318.90	45,209.30	66,518.20
1938	125,216.30	13,488.80	45,209.30	66,518.20
1939	125,410.40	13,488.80	45,209.30	66,712.40
1940	127,411.40	13,488.80	46,757.50	67,165.20
1941	145,044.00	13,488.80	46,757.50	84,797.70
1942	145,044.00	13,488.80	46,757.50	84,797.70
1943	128,900.20	13,465.50	46,757.50	68,677.30
1944	129,799.20	13,606.10	48,435.10	67,758.00
1945	127,575.70	13,956.50	48,465.90	65,153.30
1946	129,109.60	14,284.60	48,929.20	65,895.90
1947	129,298.10	14,473.00	48,929.20	65,895.90
1948	128,840.30	14,266.70	48,677.70	65,895.90
1949	128,838.60	14,265.00	48,677.70	65,895.90

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Table 10. Matrix of total riparian habitat, by year, for an example alternative (continued).

Year	Total Riparian Area (ac)	Delta Riparian Area (ac)	Upper Riverine Riparian Area (ac)	Lower Riverine Riparian Area (ac)
1950	128,273.60	13,700.00	48,677.70	65,895.90
1951	116,224.70	12,151.50	46,577.00	57,496.20
1952	102,423.30	10,661.40	44,862.80	46,899.10
1953	98,757.20	10,658.90	41,199.20	46,899.10
1954	98,757.20	10,658.90	41,199.20	46,899.10
1955	98,757.20	10,658.90	41,199.20	46,899.10
1956	98,757.20	10,658.90	41,199.20	46,899.10
1957	101,078.70	10,658.90	41,199.20	49,220.70
1958	115,806.00	12,725.40	42,518.70	60,561.90
1959	124,137.00	13,374.30	47,495.00	63,267.70
1960	127,275.40	13,727.50	47,495.00	66,052.80
1961	131,711.70	14,493.90	49,214.40	68,003.40
1962	134,191.30	14,716.60	50,603.00	68,871.70
1963	135,344.50	15,086.80	51,380.00	68,877.70
1964	137,040.90	15,280.80	51,380.00	70,380.10
1965	136,983.10	15,223.10	51,380.00	70,380.10
1966	136,597.80	15,071.70	51,146.00	70,380.10
1967	133,857.70	14,225.20	49,315.00	70,317.50
1968	133,265.30	14,224.60	48,538.90	70,501.80
1969	133,265.30	14,224.60	48,538.90	70,501.80
1970	123,177.70	12,967.30	46,060.70	64,149.70
1971	122,034.10	12,333.50	45,550.80	64,149.70
1972	111,402.40	10,289.60	44,798.40	56,314.40
1973	111,313.10	10,200.30	44,798.40	56,314.40
1974	110,035.50	10,200.30	44,798.40	55,036.80
1975	110,028.90	10,193.70	44,798.40	55,036.80
1976	101,572.80	10,193.00	36,343.10	55,036.80
1977	101,572.80	10,193.00	36,343.10	55,036.80
1978	102,606.60	11,226.70	36,343.10	55,036.80
1979	101,486.40	11,226.70	36,343.10	53,916.60
1980	102,208.70	11,226.70	36,343.10	54,638.90
1981	102,943.10	11,416.80	36,530.90	54,995.40
1982	101,475.90	11,415.70	36,611.00	53,449.20
1983	93,236.60	11,415.70	36,611.00	45,209.90
1984	89,680.80	11,621.40	36,805.70	41,253.70
1985	97,902.60	11,621.40	45,027.50	41,253.70
1986	99,057.20	12,238.50	45,565.00	41,253.70
1987	99,220.90	10,609.20	47,357.90	41,253.70
1988	99,266.10	10,654.50	47,357.90	41,253.70
1989	99,830.80	10,859.60	47,717.50	41,253.70
1990	110,892.60	10,940.70	48,289.50	51,662.40
1991	111,086.80	11,134.90	48,289.50	51,662.40
1992	121,721.50	11,138.00	49,665.10	60,918.40
1993	123,557.70	12,974.20	49,665.10	60,918.40
Mean	107,645.90	10,906.10	42,308.20	54,431.70
Min.	78,773.70	7,796.30	29,960.30	33,142.20
Max.	145,044.00	15,280.80	51,380.00	93,364.00
StdD	18,546.70	2,326.60	5,651.10	13,294.40
10%	80,890.80	8,114.80	36,343.10	35,637.20
25%	98,116.30	8,431.60	37,000.40	41,253.70
50%	102,514.90	10,658.90	41,478.30	54,817.10
75%	123,462.70	12,906.80	46,757.50	65,895.90
90%	129,648.90	14,144.20	48,677.70	67,929.80

1/ Includes subtotals for deltas and upper and lower riverine reaches and summary statistics.

LITERATURE CITED

Baker, J.B. n.d. Tolerance of planted hardwoods to spring flooding. South. J. Appl. For. 23-25.

Barnes, W.J. 1985. Population dynamics of woody plants on a river island. Can. J. Bot. 63(3): 647-655.

Bedish, J.W. 1967. Cattail moisture requirements and their significance to marsh management. Amer. Midl. Natur. 78(2):288-300.

Bell, D.T. and F.L. Johnson. 1974. Flood-caused tree mortality around Illinois reservoirs. Trans. Ill. State Acad. Sci. 67(1): 28-37.

Bragg, T.B. and A.K. Tatschl. 1977. Changes in floodplain vegetation and land use along the Missouri River from 1826 - 1972. Environ. Managd. 1(4): 343-348.

Corps (U.S. Army Corps of Engineers). 1991. Surviving the drought: public involvement in water management. Missouri River Main Stem Reservoirs Annual Operating Plan and Summary of Actual 1990-1991 Operations. U.S. Army Corps of Engineers, Missouri River Division, Omaha, Nebraska. December 1991.

Corps (U.S. Army Corps of Engineers). 1989. Missouri River wetlands: new resources in mainstem reservoirs (draft). U.S. Army Corps of Engineers, Planning Division, Omaha District, Omaha, Nebraska. February 1989.

Corps (U.S. Army Corps of Engineers). 1974. Base-line study of Missouri River - Rulo, Nebraska to mouth near St. Louis Missouri. Volume V. U.S. Army Corps of Engineers, Kansas City District, Kansas City, Missouri.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31.

Dionigi, C.P., I.A. Mendelssohn, and V.I. Sullivan. 1985. Effects of soil waterlogging on the energy status and distribution of *Salix nigra* and *S. Exigu* (Salicaceae) in the Atchafalaya River basin of Louisiana. Amer. J. Bot. 72(1): 109-119.

Fredrickson, L.H. and T.S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. U.S. Fish and Wildlife Serv. Resour. Publ. 148. 29pp.

Grace, J.B. and J.S. Harrison. 1986. The biology of Canadian weeds: *Typha latifolia* L., *Typha angustifolia* L. and *Typha glauca* Godr. Can. J. Plant Sci. 66:36-379.

Grace, J.B. And R.G. Wetzel. 1981. Habitat partitioning and competitive displacement in cattails (typha): experimental field studies. Amer. Nat. 118(4): 463-474.

Green, W. E. 1947. Effect of water impoundment on tree mortality and growth. J. For. 45: 118-120.

Hall, T.F. and G.E. Smith. 1955. Effects of flooding on woody plants, west sandy dewatering project, Kentucky reservoir. J. For. 53: 281-285.

Hall, T.F., W.T. Penfound, and A.D. Hess. 1946. Water level relationships of plants in the Tennessee Valley with particular reference to malaria control. Tenn. Acad. Sci. 18-60.

Hallberg, G.R., J.M. Harbaugh, and P.M. Witinok. 1979. Changes in the channel area of the Missouri River in Iowa, 1879-1976. Iowa Geological Survey, Iowa City, Iowa.

Harlow, W.M., E.S. Harrar, and F.M. White. 1979. Textbook of dendrology covering the important forest trees of the United States and Canada. Sixth Ed. McGraw-Hill, New York, New York. 510pp.

Harris, S.W. and W.H. Marshall. 1963. Ecology of water-level manipulation on a northern marsh. Ecology 44(2): 331-343.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest University. Seattle, Washington. 730pp.

Hoffman, G.R. 1978. Shore vegetation of Lake Oahe and Sakakawea, mainstem Missouri River Reservoirs. University of South Dakota, Vermillion, South Dakota.

Hosner, J.F. 1958. The effects of complete inundation upon seedlings of six bottomland tree species. Ecology 39:371-373.

Hosner, J.F. and S.G. Boyce. 1962. Tolerance to water saturated soil of various bottomland hardwoods. For. Sci. 8:180-187.

Johnson, W.C., R.L. Burgess, and W.R. Keammerer. 1976. Forest overstory vegetation and environment on the Missouri River floodplain in North Dakota. Ecol. Monogr. 46:59-84.

Johnson, W.C. 1992. Dams and riparian forests: Case study from the upper Missouri River. Rivers 3(4): 229-242.

Kallemeyn, L.W. and J.F. Novotny. 1977. Fish and fish food organisms in various habitats of the Missouri River in South Dakota, Nebraska, and Iowa. U.S. Fish and Wildlife Service, Columbia, Missouri.

Keddy, P.A. and T.H. Ellis. 1985. Seedling recruitment of 11 wetland plant species along a water level gradient: shared or distinct responses. Can. J. Cot. 63(10): 1876-1879.

Merendino, M.T. and L.M. Smith. 1991. Influence of drawdown date and reflood depth on wetland vegetation establishment. Wildl. Soc. Bull. 19:143-150.

Miller, J.B. 1973. Vegetation changes in shallow marsh wetlands under improving moisture conditions. Can. J. Bot. 51: 1443-1457.

Mitsch, W.J. and J.G. Gosselink. 1986. Wetlands. Van Nostrand Reinhold, New York, New York. 539pp.

Moyle, J.B. 1959. Review of literature on plant growth and water levels.

NOAA (National Oceanic and Atmospheric Administration). 1990. Climatological data annual summary (various volumes).

Noble, M.G. 1979. The origin of *Populus deltoides* and *Salix interior* zones on point bars along the Minnesota River. Amer. Midl. Nat. 102(1): 59-67.

Pfister, R.D. and R.F. Batchelor. n.d. Montana riparian vegetation types.

Polani, K.A. and W.C. Johnson. 1989. Effect of hydroperiod on seed-bank composition in semipermanent prairie wetlands. Can. J. Bot. 67: 856-864.

Reed, P.B. 1988. National list of plant species that occur in wetlands: national summary. U.S. Fish and Wildlife Service Biol. Rept. 88(24) 244pp.

Reily, P.W. and W.C. Johnson. 1982. The effects of altered hydrologic regime on tree growth along the Missouri River in North Dakota. Can. J. Bot. 60: 2410-2423.

Schumacher, C.M. 1978. Tolerance of South Dakota plants to flooding and to wet soils. U.S.D.A. Soil Conservation Service, Huron, South Dakota. 33pp.

Shay, J. and C.T. Shay. 1986. Prairie marshes in western Canada, with specific reference to the ecology of five emergent macrophytes. Can. J. Bot. 64: 443-454.

Sjoberg, K. and K. Danell. 1983. Effects of permanent flooding on *Carex-Equisetum* wetlands in northern Sweden. Aquatic Botany 15:275-286.

Stanley, L. and G.R. Hoffman. 1975. Further studies on the natural and experimental establishment of vegetation along the shorelines of Lake Oahe and Lake Sakakawea, lakes of the mainstem Missouri River. Vermillion, S.D.: University of South Dakota, Department of Biology. Note: annual report for fiscal year 1975, submitted to the U.S. Army corps of Engineers, Omaha District, Omaha, NE.

Thornwaite, C. W. 1948. An approach toward a rational classification of climate. Geogr. Rev. 38:55-94.

USDA Forest Service. 1977. Forest and range ecosystems of the United States (map).

Van der Valk, A.G. and C.B. Davis. 1980. The impact of a natural drawdown on the growth of four emergent species in a prairie glacial marsh. Aquat. Bot. 9: 301-322.

Van Haverbeke, D.F. 1990. *Populus deltoides* var. occidentalis Rydb., Plains Cottonwood. In Burns, R.M. and B.H. Honkala (Tech. Coords.), Silvics of North America, volume 2, U.S.D.A. Agricultural Handbook 654, U.S. Superintendent of Documents (Washington, D.C.).

Vaudbel, J.A. and G.R. Hoffman. 1975. A study of vegetation development in relation to age of river stabilization structures along a channelized segment of the Missouri River. University of South Dakota, Department of Biology, Vermillion, South Dakota. Note: final report submitted to the U.S. Army Corps of Engineers, Omaha District.

Wilson, R.E. 1970. Succession stands of *Populus deltoides* along the Missouri River in southeastern South Dakota. Amer. Midl. Nat. 83(2): 330-342.

Appendix A—Field and Mapping Methods

APPENDIX A

FIELD AND MAPPING METHODS

APPENDIX A

FIELD AND MAPPING METHODS

Documenting the extent, condition, and types of wetlands and riparian resources that currently exist in the study area is a prerequisite first step in evaluating the effects on these resources resulting from changes in water management. The approach to developing a data base for characterizing the existing Missouri River floodplain environment comprised four major efforts: (1) review of existing maps and acreage data; (2) construction of a Geographic Information System (GIS) database; (3) additional mapping using recent aerial photography followed by field verification; and (4) quantitative field surveys performed during 1991.

EXISTING DATA BASES

Two existing data bases covering major portions of the study area were reviewed: the United States Fish and Wildlife Service's National Wetland Inventory (NWI), and the Missouri River Basin Commission (MRBC) maps. The NWI covers most of the wetlands in the U.S. (1:24,000 scale), but in 1991 was not complete for a number of extensive areas along the Missouri River, including Lake Oahe, Lake Sharpe, the entire riverine/reservoir system in Montana and most of the river downstream of Sioux City, Iowa. In addition, use of existing NWI maps for this project was considered undesirable for other reasons: (1) exclusion of riparian areas not classified as wetland; (2) derivation in many instances from relatively out-dated aerial photography (1979); (3) no coverage for areas along the river extending below the high water mark such as wetlands that have developed in the deltas; and (4) no acreage summaries. About a quarter of the NWI maps that cover the Missouri River, however, are available in digital format and can be directly entered into a GIS.

The MRBC has inventoried wetlands as well as non-wetland riparian areas along the Missouri River from Ponca, Nebraska to St. Louis Missouri (1:24,000 scale). Each of the maps includes a summary of the amounts of various wetland and riparian types, by map and by county, but none are available in digital format. All of the MRBC mapping was based on aerial photographs flow in 1979 and are, therefore, outdated. In addition, the MRBC mapping does not use the same hydrologic modifiers as the Cowardin System.

GEOGRAPHIC INFORMATION SYSTEM

Because of the large size of the area with wetlands and riparian lands potentially affected by Missouri River management, and the evident need to simulate changes in resource abundance as a function of alternative management plan, a Geographic Information System (GIS) was utilized. These systems store spatial information in computerized format and facilitate retrieval, calculation and summarization of acreages for any given combination of resource categories or river reach.

EXHIBIT 690 022102

NWI maps and files for the study area upstream of Ponca, Nebraska, were examined. The NWI digital files, which cover large portions of Lake Sakakawea and the river from Garrison dam to the South Dakota border, were entered directly into the GIS. For the remainder of the area covered by the NWI, wetland polygons were digitized from mylar NWI maps into the GIS using ARC/INFO software (Environmental Systems Research Institute 1991). This software is an arc (line segment) based system, which stores line data as a series of arcs and then merges them into polygons. ARC/INFO automatically calculates the area of each polygon and wetland type, and allows summarizing acreage data by type, for each riverine reach or any sub-area, as necessary.

MRBC maps were utilized to develop the wetland and riparian resource inventory for the river downstream of Ponca. Because these maps include acreage summaries, the boundaries of wetland and riparian areas for this portion of the study area (excepting the 13 sites mapped and field-corroborated by Ebasco Environmental) were not digitized. Acreage summaries from the MRBC maps were adjusted to exclude wetlands outside the 100-year floodplain and than entered directly into a database management program (Excel) to calculate the acreage of each type by river reach or other sub-area, as necessary.

MAPPING

Wetland and riparian cover types were delineated on aerial photographs to: (1) fill gaps in the existing mapped data for the river upstream of Ponca; and (2) develop correction factors for updating the existing NWI and MRBC maps to 1991 conditions. The most recent aerial photographs available for the various portions of the study area were acquired from the Corps, Missouri River Division. True-color aerial photographs, taken in 1990 and 1991, are available for most riverine reaches and reservoir deltas (1:12,000 scale) upstream of Ponca. The river downstream of Ponca is covered by a combination of true color and black and white aerial photographs (1:24,000 scale) taken in 1985 and 1986.

Wetlands and riparian areas were delineated on aerial photographs using standard photo delineation procedures. For entry into the GIS, wetlands and riparian boundaries on the photographs were either: (1) transferred to U.S. Geological Survey (USGS) topographic maps (1:24,000 scale) using a zoom transfer scope and then digitized into the GIS or (2) directly entered into the GIS using a analytical plotter.

The gaps in the NWI for the river upstream of Ponca were mapped using 1990 aerial photographs. The major gaps included the reservoir deltas, which were mapped only to the high water mark, and the riverine reach between Fort Peck Dam and Culbertson, Montana. Because of drought conditions, the deltas for Fort Peck, Sakakawea, and Oahe reservoirs ranged from about 10 to 55 miles in length. These areas were mapped and about 50 percent of the mapping was field verified. Areas with relatively few wetland resources (i.e., reservoir shorelines) and reservoir deltas not affected by any water control plan alternatives (i.e., Lake Francis Case delta) were not mapped. The river between Fort Peck Dam and Culbertson is over 100 miles long. For this reach, wetland/riparian cover types were mapped for a sample 1-mile stretch every 10 miles and then expanded to the larger area.

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Mapping from aerial photography was utilized to develop correction factors to apply to existing NWI and MRBC data for riverine reaches. The NWI and MRBC data had been derived mostly from 1979 aerial photography, and were considered to be outdated. The wetlands and riparian areas at a total of 11 sites along the river upstream of Ponca, and 11 sites downstream of Ponca, were delineated on the most recent aerial photographs of these sites. Mapping at these sites was field verified, and the information from the aerial photographs digitized into the GIS to create a map and acreage summary.

Correction factors for each wetland type were generated from comparison of the acreage summaries from the NWI/MRBC maps, with the corresponding recent data developed by Ebasco Environmental for the 24 selected sites. The correction factors were applied to areas adjacent to each of the 24 sites to yield (1) NWI/MRBC data updated for 1991 conditions and (2) estimated areal extent of non-wetland riparian areas, which was not available from the NWI. The correction factors for river reaches upstream of Ponca were accomplished by using the GIS to overlay NWI and Ebasco mapping. Downstream of Ponca, GIS plots of study sites were manually superimposed on MRBC maps and MRBC/Ebasco polygons traced with a digital planimeter (SigmaScan). For instance, if a 5-acre MRBC polygon of emergent wetland was classified as 2 acres of PEMF wetland, 2 acres of PEMC wetland, and 1 acre of agricultural land by Ebasco, the correction factor would be 0.4, 0.4, and 0.2 for updating the MRBC emergent wetland to PEMF, PEMC, and agricultural lands, respectively.

Table A-1 outlines the entire wetlands/riparian database created for the Missouri River. It indicates the reaches, deltas, and reservoir areas, the existing data available for each, whether or not 1991 mapping on aerial photos was used to update an area or fill a data gap, and the number of sites that were used to develop correction factors for each reach.

FIELD INVESTIGATIONS

Field investigations were conducted to meet three objectives: (1) verify aerial photography interpretation; (2) obtain information on the species composition and condition of various wetland and riparian types; and (3) obtain data on the relationship between wetland and riparian types and water surface elevation.

A total of 42 study sites between the Ft. Peck delta and St. Louis were selected for detailed field investigation of wetland and riparian resources. The approximate locations of these sites are shown on Figure A-1. Detailed descriptions of each site are provided in Appendix B. Sites were selected on the basis of five criteria: (1) inclusion of all major wetland and riparian types (as opposed to amount or quality) present along any given river reach or delta; (2) hydrology representative of reach or delta; (3) proximity to at least one elevational control point, such as a USGS monument, one of the monuments erected by the Corps along the river for sediment range measurement, or one of the Corps' gauging stations; (4) location in a riverine reach or delta that would be affected by at least one of the water control plan alternatives; and (5) accessibility by car or boat. A total of 16 sites were selected along the approximately 615-mile lower river and 26 sites were selected in the deltas and riverine reaches of the 1,280-mile upper river.

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Table A-1. Summary of data used for the inventory of wetland and riparian resources along the Missouri River.

Reservoir/Delta/Reach	Existing Maps	Aerial Photo Mapping/Correction Factors
Fort Peck Lake Delta	None	Mapped on 1990 aerial photos (1:12,00 scale)
Fort Peck Lake	None	Not mapped, very few wetlands
Fort Peck Dam to Lake Sakakawea Delta - upper 100 miles	None	Mapped 10 sections, each 1-mile long, at 10-mile intervals; used GIS to extrapolate acreage to entire reach
Fort Peck Dam to Lake Sakakawea Delta - lower 50 miles	NWI - 1983 photography	Correction factors developed using 1990 aerial photos for the Snowden study site
Lake Sakakawea Delta	None	Mapped on 1990 aerial photos (1:12,000 scale)
Lake Sakakawea	NWI - 1983 photography (digital files)	Not used in database, very few wetlands
Garrison Dam to Lake Oahe Delta	NWI - 1983 photography	Correction factors developed from 4 sites; Stanton, Washburn, Square Butte, I-94
Lake Oahe Delta	None	Mapped on 1990 aerial photos (1:12,000 scale)
Lake Oahe	None	Not mapped, very few wetlands
Lake Oahe to Lake Sharpe Delta	None	Not mapped, very few wetlands
Lake Sharpe	None	Not mapped, no significant changes in reservoir levels expected
Lake Francis Case	None	Not mapped, no significant changes in reservoir levels expected
Fort Randall Dam to Lewis & Clark Lake Delta	NWI - 1983 photography	Correction factors developed using 1992 aerial photographs of 2 sites: Greenwood, Verdel/Choteau
Lewis & Clark Lake Delta	NWI - 1983 photography	Correction factors developed using 1992 aerial photographs of 2 sites: Bazille Creek and Niobrara
Lewis & Clark Lake	NWI - 1983 photography	Not used in database, no significant changes in reservoir level expected
Gavins Point Dam to Ponca	NWI - 1983 photography	Correction factors developed for mapping on 1990 aerial photographs of 3 sites: Myron Grove, Mulberry Point, and Elk Point
Ponca to Omaha	MRBC, 1979	Correction factors developed for mapping on 1985 and 1986 photography (1:24,000 scale) at 5 sites
Omaha to St. Joseph	MRBC, 1979	Correction factors developed for mapping on 1985 and 1986 photography (1:24,000 scale) at 3 sites
St. Joseph to St. Louis	MRBC, 1979	Correction factors developed for mapping on 1985 and 1986 photography (1:24,000 scale) at 3 sites

EXHIBIT 690 022105

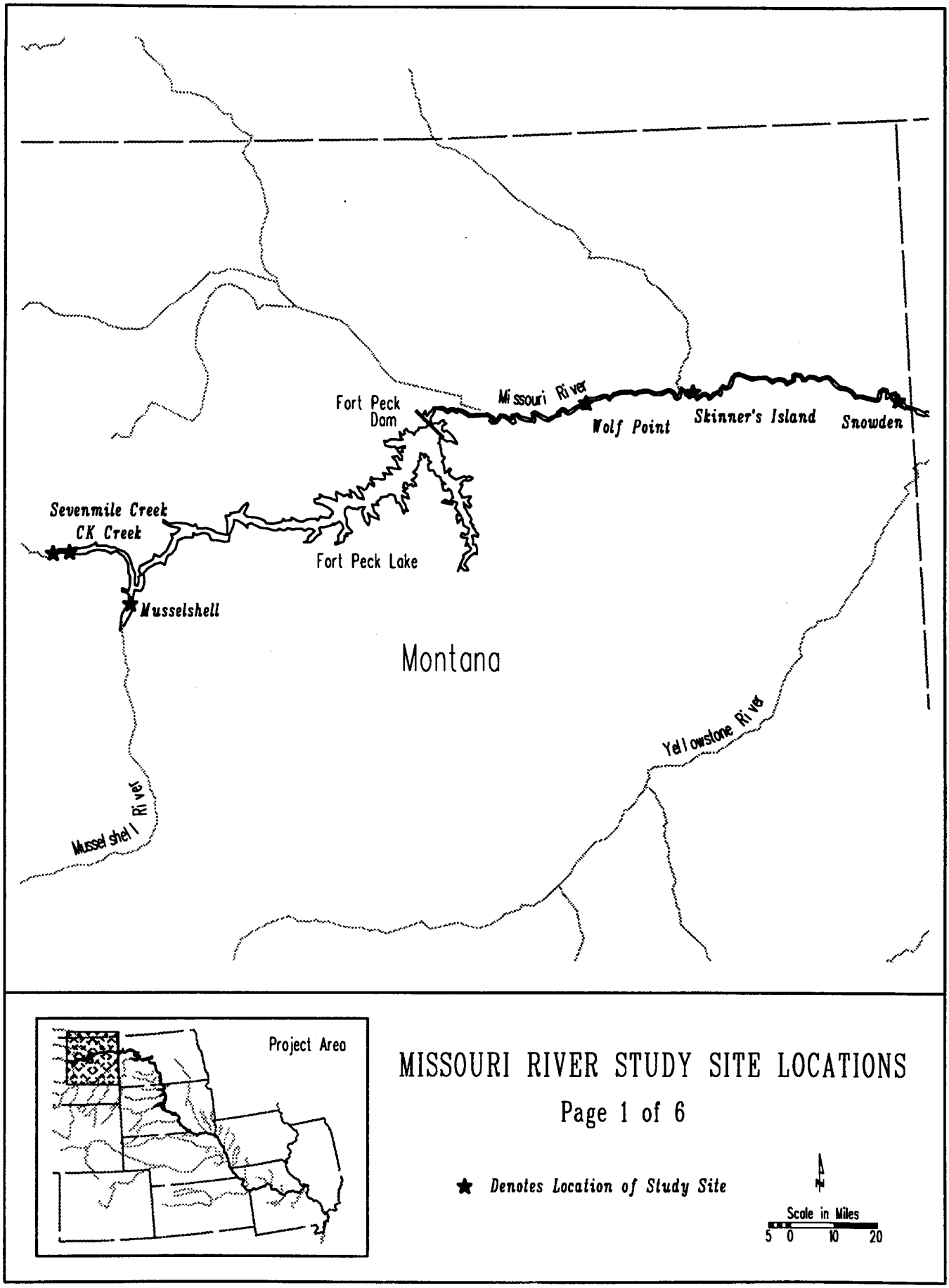
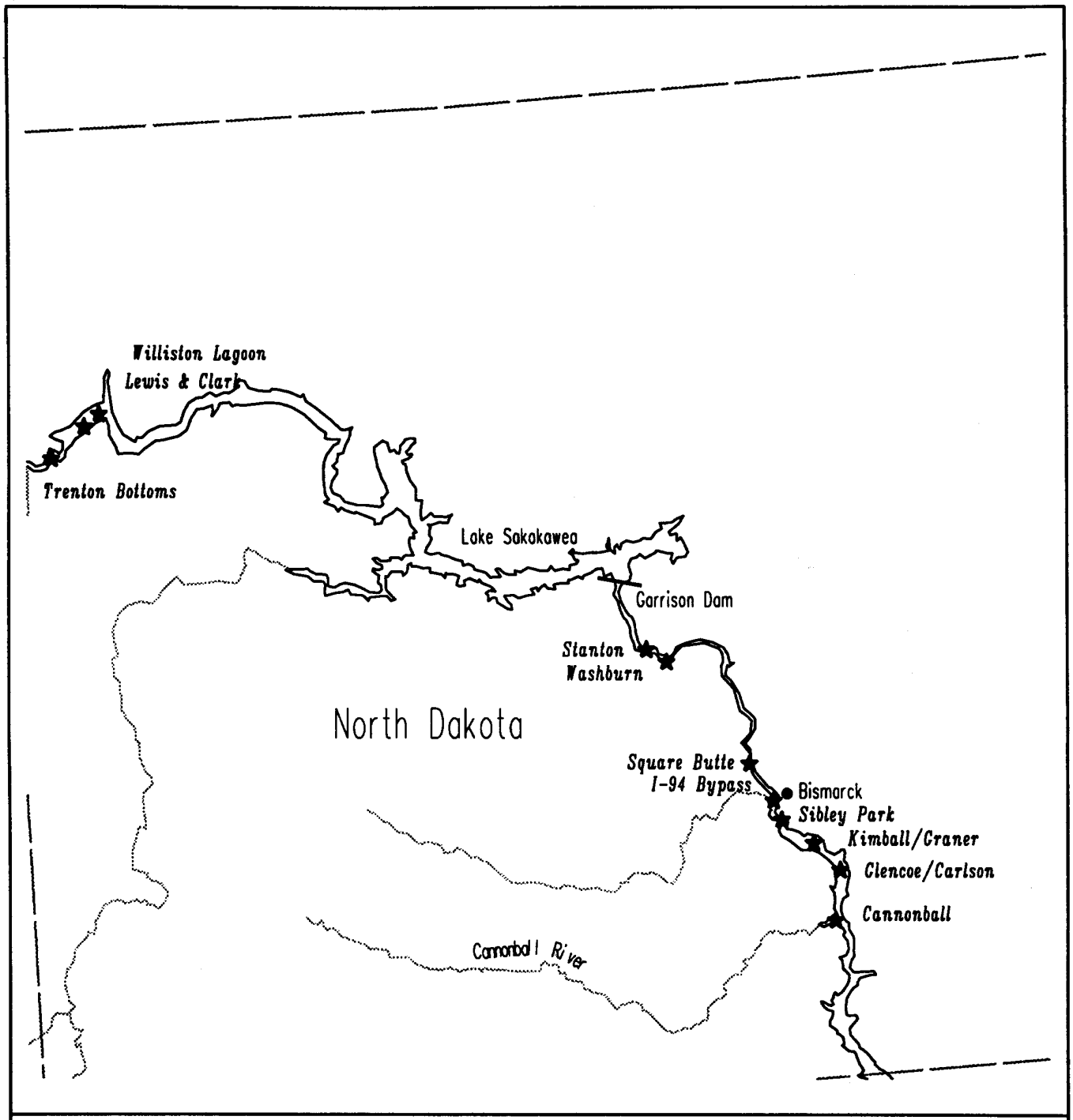
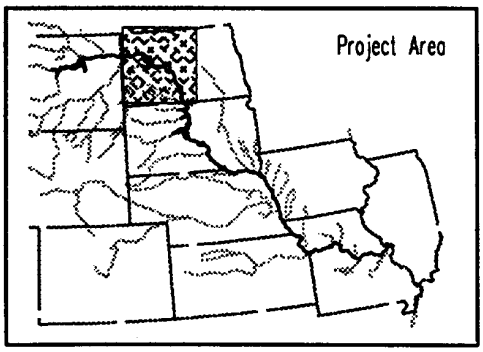


Figure A-1. Missouri River study site location.

EXHIBIT 690 022106





MISSOURI RIVER STUDY SITE LOCATIONS

Page 2 of 6

★ *Denotes Location of Study Site*

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Scale in Miles
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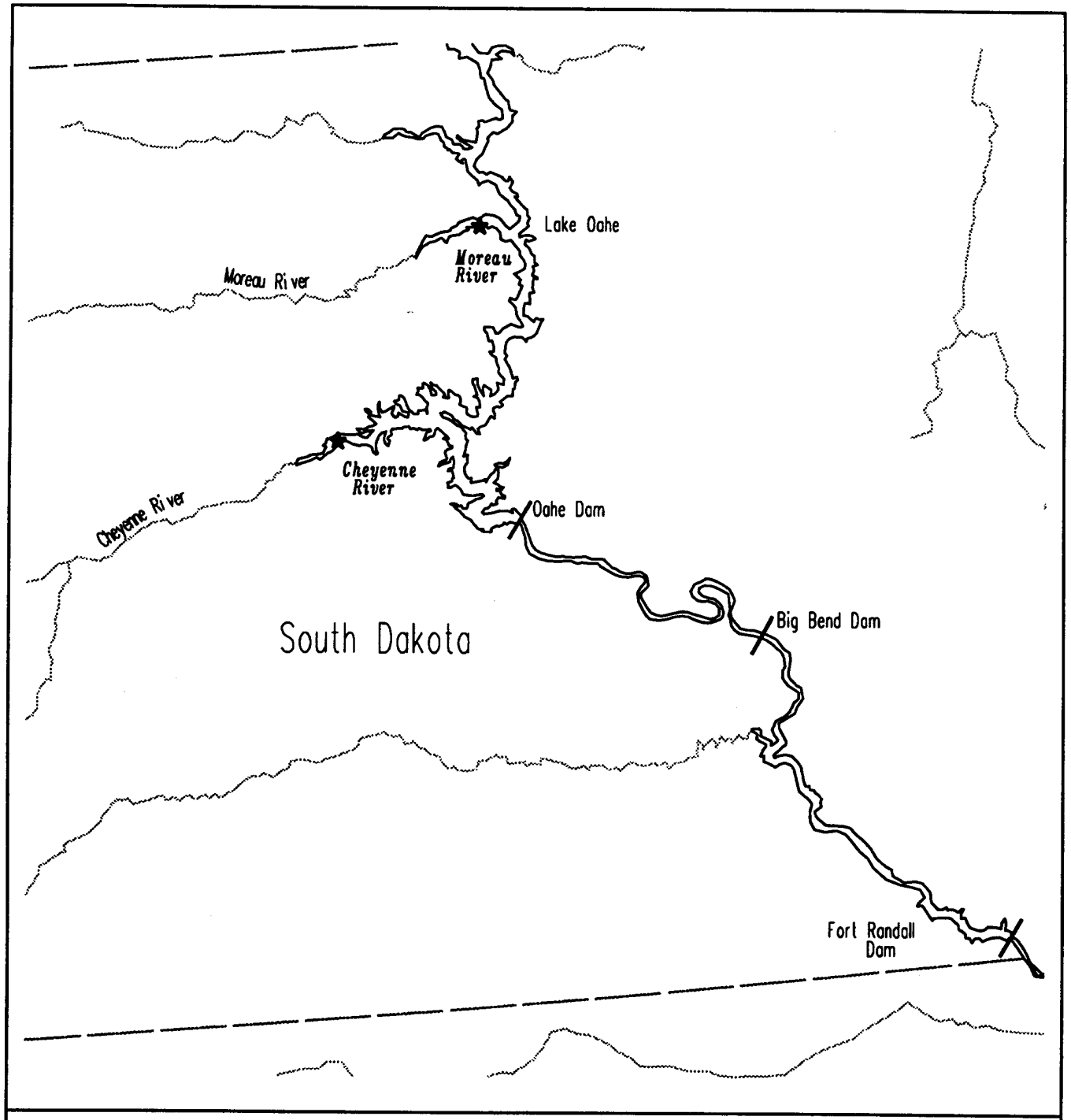

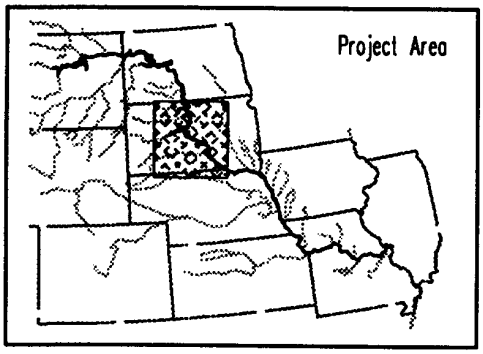

MISSOURI RIVER STUDY SITE LOCATIONS

Page 3 of 6

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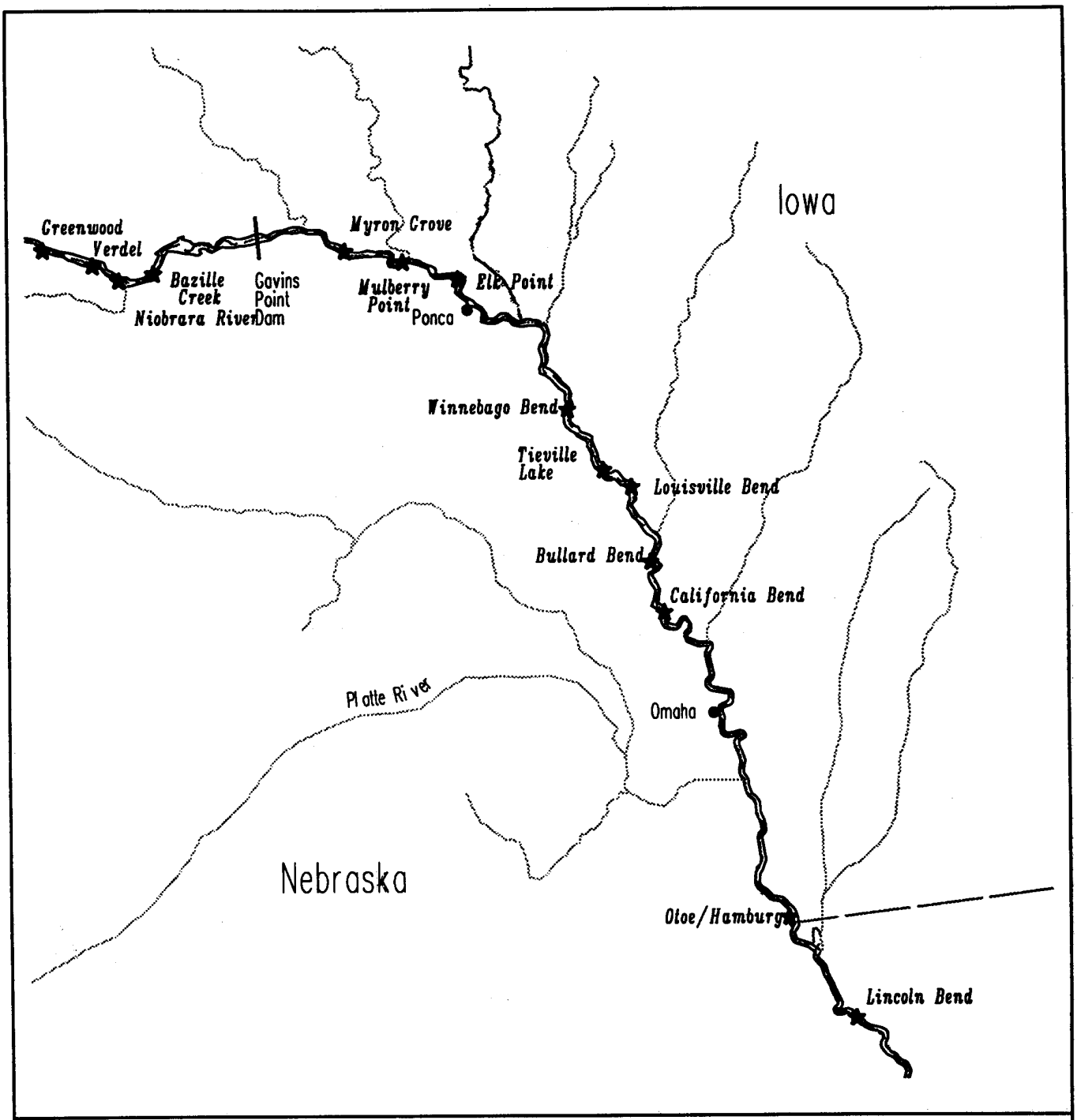

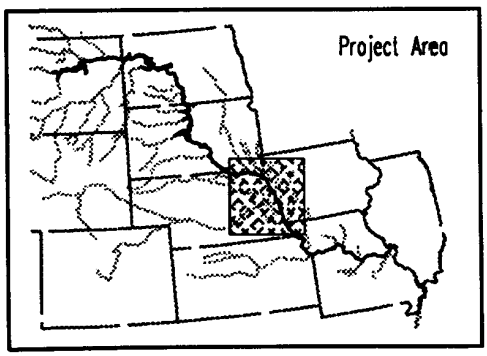

MISSOURI RIVER STUDY SITE LOCATIONS

Page 4 of 6

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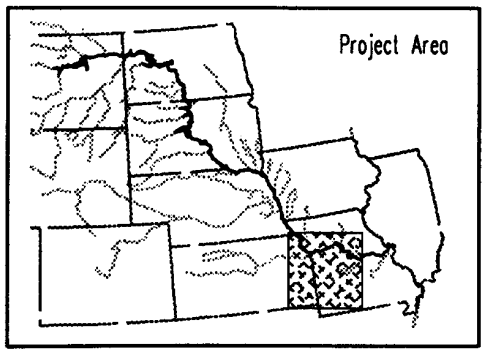

MISSOURI RIVER STUDY SITE LOCATIONS

Page 5 of 6

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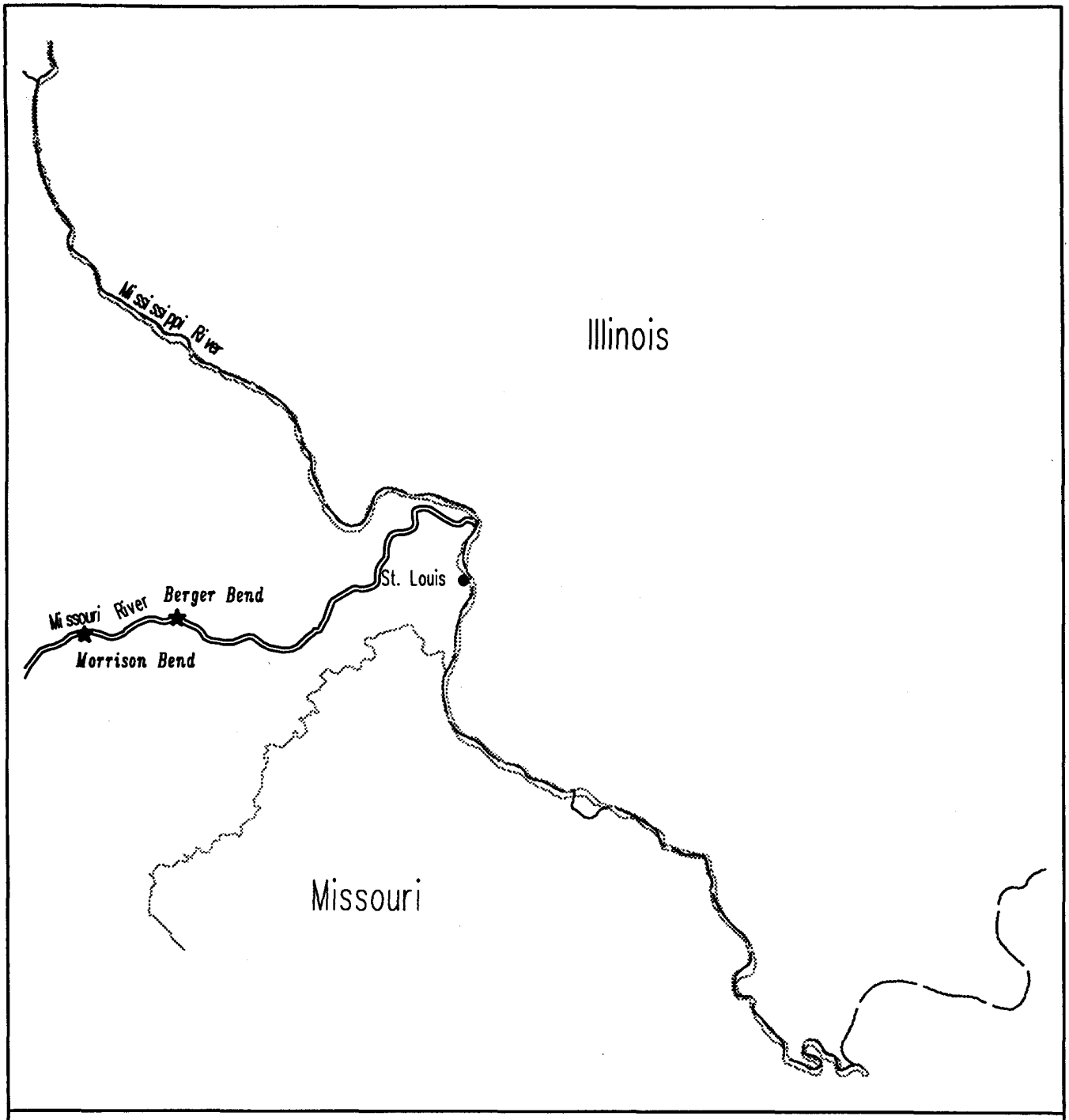

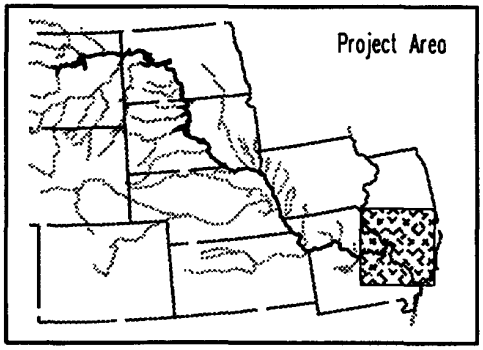

MISSOURI RIVER STUDY SITE LOCATIONS

Page 6 of 6

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Field investigations were conducted between early May and late October, 1991. Each field team consisted of 2 biologists and a professional surveyor. At each site, the mapping on aerial photographs was verified and then used to locate from 1 to 5 transects that would cross the greatest number of wetland and riparian types. Along each transect, the elevation of every transition from one wetland or riparian type to another was recorded along with data on species composition, soils, hydrology, and horizontal distance along the transect. Similar information was recorded at points where slope or aspect changed abruptly. All vertical and horizontal data were referenced to the elevational control point (USGS monument, sediment range marker) using standard electronic surveying equipment (a Leitz total station and rod with a prism). Details on river mile location, number of transects sampled, elevational reference points, and sample date for each site are presented in Appendix B.

Data collected from the field investigations were checked and entered into a computer program designed to interpolate between sampled points and assign elevations at 2-foot (linear) intervals along each transect for each site. The output from this program provided, for each of the 42 sites, the distribution of each wetland and riparian type by elevation. For example, if field sampling and interpolation at a given site resulted in 500 intersections in emergent wetlands, and 100 of these fell between elevation 1600 and 1600.5 feet, then it was assumed that 20 percent of emergent wetlands at the entire site occurred in this elevation band. The distribution information was then applied to the acreage data obtained from the GIS for that site, to estimate the acreage distribution of each type by elevation.

In addition to detailed field investigations, a relatively cursory reconnaissance of riverine cottonwood forests was performed to qualitatively assess their current condition. The field reconnaissance was performed by an Ebasco Environmental plant ecologist from September 25 through October 8, 1991. Inspection sites were selected to provide a representative perspective of the entire stretch of the Missouri River from St. Louis to Fort Peck. Several locales were identified prior to the reconnaissance as areas where riparian resources were of particular concern and possibly degrading. These areas included Berger Bend (Missouri), Fort Leavenworth (Kansas), and cottonwood stands downstream of Yankton (South Dakota) and Pierre (North Dakota). Most locales were selected because they could be accessed via public lands (without use of a boat) and, from aerial photograph or map inspection, appeared likely to contain tracts of riparian forest. Principal sites examined were: Winthrow Bottoms (Fort Peck Lake delta), Lewis and Clark Wildlife Management Area (Lake Sakakawea delta, Williston, North Dakota), McLean Bottom (Lake Oahe delta, below Bismarck, North Dakota), Farm and Laframboise Islands (vicinity of Pierre, South Dakota), Chief White Crane Recreation Area, (Gavins Point Dam), Frost Wilderness Area (RM 778, below Gavins Point Dam), Desoto Bend National Wildlife Refuge (between Omaha and Sioux City), Fort Leavenworth (Kansas), Grand Pass Wildlife Area (between Kansas City and Columbia, Missouri), Berger Bend (about 90 miles upstream of St. Louis), and Howell Island Wildlife Management Area (upstream of St. Louis, Missouri). Observations recorded at each site focused on species composition and obvious indications of tree vigor such as mortality and degree of dead branches. Where possible local resource specialists were consulted regarding observations of riparian forest resources and relationships with river hydrology.

EXHIBIT 690 022112

Appendix B—Plant and Wildlife Species and Study Site Descriptions

Table B-1. Plant species commonly encountered in and near Missouri River wetlands. 1/

Common Name	Scientific Name	Fort Peck Delta	Fort Peck to Williston	Lake Sakakawea Delta	Garrison Dam to Lake Oahe	Lake Oahe Delta	Ft. Randll to Lewis and Clark	Lewis and Clark Delta	Gavins Point to Ponca	Ponca to Rulo	Rulo to St. Joseph	St. Joseph to St. Louis
TREES												
Cottonwood	*Populus deltoides*	X	X	X	X	X	X	X	X	X	X	X
Black willow	*Salix nigra*										X	X
Peach-leaf willow	*Salix amygdaloides*	X	X	X	X	X	X		X	X	X	X
Sandbar willow	*Salix interior*	X	X	X	X	X	X		X	X	X	X
Mulberry	*Morus sp.*									X		X
Russian olive	*Elaeagnus angustifolia*				X	X	X	X	X			
Box elder	*Acer negundo*				X	X		X				X
Silver maple	*Acer saccharinum*											X
Green ash	*Fraxinius pennsylvanica*		X			X	X	X	X	X	X	X
Slippery elm	*Ulmus fulva*		X					X	X	X	X	X
Pecan	*Carya illinoensis*											X
Sycamore	*Platanus occidentalis*									X	X	X
Bur oak	*Quercus macrocarpa*						X					X
Chestnut oak	*Quercus michauxii*											X
Pawpaw	*Carica papaya*											X
Kentucky coffeetree	*Gymnocladus dioica*											X
Red elm	*Ulmus rubra*											X
Siberian elm	*Ulmus pumila*									X		
Honey locust	*Gleditsia tricanthos*											X
Black locust	*Robinia pseudacacia*											X
Red cedar	*Juniperus virginiana*							X		X		
SHRUBS												
Cottonwood	*Populus deltoides*	X	X	X	X	X	X	X	X	X	X	X
Black willow	*Salix nigra*										X	X
Indigo bush	*Amorpha fruticosa*		X		X	X	X	X	X	X		
Peach-leaf willow	*Salix amygdaloides*	X	X	X	X	X	X		X	X	X	X
Sandbar willow	*Salix interior*	X	X	X	X	X	X		X	X	X	X
Rose	*Rosa sp.*		X				X		X			
Box elder	*Acer negundo*				X	X		X	X	X	X	X
Grape	*Vitis sp.*									X		X
Red osier dogwood	*Cornus stolonifera*		X			X						X
Rough-leafed dogwood	*Cornus drummondii*						X	X	X	X		X
Gray dogwood	*Cornus racemosa*										X	X
Elderberry	*Sambucus canadensis*								X			
Snowberry	*Symphoricarpos sp.*		X	X	X		X	X				

Table B-1 (Continued).

Common Name	Scientific Name	Fort Peck Delta	Fort Peck to Willison	Lake Sakakawea Delta	Garrison Dam to Lake Oahe	Lake Oahe Delta	Ft. Randll to Lewis and Clark	Lewis and Clark Delta	Gavins Point to Ponca	Ponca to Rulo	Rulo to St. Joseph	St. Joseph to St. Louis
Buttonbush	*Cephalanthus occidentalis*											X
Greasewood	*Sarcobatus vermiculatus*	X										
FORBS												
Horsetail	*Equisetum sp.*				X	X	X	X	X	X		
Scouring rush	*Equisetum hyemale*				X	X	X	X	X	X		X
Marijuana	*Cannabis sativa*						X		X	X		
Stinging nettle	*Urtica dioica*									X	X	X
Wooly vervain	*Verbena stricta*									X		
Smartweed	*Polygonum sp.*		X			X				X	X	X
Water smartweed	*Polygonum punctatum*											X
Mild waterpepper	*Polygonum hydropiperoides*					X						X
Dock	*Rumex sp.*			X	X	X				X	X	X
Slim-leaf goosefoot	*Chenopodium*					X						
Red sage	*Kochia sp.*	X										
Pigweed	*Amaranthus retroflexus*					X						X
Tumbleweed	*Amaranthus albus*					X						
Pokeweed	*Phytolacca americana*											X
False starwort	*Boltonia asteroides*											X
Meadow anemone	*Anemone canadensis*					X	X	X	X			
Clematis	*Clematis sp.*											X
Cursed crowsfoot	*Ranunculus scleratus*											X
Marsh yellow cress	*Rorippa palustris*											X
Strawberry	*Fragaria sp.*											X
Silvery cinquefoil	*Potentilla argentea*				X	X						
Lotus	*Lotus sp.*											X
Alfalfa	*Medicago sativa*		X			X			X			
Black medic	*Medicago lupulina*		X			X						
Sweet clover	*Melilotus sp.*	X	X		X	X	X		X	X		
Praire coneflower	*Petalostemon purpureus*					X	X					
Leafy spurge	*Euphorbia podperae*				X	X		X				
Poison ivy	*Rhus radicans*		X		X	X				X		
Poison oak	*Rhus diversiloba*									X		X
Sumac	*Rhus sp.*					X						X
Violet	*Viola sp.*						X					
Prickly pear	*Opuntia sp.*		X									
Toothcup	*Rotala ramosior*											X

Table B-1 (Continued).

Common Name	Scientific Name	Fort Peck Delta	Fort Peck to Willison	Lake Sakakawea Delta	Garrison Dam to Lake Oahe	Lake Oahe Delta	Ft. Randll to Lewis and Clark	Lewis and Clark Delta	Gavins Point to Ponca	Ponca to Rulo	Rulo to St. Joseph	St. Joseph to St. Louis
Purple ammannia	*Ammannia coccinea*					X						
Purple loosestrife	*Lythrum salicaria*							X				
Willow-weed	*Epilobium sp.*					X						
Evening primrose	*Oenothera strigosa*					X						X
Water-milfoil	*Myrophyllum*		X									
Indian hemp	*Apocynum cannabinum*				X	X		X	X	X		
Milkweed	*Asclepias sp.*				X	X	X	X	X	X		
Showy milkweed	*Asclepias sp.*								X			
Morning glory	*Convolvulus sp.*									X		X
Verbena	*Verbena sp.*		X			X	X		X			
Wolly vervain	*Verbena stricta*		X				X					
Blue verbena	*Verbena hastata*									X		
Water horehound	*Lycopus americanus*				X	X						
Bugleweed	*Lycopus asper*											X
Mint	*Mentha sp.*		X		X	X	X		X	X	X	X
Hedge nettle	*Stachys palustris*					X						
Skullcap	*Scutellaria sp.*											X
Water plantain	*Plantago sp.*					X						
Wild licorice	*Galium kamtschaticum*		X		X							
Ragweed	*Ambrosia sp.*				X	X	X	X				
Giant ragweed	*Ambrosia trifida*										X	X
Sagebrush/Wormwood	*Artemisia sp.*	X				X						
Fringed sage	*Artemesia frigida*		X									
Aster	*Aster sp.*								X	X		
Begger's tick	*Bidens frondosa*					X					X	X
Canada thistle	*Cirsium arvense*	X		X	X	X	X	X	X	X		
Floodman's thistle	*Cirsium flodmani*									X		
Horseweed	*Conyza canadensis*	X				X						
Late boneset	*Eupatorium serotinum*											X
Sunflower	*Helianthus sp.*	X				X				X		
Common sunflower	*Helianthus annuus*											X
Prickly lettuce	*Lactuca serriola*	X	X			X						
Wild lettuce	*Lactuca pulchella*		X							X		
Goldenrod	*Solidago sp.*		X		X	X			X	X	X	X
Sonchus	*Sonchus sp.*					X		X				
Milk thistle	*Sonchus arvensis*				X							
Dandilion	*Taraxacum officinale*											X

Table B-1 (Continued).

Common Name	Scientific Name	Fort Peck Delta	Fort Peck to Willison	Lake Sakakawea Delta	Garrison Dam to Lake Oahe	Lake Oahe Delta	Ft. Randll to Lewis and Clark	Lewis and Clark Delta	Gavins Point to Ponca	Ponca to Rulo	Rulo to St. Joseph	St. Joseph to St. Louis
Cocklebur	*Xanthium spinosum*	X				X	X					X
River pondweed	*Potamogeton sp.*						X	X				
Sago pondweed	*Potamogeton pectinatus*				X	X	X			X		X
Virginia creeper	*Parthenocissus quinquefolia*							X				
Showy partidgepea	*Cassia fasciculata*					X			X	X		X
Agelinus	*Agelinus sp.*					X						
Fog fruit	*Phyla lanceolata*											X
GRASSES, SEDGES, RUSHES												
Torrey's rush	*Juncus torreyi*				X	X			X			
Sedge	*Carex sp.*		X			X						
Bristle-bract sedge	*Carex leptalea*											X
Hop sedge	*Carex lupulina*											X
Slough sedge	*Carex obnupta*		X	X	X	X						
Fox sedge	*Carex vulpinoidea*							X				
Dark green sedge	*Carex sp.*							X				
Rusty flatsedge	*Cyperus ferruginescens*										X	X
Spike-rush	*Eleocharis sp.*		X		X	X		X				
Small spike-rush	*Eleocharis smallii*					X						X
Few-flowered spike-rush	*Eleocharis pauciflora*					X						
Needle spike-rush	*Eleocharis acicularis*					X						X
Red-stem sedge	*Eleocharis erythropoda*								X	X		
Green bulrush	*Scirpus atrovirens*										X	X
Three-square	*Scirpus americanus*	X	X		X	X	X	X	X	X		
Hardstem bulrush	*Scirpus acutus*		X		X	X	X	X		X		
Softstem bulrush	*Scirpus validus*		X	X	X	X		X	X	X		X
River bulrush	*Scirpus fluviatilis*	X			X	X		X	X	X		X
Quackgrass	*Agropyron repens*		X	X	X	X						
Bluestem wheatgrass	*Agropyron smithii*	X	X		X							
Bentgrass	*Agrostis sp.*						X					
Redtop	*Agrostis alba*		X	X		X						
Tickle grass	*Agrostis hyemalis*						X					
Big bluestem	*Andropogon gerardii*											X
Sloughgrass	*Beckmannia syzigachne*	X										X
Blue grama	*Bouteloua gracilis*	X			X							
Eastern grama	*Bouteloua sp.*									X		
Cheat grass	*Bromus tectorum*						X					

Table B-1 (Continued).

Common Name	Scientific Name	Fort Peck Delta	Fort Peck to Willison	Lake Sakakawea Delta	Garrison Dam to Lake Oahe	Lake Oahe Delta	Ft. Randll to Lewis and Clark	Lewis and Clark Delta	Gavins Point to Ponca	Ponca to Rulo	Rulo to St. Joseph	St. Joseph to St. Louis
Smooth brome	*Bromus inermis*		X	X	X	X		X	X	X		
Barnyard-grass	*Echinochloa sp.*					X				X	X	X
Canada wildrye	*Elymus canadensis*	X			X	X	X					
Lovegrass	*Eragrostis sp.*										X	X
Wild barley	*Hordeum sp.*	X	X		X							
Foxtail barley	*Hordeum jubatum*	X			X	X	X	X				
Rice cutgrass	*Leersia oryzoides*									X	X	X
Junegrass	*Koeleria cristata*					X	X					
Marsh mulhly	*Muhlenbergia racemosa*						X	X	X			
Witchgrass	*Panicum capillare*				X	X						X
Switch grass	*Panicum virgatum*					X	X	X	X			
Fall panic grass	*Panicum sp.*											X
Reed canarygrass	*Phalaris arundinacea*	X	X	X	X	X	X	X	X	X	X	X
Common reed	*Phragmites communis*	X	X	X	X	X	X	X		X		X
Bluegrass	*Poa sp.*				X					X		
Kentucky bluegrass	*Poa pratensis*									X		
Foxtail	*Setaria sp.*											X
Prairie cordgrass	*Spartina pectinata*	X	X			X	X	X				
Johnsongrass	*Sorghum halepense*											X
Sand dropseed	*Sporobolus cryptandrus*				X					X		
Needlegrass	*Stipa sp.*				X							
Creeping lovegrass	*Eragrostis hypnoides*										X	
Wheat	*Triticum aestivum*				X							
Narrow-leaved cattail	*Typha angustifolia*		X	X	X	X	X	X	X	X	X	X
Broad-leaved cattail	*Typha latifolia*	X	X			X	X					
Hybrid cattail	*Typha sp.*		X		X	X		X				
Duckweed	*Lemna sp.*		X					X		X		X
Arrow-leaf	*Sagittaria sp.*				X	X		X		X		
Clearweed	*Pilea pumila*										X	

1/ This is not a comprehensive species list of the Missouri River. Dominant species only were recorded at each study site and the time of year of sampling factored into the identification of plants at the study sites.

Table B-2. Species observed at study site in river reaches and reservoir deltas of the Missouri River.

Species	Fort Peck Delta[1]	Fort Peck to Williston[2]	Lake Sakakawea Delta[3]	Garrison Dam to Lake Oahe[4]	Lake Oahe Delta[5]	Ft. Randall to Lewis and Clark[6]	Lewis and Clark Delta[7]	Gavins Point to Ponca[8]	Ponca to Rulo[9]	Rulo to St. Joseph[10]	St. Joseph to St. Louis[11]
Amphibians											
Bullfrog *Rana catesbeiana*						X					
Green frog *Rana clamitans*						X	X				
Tree frog *Hyla* sp.									X		
Reptiles											
Box turtle *Chrysemys* sp.						X	X		X		X
Garter snake *Thamnophis* sp.	X	X			X				X		X
Western rattlesnake *Crotalus viridis*	X										
Birds											
Waterfowl											
Grebe *Podiceps* sp.											X
American white pelican *Pelecanus erythrorhynchos*	X		X		X	X	X			X	
Double-crested cormorant *Phalacrocorax auritus*			X		X	X				X	X
Canada goose *Branta canadensis*	X		X	X							

Table B-2 (Continued).

Species	Fort Peck Delta[1/]	Fort Peck to Williston[2/]	Lake Sakakawea Delta[3/]	Garrison Dam to Lake Oahe[4/]	Lake Oahe Delta[5/]	Ft. Randall to Lewis and Clark[6/]	Lewis and Clark Delta[7/]	Gavins Point to Ponca[8/]	Ponca to Rulo[9/]	Rulo to St. Joseph[10/]	St. Joseph to St. Louis[11/]
Mallard *Anas platyrhynchos*	X	X	X		X				X		X
Northern pintail *Anas acuta*					X						
Blue-winged teal *Anas discors*	X				X						
Green-winged teal *Anas crecca*	X									X	
Wood duck *Aix sponsa*	X	X									
Raptors											
Turkey vulture *Cathartes aura*							X		X		
Black vulture *Coragyps atratus*			X				X	X	X		
Cooper's hawk *Accipiter cooperii*									X		
Northern harrier *Circus cyaneus*	X				X					X	X
Rough-legged hawk *Buteo lagopus*											X
Red-tailed hawk *Buteo jamaicensis*	X			X	X			X	X	X	
Swainson's hawk *Buteo swainsoni*					X						
Golden eagle *Aquila chrysaetos*	X									X	

Table B-2 (Continued).

Species	Fort Peck Delta[1]	Fort Peck to Williston[2]	Lake Sakakawea Delta[3]	Garrison Dam to Lake Oahe[4]	Lake Oahe Delta[5]	Ft. Randall to Lewis and Clark[6]	Lewis and Clark Delta[7]	Gavins Point to Ponca[8]	Ponca to Rulo[9]	Rulo to St. Joseph[10]	St. Joseph to St. Louis[11]
Bald eagle *Haliaeetus leucocephalus*										X	
Osprey *Pandion haliaetus*				X							
Praire falcon *Falco mexicanus*			X								
American kestrel *Falco sparverius*	X				X		X	X	X		
Grouse and Pheasant											
Northern bobwhite *Colinus virginianus*								X	X		
Wild turkey *Meleagris gallopavo*											X
Sharp-tailed grouse *Tympanuchus phasianellus*	X				X						
Ring-necked pheasant *Phasianus colchicus*								X	X		
Herons and Cranes											
Great egret *Casmerodius albus*											X
Great blue heron *Ardea herodias*	X		X		X	X	X	X	X	X	X
American bittern *Botaurus lentiginosus*			X								
Virginia rail *Rallus limicola*	X		X								
Sora *Porzana carolina*					X			X	X		

Table B-2 (Continued).

Species	Fort Peck Delta[1]	Fort Peck to Williston[2]	Lake Sakakawea Delta[3]	Garrison Dam to Lake Oahe[4]	Lake Oahe Delta[5]	Ft. Randall to Lewis and Clark[6]	Lewis and Clark Delta[7]	Gavins Point to Ponca[8]	Ponca to Rulo[9]	Rulo to St. Joseph[10]	St. Joseph to St. Louis[11]
Shorebirds											
American avocet *Recurvirostra americana*	X										
Killdeer *Charadrius vociferus*	X			X				X	X	X	X
Spotted sandpiper *Actitis macularia*					X						
Lesser yellowlegs *Tringa flavipes*			X								X
Western sandpiper *Calidris mauri*	X				X			X			
Gull *Larus* sp.	X									X	
Least tern *Sterna antillarum*		X		X		X		X			
Forster's tern *Sterna forsteri*						X	X				
Doves											
Rock dove *Columba livia*								X			
Mourning dove *Zenaida macroura*	X	X		X	X	X	X	X	X	X	
Owls and Goatsuckers											
Long-eared owl *Asio otus*											X
Common nighthawk *Chordeiles minor*	X				X						

Table B-2 (Continued).

Species	Fort Peck Delta[1]	Fort Peck to Williston[2]	Lake Sakakawea Delta[3]	Garrison Dam to Lake Oahe[4]	Lake Oahe Delta[5]	Ft. Randall to Lewis and Clark[6]	Lewis and Clark Delta[7]	Gavins Point to Ponca[8]	Ponca to Rulo[9]	Rulo to St. Joseph[10]	St. Joseph to St. Louis[11]
Trogons											
Belted kingfisher *Ceryle alcyon*	X					X	X			X	
Woodpeckers											
Yellow-shafted flicker *Colaptes auratus*				X		X	X		X		
Red-headed woodpecker *Melanerpes erythrocephalus*					X	X	X	X	X		
Downy woodpecker *Picoides pubescens*						X					X
Passerines											
Eastern kingbird *Tyrannus verticalis*	X	X	X	X	X	X	X	X	X		
Western kingbird *Tyrannus vociferans*					X	X	X	X	X		
Horned lark *Eremophila alpestris*	X										
Barn swallow *Hirundo rustica*								X	X		
Cliff swallow *Hirundo pyrrhonota*								X	X		
Tree swallow *Tachycineta bicolor*							X		X		
Bank swallow *Riparia riparia*	X					X	X	X	X		
Blue jay *Cyanocitta cristata*						X			X		X

Table B-2 (Continued).

Species	Fort Peck Delta[1]	Fort Peck to Williston[2]	Lake Sakakawea Delta[3]	Garrison Dam to Lake Oahe[4]	Lake Oahe Delta[5]	Ft. Randall to Lewis and Clark[6]	Lewis and Clark Delta[7]	Gavins Point to Ponca[8]	Ponca to Rulo[9]	Rulo to St. Joseph[10]	St. Joseph to St. Louis[11]
Steller's jay *Cyanocitta stelleri*	X										
Black-billed magpie *Pica pica*	X		X								
American crow *Corvus brachyrhynchos*											X
Black-capped chickadee *Parus atricapillus*									X	X	
Bushtit *Psaltriparus minimus*											
House wren *Troglodyte aedon*					X				X		
American robin *Turdus migratorius*	X				X	X	X		X	X	
Swainson's thrush *Catharus ustulatus*								X			
Eastern bluebird *Sialia sialis*								X			
Mountain bluebird *Sialia currucoides*	X										
House sparrow *Passer domesticus*					X						
Western meadowlark *Sturnella neglecta*	X										
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	X										
Red-winged blackbird *Agelaius tricolor*	X	X	X	X	X	X	X	X	X	X	X

Table B-2 (Continued).

Species	Fort Peck Delta[1/]	Fort Peck to Williston[2/]	Lake Sakakawea Delta[3/]	Garrison Dam to Lake Oahe[4/]	Lake Oahe Delta[5/]	Ft. Randall to Lewis and Clark[6/]	Lewis and Clark Delta[7/]	Gavins Point to Ponca[8/]	Ponca to Rulo[9/]	Rulo to St. Joseph[10/]	St. Joseph to St. Louis[11/]
Brown-headed cowbird *Molothrus ater*	X	X	X					X	X		
European starling *Sturnus vulgaris*											X
Kinglet *Regulus* sp.											X
Vireo *Vireo* sp.					X						
Yellow warbler *Dendroica petechia*							X	X	X		X
Common yellowthroat *Geothlypis trichas*	X	X	X		X	X	X	X	X		
Common grackle *Quiscalus quiscula*					X	X	X	X	X		
Orchard oriole *Icterus spurius*								X	X		
Northern oriole *Icterus galbula*						X		X	X		
Northern cardinal *Cardinalis cardinalis*										X	X
Indigo bunting *Passerina cyanea*									X		
American goldfinch *Carduelis tristis*	X				X	X	X	X	X		
Dickcissel *Spiza americana*								X	X		
Northern mockingbird *Mimus polyglottos*								X			

Table B-2 (Continued).

Species	Fort Peck Delta[1]	Fort Peck to Williston[2]	Lake Sakakawea Delta[3]	Garrison Dam to Lake Oahe[4]	Lake Oahe Delta[5]	Ft. Randall to Lewis and Clark[6]	Lewis and Clark Delta[7]	Gavins Point to Ponca[8]	Ponca to Rulo[9]	Rulo to St. Joseph[10]	St. Joseph to St. Louis[11]
Catbird *Dumetella carolinensis*						X	X	X	X		
Marsh wren *Cistothorus palustris*					X						
Brown thrasher *Toxostoma rufum*					X		X	X	X		
Sage thrasher *Oreoscoptes montanus*	X										
Lark sparrow *Chondestes grammacus*								X	X	X	
White-crowned sparrow *Zonotrichia leucophrys*											X
Song sparrow *Melospiza melodia*					X	X		X			X
Mammals											
Racoon *Procyon lotor*	X		X		X		X	X	X	X	X
Beaver *Castor canadensis*		X	X		X	X	X	X	X	X	
Muskrat *Ondatra zibethica*											
Whitetail deer *Odocoileus virginianus*	X	X	X	X	X	X	X	X	X	X	X
Mule deer *Odocoileus hemionus*	X										
Mountain lion *Felis concolor*											X

Table B-2 (Continued).

Species	Fort Peck Delta[1/]	Fort Peck to Williston[2/]	Lake Sakakawea Delta[3/]	Garrison Dam to Lake Oahe[4/]	Lake Oahe Delta[5/]	Ft. Randall to Lewis and Clark[6/]	Lewis and Clark Delta[7/]	Gavins Point to Ponca[8/]	Ponca to Rulo[9/]	Rulo to St. Joseph[10/]	St. Joseph to St. Louis[11/]
Bobcat *Lynx rufus*											X
Rabbit *Sylvilagus* sp.								X	X		
Elk *Cervus canadensis*	X										
Mink *Mustela vison*	X		X					X			X
Coyote *Canis latrans*	X		X		X					X	
Red squirrel *Tamiasciurus hudsonicus*					X						
Cottontail *Sylvilagus* sp.					X						
Pronghorn *Antilocarpa americana*	X										

1/ C.K. Creek, Sevenmile Creek, and Musselshell River study sites -- late July.
2/ Wolf Point and Large Oxbow study sites -- late July.
3/ Lewis and Clark Wildlife Refuge, Tenton Bottoms, and Williston Lagoons study sites -- early August.
4/ Washburn, Stanton, and Wildwood Lake study sites -- early August.
5/ I-94, Sibley Park, Glencoe/Carlson, Kimball/Graner/McLean, and Moreau River study sites -- mid-August.
6/ Verdel/Choteau and Greenwood study sites -- mid-June.
7/ Bazille Creek and Niobrara study sites -- mid-June.
8/ Mulberry and Elk Point study sites -- mid-June.
9/ Tieville Lake, Louisville Bend, Goose Island, Winnebago Bend, California Bend, and Bullard Bend study sites -- late June.
10/ Otoe-Hamburg, Lake Contrary, and Worthwine Island study sites -- mid-October.
11/ Ft. Leavenworth, Jackass Bend, Blue Hole, Morrison Bend, Berger Bend, and Eagle Bluff study sites -- late October.

Sevenmile Creek

The Sevenmile Creek study site was an area of low-lands and islands near the confluence of the Sevenmile Creek with the Ft. Peck Lake delta. This site, however, was classified as riverine because it is above mean pool elevation. Located on the left bank of the delta at RM 1893.5, the Sevenmile Creek site was within the Charles M. Russell Wildlife Refuge, Montana.

Under normal, non-drought conditions, portions of the Sevenmile study site is probably a shallow bay or pond that floods in the spring and retains water well into the summer. However, under drought condition this area is characterized by muddy soils and invading weedy herbaceous species. Scrub-shrub wetlands, PSSA and PSSC, represented 53.6 and 514.3 acres (5.3 and 51.1 percent) of the study site, respectively (Table SC-1). These types were found throughout the bottomlands and islands and were dominated by sandbar willow and cottonwood shrubs. PEMA wetlands supported species such as western wheatgrass and cocklebur and occupied 115.5 acres (11.5 percent) of the study site. Large stands of forested wetlands (PFOA), representing 69.6 acres, were characterized by large willow and cottonwood trees.

Table SC-1. Wetland and riparian acreages mapped in the Sevenmile study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	115.5
Palustrine emergent seasonally flooded (PEMC)	22.0
Palustrine forested temporarily flooded (PFOA)	69.6
Palustrine scrub-shrub temporarily flooded (PSSA)	53.6
Palustrine scrub-shrub seasonally flooded (PSSC)	514.3
Riparian shrub (RS)	5.9
Riparian grassland (RG)	1.0
Riverine unconsolidated bottom permanently flooded (RUBH)	159.8
Riverine unconsolidated shore (RUS)	13.1
Palustrine unconsolidated bottom permanently flooded (PUBH)	8.6
Total	1,007.0

Wetland and riparian elevational distributions were measured along 8 transects on July 23, 1991. The transects were standardized around RM 183.5. The elevational range of the cover types in the Sevenmile Creek study site was only 10.5 feet, with substantial overlap of the wetland types (Table SC-2). The water surface elevation of the Missouri River was 2242.0.

EXHIBIT 690 022128

Table SC-2. Distribution of sampling points by elevation.

Missouri River - Seven Mile Creek Study Site
River Mile 1893.5 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	RUS	PUBH	PFOA	RUS5	RG	RS	RUBH
2231.5	0	0	0	0	0	0	0	0	0	0	1
2232.0	0	0	0	0	0	0	0	0	0	0	1
2232.5	0	0	0	0	0	0	0	0	0	0	1
2233.0	0	0	0	0	0	0	0	0	0	0	1
2233.5	0	0	0	0	0	0	0	0	0	0	1
2234.0	0	0	0	0	0	0	0	0	0	0	1
2234.5	0	0	0	0	0	0	0	0	0	0	1
2235.0	0	0	0	0	0	0	0	0	0	0	1
2235.5	0	0	0	0	0	0	0	0	0	0	1
2236.0	0	0	0	0	0	0	0	0	0	0	1
2236.5	0	0	0	0	0	0	0	0	0	0	1
2237.0	0	0	0	0	0	0	0	0	0	0	1
2237.5	0	0	0	0	0	0	0	0	0	0	1
2238.0	0	0	0	0	0	0	0	0	0	0	1
2238.5	0	0	0	0	0	0	0	0	0	0	1
2239.0	0	0	0	0	0	0	0	0	0	0	1
2239.5	0	0	0	0	0	0	0	0	0	0	1
2240.0	0	0	0	0	0	0	0	0	0	0	1
2240.5	0	0	0	0	0	0	0	0	0	0	1
2241.0	9	0	4	0	0	5	0	0	0	0	1
2241.5	50	0	14	0	92	1	0	0	0	0	1
2242.0	51	0	38	0	114	1	0	0	0	0	0
2242.5	35	112	19	21	0	0	0	0	0	0	0
2243.0	14	3	17	5	0	0	0	13	0	0	0
2243.5	2	16	21	12	0	0	0	0	0	0	0
2244.0	0	31	55	0	0	0	0	0	0	0	0
2244.5	0	14	151	15	0	0	1	0	0	0	0
2245.0	0	28	18	187	0	0	0	0	0	0	0
2245.5	0	27	4	213	0	0	0	0	0	0	0
2246.0	0	28	4	132	0	0	0	0	1	1	0
2246.5	0	262	3	34	0	0	0	564	0	0	0
2247.0	0	440	3	69	0	0	11	194	0	0	0
2247.5	0	399	4	0	0	0	0	0	8	8	0
2248.0	0	87	1	0	0	0	0	0	86	86	0
2248.5	0	54	0	0	0	0	0	0	46	46	0
2249.0	0	46	0	0	0	0	0	0	32	32	0
2249.5	0	19	0	0	0	0	0	0	32	32	0
2250.0	0	0	0	0	0	0	0	0	31	31	0
2250.5	0	0	0	0	0	0	0	0	7	7	0
2251.0	0	0	0	0	0	0	0	0	2	2	0
2251.5	0	0	0	0	0	0	0	0	2	2	0
TOTAL	161	1566	356	888	206	7	12	771	247	247	21

EXHIBIT 690 022129

A wide variety of wildlife species were observed at the Ft. Peck Delta study sites, Sevenmile Creek, C.K. Creek, and Musselshell River. Listed below is a composite species list for these three sites:

Birds

red-winged blackbird
night hawk
killdeer
bank swallow
cowbird
blackbird
avocet
green-winged teal
mallard
great blue heron
red-tailed hawk
golden eagle
wood duck
kestrel
eastern kingbird
American goldfinch
meadowlark
sage thrasher
kingfisher
Canada goose
sharp-tailed grouse
Stellar's jay
western sandpiper
yellowthroat

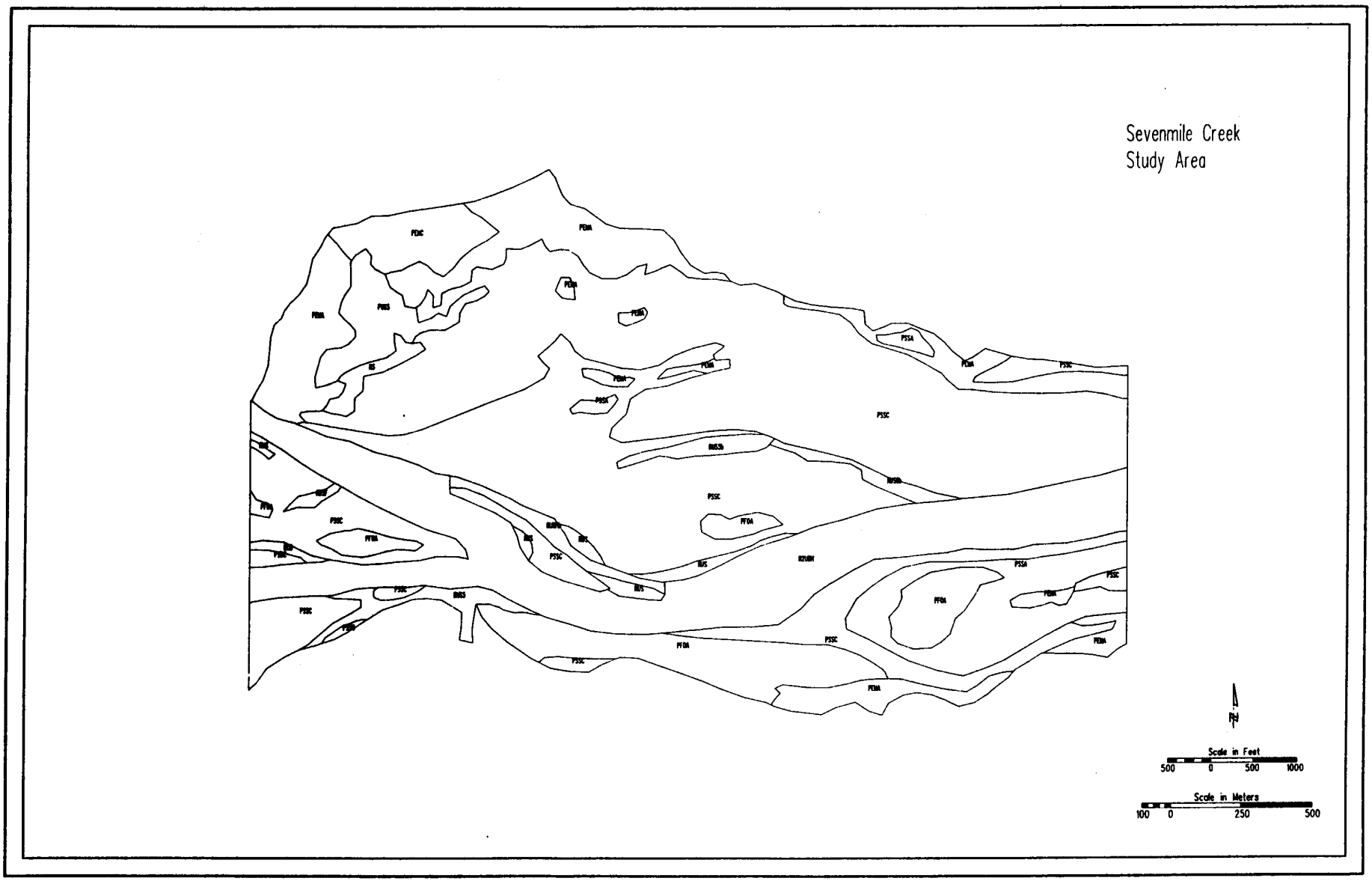
Mammals

elk
deer
raccoon (tracks)
coyote (tracks)
mink (tracks)
pronghorn

Reptiles

rattlesnake

EXHIBIT 690 022130


Sevenmile Creek
Study Area
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-4

C.K. Creek

The C.K. Creek study site was a complex of low-lands, islands, and shallow water channels near the confluence of C.K. Creek with the Ft. Peck Lake delta. This area was on the left bank of the Ft. Peck Reservoir delta, RM 1888.2, within the Charles M. Russell Wildlife Refuge, Montana.

Much of the study site was classified at PEMA wetlands (188.3 acres); however, these areas were several feet above the creek and the species composition was not completely indicative of a wetland type. Species in this cover type included Canadian thistle, western wheatgrass, and prairie cordgrass. The slope to the river was fairly gradual which, under normal conditions, may lead to temporary flooding. Also, stands of peachleaf willow at similar elevations reinforced the classification of PEMA in these areas. Scrub-shrub wetlands (PSSC), with sandbar willow as the dominant species, represented 422.9 acres (41.0 percent) of the study site (Table CK-1). A large mudflat appeared to be in the process of reflooding (PUBH). The mud in this area was 2.5 to 3 feet deep. Willows had begun to establish around the edges of the mudflat and in some areas it appeared that recent high water had deposited a new layer of sediment in the willow stands. Virtually no riparian vegetation was present at the site. The RG that was sampled occurred near the road and was dominated by Canadian thistle, bluestem wheatgrass, and cocklebur.

Table CK-1. Wetland and riparian acreages mapped in the C.K. Creek study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	188.3
Palustrine emergent seasonally flooded (PEMC)	36.6
Palustrine emergent semipermanently flooded (PEMF)	0.8
Palustrine forested temporarily flooded (PFOA)	25.7
Palustrine scrub-shrub temporarily flooded (PSSA)	56.4
Palustrine scrub-shrub seasonally flooded (PSSC)	422.9
Lacustrine unconsolidated bottom permanently flooded (LUBH)	175.4
Lacustrine unconsolidated shore (LUS)	10.6
Lacustrine unconsolidated shore vegetated (LUS5)	73.2
Palustrine unconsolidated bottom permanently flooded (PUBH)	42.2
Riparian grassland (RG)	4.0
Total	1,036.1

Wetland and riparian elevational distributions were measured along 3 transects standardized around RM 1888.2. Wetland cover type ranged from elevation 2239.0 to 2243.0 (Table CK-2). The water surface elevation of the Missouri River was 2239.0. The C.K. Creek study site was sampled on July 24, 1991.

Wildlife species identified at the C.K. Creek study site are listed in the site description of Sevenmile Creek.

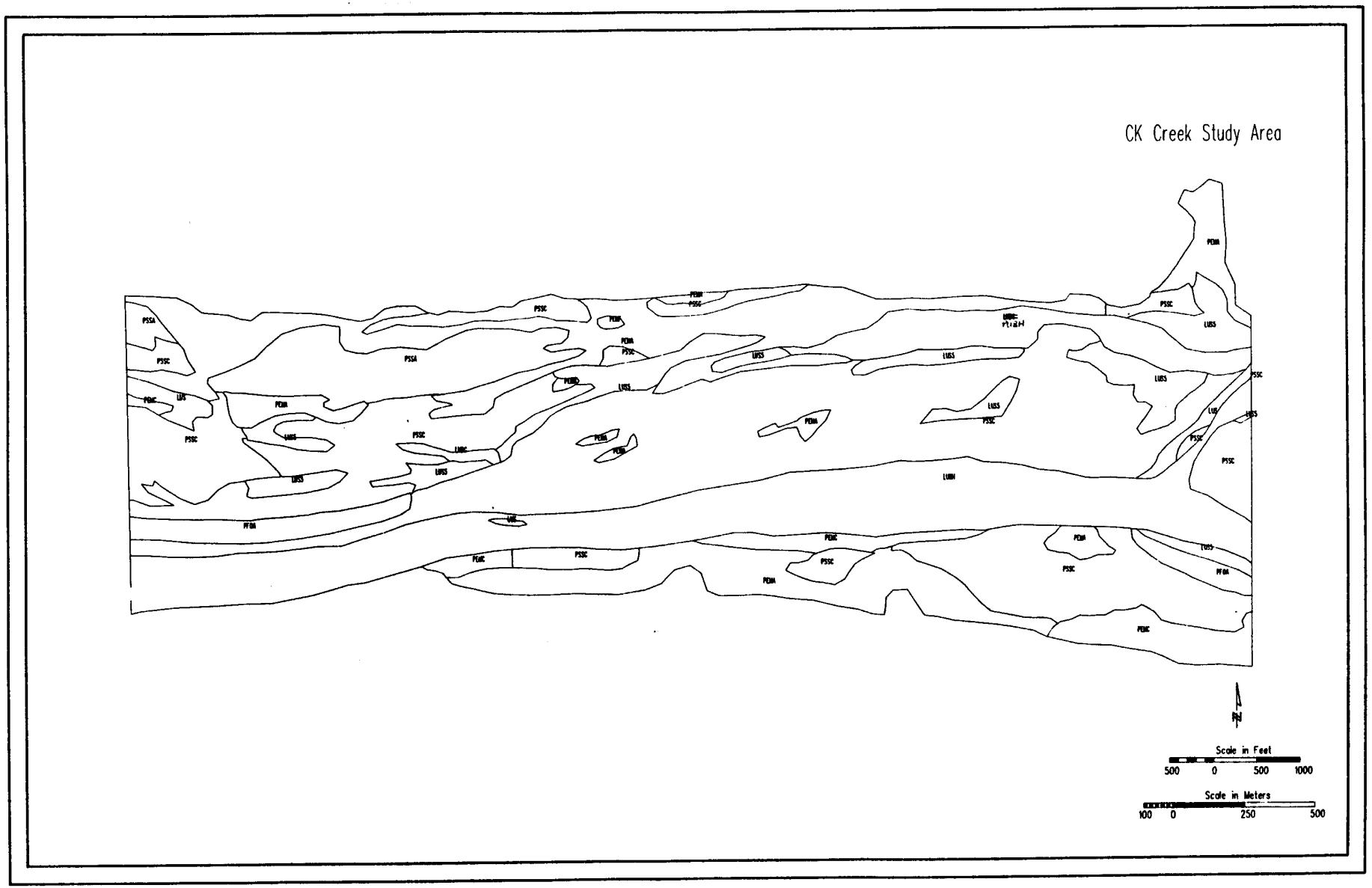
EXHIBIT 690 022132

Table CK-2. Distribution of sampling points by elevation.

Missouri River - C.K. Creek Study Site
River Miles 1888.2, 1890.2, and 1889.5 - All Transect Combined

Elevation	PEMC	PEMA	RG	PSSC	PSSA	LUS	LUS5	PFOA	PEMF	LUBH
2230.5	0	0	0	0	0	0	0	0	0	1
2231.0	0	0	0	0	0	0	0	0	0	1
2231.5	0	0	0	0	0	0	0	0	0	1
2232.0	0	0	0	0	0	0	0	0	0	1
2232.5	0	0	0	0	0	0	0	0	0	1
2233.0	0	0	0	0	0	0	0	0	0	1
2233.5	0	0	0	0	0	0	0	0	0	1
2234.0	0	0	0	0	0	0	0	0	0	1
2234.5	0	0	0	0	0	0	0	0	0	1
2235.0	0	0	0	0	0	0	0	0	0	1
2235.5	0	0	0	0	0	0	0	0	0	1
2236.0	0	0	0	0	0	0	0	0	0	1
2236.5	0	0	0	0	0	0	0	0	0	1
2237.0	0	0	0	0	0	0	0	0	0	1
2237.5	0	0	0	0	0	0	0	0	0	1
2238.0	0	0	0	0	0	0	0	0	0	1
2238.5	0	0	0	0	0	0	0	0	0	1
2239.0	0	0	0	0	0	227	78	0	227	1
2239.5	0	0	0	13	0	97	181	0	97	0
2240.0	64	0	0	331	0	214	36	0	214	0
2240.5	143	14	0	405	0	13	11	0	13	0
2241.0	2	156	0	152	6	1	0	0	1	0
2241.5	0	122	0	94	10	2	0	0	2	0
2242.0	0	177	2	65	18	0	0	0	0	0
2242.5	0	2	12	0	5	0	0	24	0	0
2243.0	0	47	8	0	0	0	0	0	0	0
2243.5	0	0	1	0	0	0	0	0	0	0
2244.0	0	0	1	0	0	0	0	0	0	0
2244.5	0	0	1	0	0	0	0	0	0	0
2245.0	0	0	1	0	0	0	0	0	0	0
2245.5	0	0	1	0	0	0	0	0	0	0
2246.0	0	0	1	0	0	0	0	0	0	0
2246.5	0	0	1	0	0	0	0	0	0	0
2247.0	0	0	1	0	0	0	0	0	0	0
2247.5	0	0	1	0	0	0	0	0	0	0
2248.0	0	0	1	0	0	0	0	0	0	0
2248.5	0	0	1	0	0	0	0	0	0	0
2249.0	0	0	1	0	0	0	0	0	0	0
2249.5	0	0	1	0	0	0	0	0	0	0
2250.0	0	0	1	0	0	0	0	0	0	0
TOTAL	209	518	36	1060	39	554	306	24	554	18

EXHIBIT 690 022133


CK Creek Study Area
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-7

Musselshell River

The Musselshell River study site was located at the confluence of the Musselshell River with the right bank of the Ft. Peck Lake delta at Missouri RM 1995.4. This site was included in the Ft. Peck delta sites and was within the Charles M. Russell Wildlife Refuge (Petoleum County), Montana. Most of the area within the study site would be flooded under normal, non-drought conditions; a boat ramp at the mouth of the Musselshell River was approximately 1 mile from the water level of the lake.

Most of the area within the Musselshell River study site was in a transitional state. The wetland cover types LUS5, PEMA, and PEMC were all characterized by similar pioneering species, including foxtail barley, prickley lettuce, and Canadian thistle. Most soils exhibited oxidized root zones and heavy mottles. The distinction between types was made by the varying depths of soil saturation and relative amounts of hydrophytic species. If drought conditions continue, it is expected that some LUS5 would transition to PEMA or PEMC wetlands. Scrub-shrub wetlands, PSSA and PSSC, contributed 825.3 and 155.2 acres, respectively (Table MS-1), and were dominated by sandbar willow. Under normal conditions, the many areas of PSSC are probably inundated.

Table MS-1. Wetland and riparian acreages mapped in the Musselshell study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	659.3
Palustrine emergent seasonally flooded (PEMC)	550.3
Palustrine emergent semipermanently flooded (PEMF)	210.2
Palustrine forested temporarily flooded (PFOA)	89.2
Palustrine scrub-shrub temporarily flooded (PSSA)	825.3
Palustrine scrub-shrub seasonally flooded (PSSC)	155.2
Riparian forest (RF)	11.5
Riparian shrub (RS)	226.8
Riparian grassland (RG)	28.7
Lacustrine unconsolidated bottom permanently flooded (LUBH)	460.9
Lacustrine unconsolidated shore (LUS)	234.0
Lacustrine unconsolidated shore vegetated (LUS5)	530.1
Riverine unconsolidated bottom permanently flooded (RUBH)	125.1
Total	4,106.4

Wetland and riparian elevational distributions were measured along 6 transects ranging in length from 122 to 5,281 feet and standardized to Crooked Creek RM 1.1. Due to the transitional nature on the study site, the elevational ranges of various wetland/riparian types often overlapped; LUS5 encompassed the entire range (Table MS-2). The water surface elevation of the Musselshell River and the Ft. Peck Lake on July 25, 1991 was 2220.0 feet at Crooked Creek RM 1.1.

The wildlife species observed at the Musselshell River study site are listed in the site description for Sevenmile Creek.

EXHIBIT 690 022135

Table MS-2. Distribution of sampling points by elevation.

Missouri River - Musselshell Study Site
River Mile Crooked Creek 1.1 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG 1/	RS 1/	RF 1/	PFOA 2/	PSSA 2/	PSSC	LUBH 3	LUS	LUS5	RUBH 3/
2207.5	0	0	0	0	0	0	0	0	0	1	0	0	0
2208.0	0	0	0	0	0	0	0	0	0	1	0	0	0
2208.5	0	0	0	0	0	0	0	0	0	1	0	0	0
2209.0	0	0	0	0	0	0	0	0	0	1	0	0	0
2209.5	0	0	0	0	0	0	0	0	0	1	0	0	0
2210.0	0	0	0	0	0	0	0	0	0	1	0	0	0
2210.5	0	0	0	0	0	0	0	0	0	1	0	0	0
2211.0	0	0	0	0	0	0	0	0	0	1	0	0	0
2211.5	0	0	0	0	0	0	0	0	0	1	0	0	0
2212.0	0	0	0	0	0	0	0	0	0	1	0	0	0
2212.5	0	0	0	0	0	0	0	0	0	1	0	0	0
2213.0	0	0	0	0	0	0	0	0	0	1	0	0	0
2213.5	0	0	0	0	0	0	0	0	0	1	0	0	1
2214.0	0	0	0	0	0	0	0	0	0	1	0	0	1
2214.5	0	0	0	0	0	0	0	0	0	1	0	0	1
2215.0	0	0	0	0	0	0	0	0	0	1	0	0	1
2215.5	0	0	0	0	0	0	0	0	0	1	0	0	1
2216.0	0	0	0	0	0	0	0	0	0	1	0	0	1
2216.5	0	0	0	0	0	0	0	0	0	1	0	0	1
2217.0	0	0	0	0	0	0	0	0	0	1	0	0	1
2217.5	0	0	0	0	0	0	0	0	0	1	0	96	1
2218.0	0	0	0	0	0	0	0	0	0	1	0	179	1
2218.5	0	0	0	0	0	0	0	0	0	1	0	204	1
2219.0	0	0	0	0	0	0	0	0	0	1	0	78	1
2219.5	247	0	0	0	0	0	0	0	0	1	0	87	1
2220.0	278	0	0	0	0	0	0	0	0	1	3	141	1
2220.5	37	372	0	0	0	0	0	0	0	0	2	54	0
2221.0	0	642	0	0	0	0	0	0	0	0	1	56	0
2221.5	0	506	85	0	0	0	0	0	0	0	0	169	0
2222.0	0	172	70	0	0	0	0	0	2	0	0	341	0
2222.5	0	224	53	0	0	0	0	0	6	0	0	228	0
2223.0	0	0	152	0	0	0	0	0	25	0	5	130	0
2223.5	0	0	452	0	0	0	0	0	23	0	3	467	0

EXHIBIT 690

022136

Table MS-2. Distribution of sampling points by elevation.

Missouri River - Musselshell Study Site
River Mile Crooked Creek 1.1 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG 1/	RS 1/	RF 1/	PFOA 2/	PSSA 2/	PSSC	LUBH 3	LUS	LUS5	RUBH 3/
2224.0	0	55	127	0	0	0	0	0	0	0	3	367	0
2224.5	0	183	0	0	0	0	0	0	0	0	2	110	0
2225.0	0	7	325	0	0	0	0	0	0	0	0	60	0
2225.5	0	0	189	0	0	0	0	0	0	0	2	30	0
2226.0	0	0	203	0	0	0	0	0	5	0	1	29	0
2226.5	0	0	162	0	0	0	0	0	12	0	0	93	0
2227.0	0	0	0	0	0	0	1	1	17	0	0	144	0
2227.5	0	0	0	0	0	0	1	1	63	0	0	163	0
2228.0	0	0	0	0	0	0	1	1	93	0	0	47	0
2228.5	0	0	0	0	0	0	1	1	89	0	0	19	0
2229.0	0	0	0	0	0	0	1	1	0	0	0	5	0
2229.5	0	0	0	0	0	0	1	1	0	0	0	5	0
2230.0	0	0	0	0	0	0	1	1	0	0	0	5	0
2230.5	0	0	0	1	1	1	0	0	0	0	0	2	0
2231.0	0	0	0	1	1	1	0	0	0	0	0	0	0
....Distribution 'HITS' of RG, RS, and RF are evenly distributed through the range not displayed.													
2249.5	0	0	0	1	1	1	0	0	0	0	0	0	0
2250.0	0	0	0	1	1	1	0	0	0	0	0	0	0
Total	562	2161	1818	39	39	39	7	7	335	26	22	3309	14

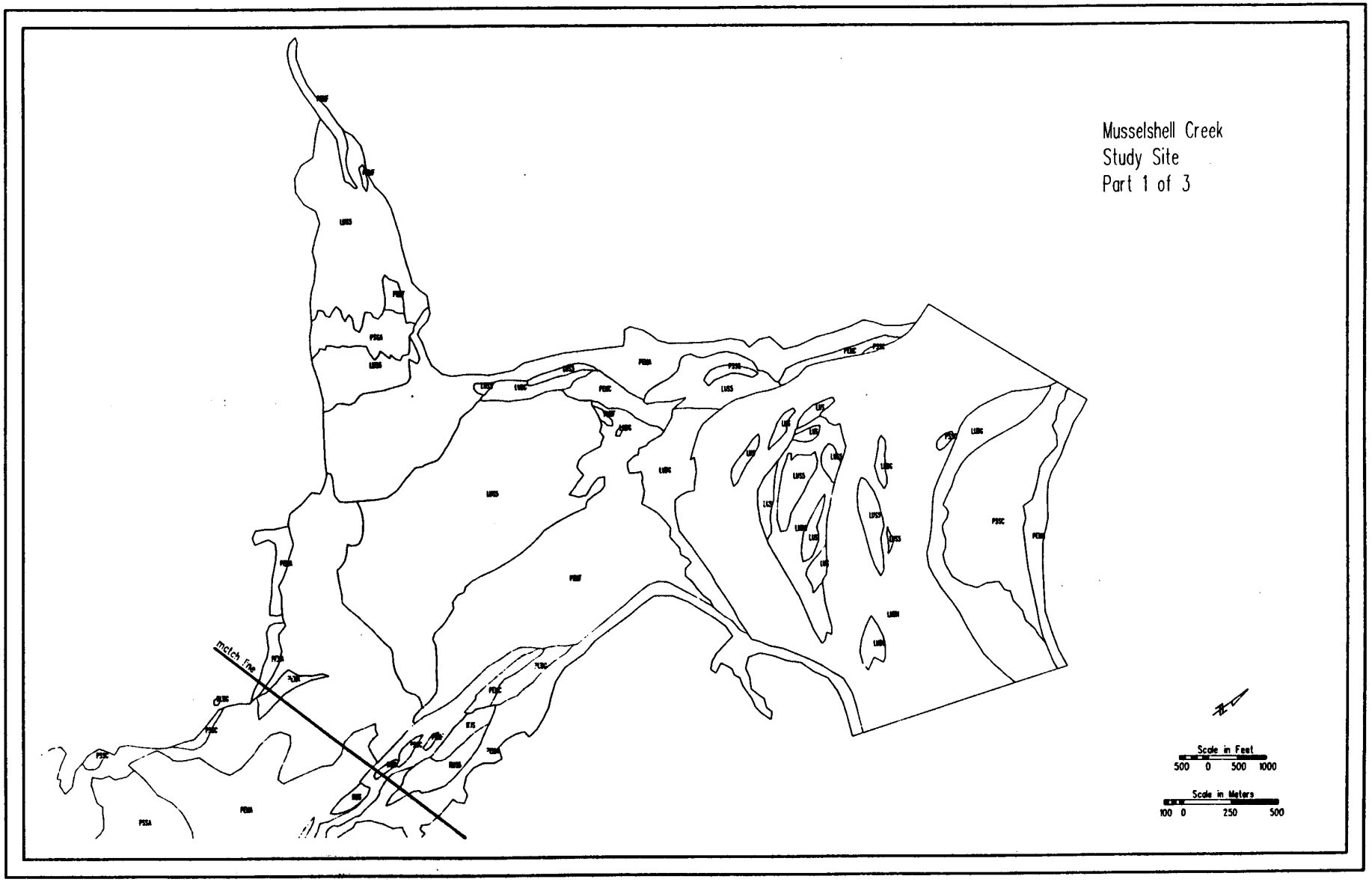
1/ Vegetation types that were not encountered during sampling, but appeared in the vegetation mapping of the site were assigned 'HIT' distributions of types with similar hydrological characteristics that were actually sampled, including:
RS = RG
RF = RG
All riparian vegetation types were evenly distributed between the lowest elevation sampled and highest elevation in the 100-year floodplain.

2/ Types PFOA and PSSA were not encountered during sampling and assigned an even distribution from the upper limit of PSSC to the lower limit of the riparian vegetation.

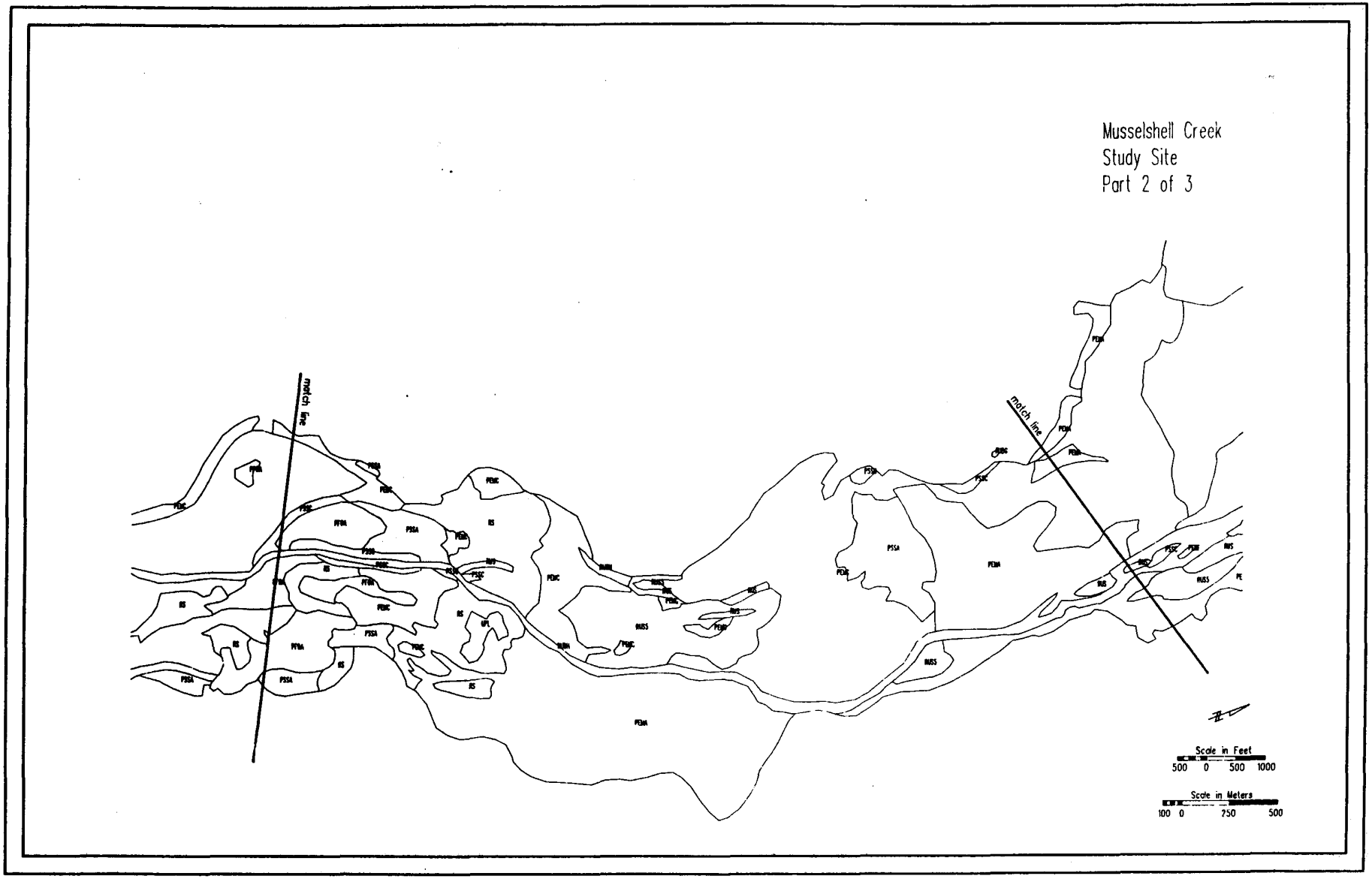
3/ LUBH and RUBH 'HITS' were evenly distributed from the water surface elevations of Ft. Peck Lake and the Musselshell River to their respective THALWEGS.

EXHIBIT 690

022137


Musselshell Creek
Study Site
Part 1 of 3
match line
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-11


Musselshell Creek
Study Site
Part 2 of 3
match line
match line
Scale in Feet
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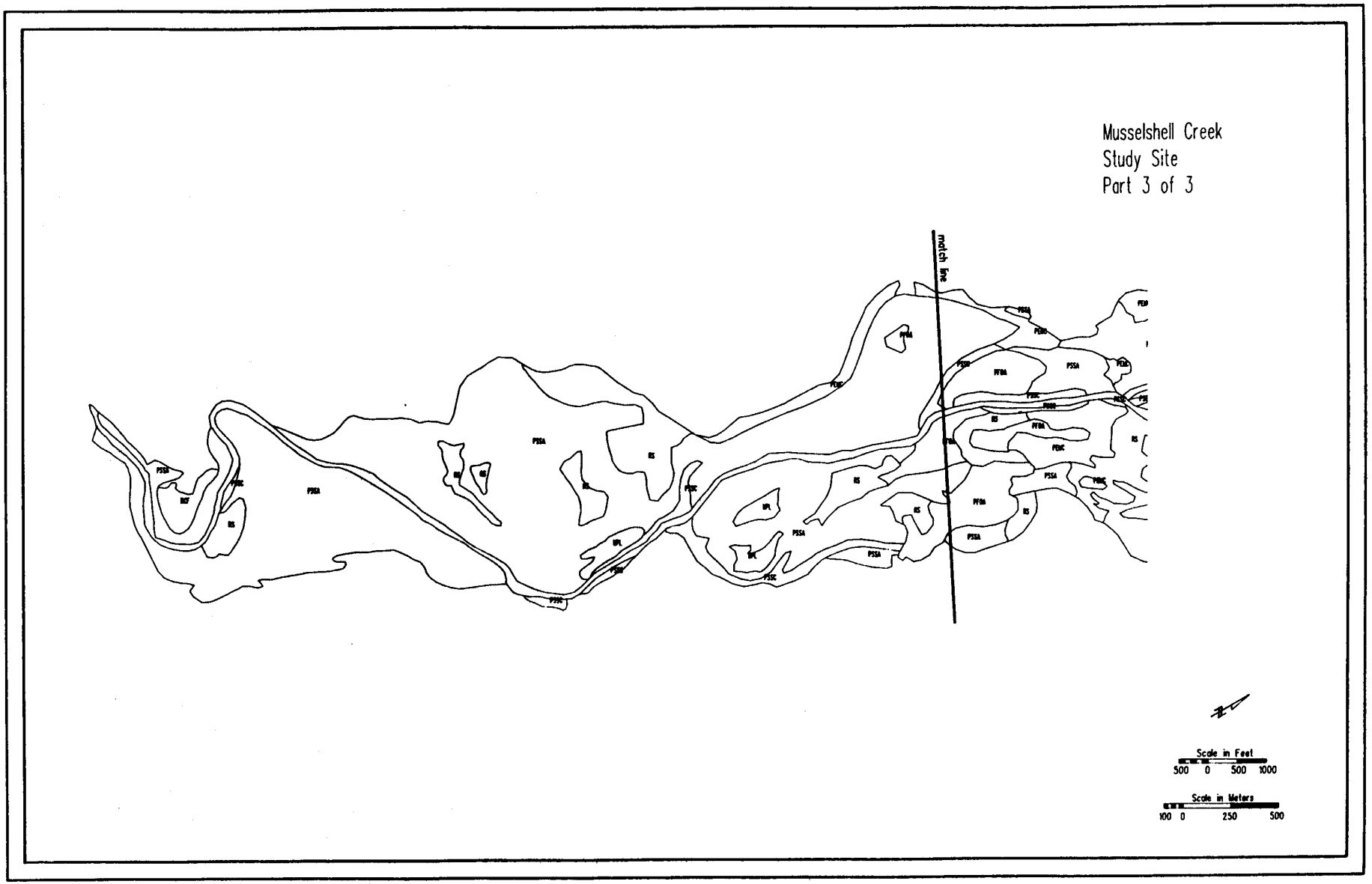
Scale in Meters
100 0 750 500

B-12


Musselshell Creek
Study Site
Part 3 of 3
match line
Scale in Feet
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Scale in Meters
100 0 250 500

B-13

Wolf Point

The Wolf Point study site was a complex of wetlands and riparian areas associated with islands and side channels at a large bend on the left bank of the Missouri River about 63 miles downstream from Ft. Peck Dam. This wetland appeared to be located in an old channel that became dissociated from the main channel. The Wolf Point study site was part of the Ft. Peck reach in the upper river.

Riparian vegetation comprised 545.2 acres (54.8 percent) (Table WP-1) of the cover types mapped in the study site. The soils, a mix of sand and clay layers, in riparian areas were dry to approximately 24 to 30 inches with weak to no mottles. At one time, this site was probably a wetland; however, as the river degraded it has become drier. Riparian shrub (RS) covered 212.0 acres and was the most dominate cover type in the study site (21.3 percent). The RS in the Wolf Point study site was unusual due to the presence of sandbar willow, a species more typical of scrub-shrub wetlands. However, these stands had the soils saturated greater that 1 foot below the surface and a prevalence of snowberry, rose, red osier dogwood, and sweet clover, all indicators of relatively dry conditions. Alfalfa and scouring rush dominated the riparian grasslands (RG) and represented 185.2 acres (18.6 percent) of the mapped area (Table WP-1). Riparian forest (RF), primarily cottonwood and peachleaf willow trees, represented 148.0 acres (14.9 percent). Palustrine emergent and scrub-shrub wetlands represented only 106.8 acres or 10.7 percent of the study site. PEMF wetlands were characterized by narrow-leaf cattails and soft-stem bulrush and occurred along the side channels and in low areas, often in water up to 5-feet deep. Common reed dominated PEMC wetlands were limited to a few location within the study site. PSSC wetlands were usually confined to narrow bands adjacent to dried out side channels.

Table WP-1. Wetland and riparian acreages mapped in the Wolf Point study site.

Wetland/Riparian Covertypes	Acres
Riparian grassland (RG)	185.2
Palustrine emergent temporarily flooded (PEMA)	13.0
Palustrine emergent seasonally flooded (PEMC)	29.2
Palustrine emergent semipermanently flooded (PEMF)	17.3
Palustrine scrub-shrub temporarily flooded (PSSA)	37.2
Palustrine scrub-shrub seasonally flooded (PSSC)	10.1
Riverine unconsolidated shore permanently flooded (RUBH)	268.7
Palustrine unconsolidated shore permanently flooded (PUBH)	6.6
Riparian forest (RF)	148.0
Riparian shrub (RS)	212.0
Riparian unconsolidated shore (RUS)	47.0
Riparian unconsolidated shore vegetated (RUS5)	20.8
Total	995.1

EXHIBIT 690 022141

The elevational distribution of the wetlands in the Wolf Point study site was sampled on July 26, 1991. Six transects were run, ranging in length from 125 to 1192 feet (38 to 363 m). The elevations ranged from a water surface of 1968.0 feet to riparian covertypes at 1975.5 (Table WP-2). The elevations of this study site were standardized around RM 1707.9, less than 1 mile upstream of Wolf Point, Montana.

A variety of birds were observed during the sampling period including red-winged blackbird, least tern, mallard, mourning dove, cowbird, and eastern kingbird. Deer were seen near the study site and signs of beaver activity were observed.

EXHIBIT 690 022142

Table WP-2. Distribution of sampling points by elevation.

Missouri River - Wolf Point Study Site
River Mile 1707.9 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RF	LUBH	RS	RUS	RUS5	RUBH
1948.0	0	0	0	0	0	0	0	0	0	0	0	1
1948.5	0	0	0	0	0	0	0	0	0	0	0	1
1949.0	0	0	0	0	0	0	0	0	0	0	0	1
1949.5	0	0	0	0	0	0	0	0	0	0	0	1
1950.0	0	0	0	0	0	0	0	0	0	0	0	1
1950.5	0	0	0	0	0	0	0	0	0	0	0	1
1951.0	0	0	0	0	0	0	0	0	0	0	0	1
1951.5	0	0	0	0	0	0	0	0	0	0	0	1
1952.0	0	0	0	0	0	0	0	0	0	0	0	1
1952.5	0	0	0	0	0	0	0	0	0	0	0	1
1953.0	0	0	0	0	0	0	0	0	0	0	0	1
1953.5	0	0	0	0	0	0	0	0	0	0	0	1
1954.0	0	0	0	0	0	0	0	0	0	0	0	1
1954.5	0	0	0	0	0	0	0	0	0	0	0	1
1955.0	0	0	0	0	0	0	0	0	0	0	0	1
1955.5	0	0	0	0	0	0	0	0	0	0	0	1
1956.0	0	0	0	0	0	0	0	0	0	0	0	1
1956.5	0	0	0	0	0	0	0	0	0	0	0	1
1957.0	0	0	0	0	0	0	0	0	0	0	0	1
1957.5	0	0	0	0	0	0	0	0	0	0	0	1
1958.0	0	0	0	0	0	0	0	0	0	0	0	1
1958.5	0	0	0	0	0	0	0	0	0	0	0	1
1959.0	0	0	0	0	0	0	0	0	0	0	0	1
1959.5	0	0	0	0	0	0	0	0	0	0	0	1
1960.0	0	0	0	0	0	0	0	0	0	0	0	1
1960.5	0	0	0	0	0	0	0	0	0	0	0	1
1961.0	0	0	0	0	0	0	0	0	0	0	0	1
1961.5	0	0	0	0	0	0	0	0	0	0	0	1
1962.0	0	0	0	0	0	0	0	0	0	0	0	1
1962.5	0	0	0	0	0	0	0	0	0	0	0	1
1963.0	0	0	0	0	0	0	0	0	0	0	0	1
1963.5	0	0	0	0	0	0	0	0	0	0	0	1
1964.0	0	0	0	0	0	0	0	0	0	0	0	1
1964.5	5	0	0	0	0	0	0	17	0	0	0	1
1965.0	5	0	0	0	0	0	0	19	0	0	0	1
1965.5	5	2	0	0	0	0	0	15	0	0	0	1
1966.0	5	9	1	0	0	0	0	3	0	0	0	1
1966.5	16	6	0	0	0	0	0	4	0	2	2	1
1967.0	49	37	0	0	2	0	0	0	0	2	2	1
1967.5	88	35	1	0	42	0	0	0	0	1	1	1
1968.0	27	29	9	0	11	46	0	0	1	0	0	0
1968.5	0	42	11	2	40	26	0	0	0	0	0	0
1969.0	0	24	44	8	99	144	0	0	1	0	0	0
1969.5	0	0	12	9	55	147	0	0	2	0	0	0
1970.0	1	0	38	28	21	64	0	0	3	0	0	0
1970.5	0	0	6	1	0	29	0	0	1	0	0	0
1971.0	0	0	0	1	0	1	0	0	2	0	0	0
1971.5	0	0	0	1	0	1	0	0	2	0	0	0

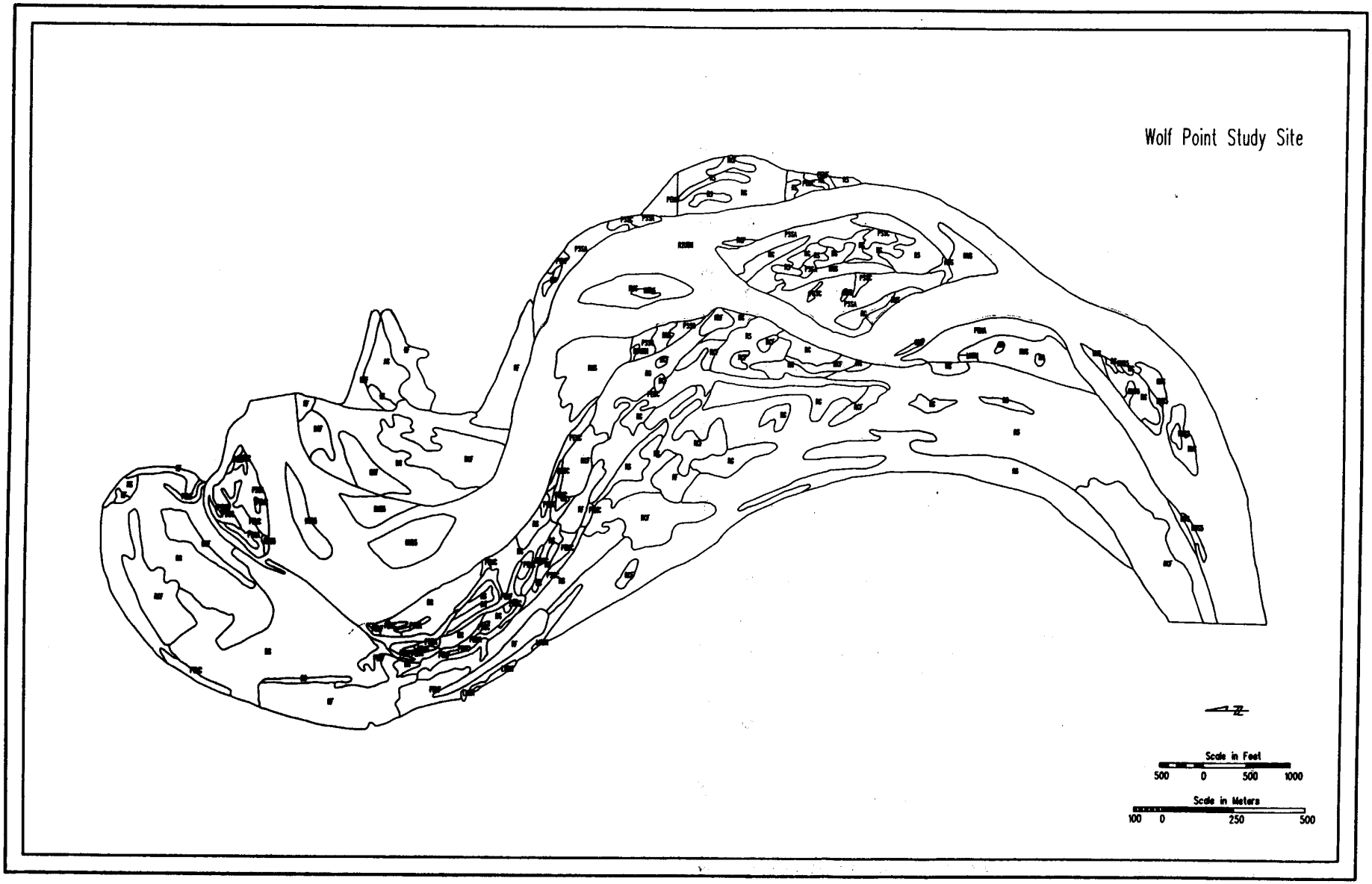
EXHIBIT 690 022143

Table WP-2 (Continued).

Missouri River - Wolf Point Study Site
River Mile 1707.9 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RF	LUBH	RS	RUS	RUS5	RUBH
1972.0	0	0	0	1	0	0	0	0	1	0	0	0
1972.5	0	0	0	1	0	2	0	0	1	0	0	0
1973.0	0	0	0	2	0	0	0	0	6	0	0	0
1973.5	0	0	0	1	0	2	43	0	148	0	0	0
1974.0	0	0	0	3	0	0	18	0	169	0	0	0
1974.5	0	0	0	1	0	1	1	0	31	0	0	0
1975.0	0	0	0	1	0	0	1	0	14	0	0	0
1975.5	0	0	0	1	0	0	1	0	0	0	0	0
1976.0	0	0	0	1	0	0	1	0	0	0	0	0
1976.5	0	0	0	1	0	0	1	0	0	0	0	0
1977.0	0	0	0	1	0	0	1	0	0	0	0	0
1977.5	0	0	0	1	0	0	1	0	0	0	0	0
1978.0	0	0	0	1	0	0	1	0	0	0	0	0
1978.5	0	0	0	1	0	0	1	0	0	0	0	0
1979.0	0	0	0	1	0	0	1	0	0	0	0	0
1979.5	0	0	0	1	0	0	1	0	0	0	0	0
1980.0	0	0	0	1	0	0	1	0	0	0	0	0
TOTAL	**201**	**184**	**122**	**70**	**270**	**463**	**73**	**58**	**382**	**5**	**5**	**40**

EXHIBIT 690 022144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Scale in Feet
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Scale in Meters
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Skinner's Island

The Skinner's Island study site was a large oxbow located on the left bank of the Missouri River, just downstream from the confluence of the Poplar River, about 100 miles from Ft. Peck dam. The oxbow is, at the most, 1 mile from the river. According to local residents, water is pumped into the oxbow during drought conditions. Under normal conditions, winter ice jams cause water to back up into the oxbow. The Skinner's Island study site is part of the Ft. Peck reach in the upper river.

The center of the oxbow consisted primarily of riparian cover types; riparian forests (RF) represented 293.1 acres (22.9 percent) and riparian grassland (RG) represented 561.9 acres (44.0 percent) (Table SI-1). A thin band of PSSC wetlands, dominated by peachleaf willow, separated the riparian vegetation from the wetlands. These PSSC wetlands accounted for 141.7 acres (11.1 percent) of the study site. PEMF wetlands represented the largest emergent wetland cover type, encompassing 117.4 acres. The cattail dominated PEMF wetlands surrounded the oxbow, often standing in up to 3 feet of water. The permanently flooded portion of the oxbow (LUBH) occupied a surface area of 44.9 acres (3.5 percent). Water depths in the oxbow were greater than 4 feet in some areas.

Table SI-1. Wetland and riparian acreages mapped in the Skinner's Island study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	46.2
Palustrine emergent seasonally flooded (PEMC)	42.8
Palustrine emergent semipermanently flooded (PEMF)	117.4
Palustrine forested temporarily flooded (PFOA)	1.0
Palustrine forested seasonally flooded (PFOC)	4.8
Palustrine scrub-shrub seasonally flooded (PSSC)	20.1
Riparian forest (RF)	293.1
Riparian shrub (RS)	141.7
Riparian grassland (RG)	561.9
Lacustrine unconsolidated bottom permanently flooded (LUBH)	44.9
Lacustrine unconsolidated shore (LUS)	2.3
Lacustrine unconsolidated shore vegetated (LUS5)	1.5
Total	1,277.7

Wetland and riparian elevational distributions were measured along 4 transects on July 27, 1991 and were standardized around RM 1670.0. Wetland cover types ranged in elevation from 1928.5 to 1935.5 while riparian cover types occurred from 1935.0 to 1942.5 (Table SI-2). The water surface elevation of Skinner's Island oxbow was 1932.5. The water surface elevation of the Missouri River was not recorded at this site.

EXHIBIT 690 022146

Table SI-2. Distribution of sampling points by elevation.

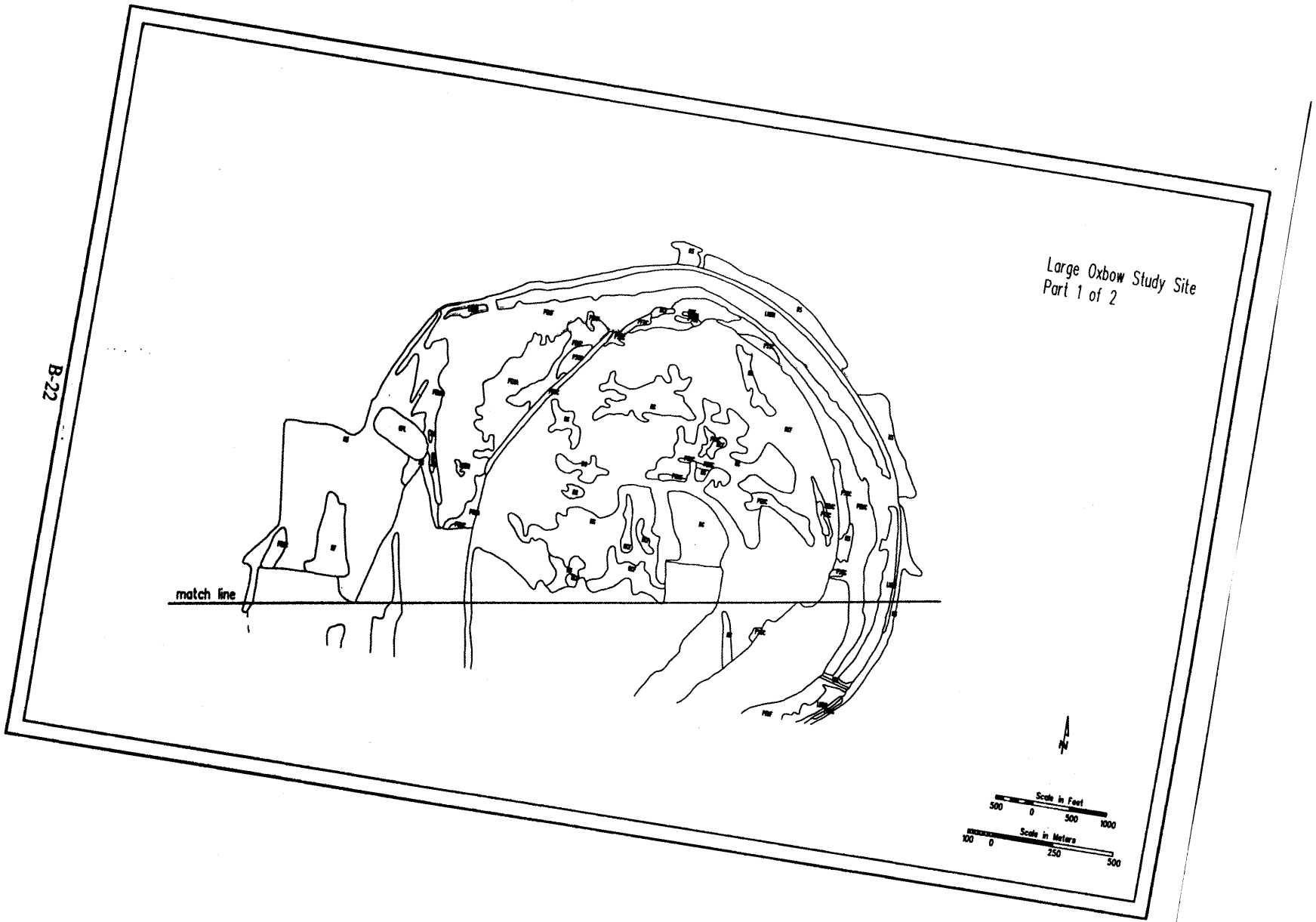
Missouri River - Large Oxbow Study Site
River Mile 1670.0 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	LUBH	PFOA	RS	PFOC	RF	RUS
1928.5	0	0	0	0	0	48	0	0	0	0	0
1929.0	7	0	0	0	0	83	0	0	0	0	0
1929.5	74	0	0	0	0	65	0	0	0	0	0
1930.0	81	0	0	0	0	0	0	0	0	0	0
1930.5	83	0	0	0	0	0	0	0	0	0	0
1931.0	107	0	0	0	0	0	0	0	0	0	0
1931.5	154	0	0	0	0	0	0	0	0	0	0
1932.0	421	41	0	0	0	0	0	0	0	0	41
1932.5	110	99	0	0	39	0	0	0	39	0	99
1933.0	3	95	7	0	47	0	0	0	47	0	95
1933.5	0	12	54	0	77	0	8	0	77	0	12
1934.0	0	7	187	0	5	0	14	2	5	2	7
1934.5	0	6	0	12	0	0	3	1	0	1	6
1935.0	0	5	0	15	0	0	0	1	0	1	5
1935.5	0	3	0	16	0	0	0	1	0	1	3
1936.0	0	0	0	16	0	0	0	0	0	0	0
1936.5	0	0	0	5	0	0	0	1	0	1	0
1937.0	0	0	0	1	0	0	0	1	0	1	0
1937.5	0	0	0	1	0	0	0	1	0	1	0
1938.0	0	0	0	1	0	0	0	0	0	0	0
1938.5	0	0	0	0	0	0	0	1	0	1	0
1939.0	0	0	0	1	0	0	0	1	0	1	0
1939.5	0	0	0	1	0	0	0	1	0	1	0
1940.0	0	0	0	1	0	0	0	0	0	0	0
1940.5	0	0	0	1	0	0	0	1	0	1	0
1941.0	0	0	0	1	0	0	0	1	0	1	0
1941.5	0	0	0	1	0	0	0	1	0	1	0
1942.0	0	0	0	1	0	0	0	0	0	0	0
1942.5	0	0	0	1	0	0	0	0	0	0	0
TOTAL	**1040**	**268**	**248**	**75**	**168**	**196**	**25**	**14**	**168**	**14**	**268**

EXHIBIT 690 022147

Wildlife species observed at the Skinner's Island study site included: mallard, wood duck, Virginia rail, yellowthroat, red-winged blackbird, mourning dove, cowbird, blackbird, and eastern kingbird.

EXHIBIT 690 022148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Part 1 of 2
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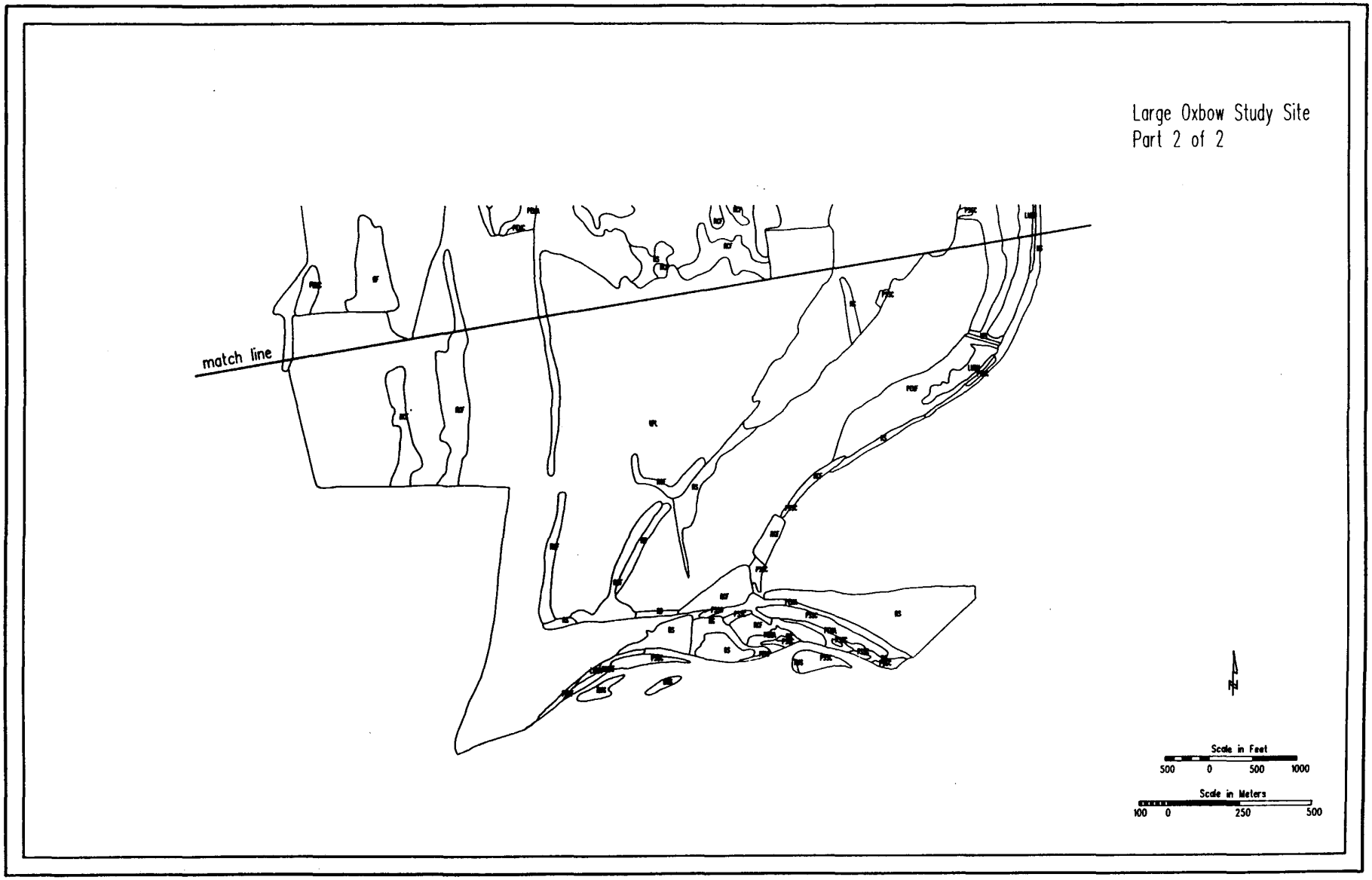
Large Oxbow Study Site
Part 2 of 2
match line
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Scale in Feet
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Scale in Meters
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Snowden

The Snowden study site was a complex of islands, chutes, and backwaters associated with a significant bend in the Missouri River at RM 1592.5. This area was located approximately 2 miles upstream of the Burlington Northern railroad crossing in Montana near the North Dakota border. The Snowden study site was part of the Ft. Peck reach in the upper river.

Riparian vegetation dominated the study site with riparian grasslands (RG), contributing 347.5 acres (20.4 percent) and riparian forests (RF) contributing 277.2 acres (16.3 percent) (Table SN-1). Riparian grasslands occurred throughout the study site and were characterized by wild licorice and leafy spurge. The RF stands were primarily old willow trees that were in the process of dying out. PEMC was the largest wetland cover type, occupying 243.4 acres (14.3 percent). These wetlands were located in old chutes and channels and common species included common reed, three-square, and cordgrass. Scrub-shrub wetlands occurred throughout the study site in small patches, usually bordering the emergent wetlands. PSSA and PSSC wetlands represented a total of 202.8 acres and were dominated by peachleaf and sandbar willow with an understory of three-square and common reed.

Table SN-1. Wetland and riparian acreages mapped in the Snowden study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	45.5
Palustrine emergent seasonally flooded (PEMC)	243.4
Palustrine emergent semipermanently flooded (PEMF)	29.8
Palustrine scrub-shrub temporarily flooded (PSSA)	168.0
Palustrine scrub-shrub seasonally flooded (PSSC)	34.8
Riparian grassland (RG)	347.5
Riparian shrub (RS)	43.7
Riparian forest (RF)	277.2
Riverine unconsolidated bottom permanently flooded (RUBH)	465.5
Riverine unconsolidated shore (RUS)	33.6
Riverine unconsolidated shore vegetated (RUS5)	2.6
Palustrine unconsolidated bottom permanently flooded (PUBH)	9.5
Total	1,701.1

Elevational data was recorded from wetland and riparian cover types on both sides of the river at the Snowden study site. A total of 5 transects were used to collect the elevational data and they were standardized around RM 1592.5. Elevations ranged from PUBH at 1867.5 to riparian vegetation at beginning at elevation 1872.0. The water surface elevation of the Missouri River was 1868.0 at approximately RM 1592.5. Sampling of the Snowden study site was done on July 27 and 28, 1991.

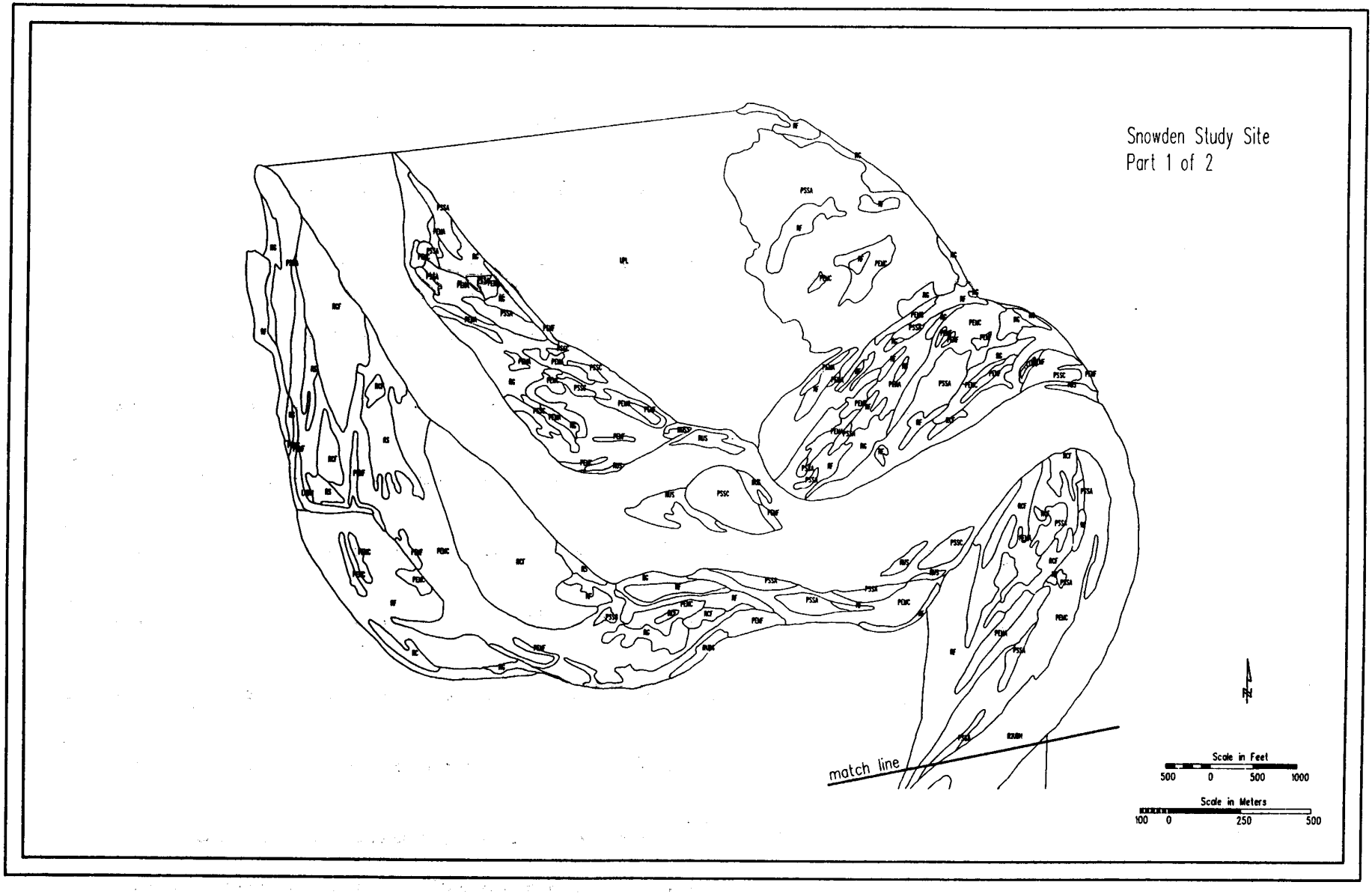
EXHIBIT 690 022151

Table SN-2. Distribution of sampling points by elevation.

Missouri River - Snowden Study Site
River Mile 1592.5 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RUS	PUBH	RF	RS	RUS5	RUBH
1860.0	0	0	0	0	0	0	0	0	0	0	0	1
1860.5	0	0	0	0	0	0	0	0	0	0	0	1
1861.0	0	0	0	0	0	0	0	0	0	0	0	1
1861.5	0	0	0	0	0	0	0	0	0	0	0	1
1862.0	0	0	0	0	0	0	0	0	0	0	0	1
1862.5	0	0	0	0	0	0	0	0	0	0	0	1
1863.0	0	0	0	0	0	0	0	0	0	0	0	1
1863.5	0	0	0	0	0	0	0	0	0	0	0	1
1864.0	0	0	0	0	0	0	0	0	0	0	0	1
1864.5	0	0	0	0	0	0	0	0	0	0	0	1
1865.0	0	0	0	0	0	0	0	0	0	0	0	1
1865.5	0	0	0	0	0	0	0	0	0	0	0	1
1866.0	0	0	0	0	0	0	0	0	0	0	0	1
1866.5	0	0	0	0	0	0	0	0	0	0	0	1
1867.0	0	0	0	0	0	0	0	0	0	0	0	1
1867.5	0	0	0	0	0	0	0	9	0	0	0	1
1868.0	2	0	0	0	0	0	0	20	0	0	0	1
1868.5	45	0	0	0	0	0	0	23	0	0	0	0
1869.0	36	0	0	0	0	0	0	17	0	0	0	0
1869.5	65	2	0	0	0	0	6	16	0	0	6	0
1870.0	160	21	0	0	3	0	8	1	0	0	8	0
1870.5	116	111	0	0	6	0	3	0	0	0	3	0
1871.0	2	114	0	0	92	0	4	0	0	0	4	0
1871.5	0	134	24	6	100	3	11	0	0	6	11	0
1872.0	0	47	31	11	89	155	2	0	9	11	2	0
1872.5	0	0	13	34	38	94	2	0	10	34	2	0
1873.0	0	0	0	73	4	163	1	0	13	73	1	0
1873.5	0	0	0	67	0	14	0	0	8	67	0	0
1874.0	0	0	0	25	0	0	0	0	1	25	0	0
1874.5	0	0	0	1	0	0	0	0	1	1	0	0
1875.0	0	0	0	1	0	0	0	0	1	1	0	0
1875.5	0	0	0	1	0	0	0	0	1	1	0	0
1876.0	0	0	0	1	0	0	0	0	1	1	0	0
1876.5	0	0	0	1	0	0	0	0	1	1	0	0
1877.0	0	0	0	1	0	0	0	0	1	1	0	0
1877.5	0	0	0	1	0	0	0	0	1	1	0	0
1878.0	0	0	0	1	0	0	0	0	1	1	0	0
1878.5	0	0	0	1	0	0	0	0	1	1	0	0
1879.0	0	0	0	1	0	0	0	0	1	1	0	0
1879.5	0	0	0	1	0	0	0	0	1	1	0	0
1880.0	0	0	0	1	0	0	0	0	1	1	0	0
1880.5	0	0	0	1	0	0	0	0	1	1	0	0
1881.0	0	0	0	1	0	0	0	0	1	1	0	0
1881.5	0	0	0	1	0	0	0	0	1	1	0	0
1882.0	0	0	0	1	0	0	0	0	1	1	0	0
1882.5	0	0	0	1	0	0	0	0	1	1	0	0
1883.0	0	0	0	1	0	0	0	0	1	1	0	0
1883.5	0	0	0	1	0	0	0	0	1	1	0	0
TOTAL	426	429	68	235	332	429	37	86	60	235	37	17

EXHIBIT 690 022152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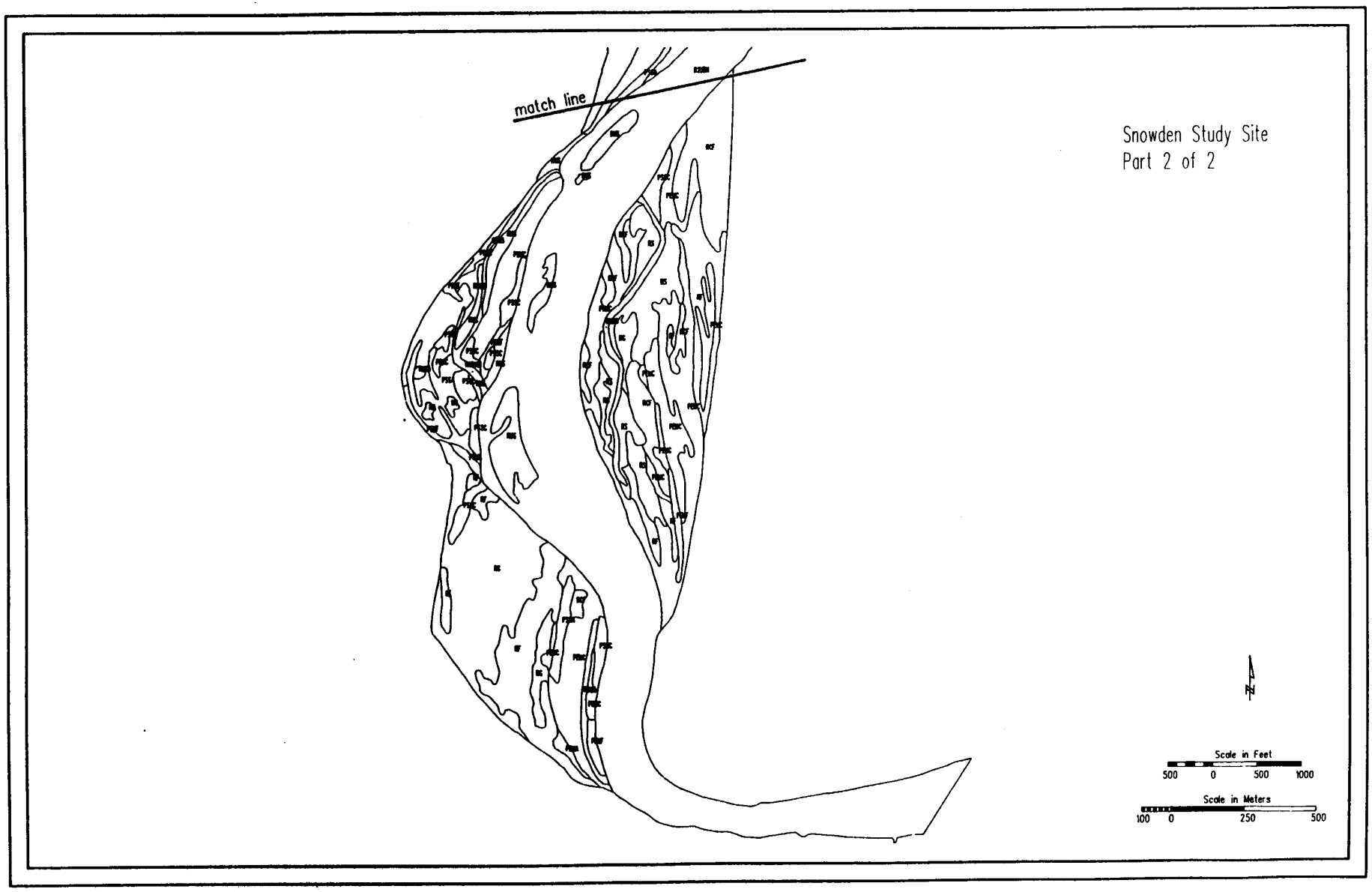
B-26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Part 2 of 2
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Scale in Feet
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Scale in Meters
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Trenton Bottoms

The Trenton Bottoms study site was located on the left bank of the Missouri River, 3 miles upstream of Trenton, North Dakota in the Lake Sakakawea delta. The upper portion of this study site, however, was typed as riverine because it is above mean pool elevation. This wetland complex was an artificial cut off, as opposed to a natural oxbow. A surface connection between the bottoms and the river does exist; however, the surface elevation of the river is usually below that of the connection.

The lands adjacent to the oxbow were primarily agricultural. As with the other study sites in the Lake Sakakawea delta, the Trenton Bottoms study site appeared to be tending toward a wetter area. Local residents reported that flooding in the area often puts water levels well above the shrubs and each flood deposits about 1 foot of silt and sediment. Additionally, residents noted paddlefish in the bottoms when it was connected to the river and large carps were observed stranded during sampling.

An enormous expanse of forested wetland (PFOA), occupying 811.7 acres (28.6 percent), was located between the oxbow and the river (Table TB-2). This stand supported mature cottonwood and green ash trees that, at one time, would have been considered a riparian forest. However, the development of a reed canarygrass herbaceous understory and soils that were moist and mottled, indicated that the forest was indeed wetland. Scrub-shrub wetlands (PSSC) represented 488.9 acres (17.2 percent) of the study site. The sandbar willow in this cover type was often in as much as 6 inches of water. The permanently flooded oxbow (LUBH) occupied a surface area of 177.9 acres. The unconsolidated shoreline (LUS) surrounding the oxbow represented 292.2 acres (10.3 percent). The amount of standing water in the LUS wetlands varied from a saturated surface to 6 inches of water. Areas sparsely vegetated with smartweed and spike rush in 6 to 8 inches of standing water were classified at PEMF wetlands and occupied 125.3 acres (4.4 percent) of the study site.

Table TB-1. Wetland and riparian acreages mapped in the Trenton Bottoms study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent seasonally flooded (PEMC)	95.0
Palustrine emergent semipermanently flooded (PEMF)	125.3
Palustrine forested temporarily flooded (PFOA)	811.7
Palustrine forested seasonally flooded (PFOC)	6.6
Palustrine scrub-shrub temporarily flooded (PSSA)	12.3
Palustrine scrub-shrub seasonally flooded (PSSC)	488.9
Riparian grassland (RG)	523.2
Riparian shrub (RS)	0.6
Riparian forest (RF)	143.6
Lacustrine unconsolidated bottom permanently flooded (LUBH)	177.9
Lacustrine unconsolidated shore (LUS)	292.2
Riverine unconsolidated bottom permanently flooded (RUBH)	157.2
Total	2,834.5

EXHIBIT 690 022155

Wetland and riparian elevational distributions were measured along 3 transects and standardized around RM 1568.8. The transects were relatively long, from 1700 to 2700 feet. The flat topography of the oxbow resulted in overlap between most wetland cover types; species composition was the determining factor for classification. The water surface elevation of the oxbow at Trenton Bottoms was 1853.0. Based on the rating curve, the Missouri River water surface elevation on the day of sampling was 1852 with flows averaging 16,000 cfs.

Cormorants, geese, pelicans, and various waterfowl were observed at the site during the sampling period.

EXHIBIT 690 022156

Table TB-2. Distribution of sampling points by elevation.

Missouri River - Trenton Bottoms Study Site
River Miles 1568.8 All Transects Combined

Elevation	PEMF	PEMC	RG	PSSC	LUS	LUBH	PFOA	PFOC	RF	PSSA	RUBH	RS
1838.0	0	0	0	0	0	0	0	0	0	0	1	0
1838.5	0	0	0	0	0	0	0	0	0	0	1	0
1839.0	0	0	0	0	0	0	0	0	0	0	1	0
1839.5	0	0	0	0	0	0	0	0	0	0	1	0
1840.0	0	0	0	0	0	0	0	0	0	0	1	0
1840.5	0	0	0	0	0	0	0	0	0	0	1	0
1841.0	0	0	0	0	0	0	0	0	0	0	1	0
1841.5	0	0	0	0	0	0	0	0	0	0	1	0
1842.0	0	0	0	0	0	0	0	0	0	0	1	0
1842.5	0	0	0	0	0	0	0	0	0	0	1	0
1843.0	0	0	0	0	0	0	0	0	0	0	1	0
1843.5	0	0	0	0	0	0	0	0	0	0	1	0
1844.0	0	0	0	0	0	0	0	0	0	0	1	0
1844.5	0	0	0	0	0	0	0	0	0	0	1	0
1845.0	0	0	0	0	0	0	0	0	0	0	1	0
1845.5	0	0	0	0	0	0	0	0	0	0	1	0
1846.0	0	0	0	0	0	0	0	0	0	0	1	0
1846.5	0	0	0	0	0	0	0	0	0	0	1	0
1847.0	0	0	0	0	0	0	0	0	0	0	1	0
1847.5	0	0	0	0	0	0	0	0	0	0	1	0
1848.0	0	0	0	0	0	0	0	0	0	0	1	0
1848.5	0	0	0	0	0	0	0	0	0	0	1	0
1849.0	0	0	0	0	0	0	0	0	0	0	1	0
1849.5	0	0	0	0	0	0	0	0	0	0	1	0
1850.0	0	0	0	0	0	0	0	0	0	0	1	0
1850.5	0	0	0	0	0	0	0	0	0	0	1	0
1851.0	0	0	0	0	0	0	0	0	0	0	1	0
1851.5	0	0	0	0	15	0	0	0	0	0	1	0
1852.0	85	2	0	0	199	0	0	0	0	0	1	0
1852.5	433	146	0	94	55	0	0	0	0	0	1	0
1853.0	349	67	0	356	49	58	0	0	0	0	1	0
1853.5	119	33	0	17	99	0	0	0	0	0	0	0
1854.0	120	68	0	23	89	0	0	0	0	0	0	0
1854.5	100	4	0	20	69	0	0	0	0	0	0	0
1855.0	9	31	0	76	69	0	1	0	0	1	0	0
1855.5	0	55	0	86	69	0	1	0	0	1	0	0
1856.0	0	3	0	54	25	0	2	0	0	2	0	0
1856.5	0	0	0	36	0	0	32	21	0	32	0	0
1857.0	0	0	0	2	0	0	3	10	0	3	0	0
1857.5	0	0	0	0	0	0	11	0	0	11	0	0
1858.0	0	0	0	0	0	0	11	0	0	11	0	0
1858.5	0	0	0	0	0	0	9	0	0	9	0	0
1859.0	0	0	0	0	0	0	2	0	0	2	0	0
1859.5	0	0	0	0	0	0	1	0	1	1	0	1
1861.0	0	0	0	0	0	0	0	0	1	0	0	1
1862.0	0	0	0	0	0	0	0	0	1	0	0	1
1863.5	0	0	0	0	0	0	0	0	1	0	0	1
1864.5	0	0	1	0	0	0	0	0	1	0	0	1

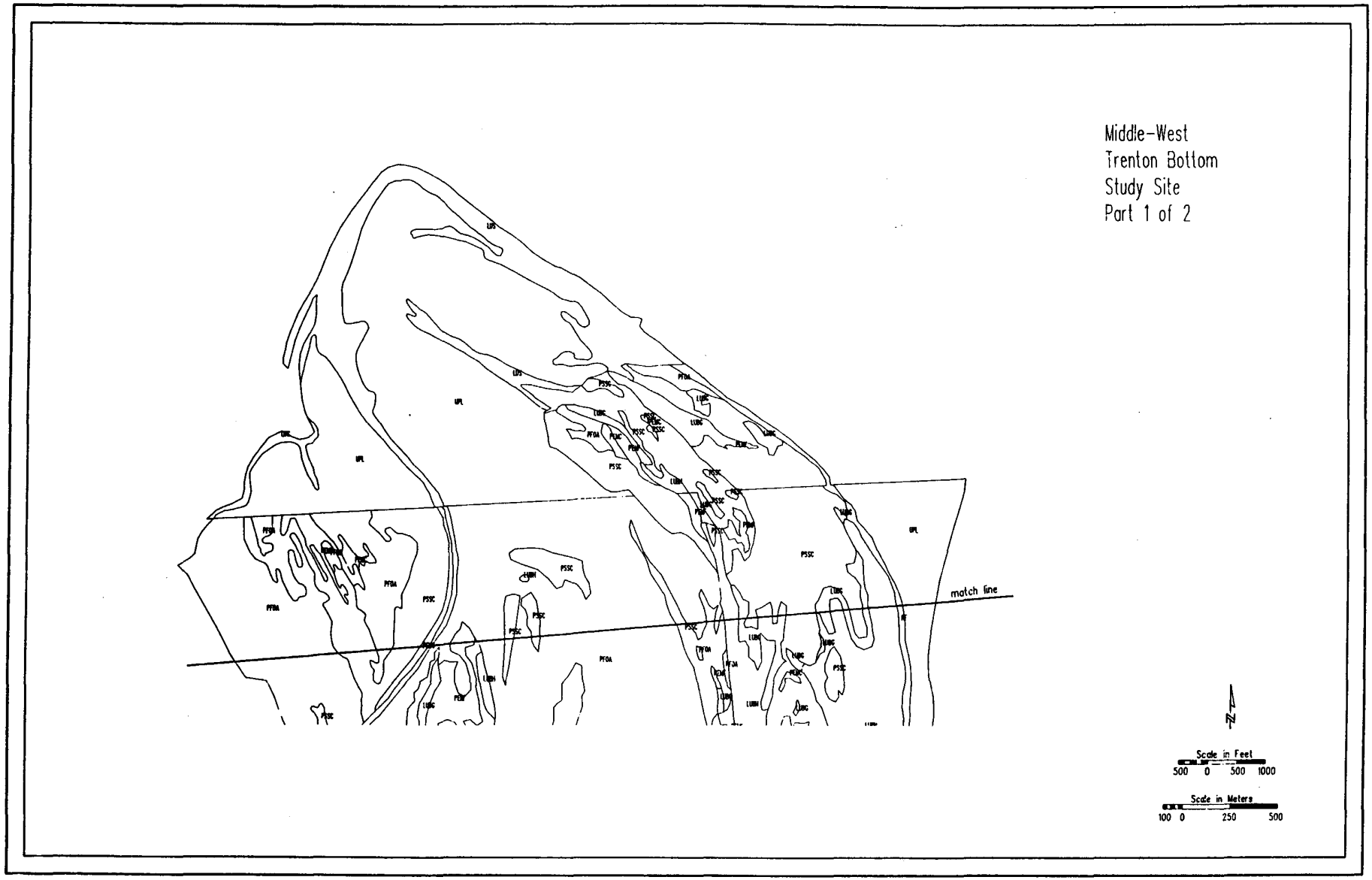
EXHIBIT 690 022157

Table TB-2 (Continued).

Missouri River - Trenton Bottoms Study Site
River Miles 1568.8 All Transects Combined

Elevation	PEMF	PEMC	RG	PSSC	LUS	LUBH	PFOA	PFOC	RF	PSSA	RUBH	RS
1865.0	0	0	1	0	0	0	0	0	1	0	0	1
1866.0	0	0	1	0	0	0	0	0	1	0	0	1
1866.5	0	0	1	0	0	0	0	0	1	0	0	1
1867.5	0	0	1	0	0	0	0	0	1	0	0	1
1868.0	0	0	1	0	0	0	0	0	1	0	0	1
TOTAL	1215	409	6	764	738	58	73	31	10	73	31	10

EXHIBIT 690 022158


Middle-West
Trenton Bottom
Study Site
Part 1 of 2
match line
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-32

Middle-West
Trenton Bottom
Study Site
Part 2 of 2

N

Scale in Feet
500 0 500 1000

Scale in Meters
100 0 250 500

B-33

Lewis and Clark Wildlife Management Area

The Lewis and Clark Wildlife Management Area study site was a large complex of backwater channels, chutes, old swales, and islands. The site was located on the right bank of the Missouri River at Highway 85, approximately 10 miles downstream of Trenton, North Dakota. This refuge area was also the site of a Duck's Unlimited project. Much of this area appeared to be wetter than it had been in the past; areas that supported mesic species such as smooth brome and snowberry, were being invaded by reed canarygrass and old cottonwood trees were dead with virtually no recolonization. The Lewis and Clark study site was included in the Lake Sakakawea delta and is part of the upper river.

Skunk Lake, the large permanently flooded oxbow (PUBH) near the Highway 85 bridge, occupied a surface area of 381.6 acres (7.3 percent) (Table LC-1). The largest wetland cover type was represented by 1619.3 acres (31.4 percent) of LUS5. Although mostly cultivated, the areas that were classified as LUS5 were low enough in the elevational distributions that seasonal flooding was likely. Emergent wetlands were found surrounding Skunk Lake, near the Missouri River shorelines, and on islands. PEMF wetlands, dominated by cattail, common reed, and hard-stem bulrush, occupied 235.3 acres (4.5 percent). PEMA and PEMC wetland, representing 102.2 and 255.6 acres, respectively, were characterized by reed canarygrass, quackgrass, and red top. The water table was typically 12 and 6 inches, respectively, beneath PEMA and PEMC wetlands. Seasonally flooded scrub-shrub wetlands, PSSC, occurred mostly on the large islands in the main channel of the river. They occupied 469.2 acres (9.0 percent) of the site. Sandbar willow was the dominant shrub species in the PSSC wetlands; adjacent forested wetlands (PFOA) were characterized by peachleaf willow trees and an understory of reed canarygrass. Riparian grassland (RG) represented 1314.9 acres (25.3 percent) and included areas that were considered upland grass at the time of sampling.

Table LC-1. Wetland and riparian acreages mapped in the Lewis & Clark study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	102.2
Palustrine emergent seasonally flooded (PEMC)	255.6
Palustrine emergent semipermanently flooded (PEMF)	235.3
Palustrine forested temporarily flooded (PFOA)	243.8
Palustrine forested seasonally flooded (PFOC)	1.0
Palustrine scrub-shrub temporarily flooded (PSSA)	3.1
Palustrine scrub-shrub seasonally flooded (PSSC)	469.2
Riparian grassland (RG)	1,314.9
Riparian forest (RF)	98.7
Lacustrine unconsolidated bottom permanently flooded (LUBH)	408.0
Lacustrine unconsolidated shore (LUS)	66.5
Lacustrine unconsolidated shore vegetated (LUS5)	1,619.3
Palustrine unconsolidated bottom permanently flooded (PUBH)	381.6
Total	5,199.4

EXHIBIT 690 022161

Wetland and riparian elevational distributions were measured along 5 transects and standardized around RM 1552.6. This study site was sampled on July 29, 1991. Cover type elevations ranged from PUBH at 1842.5 to RG and RF at 1855.0. The water surface elevation of the Missouri River was 1845.5 at RM 1552.6. The water surface elevation of Skunk Lake was 1846.5.

A variety of bird species were observed at the Lewis and Clark Wildlife Refuge study site, including mallard, double-breasted cormorant, bittern, yellowthroat, red-winged blackbird, eastern kingbird, Virginia rail, and cowbird.

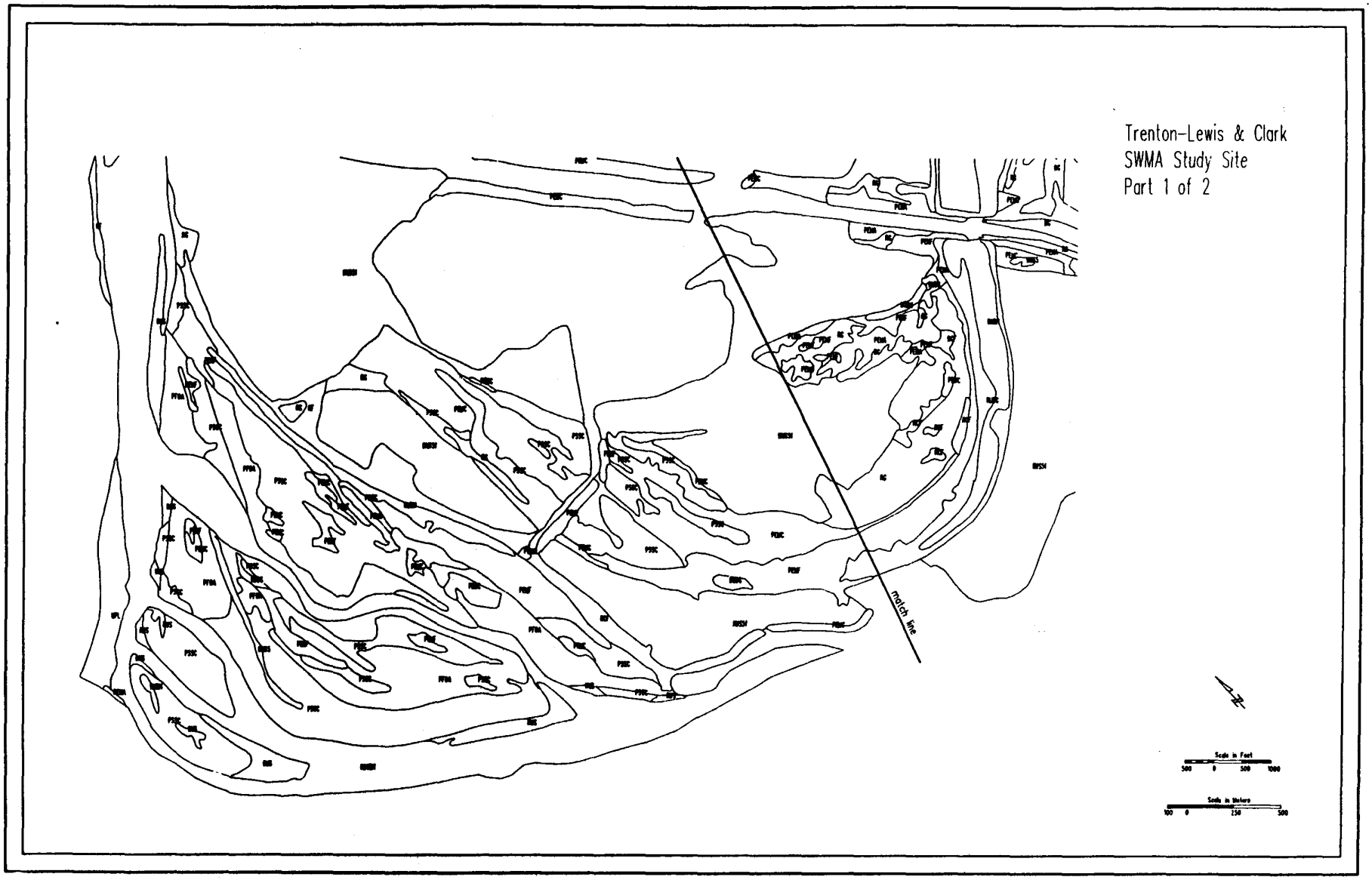
EXHIBIT 690 022162

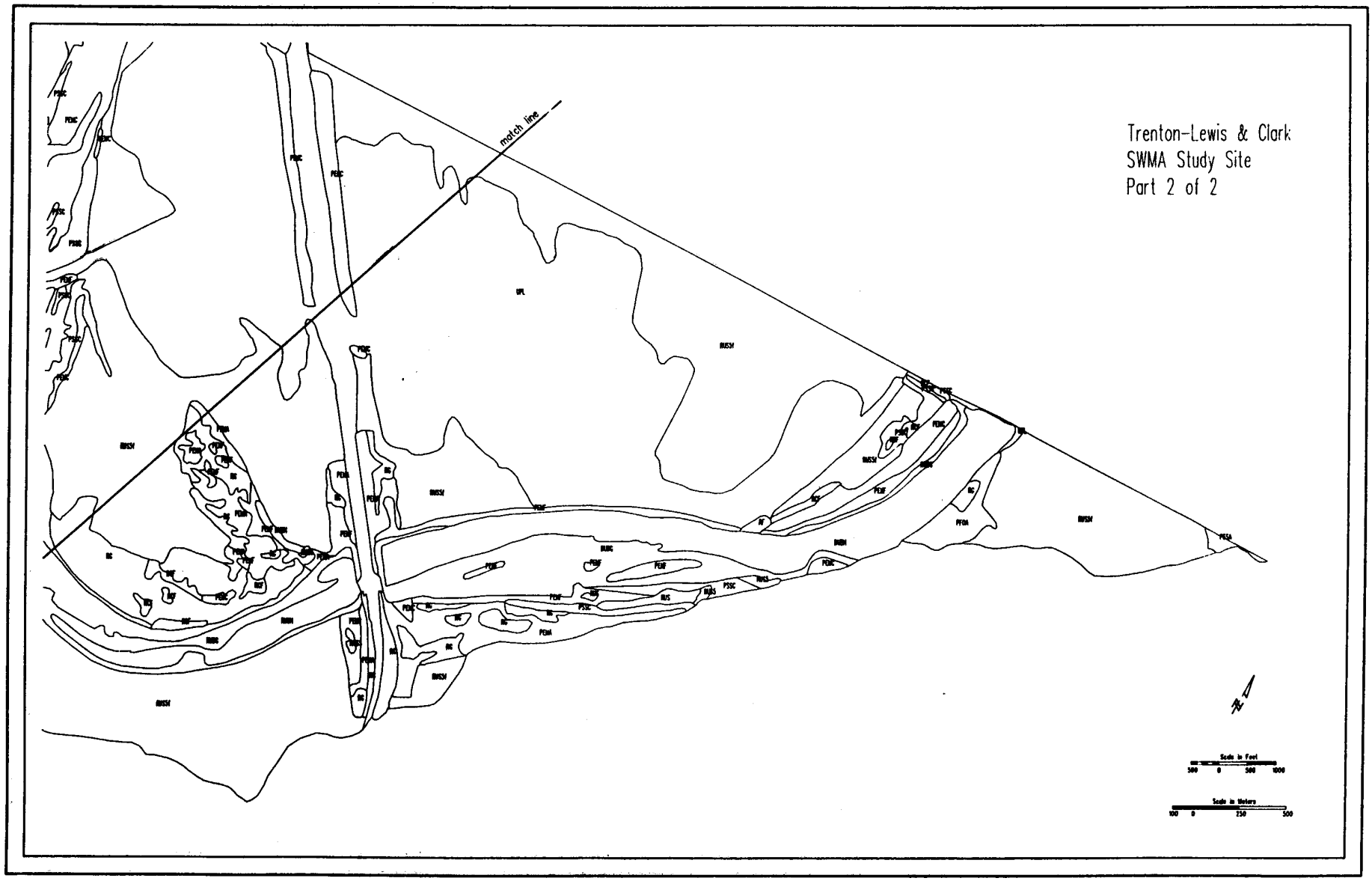
Table LC-2. Distribution of sampling points by elevation.

Missouri River - Lewis & Clark Wildlife Refuge Study Site
River Mile 1552.6 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	RF	PUBH	LUS	PFOA	PFOC	PSSA	LUS5	RUBH
1818.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1818.5	0	0	0	0	0	0	0	0	0	0	0	0	1
.....													
.....													
1840.5	0	0	0	0	0	0	0	0	0	0	0	0	1
1841.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1841.5	0	0	0	0	0	0	0	0	0	0	0	0	1
1842.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1842.5	0	0	0	0	0	0	1	0	0	0	0	0	1
1843.0	3	0	0	0	0	0	4	0	0	0	0	0	1
1843.5	5	0	0	0	0	0	6	0	0	0	0	0	1
1844.0	11	0	0	0	0	0	1	0	0	0	0	0	1
1844.5	35	0	0	0	0	0	0	0	0	0	0	0	1
1845.0	30	0	0	0	0	0	15	0	0	0	0	0	1
1845.5	196	0	0	0	0	0	11	0	0	0	0	0	1
1846.0	192	12	0	0	0	0	2	5	0	0	0	5	0
1846.5	16	51	0	0	0	0	0	5	0	0	0	5	0
1847.0	6	67	0	0	0	0	0	6	0	0	0	6	0
1847.5	6	93	23	0	1	0	0	2	0	0	23	2	0
1848.0	0	11	46	2	0	0	0	2	0	0	46	2	0
1848.5	0	2	32	7	0	0	0	2	0	1	32	2	0
1849.0	0	117	6	9	1	0	0	2	0	0	6	2	0
1849.5	0	47	0	18	22	0	0	2	0	29	0	2	0
1850.0	0	1	3	19	38	0	0	12	0	0	3	12	0
1850.5	0	0	3	15	99	0	0	11	1	0	3	11	0
1851.0	0	0	36	15	47	0	0	0	0	0	36	0	0
1851.5	0	0	48	14	12	2	0	0	0	0	48	0	0
1852.0	0	0	0	19	3	4	0	0	1	0	0	0	0
1852.5	0	0	0	28	2	5	0	0	0	0	0	0	0
1853.0	0	0	0	10	2	1	0	0	0	0	0	0	0
1853.5	0	0	0	9	3	1	0	0	0	0	0	0	0
1854.0	0	0	0	7	2	1	0	0	0	0	0	0	0
1854.5	0	0	0	6	0	1	0	0	0	0	0	0	0
1855.0	0	0	0	2	0	1	0	0	0	0	0	0	0
TOTAL	500	401	197	180	232	16	40	49	2	30	197	49	56

EXHIBIT 690 022163


Trenton-Lewis & Clark
SWMA Study Site
Part 1 of 2
match line


match line
Trenton-Lewis & Clark
SWMA Study Site
Part 2 of 2

Williston Lagoons

The Williston Lagoon study site was a large complex of low-lying wetlands just east of Williston, North Dakota. Located on both banks, this site included relatively large backwater channels, including the entrance to Skunk Lake, islands, and mud flats. The river in this area was apparently aggrading and the soils reflect this with strong mottles and invading wetland species, even in areas that seemed relatively dry. The Williston Lagoons study site was included in the Lake Sakakawea delta and is part of the upper river.

The diversity of the wetlands in any given area within the study site was relatively low; large expanses of one cover type changed abruptly to another type. Seasonally flooded scrub-shrub wetlands (PSSC) dominated the study site, occupying 460.4 acres (32.4 percent) (Table WL-1). Sandbar willow shrubs, with a sparse understory of common reed and reed canarygrass, were typical in the PSSC wetlands. The forested wetlands (PFOC) represented 315.5 acres (22.2 percent) of the study site. These stands supported large peachleaf willow trees and an herbaceous understory similar to that found in the PSSC wetlands. Dense stands of narrow-leaf cattail were typical of the PEMF wetlands. There was no standing water in the wetland cover types, with the exception of areas that appeared to be permanently flooded mudflats (LUBH) during the sampling period.

Table WL-1. Wetland and riparian acreages mapped in the Williston Lagoons study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	1.0
Palustrine emergent seasonally flooded (PEMC)	151.8
Palustrine emergent semipermanently flooded (PEMF)	130.9
Palustrine forested seasonally flooded (PFOC)	315.5
Palustrine scrub-shrub temporarily flooded (PSSA)	1.0
Palustrine scrub-shrub seasonally flooded (PSSC)	460.4
Riparian grassland (RG)	4.1
Riparian shrub (RS)	1.0
Lacustrine unconsolidated bottom permanently flooded (LUBH)	244.9
Lacustrine unconsolidated shore (LUS)	53.3
Lacustrine unconsolidated shore vegetated (LUS5)	59.3
Total	1,423.1

A total of 5 transects were used to measure the wetland and riparian elevational distributions in the Williston Lagoons study site. All transects were standardized around RM 1547.4. The wetland cover type distributions were fairly tight, ranging from LUBH at 1841.0 to PEMA at 1848.5 (Table WL-2). Riparian cover types occurred from 1848.5 to 1853.5. The water surface elevation of the Missouri River at RM

EXHIBIT 690 022166

Table WL-2. Distribution of sampling points by elevation.

Missouri River - Williston Lagoon Study Site
River Mile 1547.4 - All Transects Combined

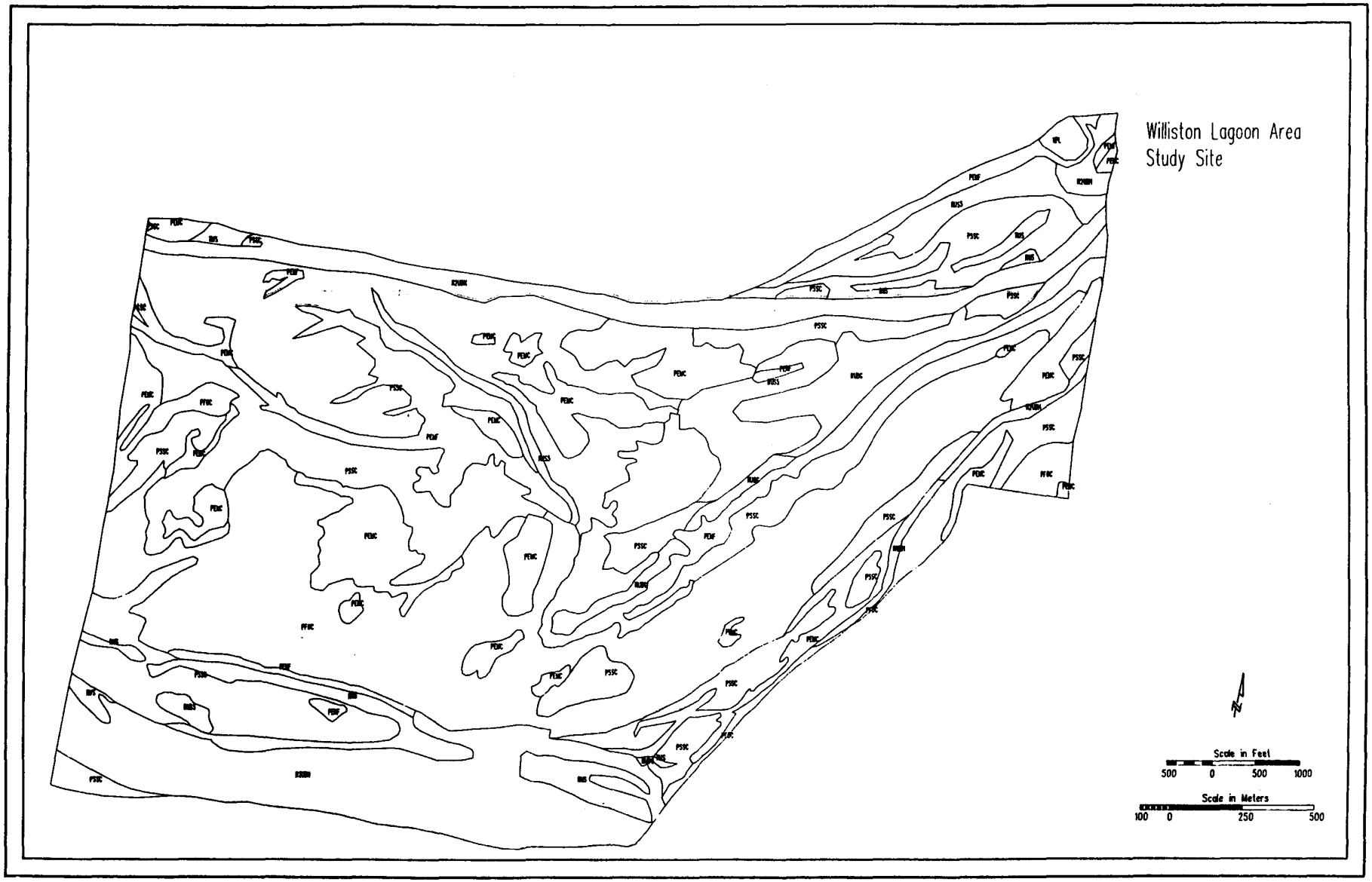
Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	LUS	LUBH	LUS5	RS	PFOC	RUBH
1815.0	0	0	0	0	0	0	0	0	0	0	0	1
1815.5	0	0	0	0	0	0	0	0	0	0	0	1
....												
....												
1839.5	0	0	0	0	0	0	0	0	0	0	0	1
1840.0	0	0	0	0	0	0	0	0	0	0	0	1
1840.5	0	0	0	0	0	0	0	0	0	0	0	1
1841.0	0	0	0	0	0	0	0	9	0	0	0	1
1841.5	0	0	0	0	0	0	0	56	0	0	0	1
1842.0	0	0	0	0	14	0	0	107	0	0	0	1
1842.5	22	0	0	0	27	0	51	211	0	0	0	1
1843.0	103	0	0	0	108	0	217	58	99	0	0	0
1843.5	417	30	0	0	192	0	199	0	95	0	0	0
1844.0	118	190	0	0	52	0	21	0	0	0	0	0
1844.5	84	355	0	0	77	0	24	0	11	0	42	0
1845.0	2	171	0	0	75	0	1	0	0	0	20	0
1845.5	0	134	0	0	53	0	0	0	0	0	14	0
1846.0	0	73	0	0	101	55	1	0	0	0	0	0
1846.5	0	12	53	0	105	34	0	0	0	0	0	0
1847.0	0	3	45	0	19	0	0	0	0	0	0	0
1847.5	0	0	34	0	0	0	0	0	0	0	0	0
1848.0	0	0	30	0	0	0	0	0	0	0	0	0
1848.5	0	0	17	6	0	0	0	0	0	0	0	0
1849.0	0	0	0	13	0	0	0	0	0	0	0	0
1849.5	0	0	0	10	0	0	0	0	0	0	0	0
1850.0	0	0	0	4	0	0	0	0	0	0	0	0
1850.5	0	0	0	4	0	0	0	0	0	0	0	0
1851.0	0	0	0	5	0	0	0	0	0	0	0	0
1851.5	0	0	0	4	0	0	0	0	0	0	0	0
1852.0	0	0	0	4	0	0	0	0	0	0	0	0
1852.5	0	0	0	1	0	0	0	0	0	7	0	0
1853.0	0	0	0	0	0	0	0	0	0	10	0	0
1853.5	0	0	0	1	0	0	0	0	0	6	0	0
TOTAL	746	968	179	52	823	89	514	441	205	23	76	56

EXHIBIT 690 022167

1547.4 was 1842.5. The study site was sampled on July 30 and 31, 1991.

White-tailed deer were seen at the Williston Lagoon study site during the sampling period, as well as mink, raccoon, and coyote tracks and an old beaver lodge. Bird species identified included great blue heron, magpie, yellowlegs, bittern, yellowthroat, prairie falcon, and vulture.

EXHIBIT 690 022168


Williston Lagoon Area
Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Stanton

The Stanton study site was located on the left bank of the Missouri River, directly across the river from the Stanton Power Plant, North Dakota. This site was of particular interest because it contained the only bald eagle nest site on the Missouri River in North Dakota. The Stanton study site was part of the Garrison reach in the upper river.

The site was a lowland area with a dune-swale topography that mainly supported riparian cover types. Riparian forests (RF) occupied 784.7 acres (39.8 percent) (Table ST-1) of the study site and was dominated by large stands of cottonwood trees with an understory of leafy spurge and smooth brome. Riparian grassland (RG) represented 549.6 acres (27.9 percent) of the study site and included species such as smooth brome, leafy spurge, bluegrass, and wheat. The wetlands in the study site were confined to a small area in and around a dry backwater channel. PEMC wetlands, dominated by reed canarygrass, bulrush, and three-square, occupied 40.7 acres of this dry channel. Small pockets of PEMF wetland, mostly dominated by soft-stem bulrush (15.1 acres), were also found in the channel.

Table ST-1. Wetland and riparian acreages mapped in the Stanton study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	5.6
Palustrine emergent seasonally flooded (PEMC)	40.7
Palustrine emergent semipermanently flooded (PEMF)	15.1
Palustrine scrub-shrub temporarily flooded (PSSA)	1.0
Riparian grassland (RG)	549.6
Riparian forest (RF)	784.7
Riverine unconsolidated bottom permanently flooded (RUBH)	432.8
Riverine unconsolidated shore (RUS)	116.0
Riverine unconsolidated shore vegetated (RUS5)	26.3
Total	1,971.8

The elevational distributions of the wetland and riparian cover types were measured along 4 transects and standardized around RM 1371.8. The Stanton study site was sampled on July 2, 1991. Cover type elevations ranged from 1660.0 to 1680.0 (Table ST-2). The water surface elevation of the Missouri River at RM 1371.5 was 1660.5.

No bald eagle activity was noted at the time of sampling, however other species were observed, including red-tailed hawk, killdeer, mourning dove, and eastern kingbird.

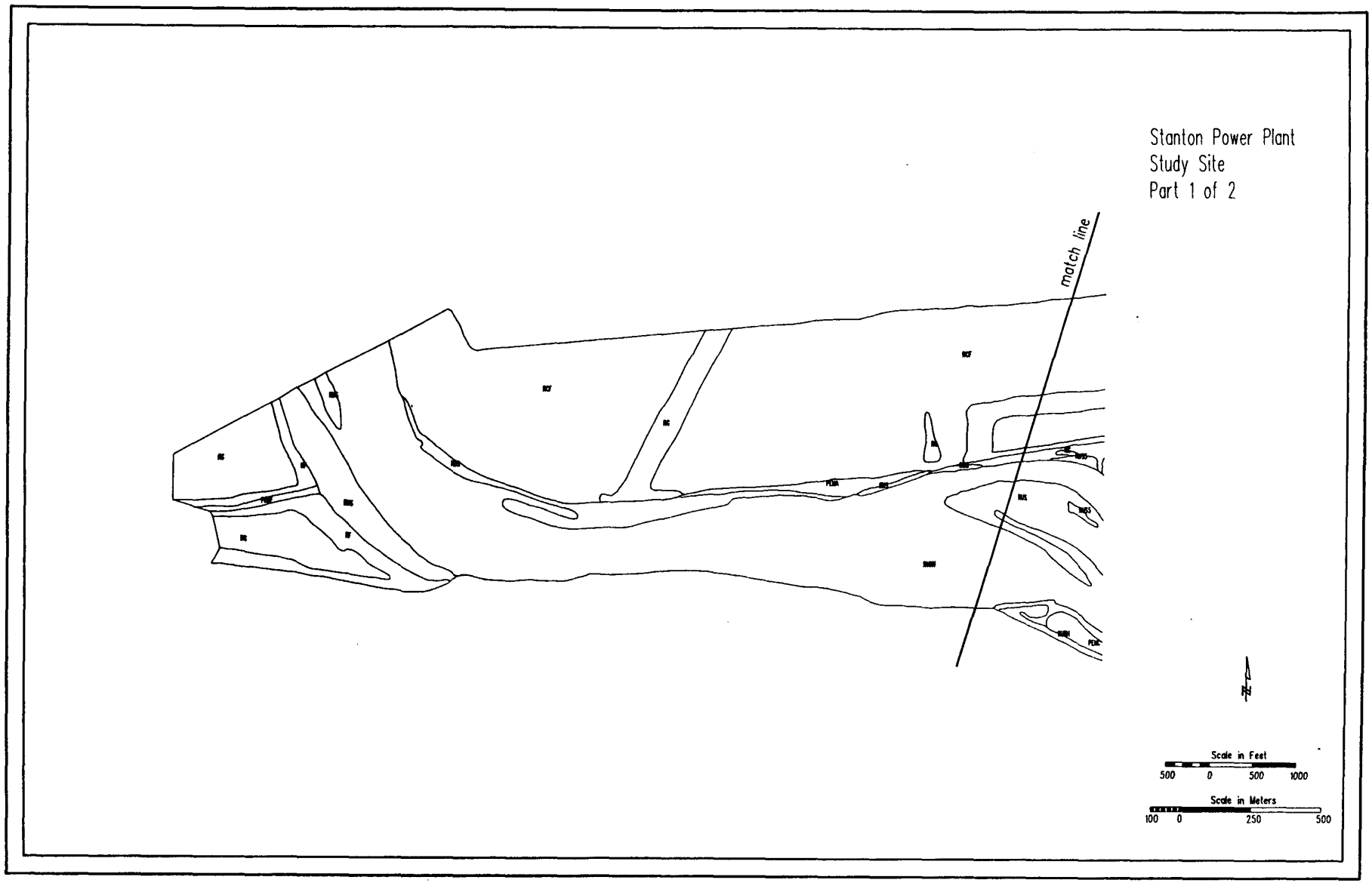
EXHIBIT 690 022170

Table ST-2. Distribution of sampling points by elevation.

Missouri River - Stanton Study Site
River Mile 1371.8 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSA	RF	RUS	RUS5	RUBH
1599.5	0	0	0	0	0	0	0	0	1
1600.0	0	0	0	0	0	0	0	0	1
....									
....									
1658.5	0	0	0	0	0	0	0	0	1
1659.0	0	0	0	0	0	0	0	0	1
1659.5	0	0	0	0	0	0	0	0	1
1660.0	20	0	0	0	0	0	0	0	1
1660.5	18	0	0	0	0	0	4	0	1
1661.0	19	0	0	0	0	0	6	0	0
1661.5	34	3	0	0	0	0	7	0	0
1662.0	24	42	0	1	0	0	9	34	0
1662.5	5	52	2	2	0	0	3	37	0
1663.0	0	17	17	2	0	0	0	0	0
1663.5	0	9	34	4	1	0	0	0	0
1664.0	0	14	17	5	2	0	0	0	0
1664.5	0	4	22	4	2	0	0	0	0
1665.0	0	3	21	15	3	0	0	0	0
1665.5	0	3	2	12	2	0	0	0	0
1666.0	0	2	9	8	3	0	0	0	0
1666.5	0	1	0	12	2	0	0	0	0
1667.0	0	1	0	15	3	0	0	0	0
1667.5	0	1	0	30	3	0	0	0	0
1668.0	0	1	0	51	2	0	0	0	0
1668.5	0	1	0	65	3	0	0	0	0
1669.0	0	0	0	38	3	0	0	0	0
1669.5	0	0	0	12	3	0	0	0	0
1670.0	0	0	0	1	3	0	0	0	0
1670.5	0	0	0	3	2	0	0	0	0
1671.0	0	0	0	0	3	0	0	0	0
1671.5	0	0	0	2	1	0	0	0	0
1672.0	0	0	0	1	0	0	0	0	0
1672.5	0	0	0	2	0	0	0	0	0
1673.0	0	0	0	3	0	0	0	0	0
1673.5	0	0	0	1	0	0	0	0	0
1674.0	0	0	0	2	0	0	0	0	0
1674.5	0	0	0	1	0	0	0	0	0
1675.0	0	0	0	2	0	0	0	0	0
1675.5	0	0	0	2	0	0	0	0	0
1676.0	0	0	0	2	0	0	0	0	0
1676.5	0	0	0	1	0	0	0	0	0
1677.0	0	0	0	2	0	0	0	0	0
1677.5	0	0	0	2	0	0	0	0	0
1678.0	0	0	0	1	0	0	0	0	0
1678.5	0	0	0	2	0	3	0	0	0
1679.0	0	0	0	0	0	6	0	0	0
1679.5	0	0	0	1	0	5	0	0	0
1680.0	0	0	0	0	0	5	0	0	0
TOTAL	120	154	124	307	41	19	29	71	123

EXHIBIT 690 022171


Stanton Power Plant
Study Site
Part 1 of 2
match line
Scale in Feet
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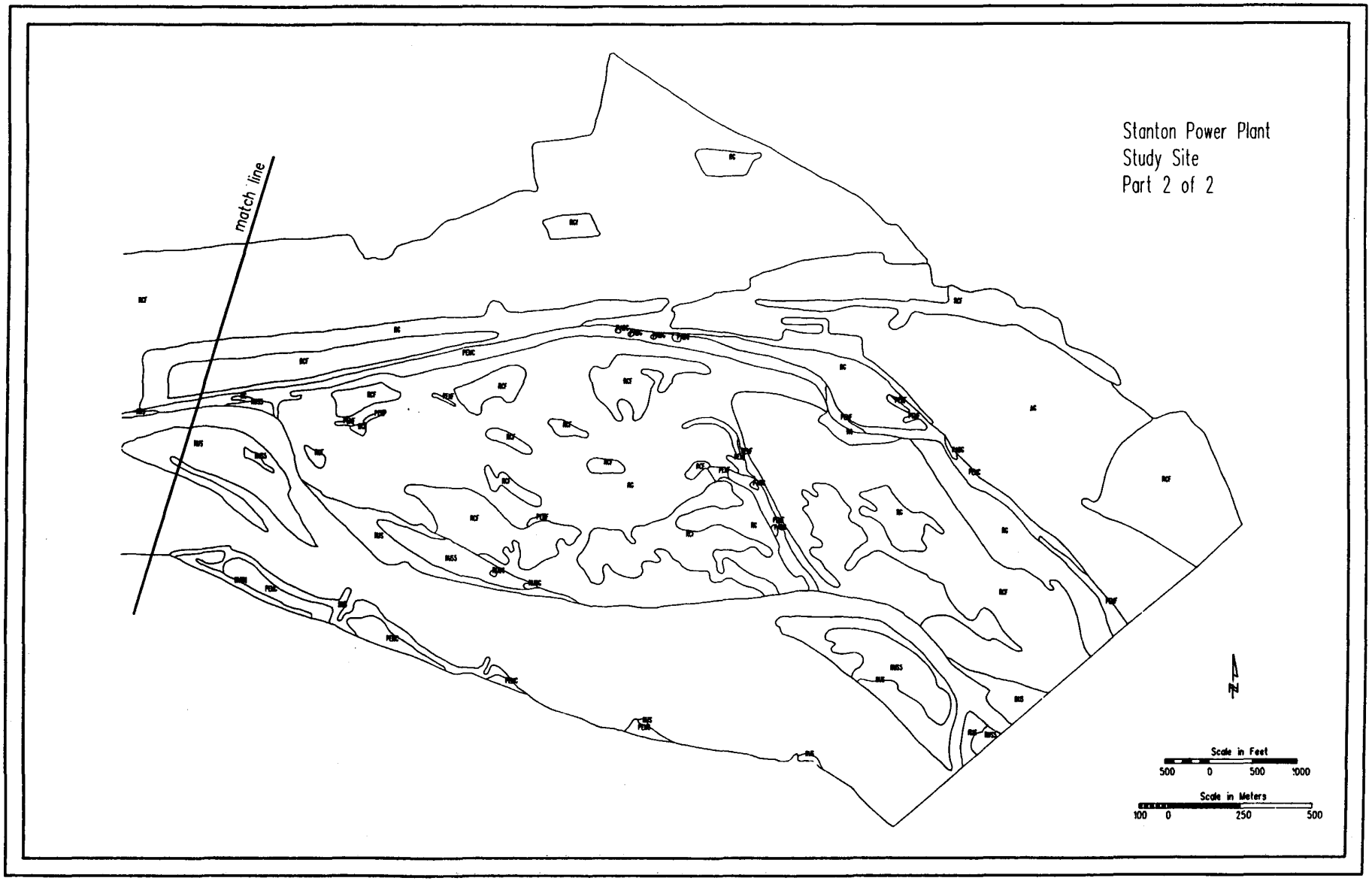
Scale in Meters
100 0 250 500

B-45


match line
Stanton Power Plant
Study Site
Part 2 of 2
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Washburn

The Washburn study site was located on the right bank of the Missouri River, approximately 10 miles upstream of Washburn, North Dakota. This area was a complex of wetland and riparian cover types associated with a number of side channels, backwaters, and shorelines. Riparian grassland and agricultural fields bordered the study site on the south, with the Missouri River to the north. The Washburn study site was included in the Garrison reach in the upper river.

Riparian grassland (RG) and riparian forest (RF) cover types dominated the study site. RG occupied 633.3 acres (43.1 percent) of the study site and was characterized by smooth brome and bluegrass (Table WA-1). The RG cover type also included cultivated lands. RF stands were dominated by cottonwoods and represented 165.8 acres (11.3 percent). Unconsolidated shorelines (RUS) contributed the largest acreage to the wetland cover types, occupying 212.3 acres (14.5 percent) of the study site. The RUS wetlands were unvegetated; however, shorelines dominated by pioneering species such as ragweed, three-square, and clover were classified as RUS5 wetlands (75.2 acres). Small patches of PSSA wetlands were scattered throughout the study site, occupying a total of 46.7 acres (3.2 percent). Indigo bush and peachleaf willow shrubs were the most prevalent species in the PSSA wetlands. Permanently flooded backwaters and ponds (PUBH) occupied a total surface area of 25.6 acres within the study site.

Table WA-1. Wetland and riparian acreages mapped in the Washburn study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	20.5
Palustrine emergent semipermanently flooded (PEMF)	0.3
Palustrine scrub-shrub temporarily flooded (PSSA)	46.7
Palustrine scrub-shrub seasonally flooded (PSSC)	0.6
Riparian grassland (RG)	633.3
Riparian shrub (RS)	23.5
Riparian forest (RF)	165.8
Riverine unconsolidated bottom permanently flooded (RUBH)	264.3
Riverine unconsolidated shore (RUS)	212.3
Riverine unconsolidated shore vegetated (RUS5)	75.2
Palustrine unconsolidated bottom permanently flooded (PUBH)	25.6
Total	1,468.0

Only 1 transect was used to measure the cover type elevation in the Washburn study site. This sampling was done on July 1, 1991. Cover type elevations for the Washburn study site ranged from 1655.0 to 1670.0. The water surface elevation of the Missouri River was 1657.0 at RM 1365.5. Elevation data on the wetland and riparian cover types associated with Lake Mandan was also recorded. However, this information

EXHIBIT 690 022174

has not been presented because Lake Mandan is not hydrologically tied to the Missouri River; it receives water from upland drainage systems.

Bird species identified during the sampling period included: least tern, killdeer, red-tailed hawk, Canada goose, eastern kingbird, blackbird, and white-tailed deer.

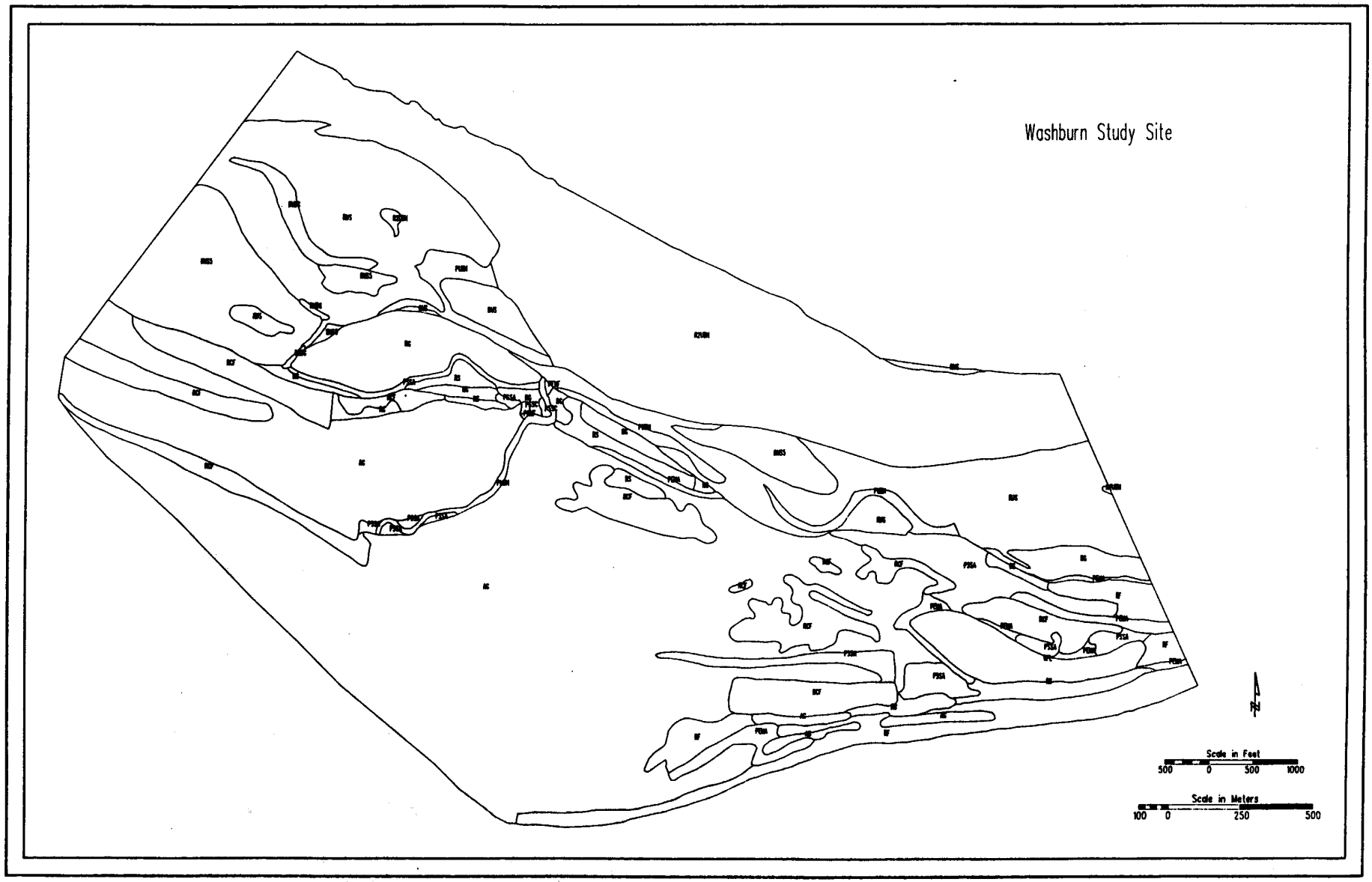
EXHIBIT 690 022175

Table WA-2. Distribution of sampling points by elevation.

Missouri River - Washburn Study Site
River Mile 1365.5 - Transect A only

Elevation	RG	PSSA	RF	RUS5	RUBH	RUS	RS	PEMA	PEMF	PSSC	PUBH
1604.0	0	0	0	0	1	0	0	0	0	0	0
1604.5	0	0	0	0	1	0	0	0	0	0	0
....											
....											
1654.0	0	0	0	0	1	0	0	0	0	0	0
1654.5	0	0	0	0	1	0	0	0	0	0	0
1655.0	0	0	0	0	1	0	0	0	0	0	1
1655.5	0	0	0	0	1	0	0	0	0	0	11
1656.0	0	0	0	0	1	0	0	0	0	0	12
1656.5	0	0	0	0	1	0	0	0	0	0	13
1657.0	0	0	0	0	1	0	0	0	0	0	12
1657.5	0	0	0	0	0	0	0	0	0	0	11
1658.0	0	0	0	0	0	15	0	0	0	0	2
1658.5	0	2	0	0	0	13	0	2	0	0	1
1659.0	0	2	0	4	0	9	0	2	4	4	0
1659.5	0	3	0	12	0	2	0	3	12	12	0
1660.0	0	2	0	66	0	1	0	2	66	66	0
1660.5	0	2	0	67	0	0	0	2	67	67	0
1661.0	0	1	0	47	0	1	0	1	47	47	0
1661.5	0	2	0	40	0	0	0	2	40	40	0
1662.0	0	3	0	0	0	0	0	3	0	0	0
1662.5	0	4	0	0	0	1	0	4	0	0	0
1663.0	0	4	0	0	0	0	0	4	0	0	0
1663.5	1	10	0	0	0	1	0	10	0	0	0
1664.0	14	5	0	0	0	0	0	5	0	0	0
1664.5	63	2	0	0	0	0	21	2	0	0	0
1665.0	125	0	0	0	0	1	43	0	0	0	0
1665.5	132	0	0	0	0	0	4	0	0	0	0
1666.0	58	0	0	0	0	0	0	0	0	0	0
1666.5	34	0	0	0	0	0	0	0	0	0	0
1667.0	18	0	0	0	0	0	0	0	0	0	0
1667.5	14	0	0	0	0	0	0	0	0	0	0
1668.0	1	0	3	0	0	0	0	0	0	0	0
1668.5	1	0	4	0	0	0	0	0	0	0	0
1669.0	1	0	5	0	0	0	0	0	0	0	0
1669.5	1	0	4	0	0	0	0	0	0	0	0
1670.0	1	0	3	0	0	0	0	0	0	0	0
Total	464	42	19	236	107	44	68	42	236	236	63

EXHIBIT 690 022176


Washburn Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-50

Square Butte

The Square Butte study site was a complex of chutes and channels and their associated wetlands between the Missouri River and Square Butte Creek at RM 1322.5. This study site was located on the right bank of the Missouri River, approximately 5 miles upstream of Bismarck, North Dakota. Square Butte was part of the Garrison reach in the upper river.

PEMA wetlands represented the largest wetland cover type, occupying 143.6 acres (14.7 percent) (Table SQ-1). Slough sedge, clover, reed canarygrass, and foxtail barley were the dominant species in this cover type. Soils in the study area consisted of a clay layer, approximately 8 inches deep, on top of a sandy soil. At the time of sampling, soils in the PEMA wetlands were saturated near the surface with oxidized root zones and mottles 12 inches below. PEMF wetlands, characterized by cattail and three-square, were restricted to the edges of ponds and chutes and occupied 20.7 acres (2.1 percent). Permanently flooded ponds and backwater chutes (PUBH) covered a total surface area of 50.7 acres (5.2 percent). Riparian grassland (RG) represented 215.3 acres (22.0 percent) of the study site. The RG cover type typically supported indian hemp, cocklebur, and clover. Areas of RG were found throughout the study site.

Table SQ-1. Wetland and riparian acreages mapped in the Square Butte study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	143.6
Palustrine emergent seasonally flooded (PEMC)	4.4
Palustrine emergent semipermanently flooded (PEMF)	20.7
Palustrine scrub-shrub temporarily flooded (PSSA)	41.5
Palustrine scrub-shrub seasonally flooded (PSSC)	1.0
Riparian grassland (RG)	215.3
Riparian shrub (RS)	44.0
Riparian forest (RF)	24.6
Riverine unconsolidated bottom permanently flooded (RUBH)	259.5
Riverine unconsolidated shore (RUS)	128.2
Riverine unconsolidated shore vegetated (RUS5)	46.1
Palustrine unconsolidated bottom permanently flooded (PUBH)	50.7
Total	979.7

Wetland and riparian elevational distributions were measured along 2 transects, 3,100 and 1,900 feet long. The range of cover type elevations was only 10.5 feet, with PUBH at 1626.0 and riparian vegetation at 1636.5 (Table SQ-2). The water surface elevation of the Missouri River at RM 1322.5 was 1630.5. All elevational data was standardized to RM 1322.5. Cover type sampling was done on August 1, 1991.

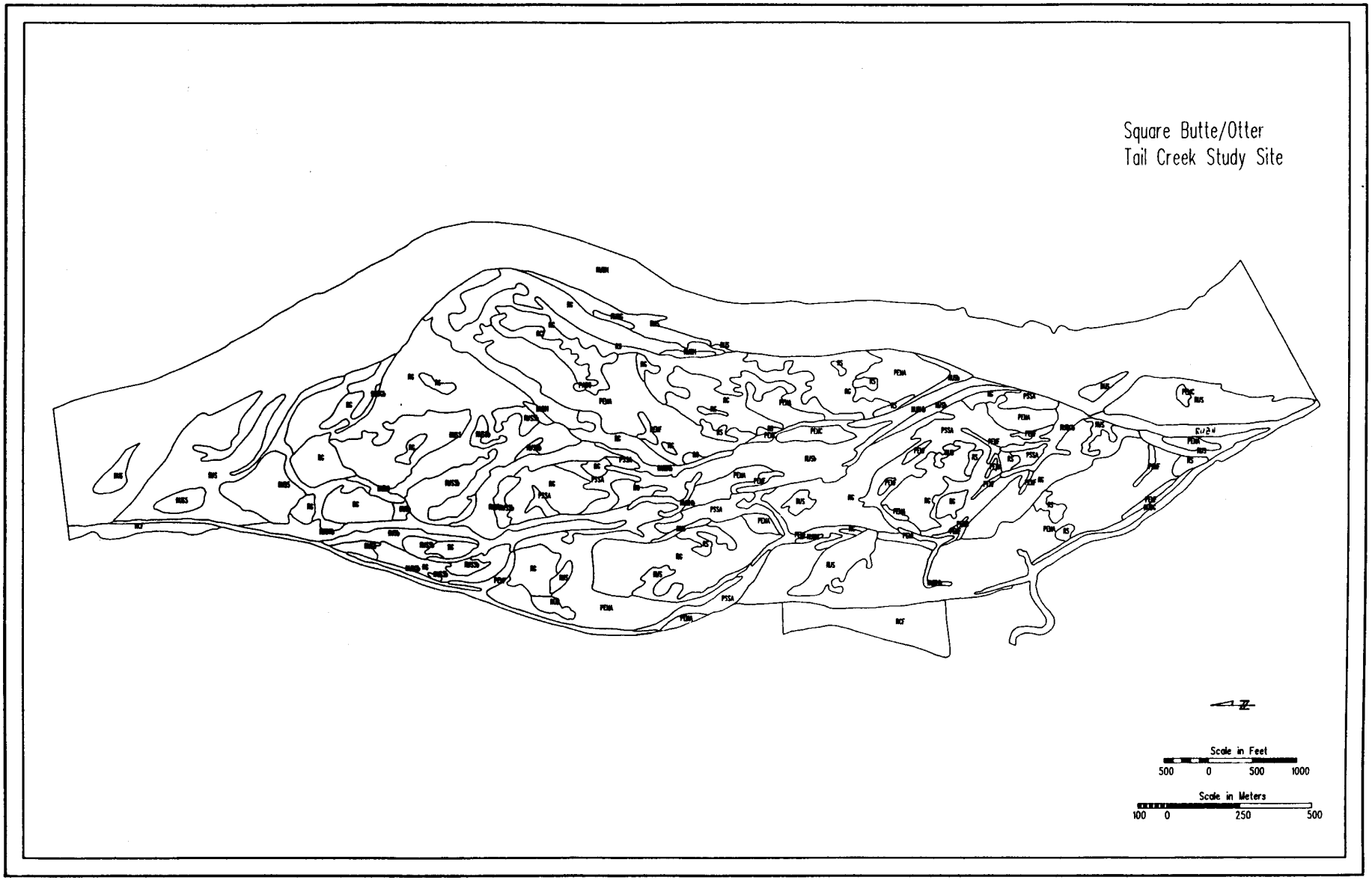
EXHIBIT 690 022178

Table SQ-2. Distribution of sampling points by elevation.

Missouri River - Square Butte Creek Study Site
River Mile 1322.5 All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	PUBH	RUS	RS	RF	RUS5	RUBH
1577.0	0	0	0	0	0	0	0	0	0	0	0	1
1577.5	0	0	0	0	0	0	0	0	0	0	0	1
....												
....												
1625.0	0	0	0	0	0	0	0	0	0	0	0	1
1625.5	0	0	0	0	0	0	0	0	0	0	0	1
1626.0	0	0	0	0	0	0	1	0	0	0	0	1
1626.5	0	0	0	0	0	0	2	0	0	0	0	1
1627.0	0	0	0	0	0	0	1	0	0	0	0	1
1627.5	0	0	0	0	0	0	3	0	0	0	0	1
1628.0	0	0	0	0	0	0	15	0	0	0	0	1
1628.5	2	0	0	0	0	0	18	0	0	0	0	1
1629.0	12	0	0	0	0	0	9	0	0	0	0	1
1629.5	33	4	0	0	0	0	6	1	0	0	1	1
1630.0	14	21	0	0	3	0	5	0	0	0	0	1
1630.5	0	28	0	0	1	190	2	0	0	0	0	1
1631.0	0	9	23	13	2	256	0	0	0	0	0	0
1631.5	0	2	248	47	6	210	0	0	0	0	0	0
1632.0	0	0	282	33	1	107	0	0	2	2	0	0
1632.5	0	0	116	106	0	4	0	0	0	0	0	0
1633.0	0	0	34	108	0	0	0	0	6	6	0	0
1633.5	0	0	60	80	0	0	0	0	26	26	0	0
1634.0	0	0	0	134	0	0	0	0	26	26	0	0
1634.5	0	0	0	107	0	0	0	0	5	5	0	0
1635.0	0	0	0	24	0	0	0	0	26	26	0	0
1635.5	0	0	0	2	0	0	0	0	6	6	0	0
1636.0	0	0	0	0	0	0	0	0	9	9	0	0
1636.5	0	0	0	0	0	0	0	0	6	6	0	0
TOTAL	61	64	763	654	13	767	62	1	112	112	1	108

EXHIBIT 690 022179


Square Butte/Otter
Tail Creek Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-53

I-94

The I-94 study site was a large complex of ponds, backwater channels, islands, and wetlands located between the Highway 10 and Interstate 94 Memorial bridges in Bismarck, North Dakota at RM 1314.0. The study site was on the left bank of the river, bordered to the east by riparian forests and agricultural fields. This area, was within the Bismarck city limits and showed disturbance primarily from recreational use. The I-94 study site was part of the Garrison reach in the upper river.

The unvegetated unconsolidated shoreline (LUS wetland) was the largest cover type in the study site, occupying 72.3 acres (11.7 percent) (Table I-1). LUS wetlands occurred on the islands in the river and a large expanse was located along the shoreline. Emergent wetlands represented a total of 128.1 acres (20.7 percent) of the study site. PEMF wetlands (34.3 acres) were located in narrow bands bordering chutes and channels and were dominated by cattails. PEMA (59.6 acres) and PEMC (34.2 acres) wetlands were found in the expansive flats between the riparian vegetation bordering the study site and the river. The soils in these wetlands were typically saturated at the surface with oxidized root zones and mottles and supported wetland species, such as prickly lettuce, slough sedge, three-square, and reed canarygrass. The riparian forest (RF), which bordered the study site, occupied 82.4 acres (13.3 acres). This RF stand consisted of old cottonwood trees that were decadent and succeeding to green ash.

Table I-1. Wetland and riparian acreages mapped in the I-94 study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	59.6
Palustrine emergent seasonally flooded (PEMC)	34.2
Palustrine emergent semipermanently flooded (PEMF)	34.3
Palustrine scrub-shrub temporarily flooded (PSSA)	47.3
Palustrine scrub-shrub seasonally flooded (PSSC)	17.7
Palustrine forest temporarily flooded (PFOA)	7.7
Riparian grassland (RG)	42.4
Riparian shrub (RS)	1.7
Riparian forest (RF)	82.4
Riverine unconsolidated bottom permanently flooded (RUBH)	202.0
Riverine unconsolidated shore (RUS)	72.3
Riverine unconsolidated shore vegetated (RUS5)	5.8
Palustrine unconsolidated bottom permanently flooded (PUBH)	12.8
Total	620.2

Wetland and riparian elevational distributions were measured along 5 transects on August 21, 1991 and standardized to RM 1314.0. Cover type elevations in the I-94 study site ranged from 1622.0 to 1635.0 (Table I-2). The water surface elevation of the Missouri River at RM 1314.0 was 1624.5. Given the water surface elevation that was

EXHIBIT 690 022181

Table I-2. Distribution of sampling points by elevation.

Missouri River - I-94 Study Site
River Mile 1314.0 - All Transects Combined

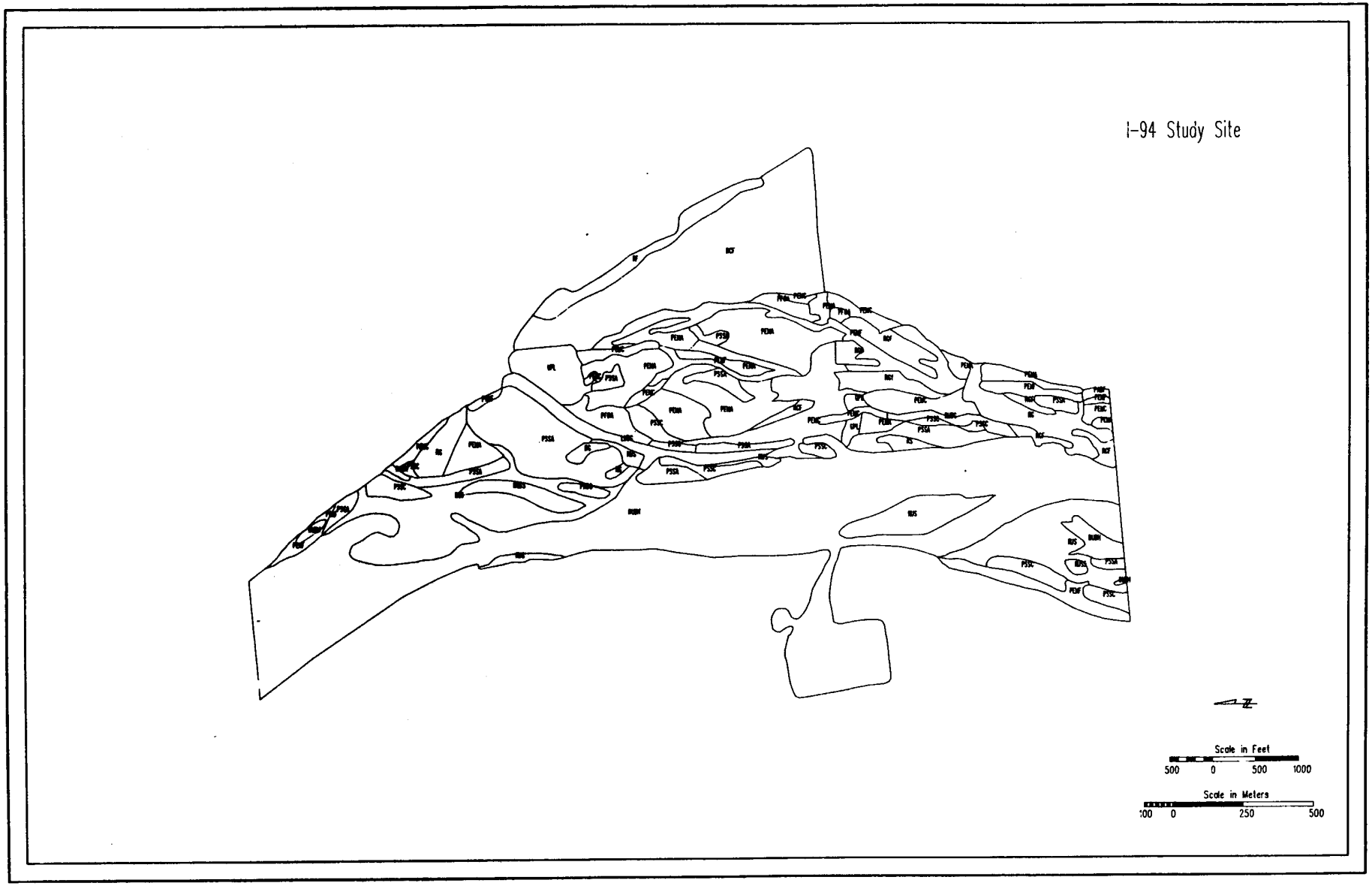
Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RF	LUS	LUS5	PUBH	PFOA	RS	LUBH
1555.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1555.5	0	0	0	0	0	0	0	0	0	0	0	0	1
....													
....													
1620.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1620.5	0	0	0	0	0	0	0	0	0	0	0	0	1
1621.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1621.5	0	0	0	0	0	0	0	0	0	0	0	0	1
1622.0	0	0	0	0	0	0	0	0	0	1	0	0	1
1623.0	0	0	0	0	0	0	0	0	0	10	0	0	1
1623.5	12	0	0	0	0	0	0	0	0	12	0	0	1
1624.0	35	1	0	0	0	0	0	79	0	18	0	0	1
1624.5	49	27	0	0	0	0	0	4	5	15	0	0	1
1625.0	2	49	0	0	4	0	0	2	85	0	0	0	0
1625.5	1	78	0	0	53	0	0	1	97	0	0	0	0
1626.0	0	80	9	0	136	33	0	0	82	0	0	1	0
1626.5	0	7	52	2	14	33	0	0	160	0	0	0	0
1627.0	0	3	194	1	17	249	0	0	8	0	1	1	0
1627.5	0	0	54	2	42	309	0	0	0	0	1	1	0
1628.0	0	0	59	2	0	24	0	0	0	0	17	1	0
1628.5	0	0	8	3	0	10	0	0	0	0	4	1	0
1629.0	0	0	0	2	0	6	0	0	0	0	3	0	0
1629.5	0	0	0	2	0	5	0	0	0	0	3	1	0
1630.0	0	0	0	3	0	6	7	0	0	0	1	1	0
1630.5	0	0	0	5	0	0	1	0	0	0	0	0	0
1631.0	0	0	0	1	0	0	1	0	0	0	0	0	0
1631.5	0	0	0	1	0	0	1	0	0	0	0	0	0
1632.0	0	0	0	1	0	0	1	0	0	0	0	0	0
1632.5	0	0	0	1	0	0	1	0	0	0	0	0	0
1633.0	0	0	0	1	0	0	1	0	0	0	0	0	0
1633.5	0	0	0	1	0	0	1	0	0	0	0	0	0
1634.0	0	0	0	1	0	0	1	0	0	0	0	0	0
1634.5	0	0	0	1	0	0	1	0	0	0	0	0	0
1635.0	0	0	0	1	0	0	1	0	0	0	0	0	0
TOTAL	99	245	376	31	266	676	17	86	437	56	30	7	139

EXHIBIT 690 022182

recorded during the sampling and maximum depth data from Corps, the Missouri River was approximately 70 feet deep at RM 1314.0.

Mammals observed at the I-94 study site included white-tailed deer, cottontail rabbit, red squirrel, and signs of beaver activity. Bird species identified were Swainson's hawk, American goldfinch, yellowthroat, wren, vireo, nighthawk, eastern kingbird, and blackbird.

EXHIBIT 690 022183


I-94 Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-57

Sibley Park

The Sibley Park study site was a complex of chutes, channels, and islands at Sibley Park, near the southern city limits of Bismarck, North Dakota. It was located on the left bank of the Missouri River near RM 1306.5. The Sibley Park study site was the most upstream site included in the Oahe delta but was classified as riverine because it is above mean pool elevation.

The most abundant cover type in the study site was PEMC wetlands which accounted for 158.1 acres (25.0 percent) (Table SP-1). The dominant species in these wetlands were reed canarygrass, common reed, silvery cinquefoil, three-square, and slough sedge. The soils in the PEMC wetlands were saturated 6 to 12 inches below the surface with heavy mottles and oxidized root zones. A large stand of riparian forest (RF), 60.1 acres (9.5 percent), was located at the upstream end of the study site and supported, primarily, cottonwood trees. Scrub-shrub wetlands, PSSA and PSSC, were typically situated on berms. Sandbar willow, peachleaf willow, and cottonwood shrubs were the dominant species in the scrub-shrub wetlands; an understory consisting of the herbaceous PEMC wetland species was also present is PSSC wetlands. Permanently flooded chutes and channels (PUBH) occupied a total surface area of 31.5 acres (5.0 percent) of the study site.

Table SP-1. Wetland and riparian acreages mapped in the Sibley Park study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	19.6
Palustrine emergent seasonally flooded (PEMC)	158.1
Palustrine emergent semipermanently flooded (PEMF)	25.9
Palustrine scrub-shrub temporarily flooded (PSSA)	31.0
Palustrine scrub-shrub seasonally flooded (PSSC)	31.1
Palustrine forest temporarily flooded (PFOA)	6.0
Riparian grassland (RG)	3.0
Riparian shrub (RS)	6.8
Riparian forest (RF)	60.1
Riverine unconsolidated bottom permanently flooded (RUBH)	150.5
Riverine unconsolidated shore (RUS)	98.3
Riverine unconsolidated shore vegetated (RUS5)	10.0
Palustrine unconsolidated bottom permanently flooded (PUBH)	31.5
Total	631.9

Wetland and riparian elevational distributions were measured along 5 transects on August 21, 1991 and standardized around RM 1306.5. Elevations ranged from PUBH wetlands at 1615.0 (measured in a channel approximately 4.5 feet deep) to temporarily flooded wetlands and riparian vegetation at 1624.5 (Table SP-2). The water surface of the Missouri River at RM 1306.5 was 1620.0.

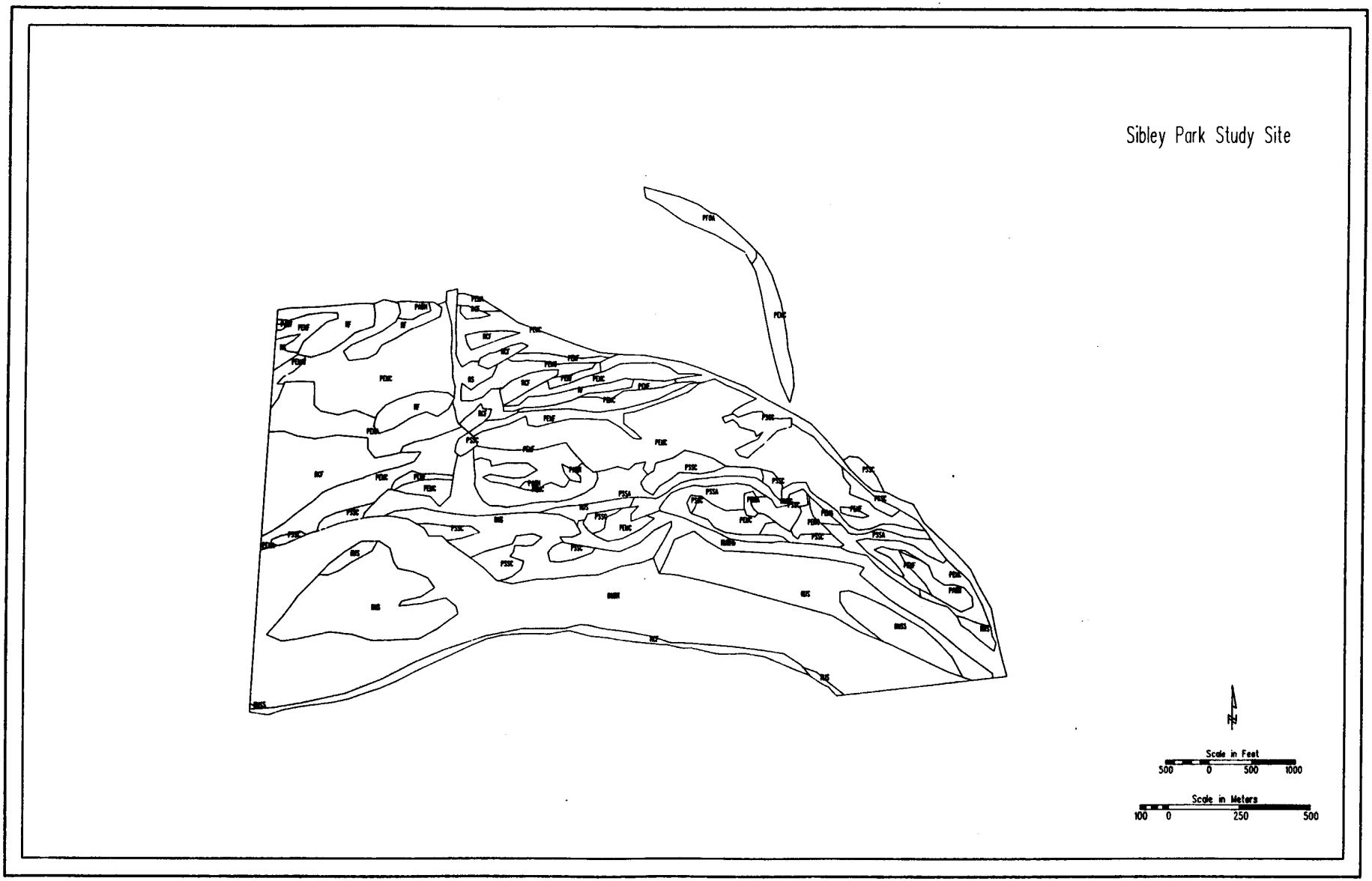
EXHIBIT 690 022185

Table SP-2. Distribution of sampling points by elevation.

Missouri River - SIBLEY Study Site
River Mile 1306.5 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	PSSC	PSSA	LUBH	LUS	RG	PFOA	RF	RS	LUS5	PUBH
1555.0	0	0	0	0	0	1	0	0	0	0	0	0	0
1555.5	0	0	0	0	0	1	0	0	0	0	0	0	0
.....													
.....													
1614.0	0	0	0	0	0	1	0	0	0	0	0	0	0
1614.5	0	0	0	0	0	1	0	0	0	0	0	0	0
1615.0	0	0	0	0	0	1	0	0	0	0	0	0	0
1615.5	0	0	0	0	0	1	0	0	0	0	0	0	1
1616.0	0	0	0	0	0	1	0	0	0	0	0	0	9
1616.5	0	0	0	0	0	1	0	0	0	0	0	0	14
1617.0	0	0	0	0	0	1	0	0	0	0	0	0	15
1617.5	0	0	0	0	0	1	0	0	0	0	0	0	15
1618.0	0	0	0	0	0	1	0	0	0	0	0	0	14
1618.5	0	0	0	1	0	1	0	0	0	0	0	0	16
1619.0	4	0	0	2	0	1	1	0	0	0	0	1	11
1619.5	12	2	0	1	0	1	0	0	0	0	0	0	8
1620.0	21	22	0	2	0	1	0	0	0	0	0	0	5
1620.5	26	88	0	1	0	0	0	0	0	0	0	0	0
1621.0	0	131	0	2	0	0	1	0	0	0	0	1	0
1621.5	0	277	0	3	2	0	0	0	2	2	2	0	0
1622.0	0	254	0	6	15	0	0	0	15	15	15	0	0
1622.5	0	35	11	88	43	0	0	11	43	43	43	0	0
1623.0	0	0	16	42	80	0	0	16	80	80	80	0	0
1623.5	0	0	15	52	36	0	0	15	36	36	36	0	0
1624.0	0	0	55	1	64	0	0	55	64	64	64	0	0
1624.5	0	0	0	0	6	0	0	0	6	6	6	0	0
TOTAL	63	809	97	201	246	130	2	97	246	246	246	2	108

EXHIBIT 690 022186


Sibley Park Study Site
N
Scale in Feet
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Scale in Meters
100 0 250 500

Kimball/Graner/McLean

The Kimball/Graner/McLean study site was a large expanse of bottomlands between the Kimball, Graner, and McLean bottoms, approximately 10 miles upstream of Huff, North Dakota. This area was considered to be the in the Lake Oahe delta although the upper end is classified as riverine because it is above the mean pool elevation. The site was comprised of numerous chutes, backwaters, and islands in a meandering portion of the river. These bottomlands contain the Oahe Game Management Area managed by the state of North Dakota, as well as a Ducks Unlimited project in an area near the McLean Bottoms boat ramp (RM 1296.5). Portions of the study site were being managed for wildlife by growing non-cash crops.

Much of the Kimball/Graner/McLean study site consisted of riparian vegetation. Riparian forests (RF) contributed 1363.1 acres (25.6 percent) (Table KG-1) and were dominated by large cottonwood trees with a typical understory of golden rod and clover. RF stands were found in the bottomlands and the lands adjacent to the study site. The most prevalent wetland cover type was PEMC, contributing 688.4 acres (12.9 percent) to the 1899.1 total acres of emergent and scrub-shrub wetlands in the study site. PEMC wetlands were located throughout the study site adjacent to old chutes and were characterized by reed canarygrass, common reed, and slough sedge. PEMF wetlands were concentrated around McLean Bottoms and were dominated by cattail (284.6 acres). Although there was no standing water in these wetlands, river bulrush and hardstem bulrush, along with cattail, were persistent and healthy. Soils throughout the wetland cover types were moist at the surface and mottled, however, the water table was not encountered, even 2 feet below the surface.

Table KG-1. Wetland and riparian acreages mapped in the Kimball/Graner/McLean study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	562.5
Palustrine emergent seasonally flooded (PEMC)	688.4
Palustrine emergent semipermanently flooded (PEMF)	284.6
Palustrine scrub-shrub temporarily flooded (PSSA)	236.2
Palustrine scrub-shrub seasonally flooded (PSSC)	127.4
Palustrine forest temporarily flooded (PFOA)	196.5
Palustrine forest seasonally flooded (PFOC)	7.0
Riparian grassland (RG)	764.2
Riparian shrub (RS)	44.9
Riparian forest (RF)	1,363.1
Lacustrine unconsolidated bottom permanently flooded (LUBH)	560.5
Lacustrine unconsolidated shore (LUS)	350.6
Lacustrine unconsolidated shore vegetated (LUS5)	54.8
Palustrine unconsolidated bottom permanently flooded (PUBH)	26.4
Riverine unconsolidated bottom permanently flooded (RUBH)	60.6
Total	5,327.7

EXHIBIT 690 022188

Wetland and riparian elevational distributions were measured along transects in two separate areas; 4 transects were located in McLean Bottoms near the Ducks Unlimited project and 4 transects were located at Kimball Bottoms. All transects were standardized around RM 1293.5. Cover type elevations ranged from PUBH at 1608.5 to riparian vegetation and temporarily flooded wetlands at 1619.5. The water surface elevation of the Missouri River was 1611.0 near RM 1289 and 1611.9 near RM 1293. Sampling was done on August, 22, 1991.

Bird species identified at the Kimball/Graner/McLean study site included sora, mallard, pintail, blue-winged teal, eastern kingbird, American goldfinch, grackle, Swainson's hawk, marsh wren, and western sandpiper.

EXHIBIT 690 022189

Table KG-2. Distribution of Sampling Points by Elevation.

Missouri River - Kimball/Graner/McLean Study Site
River Mile 1293 - All Transects Combined

Elevation	PEMF	PEMC	PEMA 1/	PSSC	PSSA	PFOC 1/	PFOA 1/	RF	RS 1/	LUBH 2/	RG	PUBH	LUS 1/	LUS5	RUBH 2/
1548.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1549.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
.... Distribution 'HITS' of LUBH and RUBH are evenly distributed through the range not displayed.															
1606.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1607.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1607.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1608.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1608.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1609.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1609.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1610.0	0	0	0	0	0	0	0	0	0	1	0	0	6	6	1
1610.5	18	3	0	0	0	0	0	0	0	1	0	0	6	6	1
1611.0	31	2	0	0	0	0	0	0	0	1	0	0	19	19	1
1611.5	66	2	0	11	0	11	0	0	0	1	0	0	2	2	1
1612.0	130	7	0	10	0	10	0	0	0	1	0	67	4	4	1
1612.5	14	52	0	11	0	11	0	0	0	1	0	43	8	8	1
1613.0	31	49	0	11	0	11	0	0	0	1	0	0	7	7	1
1613.5	171	44	0	2	0	2	0	0	0	0	0	0	0	0	0
1614.0	451	46	10	0	10	0	10	0	0	0	0	0	0	0	0
1614.5	539	127	21	0	21	0	21	0	0	0	22	0	0	0	0
1615.0	18	72	36	9	36	9	36	0	0	0	27	0	0	0	0
1615.5	0	110	32	58	32	58	32	0	0	0	27	0	0	0	0
1616.0	0	72	11	91	11	91	11	0	0	0	0	0	1	1	0
1616.5	0	25	46	189	46	189	46	0	0	0	0	0	0	0	0
1617.0	0	12	3	94	3	94	3	0	0	0	0	0	0	0	0
1617.5	0	0	8	85	8	85	8	0	0	0	0	0	0	0	0
1618.0	0	0	8	0	8	0	8	0	0	0	1	0	0	0	0
1618.5	0	0	4	0	4	0	4	0	0	0	0	0	0	0	0
1619.0	0	0	2	0	2	0	2	0	0	0	1	0	0	0	0
1619.5	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
1620.0	0	0	2	0	2	0	2	0	0	0	1	0	0	0	0
1620.5	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0

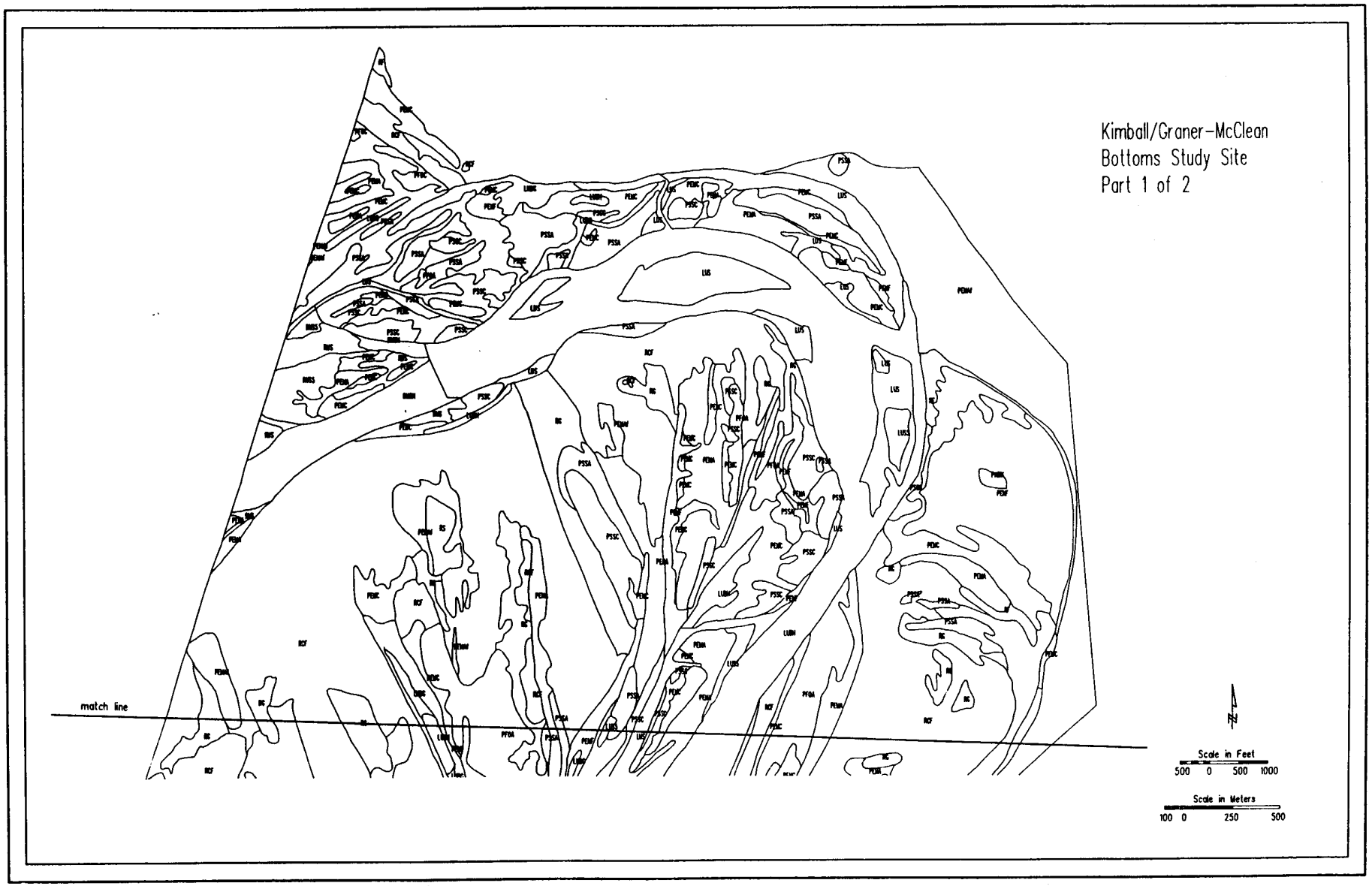
Table KG-2. Distribution of Sampling Points by Elevation.

Missouri River - Kimball/Graner/McLean Study Site
River Mile 1293 - All Transects Combined

Elevation	PEMF	PEMC	PEMA 1/	PSSC	PSSA	PFOC 1/	PFOA 1/	RF	RS 1/	LUBH 2/	RG	PUBH	LUS 1/	LUS5	RUBH 2/
1621.0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
1621.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1622.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1623.5	0	0	0	0	0	0	0	24	24	0	1	0	0	0	0
1624.0	0	0	0	0	0	0	0	56	56	0	0	0	0	0	0
1624.5	0	0	0	0	0	0	0	85	85	0	1	0	0	0	0
1625.0	0	0	0	0	0	0	0	100	100	0	0	0	0	0	0
1625.5	0	0	0	0	0	0	0	32	32	0	1	0	0	0	0
1626.0	0	0	0	0	0	0	0	239	239	0	10	0	0	0	0
1626.5	0	0	0	0	0	0	0	94	94	0	0	0	0	0	0
1627.0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0
Total	1469	623	186	571	186	571	186	633	633	130	94	110	53	53	130

1/ Vegetation types that were not encountered during sampling, but appeared in the vegetation mapping of the site were assigned 'HIT' distributions of types with similar hydrological characteristics that were sampled, including:
PEMA = PSSA
PFOC = PSSC
PFOA = PSSA
RS = RF
LUS = LUS5

2/ LUBH and RUBH 'HITS' were evenly distributed from the water surface elevation to THALWEG at RM 1293.


Kimball/Graner-McClean
Bottoms Study Site
Part 1 of 2
match line
Scale in Feet
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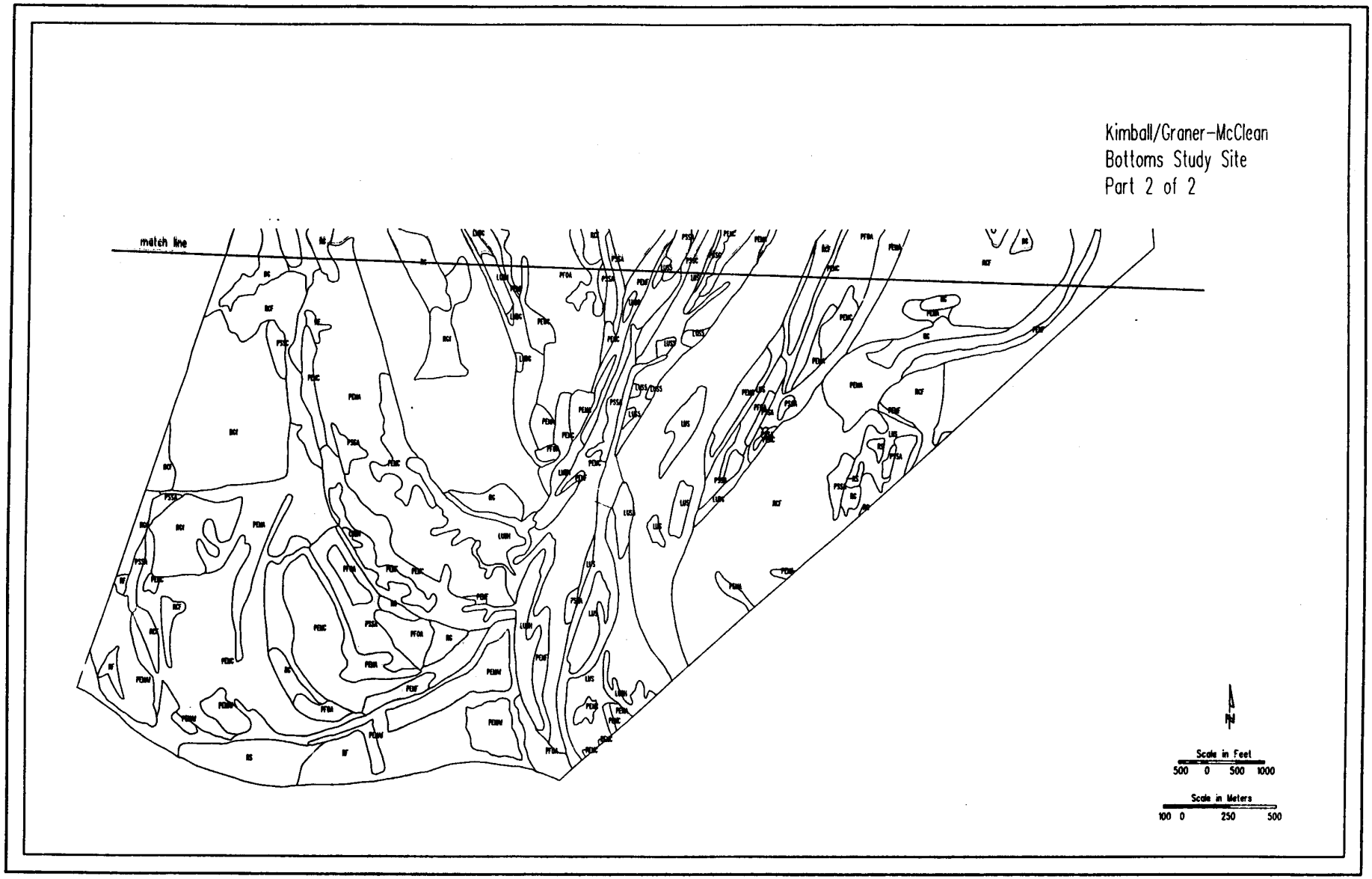
Scale in Meters
100 0 250 500


Kimball/Graner-McClean
Bottoms Study Site
Part 2 of 2
match line
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Glencoe/Carlson

The Glencoe/Carlson study site was a very large site consisting of 2 backwater areas in the Lake Oahe delta that are mostly underwater when the reservoir is at maximum pool. However, at the time of sampling, the site was characterized by 2 side lakes or ponds connected to the river by a series of active channels and sloughs. This site was located on the left bank of the Missouri River, approximately 5 miles upstream of Fort Rice, North Dakota, and extended from just south of Glencoe Slough to south of Wilde Lake.

Carlson Lake, although relatively shallow, was the largest lake in the study site and Wilde Lake was approximately half the size of Carlson. Together these lakes (PUBH) occupied a surface area of 676.9 acres (Table GC-1). Both lakes were surrounded by thin bands of PEMF wetland, dominated by cattail, and occupied 143.8 acres. PEMC wetlands, which contributed 868.8 acres (10.2 percent) to the study site, were found throughout the area. However, the healthiest, most extensive expanses were surrounding Carlson Lake. River bulrush, beggar's tick, and cutgrass were the dominant species in the PEMC wetlands. A significant portion of the study site, 3,909.4 acres (46.0 percent), was recently-exposed LUS5 sediments that were colonized by sunflower, cocklebur, and sweet clover. Scrub-shrub wetlands were found bordering the expanses of LUS5 and occupied a total of 906.3 acres (10.7 percent).

Table GC-1. Wetland and riparian acreages mapped in the Glencoe/Carlson study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	269.6
Palustrine emergent seasonally flooded (PEMC)	868.8
Palustrine emergent semipermanently flooded (PEMF)	143.8
Palustrine scrub-shrub temporarily flooded (PSSA)	212.7
Palustrine scrub-shrub seasonally flooded (PSSC)	693.6
Palustrine forest temporarily flooded (PFOA)	27.4
Riparian grassland (RG)	106.1
Riparian shrub (RS)	108.2
Riparian forest (RF)	279.3
Lacustrine unconsolidated bottom permanently flooded (LUBH)	711.4
Lacustrine unconsolidated shore (LUS)	487.4
Lacustrine unconsolidated shore vegetated (LUS5)	3,909.4
Palustrine unconsolidated bottom permanently flooded (PUBH)	676.9
Total	8,494.7

The elevational distribution of wetland and riparian types were measured along 9 transects that were standardized around RM 1282.5. Cover type elevations ranged from PUBH at 1601.5 to RF at 1615.0 (Table GC-2). The water surface elevation of the Missouri River was 1602.5 at RM 1282.5. Sampling was done on August 23, 1991.

EXHIBIT 690 022194

Table GC-2. Distribution of Sampling Points by Elevation.

Missouri River - Glencoe/Carlson Bottoms Study Site
River Mile 1278 - All Transects Combined

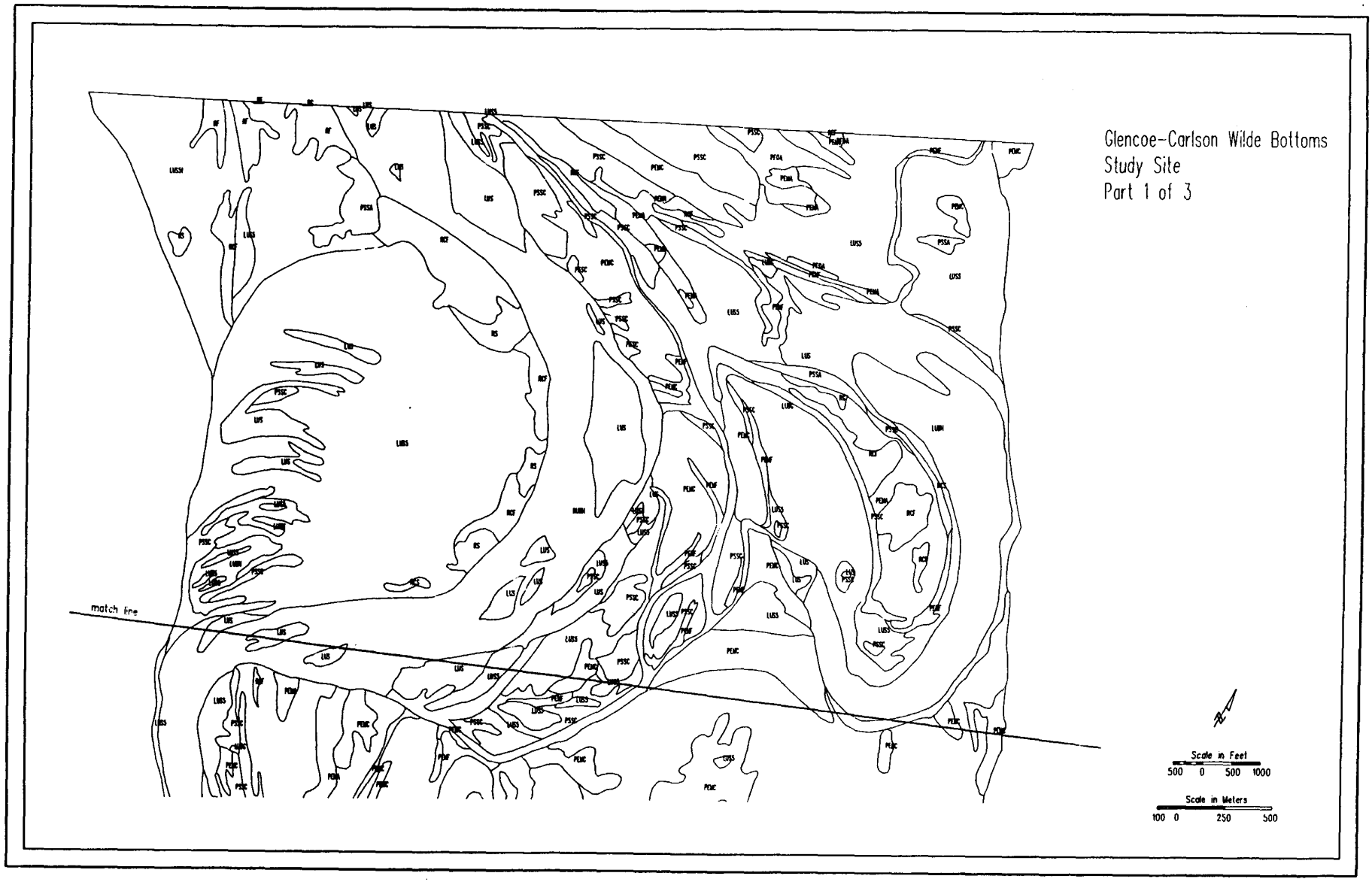
Elevation	PEMF	PEMC	PEMA	RG 3/	PSSC	PSSA	RF 3/	RS 1/ 3/	LUBH 2/	PFOA	PUBH	LUS5	LUS 1/
1548.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1549.0	0	0	0	0	0	0	0	0	1	0	0	0	0
.... Distribution "HITS" of LUBH are evenly distributed through the range not displayed.													
1598.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1598.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1599.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1599.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1600.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1600.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1601.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1601.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1602.0	32	0	0	0	0	0	0	0	1	0	39	0	0
1602.5	60	37	0	0	0	0	0	0	1	0	7	1	1
1603.0	46	34	0	0	0	0	0	0	1	0	185	5	5
1603.5	249	61	0	0	5	0	0	0	1	0	92	6	6
1604.0	28	56	0	0	176	0	0	0	0	0	0	35	35
1604.5	11	41	0	0	43	0	0	0	0	0	0	88	88
1605.0	6	39	0	0	86	1	0	0	0	0	0	12	12
1605.5	6	31	4	0	157	18	0	0	0	0	0	405	405
1606.0	7	50	4	0	235	25	0	0	0	0	0	285	285
1606.5	6	7	11	0	180	9	0	0	0	0	0	174	174
1607.0	6	0	40	0	27	98	0	0	0	0	0	121	121
1607.5	3	0	30	0	3	5	0	0	0	0	0	97	97
1608.0	0	0	123	0	0	27	0	0	0	0	0	91	91
1608.5	0	0	51	1	0	0	0	0	0	2	0	81	81
1609.0	0	0	76	1	0	6	0	0	0	10	0	14	14
1609.5	0	0	90	1	0	34	0	0	0	11	0	0	0
1610.0	0	0	61	1	0	3	0	0	0	10	0	0	0
1610.5	0	0	8	1	0	0	0	0	0	1	0	0	0
1611.0	0	0	2	1	0	0	1	1	0	0	0	0	0
1611.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1612.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1612.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1613.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1613.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1614.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1614.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1615.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1615.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1616.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1616.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1617.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1617.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1618.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1618.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1619.0	0	0	0	1	0	0	1	1	0	0	0	0	0
1619.5	0	0	0	1	0	0	1	1	0	0	0	0	0
1620.0	0	0	0	1	0	0	1	1	0	0	0	0	0
Total	460	356	500	24	912	226	19	19	111	34	323	1415	1415

1/ Vegetation types that were not encountered during sampling, but appeared in the vegetation mapping of the site were assigned 'HIT' distributions of types with similar hydrological characteristics that were sampled, including:
RS = RF
LUS = LUS5

2/ LUBH 'HITS' were evenly distributed from the water surface elevation to THALWEG at RM 1278.

3/ All riparian vegetation types were evenly distributed from the lowest elevation sampled to the highest elevation in the 100-year floodplain.

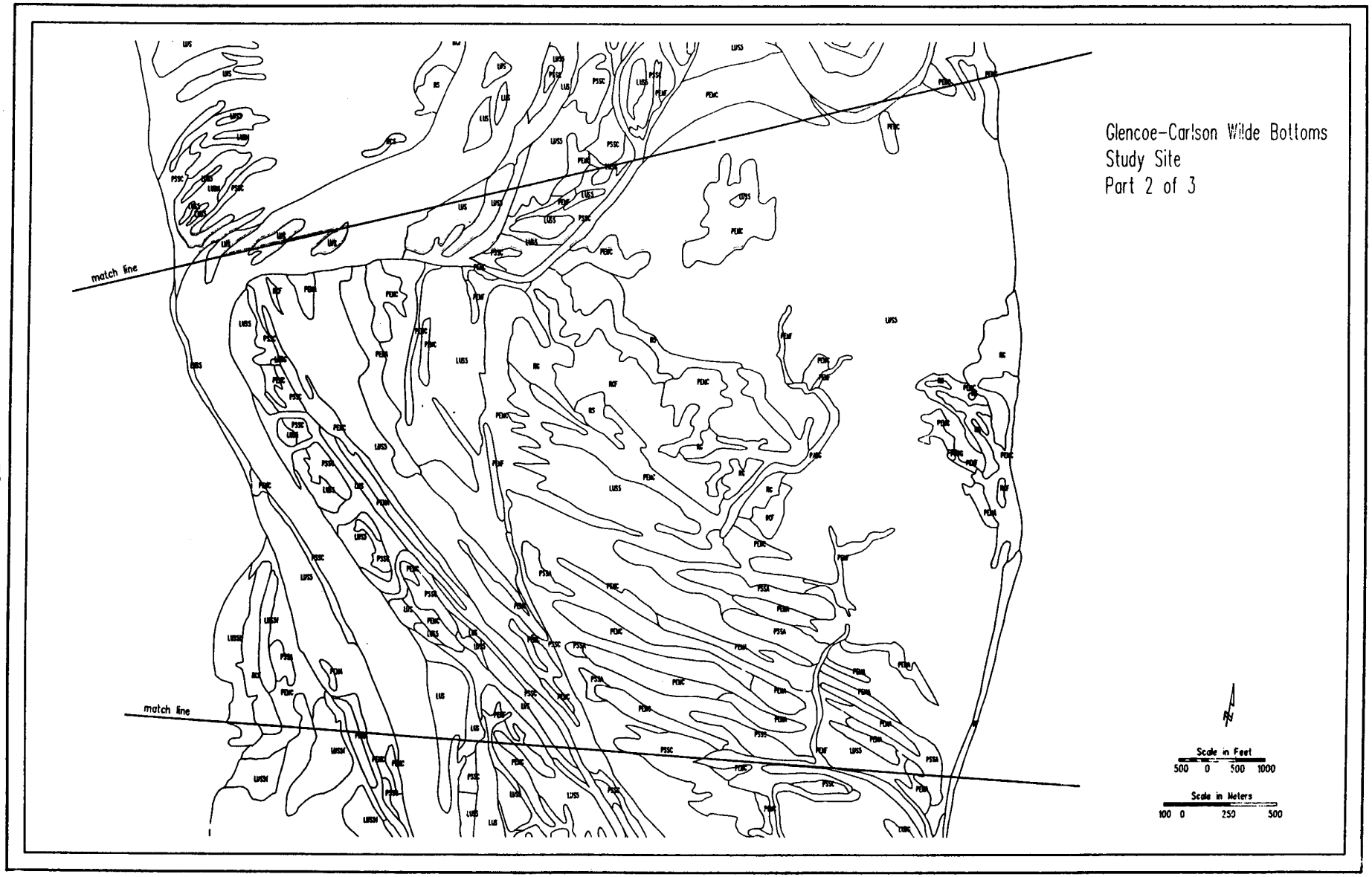
EXHIBIT 690 022195



B-69

EXHIBIT 690

022196


Glencoe-Carlson Wilde Bottoms
Study Site
Part 2 of 3
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Scale in Meters
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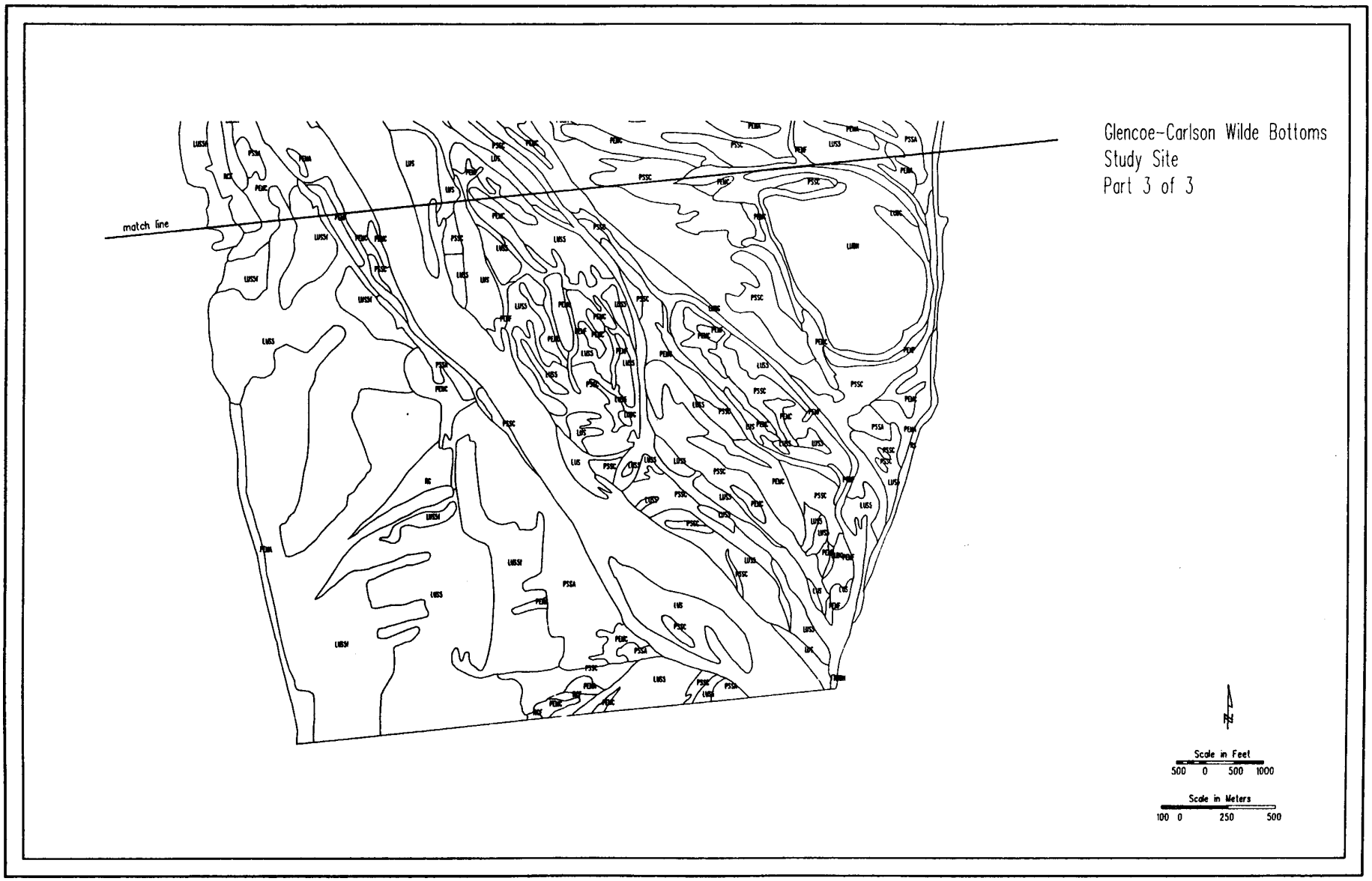
B-70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Glencoe-Carlson Wilde Bottoms
Study Site
Part 3 of 3
Scale in Feet
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Scale in Meters
100 0 250 500

Cannonball River

The Cannonball River study site was an expansive complex of vegetated drawdown zone and scattered wetlands located at the confluence of the Cannonball and Missouri rivers at RM 1269.5. The study site was within the Standing Rock Indian Reservation, near the town of Cannonball, North Dakota. This study site was included in the Oahe tributary deltas and was part of the upper river.

This study site, a large expanse of bottomlands in the Cannonball River delta, was dominated by vegetated, unconsolidated shoreline wetlands (LUS5), which occupied 3184.5 acres (64.5 percent) (Table CN-1). During periods of low water, tribal members often plant non-cash crops in the bottomlands. However, during the sampling period most of these lands were characterized by pioneering species, including sunflower, pigweed, Canadian thistle, and clover. The soils in the LUS5 cover type were dry at the surface, yet moist and mottled 4 to 18 inches below the surface. Scrub-shrub wetlands (PSSA) were found in old oxbow beds and on a large island located in Lake Oahe, at the mouth of the Cannonball River. Representing 412.5 acres (8.4 percent) of the study site, PSSA wetlands were characterized by sandbar willow, peachleaf willow, and cottonwood shrubs.

Table CN-1. Wetland and riparian acreages mapped in the Cannonball River study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	98.1
Palustrine emergent seasonally flooded (PEMC)	21.3
Palustrine emergent semipermanently flooded (PEMF)	1.0
Palustrine scrub-shrub temporarily flooded (PSSA)	412.5
Palustrine scrub-shrub seasonally flooded (PSSC)	1.2
Palustrine forest temporarily flooded (PFOA)	21.3
Riparian grassland (RG)	98.6
Riparian forest (RF)	107.6
Lacustrine unconsolidated bottom permanently flooded (LUBH)	583.4
Lacustrine unconsolidated shore vegetated (LUS5)	3,184.5
Lacustrine unconsolidated shore (LUS)	330.4
Riverine unconsolidated bottom permanently flooded (RUBH)	74.0
Total	4,933.9

Wetland and riparian elevational distributions were measured along 4 transects during a 2-day sampling period, August 23 and 24, 1991. Cover type elevations ranged from PEMF wetlands at 1595.5 to riparian cover types at 1620.0 (Table CN-2). The water surface elevation of the Cannonball River was 1599.7 at Cannonball RM 0.1. The water surface elevation of Lake Oahe was 1597.2 at Missouri RM 1269.5.

EXHIBIT 690 022199

Table CN-2. Distribution of sampling points by elevation.

Missouri River - Cannonball River Study Site
River Mile 1269.5 (Missouri River) and 0.1 (Cannonball River)

Elevation	PEMF	PEMC	PEMA	PSSA	LUBH 2/	LUS	RUBH 2/	RG	LUS5	PFOA 1/	RF 1/	PSSC 1/
1582.0	0	0	0	0	1	0	0	0	0	0	0	0
1582.5	0	0	0	0	1	0	0	0	0	0	0	0
1583.0	0	0	0	0	1	0	0	0	0	0	0	0
1583.5	0	0	0	0	1	0	0	0	0	0	0	0
1584.0	0	0	0	0	1	0	0	0	0	0	0	0
1584.5	0	0	0	0	1	0	0	0	0	0	0	0
1585.0	0	0	0	0	1	0	0	0	0	0	0	0
1585.5	0	0	0	0	1	0	0	0	0	0	0	0
1586.0	0	0	0	0	1	0	0	0	0	0	0	0
1586.5	0	0	0	0	1	0	0	0	0	0	0	0
1587.0	0	0	0	0	1	0	0	0	0	0	0	0
1587.5	0	0	0	0	1	0	0	0	0	0	0	0
1588.0	0	0	0	0	1	0	0	0	0	0	0	0
1588.5	0	0	0	0	1	0	0	0	0	0	0	0
1589.0	0	0	0	0	1	0	0	0	0	0	0	0
1589.5	0	0	0	0	1	0	0	0	0	0	0	0
1590.0	0	0	0	0	1	0	0	0	0	0	0	0
1590.5	0	0	0	0	1	0	0	0	0	0	0	0
1591.0	0	0	0	0	1	0	0	0	0	0	0	0
1591.5	0	0	0	0	1	0	0	0	0	0	0	0
1592.0	0	0	0	0	1	0	0	0	0	0	0	0
1592.5	0	0	0	0	1	0	0	0	0	0	0	0
1593.0	0	0	0	0	1	0	0	0	0	0	0	0
1593.5	0	0	0	0	1	0	1	0	0	0	0	0
1594.0	0	0	0	0	1	0	1	0	0	0	0	0
1594.5	0	0	0	0	1	0	1	0	0	0	0	0
1595.0	0	0	0	0	1	0	1	0	0	0	0	0
1595.5	1	0	0	0	1	0	1	0	0	0	0	0
1596.0	1	0	0	0	1	0	1	0	0	0	0	0
1596.5	1	3	0	0	1	0	1	0	0	0	0	3
1597.0	0	2	0	0	1	3	1	0	1	0	0	2
1597.5	0	1	0	0	0	6	1	0	0	0	0	1
1598.0	0	1	0	0	0	5	1	0	3	0	0	1
1598.5	0	0	0	0	0	6	1	0	7	0	0	0
1599.0	0	0	0	0	0	6	1	0	5	0	0	0
1599.5	0	0	0	0	0	6	1	0	10	0	0	0
1600.0	0	0	0	0	0	6	0	0	11	0	0	0
1600.5	0	0	0	0	0	6	0	0	21	0	0	0
1601.0	0	0	0	0	0	5	0	0	263	0	0	0
1601.5	0	0	0	8	0	0	0	0	700	0	0	0
1602.0	0	0	0	1	0	0	0	0	525	0	0	0
1602.5	0	0	0	34	0	0	0	0	351	0	0	0
1603.0	0	0	0	28	0	0	0	0	199	0	0	0
1603.5	0	0	19	12	0	0	0	0	134	0	0	0
1604.0	0	0	0	38	0	0	0	0	135	0	0	0
1604.5	0	0	0	38	0	0	0	0	134	0	0	0
1605.0	0	0	0	35	0	0	0	0	135	0	0	0
1605.5	0	0	0	25	0	0	0	0	148	0	0	0

EXHIBIT 690 022200

Table CN-2. Distribution of sampling points by elevation.

Missouri River - Cannonball River Study Site
River Mile 1269.5 (Missouri River) and 0.1 (Cannonball River)

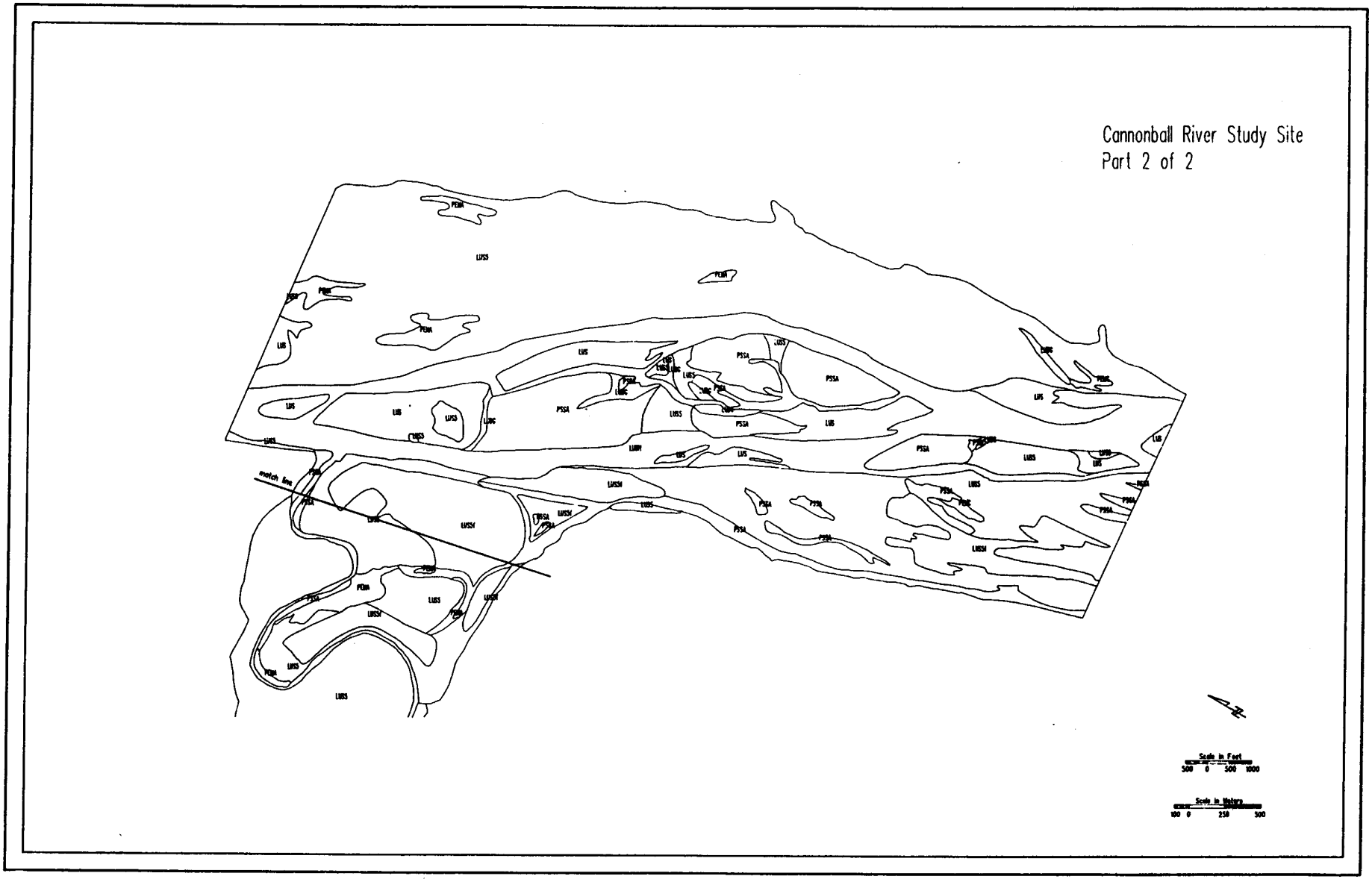
Elevation	PEMF	PEMC	PEMA	PSSA	LUBH 2/	LUS	RUBH 2/	RG	LUS5	PFOA 1/	RF 1/	PSSC 1/
1606.0	0	0	0	12	0	0	0	0	194	0	0	0
1606.5	0	0	19	9	0	0	0	0	162	0	0	0
1607.0	0	0	22	6	0	0	0	0	33	0	0	0
1607.5	0	0	89	7	0	0	0	0	68	0	0	0
1608.0	0	0	28	7	0	0	0	0	198	1	0	0
1608.5	0	0	28	7	0	0	0	0	263	1	0	0
1609.0	0	0	5	6	0	0	0	0	174	1	0	0
1609.5	0	0	0	7	0	0	0	0	28	1	0	0
1610.0	0	0	0	7	0	0	0	0	0	1	0	0
1610.5	0	0	0	7	0	0	0	0	0	1	0	0
1611.0	0	0	0	6	0	0	0	0	0	1	0	0
1611.5	0	0	0	7	0	0	0	0	0	1	0	0
1612.0	0	0	0	7	0	0	0	0	0	1	0	0
1612.5	0	0	0	7	0	0	0	0	0	1	0	0
1613.0	0	0	0	6	0	0	0	0	0	1	0	0
1613.5	0	0	0	7	0	0	0	0	0	1	0	0
1614.0	0	0	0	7	0	0	0	0	0	1	0	0
1614.5	0	0	0	7	0	0	0	0	0	1	0	0
1615.0	0	0	0	6	0	0	0	0	0	1	0	0
1615.5	0	0	0	7	0	0	0	0	0	1	0	0
1616.0	0	0	0	7	0	0	0	0	0	1	0	0
1616.5	0	0	0	7	0	0	0	0	0	1	0	0
1617.0	0	0	0	6	0	0	0	0	0	1	0	0
1619.0	0	0	0	0	0	0	0	1	0	1	1	0
1619.5	0	0	0	0	0	0	0	1	0	1	1	0
1620.0	0	0	0	0	0	0	0	1	0	1	1	0
Total	3	7	210	381	31	49	13	3	3902	22	3	7

1/ Vegetation types that were not encountered during sampling, but appeared in the vegetation mapping of the site were assigned 'HIT' distributions of types with similar hydrological characteristics that were sampled, including:
RF = RG
PSSC = PEMC
PFOA was evenly distributed from the lowest point sampled to its highest possible elevation in the 100-year floodplain

2/ LUBH 'HITS' were evenly distributed from the water surface elevation to THALWEG at Missouri RM 1296.5 and RUBH 'HITS' were evenly distributed from the Cannonball River water surface elvation to THALWEG at RM 0.1.

EXHIBIT 690 022201

Cannonball River Study Site
Part 1 of 2


Cannonball River Study Site
Part 2 of 2
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Moreau River

The Moreau River, a major right-bank tributary of the Missouri River, enters Lake Oahe at RM 1336.0. The study site was located in the Moreau River delta, RM 29.7, which lies within the Cheyenne River Indian Reservation near Promise, South Dakota. The Moreau River study site was included in the Oahe tributary delta and was part of the upper river.

Large expanses of unconsolidated shoreline, both barren and vegetated (LUS and LUS5, respectively), occupied a significant portion, 4299.4 acres (27.3 percent), of the study site (Table MO-1). These cover types occurred from the area that was sampled (Moreau RM 29.7) to the confluence of the Moreau and Missouri rivers. LUS5 areas were dominated by pioneering species such as Canadian thistle, prickly lettuce, smartweed, and cocklebur. Scrub-shrub wetlands, PSSA and PSSC, represented a total of 1962.9 acres (12.5 percent) of the study area. Aerial photography from 1986 shows water covering a significant portion of the area currently occupied by scrub-shrub wetlands. There was, however, no standing water at the time of sampling. Soils were saturated 4 inches below the surface and mottles and oxidized roots zones were present. Sandbar willow was the dominant species in both the PSSA and PSSC wetlands. Small stands of PFOA wetlands, dominated by peachleaf willow, were scattered throughout the upper end of the study site and occupied 103.7 acres (less than 1 percent).

Table MO-1. Wetland and riparian acreages mapped in the Moreau River delta study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	55.7
Palustrine emergent seasonally flooded (PEMC)	309.9
Palustrine scrub-shrub temporarily flooded (PSSA)	166.3
Palustrine scrub-shrub seasonally flooded (PSSC)	1,796.6
Palustrine forest temporarily flooded (PFOA)	103.7
Riparian grassland (RG)	160.8
Riparian forest (RF)	60.4
Lacustrine unconsolidated bottom permanently flooded (LUBH)	8,660.4
Lacustrine unconsolidated shore vegetated (LUS5)	1,693.6
Lacustrine unconsolidated shore (LUS)	2,605.8
Riverine unconsolidated bottom permanently flooded (RUBH)	105.5
Riverine unconsolidated shore (RUS)	28.3
Total	15,747.0

Four transects, standardized around Moreau RM 29.7, were used to measure the wetland and riparian elevational distributions. Sampling took place on August 26, 1991. LUS5 was found throughout the elevational distribution of all other wetland types at the site, from 1605.0 to 1623.5 (Table MO-2). The Moreau River, at the time of sampling,

EXHIBIT 690 022204

Table MO-2. Distribution of sampling points by elevation.

Missouri River - Moreau River Study Site
River Mile 29.7 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	RUBH 1/	LUBH 1/	PFOA	LUS 2/	LUS5 2/	RUS 3/	RG 3/	RF 3/
1524.0	0	0	0	0	0	1	0	0	0	0	0	0
1524.5	0	0	0	0	0	1	0	0	0	0	0	0
....Distributions 'HITS' of LUBH are evenly distributed through the range not displayed.										0	0	0
1586.0	0	0	0	0	0	1	0	0	0	0	0	0
1586.5	0	0	0	0	0	1	0	0	0	0	0	0
1587.0	0	0	0	0	0	1	0	0	0	0	0	0
1587.5	0	0	0	0	1	0	0	1	1	0	0	0
1588.0	0	0	0	0	1	0	0	1	1	0	0	0
1588.5	0	0	0	0	1	0	0	1	1	0	0	0
1589.0	0	0	0	0	1	0	0	1	1	0	0	0
1589.5	0	0	0	0	1	0	0	1	1	0	0	0
1590.0	0	0	0	0	1	0	0	1	1	0	0	0
1590.5	0	0	0	0	1	0	0	1	1	0	0	0
1591.0	0	0	0	0	1	0	0	1	1	0	0	0
1591.5	0	0	0	0	1	0	0	1	1	0	0	0
1592.0	0	0	0	0	1	0	0	1	1	0	0	0
1592.5	0	0	0	0	1	0	0	1	1	0	0	0
1593.0	0	0	0	0	1	0	0	1	1	0	0	0
1593.5	0	0	0	0	1	0	0	1	1	0	0	0
1594.0	0	0	0	0	1	0	0	1	1	0	0	0
1594.5	0	0	0	0	1	0	0	1	1	0	0	0
1595.0	0	0	0	0	1	0	0	1	1	0	0	0
1595.5	0	0	0	0	1	0	0	1	1	0	0	0
1596.0	0	0	0	0	1	0	0	1	1	0	0	0
1596.5	0	0	0	0	1	0	0	1	1	0	0	0
1597.0	0	0	0	0	1	0	0	1	1	0	0	0
1597.5	0	0	0	0	1	0	0	1	1	0	0	0
1598.0	0	0	0	0	1	0	0	1	1	0	0	0
1598.5	0	0	0	0	1	0	0	1	1	0	0	0
1599.0	0	0	0	0	1	0	0	1	1	0	0	0

EXHIBIT 690

022205

Table MO-2. Distribution of sampling points by elevation.

Missouri River - Moreau River Study Site
River Mile 29.7 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	RUBH 1/	LUBH 1/	PFOA	LUS 2/	LUS5 2/	RUS 3/	RG 3/	RF 3/
1599.5	0	0	0	0	1	0	0	1	1	0	0	0
1600.0	0	0	0	0	1	0	0	1	1	0	0	0
1600.5	0	0	0	0	1	0	0	1	1	0	0	0
1601.0	0	0	0	0	1	0	0	1	1	0	0	0
1601.5	0	0	0	0	1	0	0	1	1	0	0	0
1602.0	0	0	0	0	1	0	0	1	1	0	0	0
1602.5	0	0	0	0	1	0	0	1	1	0	0	0
1603.0	0	0	0	0	1	0	0	1	1	0	0	0
1603.5	0	0	0	0	1	0	0	1	1	0	0	0
1604.0	0	0	0	0	1	0	0	1	1	0	0	0
1605.0	0	0	0	0	1	0	0	1	1	0	0	0
1605.5	0	0	0	0	1	0	0	1	1	5	0	0
1606.0	1	0	0	0	1	0	0	1	1	10	0	0
1606.5	3	0	0	0	0	0	0	1	1	6	0	0
1607.0	15	0	0	0	0	0	0	1	1	6	0	0
1607.5	16	0	2	0	0	0	0	1	1	6	0	0
1608.0	9	0	5	0	0	0	0	1	1	2	0	0
1608.5	7	0	9	0	0	0	0	0	1	0	0	0
1609.0	1	0	16	0	0	0	0	0	1	0	0	0
1609.5	297	0	19	0	0	0	0	0	1	0	0	0
1610.0	722	0	41	0	0	0	0	0	1	0	0	0
1610.5	1028	6	60	0	0	0	0	0	1	0	0	0
1611.0	677	30	24	5	0	0	0	0	1	0	0	0
1611.5	126	650	56	81	0	0	0	0	1	0	0	0
1612.0	5	620	1	159	0	0	0	0	1	0	0	0
1612.5	0	7	0	188	0	0	0	0	1	0	0	0
1613.0	0	45	0	127	0	0	0	0	1	0	0	0
1613.5	0	23	0	93	0	0	14	0	1	0	0	0
1614.0	0	3	0	0	0	0	137	0	1	0	0	0
1614.5	0	0	0	0	0	0	207	0	1	0	0	0

Table MO-2. Distribution of sampling points by elevation.

Missouri River - Moreau River Study Site
River Mile 29.7 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	RUBH 1/	LUBH 1/	PFOA	LUS 2/	LUS5 2/	RUS 3/	RG 3/	RF 3/
1615.0	0	0	0	0	0	0	70	0	1	0	0	0
1615.5	0	0	0	0	0	0	0	0	1	0	0	0
1616.0	0	0	0	0	0	0	0	0	1	0	1	1
1616.5	0	0	0	0	0	0	0	0	1	0	1	1
1617.0	0	0	0	0	0	0	0	0	1	0	1	1
1617.5	0	0	0	0	0	0	0	0	1	0	1	1
1618.0	0	0	0	0	0	0	0	0	1	0	1	1
1618.5	0	0	0	0	0	0	0	0	1	0	1	1
1619.0	0	0	0	0	0	0	0	0	1	0	1	1
1619.5	0	0	0	0	0	0	0	0	1	0	1	1
1620.0	0	0	0	0	0	0	0	0	1	0	1	1
1620.5	0	0	0	0	0	0	0	0	1	0	1	1
1621.0	0	0	0	0	0	0	0	0	1	0	1	1
1621.5	0	0	0	0	0	0	0	0	1	0	1	1
1622.0	0	0	0	0	0	0	0	0	1	0	1	1
1622.5	0	0	0	0	0	0	0	0	1	0	1	1
1623.0	0	0	0	0	0	0	0	0	1	0	1	1
1623.5	0	0	0	0	0	0	0	0	1	0	1	1
Total	2907	1384	233	653	37	126	428	41	72	35	16	16

1/ RUBH and LUBH 'HITS' were evenly distributed from the water surface elevations of Lake Oahe and the Moreau River to their respective THALWEGS.

2/ LUS and LUS5 'HITS' were evenly distributed from the highest elevation sampled to the Lake Oahe water surface elevation.

3/ RF was not encountered during sampling but was included in the study site mapping. Therefore, RF was assigned the identical elevational distribution as RG. Both RF and RG were then evenly distributed from the lowest elevation sampled to the highest elevation in the 100-year floodplain.

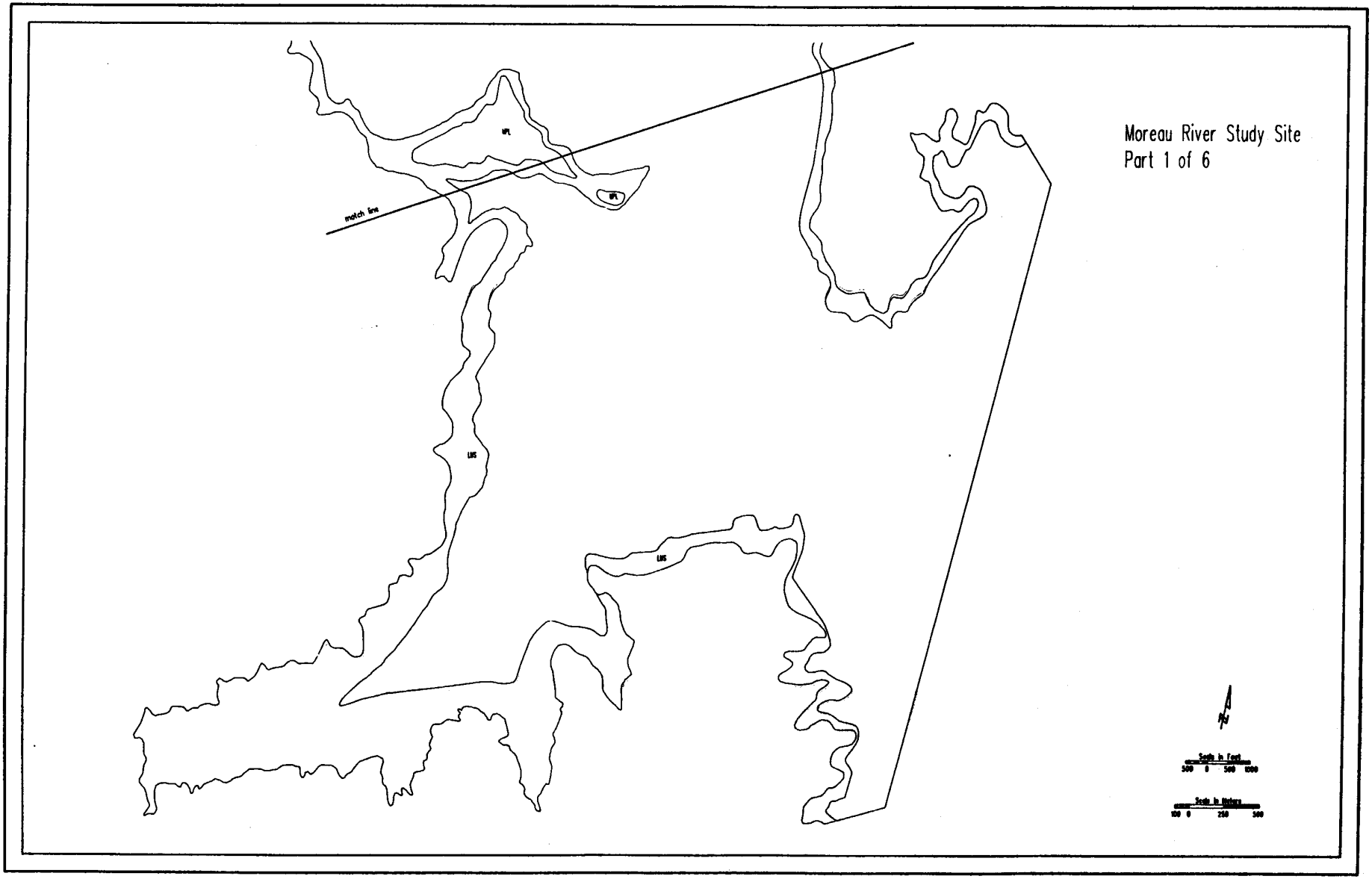
EXHIBIT 690

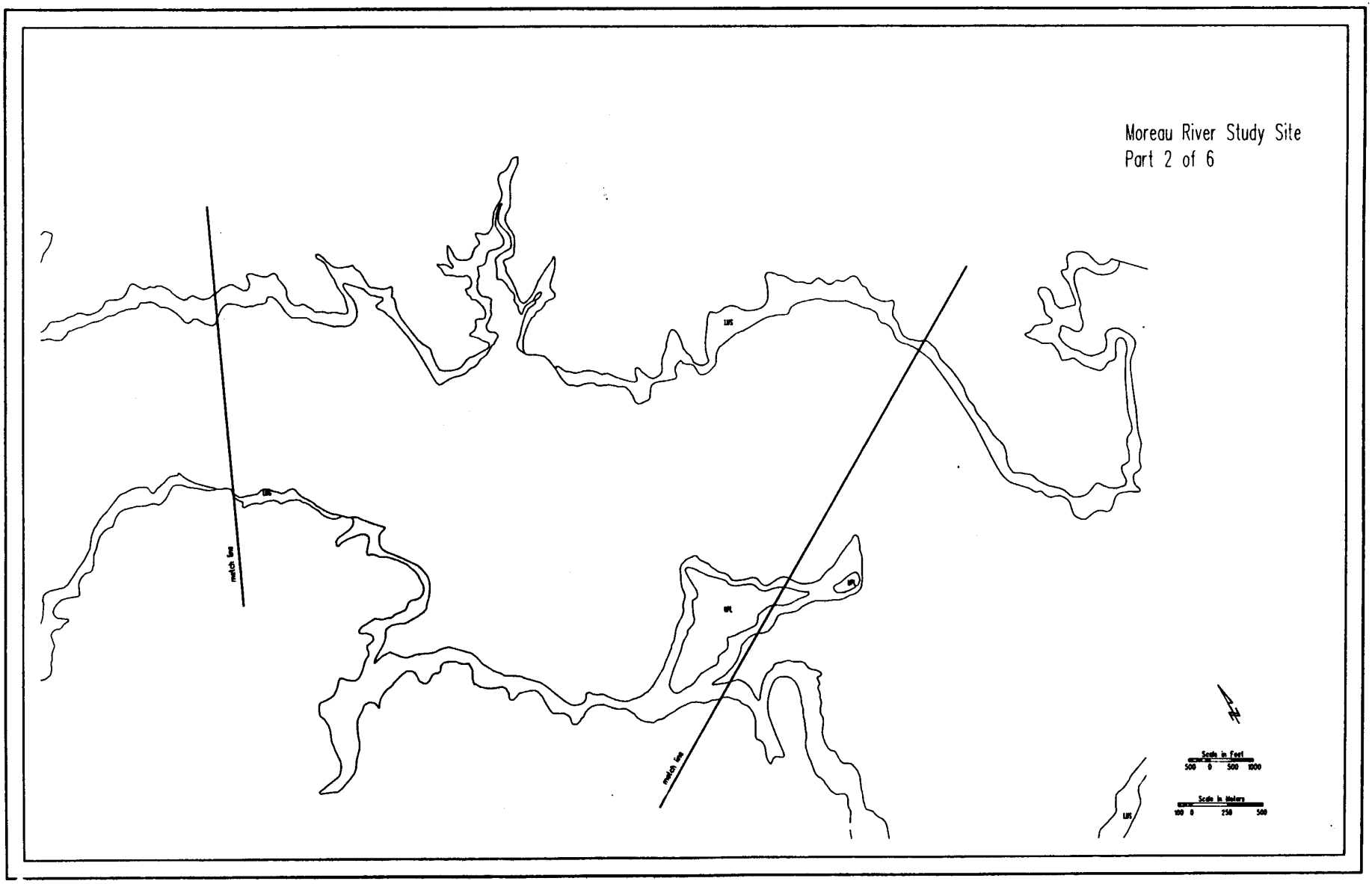
022207

was only about 1 foot wide and very shallow and had a water surface elevation of 1606.6. According to U.S. Army Corps of Engineers data, the water surface of Lake Oahe, approximately 30 miles downstream, was 1587.0.

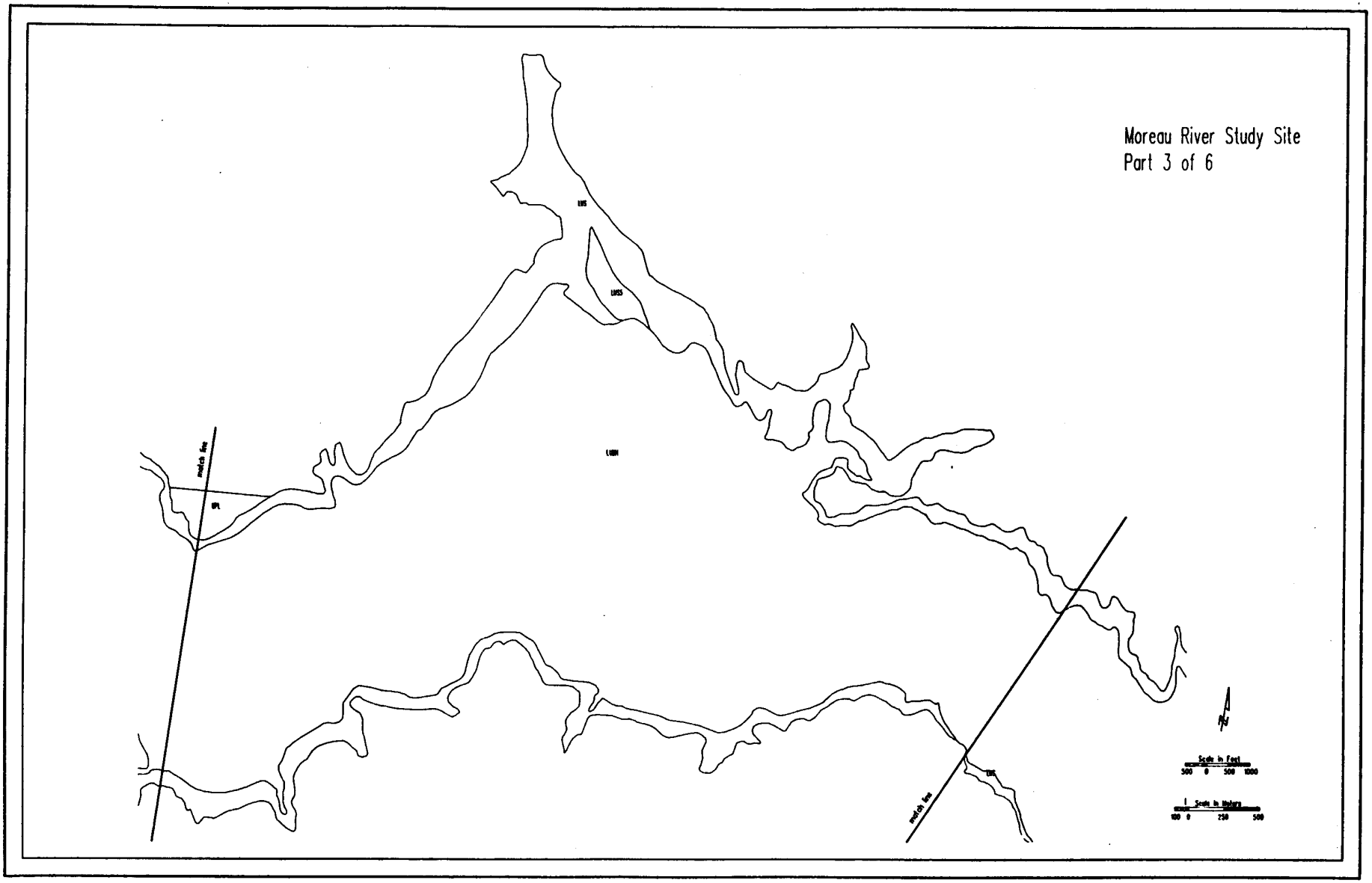
Wildlife species observed at the Moreau River study site included: red-tailed hawk, kestrel, marsh hawk, grackle, red-winged blackbird, mourning dove, sharp-tailed grouse, great blue heron, western kingbird, raccoon, and white-tailed deer.

EXHIBIT 690 022208

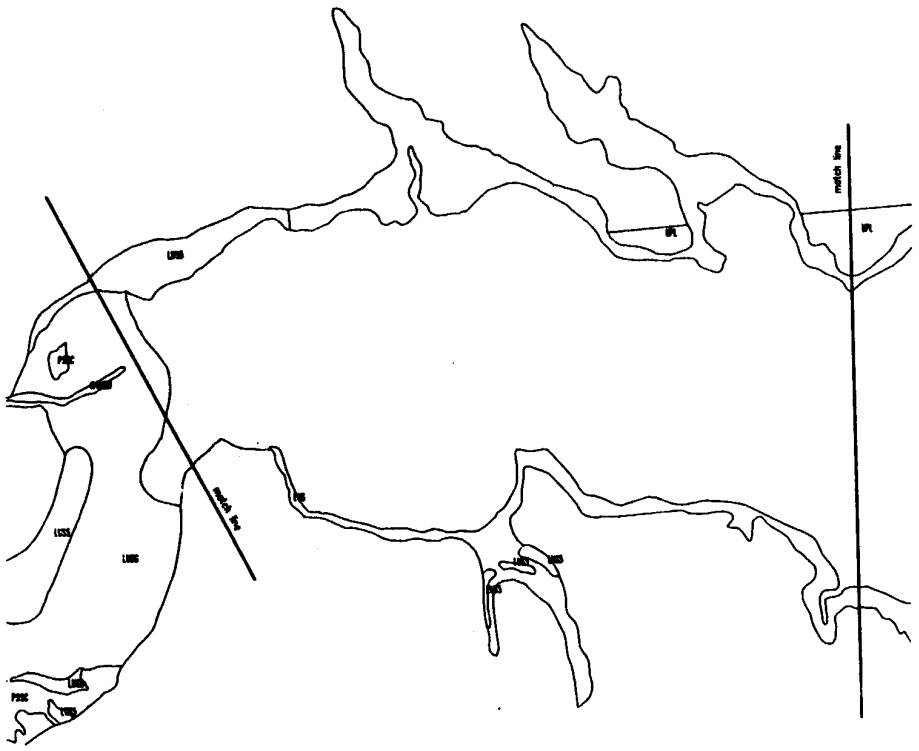

Moreau River Study Site
Part 1 of 6
match line
WPL
WPL
LMS
LMS

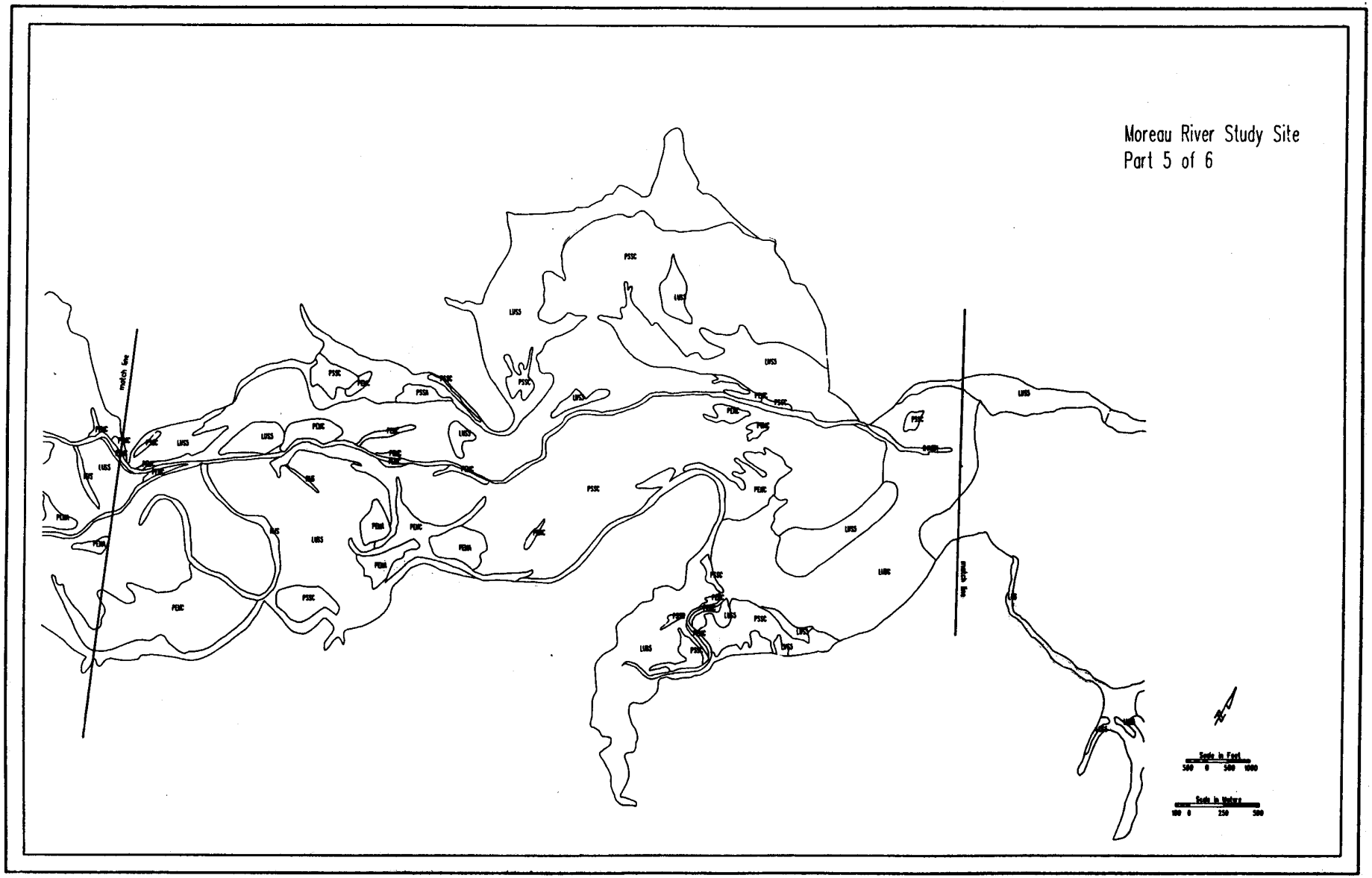

Moreau River Study Site
Part 2 of 6
match line
match line
LWS
LWS
LWS
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-83

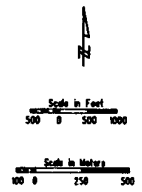

Moreau River Study Site
Part 3 of 6

Moreau River Study Site
Part 4 of 6




Moreau River Study Site
Part 5 of 6

Moreau River Study Site
Part 6 of 6



Cheyenne River

The Cheyenne River, a major right-bank tributary of the Missouri River, enters Lake Oahe at RM 1165.5. The study site was located at Cheyenne RM 26.4, near the Sunshine Ranch in the Cheyenne River Indian Reservation, South Dakota. The Cheyenne River study site was included in the Oahe tributary deltas and was part of the upper river.

The expansive bottomlands in the Cheyenne River delta were primarily classified as LUS5. Occupying 3223.7 acres (45.0 percent) of the study (Table CY-1), LUS5 areas were dominated by pioneering species, including smartweed, beggar's tick, switchgrass, prickly lettuce, and Canadian thistle. Scrub-shrub wetlands represented a total of 1631.3 acres (22.8 percent); PSSC wetlands contributed 1618.5 of those acres. Characterized by stands of sandbar willow shrubs and an understory of the LUS5 species listed above, the PSSC wetlands were located throughout the Cheyenne River delta at elevations equal to, or higher than, the elevational distribution of the LUS5 (Table CY-2). Stands of forested wetlands (PFOC) were found relatively close to the Cheyenne River. Cottonwood was the dominant tree species in the PFOC wetlands that occupied 380.5 acres (5.3 percent) of the study site.

Table CY-1. Wetland and riparian acreages mapped in the Cheyenne River Delta study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent seasonally flooded (PEMC)	90.4
Palustrine scrub-shrub temporarily flooded (PSSA)	12.8
Palustrine scrub-shrub seasonally flooded (PSSC)	1,618.5
Palustrine forest seasonally flooded (PFOC)	380.5
Riparian grassland (RG)	5.3
Lacustrine unconsolidated bottom permanently flooded (LUBH)	659.8
Lacustrine unconsolidated shore vegetated (LUS5)	3,223.7
Riverine unconsolidated bottom permanently flooded (RUBH)	213.4
Riverine unconsolidated shore (RUS)	959.7
Total	7,163.9

Wetland and riparian elevational distributions were measured along 3 transects on September 21, 1991. Cover type elevations ranged from RUS at 1589.5 to PSSC and RG at 1600.5 (Table CY-2). Based on a comparison of vegetation and topographic maps, it is estimated that PFOC and PSSC extend upward to at least elevation 1617 within the Cheyenne River basin. The water surface elevations of the Cheyenne River and Lake Oahe were 1589.5 (based on field data) and 1587.0 (ACOE reservoir level data), respectively.

EXHIBIT 690 022215

Table CY-2. Distribution of sampling points by elevation.

Missouri River - Cheyenne River Study Site
River Mile 26.4 - All Transects Combined

Elevation	PEMC	PSSC 1/	PSSA	RUBH 3/	RUS	PFOC 1/	RG 1/	LUS5 2/	LUBH 3/
1466.0	0	0	0	0	0	0	0	0	1
1466.5	0	0	0	0	0	0	0	0	1
....Distribution 'HITS' of LUBH are evenly distributed through range not displayed.									
1575.0	0	0	0	0	0	0	0	0	1
1575.5	0	0	0	0	0	0	0	0	1
1576.0	0	0	0	0	0	0	0	0	1
1576.5	0	0	0	1	0	0	0	0	1
1577.0	0	0	0	1	0	0	0	0	1
1577.5	0	0	0	1	0	0	0	0	1
1578.0	0	0	0	1	0	0	0	0	1
1578.5	0	0	0	1	0	0	0	0	1
1579.0	0	0	0	1	0	0	0	0	1
1579.5	0	0	0	1	0	0	0	0	1
1580.0	0	0	0	1	0	0	0	0	1
1580.5	0	0	0	1	0	0	0	0	1
1581.0	0	0	0	1	0	0	0	0	1
1581.5	0	0	0	1	0	0	0	0	1
1582.0	0	0	0	1	0	0	0	0	1
1582.5	0	0	0	1	0	0	0	0	1
1583.0	0	0	0	1	0	0	0	0	1
1583.5	0	0	0	1	0	0	0	0	1
1584.0	0	0	0	1	0	0	0	0	1
1584.5	0	0	0	1	0	0	0	0	1
1585.0	0	0	0	1	0	0	0	0	1
1585.5	0	0	0	1	0	0	0	0	1
1586.0	0	0	0	1	0	0	0	0	1
1586.5	0	0	0	1	0	0	0	0	1
1587.0	0	0	0	1	0	0	0	0	1
1587.5	0	0	0	1	0	0	0	1	0
1588.0	0	0	0	1	0	0	0	1	0
1588.5	0	0	0	1	0	0	0	1	0
1589.0	0	0	0	1	0	0	0	1	0
1589.5	0	0	0	1	1	0	0	1	0
1590.0	0	0	0	0	2	0	0	1	0
1590.5	0	0	0	0	2	0	0	1	0
1591.0	0	0	0	0	2	0	0	1	0
1591.5	0	0	0	0	1	0	0	1	0
1592.0	0	0	0	0	0	0	0	1	0
1592.5	96	0	0	0	0	0	0	1	0
1593.0	0	1	0	0	0	0	0	1	0
1593.5	0	1	0	0	0	0	0	1	0
1594.0	0	1	0	0	0	0	0	1	0
1594.5	0	1	0	0	0	0	0	1	0
1595.0	0	1	0	0	0	1	1	1	0
1595.5	0	1	0	0	0	1	1	1	0

EXHIBIT 690 022216

Table CY-2. Distribution of sampling points by elevation.

Missouri River - Cheyenne River Study Site
River Mile 26.4 - All Transects Combined

Elevation	PEMC	PSSC 1/	PSSA	RUBH 3/	RUS	PFOC 1/	RG 1/	LUS5 2/	LUBH 3/
1596.0	0	1	0	0	0	1	1	1	0
1596.5	0	1	27	0	0	1	1	1	0
1597.0	0	1	163	0	0	1	1	1	0
1597.5	0	1	0	0	0	1	1	1	0
1598.0	0	1	0	0	0	1	1	0	0
1598.5	0	1	0	0	0	1	1	0	0
1599.0	0	1	0	0	0	1	1	0	0
1599.5	0	1	0	0	0	1	1	0	0
1600.0	0	1	0	0	0	1	1	0	0
1600.5	0	1	0	0	0	1	1	0	0
1601.0	0	1	0	0	0	1	1	0	0
1601.5	0	1	0	0	0	1	1	0	0
1602.0	0	1	0	0	0	1	1	0	0
1602.5	0	1	0	0	0	1	1	0	0
1603.0	0	1	0	0	0	1	1	0	0
1603.5	0	1	0	0	0	1	1	0	0
1604.0	0	1	0	0	0	1	1	0	0
1604.5	0	1	0	0	0	1	1	0	0
1605.0	0	1	0	0	0	1	1	0	0
1605.5	0	1	0	0	0	1	1	0	0
1606.0	0	1	0	0	0	1	1	0	0
1606.5	0	1	0	0	0	1	1	0	0
1607.0	0	1	0	0	0	1	1	0	0
1607.5	0	1	0	0	0	1	1	0	0
1608.0	0	1	0	0	0	1	1	0	0
1608.5	0	1	0	0	0	1	1	0	0
1609.0	0	1	0	0	0	1	1	0	0
1609.5	0	1	0	0	0	1	1	0	0
1610.0	0	1	0	0	0	1	1	0	0
1610.5	0	1	0	0	0	1	1	0	0
1611.0	0	1	0	0	0	1	1	0	0
1611.5	0	1	0	0	0	1	1	0	0
1612.0	0	1	0	0	0	1	1	0	0
1612.5	0	1	0	0	0	1	1	0	0
1613.0	0	1	0	0	0	1	1	0	0
1613.5	0	1	0	0	0	1	1	0	0
1614.0	0	1	0	0	0	1	1	0	0
1614.5	0	1	0	0	0	1	1	0	0
1615.0	0	1	0	0	0	1	1	0	0
1615.5	0	1	0	0	0	1	1	0	0
1616.0	0	1	0	0	0	1	1	0	0
1616.5	0	1	0	0	0	1	1	0	0
1617.0	0	1	0	0	0	1	1	0	0
1617.5	0	0	0	0	0	0	1	0	0
1618.0	0	0	0	0	0	0	1	0	0

EXHIBIT 690 022217

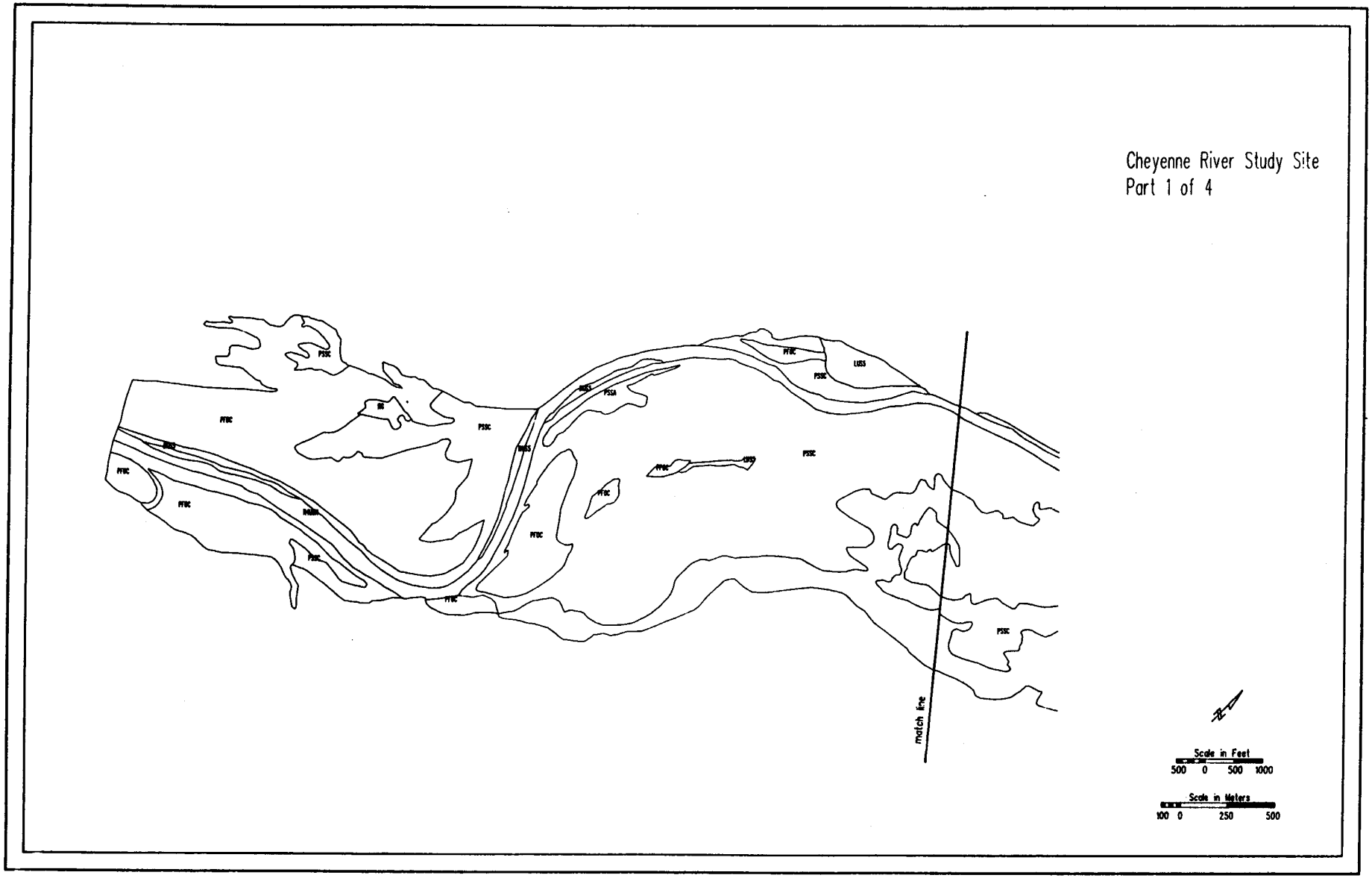
Table CY-2. Distribution of sampling points by elevation.

Missouri River - Cheyenne River Study Site
River Mile 26.4 - All Transects Combined

Elevation	PEMC	PSSC 1/	PSSA	RUBH 3/	RUS	PFOC 1/	RG 1/	LUS5 2/	LUBH 3/
1618.5	0	0	0	0	0	0	1	0	0
1619.0	0	0	0	0	0	0	1	0	0
1619.5	0	0	0	0	0	0	1	0	0
1620.0	0	0	0	0	0	0	1	0	0
Total	96	49	190	27	8	45	51	21	242

1/ PSSC, PFOC, and RG were evenly distributed between the lowest elevation sampled to the highest possible elevation on the USGS topographic map.
2/ LUS5 was evenly distributed between the highest elevation sampled and the water surface elevation of Lake Oahe.
3/ RUBH and LUBH were evenly distributed from the water surface elevations of Lake Oahe and the Cheyenne River to their respective THALWEGS.

EXHIBIT 690 022218


Cheyenne River Study Site
Part 1 of 4
match line
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Scale in Meters
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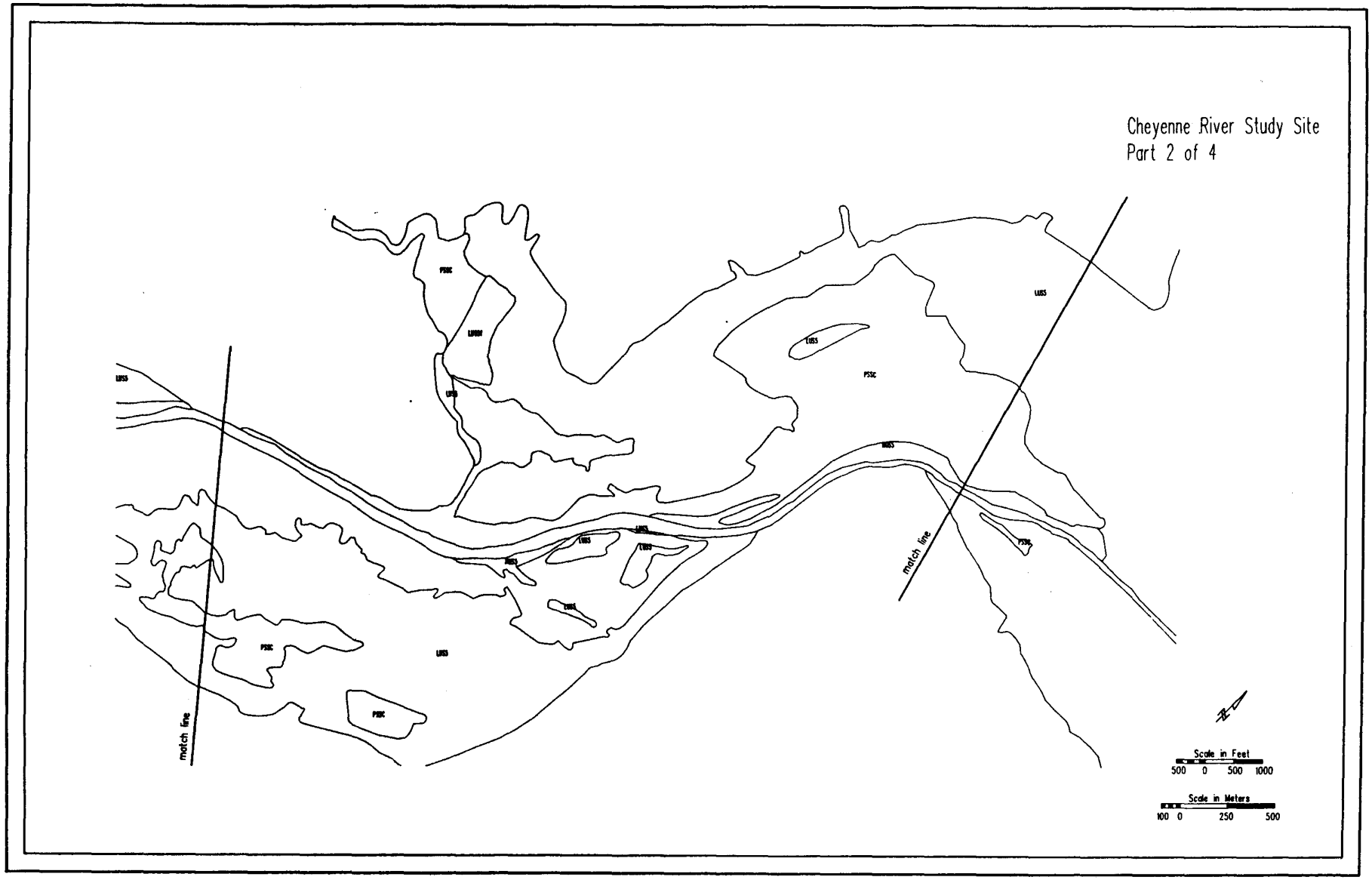
Cheyenne River Study Site
Part 2 of 4
match line
match line
Scale in Feet
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Scale in Meters
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B-93

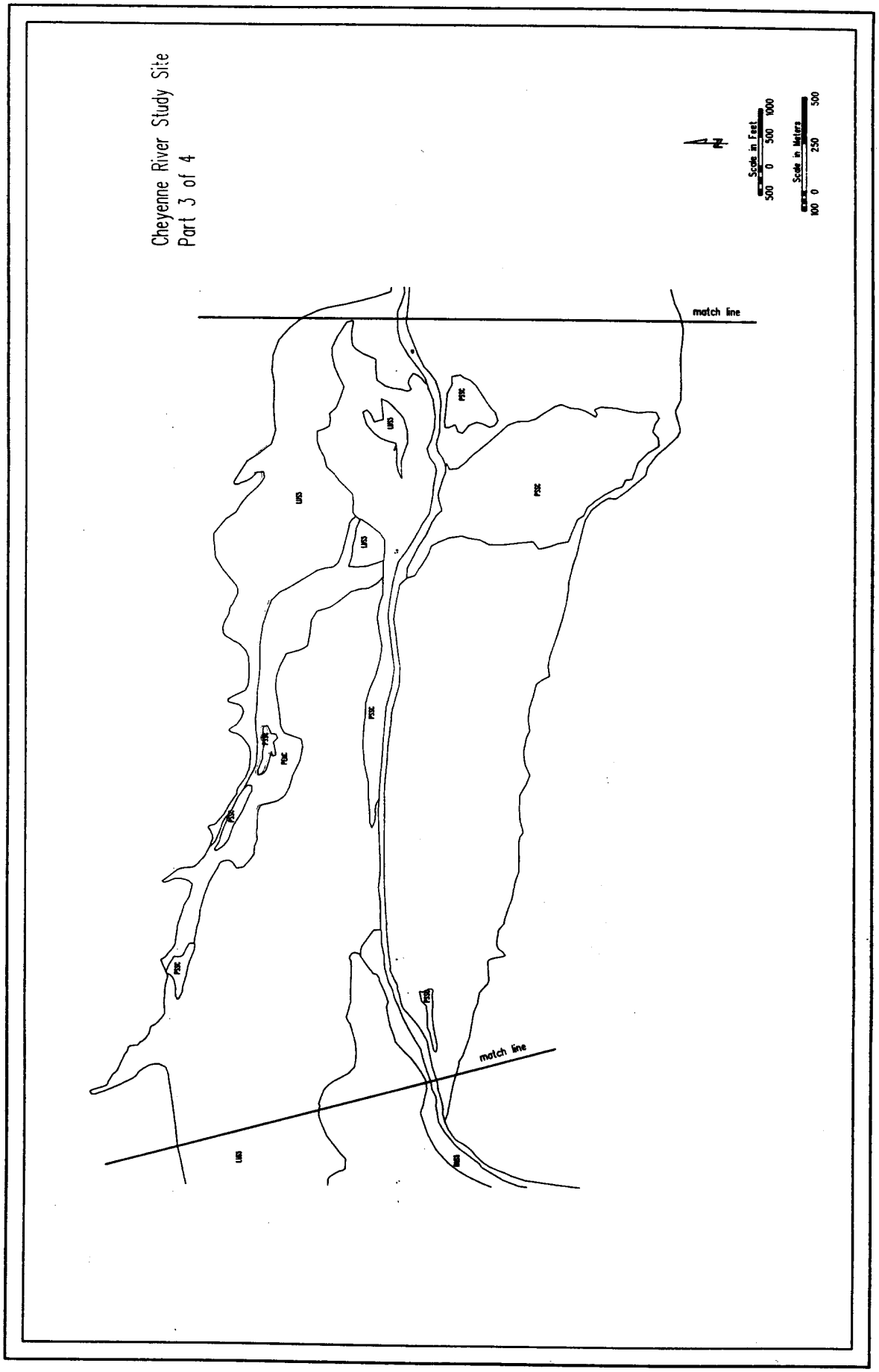
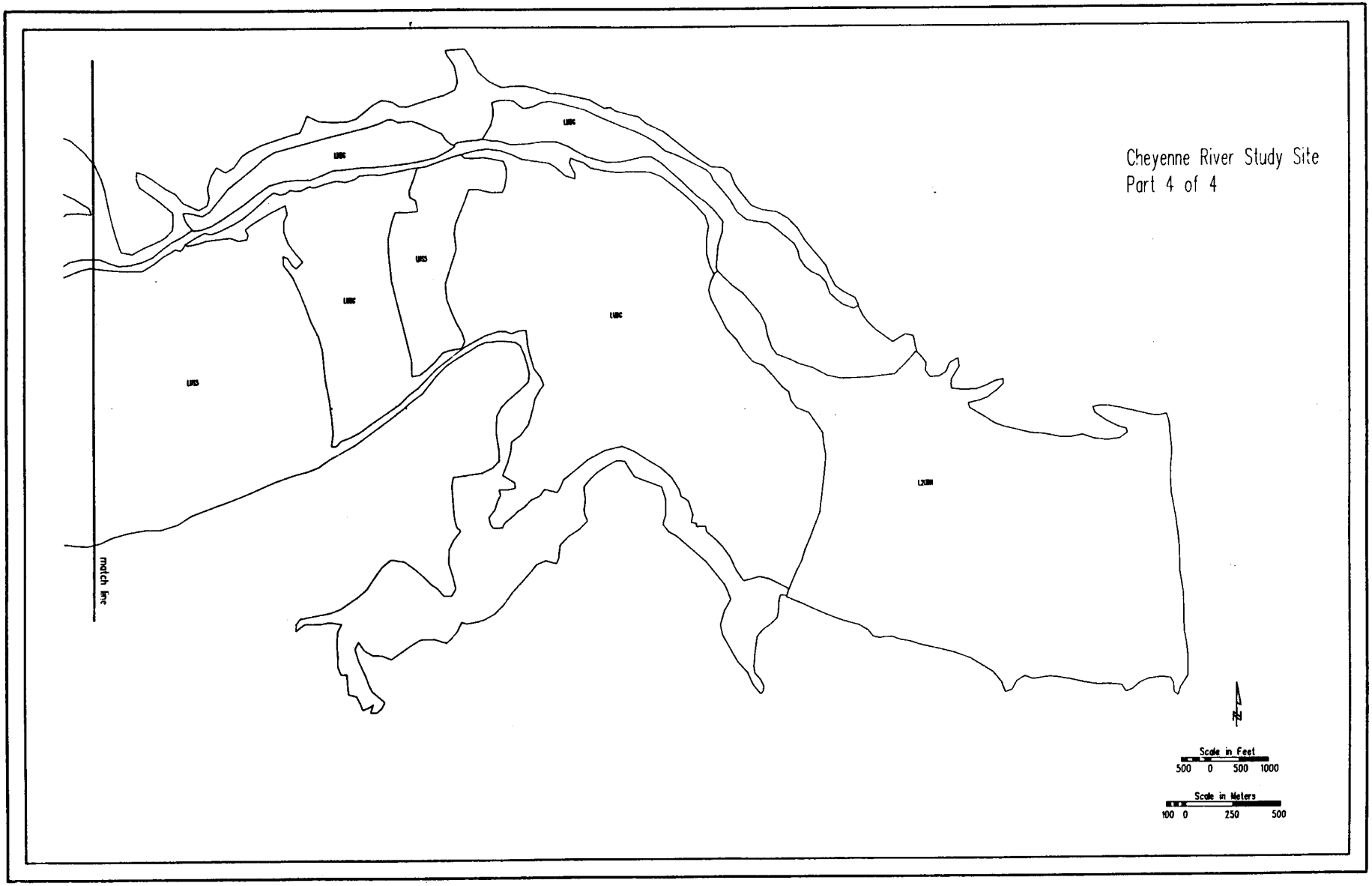


EXHIBIT 690
022221


Cheyenne River Study Site
Part 4 of 4
match line
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Greenwood

The Greenwood study site was a series of channels and chutes on the right bank of the Missouri River, approximately 2 miles downstream of Greenwood, South Dakota. This area had changed notably compared to 1984 aerial photography. At the time of sampling, there was little or no standing water in the channels and chutes and the banks had experienced significant erosion. Portions of the study site had been heavily grazed. The Greenwood study site was part of the Ft. Randall reach in the upper river.

Healthy stands of riparian forests (RF), dominated by cottonwood with switchgrass, scouring rush, and rough-leaved dogwood in the understory, represented 564.0 acres (32.4 percent) of the study site (Table GR-1). Emergent wetlands accounted for a total of 235.1 acres (13.5 percent). PEMF wetlands, dominated by cattails, contributed 104.2 acres and were found in the old channels and chutes. Although there was no standing water in the PEMF wetlands, the soil was saturated 4 to 6 inches below the surface. Many areas were grading from stands of solid cattail to a mix of cattail and weeds, resulting in a transitional zone classified as PEMC wetlands (130.9 acres). Besides cattail, these areas supported hard-stem bulrush, sedges, ragweed, and Canadian thistle. Soils in these PEMC wetlands were saturated, with water less than 18 inches below the surface, and generally sandy with little to no mottles.

Table GR-1. Wetland and riparian acreages mapped in the Greenwood study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	1.0
Palustrine emergent seasonally flooded (PEMC)	130.9
Palustine emergent semipermanently flooded (PEMF)	104.2
Palustrine scrub-shrub temporarily flooded (PSSA)	23.6
Palustrine scrub-shrub seasonally flooded (PSSC)	38.4
Riparian grassland (RG)	102.6
Riparian shrub (RS)	2.1
Riparian forest (RF)	564.0
Riverine unconsolidated bottom permanently flooded (RUBH)	714.0
Riverine unconsolidated shore (RUS)	11.0
Palustrine unconsolidated bottom permanently flooded (PUBH)	48.9
Total	1,740.8

Wetland and riparian cover type elevations were sampled on June 18, 1991 along 5 transects, standardized around RM 863.6. Elevations ranged from 1224.5 to 1231.5 (Table GR-2). The water surface elevation of the Missouri River at RM 863.6 was 1225.5.

A wide variety of wildlife was noted at the Greenwood study site. Mammals observations included a white-tailed deer with 3 fawns, signs of beaver activity, and

EXHIBIT 690 022223

Table GR-2. Distribution of sampling points by elevation.

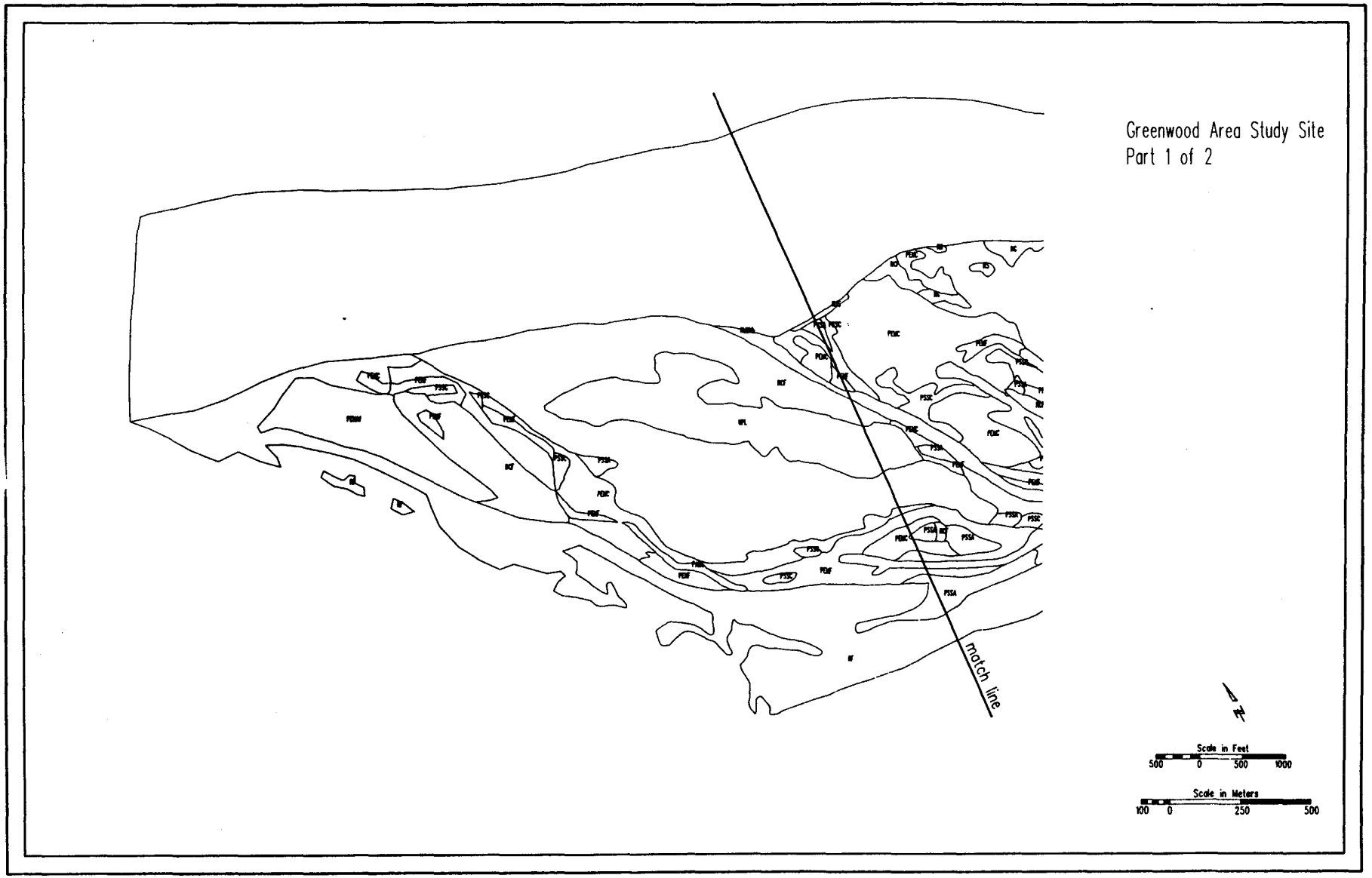
Missouri River - Greenwood Study Site
River Mile 863.6 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RF	RUS	RUBH	RS	PUBH
1213.5	0	0	0	0	0	0	0	0	1	0	0
1214.0	0	0	0	0	0	0	0	0	1	0	0
1214.5	0	0	0	0	0	0	0	0	1	0	0
1215.0	0	0	0	0	0	0	0	0	1	0	0
1215.5	0	0	0	0	0	0	0	0	1	0	0
1216.0	0	0	0	0	0	0	0	0	1	0	0
1216.5	0	0	0	0	0	0	0	0	1	0	0
1217.0	0	0	0	0	0	0	0	0	1	0	0
1217.5	0	0	0	0	0	0	0	0	1	0	0
1218.0	0	0	0	0	0	0	0	0	1	0	0
1218.5	0	0	0	0	0	0	0	0	1	0	0
1219.0	0	0	0	0	0	0	0	0	1	0	0
1219.5	0	0	0	0	0	0	0	0	1	0	0
1220.0	0	0	0	0	0	0	0	0	1	0	0
1220.5	0	0	0	0	0	0	0	0	1	0	0
1221.0	0	0	0	0	0	0	0	0	1	0	0
1221.5	0	0	0	0	0	0	0	0	1	0	0
1222.0	0	0	0	0	0	0	0	0	1	0	0
1222.5	0	0	0	0	0	0	0	0	1	0	0
1223.0	0	0	0	0	0	0	0	0	1	0	0
1223.5	0	0	0	0	0	0	0	0	1	0	0
1224.0	0	0	0	0	0	0	0	0	1	0	0
1224.5	8	0	0	0	0	0	0	0	1	0	2
1225.0	70	0	0	0	0	0	0	2	1	0	2
1225.5	43	0	0	0	0	0	0	2	1	0	2
1226.0	363	9	0	0	9	0	0	2	0	0	0
1226.5	149	152	0	0	20	0	0	2	0	0	0
1227.0	35	642	3	0	87	10	0	2	0	0	0
1227.5	0	268	64	1	202	72	0	1	0	0	0
1228.0	0	6	45	25	6	106	1	2	0	1	0
1228.5	0	3	10	41	0	72	0	2	0	0	0
1229.0	0	0	17	43	0	60	0	0	0	0	0
1229.5	0	0	0	29	0	19	2	0	0	2	0
1230.0	0	0	0	11	0	8	9	0	0	9	0
1230.5	0	0	0	1	0	9	9	0	0	9	0
1231.0	0	0	0	1	0	8	3	0	0	3	0
1231.5	0	0	0	1	0	2	2	0	0	2	0
1232.0	0	0	0	1	0	0	1	0	0	1	0
TOTAL	668	1080	139	154	324	366	27	15	25	27	6

EXHIBIT 690 022224

raccoon prints. Bird species identified included the following: northern oriole, kingfisher, western kingbird, eastern kingbird, red-headed woodpecker, downy woodpecker, Forester's tern, least tern, yellowthroat, bank swallow, great blue heron, grackle, song sparrow, cormorant, white pelican, killdeer, blue jay, red-winged blackbird, American goldfinch, yellow warbler, and mourning dove.

EXHIBIT 690 022225


Greenwood Area Study Site
Part 1 of 2
match line
N
Scale in Feet
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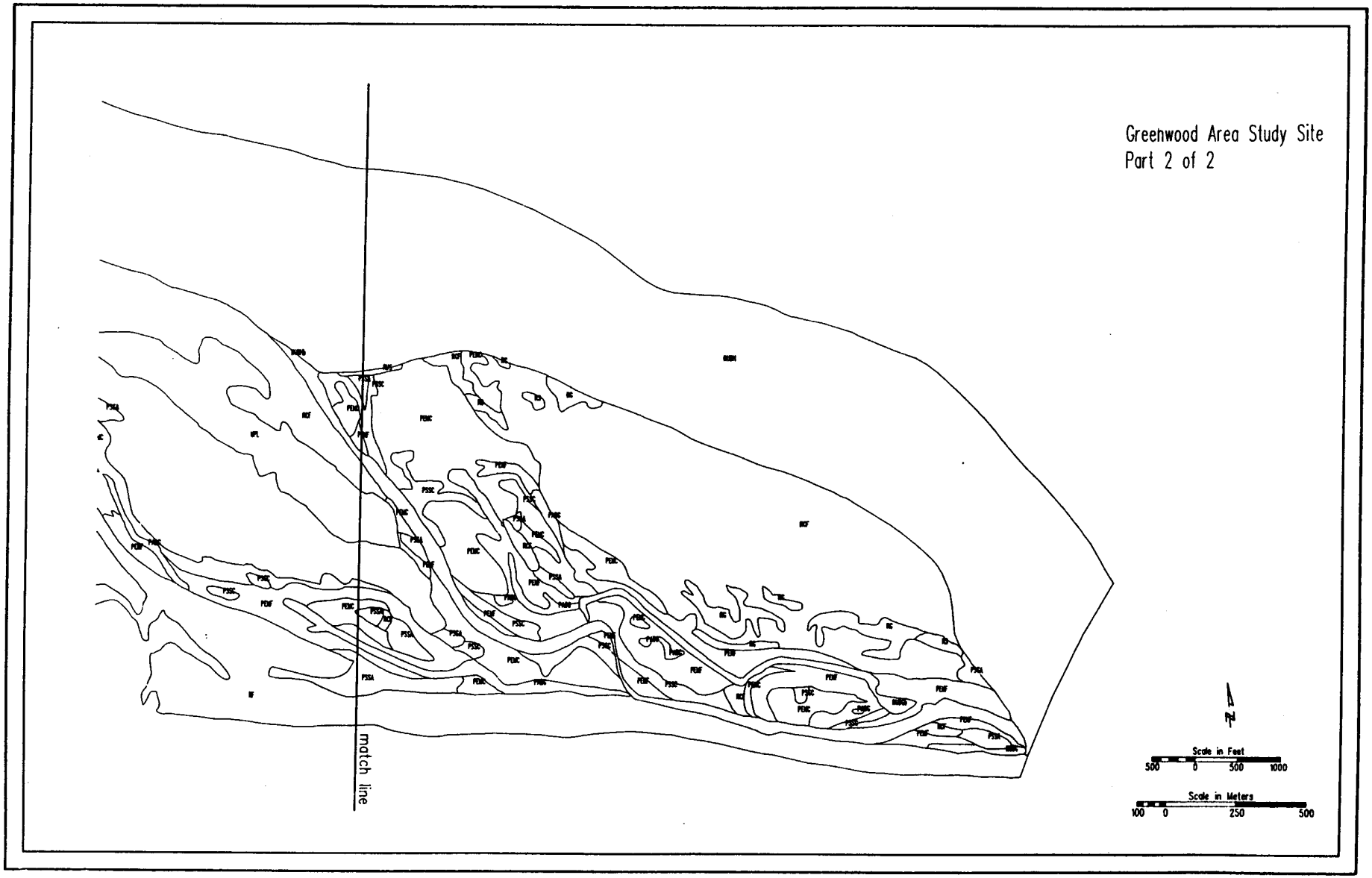
Scale in Meters
100 0 250 500

B-99


Greenwood Area Study Site
Part 2 of 2
match line
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-100

Verdel/Choteau

The Verdel/Choteau study site was a wetland complex associated with several islands and shorelines on the right bank of the Missouri River, approximately 12 miles upstream from Niobrara, Nebraska. The lands to the north of the study site were primarily agricultural and had been heavily disturbed by livestock. This study site was part of the Ft. Randall reach in the upper river.

A large stand of riparian forest (RF) (152.6 acres) was located on the north side of the study site, adjacent to the farm lands (Table VC-1). Cottonwood was the dominant species in the RF with rough leaf dogwood, smooth sumac, rose, and snowberry representing the understory. Dominated by cattail and bulrush, PEMF wetlands were found along side channels and surrounding the islands and represented 85.0 acres. PEMC wetlands were restricted to the main land, rather than the islands, and supported milkweed, cordgrass, bluegrass, reed canarygrass, and foxtail barley. PEMC wetland occupied 87.1 acres (6.5 percent) of the study site. Permanently flooded channels and backwaters (PUBH) occupied a total surface area of 43.4 acres of the study site. Some PUBH wetlands, with water temperatures as high as 76 °F, supported aquatic vegetation including sago pondweed.

Table VC-1. Wetland and riparian acreages mapped in the Verdel/Choteau study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	5.4
Palustrine emergent seasonally flooded (PEMC)	87.1
Palustine emergent semipermanently flooded (PEMF)	85.0
Palustrine scrub-shrub seasonally flooded (PSSC)	55.3
Palustrine forest temporarily flooded (PFOA)	88.2
Riparian grassland (RG)	1.5
Riparian shrub (RS)	40.4
Riparian forest (RF)	152.6
Riverine unconsolidated bottom permanently flooded (RUBH)	771.6
Riverine unconsolidated shore (RUS)	1.2
Palustrine unconsolidated bottom permanently flooded (PUBH)	43.4
Total	1,331.6

A total of 9 transects were sampled over a 2-day period, June 18 and 19, 1991. Wetland and riparian elevational distributions ranged from PUBH at 1213.0 to riparian vegetation at 1226.5 (Table VC-2). The water surface elevation of the Missouri River was 1218.0 at RM 853.4.

EXHIBIT 690 022228

Table VC-2. Distribution of sampling points by elevation.

Missouri River - Verdel/Choteau Creek Study Site
River Mile 853.4 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	RS	RF	PUBH	RUBH 2/	RUS	PFOA
1210.0	0	0	0	0	0	0	0	0	1	0	0
1210.5	0	0	0	0	0	0	0	0	1	0	0
1211.0	0	0	0	0	0	0	0	0	1	0	0
1211.5	0	0	0	0	0	0	0	0	1	0	0
1212.0	0	0	0	0	0	0	0	0	1	0	0
1212.5	0	0	0	0	0	0	0	0	1	0	0
1213.0	0	0	0	0	0	0	0	0	1	0	0
1213.5	0	0	0	0	0	0	0	0	1	0	0
1214.0	0	0	0	0	0	0	0	0	1	0	0
1214.5	0	0	0	0	0	0	0	0	1	0	0
1215.0	0	0	0	0	0	0	0	0	1	0	0
1215.5	0	0	0	0	0	0	0	0	1	0	0
1216.0	0	0	0	0	0	0	0	0	1	0	0
1216.5	0	0	0	0	0	0	0	0	1	0	0
1217.0	0	0	0	0	0	0	0	0	1	0	0
1217.5	0	0	0	0	0	0	0	0	1	0	0
1218.0	17	0	0	0	0	0	0	0	1	0	0
1218.5	26	0	0	0	17	0	0	0	1	0	0
1219.0	21	0	0	0	21	0	0	12	1	0	0
1219.5	25	0	0	0	17	0	0	2	1	0	0
1220.0	51	0	0	0	6	0	0	1	1	6	0
1220.5	169	0	0	0	5	0	0	0	1	128	0
1221.0	110	1	0	0	6	0	0	0	7	77	0
1221.5	94	3	0	0	21	0	0	0	1	13	0
1222.0	77	1	1	0	32	0	0	0	0	5	1
1222.5	93	3	1	0	158	2	0	0	0	2	1
1223.0	14	7	0	0	77	4	0	0	0	0	0
1223.5	0	39	2	0	52	3	13	0	0	0	2
1224.0	0	38	11	65	18	5	16	0	0	0	11
1224.5	0	35	5	0	0	5	5	0	0	0	5
1225.0	0	35	0	0	0	3	46	0	0	0	0
1225.5	0	5	0	0	0	0	0	0	0	0	0
Total	697	167	20	65	430	22	80	15	30	231	20

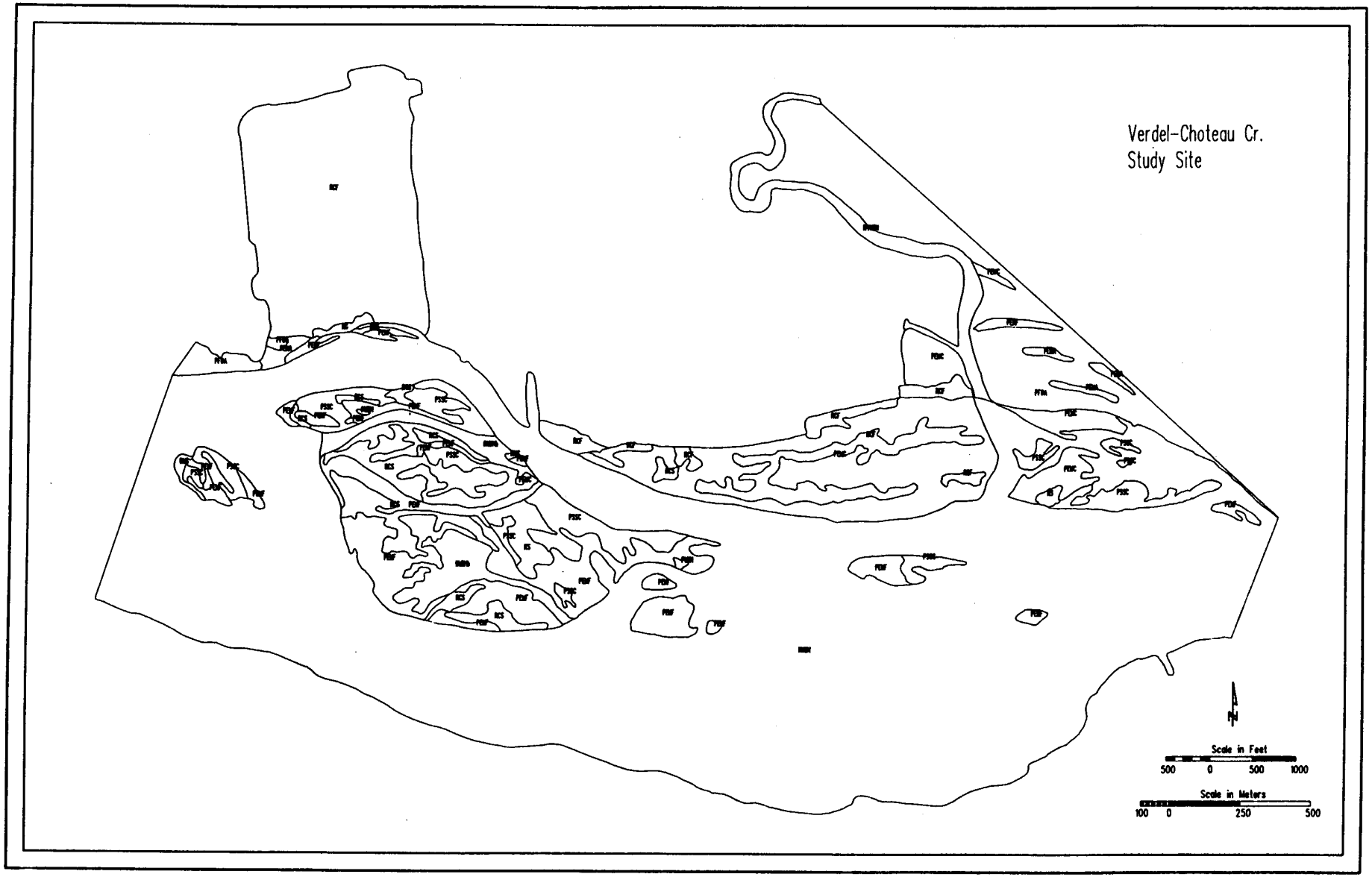
1/ Vegetation types that were not encountered during sampling, but appeared in the vegetation mapping of the site were assigned 'HIT' distributions of types with similar hydrological characteristics that were sampled, including:
PFOA = PEMA

2/ RUBH 'HITS' were evenly distributed from the water surface elevation to THALWEG at RM 853.4.

EXHIBIT 690 022229

A variety of wildlife species were observed at the Verdel/Choteau study site. Numerous large fish and snapping turtles were seen in the backwater channels. Bird species identified included red-headed woodpecker, kingbird, American goldfinch, and a northern oriole nest.

EXHIBIT 690 022230


Verdel-Choteau Cr.
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-104

Niobrara

The Niobrara study site was an island complex with chutes and backwaters at the confluence of the Missouri and Niobrara rivers near Niobrara, Nebraska. The Missouri River serves as a state border in this area, with South Dakota on the north side and Nebraska on the south. The elevational distributions of wetland/riparian types were measured on both sides of the river. The Niobrara study site was part of the Lewis and Clark Lake delta of the upper river.

PEMF wetlands were the most abundant cover type, occupying 492.7 acres (15.6 percent) of the study site (Table NI-1). These wetlands were dominated by cattail. PEMF wetlands were closest to chutes and channels had 6 to 8 inches of standing water and often supported bulrush and reed canarygrass in addition to the cattail. Several PEMF wetlands were in areas that had once been forested. These areas were characterized by saturated soils and dead cottonwood trees and shrubs. PEMC wetlands occupied 404.4 acres (12.8 percent) of the study site and were characterized by reed canarygrass, common reed, and three-square. Riparian forest (RF) stands occurred at the upstream end of the study sites. These stands, dominated by cottonwood trees, were approximately 80 years old and appeared healthy (i.e., no grazing or encroachment). PFOC wetlands were also characterized by cottonwood trees. However, an understory of reed canarygrass, sedge, and bulrush indicated that these areas were, in fact, wetlands. The numerous, permanently flooded chutes and backwaters occupied a total surface area of 104.9 acres (3.3 percent) of the study area.

Table NI-1. Wetland and riparian acreages mapped in the Niobrara study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	1.0
Palustrine emergent seasonally flooded (PEMC)	404.4
Palustine emergent semipermanently flooded (PEMF)	492.7
Palustrine scrub-shrub temporarily flooded (PSSA)	1.0
Palustrine scrub-shrub seasonally flooded (PSSC)	220.7
Palustrine forest temporarily flooded (PFOA)	26.7
Palustrine forest seasonally flooded (PFOC)	172.2
Riparian grassland (RG)	439.5
Riparian shrub (RS)	2.4
Riparian forest (RF)	93.5
Lacustrine unconsolidated bottom permanently flooded (LUBH)	1,188.6
Lacustrine unconsolidated shore (LUS)	5.1
Palustrine unconsolidated bottom permanently flooded (PUBH)	104.9
Total	3,152.6

A total of 8 transects were run to collect the elevational distributions data for the wetland and riparian cover types in the Niobrara study site. The transects were

EXHIBIT 690 022232

standardized around RM 844.0. Elevations of the cover types ranged from unconsolidated shoreline (RUS) at 1212.5 to riparian vegetation at 1231.0 (Table NI-2). The water surface elevation of the Missouri River on June 20, 1991 was 1219.5 near RM 844.0.

Numerous wildlife species were observed at the Niobrara study site. Birds identified during the sampling included: black vulture, eastern kingbird, western kingbird, American goldfinch, red-winged blackbird, mourning dove, grackle, northern flicker, brown thrasher, yellow warbler, great blue heron, red-headed woodpecker, white pelican, and kingfisher. Muskrat and raccoon tracks were also observed at the study site.

EXHIBIT 690 022233

Table NI-2. Distribution of sampling points by elevation.

Missouri River - Niobrara Study Site
River Mile 884.0 - All Transects Combined

Elevaton	PEMF	PEMC	PEMA	PSSC	PSSA	RF	RS 2/	PUBH	PFOA	PFOC	RG	RUS 1/	RUBH 2/
1190.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1190.5	0	0	0	0	0	0	0	0	0	0	0	0	1
....Distribution 'HITS' of RUBH evenly distributed through range not displayed.													
1211.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1211.5	0	0	0	0	0	0	0	0	0	0	0	0	1
1212.0	0	0	0	0	0	0	0	0	0	0	0	0	1
1212.5	0	0	0	0	0	0	0	1	0	0	0	1	1
1213.0	0	0	0	0	0	0	0	2	0	0	0	2	1
1213.5	0	0	0	0	0	0	0	1	0	0	0	1	1
1214.0	0	0	0	0	0	0	0	2	0	0	0	2	1
1214.5	0	0	0	0	0	0	0	1	0	0	0	1	1
1215.0	0	0	0	0	0	0	0	8	0	0	0	8	1
1215.5	0	0	0	0	0	0	0	10	0	0	0	10	1
1216.0	0	0	0	0	0	0	0	11	0	0	0	11	1
1216.5	5	0	0	0	0	0	0	37	0	0	0	37	1
1217.0	16	0	0	0	0	0	0	42	0	0	0	42	1
1217.5	64	1	0	0	0	0	0	13	0	0	0	13	1
1218.0	91	3	0	0	0	0	0	3	0	0	0	3	1
1218.5	306	13	1	1	0	0	0	0	0	7	0	0	1
1219.0	239	178	0	1	0	0	0	20	0	69	0	20	1
1219.5	71	137	1	3	0	0	0	4	0	84	0	4	1
1220.0	7	27	1	2	0	0	0	0	0	0	0	0	0
1220.5	16	9	6	0	0	0	0	0	4	0	0	0	0
1221.0	3	56	6	0	8	0	0	0	4	0	2	0	0
1221.5	0	0	0	0	0	0	0	0	0	0	3	0	0
1222.0	0	0	0	0	0	0	0	0	0	0	3	0	0
1222.5	0	0	0	0	0	0	0	0	0	0	3	0	0
1223.0	0	0	0	0	0	0	0	0	0	0	3	0	0
1223.5	0	0	0	0	0	8	8	0	0	0	1	0	0
1224.0	0	0	0	0	0	9	9	0	0	0	2	0	0

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Table NI-2. Distribution of sampling points by elevation.

Missouri River - Niobrara Study Site
River Mile 884.0 - All Transects Combined

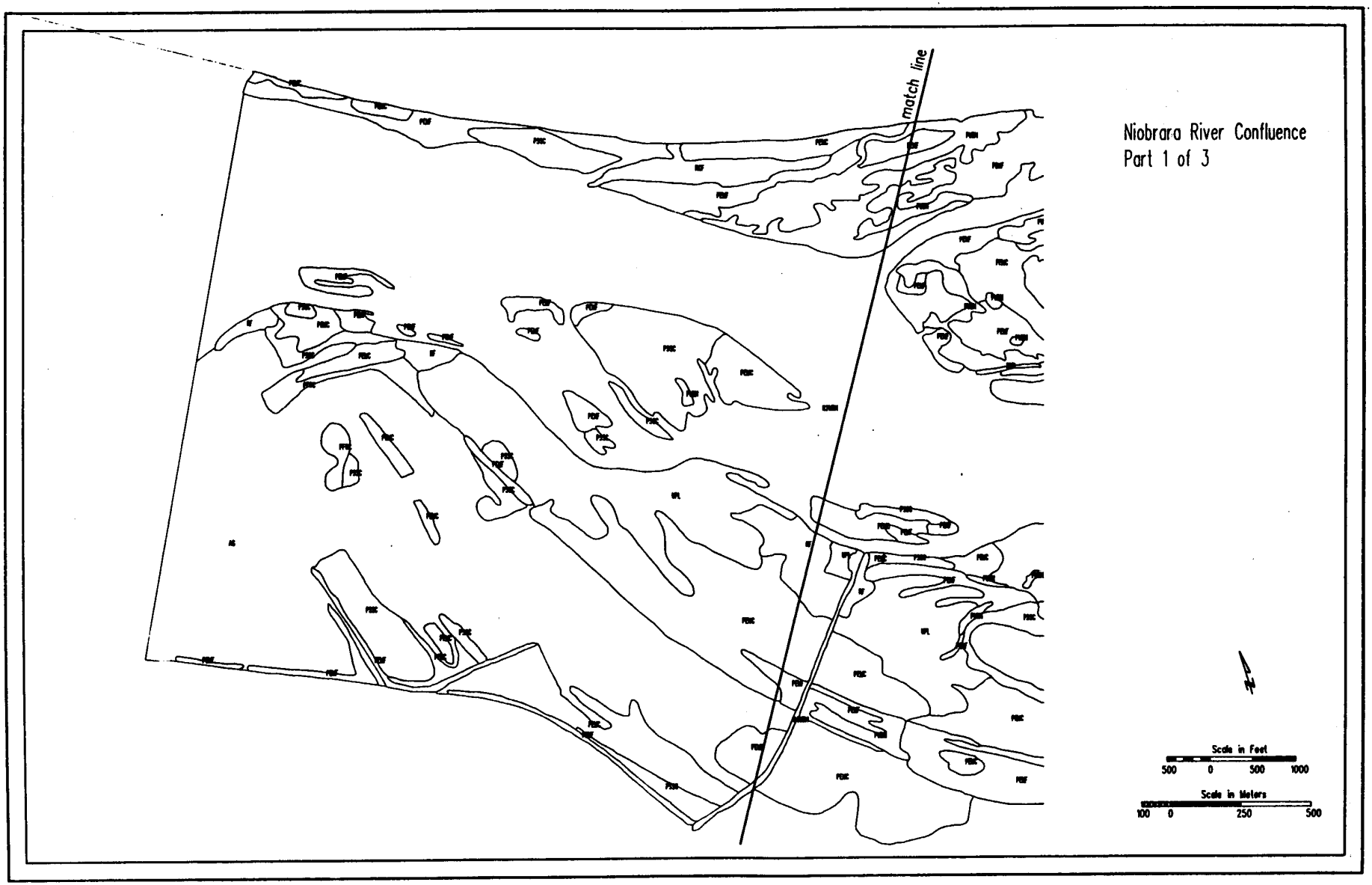
Elevaton	PEMF	PEMC	PEMA	PSSC	PSSA	RF	RS 2/	PUBH	PFOA	PFOC	RG	RUS 1/	RUBH 2/
1224.5	0	0	0	0	0	2	2	0	0	0	1	0	0
1225.0	0	0	0	0	0	1	1	0	0	0	1	0	0
1225.5	0	0	0	0	0	2	2	0	0	0	2	0	0
1226.0	0	0	0	0	0	1	1	0	0	0	1	0	0
1226.5	0	0	0	0	0	1	1	0	0	0	2	0	0
1227.0	0	0	0	0	0	1	1	0	0	0	1	0	0
1227.5	0	0	0	0	0	1	1	0	0	0	2	0	0
1228.0	0	0	0	0	0	1	1	0	0	0	1	0	0
1228.5	0	0	0	0	0	3	3	0	0	0	1	0	0
1229.0	0	0	0	0	0	4	4	0	0	0	0	0	0
1229.5	0	0	0	0	0	3	3	0	0	0	0	0	0
1230.0	0	0	0	0	0	4	4	0	0	0	0	0	0
1230.5	0	0	0	0	0	3	3	0	0	0	0	0	0
1231.0	0	0	0	0	0	2	2	0	0	0	0	0	0
Total	818	424	15	7	8	46	46	155	8	160	29	155	59

1/ Types not encountered during sampling but were included in the study site mapping were assigned 'HIT' distributions of types with similiar hydrological characteristics that were sampled, including:
RUS = PUBH
RS = RF

2/ RUBH 'HITS' were evenly distributed from the water surface elevation to its THALWEG.

EXHIBIT 690

022235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Part 1 of 3
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Scale in Meters
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B-109

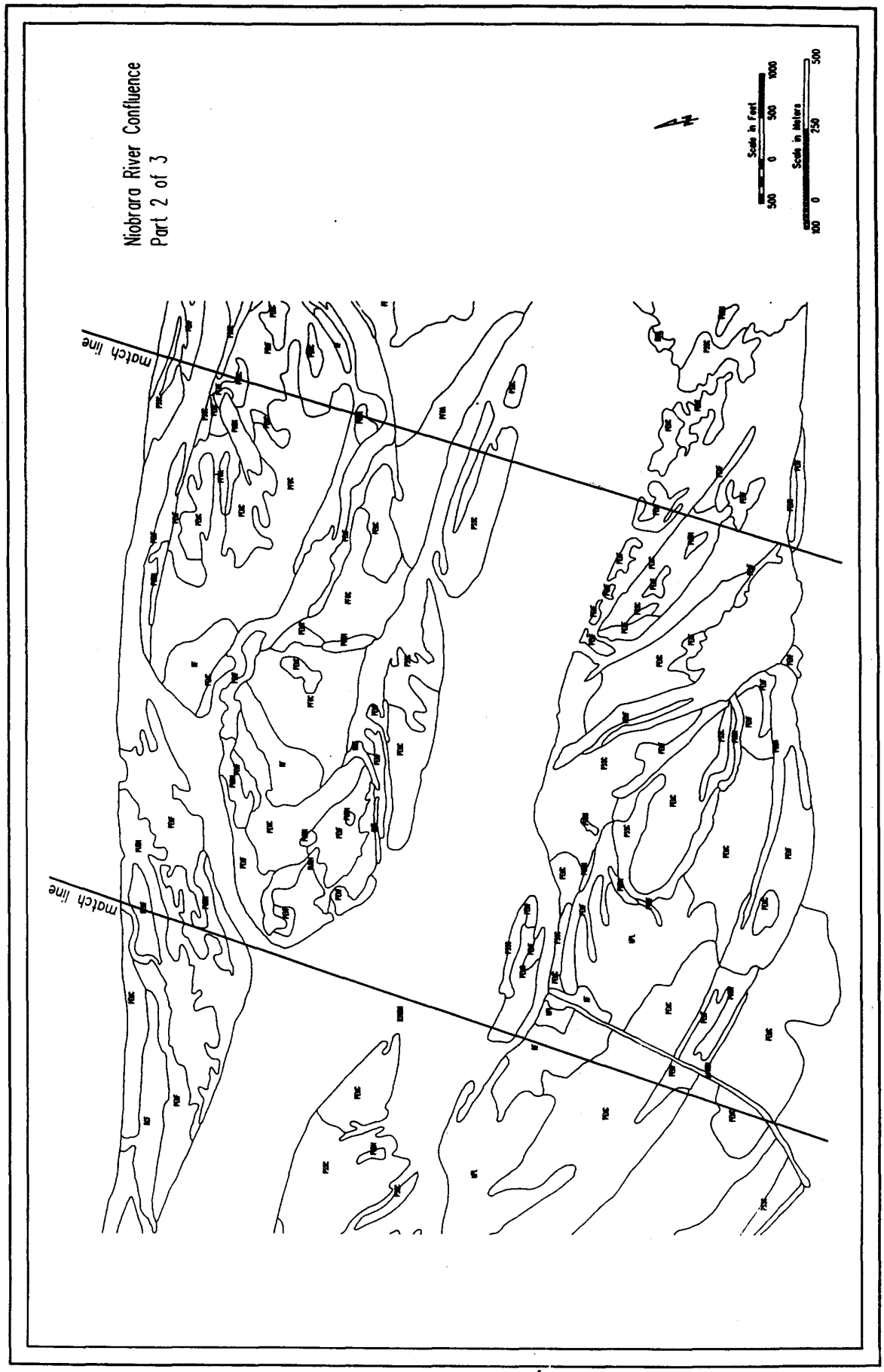
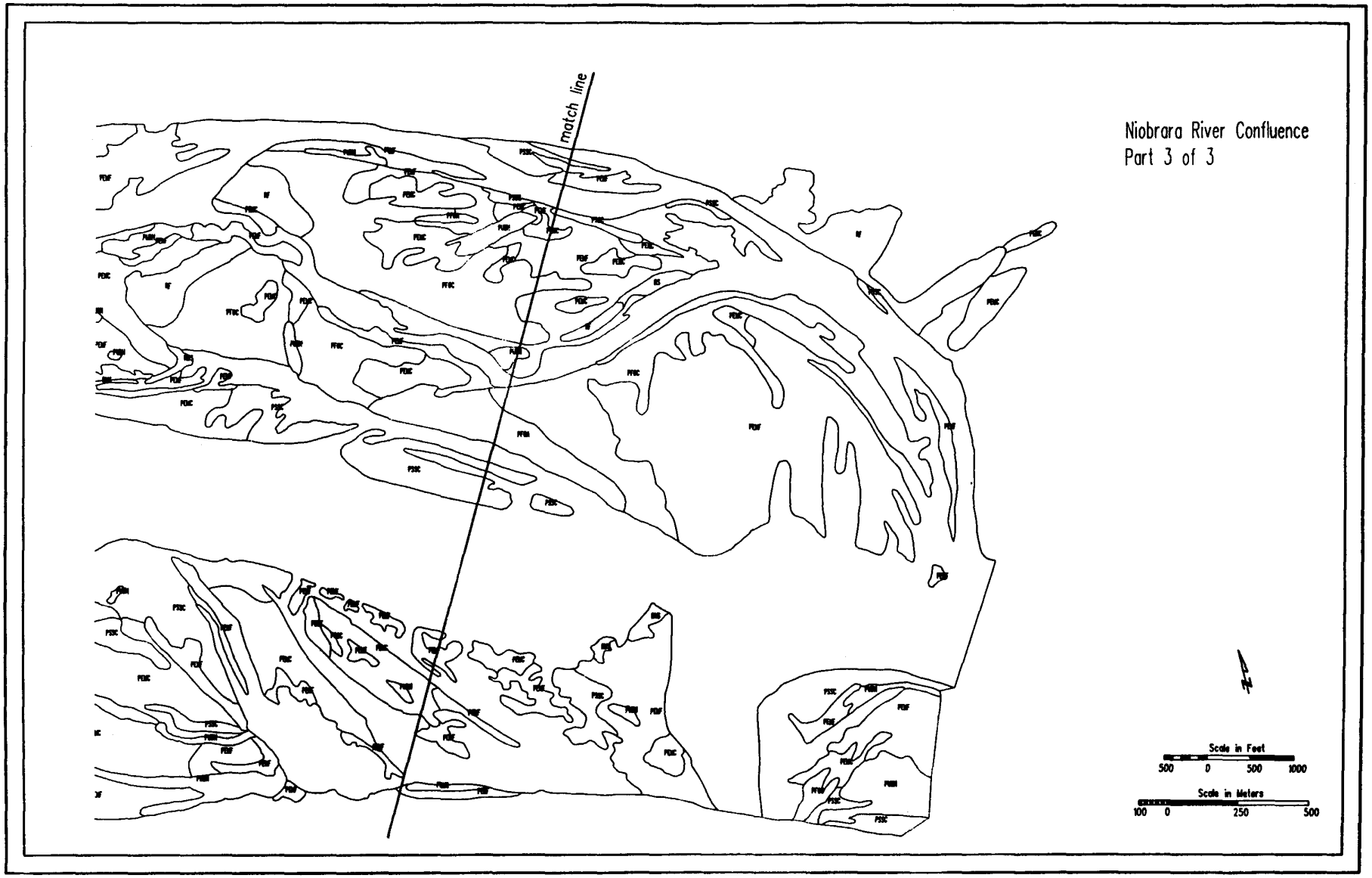


EXHIBIT 690
022237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Niobrara River Confluence
Part 3 of 3
Scale in Feet
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Scale in Meters
100 0 250 500

Bazille Creek

The Bazille Creek study site was a complex of islands, shorelines, and backwaters located on the right bank of the Missouri River at the confluence of Bazille Creek at RM 837.0. This area was approximately 5 miles downstream of Springfield, South Dakota and is in the Lewis and Clark Lake delta.

Emergent wetlands dominated the study site. PEMC wetlands occupied 1,378.5 acres on shorelines and islands (43.0 percent) (Table BZ-1) and were dominated by common reed, jewelweed, purple loosestrife, and three-square. PEMF wetlands, characterized by cattail and bulrush, were typically found around permanently flooded backwater areas and on island shorelines. PEMF represented 177.6 acres of the study site. Scrub-shrub wetlands (PSSC) occupied 227.0 acres (7.1 percent) of the mapped area and were dominated by indigo bush and elderberry. The numerous pond and backwater channels (PUBH) had a surface area of 99.3 acres. Some of the PUBH areas were very productive aquatic beds, comprised of dense patches of sago pondweed. Riparian cover types were limited; riparian forest (RF) contributed 123.1 acres (3.8 percent) to the study area. RS and RG together represented less than 60 acres.

Table BZ-1. Wetland and riparian acreages mapped in the Bazille Creek study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	3.3
Palustrine emergent seasonally flooded (PEMC)	1,378.5
Palustine emergent semipermanently flooded (PEMF)	177.6
Palustrine scrub-shrub seasonally flooded (PSSC)	227.0
Palustrine forest temporarily flooded (PFOA)	43.2
Riparian grassland (RG)	46.5
Riparian shrub (RS)	12.7
Riparian forest (RF)	123.1
Lacustrine unconsolidated bottom permanently flooded (LUBH)	915.6
Lacustrine unconsolidated shore (LUS)	174.9
Lacustrine unconsolidated shore vegetated (LUS5)	1.0
Palustrine unconsolidated bottom permanently flooded (PUBH)	99.3
Total	3,202.6

Wetland and riparian elevational distributions were measured along 6 transects on June 20, 1991 and standardized around RM 837.0. The elevational distribution of the various wetland and riparian types over-lapped substantially. The water surface elevation of the Missouri River was 1211.5 near RM 837.

EXHIBIT 690 022239

Table BZ-2. Distribution of sampling points by elevation.

Missouri River - Bazille Creek Study Site
River Mile 837.0 - All Transects Combined

Elevation	PEMF	PEMC	PSSC	RUS5	RUBH 2/	RUS	RS	RG 1/	RF 1/	PUBH	PEMA 1/	PFOA 1/
1199.5	0	0	0	0	1	0	0	0	0	0	0	0
1200.0	0	0	0	0	1	0	0	0	0	0	0	0
1200.5	0	0	0	0	1	0	0	0	0	0	0	0
1201.0	0	0	0	0	1	0	0	0	0	0	0	0
1201.5	0	0	0	0	1	0	0	0	0	0	0	0
1202.0	0	0	0	0	1	0	0	0	0	0	0	0
1202.5	0	0	0	0	1	0	0	0	0	0	0	0
1203.0	0	0	0	0	1	0	0	0	0	0	0	0
1203.5	0	0	0	0	1	0	0	0	0	0	0	0
1204.0	0	0	0	0	1	0	0	0	0	0	0	0
1204.5	0	0	0	0	1	0	0	0	0	0	0	0
1205.0	0	0	0	0	1	0	0	0	0	0	0	0
1205.5	0	0	0	0	1	0	0	0	0	0	0	0
1206.0	0	0	0	0	1	0	0	0	0	0	0	0
1206.5	0	0	0	0	1	0	0	0	0	0	0	0
1207.0	0	0	0	0	1	0	0	0	0	0	0	0
1207.5	0	0	0	0	1	0	0	0	0	5	0	0
1208.0	0	0	0	0	1	0	0	0	0	6	0	0
1208.5	0	0	0	0	1	0	0	0	0	6	0	0
1209.0	0	0	0	0	1	0	0	0	0	72	0	0
1209.5	5	0	0	0	1	0	0	0	0	141	0	0
1210.0	16	4	0	0	1	0	0	0	0	128	0	0
1210.5	10	39	0	0	1	0	0	0	0	238	0	0
1211.0	29	117	0	0	1	13	0	0	0	200	0	0
1211.5	131	213	0	0	1	48	0	0	0	78	0	0
1212.0	198	146	0	0	0	105	0	0	0	0	0	0
1212.5	257	347	14	30	0	24	1	1	1	0	14	14
1213.0	167	284	64	0	0	1	1	1	1	0	64	64
1213.5	1	19	2	0	0	0	1	1	1	0	2	2
1214.0	0	0	0	0	0	0	1	1	1	0	0	0
1214.5	0	0	0	0	0	0	1	1	1	0	0	0
1215.0	0	0	0	0	0	0	1	1	1	0	0	0
1215.5	0	0	0	0	0	0	1	1	1	0	0	0
1216.0	0	0	0	0	0	0	1	1	1	0	0	0
1216.5	0	0	0	0	0	0	1	1	1	0	0	0
1217.0	0	0	0	0	0	0	1	1	1	0	0	0
1217.5	0	0	0	0	0	0	1	1	1	0	0	0
1218.0	0	0	0	0	0	0	1	1	1	0	0	0
1218.5	0	0	0	0	0	0	1	1	1	0	0	0
1219.0	0	0	0	0	0	0	1	1	1	0	0	0
1219.5	0	0	0	0	0	0	1	1	1	0	0	0
1220.0	0	0	0	0	0	0	1	1	1	0	0	0

Table BZ-2. Distribution of sampling points by elevation.

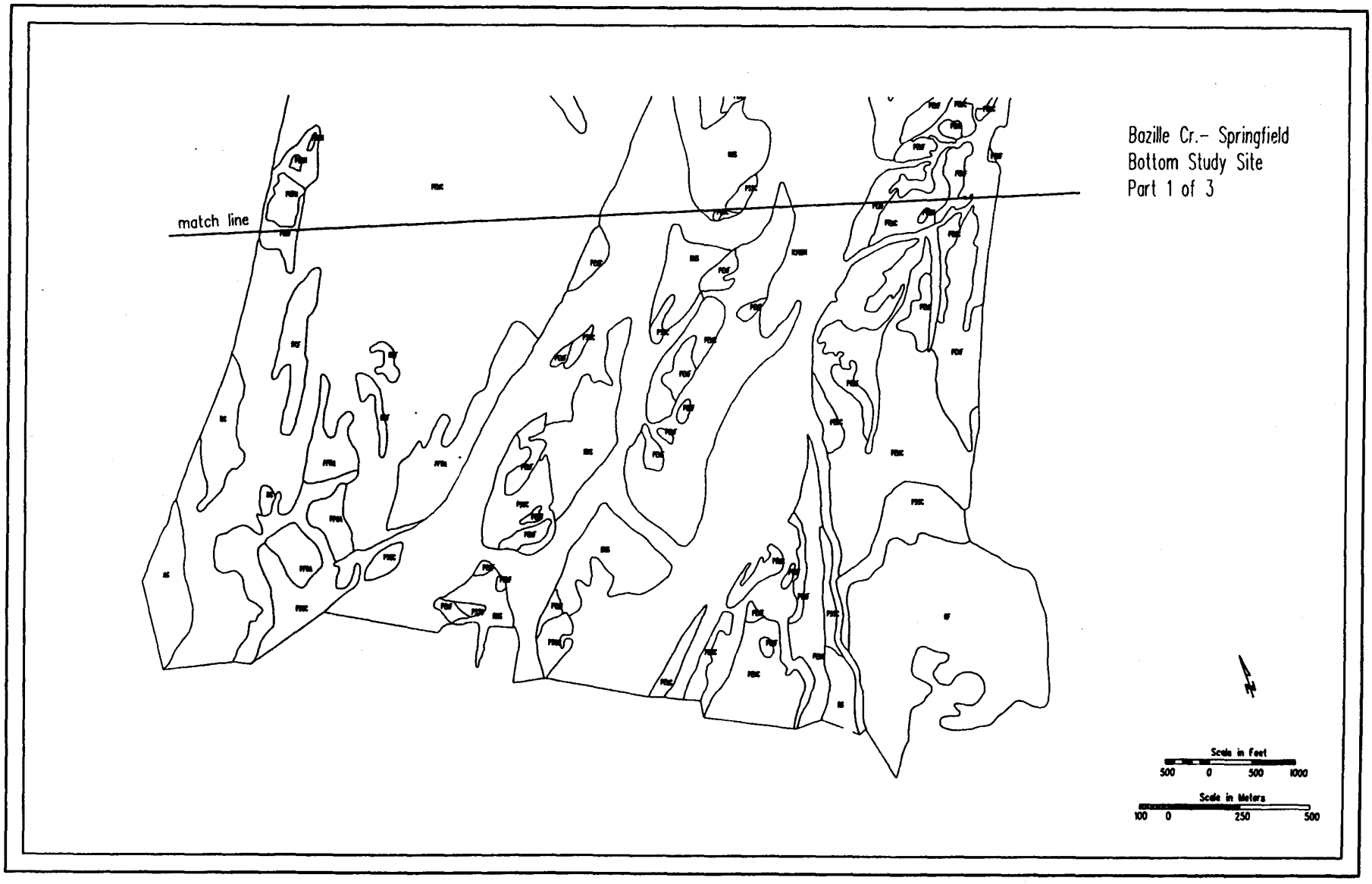
Missouri River - Bazille Creek Study Site
River Mile 837.0 - All Transects Combined

Elevation	PEMF	PEMC	PSSC	RUS5	RUBH 2/	RUS	RS	RG 1/	RF 1/	PUBH	PEMA 1/	PFOA 1/
1220.5	0	0	0	0	0	0	1	1	1	0	0	0
1221.0	0	0	0	0	0	0	1	1	1	0	0	0
1221.5	0	0	0	0	0	0	1	1	1	0	0	0
1222.0	0	0	0	0	0	0	1	1	1	0	0	0
Total	814	1169	80	30	25	191	20	20	20	874	80	80

1/ Vegetation types that were not encountered during sampling, but appeared in the vegetation mapping of the site were assigned 'HIT' distributions of types with similar hydrological characteristics that were sampled, including:
PEMA = PSSC
RG = RS
RF = RS
PFOA = PSSC
RF, RS, and RG were evenly distributed from the lowest elevation sampled to the highest elevation in the 100-year floodplain.

2/ RUBH 'HITS' were evenly distributed from the water surface elevation to THALWEG at RM 837.0.

EXHIBIT 690 022241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Bazille Cr.- Springfield
Bottom Study Site
Part 1 of 3
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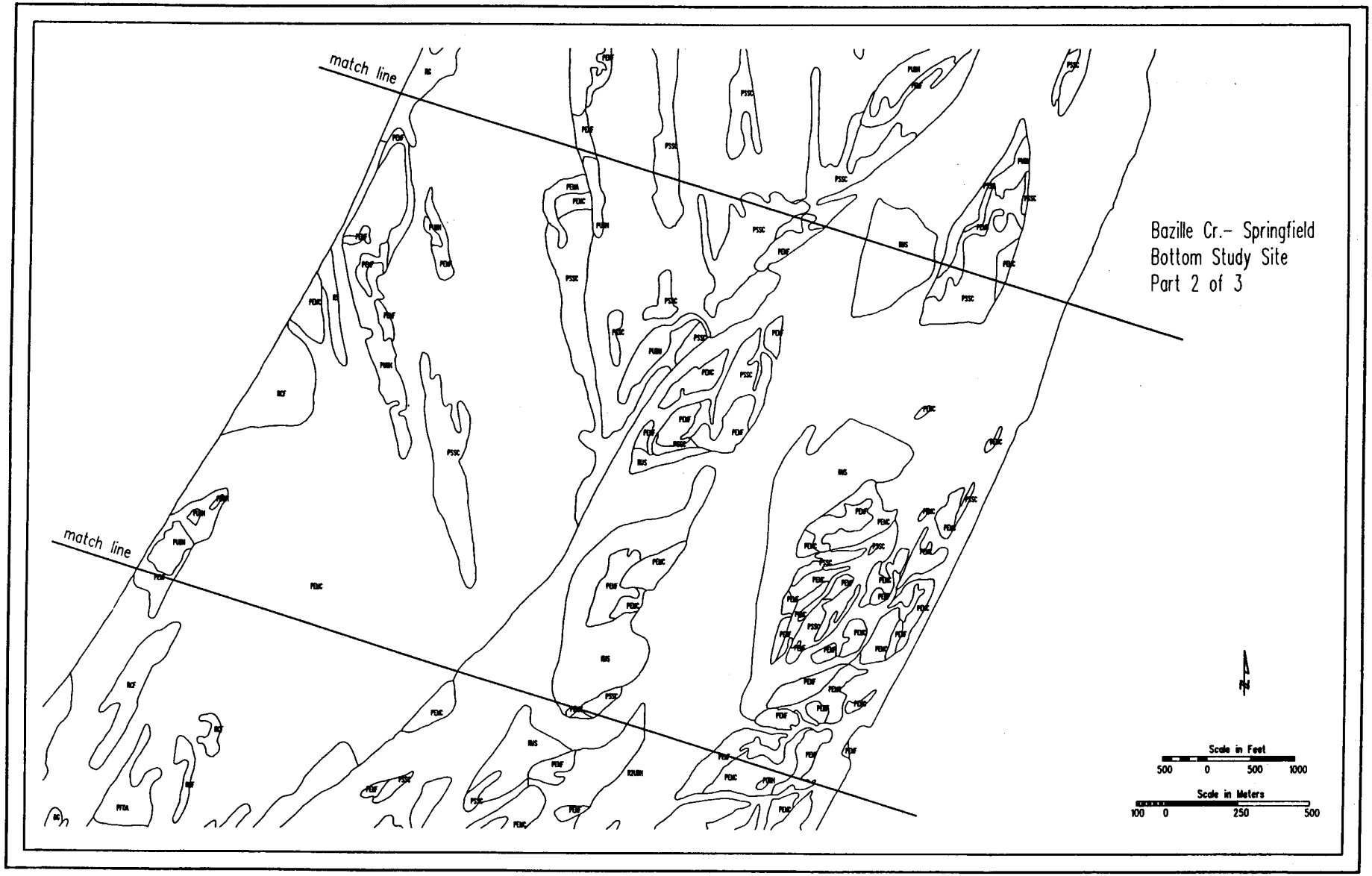
Scale in Meters
100 0 250 500

B-115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Bottom Study Site
Part 2 of 3
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Scale in Meters
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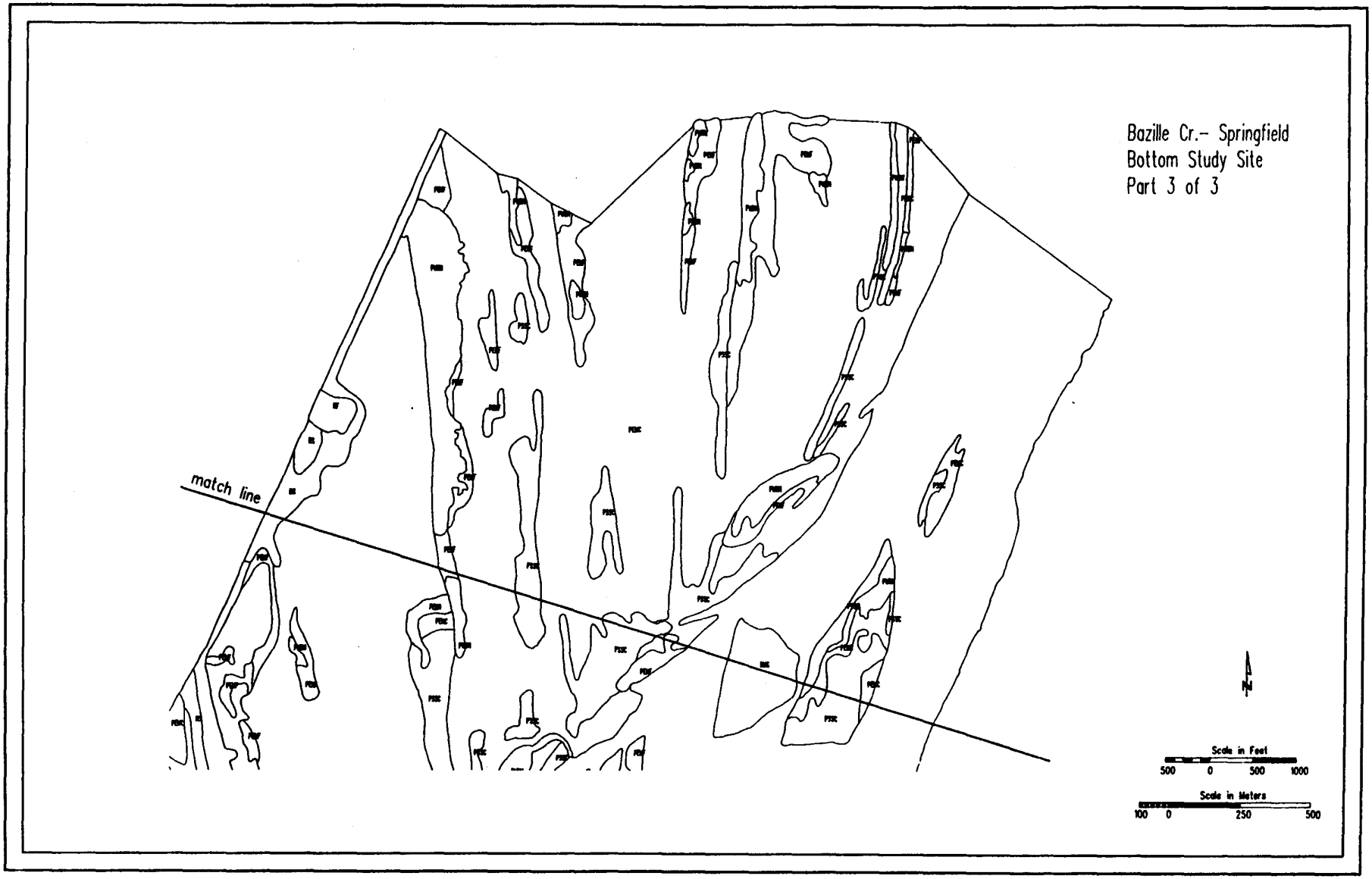
B-116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Bottom Study Site
Part 3 of 3
match line
N
Scale in Feet
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Scale in Meters
100 0 250 500

B-117

Myron Grove

The Myron Grove study site was selected for the pilot study at the start of the field sampling effort. This site was comprised of backwater chutes, side channels, and wetlands approximately 16 miles downstream of Yankton, South Dakota. This area had been slightly disturbed by grazing. The Myron Grove study site was part of the National Recreation River reach in the upper river. Sampling was conducted on both banks of the river.

Large stands of riparian cottonwood forests (RF) were located adjacent to the steep shorelines on both sides of the river and in smaller stands intermixed with wetlands. The RF cover type occupied 143.5 acres (11.6 percent) of the mapped area (Table MG-1). Scrub-shrub wetlands (PSSC) were found throughout the study site, usually in relatively small patches bordering chutes and channels. PSSC wetland represented 107.0 acres of the study site and were dominated by cottonwood and peachleaf willow shrubs and indigo bush. Emergent wetlands contributed a total of 152.9 acres (12.3 percent) to the study site. PEMF wetlands (39.8 acres) were dominated by cattail and were located next to permanently flooded chutes, often in water up to 2 feet deep. Horsetail, goldenrod, and aster were the characteristic species in the PEMC wetlands (70.9 acres), these areas appeared to support cattail in previous years. The backwaters and chutes (PUBH) occupied a surface area of 64.9 acres (5.2 percent).

Table MG-1. Wetland and riparian acreages mapped in the Myron Grove study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	42.2
Palustrine emergent seasonally flooded (PEMC)	70.9
Palustine emergent semipermanently flooded (PEMF)	39.8
Palustrine scrub-shrub temporarily flooded (PSSA)	10.4
Palustrine scrub-shrub seasonally flooded (PSSC)	107.0
Riparian grassland (RG)	80.9
Riparian shrub (RS)	29.2
Riparian forest (RF)	143.5
Riverine unconsolidated bottom permanently flooded (RUBH)	636.9
Riverine unconsolidated shore (RUS)	5.9
Riverine unconsolidated shore vegetated (RUS5)	8.9
Palustrine unconsolidated bottom permanently flooded (PUBH)	64.9
Total	1,240.4

Wetland and riparian elevational distributions were measured along 6 transects over a 2-day sampling period, May 8 and 9, 1991. All transects were standardized to RM 788.9. The elevational distributions of wetland cover types were tightly clustered within 8 feet (between 1137.5 to 1145.5) and there was substantial overlap between

EXHIBIT 690 022245

types. Riparian cover types ranged from 1140.5 to 1154.5. The water surface elevation of the Missouri River was 1140.5 at RM 788.9.

Wildlife observed at the Myron Grove study site included the following birds: white-crowned sparrow, mockingbird, Franklin's gull, white pelican, cormorant, solitary sandpiper, kingfisher, cedar waxwing, northern oriole, Forester's tern, and hairy woodpecker. Mammal observations included white-tailed deer, raccoon, red squirrel, and beaver.

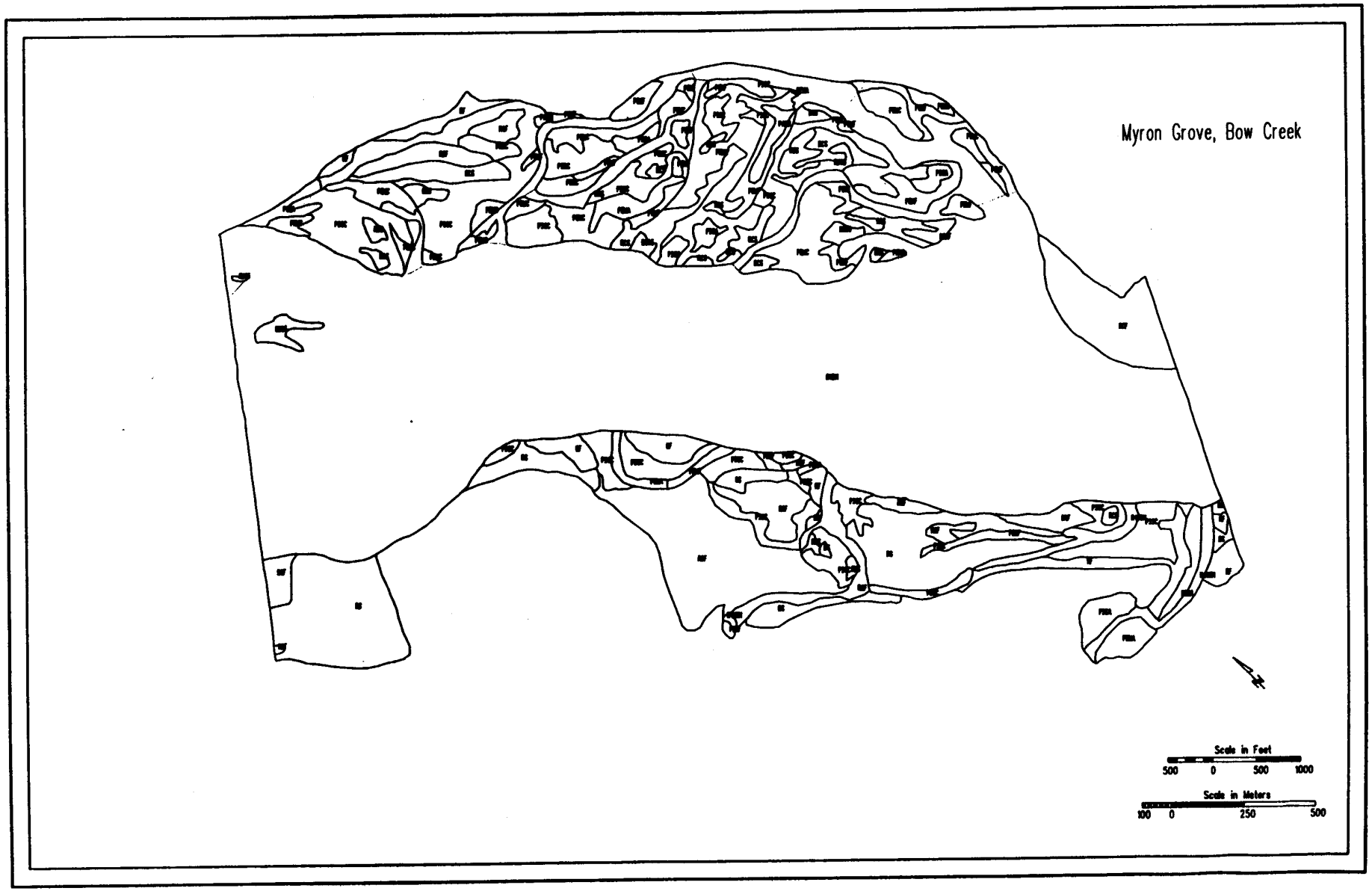
EXHIBIT 690 022246

Table MG-2. Distribution of sampling points by elevation.

Missouri River - Myron Grove Study Site
River Mile 788.9 - All Transects Combine

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RS	RF	RUS	RUBH	RUS5	PUBH
1129.5	0	0	0	0	0	0	0	0	0	1	0	0
1130.0	0	0	0	0	0	0	0	0	0	1	0	0
1131.0	0	0	0	0	0	0	0	0	0	1	0	0
1131.5	0	0	0	0	0	0	0	0	0	1	0	0
1132.0	0	0	0	0	0	0	0	0	0	1	0	0
1132.5	0	0	0	0	0	0	0	0	0	1	0	0
1133.0	0	0	0	0	0	0	0	0	0	1	0	0
1133.5	0	0	0	0	0	0	0	0	0	1	0	0
1134.0	0	0	0	0	0	0	0	0	0	1	0	0
1134.5	0	0	0	0	0	0	0	0	0	1	0	0
1135.0	0	0	0	0	0	0	0	0	0	1	0	0
1135.5	0	0	0	0	0	0	0	0	0	1	0	0
1136.0	0	0	0	0	0	0	0	0	0	1	0	0
1136.5	0	0	0	0	0	0	0	0	0	1	0	0
1137.0	0	0	0	0	0	0	0	0	0	1	0	0
1137.5	0	0	0	0	0	0	0	0	0	1	0	7
1138.0	0	0	0	0	0	0	0	0	0	1	0	15
1138.5	13	0	0	0	0	0	0	0	0	1	0	49
1139.0	87	0	0	0	0	0	0	0	1	1	0	108
1139.5	96	1	0	0	0	0	0	0	34	1	0	109
1140.0	117	1	2	0	0	0	0	0	64	1	0	43
1140.5	179	7	17	1	24	0	0	0	29	1	0	34
1141.0	314	6	39	0	116	0	0	0	5	0	0	21
1141.5	336	4	44	0	135	30	3	0	5	0	0	13
1142.0	144	76	84	1	259	19	48	0	58	0	1	7
1142.5	29	41	57	0	385	76	92	0	0	0	0	0
1143.0	74	159	51	15	514	81	97	0	32	0	50	0
1143.5	20	54	5	47	93	45	264	0	128	0	16	0
1144.0	0	47	1	102	121	43	208	6	0	0	0	0
1144.5	0	8	0	110	68	49	96	12	0	0	0	0
1145.0	0	0	0	91	51	28	37	14	1	0	0	0
1145.5	0	0	0	23	7	2	14	53	0	0	0	0
1146.0	0	0	0	65	0	0	12	71	0	0	0	0
1146.5	0	0	0	11	0	0	12	5	0	0	0	0
1147.0	0	0	0	1	0	0	10	5	0	0	0	0
1147.5	0	0	0	1	0	0	1	6	0	0	0	0
1148.0	0	0	0	0	0	0	0	4	0	0	0	0
1148.5	0	0	0	2	0	0	0	5	0	0	0	0
1149.0	0	0	0	0	0	0	0	6	0	0	0	0
1149.5	0	0	0	1	0	0	0	16	0	0	0	0
1150.0	0	0	0	2	0	0	0	12	0	0	0	0
1151.0	0	0	0	1	0	0	0	1	0	0	0	0
1151.5	0	0	0	1	0	0	0	1	0	0	0	0
1152.0	0	0	0	1	0	0	0	1	0	0	0	0
1152.5	0	0	0	1	0	0	0	1	0	0	0	0
1153.5	0	0	0	2	0	0	0	1	0	0	0	0
1154.5	0	0	0	1	0	0	0	1	0	0	0	0
TOTAL	1409	404	300	480	1773	373	894	221	357	22	67	406

EXHIBIT 690 022247


Myron Grove, Bow Creek
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Scale in Meters
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Mulberry Point

The Mulberry Point study site was a complex of wetlands and riparian areas on islands and shorelines, approximately 2 miles upstream of the confluence of the Vermillion River. This area had changed significantly since the 1983 National Wetlands Inventory Map conditions; the Nebraska side of the river had eroded significantly while the South Dakota side had agraded. For example, less than 2 years ago, a survey control point was placed 200 feet from the river bank. At the time of sampling, this same control point was only 15 feet from the shoreline. The Mulberry Point study site was part of the National Recreation River reach in the upper river.

Wetland and riparian elevational distributions were sampled on both the right and left banks of the Missouri River. The north side of the river, South Dakota, consisted primarily of riparian vegetation with scrub-shrub wetlands (PSSA) confined to the old chutes. The south side, Nebraska, included mainly PSSA and PSSC wetlands. PSSA and PSSC wetlands, dominated by indigo bush, sandbar willow, and peachleaf willow, occupied 145.4 acres (7.2 percent) and 114.1 acres (5.6 percent), respectively (Table MP-1). Riparian forests (RF), representing 289.6 acres (14.3 percent), was the most prevalent cover type in the study site. PEMF wetlands (41.0 acres) were found mostly in small patches along side channels or on islands. Small ponds and backwaters (PUBH wetlands) occupied a total surface area of only 40.2 acres of the study area.

Table MP-1. Wetland and riparian acreages mapped in the Mulberry Point study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	86.6
Palustrine emergent seasonally flooded (PEMC)	50.7
Palustine emergent semipermanently flooded (PEMF)	41.0
Palustrine scrub-shrub temporarily flooded (PSSA)	145.4
Palustrine scrub-shrub seasonally flooded (PSSC)	114.1
Riparian grassland (RG)	68.5
Riparian shrub (RS)	7.4
Riparian forest (RF)	289.6
Riverine unconsolidated bottom permanently flooded (RUBH)	1,124.0
Riverine unconsolidated shore (RUS)	45.5
Riverine unconsolidated shore vegetated (RUS5)	14.6
Palustrine unconsolidated bottom permanently flooded (PUBH)	40.2
Total	2,027.4

Wetland and riparian cover type elevations were measured along 5 transects on the north side of the river and 2 on the south. The transects were standardized around RM 773.6 and ranged in length form 145 to 1,824 feet. The elevational distributions of the cover types, as recorded on June 22, 1991, ranged from PUBH (water

EXHIBIT 690 022249

approximately 1.5 feet deep) at 1120.0 to RG and RF at 1142.0 with relatively little overlap between types (Table MP-2). The water surface elevation of the Missouri River was 1121.0 at RM 773.6.

Numerous birds were observed during the sampling period. Species included: catbird, eastern bluebird, mockingbird, bank swallow, sang sparrow, bobwhite, pheasant, great blue heron, kestrel goldfinch, barn swallow, black vulture, dickcissel, yellow warbler, yellow throat, red-winged blackbird, cowbird, least tern, brown thrasher, and red-tailed hawk. Also, nesting activity was noted for mourning dove, lark sparrow, and eastern kingbird.

EXHIBIT 690 022250

Table MP-2. Distribution of sampling points by elevation.

Missouri River - Mulberry Point (Mid Section) Study Site
River Mile 773.6 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RF	RUBH	RUS	RS	RUS5	PUBH
1105.5	0	0	0	0	0	0	0	1	0	0	0	0
1106.0	0	0	0	0	0	0	0	1	0	0	0	0
1106.5	0	0	0	0	0	0	0	1	0	0	0	0
1107.0	0	0	0	0	0	0	0	1	0	0	0	0
1107.5	0	0	0	0	0	0	0	1	0	0	0	0
1108.0	0	0	0	0	0	0	0	1	0	0	0	0
1108.5	0	0	0	0	0	0	0	1	0	0	0	0
1109.0	0	0	0	0	0	0	0	1	0	0	0	0
1109.5	0	0	0	0	0	0	0	1	0	0	0	0
1110.0	0	0	0	0	0	0	0	1	0	0	0	0
1110.5	0	0	0	0	0	0	0	1	0	0	0	0
1111.0	0	0	0	0	0	0	0	1	0	0	0	0
1111.5	0	0	0	0	0	0	0	1	0	0	0	0
1112.0	0	0	0	0	0	0	0	1	0	0	0	0
1112.5	0	0	0	0	0	0	0	1	0	0	0	0
1113.0	0	0	0	0	0	0	0	1	0	0	0	0
1113.5	0	0	0	0	0	0	0	1	0	0	0	0
1114.0	0	0	0	0	0	0	0	1	0	0	0	0
1114.5	0	0	0	0	0	0	0	1	0	0	0	0
1115.0	0	0	0	0	0	0	0	1	0	0	0	0
1115.5	0	0	0	0	0	0	0	1	0	0	0	0
1116.0	0	0	0	0	0	0	0	1	0	0	0	0
1116.5	0	0	0	0	0	0	0	1	0	0	0	0
1117.0	0	0	0	0	0	0	0	1	0	0	0	0
1117.5	0	0	0	0	0	0	0	1	0	0	0	0
1118.0	0	0	0	0	0	0	0	1	0	0	0	0
1118.5	0	0	0	0	0	0	0	1	0	0	0	0
1119.0	0	0	0	0	0	0	0	1	0	0	0	0
1119.5	0	0	0	0	0	0	0	1	0	0	0	0
1120.0	0	0	0	0	0	0	0	1	0	0	0	4
1120.5	0	0	0	0	0	0	0	1	0	0	0	19
1121.0	1	0	0	0	1	0	0	1	0	0	0	164
1121.5	31	3	0	0	3	0	0	0	1	0	1	133
1122.0	112	24	0	0	4	0	0	0	13	0	13	10
1122.5	20	245	0	0	117	0	0	0	0	0	0	10
1123.0	1	160	0	0	501	0	0	0	1	0	1	10
1123.5	1	0	0	0	514	9	0	0	1	0	1	0
1124.0	0	0	0	0	150	27	0	0	0	0	0	0
1124.5	0	0	0	0	151	53	0	0	1	0	1	0
1125.0	0	0	0	0	35	11	0	0	0	0	0	0
1125.5	0	0	0	0	27	17	0	0	0	0	0	0
1126.0	0	0	0	0	6	44	0	0	0	0	0	0
1126.5	0	0	4	0	0	124	0	0	0	0	0	0
1127.0	0	0	88	1	0	41	0	0	0	1	0	0
1127.5	0	0	10	1	0	0	0	0	0	2	0	0
1128.0	0	0	0	1	0	0	0	0	0	1	0	0
1128.5	0	0	0	1	0	0	0	0	0	2	0	0
1129.0	0	0	0	1	0	0	0	0	0	1	0	0

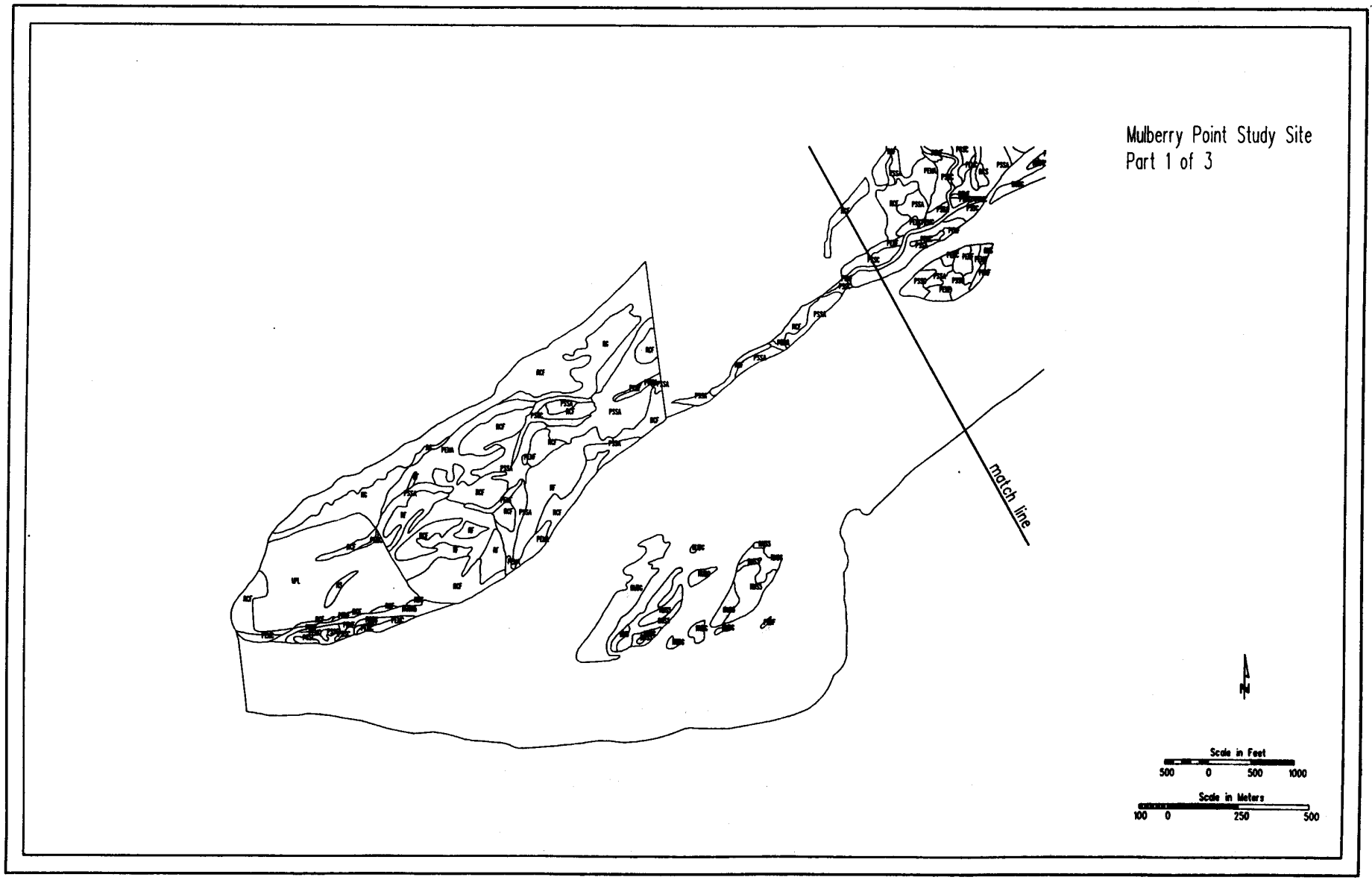
EXHIBIT 690 022251

Table MP-2 (Continued).

Missouri River - Mulberry Point (Mid Section) Study Site
River Mile 773.6 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RF	RUBH	RUS	RS	RUS5	PUBH
1129.5	0	0	0	1	0	0	0	0	0	1	0	0
1130.0	0	0	0	1	0	0	0	0	0	2	0	0
1130.5	0	0	0	1	0	0	0	0	0	1	0	0
1131.0	0	0	0	7	0	0	0	0	0	0	0	0
1131.5	0	0	0	7	0	0	0	0	0	0	0	0
1132.0	0	0	0	7	0	0	0	0	0	0	0	0
1132.5	0	0	0	8	0	0	0	0	0	0	0	0
1133.0	0	0	0	7	0	0	0	0	0	0	0	0
1133.5	0	0	0	7	0	0	0	0	0	0	0	0
1134.0	0	0	0	8	0	0	0	0	0	0	0	0
1134.5	0	0	0	7	0	0	0	0	0	0	0	0
1135.0	0	0	0	7	0	0	0	0	0	0	0	0
1135.5	0	0	0	8	0	0	0	0	0	0	0	0
1136.0	0	0	0	7	0	0	0	0	0	0	0	0
1136.5	0	0	0	7	0	0	0	0	0	0	0	0
1137.0	0	0	0	8	0	0	0	0	0	0	0	0
1137.5	0	0	0	4	0	0	1	0	0	0	0	0
1138.0	0	0	0	1	0	0	4	0	0	0	0	0
1138.5	0	0	0	1	0	0	3	0	0	0	0	0
1139.0	0	0	0	1	0	0	3	0	0	0	0	0
1139.5	0	0	0	1	0	0	3	0	0	0	0	0
1140.0	0	0	0	1	0	0	4	0	0	0	0	0
1140.5	0	0	0	1	0	0	3	0	0	0	0	0
1141.0	0	0	0	1	0	0	3	0	0	0	0	0
1141.5	0	0	0	1	0	0	3	0	0	0	0	0
1142.0	0	0	0	1	0	0	1	0	0	0	0	0
TOTAL	**166**	**432**	**102**	**116**	**1509**	**326**	**28**	**32**	**17**	**11**	**17**	**350**

EXHIBIT 690 022252


Mulberry Point Study Site
Part 1 of 3
match line
N
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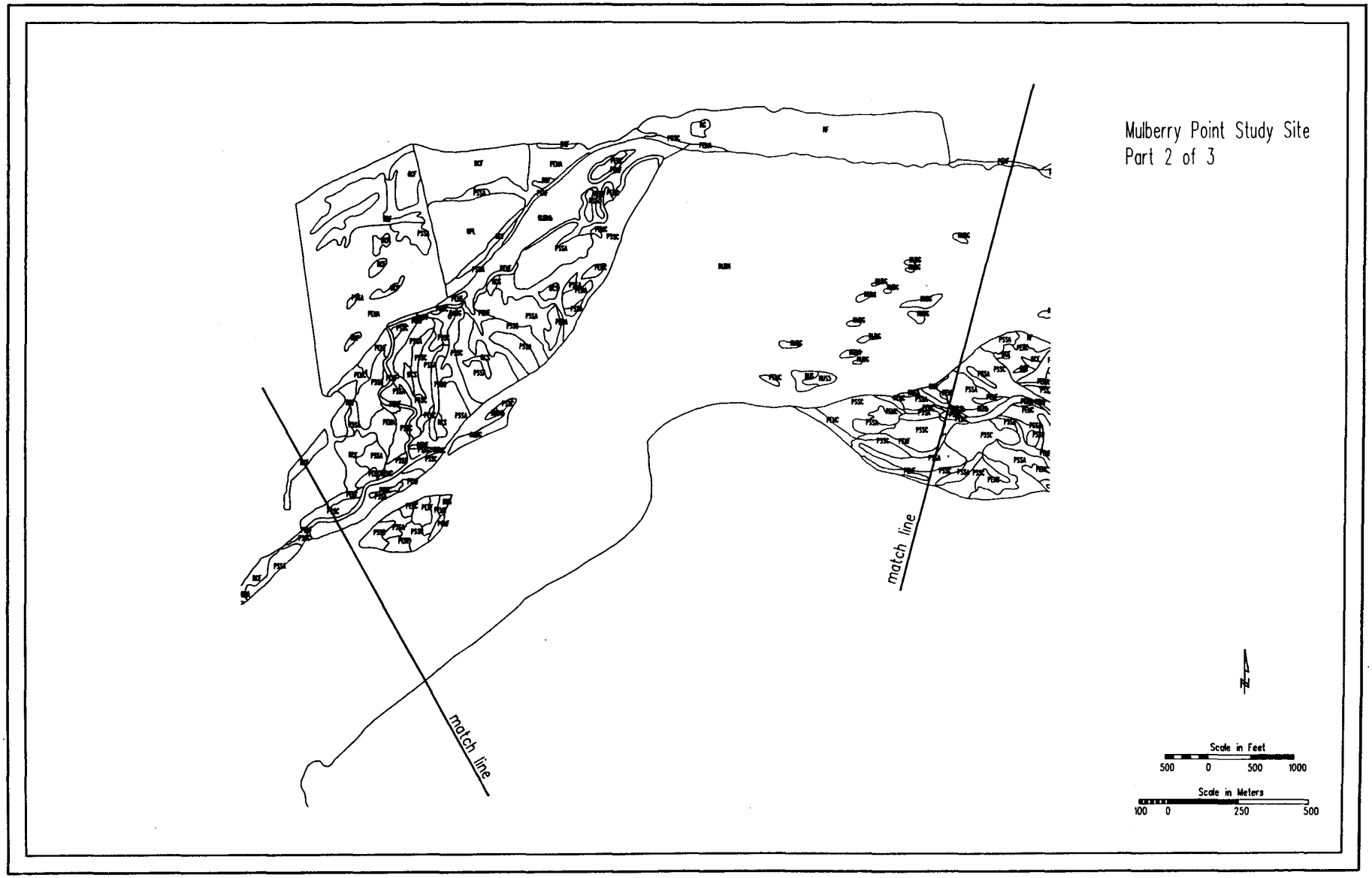
Scale in Meters
100 0 250 500

B-126


Mulberry Point Study Site
Part 2 of 3
match line
match line
N
Scale in Feet
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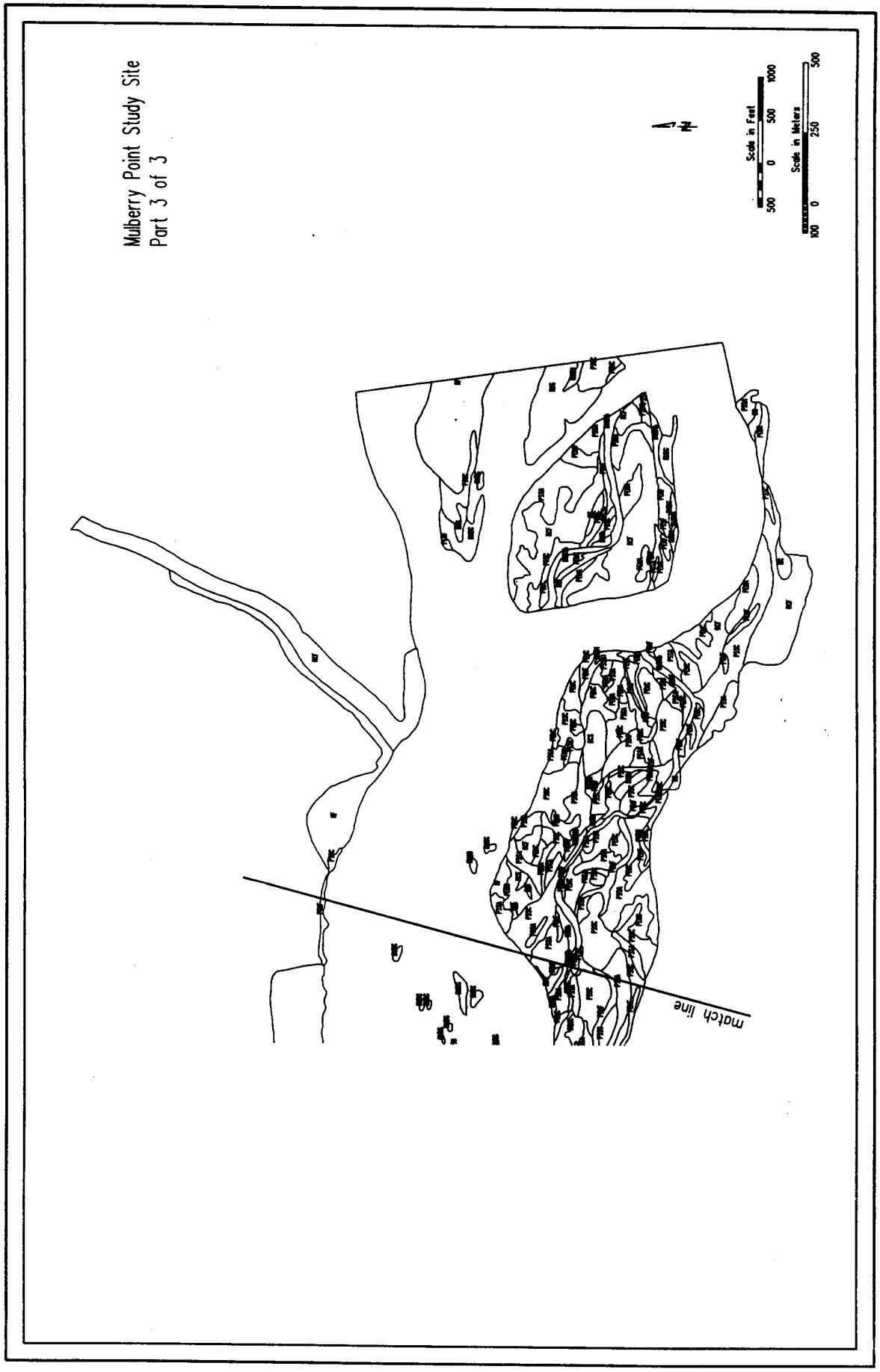
Scale in Meters
100 0 250 500

B-127


Mulberry Point Study Site
Part 3 of 3
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500
match line

Elk Point

The Elk Point study site was located 5 miles upstream of the Ponca State Park boat ramp on the left bank of the Missouri River. It was a wetland complex consisting of channels, chutes, and islands on the outside of a bend at RM 758.4. The study site was bordered to the north by cottonwood forests and cultivated lands. Bank erosion and sediment deposition had altered the site from the 1983 National Wetland Inventory Map conditions. The Elk Point study site was part of the National Recreation River reach of the upper river.

Palustrine scrub-shrub wetlands were the most prevalent cover type, representing 262.4 acres (16.0 percent) of the study site (Table EP-1). The PSSA and PSSC wetlands (129.3 and 133.1 acres, respectively) were dominated by cottonwood, sandbar willow, and indigo bush shrubs with an understory of equisetum and goldenrod. Riparian forest (RF) accounted for 157.5 acres (9.6 percent) of the study site and were dominated by cottonwood trees. PEMF wetlands were characterized by narrow-leaved cattail and softstem bulrush and were found bordering the channels and chutes and around the islands. PEMF wetlands occupied 55.3 acres (3.4 percent) of the study site. Many small islands located in the main channel of the Missouri River were either barren or sparsely vegetated. Areas of RUS5 were characterized by cattail, sedges, and marsh anemone and contributed 101.2 acres (6.2 percent) to the total study area.

Table EP-1. Wetland and riparian acreages mapped in the Elk Point study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	27.4
Palustrine emergent seasonally flooded (PEMC)	41.1
Palustine emergent semipermanently flooded (PEMF)	55.3
Palustrine scrub-shrub temporarily flooded (PSSA)	129.3
Palustrine scrub-shrub seasonally flooded (PSSC)	133.1
Riparian grassland (RG)	36.1
Riparian shrub (RS)	94.5
Riparian forest (RF)	157.5
Riverine unconsolidated bottom permanently flooded (RUBH)	847.0
Riverine unconsolidated shore (RUS)	76.8
Riverine unconsolidated shore vegetated (RUS5)	24.4
Palustrine unconsolidated bottom permanently flooded (PUBH)	14.0
Total	1,636.5

The wetland and riparian cover type elevations were measured along 7 transects on June 23, 1991; 3 transects at the extreme downstream end of the study site and 4 transects in the middle. All transects were standardized to RM 758.4. Elevations ranged from PUBH at 1100.0 (water 1.5 feet deep) to RF and RG at 1121.5 (Table

EXHIBIT 690 022256

EP-2) with relatively little overlap between types. The Missouri River water surface elevation was 1101.5 at RM 758.4.

Wildlife species observed at the Elk Point study site included the following bird species: brown thrasher, red-winged blackbird, killdeer, least tern, cliff swallow, dickcissel, bobwhite, catbird, eastern kingbird, mourning dove, barn swallow, yellowthroat, orchard oriole, Swainson's thrush, yellow warbler, northern oriole, pheasant, red-headed woodpecker, and rock dove. Deer, beaver, rabbit, and raccoon were the mammal species observed at the site.

EXHIBIT 690 022257

Table EP-2. Distribution of sampling points by elevation.

Missouri River - Elk Point Study Site
River Mile 758.4 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RS	RF	RUBH	RUS	RUS5	PUBH
1085.5	0	0	0	0	0	0	0	0	1	0	0	0
1086.0	0	0	0	0	0	0	0	0	1	0	0	0
1086.5	0	0	0	0	0	0	0	0	1	0	0	0
1087.0	0	0	0	0	0	0	0	0	1	0	0	0
1087.5	0	0	0	0	0	0	0	0	1	0	0	0
1088.0	0	0	0	0	0	0	0	0	1	0	0	0
1088.5	0	0	0	0	0	0	0	0	1	0	0	0
1089.0	0	0	0	0	0	0	0	0	1	0	0	0
1089.5	0	0	0	0	0	0	0	0	1	0	0	0
1090.0	0	0	0	0	0	0	0	0	1	0	0	0
1090.5	0	0	0	0	0	0	0	0	1	0	0	0
1091.0	0	0	0	0	0	0	0	0	1	0	0	0
1091.5	0	0	0	0	0	0	0	0	1	0	0	0
1092.0	0	0	0	0	0	0	0	0	1	0	0	0
1092.5	0	0	0	0	0	0	0	0	1	0	0	0
1093.0	0	0	0	0	0	0	0	0	1	0	0	0
1093.5	0	0	0	0	0	0	0	0	1	0	0	0
1094.0	0	0	0	0	0	0	0	0	1	0	0	0
1094.5	0	0	0	0	0	0	0	0	1	0	0	0
1095.0	0	0	0	0	0	0	0	0	1	0	0	0
1095.5	0	0	0	0	0	0	0	0	1	0	0	0
1096.0	0	0	0	0	0	0	0	0	1	0	0	0
1096.5	0	0	0	0	0	0	0	0	1	0	0	0
1097.0	0	0	0	0	0	0	0	0	1	0	0	0
1097.5	0	0	0	0	0	0	0	0	1	0	0	0
1098.0	0	0	0	0	0	0	0	0	1	0	0	0
1098.5	0	0	0	0	0	0	0	0	1	0	0	0
1099.0	0	0	0	0	0	0	0	0	1	0	0	0
1099.5	0	0	0	0	0	0	0	0	1	0	0	0
1100.0	0	0	0	0	0	0	0	0	1	0	0	1
1100.5	0	0	0	0	0	0	0	0	1	0	0	1
1101.0	0	0	0	0	0	0	0	0	1	0	0	34
1101.5	23	0	0	0	0	0	0	0	1	0	10	73
1102.0	141	0	0	0	0	0	0	0	0	1	25	1
1102.5	231	20	0	0	1	0	0	0	0	1	0	0
1103.0	32	132	0	0	29	0	1	0	0	0	0	0
1103.5	0	221	2	1	93	3	1	0	0	0	0	0
1104.0	0	114	58	1	327	33	1	0	0	1	0	0
1104.5	0	0	10	1	319	145	1	0	0	0	0	0
1105.0	0	7	25	1	74	145	6	0	0	0	0	0
1105.5	0	5	19	2	139	264	15	0	0	0	0	0
1106.0	0	0	0	2	4	257	45	0	0	0	0	0
1106.5	0	0	0	3	0	48	50	0	0	0	0	0
1107.0	0	0	0	3	0	1	61	0	0	0	0	0
1107.5	0	0	0	3	0	0	19	0	0	0	0	0
1108.0	0	0	0	3	0	0	11	0	0	0	0	0
1108.5	0	0	0	3	0	0	10	0	0	0	0	0
1109.0	0	0	0	2	0	0	11	0	0	0	0	0

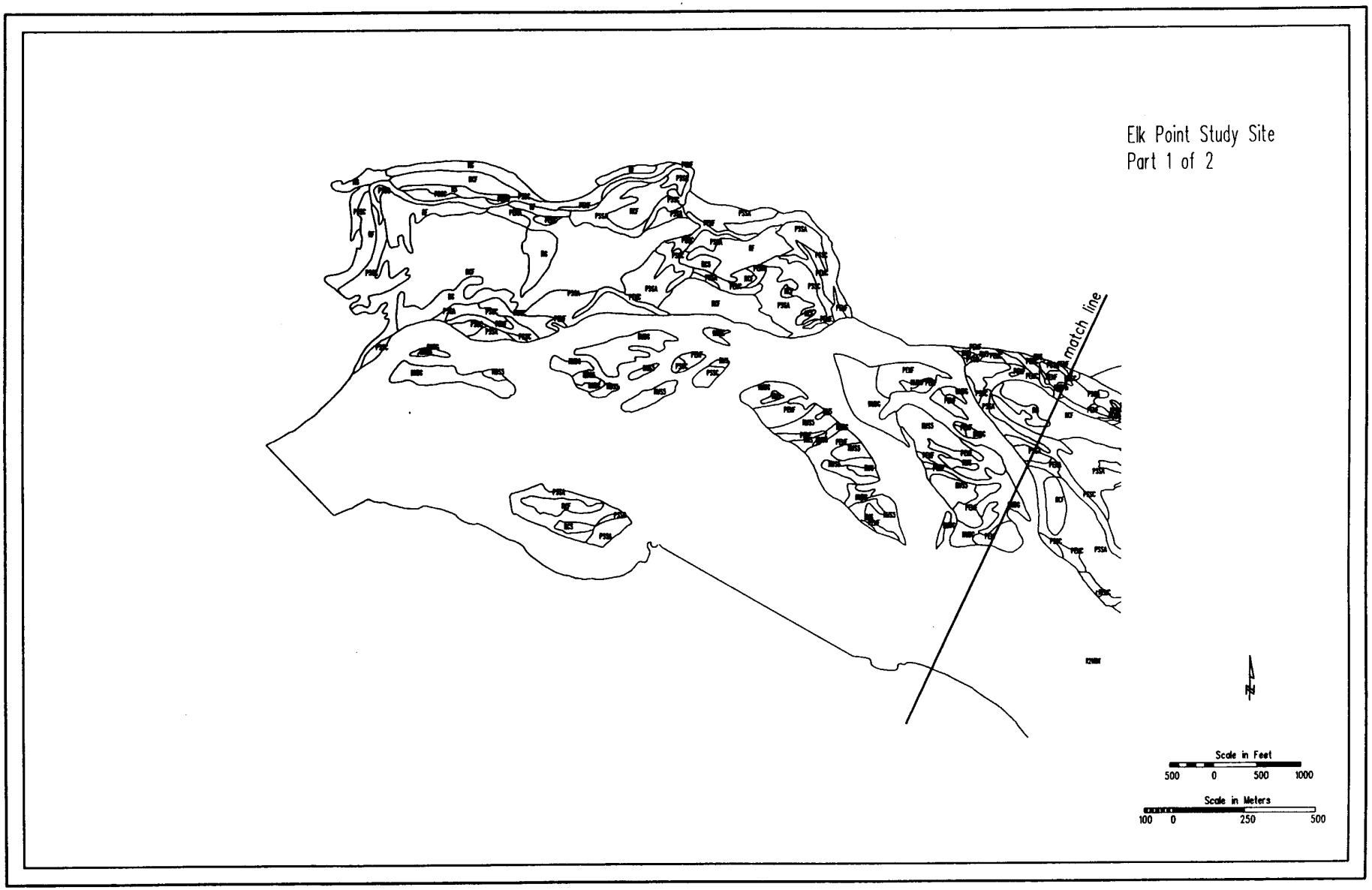
EXHIBIT 690 022258

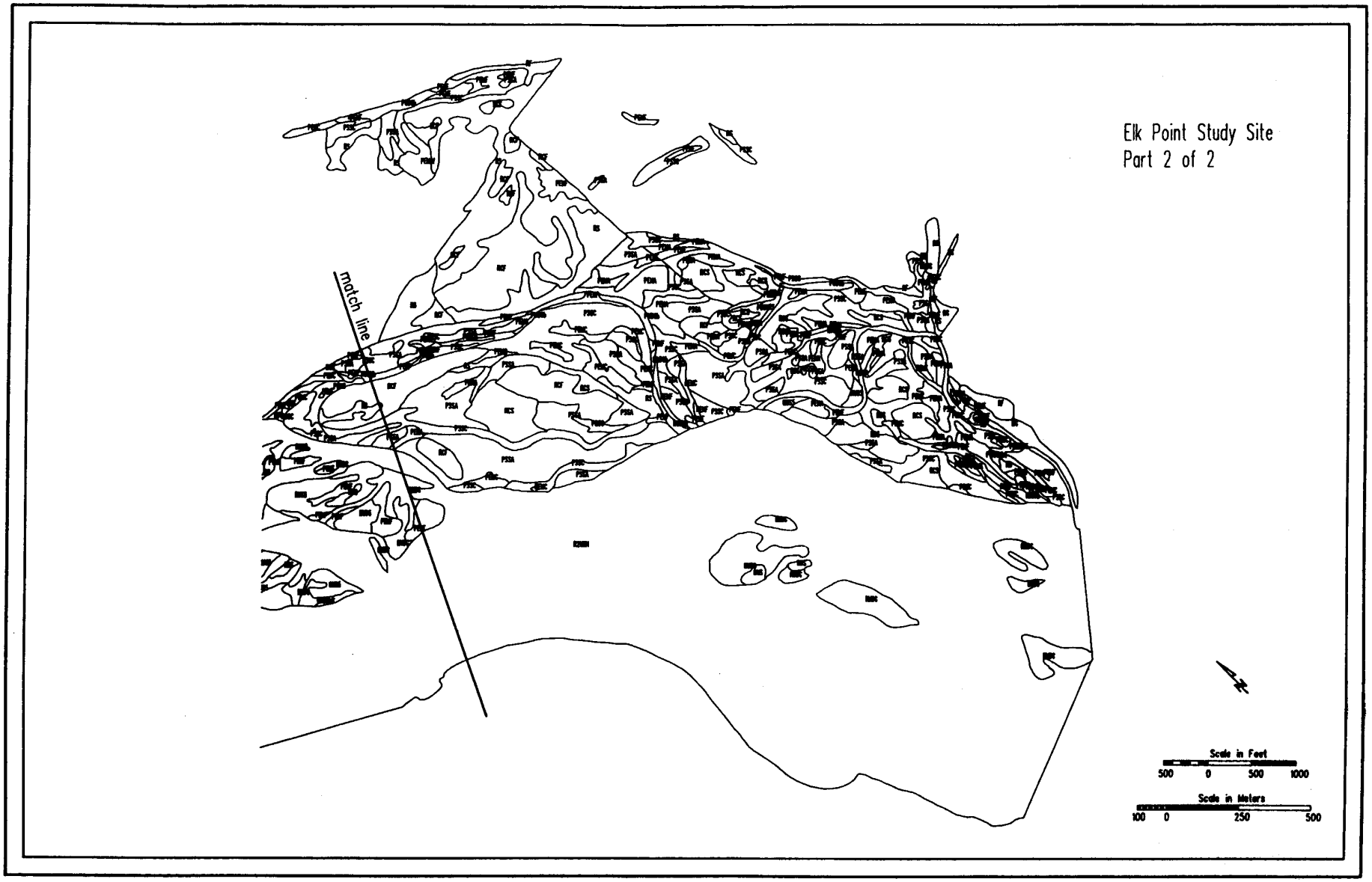
Table EP-2 (Continued).

Missouri River - Elk Point Study Site
River Mile 758.4 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RS	RF	RUBH	RUS	RUS5	PUBH
1109.5	0	0	0	4	0	0	9	0	0	0	0	0
1110.0	0	0	0	1	0	0	9	1	0	0	0	0
1110.5	0	0	0	1	0	0	8	1	0	0	0	0
1111.0	0	0	0	1	0	0	7	1	0	0	0	0
1111.5	0	0	0	1	0	0	0	1	0	0	0	0
1112.0	0	0	0	1	0	0	0	1	0	0	0	0
1112.5	0	0	0	1	0	0	0	1	0	0	0	0
1113.0	0	0	0	1	0	0	0	1	0	0	0	0
1113.5	0	0	0	1	0	0	0	1	0	0	0	0
1114.0	0	0	0	1	0	0	0	1	0	0	0	0
1114.5	0	0	0	1	0	0	0	1	0	0	0	0
1115.0	0	0	0	1	0	0	0	1	0	0	0	0
1115.5	0	0	0	1	0	0	0	1	0	0	0	0
1116.0	0	0	0	1	0	0	0	1	0	0	0	0
1116.5	0	0	0	1	0	0	0	1	0	0	0	0
1117.0	0	0	0	1	0	0	0	1	0	0	0	0
1117.5	0	0	0	1	0	0	0	1	0	0	0	0
1118.0	0	0	0	1	0	0	0	1	0	0	0	0
1118.5	0	0	0	1	0	0	0	1	0	0	0	0
1119.0	0	0	0	1	0	0	0	1	0	0	0	0
1119.5	0	0	0	1	0	0	0	1	0	0	0	0
1120.0	0	0	0	1	0	0	0	1	0	0	0	0
1120.5	0	0	0	1	0	0	0	1	0	0	0	0
1121.0	0	0	0	1	0	0	0	1	0	0	0	0
1121.5	0	0	0	1	0	0	0	1	0	0	0	0
TOTAL	427	499	114	53	986	896	265	24	33	3	35	110

EXHIBIT 690 022259


Elk Point Study Site
Part 1 of 2
match line
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500


Elk Point Study Site
Part 2 of 2
match line
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Winnebago Bend

The Winnebago Bend study site was a complex of wetland and riparian areas associated with an oxbow. This area was located on the left bank of the Missouri River (Iowa), approximately 9 miles upstream of Macy, Nebraska. No obvious upstream inlet to the oxbow existed. Therefore, it was assumed that during times of high water, the hydrology of the area reversed and water backed up into the oxbow through a small channel at the downstream end of the study site. The southern portion of the study site is partially confined by a levee. The Winnebago Bend study site was part of the Ponca to Omaha reach of the upper river.

The permanently flooded (PUBH) portion of the oxbow occupied 58.1 acres (4.0 percent) of the study site (Table WB-1). The oxbow was only about 1 foot deep and sparsely vegetated with arrowleaf, eastern gramma, and barnyard grass. Riparian cover types represented over half of the area mapped in the study site. Riparian forests (RF), occupying 539.5 acres (37.1 percent), were located primarily in the area between the oxbow and the river. Cottonwood was the dominant species in the RF stands. Riparian shrubs (RS), located throughout the site, were dominated by cottonwood shrubs and represented 218.5 acres (15.0 percent). Emergent wetlands were limited to areas surrounding the oxbow and accounted for only 6.5 percent of the total area mapped. Scrub-shrub wetlands (PSSA and PSSC) were concentrated at the downstream portion of the study site, near the channel connecting the oxbow and river. Sandbar willow was the dominant species in both the PSSA and PSSC wetland.

Table WB-1. Wetland and riparian acreages mapped in the Winnebago Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	21.3
Palustrine emergent seasonally flooded (PEMC)	43.8
Palustine emergent semipermanently flooded (PEMF)	29.4
Palustrine scrub-shrub temporarily flooded (PSSA)	99.7
Palustrine scrub-shrub seasonally flooded (PSSC)	120.2
Palustrine forest seasonally flooded (PFOC)	3.8
Riparian grassland (RG)	93.8
Riparian shrub (RS)	218.5
Riparian forest (RF)	539.5
Riverine unconsolidated bottom permanently flooded (RUBH)	203.8
Riverine unconsolidated shore (RUS)	19.5
Riverine unconsolidated shore vegetated (RUS5)	0.9
Palustrine unconsolidated bottom permanently flooded (PUBH)	58.1
Total	1,452.3

EXHIBIT 690 022262

For sampling purposes, the Winnebago Bend study site was divided in half. Four transects at the south end of the site were sampled on June 24, 1991; another 4 transects were sampled in the northern half of the study site on June 25, 1991. All transects were standardized around RM 708.8. All wetland types occurred within a 7-foot elevational range. Consequently, there was considerable over-lap in the elevational distribution of various types (Table WB-2). The water surface elevation of the oxbow was 1049.5 and the elevation of the Missouri River at RM 708.8 was 1049.0.

A wide variety of wildlife species were observed at the Winnebago Bend study site, including the following birds: catbird, yellow warbler, yellowthroat, goldfinch, bank swallow, cliff swallow, great blue heron, indigo bunting, sora, red-headed woodpecker, northern oriole, orchard oriole, Cooper's hawk, and pheasant. Mammals seen during the sampling period included beaver, rabbit, raccoon, and deer.

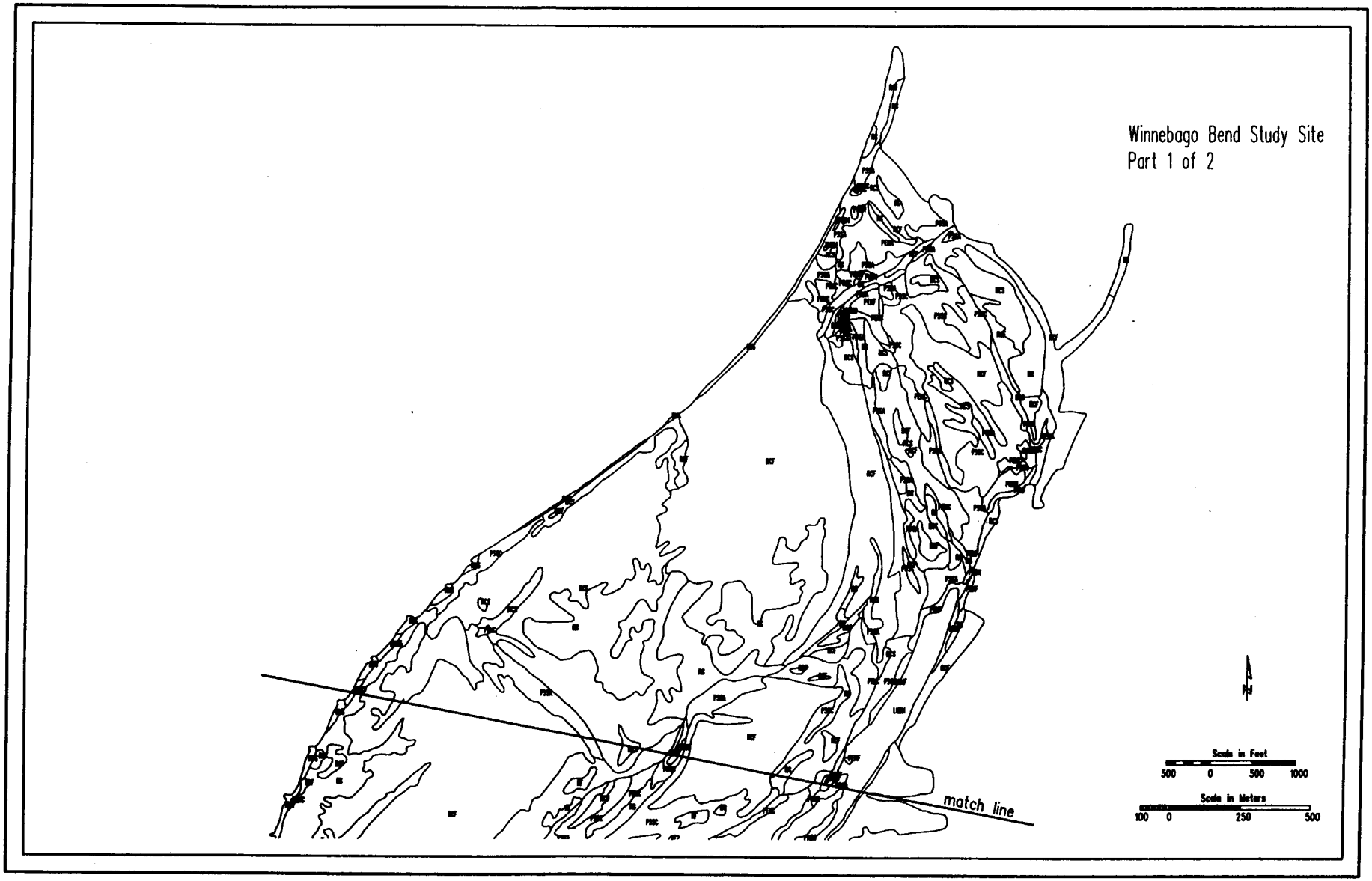
EXHIBIT 690 022263

Table WB-2. Distribution of sampling points by elevation.

Missouri River - Winnebago Study Site
River Mile 708.8 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RS	RF	RUBH	PFOC	RUS	RUS5	PUBH
1030.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1030.5	0	0	0	0	0	0	0	0	1	0	0	0	0
....													
....													
1045.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1045.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1046.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1046.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1047.0	0	0	0	0	0	0	0	0	1	0	0	0	0
1047.5	0	0	0	0	0	0	0	0	1	0	0	0	0
1048.0	0	0	0	0	0	0	0	0	1	0	15	15	16
1048.5	0	0	0	0	0	0	0	0	1	0	71	71	47
1049.0	28	1	0	0	0	0	0	0	1	0	43	43	35
1049.5	51	30	0	0	0	0	0	0	0	0	10	10	1
1050.0	48	41	1	0	0	1	0	0	0	0	19	19	0
1050.5	225	9	3	0	7	2	0	0	0	0	24	24	0
1051.0	25	106	23	0	28	13	0	0	0	0	27	27	0
1051.5	0	76	21	1	16	19	1	0	0	0	3	3	0
1052.0	0	10	28	0	42	4	0	0	0	0	0	0	0
1052.5	0	3	30	1	61	6	0	0	0	5	0	0	0
1053.0	0	23	17	2	15	6	29	0	0	1	0	0	0
1053.5	0	61	117	24	10	6	56	0	0	0	0	0	0
1054.0	0	8	73	22	1	19	0	0	0	0	0	0	0
1054.5	0	9	23	6	3	21	1	0	0	0	0	0	0
1055.0	0	12	28	9	6	32	1	0	0	0	1	1	0
1055.5	0	11	8	3	7	0	0	0	0	0	0	0	0
1056.0	0	0	0	3	5	0	0	0	0	0	0	0	0
1056.5	0	0	0	2	0	0	0	0	0	0	0	0	0
1057.0	0	0	0	3	0	0	0	0	0	0	0	0	0
1057.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1058.0	0	0	0	0	0	0	0	1	0	0	0	0	0
1058.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1059.0	0	0	0	0	0	0	0	1	0	0	0	0	0
1059.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1060.0	0	0	0	0	0	0	0	1	0	0	0	0	0
1060.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1061.0	0	0	0	0	0	0	0	1	0	0	0	0	0
1061.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1062.0	0	0	0	0	0	0	0	1	0	0	0	0	0
1062.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1063.0	0	0	0	0	0	0	0	1	0	0	0	0	0
1063.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1064.0	0	0	0	0	0	0	0	1	0	0	0	0	0
1064.5	0	0	0	0	0	0	0	1	0	0	0	0	0
1065.0	0	0	0	0	0	0	0	1	0	0	0	0	0
TOTAL	377	400	372	76	201	129	88	16	39	6	213	213	99

EXHIBIT 690 022264


Winnebago Bend Study Site
Part 1 of 2
match line
Scale in Feet
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Scale in Meters
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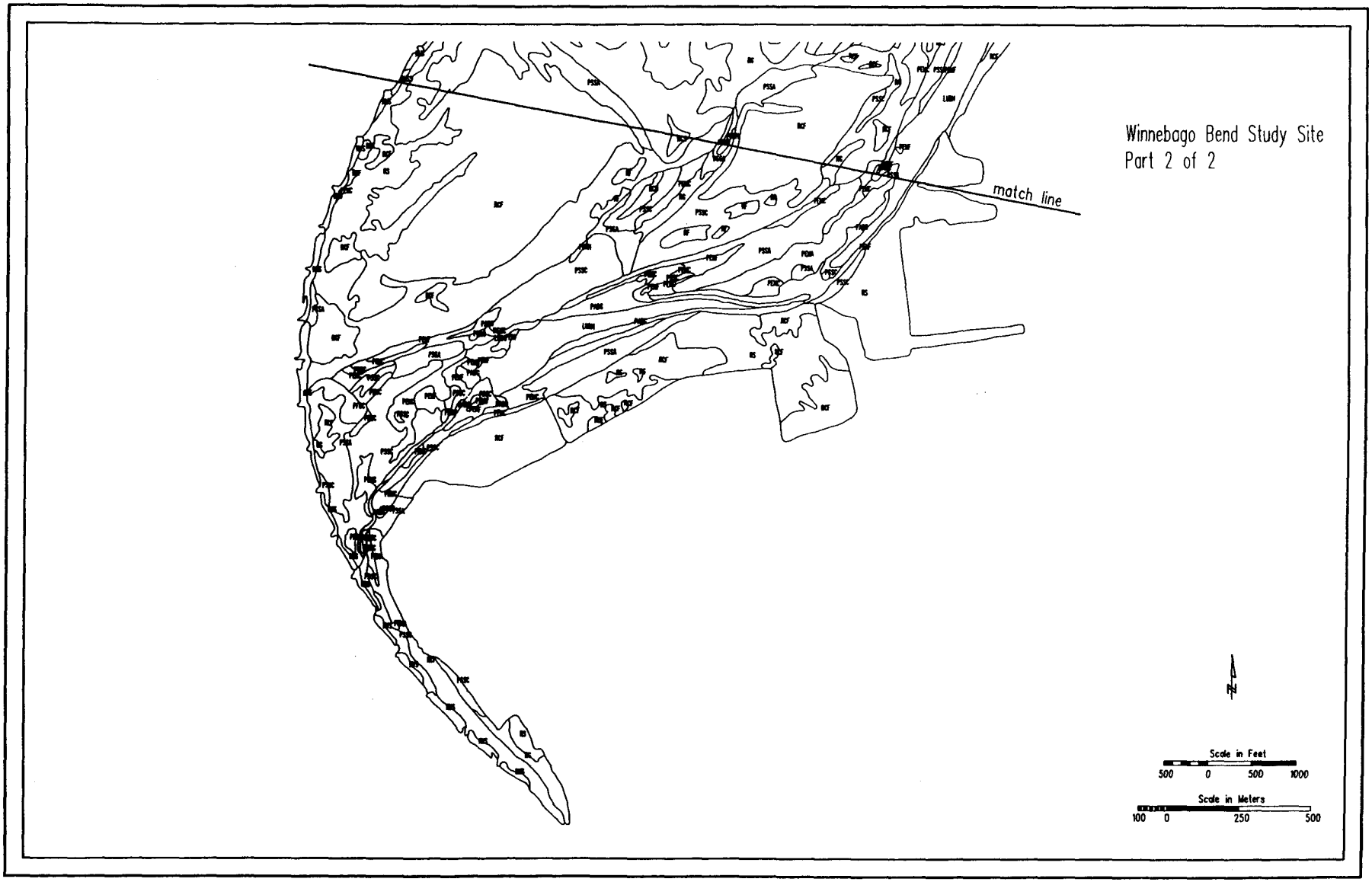
Winnebago Bend Study Site
Part 2 of 2
match line
N
Scale in Feet
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Scale in Meters
100 0 250 500

Tieville Lake

The Tieville Lake study site included an oxbow lake located on the right bank of the Missouri River just outside of Decatur, Nebraska near the Highway 75 bridge. Most of the oxbow and its associated wetlands are north (upstream) of the highway. However, some smaller ponds and wetlands occur on the south side of Highway 75. Both portions have a direct connection with the Missouri River at high flows and water levels are likely to fluctuate with the river due to a groundwater correction. Because of the distance between the two parts of the study site, the physical separation (Highway 75), and the different riverine influences, the Tieville Lake study site was divided into Upper and Lower Tieville Lake. Only Lower Tieville Lake was used in the model because the upper portion of the site was disturbed by sorghum fields. Both sites were in the Ponca to Omaha reach of the lower river. Detailed site descriptions for both the upper and lower sites are provided below.

Tieville Lake was located in the Upper Tieville Lake study site and occupied a surface area of 52.8 acres (4.0 percent) (Table TV-1). Emergent wetlands dominated the study site, representing a total of 827.2 acres (61.2 percent). PEMC wetlands contributed 507.1 acres and were dominated by indian hemp, common reed, and mint. Areas that had been recently cultivated were classified as PEMA wetlands. Although these areas supported a sorghum crop, soft-stem and river bulrushes were also present indicating that temporary flooding occurred. PEMA wetlands occupied 287.7 acres (21.5 percent) of the study site.

Table TV-1. Wetland and riparian acreages mapped in the Upper Tieville Lake study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	287.7
Palustrine emergent seasonally flooded (PEMC)	507.1
Palustine emergent semipermanently flooded (PEMF)	32.4
Palustrine scrub-shrub temporarily flooded (PSSA)	5.9
Palustrine scrub-shrub seasonally flooded (PSSC)	65.3
Riparian grassland (RG)	24.6
Riparian shrub (RS)	7.6
Riparian forest (RF)	109.6
Lacustrine unconsolidated bottom permanently flooded (LUBH)	52.8
Lacustrine unconsolidated shore (LUS)	29.6
Lacustrine unconsolidated shore vegetated (LUS5)	6.3
Riverine unconsolidated bottom permanently flooded (RUBH)	196.3
Total	1,335.4

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Wetland and riparian elevational distributions were measured along 3 transects on June 24, 1991. The water surface elevation of Tieville Lake and the Missouri River (RM 692.0) was 1028.0. Cover type elevations ranged from LUBH at 1027.0 to riparian elevation at 1050.0 (Table TV-3).

The Lower Tieville Lake study site was located south of Highway 75 and included several ponds and associated wetlands. Like Tieville Lake, this portion of the oxbow received surface water from the river only during high flows.

Riparian vegetation dominated this study site, with riparian forest (RF) and riparian grassland (RG) representing 144.5 acres (22.3 percent) and 143.4 acres (22.2 percent), respectively (Table TV-2). RF was dominated by cottonwood trees with mulberry and dogwood shrubs in the understory. The RG cover type included upland areas that were within the mapped area of the study site. Scrub-shrub wetlands, both PSSA and PSSC, were characterized by sandbar willow and contributed 74.7 acres (11.5 percent) to the study site. The permanently flooded ponds (LUBH) occupied a surface area of only 6.1 acres.

Table TV-2. Wetland and riparian acreages mapped in the Lower Tieville Lake study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	19.4
Palustrine emergent seasonally flooded (PEMC)	96.0
Palustine emergent semipermanently flooded (PEMF)	14.5
Palustrine scrub-shrub temporarily flooded (PSSA)	24.6
Palustrine scrub-shrub seasonally flooded (PSSC)	50.1
Riparian grassland (RG)	143.4
Riparian shrub (RS)	9.7
Riparian forest (RF)	144.5
Lacustrine unconsolidated bottom permanently flooded (LUBH)	6.1
Riverine unconsolidated shore (RUS)	24.2
Riverine unconsolidated bottom permanently flooded (RUBH)	114.9
Total	647.4

The Lower Tieville Lake study site was sampled on June 25, 1991. Cover type elevations were measured along 2 transects. Wetland and riparian elevational distributions ranged from 1033.0 to 1050.0 (Table TV-4) and were standardized to RM 692; the location of the nearest rating curve. The water surface elevation of the ponds (LUBH) in the lower site was 1035.5, approximately 7.5 higher than the Missouri River elevation at the upper site. The Missouri River water surface elevation was not measured at the lower site.

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Table TV-3. Distribution of sampling points by elevation.

Missouri River - Tieville Study Site, River Mile 692.0
Transects A, B, and C combined = North

Elevation	PEMF	PEMC	RG	PSSC	PSSA	RF	LUBH	LUS	LUS5	RUBH	PEMA	RS	RUS
1017.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1017.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1018.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1018.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1019.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1019.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1020.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1020.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1021.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1021.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1022.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1022.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1023.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1023.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1024.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1024.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1025.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1025.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1026.0	0	0	0	0	0	0	0	0	0	1	0	0	0
1026.5	0	0	0	0	0	0	0	0	0	1	0	0	0
1027.0	0	0	0	0	0	0	1	0	0	1	0	0	0
1027.5	10	0	0	0	0	0	6	0	0	1	0	0	0
1028.0	18	0	0	0	0	0	5	1	0	1	0	0	1
1028.5	16	0	0	0	0	0	0	0	0	0	0	0	0
1029.0	14	3	0	0	0	0	0	1	0	0	0	0	1
1029.5	6	12	0	0	0	0	0	2	0	0	0	0	2
1030.0	6	11	0	0	0	0	0	1	1	0	0	0	1
1030.5	1	17	0	0	0	0	0	0	2	0	0	0	0
1031.0	0	17	1	0	0	0	0	0	1	0	1	0	0
1031.5	0	78	1	0	0	0	0	0	2	0	1	0	0
1032.0	0	206	19	4	3	0	0	0	1	0	19	0	0
1032.5	0	399	222	149	16	0	0	0	0	0	222	0	0
1033.0	0	180	263	206	0	0	0	0	0	0	263	0	0
1033.5	0	368	27	143	0	0	0	0	0	0	27	0	0
1034.0	0	0	26	0	0	0	0	0	0	0	26	0	0
1034.5	0	0	14	0	0	0	0	0	0	0	14	0	0
1035.0	0	0	9	0	0	0	0	0	0	0	9	0	0
1035.5	0	0	9	0	0	0	0	0	0	0	9	0	0
1036.0	0	0	6	0	0	1	0	0	0	0	6	1	0
1036.5	0	0	2	0	0	2	0	0	0	0	2	2	0
1037.0	0	0	1	0	0	3	0	0	0	0	1	3	0
1037.5	0	0	1	0	0	2	0	0	0	0	1	2	0
1038.0	0	0	1	0	0	2	0	0	0	0	1	2	0
1038.5	0	0	1	0	0	3	0	0	0	0	0	3	0
1039.0	0	0	1	0	0	2	0	0	0	0	0	2	0
1039.5	0	0	1	0	0	2	0	0	0	0	0	2	0
1040.0	0	0	1	0	0	1	0	0	0	0	0	1	0
1040.5	0	0	1	0	0	1	0	0	0	0	0	1	0

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Table TV-3 (Continued).

Missouri River - Tieville Study Site, River Mile 692.0
Transects A, B, and C combined = North

Elevation	PEMF	PEMC	RG	PSSC	PSSA	RF	LUBH	LUS	LUS5	RUBH	PEMA	RS	RUS
1041.0	0	0	1	0	0	1	0	0	0	0	0	1	0
1041.5	0	0	1	0	0	1	0	0	0	0	0	1	0
1042.0	0	0	1	0	0	1	0	0	0	0	0	1	0
1042.5	0	0	1	0	0	1	0	0	0	0	0	1	0
1043.0	0	0	1	0	0	1	0	0	0	0	0	1	0
1043.5	0	0	1	0	0	1	0	0	0	0	0	1	0
1044.0	0	0	1	0	0	1	0	0	0	0	0	1	0
1044.5	0	0	1	0	0	1	0	0	0	0	0	1	0
1045.0	0	0	1	0	0	1	0	0	0	0	0	1	0
1045.5	0	0	0	0	0	1	0	0	0	0	0	1	0
1046.0	0	0	0	0	0	1	0	0	0	0	0	1	0
1046.5	0	0	0	0	0	1	0	0	0	0	0	1	0
1047.0	0	0	0	0	0	1	0	0	0	0	0	1	0
1047.5	0	0	0	0	0	1	0	0	0	0	0	1	0
1048.0	0	0	0	0	0	1	0	0	0	0	0	1	0
1048.5	0	0	0	0	0	1	0	0	0	0	0	1	0
1049.0	0	0	0	0	0	1	0	0	0	0	0	1	0
1049.5	0	0	0	0	0	1	0	0	0	0	0	1	0
1050.0	0	0	0	0	0	1	0	0	0	0	0	1	0
TOTAL	**71**	**1291**	**616**	**502**	**19**	**38**	**12**	**5**	**7**	**23**	**602**	**38**	**5**

EXHIBIT 690 022270

Table TV-4. Distribution of sampling points by elevation.

Missouri River - Tieville Study Site, River Mile 692.0
Transects D and E combined = Lower

Elevation	PEMF	PEMC	RG	PSSC	RF	LUBH	RS	RUBH	LUS	PEMA	PSSA	RUS
1017.0	0	0	0	0	0	0	0	1	0	0	0	0
1017.5	0	0	0	0	0	0	0	1	0	0	0	0
1018.0	0	0	0	0	0	0	0	1	0	0	0	0
1018.5	0	0	0	0	0	0	0	1	0	0	0	0
1019.0	0	0	0	0	0	0	0	1	0	0	0	0
1019.5	0	0	0	0	0	0	0	1	0	0	0	0
1020.0	0	0	0	0	0	0	0	1	0	0	0	0
1020.5	0	0	0	0	0	0	0	1	0	0	0	0
1021.0	0	0	0	0	0	0	0	1	0	0	0	0
1021.5	0	0	0	0	0	0	0	1	0	0	0	0
1022.0	0	0	0	0	0	0	0	1	0	0	0	0
1022.5	0	0	0	0	0	0	0	1	0	0	0	0
1023.0	0	0	0	0	0	0	0	1	0	0	0	0
1023.5	0	0	0	0	0	0	0	1	0	0	0	0
1024.0	0	0	0	0	0	0	0	1	0	0	0	0
1024.5	0	0	0	0	0	0	0	1	0	0	0	0
1025.0	0	0	0	0	0	0	0	1	0	0	0	0
1025.5	0	0	0	0	0	0	0	1	0	0	0	0
1026.0	0	0	0	0	0	0	0	1	0	0	0	0
1026.5	0	0	0	0	0	0	0	1	0	0	0	0
1027.0	0	0	0	0	0	0	0	1	0	0	0	0
1027.5	0	0	0	0	0	0	0	1	0	0	0	0
1028.0	0	0	0	0	0	0	0	1	0	0	0	0
1028.5	0	0	0	0	0	0	0	1	0	0	0	0
1029.0	0	0	0	0	0	0	0	1	0	0	0	0
1029.5	0	0	0	0	0	0	0	1	0	0	0	0
1030.0	0	0	0	0	0	0	0	1	0	0	0	0
1030.5	0	0	0	0	0	0	0	1	0	0	0	0
1031.0	0	0	0	0	0	0	0	1	0	0	0	0
1031.5	0	0	0	0	0	0	0	1	0	0	0	0
1032.0	0	0	0	0	0	0	0	1	0	0	0	0
1032.5	0	0	0	0	0	0	0	1	0	0	0	0
1033.0	0	0	0	0	0	22	0	0	22	0	0	22
1033.5	0	0	0	0	0	56	0	0	56	0	0	56
1034.0	107	0	0	0	0	19	0	0	19	0	0	19
1034.5	219	0	0	0	0	6	0	0	6	0	0	6
1035.0	159	0	0	0	0	7	0	0	7	0	0	7
1035.5	47	0	0	0	0	1	0	0	1	0	0	1
1036.0	19	37	0	0	0	0	0	0	0	0	0	0
1036.5	2	48	0	0	0	0	0	0	0	0	0	0
1037.0	3	37	0	0	0	0	0	0	0	0	0	0
1037.5	2	87	0	0	0	0	0	0	0	0	0	0
1038.0	2	74	0	17	0	0	0	0	0	0	0	0
1038.5	2	88	0	10	0	0	0	0	0	0	0	0
1039.0	0	92	0	16	0	0	0	0	0	0	0	0
1039.5	0	84	0	43	0	0	0	0	0	0	0	0
1040.0	0	34	42	16	0	0	0	0	0	42	0	0
1040.5	0	58	16	0	0	0	0	0	0	16	0	0

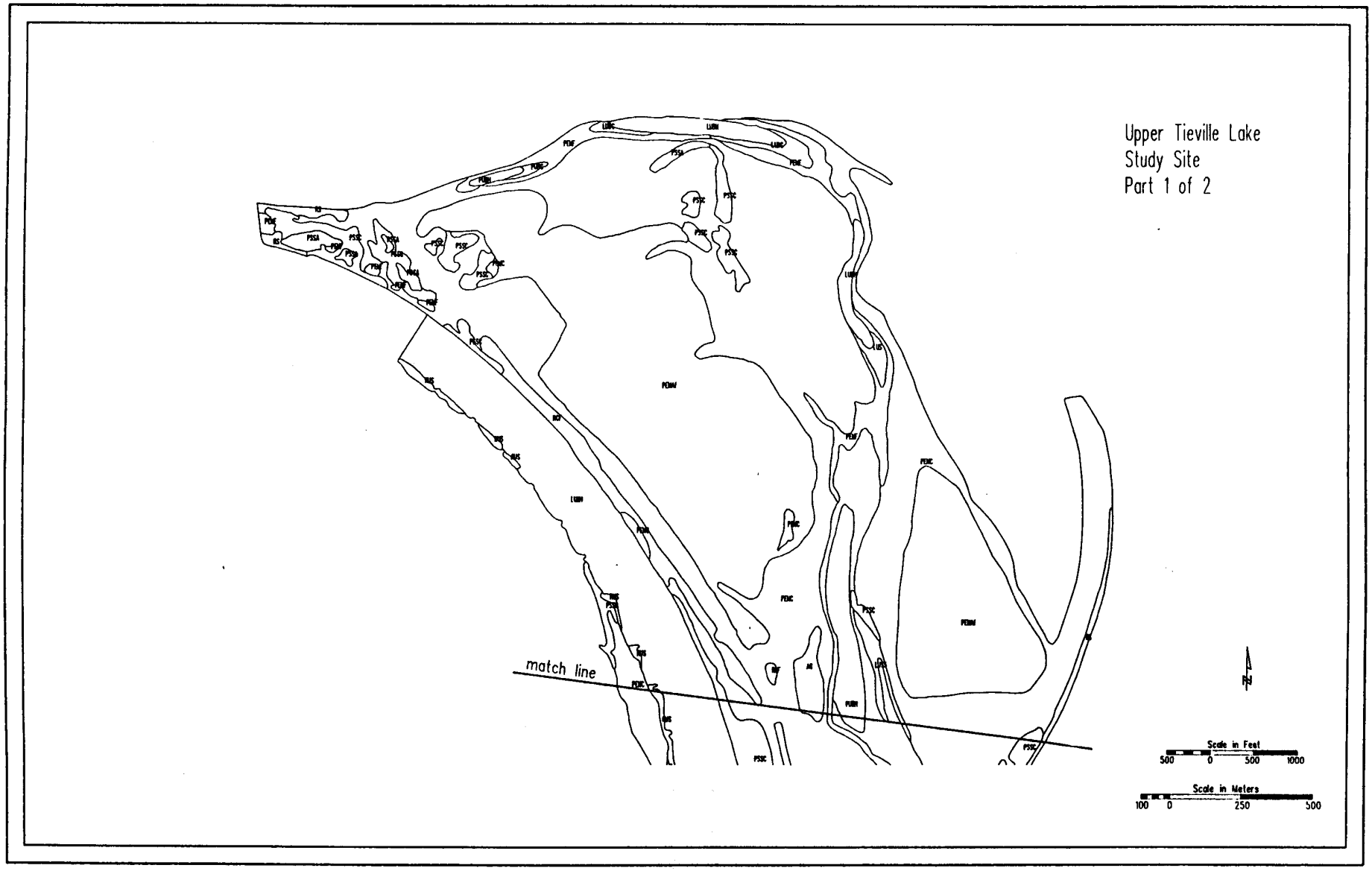
EXHIBIT 690 022271

Table TV-4 (Continued).

Missouri River - Tieville Study Site, River Mile 692.0
Transects D and E combined = Lower

Elevation	PEMF	PEMC	RG	PSSC	RF	LUBH	RS	RUBH	LUS	PEMA	PSSA	RUS
1041.0	0	3	0	0	0	0	11	0	0	0	0	0
1041.5	0	0	0	0	0	0	13	0	0	0	0	0
1042.0	0	0	54	0	0	0	5	0	0	54	0	0
1042.5	0	0	0	0	2	0	0	0	0	0	2	0
1043.0	0	0	0	0	1	0	0	0	0	0	1	0
1043.5	0	0	0	0	1	0	0	0	0	0	1	0
1044.0	0	0	0	0	2	0	0	0	0	0	2	0
1044.5	0	0	0	0	1	0	0	0	0	0	1	0
1045.0	0	0	0	0	1	0	0	0	0	0	1	0
1045.5	0	0	0	0	2	0	0	0	0	0	2	0
1046.0	0	0	1	0	1	0	0	0	0	1	0	0
1046.5	0	0	1	0	1	0	0	0	0	0	0	0
1047.0	0	0	1	0	1	0	0	0	0	0	0	0
1047.5	0	0	1	0	1	0	0	0	0	0	0	0
1048.0	0	0	1	0	1	0	0	0	0	0	0	0
1048.5	0	0	1	0	1	0	0	0	0	0	0	0
1049.0	0	0	1	0	1	0	0	0	0	0	0	0
1049.5	0	0	1	0	1	0	0	0	0	0	0	0
1050.0	0	0	1	0	1	0	0	0	0	0	0	0
TOTAL	562	642	121	102	18	111	29	32	111	113	10	111

EXHIBIT 690 022272


Upper Tieville Lake
Study Site
Part 1 of 2
match line
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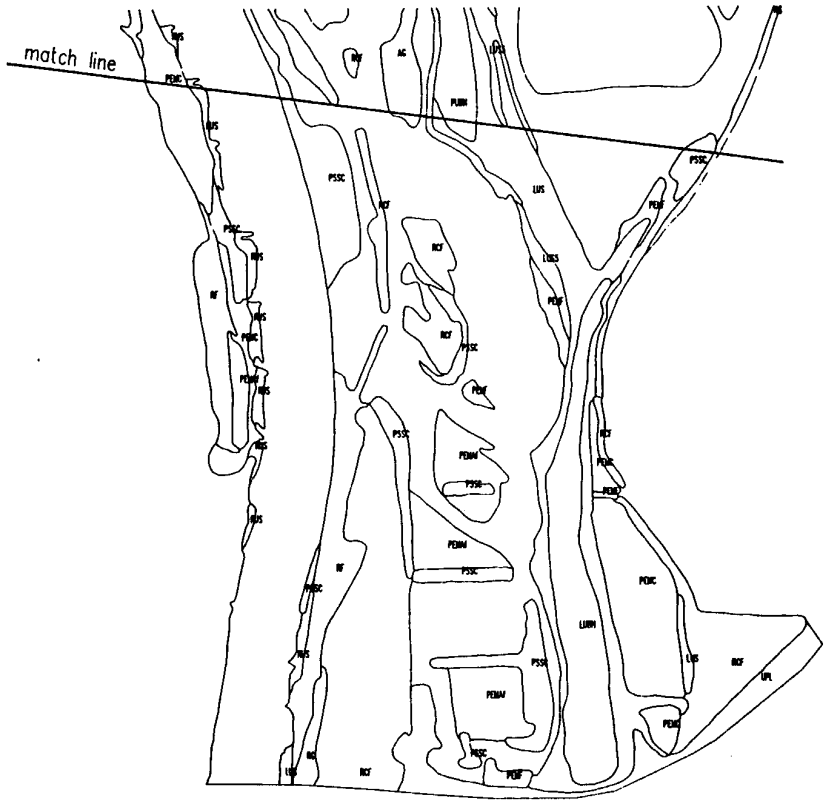
Scale in Meters
100 0 250 500

B-146



Upper Tieville Lake
Study Site
Part 2 of 2

N

Scale in Feet
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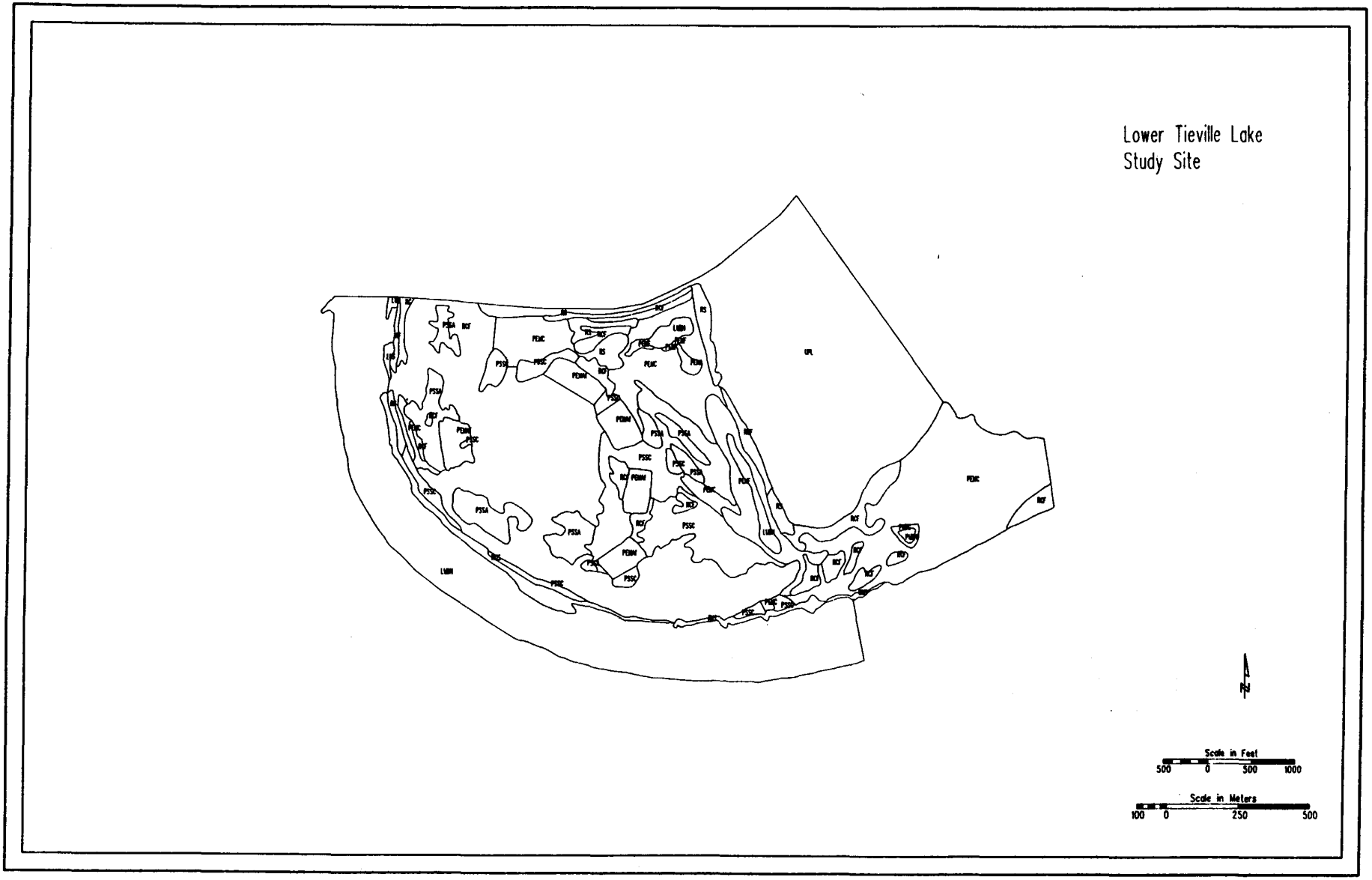
Scale in Meters
100 0 250 500

B-147


Lower Tieville Lake
Study Site
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Scale in Feet
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Scale in Meters
100 0 250 500

B-148

Louisville Bend

The Louisville Bend study site was an oxbow located on the left bank of the Missouri River, approximately 9 miles downstream of Decatur, Iowa. Although there was no apparent upstream inlet to the oxbow, a small channel connected the oxbow to the river at RM 682.5. This site is in the Ponca to Omaha reach of the lower river.

Riparian forest (RF) was the most prevalent cover type in the study site, occupying 228.1 acres (21.2 percent) primarily the downstream end of the site (Table LB-1). These areas supported stands of large cottonwood trees with an understory of dogwood shrubs and poison ivy. PSSA wetlands occurred throughout the study site, representing 211.6 acres (19.6 percent). Sandbar willow, the dominant species in the PSSA wetlands, reached heights of up to 16 feet. Areas that had been cultivated were classified as PEMA wetlands because they occurred at elevations similar the PSSA wetlands. PEMC and PEMF wetlands were characterized by river bulrush/reed canary grass and soft stem bulrush/cattail, respectively. The permanently flooded portion of the oxbow (PUBH) occupied a surface area of 60.6 acres.

Table LB-1. Wetland and riparian acreages mapped in the Louisville Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	180.2
Palustrine emergent seasonally flooded (PEMC)	74.5
Palustine emergent semipermanently flooded (PEMF)	12.1
Palustrine scrub-shrub temporarily flooded (PSSA)	211.6
Palustrine scrub-shrub seasonally flooded (PSSC)	17.1
Palustrine forest temporarily flooded (PFOA)	23.3
Riparian grassland (RG)	3.0
Riparian shrub (RS)	15.3
Riparian forest (RF)	228.1
Riverine unconsolidated bottom permanently flooded (RUBH)	222.7
Riverine unconsolidated shore (RUS)	29.1
Palustrine unconsolidated bottom permanently flooded (PUBH)	60.6
Total	1,077.5

Wetland and riparian elevational distributions were measured along 5 transects, 3 at the downstream end of the oxbow and 2 in the middle. All transects were standardized to RM 682.5. Wetland elevations ranged from (PUBH) at 1021.0 feet to riparian vegetation at 1029.5 feet. The water surface elevation of the Missouri River on June 25, 1991 at RM 682.5 was 1023.0.

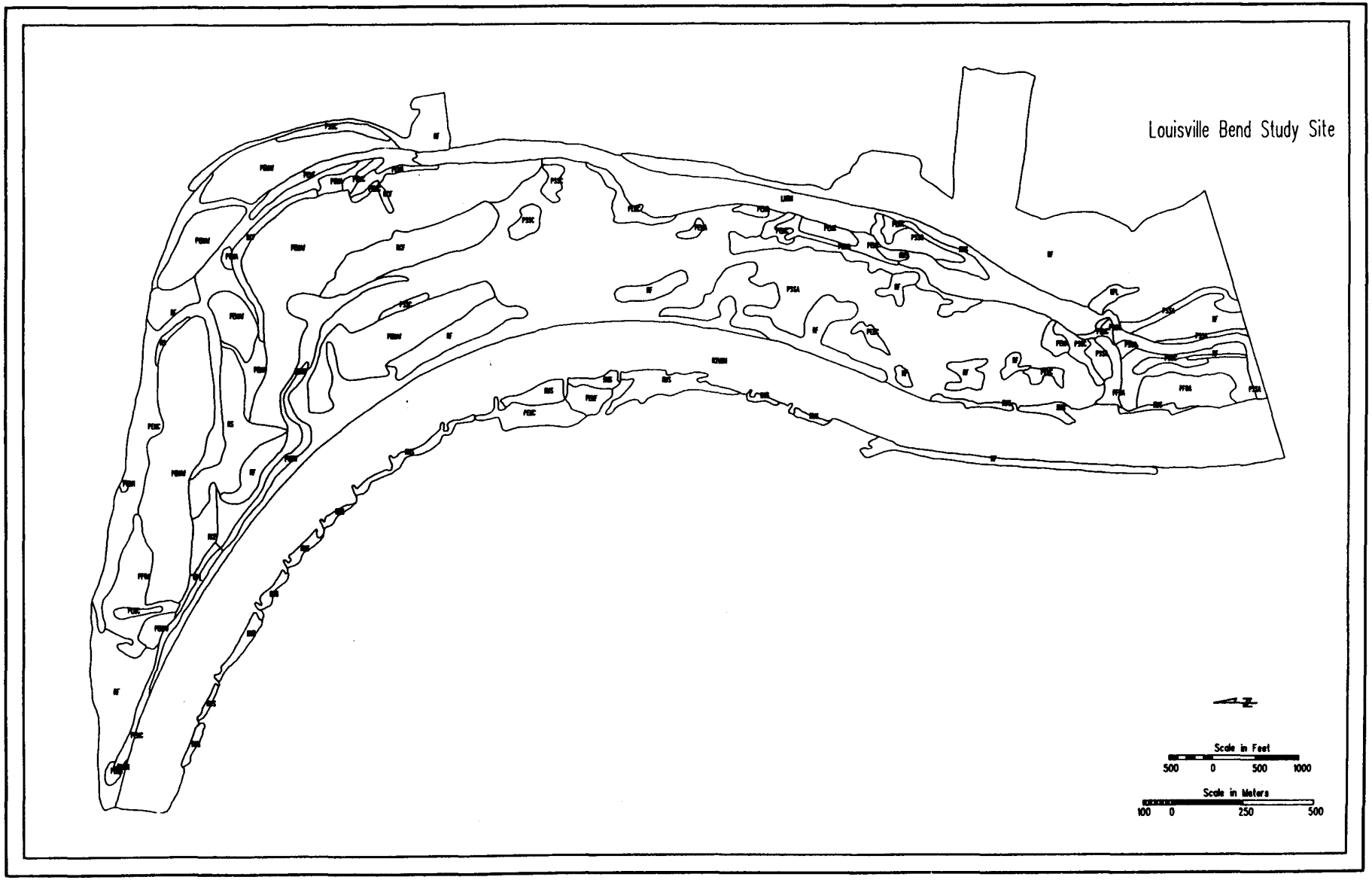
EXHIBIT 690 022276

Table LB-2. Distribution of sampling points by elevation.

Missouri River - Upper Louisville Study Site
River Mile 682.5 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSC	PSSA	RF	RUBH	PFOA	RUS	RS	PUBH
1002.5	0	0	0	0	0	0	0	1	0	0	0	0
1003.0	0	0	0	0	0	0	0	1	0	0	0	0
....												
....												
1021.0	0	0	0	0	0	0	0	1	0	0	0	0
1021.5	0	0	0	0	0	0	0	1	0	0	0	5
1022.0	0	0	0	0	0	0	0	1	0	0	0	11
1022.5	0	0	0	0	0	0	0	1	0	0	0	15
1023.0	8	0	0	0	0	0	0	1	0	4	0	17
1023.5	29	0	0	0	0	0	0	0	0	0	0	0
1024.0	78	9	0	0	0	0	0	0	0	0	0	0
1024.5	131	27	0	2	0	0	0	0	0	0	0	0
1025.0	26	73	0	2	0	0	0	0	0	0	0	0
1025.5	0	54	3	3	0	0	0	0	1	0	0	0
1026.0	0	36	12	2	83	2	0	0	6	0	0	0
1026.5	0	7	16	3	9	3	0	0	4	0	0	0
1027.0	0	0	44	3	4	3	0	0	4	0	11	0
1027.5	0	0	11	3	2	4	0	0	5	0	22	0
1028.0	0	16	33	3	3	0	0	0	5	0	17	0
1028.5	0	13	37	2	0	19	1	0	5	0	0	0
1029.0	0	0	152	4	0	314	0	0	49	0	0	0
1029.5	0	0	14	2	0	61	27	0	43	0	0	0
1030.0	0	0	0	4	0	0	0	0	5	0	0	0
1030.5	0	0	0	2	0	0	0	0	5	0	0	0
1031.0	0	0	0	4	0	0	0	0	1	0	0	0
1031.5	0	0	0	2	0	0	0	0	0	0	0	0
1032.0	0	0	0	38	0	0	0	0	0	0	0	0
1032.5	0	0	0	7	0	0	2	0	0	0	0	0
1033.0	0	0	0	8	0	0	3	0	0	0	0	0
1033.5	0	0	0	9	0	0	2	0	0	0	0	0
1034.0	0	0	0	7	0	0	2	0	0	0	0	0
1034.5	0	0	0	4	0	0	3	0	0	0	0	0
1035.0	0	0	0	1	0	0	2	0	0	0	0	0
1035.5	0	0	0	1	0	0	2	0	0	0	0	0
1036.0	0	0	0	1	0	0	3	0	0	0	0	0
1036.5	0	0	0	1	0	0	2	0	0	0	0	0
1037.0	0	0	0	1	0	0	2	0	0	0	0	0
1037.5	0	0	0	1	0	0	2	0	0	0	0	0
1038.0	0	0	0	1	0	0	1	0	0	0	0	0
1038.5	0	0	0	1	0	0	1	0	0	0	0	0
1039.0	0	0	0	1	0	0	1	0	0	0	0	0
1039.5	0	0	0	1	0	0	1	0	0	0	0	0
1040.0	0	0	0	1	0	0	1	0	0	0	0	0
TOTAL	272	235	322	125	101	406	58	42	133	4	50	48

EXHIBIT 690 022277


Louisville Bend Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Bullard Bend

The Bullard Bend study site was located in Nebraska on the right bank of the Missouri River, approximately 6 miles downstream of River Sioux, Iowa. This site was an old oxbow that, until flooding during the 1991 growing season, was in the process of drying out. The Bullard Bend study site was part of the Ponca to Omaha reach in the lower river.

Large expanses of riparian grassland (RG) and cultivated lands (196.4 acres or 33.4 percent) occupied the study site (Table BB-1). Riparian forests (RF) represented 133.1 acres (22.6 acres) and included several stands of large cottonwood trees (>3 feet in diameter) and a large stand of mixed riparian species, such as slippery elm and green ash. At the time of surveying, most of the area was flooded, with water depths ranging from less than 1 foot in the emergent wetlands to greater than 2 feet in some areas of riparian vegetation. PEMC wetlands contributed the largest acreage (65.3 acres) to the total amount of emergent wetlands (79.9 acres) in the study site.

Table BB-1. Wetland and riparian acreages mapped in the Bullard Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	6.7
Palustrine emergent seasonally flooded (PEMC)	65.3
Palustine emergent semipermanently flooded (PEMF)	7.9
Palustrine scrub-shrub temporarily flooded (PSSA)	11.1
Palustrine scrub-shrub seasonally flooded (PSSC)	3.3
Riparian grassland (RG)	196.4
Riparian shrub (RS)	13.6
Riparian forest (RF)	133.1
Riverine unconsolidated bottom permanently flooded (RUBH)	119.3
Riverine unconsolidated shore (RUS)	2.1
Riverine unconsolidated shore vegetated (RUS5)	1.0
Palustrine unconsolidated bottom permanently flooded (PUBH)	28.4
Total	588.3

One transect, 1,831 feet long, was used to record the elevational distributions of the wetland and riparian cover types which ranged from 1005.0 (PUBH) to 1019.5 (RF) (Table BB-2). The transect was located at RM 663.6. The water surface elevation of the Missouri River was recorded 1006.0 at RM 663.6 on June 27, 1991.

Bird observations made during the sampling included the following species: northern oriole, dicksissel, red-winged blackbird, red-headed woodpecker, killdeer, mourning dove, red-tail hawk, eastern kingbird, orchard oriole, bobwhite, yellowthroat, and grackle.

EXHIBIT 690 022279

Table BB-2. Distribution of sampling points by elevation.

Missouri River - Bullard Bend
River Mile 663.6 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSA	RS	RF	RUBH	RUS5	PSSC	RUS	PUBH
989.5	0	0	0	0	0	0	0	1	0	0	0	0
990.0	0	0	0	0	0	0	0	1	0	0	0	0
990.5	0	0	0	0	0	0	0	1	0	0	0	0
991.0	0	0	0	0	0	0	0	1	0	0	0	0
991.5	0	0	0	0	0	0	0	1	0	0	0	0
992.0	0	0	0	0	0	0	0	1	0	0	0	0
992.5	0	0	0	0	0	0	0	1	0	0	0	0
993.0	0	0	0	0	0	0	0	1	0	0	0	0
993.5	0	0	0	0	0	0	0	1	0	0	0	0
994.0	0	0	0	0	0	0	0	1	0	0	0	0
994.5	0	0	0	0	0	0	0	1	0	0	0	0
995.0	0	0	0	0	0	0	0	1	0	0	0	0
995.5	0	0	0	0	0	0	0	1	0	0	0	0
996.0	0	0	0	0	0	0	0	1	0	0	0	0
996.5	0	0	0	0	0	0	0	1	0	0	0	0
997.0	0	0	0	0	0	0	0	1	0	0	0	0
997.5	0	0	0	0	0	0	0	1	0	0	0	0
998.0	0	0	0	0	0	0	0	1	0	0	0	0
998.5	0	0	0	0	0	0	0	1	0	0	0	0
999.0	0	0	0	0	0	0	0	1	0	0	0	0
999.5	0	0	0	0	0	0	0	1	0	0	0	0
1000.0	0	0	0	0	0	0	0	1	0	0	0	0
1000.5	0	0	0	0	0	0	0	1	0	0	0	0
1001.0	0	0	0	0	0	0	0	1	0	0	0	0
1001.5	0	0	0	0	0	0	0	1	0	0	0	0
1002.0	0	0	0	0	0	0	0	1	0	0	0	0
1002.5	0	0	0	0	0	0	0	1	0	0	0	0
1003.0	0	0	0	0	0	0	0	1	0	0	0	0
1003.5	0	0	0	0	0	0	0	1	0	0	0	0
1004.0	0	0	0	0	0	0	0	1	0	0	0	0
1004.5	0	0	0	0	0	0	0	1	0	0	0	0
1005.0	0	0	0	0	0	0	0	1	0	0	0	20
1005.5	3	0	0	0	0	0	0	1	0	0	0	37
1006.0	8	0	0	0	0	0	0	1	1	0	1	33
1006.5	9	3	0	0	0	0	0	0	1	3	1	6
1007.0	7	4	0	0	0	0	0	0	2	4	2	0
1007.5	2	20	0	0	0	0	0	0	1	20	1	1
1008.0	0	10	0	0	1	0	0	0	0	10	0	0
1008.5	0	61	1	0	0	0	0	0	0	61	0	0
1009.0	0	18	7	0	1	0	0	0	0	18	0	0
1009.5	0	10	18	0	2	0	0	0	0	10	0	0
1010.0	0	6	16	79	5	0	0	0	0	6	0	0
1010.5	0	0	5	57	9	27	0	0	0	0	0	0
1011.0	0	0	0	39	9	25	0	0	0	0	0	0
1011.5	0	0	0	51	5	27	0	0	0	0	0	0
1012.0	0	0	0	18	1	0	0	0	0	0	0	0
1012.5	0	0	0	19	0	0	0	0	0	0	0	0
1013.0	0	0	0	26	1	0	0	0	0	0	0	0

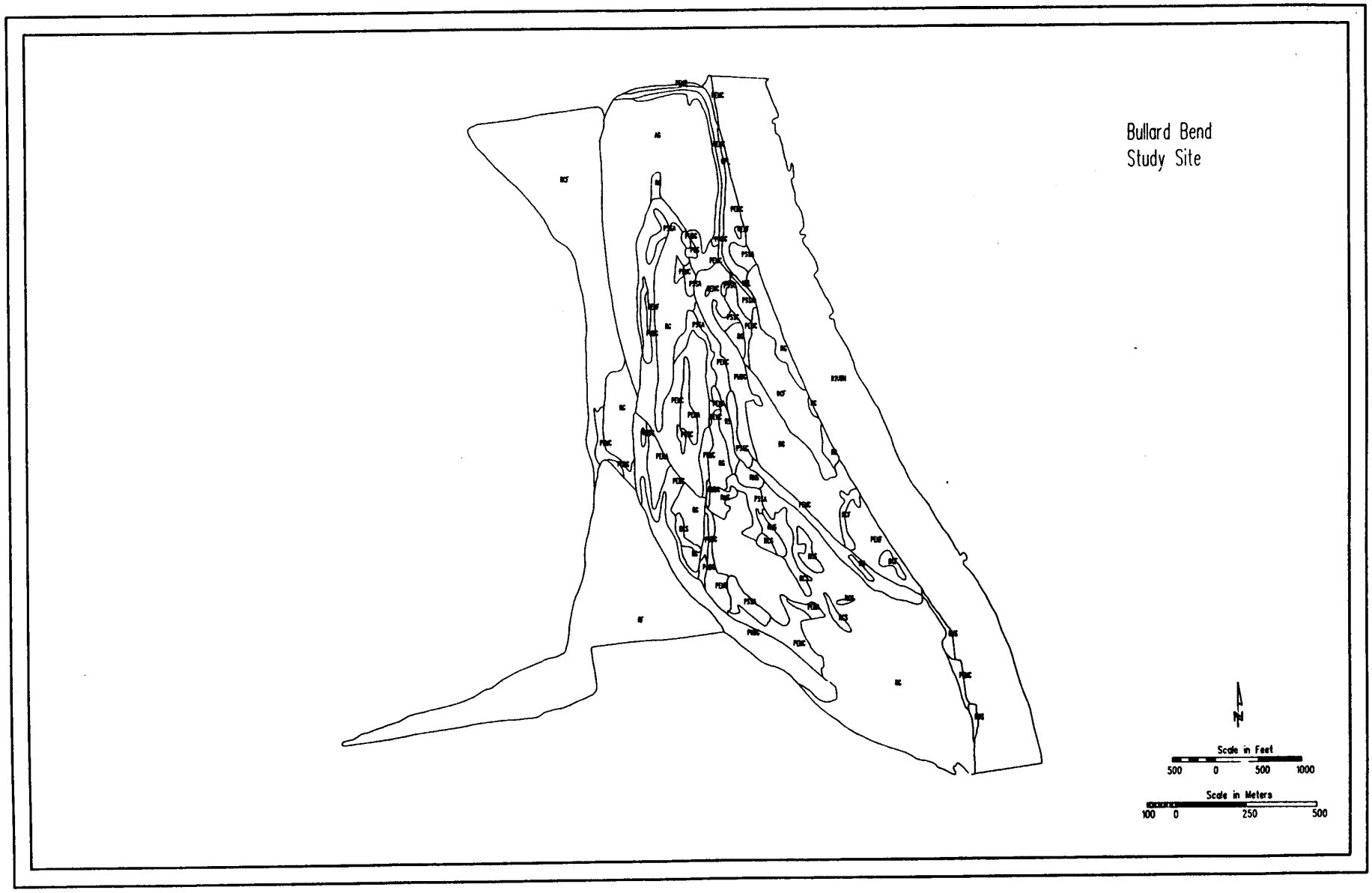
EXHIBIT 690 022280

Table BB-2 (Continued).

Missouri River - Bullard Bend
River Mile 663.6 - All Transects Combined

Elevation	PEMF	PEMC	PEMA	RG	PSSA	RS	RF	RUBH	RUS5	PSSC	RUS	PUBH
1013.5	0	0	0	29	0	0	0	0	0	0	0	0
1014.0	0	0	0	30	1	0	0	0	0	0	0	0
1014.5	0	0	0	14	1	0	0	0	0	0	0	0
1015.0	0	0	0	13	0	0	0	0	0	0	0	0
1015.5	0	0	0	13	1	0	0	0	0	0	0	0
1016.0	0	0	0	13	0	0	0	0	0	0	0	0
1016.5	0	0	0	22	0	0	0	0	0	0	0	0
1017.0	0	0	0	21	0	0	0	0	0	0	0	0
1017.5	0	0	0	22	0	0	0	0	0	0	0	0
1018.0	0	0	0	17	0	0	0	0	0	0	0	0
1018.5	0	0	0	3	0	0	0	0	0	0	0	0
1019.0	0	0	0	4	0	0	0	0	0	0	0	0
1019.5	0	0	0	0	0	0	1	0	0	0	0	0
TOTAL	29	132	47	490	37	79	1	34	5	132	5	97

EXHIBIT 690 022281


Bullard Bend
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

California Bend

The California Bend study site, an old oxbow lake/backwater system, was a pond/marsh wetland complex located in Iowa on the left bank of the Missouri River, approximately 3 miles upstream of Blair, Nebraska. The pond drained into the Missouri River at RM 649.5 by a long, relatively deep channel. During high water periods, the hydrology of the complex must reverse since there was no visible upstream inlet to the pond. The California Bend study site was part of the Ponca to Omaha reach in the lower river.

During the sampling, the water surface elevation of the Missouri River was very high from tributary inflow (994.5) (Table CB-2) and there was evidence of recent flooding (i.e., flattened vegetation and a debris line). Emergent wetlands accounted for a relatively large amount (75.6 acres or 13.4 percent) of the California Bend study site (CB-1). PEMC wetlands contributed 59.8 acres (10.6 percent of the total acreage) and was dominated by golden rod and reed canarygrass. Although the high water conditions resulted in standing water (1 to 4 inches deep), the majority of the emergent wetlands were classified as "seasonally flooded" (Cowardin et al., 1979) because of the species composition in the area. PEMF wetlands represented 15.8 acres (2.8 percent of the total acreage) of the study site, with cattails as the dominant species. Scrub-shrub wetlands, characterized by sandbar and peachleaf willow, and cottonwood shrubs, accounted for 73.1 acres (13.0 percent) of the study site and were mostly located adjacent to the emergent wetlands. Some areas of PSSC and PSSA wetlands were also flooded with a few inches of water at the time of sampling, most likely the result of high discharges from upstream tributaries approximately 10 days before sampling.

Table CB-1. Wetland and riparian acreages mapped in the California Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent seasonally flooded (PEMC)	59.8
Palustine emergent semipermanently flooded (PEMF)	15.8
Palustrine scrub-shrub temporarily flooded (PSSA)	52.3
Palustrine scrub-shrub seasonally flooded (PSSC)	20.3
Palustrine forest temporarily flooded (PFOA)	7.4
Riparian grassland (RG)	
13.6	
Riparian forest (RF)	227.7
Riverine unconsolidated bottom permanently flooded (RUBH)	132.0
Riverine unconsolidated shore (RUS)	5.8
Palustrine unconsolidated bottom permanently flooded (PUBH)	29.7
Total	564.3

Elevations of wetland and riparian cover types were recorded on June 26, 1992 along 4 transects, varying in length from 63 to 1,520 feet and standardized to RM

EXHIBIT 690 022283

649.5. Recorded elevations ranged from 986.5 in PUBH, 8 feet below the Missouri River water surface elevation, to RG at 1005.0 (Table CB-2). The water surface of the Missouri River was 978.5 feet at RM 649.5.

Many wildlife species were observed at the California Bend study site. Mink and raccoon tracks and obvious beaver activity were present at the time of sampling. A wide variety of birds were also present, including: eastern kingbird, bank swallow, dickcissel, great blue heron, kestrel robin, red-winged blackbird, grackle, tree swallow, yellowthroat, mourning dove, northern oriole, flicker, red-headed woodpecker, black-capped chickadee, blue jay, and mallard.

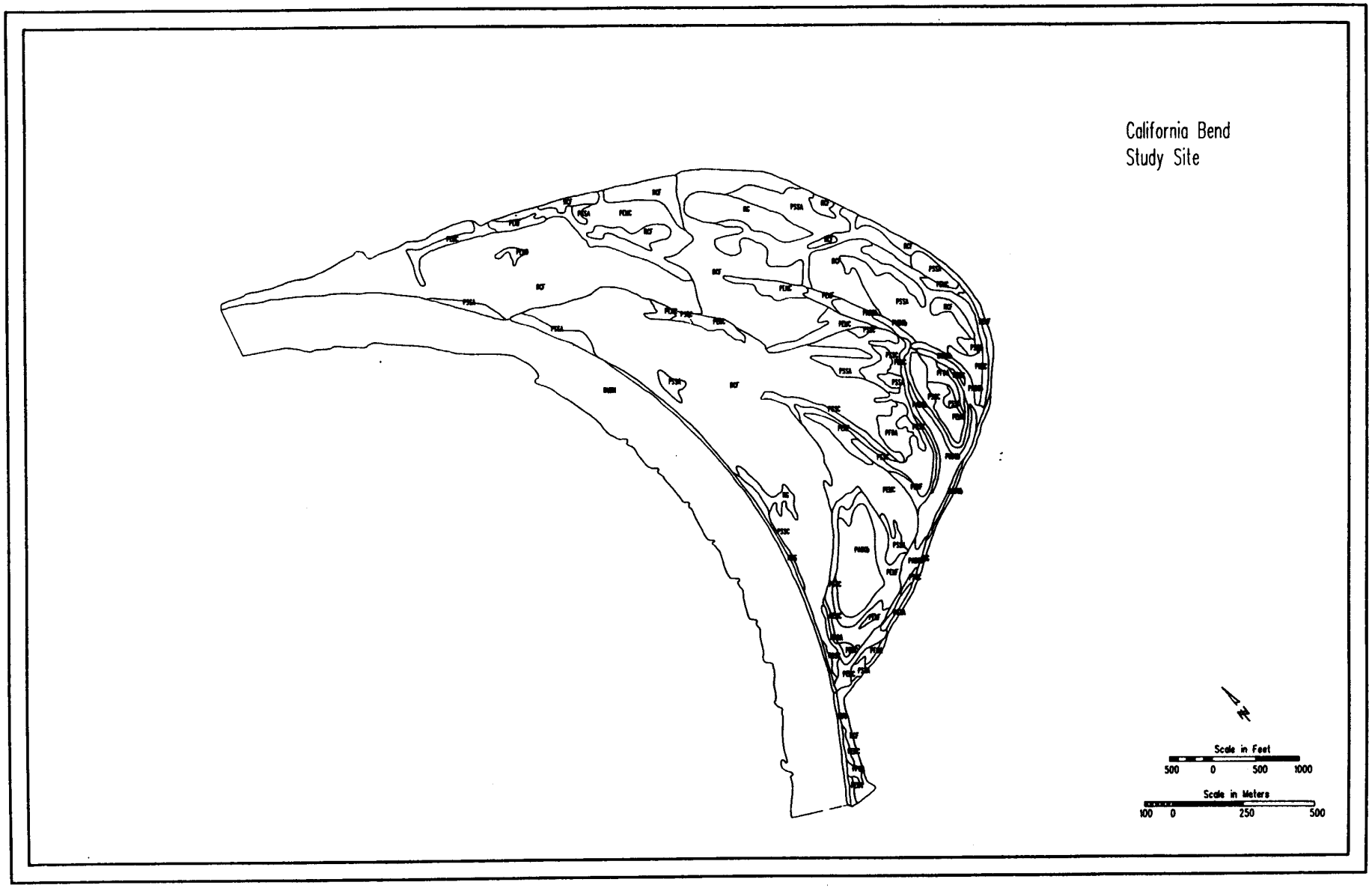
EXHIBIT 690 022284

Table CB-2. Distribution of sampling points by elevation.

Missouri River - California Bend Study Site
River Mile 649.5 - All Transects Combined

Elevation	PEMF	PEMC	RG	PSSC	RF	RUS	PUBH	PFOA	PSSA	RUBH
973.5	0	0	0	0	0	0	0	0	0	1
974.0	0	0	0	0	0	0	0	0	0	1
....										
....										
985.5	0	0	0	0	0	0	0	0	0	1
986.0	0	0	0	0	0	0	0	0	0	1
986.5	0	0	0	0	0	0	2	0	0	1
988.0	0	0	0	0	0	0	2	0	0	1
989.0	0	0	0	0	0	0	2	0	0	1
990.0	0	0	0	0	0	0	1	0	0	1
990.5	0	0	0	0	0	0	1	0	0	1
991.0	0	0	0	0	0	0	1	0	0	1
991.5	0	0	0	0	0	0	14	0	0	1
992.0	0	0	0	0	0	0	58	0	0	1
992.5	1	0	0	0	0	0	49	0	0	1
993.0	7	0	0	0	0	0	3	0	0	1
993.5	193	0	0	0	0	8	146	0	0	1
994.0	166	0	0	18	0	16	4	0	0	1
994.5	91	43	0	55	0	0	1	0	0	1
995.0	3	105	0	76	0	0	0	0	0	0
995.5	0	146	0	70	0	0	0	0	0	0
996.0	0	93	0	21	0	0	0	0	0	0
996.5	0	29	1	22	0	0	0	0	0	0
997.0	0	21	0	20	2	0	0	0	0	0
997.5	0	11	1	10	5	0	0	2	2	0
998.0	0	1	1	8	0	0	0	3	3	0
998.5	0	0	1	8	0	0	0	0	0	0
999.0	0	0	0	3	1	0	0	0	0	0
999.5	0	0	1	0	0	0	0	0	0	0
1000.5	0	0	1	0	0	0	0	0	0	0
1001.5	0	0	1	0	0	0	0	0	0	0
1003.0	0	0	1	0	0	0	0	0	0	0
1004.0	0	0	1	0	0	0	0	0	0	0
1005.0	0	0	1	0	0	0	0	0	0	0
TOTAL	461	449	10	311	8	24	284	5	5	39

EXHIBIT 690 022285


California Bend
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-159

Otoe-Hamburg

The Otoe-Hamburg study site was located on both banks of the Missouri River, near the Nebraska City Power Plant. This site was a complex of wetlands and sparsely vegetated dry chutes that formed as a result of dikes and levees on an outside bend of the river. The Otoe-Hamburg site was part of the Omaha to St. Joseph reach in the lower river.

Riparian forest (RF) was the most prevalent cover type in the portion of the study site on the right bank, occupying 132.1 acres (39.5 percent) (Table OH-1). Cottonwood, black willow, and sandbar willow were the dominant tree species. The wetlands in this study site were restricted to the edges of side chutes from a large pond behind the dike system. The side chutes were primarily RUS5 and were sparsely vegetated with smartweed and lovegrass. The soils in these chutes were moist at the surface with heavy mottles. A large chute that connected the pond behind the dike to the river about one half a mile downstream contained another shallow pond. These RUS5 areas were bordered by scrub-shrub wetlands (PSSC), with peachleaf willow, sandbar willow, and cottonwood as the dominant shrubs.

RF also dominated the portion of the Otoe-Hamburg site on the left bank. This area occurred on the inside curve of the bend and was characterized by cottonwood up to 12 inches dbh and 50 feet in height. Small stands of forested wetlands (PFOA) (3.1 acres) were intermixed with the RF. Black willow was the dominant tree species in the PFOA with reed canarygrass in the understory. A relatively large area of PEMA wetlands, covering 35.3 acres or 10.6 percent of the study site, occurred in a forest clearing. Reed canarygrass dominated the PEMA wetlands.

Table OH-1. Wetland and riparian acreages mapped in the Otoe-Hamburg study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	35.3
Palustrine emergent seasonally flooded (PEMC)	2.7
Palustrine scrub-shrub temporarily flooded (PSSA)	1.0
Palustrine scrub-shrub seasonally flooded (PSSC)	12.3
Palustrine forest temporarily flooded (PFOA)	3.1
Palustrine forest seasonally flooded (PFOC)	1.0
Riparian grassland (RG)	0.2
Riparian forest (RF)	132.1
Riverine unconsolidated bottom permanently flooded (RUBH)	125.0
Riverine unconsolidated shore (RUS)	0.5
Riverine unconsolidated shore vegetated (RUS5)	5.3
Palustrine unconsolidated bottom permanently flooded (PUBH)	16.0
Total	334.5

EXHIBIT 690 022287

The elevational surveys were conducted on October 16, 1991. A total of 6 transects were standardized at RM 555.4 and wetland and riparian elevations ranged from 908.0 to 922.5 (Table OH-2). The Missouri River water surface elevation was 906.3 at RM 555.4.

Wildlife species observed at the Otoe-Hamburg study site included: kingfisher, killdeer, bald eagle, cormorant, and great blue heron. Deer were also seen, as well as coyote tracks.

EXHIBIT 690 022288

Table OH-2. Distribution of sampling points by elevation.

Missouri River - Otoe Hamburg Study Site
River Mile 555.4 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	PUBH	RUS	PFOA	PFOC	RG	RUS5	RF	RUBH
889.5	0	0	0	0	0	0	0	0	0	0	0	1
890.0	0	0	0	0	0	0	0	0	0	0	0	1
890.5	0	0	0	0	0	0	0	0	0	0	0	1
891.0	0	0	0	0	0	0	0	0	0	0	0	1
891.5	0	0	0	0	0	0	0	0	0	0	0	1
892.0	0	0	0	0	0	0	0	0	0	0	0	1
892.5	0	0	0	0	0	0	0	0	0	0	0	1
893.0	0	0	0	0	0	0	0	0	0	0	0	1
893.5	0	0	0	0	0	0	0	0	0	0	0	1
894.0	0	0	0	0	0	0	0	0	0	0	0	1
894.5	0	0	0	0	0	0	0	0	0	0	0	1
895.0	0	0	0	0	0	0	0	0	0	0	0	1
895.5	0	0	0	0	0	0	0	0	0	0	0	1
896.0	0	0	0	0	0	0	0	0	0	0	0	1
896.5	0	0	0	0	0	0	0	0	0	0	0	1
897.0	0	0	0	0	0	0	0	0	0	0	0	1
897.5	0	0	0	0	0	0	0	0	0	0	0	1
898.0	0	0	0	0	0	0	0	0	0	0	0	1
898.5	0	0	0	0	0	0	0	0	0	0	0	1
899.0	0	0	0	0	0	0	0	0	0	0	0	1
899.5	0	0	0	0	0	0	0	0	0	0	0	1
900.0	0	0	0	0	0	0	0	0	0	0	0	1
900.5	0	0	0	0	0	0	0	0	0	0	0	1
901.0	0	0	0	0	0	0	0	0	0	0	0	1
901.5	0	0	0	0	0	0	0	0	0	0	0	1
902.0	0	0	0	0	0	0	0	0	0	0	0	1
902.5	0	0	0	0	0	0	0	0	0	0	0	1
903.0	0	0	0	0	0	0	0	0	0	0	0	1
903.5	0	0	0	0	0	0	0	0	0	0	0	1
904.0	0	0	0	0	0	0	0	0	0	0	0	1
904.5	0	0	0	0	0	0	0	0	0	0	0	1
905.0	0	0	0	0	0	0	0	0	0	0	0	1
905.5	0	0	0	0	0	0	0	0	0	0	0	1
906.0	0	0	0	0	0	0	0	0	0	0	0	1
906.5	0	0	0	0	0	0	0	0	0	0	0	1
907.0	0	0	0	0	0	0	0	0	0	0	0	1
907.5	0	0	0	0	0	0	0	0	0	0	0	1
908.0	0	0	0	0	1	15	0	0	0	0	0	1
908.5	0	0	0	0	1	14	0	0	0	0	0	1
909.0	0	0	0	0	0	9	0	0	0	40	0	0
909.5	0	0	0	0	0	0	0	0	0	40	0	0
910.0	0	0	0	0	0	0	0	0	0	44	0	0
910.5	0	0	5	0	0	0	0	0	0	19	0	0
911.0	0	0	3	0	0	0	0	0	0	17	0	0
911.5	77	0	5	0	0	0	0	0	0	24	0	0
912.0	61	0	24	2	0	0	0	0	0	38	0	0
912.5	54	0	4	4	0	0	0	0	0	24	0	0
913.0	19	0	1	4	0	0	0	0	1	26	1	0

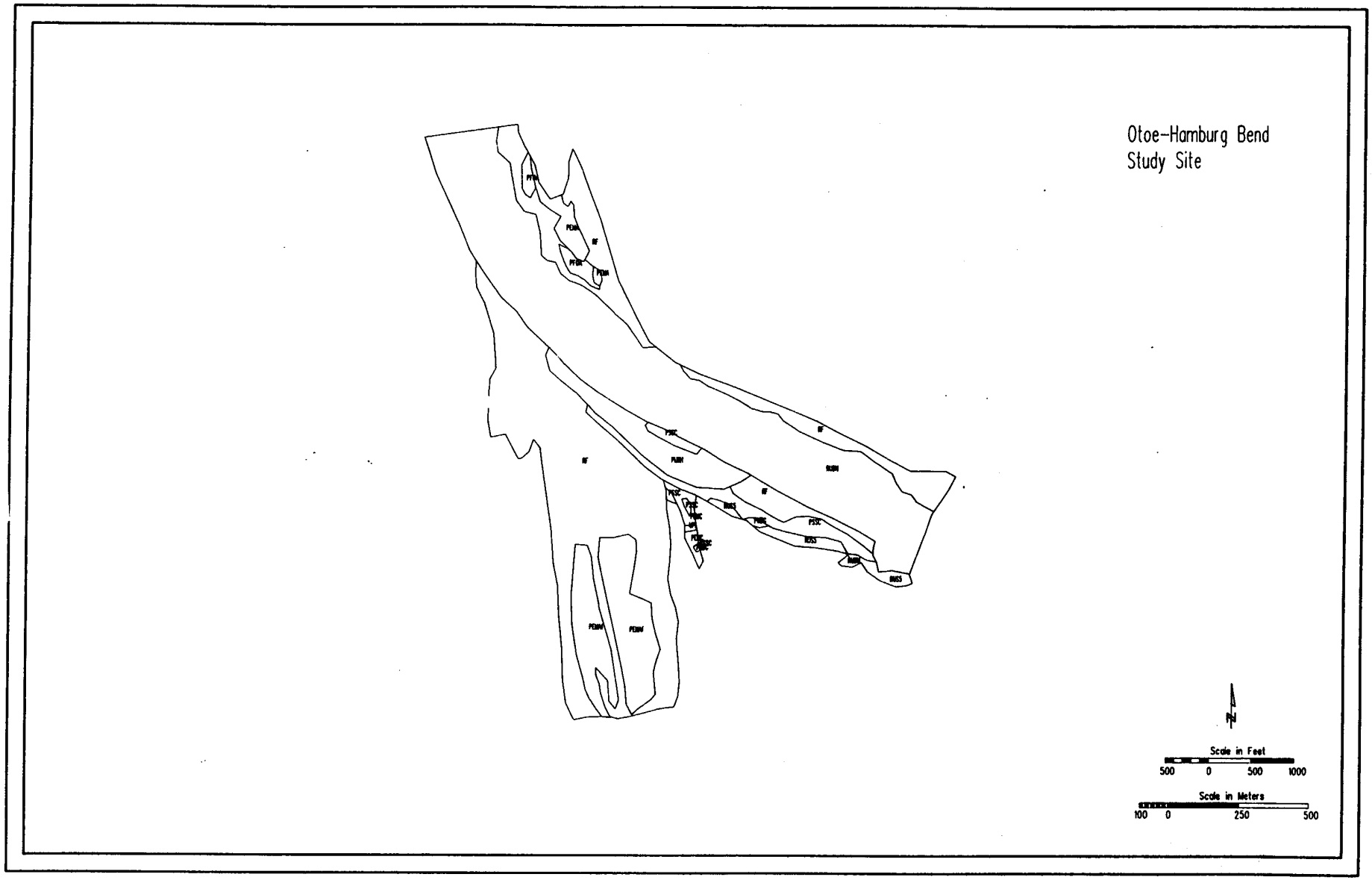
EXHIBIT 690 022289

Table OH-2 (Continued).

Missouri River - Otoe Hamburg Study Site
River Mile 555.4 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	PUBH	RUS	PFOA	PFOC	RG	RUS5	RF	RUBH
913.5	25	0	5	1	0	0	0	0	0	40	0	0
914.0	26	0	14	2	0	0	0	0	0	29	0	0
914.5	24	0	1	1	0	0	0	0	1	4	0	0
915.0	26	6	2	1	0	0	10	0	0	4	5	0
915.5	51	30	1	3	0	0	10	1	1	5	13	0
916.0	0	23	0	3	0	0	8	3	0	3	6	0
916.5	0	23	0	3	0	0	9	2	1	4	2	0
917.0	0	20	0	3	0	0	4	0	0	0	23	0
917.5	0	0	0	3	0	0	0	0	0	0	20	0
918.0	0	0	0	0	0	0	0	0	1	1	11	0
918.5	0	0	0	0	0	0	0	0	0	0	6	0
919.0	0	0	0	0	0	0	0	0	1	0	6	0
919.5	0	0	0	0	0	0	0	0	0	1	5	0
920.0	0	0	0	0	0	0	0	0	1	0	0	0
921.5	0	0	0	0	0	0	0	0	1	0	0	0
922.5	0	0	0	0	0	0	0	0	1	0	0	0
TOTAL	363	102	65	30	2	38	41	6	9	363	98	39

EXHIBIT 690 022290


Otoe-Hamburg Bend
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-164

Lincoln Bend

The Lincoln Bend study site was located on the right bank of the Missouri River, approximately 9 miles downstream of Nemaha, Nebraska. A series of dikes and levees had dissociated a large back-water chute from the main channel and the area was primarily agricultural. Except for a few areas that retain surface water, the chute was completely dry and, as evident in 1989 aerial photos, has been cultivated on occasion. The Lincoln Bend study site was part of the Omaha to St. Joseph reach in the lower river.

The most prevalent cover type in the Lincoln Bend study site was cultivated emergent wetlands (PEMAf). PEMAf occupies 584.1 acres (44.3 percent) of the study site (Table LB-1). Riparian forest (RF) is the second largest cover type (276.0 acres). At the time of sampling, a large portion (53.1 acres) of the old chute was LUS5 and was sparsely vegetated with smartweed. The downstream end of the chute also supported a few small stands of forested wetlands (PFOC). Representing only 2.6 acres (less than 1 percent) of the study site, the PFOC wetlands included black willow and mulberry trees with reed canarygrass in the understory.

Table LB-1. Wetland and riparian acreages mapped in the Lincoln Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (farmed) (PEMAf)	584.1
Palustrine emergent seasonally flooded (PEMC)	24.0
Palustrine forest seasonally flooded (PFOC)	2.6
Riparian grassland (RG)	58.5
Riparian forest (RF)	276.0
Riverine unconsolidated bottom permanently flooded (RUBH)	320.0
Lacustrine unconsolidated shore (LUS)	1.0
Lacustrine unconsolidated shore vegetated (LUS5)	53.1
Total	1,319.2

The elevational distributions of the wetlands and riparian cover types in the Lincoln Bend study site were recorded along 2 transects, 3,957 and 1,685 feet long, respectively, at the downstream end of the site (RM 519.9). The surveys were conducted on October 17, 1991. Elevations ranged from 867.5 to 878.5, with a Missouri River water surface elevation of 867.5 (Table LB-2) at RM 519.9.

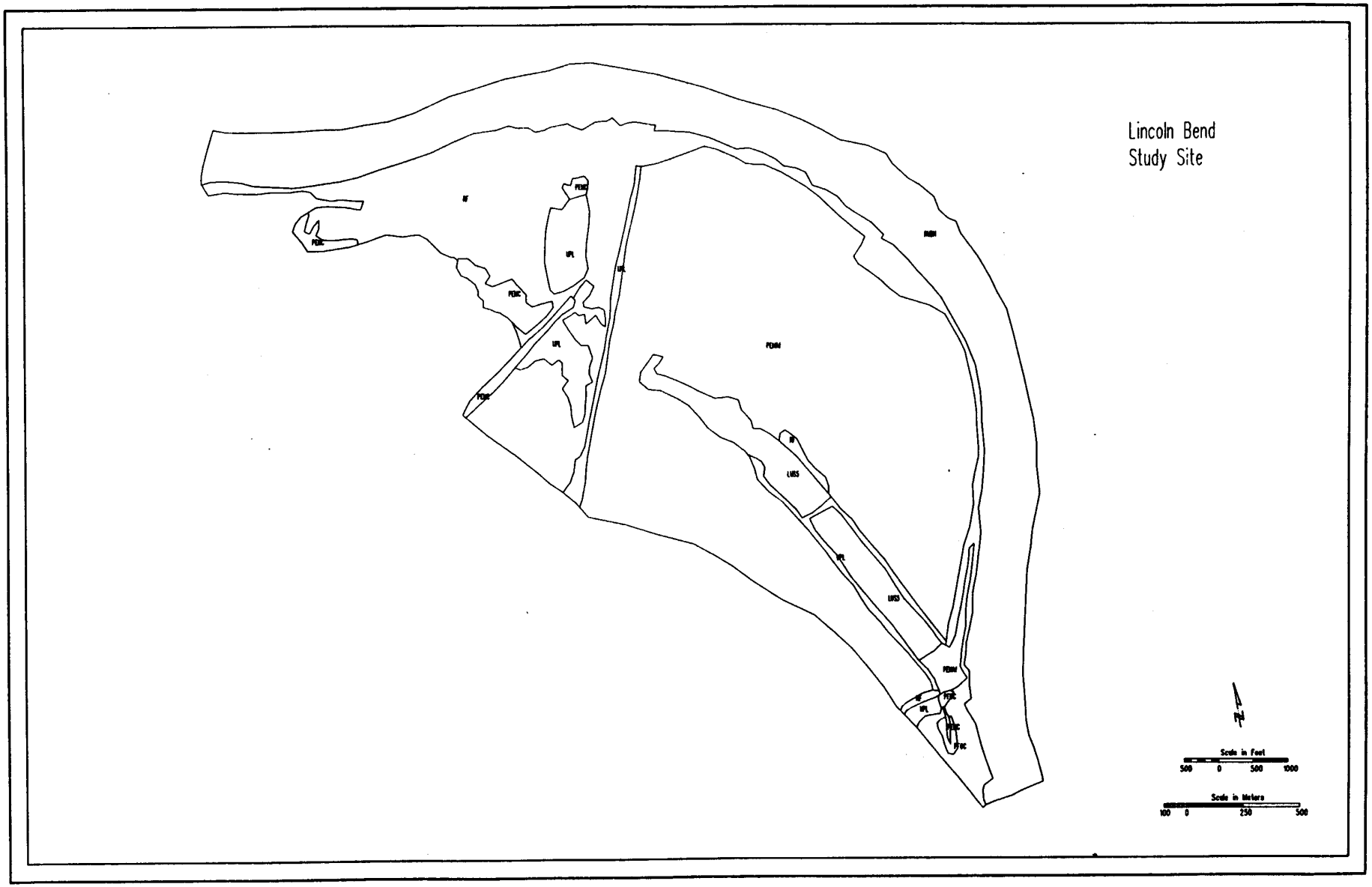
EXHIBIT 690 022292

Table LB-2. Distribution of sampling points by elevation.

Missouri River - Lincoln Bend Study Site
River Mile 519.9 - All Transects Combine

Elevation	PEMC	RG	RUBH	LUS	PFOC	LUS5	RF	PEMA
846.0	0	0	1	0	0	0	0	0
846.5	0	0	1	0	0	0	0	0
....								
....								
866.0	0	0	1	0	0	0	0	0
866.5	0	0	1	0	0	0	0	0
867.0	0	0	1	0	0	0	0	0
867.5	0	0	1	127	0	0	0	0
868.0	0	0	0	41	0	80	0	0
868.5	0	0	0	0	0	112	0	0
869.0	0	0	0	0	0	112	0	0
869.5	0	0	0	0	0	59	0	0
870.0	0	0	0	0	0	37	0	0
870.5	0	0	0	0	0	37	0	0
871.0	0	0	0	0	0	37	0	0
871.5	0	2	0	0	0	37	0	2
872.0	0	34	0	0	0	26	0	34
872.5	0	73	0	0	0	0	0	73
873.0	26	74	0	0	0	0	0	74
873.5	12	62	0	0	6	0	0	62
874.0	10	23	0	0	17	0	0	23
874.5	6	23	0	0	7	0	2	23
875.0	2	24	0	0	0	0	6	24
875.5	0	24	0	0	0	0	3	24
876.0	0	4	0	0	0	0	0	4
876.5	0	5	0	0	0	0	0	5
877.0	0	3	0	0	0	0	0	3
877.5	0	5	0	0	0	0	0	5
878.0	0	4	0	0	0	0	0	4
878.5	0	3	0	0	0	0	0	3
TOTAL	56	363	44	168	30	537	11	363

EXHIBIT 690 022293


Lincoln Bend
Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-167

Worthwine Island

The Worthwine Island study site was located on the left bank of the Missouri River at RM 457.0, approximately 8 miles upstream of St. Joseph, Missouri. This wetland complex was located within an old channel segment that had been dissociated from the main channel by a series of dikes and subsequent aggradation. The Worthwine study site was part of the Omaha to St. Joseph reach in the lower river.

Riparian forest (RF) is the most prevalent cover type in this study site, occupying 164.4 acres (39.6 percent) (Table WI-1) and dominated by silver maple and cottonwood. The middle of the study site is bisected by a culvert and road leading to a cultivated area. Emergent wetlands (PEMC) lie on either side of the culvert in the channel bed and represent 39.9 acres (9.6 percent) of the study area. The most common species found in the PEMC wetlands were pigweed, rusty flat sedge, green bulrush, reed canarygrass, and late boneset. Areas very sparsely revegetated with similar species were classified as LUS5 (7.8 acres).

Table WI-1. Wetland and riparian acreages mapped in the Worthwine Island study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent seasonally flooded (PEMC)	39.9
Palustrine scrub-shrub seasonally flooded (PSSC)	0.3
Palustrine forest temporarily flooded (PFOA)	1.0
Palustrine forest seasonally flooded (PFOC)	1.0
Riparian grassland (RG)	25.9
Riparian forest (RF)	164.4
Riverine unconsolidated bottom permanently flooded (RUBH)	168.1
Riverine unconsolidated shore (RUS)	4.3
Lacustrine unconsolidated shore (LUS)	2.6
Lacustrine unconsolidated shore vegetated (LUS5)	7.8
Total	415.3

The wetland and riparian cover type elevations were measured along a total of 4 transects on October 18, 1991; transects were standardized to RM 457.0. Elevations in the Worthwine Island study site ranged from PEMC wetlands at 809.0 to riparian grassland (RG) at 823.5 (Table WI-2). The water surface elevation of the Missouri River on the day of sampling was 806.0 at RM 457.0.

EXHIBIT 690 022295

Table WI-2. Distribution of sampling points by elevation.

Missouri River - Worthwine Island Study Site
River Mile 457.0 - All Transects Combined

Elevation	PEMC	RG	PSSC	PFOA	PFOC	LUS5	RF	RUBH	LUS	RUS
791.0	0	0	0	0	0	0	0	1	0	0
791.5	0	0	0	0	0	0	0	1	0	0
792.0	0	0	0	0	0	0	0	1	0	0
792.5	0	0	0	0	0	0	0	1	0	0
793.0	0	0	0	0	0	0	0	1	0	0
793.5	0	0	0	0	0	0	0	1	0	0
794.0	0	0	0	0	0	0	0	1	0	0
794.5	0	0	0	0	0	0	0	1	0	0
795.0	0	0	0	0	0	0	0	1	0	0
795.5	0	0	0	0	0	0	0	1	0	0
796.0	0	0	0	0	0	0	0	1	0	0
796.5	0	0	0	0	0	0	0	1	0	0
797.0	0	0	0	0	0	0	0	1	0	0
797.5	0	0	0	0	0	0	0	1	0	0
798.0	0	0	0	0	0	0	0	1	0	0
798.5	0	0	0	0	0	0	0	1	0	0
799.0	0	0	0	0	0	0	0	1	0	0
799.5	0	0	0	0	0	0	0	1	0	0
800.0	0	0	0	0	0	0	0	1	0	0
800.5	0	0	0	0	0	0	0	1	0	0
801.0	0	0	0	0	0	0	0	1	0	0
801.5	0	0	0	0	0	0	0	1	0	0
802.0	0	0	0	0	0	0	0	1	0	0
802.5	0	0	0	0	0	0	0	1	0	0
803.0	0	0	0	0	0	0	0	1	0	0
803.5	0	0	0	0	0	0	0	1	0	0
804.0	0	0	0	0	0	0	0	1	0	0
804.5	0	0	0	0	0	0	0	1	0	0
805.0	0	0	0	0	0	0	0	1	0	0
805.5	0	0	0	0	0	0	0	1	0	0
806.0	0	0	0	0	0	0	0	1	0	0
809.0	8	0	0	0	0	0	0	0	0	0
809.5	106	0	0	0	0	0	0	0	0	0
810.0	236	0	0	0	0	0	0	0	0	0
810.5	157	1	0	0	0	0	0	0	0	0
811.0	105	1	0	0	0	0	0	0	0	0
811.5	62	2	0	0	0	0	0	0	0	0
812.0	330	1	5	0	0	0	0	0	0	0
812.5	134	2	5	0	0	215	1	0	215	215
813.0	2	3	0	0	0	0	0	0	0	0
813.5	9	3	0	0	0	0	0	0	0	0
814.0	28	3	0	0	18	0	0	0	0	0

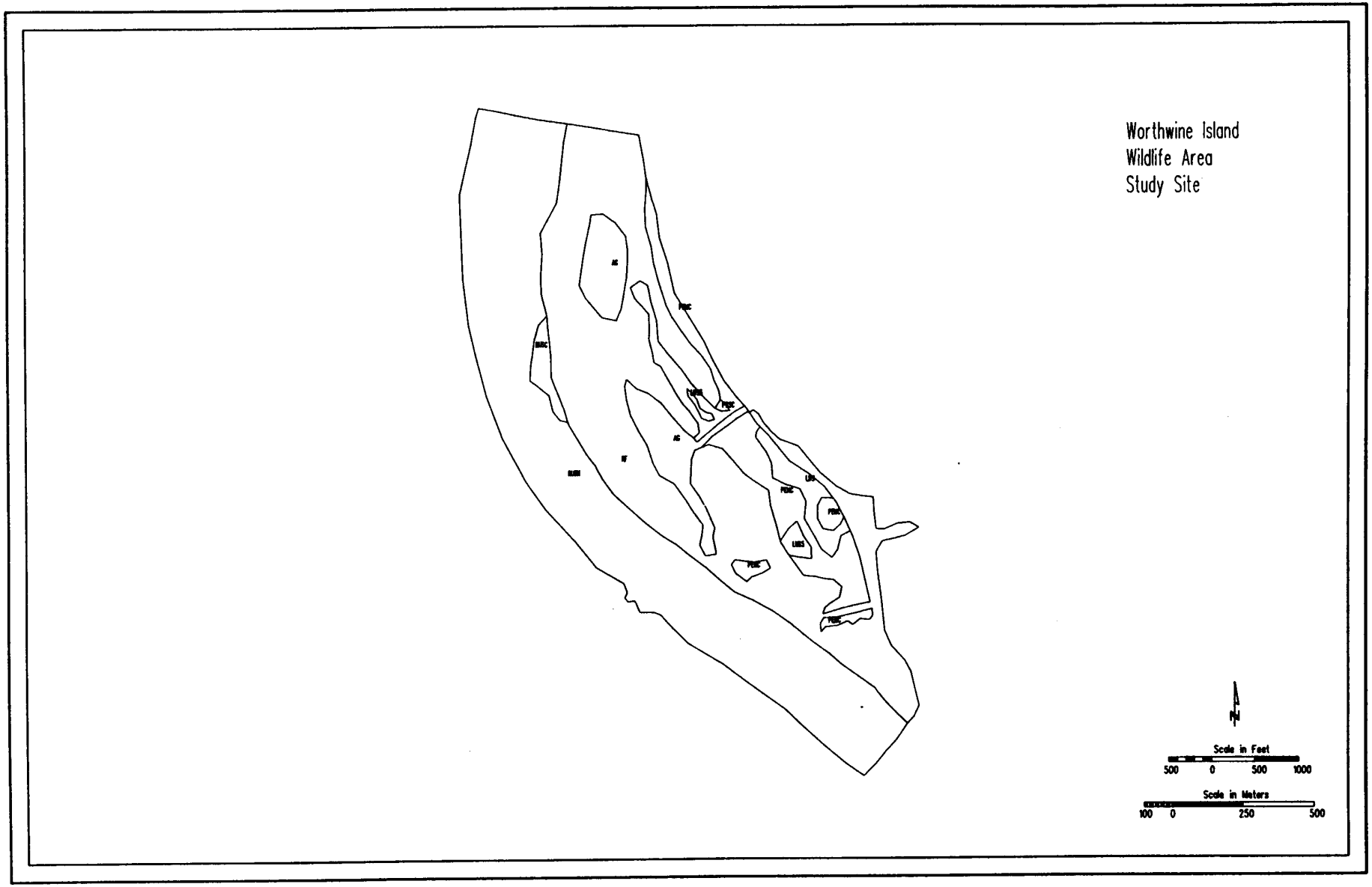
EXHIBIT 690 022296

Table WI-2 (Continued).

Missouri River - Worthwine Island Study Site
River Mile 457.0 - All Transects Combined

Elevation	PEMC	RG	PSSC	PFOA	PFOC	LUS5	RF	RUBH	LUS	RUS
814.5	31	4	0	0	26	0	1	0	0	0
815.0	4	5	0	13	0	0	1	0	0	0
815.5	0	7	0	4	0	0	1	0	0	0
816.0	0	7	0	0	0	0	2	0	0	0
816.5	0	9	0	0	0	0	6	0	0	0
817.0	0	7	0	0	0	0	9	0	0	0
817.5	0	8	0	0	0	0	9	0	0	0
818.0	0	7	0	0	0	0	0	0	0	0
818.5	0	5	0	0	0	0	0	0	0	0
819.0	0	5	0	0	0	0	0	0	0	0
819.5	0	4	0	0	0	0	0	0	0	0
820.0	0	3	0	0	0	0	0	0	0	0
820.5	0	2	0	0	0	0	0	0	0	0
821.0	0	2	0	0	0	0	0	0	0	0
821.5	0	3	0	0	0	0	0	0	0	0
822.0	0	2	0	0	0	0	0	0	0	0
822.5	0	2	0	0	0	0	0	0	0	0
823.0	0	2	0	0	0	0	0	0	0	0
823.5	0	2	0	0	0	0	0	0	0	0
TOTAL	1212	102	10	17	44	215	30	31	215	215

EXHIBIT 690 022297


Worthwine Island
Wildlife Area
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-171

Lake Contrary

The Lake Contrary study site was an old oxbow on the left bank of the Missouri River, 6 miles downstream of St. Joseph, Missouri that had been cut off from the river by the levee system. The lake water level is maintained during the summer months by pumping. Drought conditions, however, had lowered the lake elevation, drying out of some portions of the emergent wetlands which had then been converted to agricultural lands. The Lake Contrary study site was not used in the model because its hydrology is affected by pumping.

Lake Contrary occupied a surface area of 281.1 acres (45.4 percent) of the study site (Table LC-1). The maximum water depths of the lake was recorded at 4 feet. The east and west ends of the lake supported expanses of aquatic beds dominated by lotus and duckweed, with smartweed in the shallower waters.

The majority of the wetlands at Lake Contrary were restricted to the east and west ends of the lake. The north and south shores were predominantly residential and agricultural lands. Portions of the shoreline and old chutes were lined with PEMF wetlands dominated by cattails. The PEMF wetlands represented 90.6 acres (14.6 percent) of the study area. The remainder of the emergent wetlands (26.4 acres of PEMC wetlands and 27.8 acres of PEMA wetlands) occurred in the drier areas adjacent to the PEMF and were characterized by reed canarygrass, witchgrass, and spike rush. A small stand of PFOC wetlands was identified between the levee system and the river. Elm, silver maple, and mulberry were the dominant species in this stand; bulrush occurred in the understory. The remainder of the forested areas in the study area were classified as riparian forest with slippery elm as the dominant tree species.

Table LC-1. Wetland and riparian acreages mapped in the Lake Contrary study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	27.8
Palustrine emergent seasonally flooded (PEMC)	26.4
Palustrine emergent semipermanently flooded (PEMF)	90.6
Palustrine scrub-shrub temporarily flooded (PSSA)	3.7
Palustrine scrub-shrub seasonally flooded (PSSC)	10.4
Palustrine forest temporarily flooded (PFOA)	1.4
Palustrine forest seasonally flooded (PFOC)	3.7
Riparian grassland (RG)	4.5
Riparian shrub (RS)	1.6
Riparian forest (RF)	102.6
Lacustrine unconsolidated bottom permanently flooded (LUBH)	281.1
Lacustrine unconsolidated shore (LUS)	64.3
Lacustrine unconsolidated shore vegetated (LUS5)	1.1
Total	619.2

EXHIBIT 690 022299

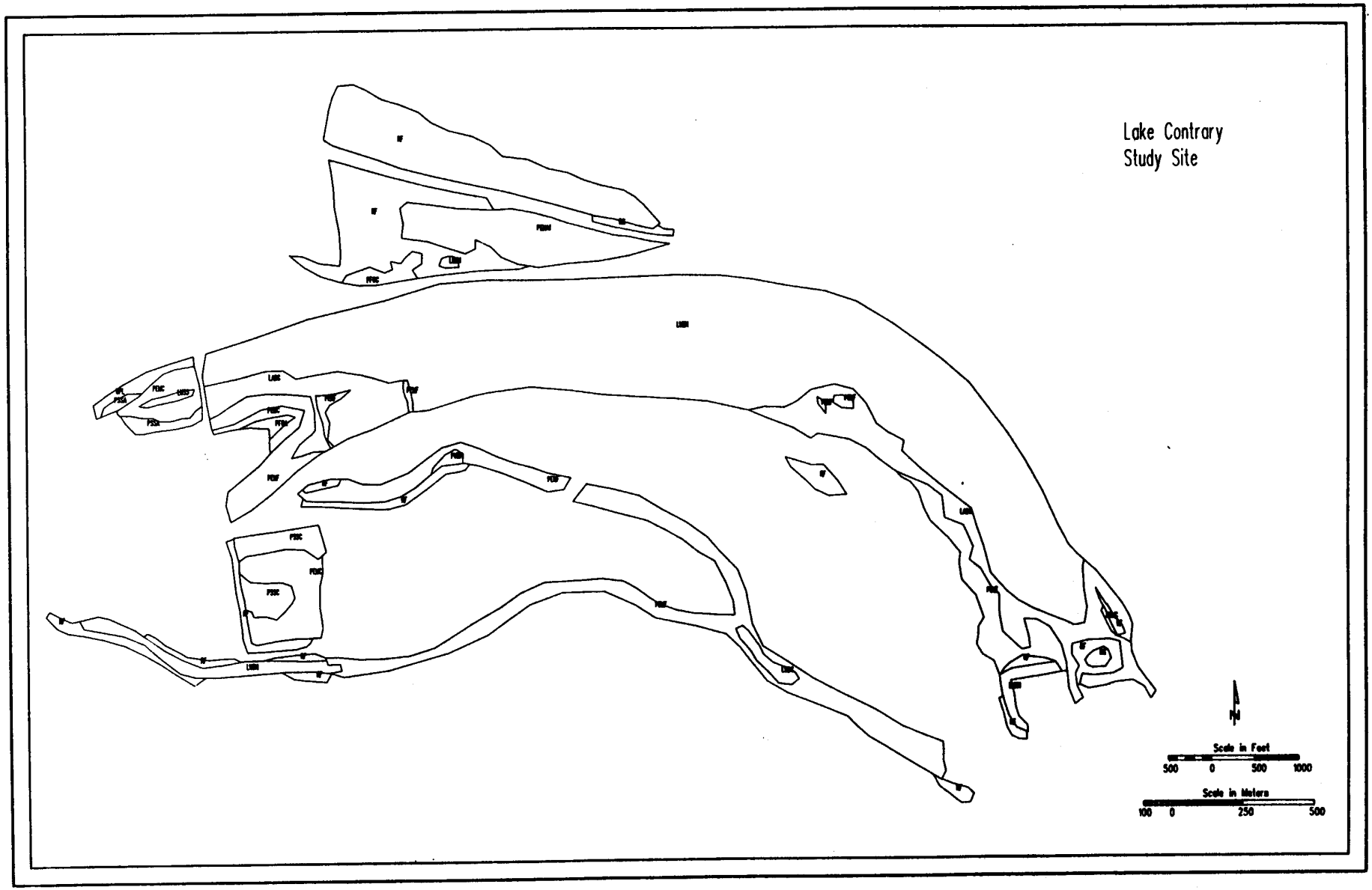
Cover type surveying of the Lake Contrary study site was done on October 15 and 17, 1991. Wetland and riparian elevations were measured along a total of 6 transects standardized around RM 442.5. Four transects were located at the west end of the lake and 2 at the east end. Several additional transects were sampled on October 15, 1991 to measure the water depths of the lake. The water surface elevation of Lake Contrary was 798.1.

Many species of birds were observed at the study site, including: northern harrier, pelican, cormorants, bald eagle, great blue heron, red-winged blackbird, gulls, teal, black-capped chickadee, lark sparrow, cardinal, and American coot. Deer tracks were also seen at the site.

Table LC-2. Distribution of sampling points by elevation.

Missouri River - Lake Contrary Study Site
River Mile 442.5 - All Transects Combined

Elevation	PEMF	PEMC	PSSC	PSSA	LUBH	PFOA	PFOC	RG	LUS5	RS	RF	LUS	PEMA
793.0	0	0	0	0	26	0	0	0	0	0	0	0	0
793.5	0	0	0	0	324	0	0	0	0	0	0	0	0
794.0	0	0	0	0	771	0	0	0	0	0	0	0	0
794.5	0	0	0	0	1011	0	0	0	0	0	0	0	0
795.0	7	0	0	0	447	0	0	0	0	0	0	0	0
795.5	42	2	0	0	631	0	0	0	0	0	0	0	0
796.0	19	98	0	0	242	0	0	0	0	0	0	0	0
796.5	0	56	0	0	156	0	0	1	0	0	0	0	0
797.0	4	4	0	29	189	0	0	9	0	0	0	0	29
797.5	156	0	0	0	94	0	0	7	0	0	0	0	0
798.0	77	2	0	0	11	0	0	3	1	2	0	1	0
798.5	27	3	2	0	0	0	0	2	0	1	0	0	0
799.0	24	3	2	1	0	0	19	1	0	2	0	0	1
799.5	0	50	0	5	0	0	21	4	0	1	0	0	5
800.0	0	16	0	7	0	33	2	2	0	1	1	0	7
800.5	0	0	0	0	0	0	0	3	0	0	2	0	0
801.0	0	0	0	0	0	0	0	1	0	0	1	0	0
801.5	0	0	0	0	0	0	0	1	0	0	3	0	0
802.0	0	0	0	0	0	0	0	2	0	0	2	0	0
802.5	0	0	0	0	0	0	0	1	0	0	3	0	0
803.0	0	0	0	0	0	0	0	2	0	0	1	0	0
803.5	0	0	0	0	0	0	0	1	0	0	2	0	0
804.0	0	0	0	0	0	0	0	2	0	0	1	0	0
804.5	0	0	0	0	0	0	0	2	0	0	0	0	0
805.0	0	0	0	0	0	0	0	1	0	0	0	0	0
805.5	0	0	0	0	0	0	0	2	0	0	0	0	0
806.0	0	0	0	0	0	0	0	1	0	0	0	0	0
806.5	0	0	0	0	0	0	0	2	0	0	0	0	0
TOTAL	356	234	4	42	3902	33	42	50	1	7	16	1	42


Lake Contrary
Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-175

Horseshoe Lake

The Horseshoe Lake study site was an old oxbow lake on the left bank of the Missouri River at RM 391.0, approximately 2 miles downstream of Farley, Missouri. The oxbow was located between levees along the Missouri and Little Platte rivers. Horseshoe Lake study site was not used in the model because of an uncertain hydrologic connection to the river.

Approximately one third of the old oxbow is currently under cultivation. The remainder of the dried lake bottom supported expansive stands of rice cutgrass and smartweed and was classified as palustrine emergent seasonally flooded wetland (PEMC). PEMC wetlands dominated the study site and occupied 282.6 acres or 45.2 percent of the area mapped (Table HL-1). Although 1989 aerial photographs showed some open water, the oxbow was completely dry during the sampling period. Water levels were approximately 6 to 14 inches below the surface. Some old stands of cattail and lotus were encountered in the PEMC, remnants of the 1989-1990 growing seasons. The shoreline of the oxbow lake bed was characterized by thin bands of PEMA wetlands (51.4 acres or 8.2 percent), as well as wetland and riparian shrubs and trees. Palustrine scrub-shrub wetlands represented only 12.2 acres (2 percent) of the total area mapped and included: red osier dogwood, sandbar willow, peachleaf willow, buttonbush, and cottonwood. The center of the oxbow was agricultural land, but included a small stand of PFOA. This stand was dominated by silver maple, cottonwood, elm, and peachleaf willow, and represented 6.4 acres (1 percent) of the area mapped.

Table HL-1. Wetland and riparian acreages mapped in the Horseshoe Lake study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	51.4
Palustrine emergent seasonally flooded (PEMC)	282.6
Palustrine forest temporarily flooded (PFOA)	6.1
Palustrine scrub-shrub temporarily flooded (PSSA)	4.7
Palustrine scrub-shrub seasonally flooded (PSSC)	7.5
Riparian grassland (RG)	40.1
Riparian forest (RF)	129.3
Riparian shrub (RS)	3.3
Riverine unconsolidated bottom permanently flooded (RUBH)	98.5
Riverine unconsolidated shore (RUS5)	2.1
Total	625.6

The Horseshoe Lake study site was sampled on October 18, 1991. Wetland and riparian elevation were measured along a total of 4 four transects and a water surface elevation was recorded at the Missouri River (743.5 feet); all transects were

EXHIBIT 690 022303

standardized to RM 391.0. Elevations ranged from RUS at 744.0 to RG at 761.0 (Table HL-2).

Wildlife species observed at the Horseshoe Lake study site include: cardinal, kinglet, northern harrier, sparrow, and rough-legged hawk. Deer and raccoon tracks were also noted.

EXHIBIT 690 022304

Table HL-2. Distribution of sampling points by elevation.

Missouri River - Horseshoe Lake Study Site
River Mile 391.0 - All Transects Combined

Elevation	PEMC	PEMA	RG	PSSC	PSSA	PFOA	RF	RUBH	RS	RUS
727.5	0	0	0	0	0	0	0	1	0	1
728.0	0	0	0	0	0	0	0	1	0	1
728.5	0	0	0	0	0	0	0	1	0	1
729.0	0	0	0	0	0	0	0	1	0	1
729.5	0	0	0	0	0	0	0	1	0	1
730.0	0	0	0	0	0	0	0	1	0	1
730.5	0	0	0	0	0	0	0	1	0	1
731.0	0	0	0	0	0	0	0	1	0	1
731.5	0	0	0	0	0	0	0	1	0	1
732.0	0	0	0	0	0	0	0	1	0	1
732.5	0	0	0	0	0	0	0	1	0	1
733.0	0	0	0	0	0	0	0	1	0	1
733.5	0	0	0	0	0	0	0	1	0	1
734.0	0	0	0	0	0	0	0	1	0	1
734.5	0	0	0	0	0	0	0	1	0	1
735.0	0	0	0	0	0	0	0	1	0	1
735.5	0	0	0	0	0	0	0	1	0	1
736.0	0	0	0	0	0	0	0	1	0	1
736.5	0	0	0	0	0	0	0	1	0	1
737.0	0	0	0	0	0	0	0	1	0	1
737.5	0	0	0	0	0	0	0	1	0	1
738.0	0	0	0	0	0	0	0	1	0	1
738.5	0	0	0	0	0	0	0	1	0	1
739.0	0	0	0	0	0	0	0	1	0	1
739.5	0	0	0	0	0	0	0	1	0	1
740.0	0	0	0	0	0	0	0	1	0	1
740.5	0	0	0	0	0	0	0	1	0	1
741.0	0	0	0	0	0	0	0	1	0	1
741.5	0	0	0	0	0	0	0	1	0	1
742.0	0	0	0	0	0	0	0	1	0	1
742.5	0	0	0	0	0	0	0	1	0	1
743.0	0	0	0	0	0	0	0	1	0	1
743.5	0	0	0	0	0	0	0	1	0	1
744.0	71	0	0	0	0	0	0	0	0	0
744.5	122	0	0	1	0	0	0	0	0	0
745.0	34	0	0	7	0	0	0	0	0	0
745.5	31	0	0	2	0	0	0	0	0	0
746.0	26	1	0	0	0	0	0	0	0	0
746.5	93	2	0	0	0	0	0	0	0	0
747.0	219	2	0	1	0	0	0	0	0	0
747.5	171	20	34	3	0	0	0	0	0	0
748.0	42	22	47	0	10	0	0	0	0	0

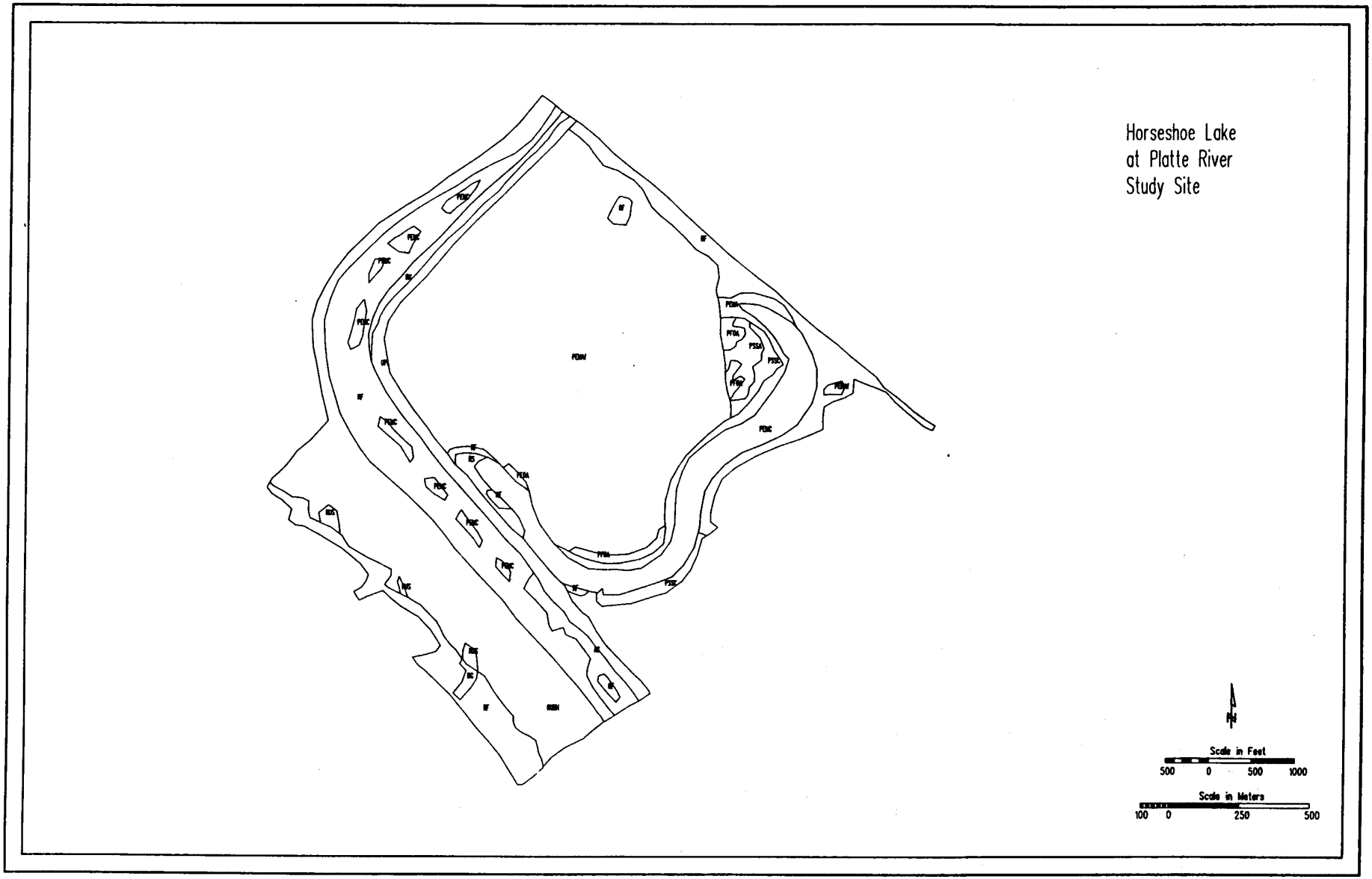
EXHIBIT 690 022305

Table HL-2 (Continued).

Missouri River - Horseshoe Lake Study Site
River Mile 391.0 - All Transects Combined

Elevation	PEMC	PEMA	RG	PSSC	PSSA	PFOA	RF	RUBH	RS	RUS
748.5	14	29	47	0	13	0	0	0	0	0
749.0	8	21	9	1	33	0	1	0	1	0
749.5	0	25	0	0	21	2	0	0	0	0
750.0	0	28	0	0	0	2	0	0	0	0
750.5	0	2	0	0	1	1	1	0	1	0
751.0	0	0	0	0	0	2	0	0	0	0
751.5	0	0	0	0	1	2	0	0	0	0
752.0	0	0	0	0	3	2	1	0	1	0
752.5	0	0	0	0	3	1	0	0	0	0
753.0	0	0	0	0	3	4	0	0	0	0
753.5	0	0	0	0	3	1	0	0	0	0
754.0	0	0	1	0	2	1	0	0	0	0
754.5	0	0	0	0	3	0	0	0	0	0
755.0	0	0	0	0	3	0	0	0	0	0
755.5	0	0	0	0	3	1	0	0	0	0
756.0	0	0	0	0	3	0	0	0	0	0
756.5	0	0	0	0	3	1	0	0	0	0
757.0	0	0	1	0	3	3	0	0	0	0
757.5	0	0	2	0	0	0	0	0	0	0
758.0	0	0	3	0	0	0	0	0	0	0
758.5	0	0	3	0	0	0	0	0	0	0
759.0	0	0	3	0	0	0	0	0	0	0
759.5	0	0	2	0	0	0	0	0	0	0
760.0	0	0	3	0	0	0	0	0	0	0
760.5	0	0	3	0	0	0	0	0	0	0
761.0	0	0	2	0	0	0	0	0	0	0
TOTAL	831	152	160	15	111	23	3	33	3	33

EXHIBIT 690 022306


Horseshoe Lake
at Platte River
Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-180

Jackass Bend

The Jackass Bend study site was a large oxbow lake that was located on the left bank of the Missouri River, just across from Ft. Osage, Missouri. Most of the land surrounding the oxbow was cultivated farm lands. The Jackass Bend study site was part of the St. Joseph to St. Louis reach in the lower river.

At the time of sampling, the oxbow had shallow standing water, approximately 1 to 1.5 feet deep, and a soft, mucky bottom. This area, typed as LUBH, was sparsely vegetated with duck weed and represented 54.9 acres (2.9 percent) of the study site (Table JB-1). The drier portions of the oxbow supported emergent wetlands; PEMF wetlands represented 83.6 acres (4.4 percent) and PEMC wetlands represented 55.6 acres (2.9 percent). The dominant species within the PEMF wetlands included rusty flat sedge, barnyard grass, and mild waterpepper. Rice cutgrass was the dominant species in PEMC wetland. The majority of the oxbow was surrounded by forested wetlands, primarily PFOC (308.7 acres or 16 percent) dominated by cottonwood, black willow, peachleaf willow, and silver maple. The middle of the oxbow was mostly agricultural lands, with a few ponds used for livestock. Agricultural lands were typed as PEMA.

Table JB-1. Wetland and riparian acreages mapped in the Jackass Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	635.1
Palustrine emergent seasonally flooded (PEMC)	55.6
Palustrine emergent semipermanently flooded (PEMF)	83.6
Palustrine scrub-shrub temporarily flooded (PSSA)	5.4
Palustrine scrub-shrub seasonally flooded (PSSC)	13.4
Palustrine forest temporarily flooded (PFOA)	1.7
Palustrine forest seasonally flooded (PFOC)	308.7
Riparian grassland (RG)	1.6
Riparian shrub (RS)	1.0
Riparian forest (RF)	352.3
Riverine unconsolidated bottom permanently flooded (RUBH)	349.4
Riverine unconsolidated shore (RUS)	15.4
Riverine unconsolidated shore vegetated (RUS5)	11.7
Lacustrine unconsolidated bottom permanently flooded (LUBH)	54.9
Total	1,889.7

The Jackass Bend study site was sampled on October 19, 1991. The water surface elevation of the Missouri River was recorded at 694.5 at RM 338.0. A total of 10 relatively short (131 to 1,606 feet) transects were standardized around RM 338.0.

EXHIBIT 690 022308

The elevational distribution of the wetland and riparian cover types ranged from the water surface at 649.5 to riparian vegetation at 710.5 (Table JB-2). All wetland types occurred within a 4-foot band, with substantial overlap in elevational distributions. The cultivated lands in the center of the oxbow were at the same elevation, or lower, than the water types on the edges, most likely because of dikes or local soil conditions.

Many wildlife species were observed at the Jackass Bend study site, among them a wide variety of birds. Species of birds included: giant egret, cormorants, lesser yellowlegs, mallard, killdeer, downy woodpecker, red winged blackbird, starling, sparrow, northern harrier, great blue heron, and blue jay. Deer and raccoon track were also noted during the sampling.

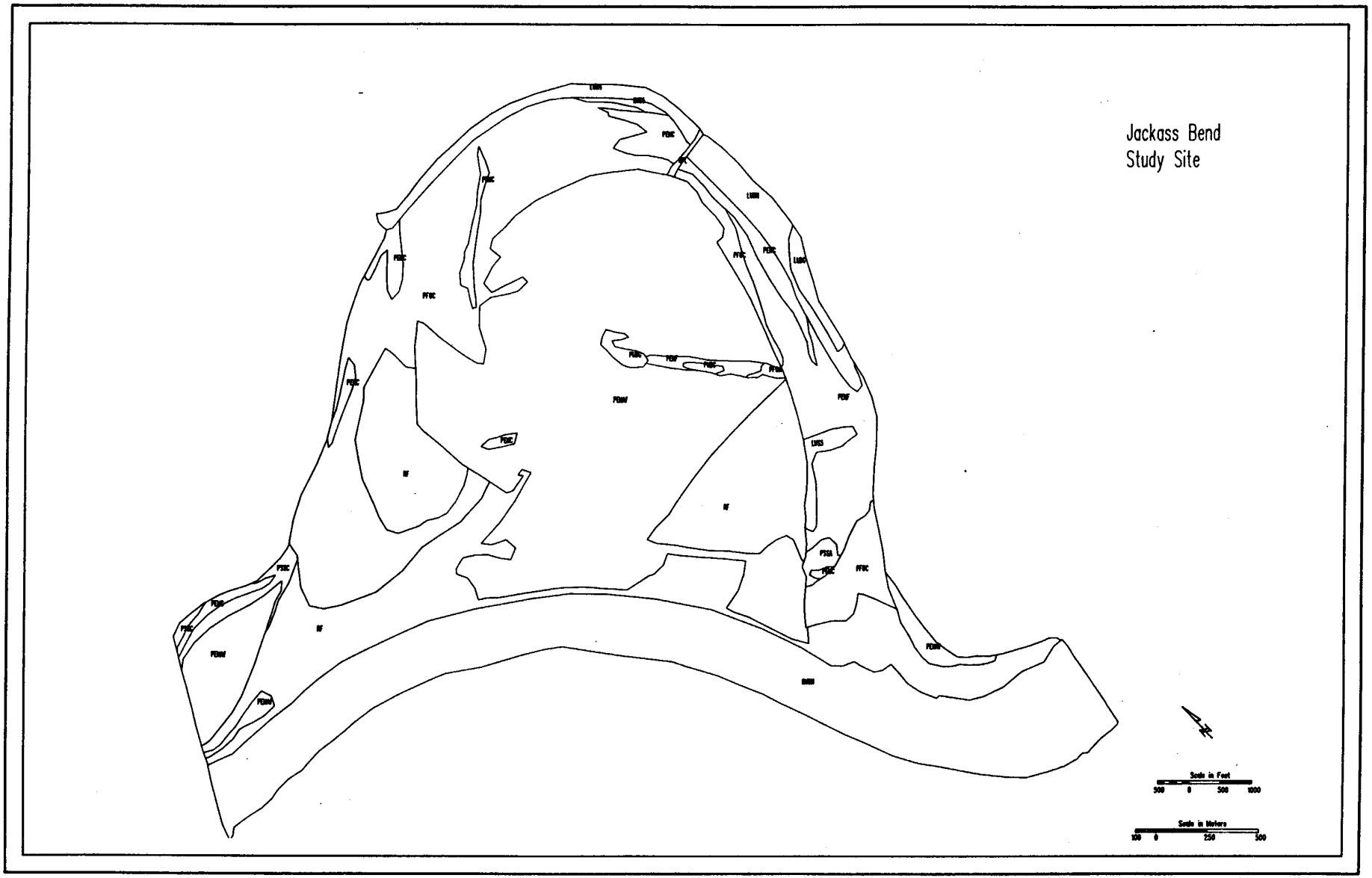
EXHIBIT 690 022309

Table JB-2. Distribution of sampling points by elevation.

Missouri River - Jackass Bend Study Site
River Mile 338.0 - All Transects Combined

Elevatio	PEMF	PEMC	PSSC	PSSA	RUBH	PFOC	RG	RS	RF	PEMA	PFOA	RUS5	RUS
673.0	0	0	0	0	1	0	0	0	0	0	0	0	0
673.5	0	0	0	0	1	0	0	0	0	0	0	0	0
....													
....													
693.0	0	0	0	0	1	0	0	0	0	0	0	0	0
693.5	0	0	0	0	1	0	0	0	0	0	0	0	0
694.0	0	0	0	0	1	0	0	0	0	0	0	0	0
694.5	0	0	0	0	1	0	0	0	0	0	0	0	0
695.0	0	0	0	0	0	0	0	0	0	0	0	0	0
695.5	0	0	0	0	0	0	0	0	0	0	0	0	0
696.0	0	0	0	1	0	0	0	0	0	1	1	0	0
696.5	0	0	0	3	0	0	0	0	0	3	3	0	0
697.0	0	0	0	5	0	0	0	0	0	5	5	151	151
697.5	74	0	0	50	0	0	0	0	0	50	50	310	310
698.0	185	0	0	23	0	0	0	1	0	23	23	42	42
698.5	100	96	0	10	0	0	0	0	0	10	10	27	27
699.0	61	221	0	80	0	7	0	0	0	80	80	0	0
699.5	2	527	0	11	0	34	0	1	0	11	11	0	0
700.0	0	9	13	0	0	75	0	0	1	0	0	0	0
700.5	0	0	14	0	0	42	0	0	2	0	0	0	0
701.0	0	0	0	0	0	7	0	1	2	0	0	0	0
701.5	0	0	0	0	0	0	0	0	1	0	0	0	0
702.0	0	0	0	0	0	0	0	0	2	0	0	0	0
702.5	0	0	0	0	0	0	0	1	2	0	0	0	0
703.0	0	0	0	0	0	0	0	0	1	0	0	0	0
703.5	0	0	0	0	0	0	0	0	2	0	0	0	0
704.0	0	0	0	0	0	0	0	1	2	0	0	0	0
704.5	0	0	0	0	0	0	0	0	1	0	0	0	0
705.0	0	0	0	0	0	0	0	0	2	0	0	0	0
705.5	0	0	0	0	0	0	0	1	2	0	0	0	0
706.0	0	0	0	0	0	0	0	0	1	0	0	0	0
706.5	0	0	0	0	0	0	1	0	1	0	0	0	0
707.0	0	0	0	0	0	0	1	1	1	0	0	0	0
707.5	0	0	0	0	0	0	1	1	1	0	0	0	0
708.0	0	0	0	0	0	0	1	1	1	0	0	0	0
708.5	0	0	0	0	0	0	1	1	1	0	0	0	0
709.0	0	0	0	0	0	0	1	1	1	0	0	0	0
710.0	0	0	0	0	0	0	1	1	1	0	0	0	0
710.5	0	0	0	0	0	0	1	0	1	0	0	0	0
TOTAL	422	853	27	183	44	165	9	9	30	183	183	530	530

EXHIBIT 690 022310


Jackass Bend
Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Blue Hole

The Blue Hole study site was a natural pond in the Grand Pass Wildlife Refuge, operated by the Missouri Department of Conservation. The pond was located on the right bank at approximately Missouri RM 270.0 and was apparently hydrologically tied to the River as well as a nearby artificial pond that was created and maintained by pumping. Water had recently been pumped into the artificial pond, so the water level of the Blue Hole, recorded at elevation 638.5 (Table BH-2), was probably higher than what would be expected for the time of year it was sampled. Because of the pumping influence, the Blue Hole study site was not used in the model.

The Blue Hole was surrounded by a thin band of PEMC wetland, dominated by smartweed, and represented only 0.6 acres of the study area (Table BH-1). Adjacent to the PEMC were a few small patches of PEMA, PSSA, and PFOA, each occupying only 1.0 acres of the study site. A relatively steep bank surrounded the pond, limiting the amount of wetlands adjacent to the Blue Hole. Riparian forest (RF) was the dominant cover type in the study site, occupying 236.0 acres (39.6 percent). Cottonwood was the predominant species in the RF, however, some dogwood and mulberry were found in the understory. PEMF wetlands, representing 43.4 acres (7.3 percent), were located primarily in the man-made sloughs within the refuge.

Table BH-1. Wetland and riparian acreages mapped in the Blue Hole study site.

Wetland/Riparian Cover types	Acres	
Palustrine emergent temporarily flooded (PEMA)	1.0	
Palustrine emergent seasonally flooded (PEMC)	0.6	
Palustrine emergent semipermanently flooded (PEMF)	43.4	
Palustrine scrub-shrub temporarily flooded (PSSA)	1.0	
Palustrine forest temporarily flooded (PFOA)	0.9	
Riparian grassland (RG)		56.7
Riparian shrub (RS)	5.2	
Riparian forest (RF)	236.0	
Riverine unconsolidated bottom permanently flooded (RUBH)	215.5	
Riverine unconsolidated shore (RUS)	28.6	
Palustrine unconsolidated bottom permanently flooded (PUBH)	7.9	
Total	596.7	

The elevational distributions of the wetland and riparian cover types in the Blue Hole study site were recorded along 3 transects on October 21, 1991. The cover type elevations ranged from 638.5 to 947.5. A water surface elevation of 634.0 was recorded at RM 270.0 of the Missouri River.

EXHIBIT 690 022312

Wildlife species observed at the study site included mallard, great blue heron, grebe, cardinal, white-crowned sparrow, blue jay, woodpecker and a white-tailed deer.

EXHIBIT 690 022313

Table BH-2. Distribution of sampling points by elevation.

Missouri River - Blue Hole Study Site
River Mile 270.0 - All Transects Combin

Elevation	PEMF	PEMC	PEMA	PSSA	RF	PUBH	PFOA	RS	RG	RUS	RUBH
619.0	0	0	0	0	0	0	0	0	0	0	1
619.5	0	0	0	0	0	0	0	0	0	0	1
620.0	0	0	0	0	0	0	0	0	0	0	1
620.5	0	0	0	0	0	0	0	0	0	0	1
621.0	0	0	0	0	0	0	0	0	0	0	1
621.5	0	0	0	0	0	0	0	0	0	0	1
622.0	0	0	0	0	0	0	0	0	0	0	1
622.5	0	0	0	0	0	0	0	0	0	0	1
623.0	0	0	0	0	0	0	0	0	0	0	1
623.5	0	0	0	0	0	0	0	0	0	0	1
624.0	0	0	0	0	0	0	0	0	0	0	1
624.5	0	0	0	0	0	0	0	0	0	0	1
625.0	0	0	0	0	0	0	0	0	0	0	1
625.5	0	0	0	0	0	0	0	0	0	0	1
626.0	0	0	0	0	0	0	0	0	0	0	1
626.5	0	0	0	0	0	0	0	0	0	0	1
627.0	0	0	0	0	0	0	0	0	0	0	1
627.5	0	0	0	0	0	0	0	0	0	0	1
628.0	0	0	0	0	0	0	0	0	0	0	1
628.5	0	0	0	0	0	0	0	0	0	0	1
629.0	0	0	0	0	0	0	0	0	0	0	1
629.5	0	0	0	0	0	0	0	0	0	0	1
630.0	0	0	0	0	0	0	0	0	0	0	1
630.5	0	0	0	0	0	0	0	0	0	0	1
631.0	0	0	0	0	0	0	0	0	0	0	1
631.5	0	0	0	0	0	0	0	0	0	0	1
632.0	0	0	0	0	0	0	0	0	0	0	1
632.5	0	0	0	0	0	0	0	0	0	0	1
633.0	0	0	0	0	0	0	0	0	0	0	1
633.5	0	0	0	0	0	0	0	0	0	0	1
634.0	0	0	0	0	0	0	0	0	0	0	1
634.5	0	0	0	0	0	0	0	0	0	0	0
635.0	0	0	0	0	0	0	0	0	0	0	0
635.5	0	0	0	0	0	0	0	0	0	0	0
636.0	0	0	0	0	0	0	0	0	0	0	0
636.5	0	0	0	0	0	0	0	0	0	0	0
637.0	0	0	0	0	0	0	0	0	0	0	0
637.5	0	0	0	0	0	0	0	0	0	0	0
638.0	0	0	0	0	0	0	0	0	0	0	0
638.5	0	0	0	0	0	3	0	0	0	3	0
639.0	0	1	0	0	0	9	0	0	0	9	0
639.5	9	1	0	0	0	0	0	0	0	0	0
640.0	6	8	0	0	0	0	0	0	0	0	0
640.5	0	12	0	0	0	0	0	0	0	0	0
641.0	0	21	0	0	0	0	0	0	0	0	0
641.5	0	27	7	0	0	0	2	0	0	0	0
642.0	0	17	9	0	0	0	3	0	0	0	0
642.5	0	0	21	1	0	0	8	0	0	0	0
643.0	0	0	26	1	0	0	3	0	0	0	0
643.5	0	0	7	1	0	0	6	0	0	0	0
644.0	0	0	1	0	0	0	0	0	0	0	0

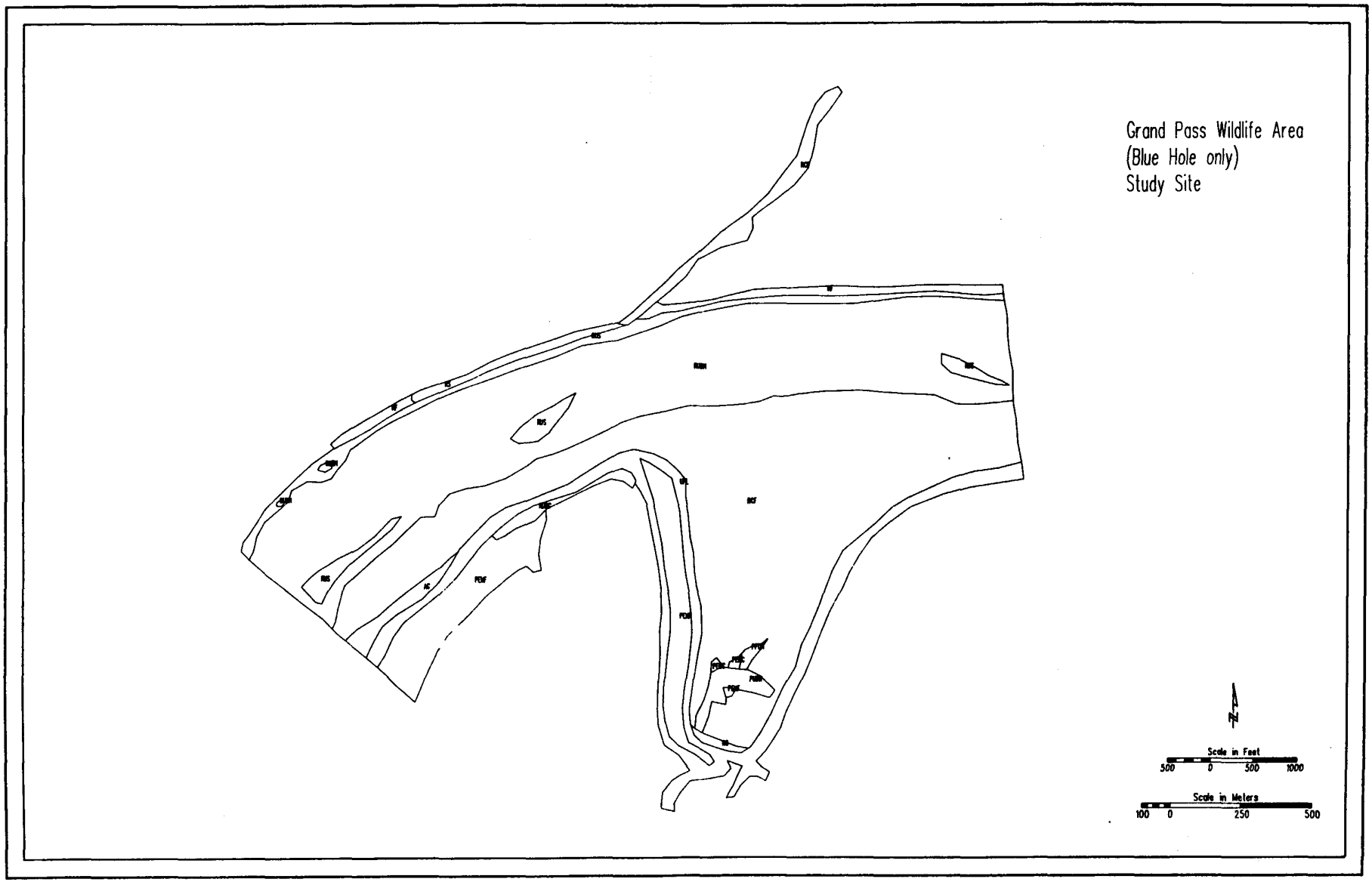
EXHIBIT 690 022314

Table BH-2 (Continued).

Missouri River - Blue Hole Study Site
River Mile 270.0 - All Transects Combin

Elevation	PEMF	PEMC	PEMA	PSSA	RF	PUBH	PFOA	RS	RG	RUS	RUBH
644.5	0	0	1	1	0	0	0	0	0	0	0
645.0	0	0	0	1	0	0	0	0	0	0	0
645.5	0	0	0	1	0	0	0	1	1	0	0
646.0	0	0	0	0	0	0	0	1	1	0	0
646.5	0	0	0	1	2	0	0	1	1	0	0
647.0	0	0	0	0	9	0	0	0	0	0	0
647.5	0	0	0	0	1	0	0	0	0	0	0
TOTAL	15	87	72	7	12	12	22	3	3	12	31

EXHIBIT 690 022315


Grand Pass Wildlife Area
(Blue Hole only)
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-189

Overton Bottoms

The Overton Bottoms study site was located on the left bank of the Missouri River in the Searcys Bend, just outside of Huntsdale, Missouri. The wetlands in this study site occurred in an old chute that was diked at the upstream end but open to the river at the lower end (RM 178.0). The Overton Bottoms study was part of the St. Joseph to St. Louis reach in the lower river.

The majority of the land in the Overton Bottom study site was cultivated farm lands (469.9 acres or 48.1 percent) which was classified as RG (Table OB-1). Wetlands were limited to the old chute, and included emergent (14.5 acres), scrub-shrub (24.6 acres), and forested (7.9 acres) wetlands. The PEMC wetlands occurred in the lowest areas of the chute and were dominated by reed canarygrass and skullcap. PSSA wetlands, characterized by cottonwood and sandbar and peachleaf willow shrubs, bordered the chutes. PFOA wetlands were located only in a thin strip at the upstream end of the chute, between the dike and the river. A large expanse (64.9 acres) of RUS and RUS5 was adjacent to the river; RUS5 was areas of sparsely vegetated by pigweed and zig-zag grass.

Table OB-1. Wetland and riparian acreages mapped in the Overton Bottoms study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent seasonally flooded (PEMC)	14.5
Palustrine scrub-shrub temporarily flooded (PSSA)	24.6
Palustrine forest temporarily flooded (PFOA)	7.9
Riparian grassland (RG)	469.9
Riparian shrub (RS)	1.0
Riparian forest (RF)	100.7
Riverine unconsolidated bottom permanently flooded (RUBH)	292.5
Riverine unconsolidated shore (RUS)	48.5
Riverine unconsolidated shore vegetated (RUS5)	16.4
Total	976.0

Sampling of the elevational distributions of the wetland and riparian cover types in the Overton Bottoms study site was done on October 21, 1991 using a total of four transects standardized at RM 178.0. Wetland elevations ranged from 556.5 to 570.0 and riparian cover types ranged in elevation from 563.5 to 583.0. The Missouri River water surface elevation at RM 178.0 at the time of sampling was 556.0.

EXHIBIT 690 022317

Table OB-2. Distribution of sampling points by elevation.

Missouri River - Overton Bottoms Study Site
River Mile 178.0 - All Transects Combined

Elevation	PEMC	RG	PSSA	RUS	RUS5	RUBH	RS	RF	PFOA
554.0	0	0	0	0	0	1	0	0	0
554.5	0	0	0	0	0	1	0	0	0
555.0	0	0	0	0	0	1	0	0	0
555.5	0	0	0	0	0	1	0	0	0
556.0	0	0	0	0	0	1	0	0	0
556.5	0	0	0	1	0	1	0	0	0
557.0	0	0	0	6	0	0	0	0	0
557.5	0	0	0	7	0	0	0	0	0
558.0	0	0	0	7	0	0	0	0	0
558.5	0	0	0	7	0	0	0	0	0
559.0	0	0	0	8	0	0	0	0	0
559.5	0	0	0	7	0	0	0	0	0
560.0	0	0	0	7	0	0	0	0	0
560.5	0	0	0	7	0	0	0	0	0
561.0	0	0	0	7	0	0	0	0	0
561.5	0	0	0	8	0	0	0	0	0
562.0	0	0	0	7	0	0	0	0	0
562.5	0	0	0	7	0	0	0	0	0
563.0	0	0	0	5	4	0	0	0	0
563.5	1	1	0	1	20	0	0	0	0
564.0	4	3	0	0	35	0	0	0	0
564.5	3	3	0	0	48	0	0	0	0
565.0	4	5	2	0	46	0	0	0	2
565.5	3	26	1	0	0	0	0	0	1
566.0	3	27	2	0	0	0	0	0	2
566.5	2	17	6	0	0	0	0	0	6
567.0	2	1	25	0	0	0	2	0	25
567.5	3	2	22	0	0	0	2	0	22
568.0	1	1	11	0	0	0	6	0	11
568.5	0	3	65	0	0	0	4	0	65
569.0	0	7	2	0	0	0	4	0	2
569.5	0	8	2	0	0	0	3	0	2
570.0	0	7	1	0	0	0	2	0	1
570.5	0	8	0	0	0	0	2	0	0
571.0	0	6	0	0	0	0	4	0	0
571.5	0	14	0	0	0	0	3	0	0
572.0	0	6	0	0	0	0	4	0	0
572.5	0	2	0	0	0	0	4	0	0
573.0	0	1	0	0	0	0	2	0	0
573.5	0	2	0	0	0	0	4	0	0
574.0	0	3	0	0	0	0	3	0	0
574.5	0	2	0	0	0	0	4	0	0

EXHIBIT 690 022318

Table OB-2 (Continued).

Missouri River - Overton Bottoms Study Site
River Mile 178.0 - All Transects Combined

Elevation	PEMC	RG	PSSA	RUS	RUS5	RUBH	RS	RF	PFOA
533.0	0	0	0	0	0	1	0	0	0
533.5	0	0	0	0	0	1	0	0	0
534.0	0	0	0	0	0	1	0	0	0
534.5	0	0	0	0	0	1	0	0	0
535.0	0	0	0	0	0	1	0	0	0
535.5	0	0	0	0	0	1	0	0	0
536.0	0	0	0	0	0	1	0	0	0
536.5	0	0	0	0	0	1	0	0	0
537.0	0	0	0	0	0	1	0	0	0
537.5	0	0	0	0	0	1	0	0	0
538.0	0	0	0	0	0	1	0	0	0
538.5	0	0	0	0	0	1	0	0	0
539.0	0	0	0	0	0	1	0	0	0
539.5	0	0	0	0	0	1	0	0	0
540.0	0	0	0	0	0	1	0	0	0
540.5	0	0	0	0	0	1	0	0	0
541.0	0	0	0	0	0	1	0	0	0
541.5	0	0	0	0	0	1	0	0	0
542.0	0	0	0	0	0	1	0	0	0
542.5	0	0	0	0	0	1	0	0	0
543.0	0	0	0	0	0	1	0	0	0
543.5	0	0	0	0	0	1	0	0	0
544.0	0	0	0	0	0	1	0	0	0
544.5	0	0	0	0	0	1	0	0	0
545.0	0	0	0	0	0	1	0	0	0
545.5	0	0	0	0	0	1	0	0	0
546.0	0	0	0	0	0	1	0	0	0
546.5	0	0	0	0	0	1	0	0	0
547.0	0	0	0	0	0	1	0	0	0
547.5	0	0	0	0	0	1	0	0	0
548.0	0	0	0	0	0	1	0	0	0
548.5	0	0	0	0	0	1	0	0	0
549.0	0	0	0	0	0	1	0	0	0
549.5	0	0	0	0	0	1	0	0	0
550.0	0	0	0	0	0	1	0	0	0
550.5	0	0	0	0	0	1	0	0	0
551.0	0	0	0	0	0	1	0	0	0
551.5	0	0	0	0	0	1	0	0	0
552.0	0	0	0	0	0	1	0	0	0
552.5	0	0	0	0	0	1	0	0	0
553.0	0	0	0	0	0	1	0	0	0
553.5	0	0	0	0	0	1	0	0	0

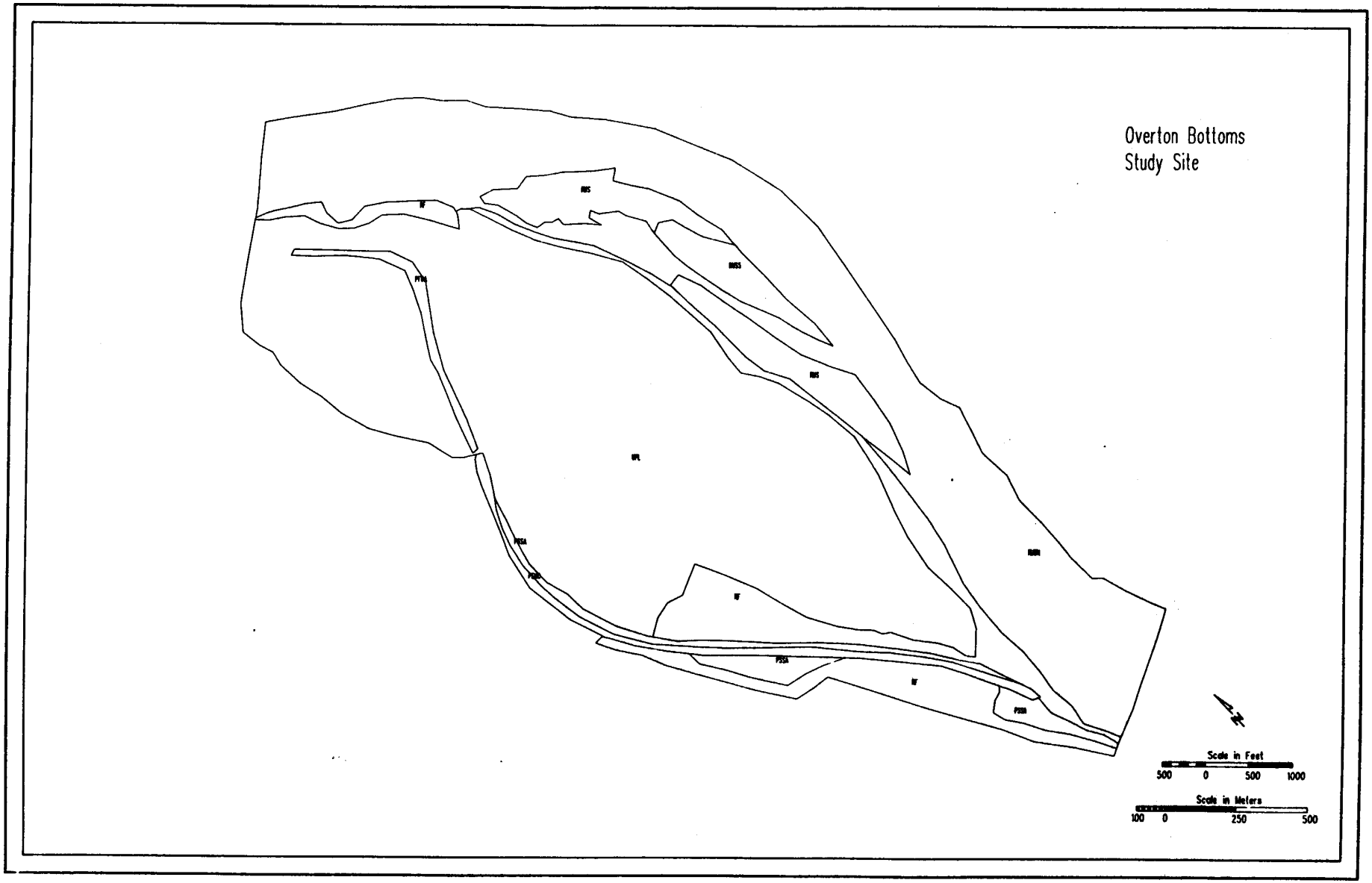
EXHIBIT 690 022319

Table OB-2 (Continued).

Missouri River - Overton Bottoms Study Site
River Mile 178.0 - All Transects Combined

Elevation	PEMC	RG	PSSA	RUS	RUS5	RUBH	RS	RF	PFOA
575.0	0	1	0	0	0	0	3	4	0
575.5	0	2	0	0	0	0	3	18	0
576.0	0	2	0	0	0	0	2	4	0
576.5	0	3	0	0	0	0	3	0	0
577.0	0	1	0	0	0	0	2	0	0
577.5	0	2	0	0	0	0	1	0	0
578.0	0	2	0	0	0	0	0	0	0
578.5	0	2	0	0	0	0	0	0	0
579.0	0	2	0	0	0	0	0	0	0
579.5	0	2	0	0	0	0	0	0	0
580.0	0	2	0	0	0	0	0	0	0
580.5	0	1	0	0	0	0	0	0	0
581.0	0	3	0	0	0	0	0	0	0
581.5	0	2	0	0	0	0	0	0	0
582.0	0	2	0	0	0	0	0	0	0
582.5	0	1	0	0	0	0	0	0	0
583.0	0	2	0	0	0	0	0	0	0
TOTAL	26	187	139	92	153	48	67	26	139

EXHIBIT 690 022320


Overton Bottoms
Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

Eagle Bluff

The Eagle Bluff study site was located on the left bank of the Missouri River, at RM 174.4, just across from Lupus, Missouri. Eagle Bluff was an expanse (approximately 3,000 acres) of bottomland located between the Missouri River and the bluffs adjacent to Perchy Creek. Most of the area was agricultural; however, there was an area of riparian forest between the main levee and the river. The entire area was under construction as part of a new wildlife refuge. The Eagle Bluff study site was part of the St. Joseph to St. Louis reach in the lower river.

The majority of the study site was classified as riparian grassland (RG) (456.7 acres or 42 percent) (Table EB-1). Riparian forest (RF) was the next most prevalent cover type, representing 275.1 acres (25.4 percent) and dominated by cottonwood, sycamore, silver maple, boxelder, and mulberry. The riparian forest was interrupted by an old chute that supported a small strip of palustrine emergent wetlands. The entrance of the chute at the upstream end was about 20 feet above the water surface. PEMA wetlands (6.0 acres) occurred on the outer edges of the chute; PEMC wetlands (8.3 acres) were found in patches in the bottom of the chute bed. The dominant species in the emergent wetlands was mild waterpepper. The surface of the chute was moist and cracked with black, mottled soil that was saturated about 6 inches below the surface.

Table EB-1. Wetland and riparian acreages mapped in the Eagle Bluff study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	6.0
Palustrine emergent seasonally flooded (PEMC)	8.3
Palustrine emergent semipermanently flooded (PEMF)	1.0
Palustrine scrub-shrub temporarily flooded (PSSA)	4.0
Palustrine scrub-shrub seasonally flooded (PSSC)	8.5
Riparian grassland (RG)	456.7
Riparian shrub (RS)	1.0
Riparian forest (RF)	275.1
Riverine unconsolidated bottom permanently flooded (RUBH)	287.4
Riverine unconsolidated shore (RUS)	21.1
Riverine unconsolidated shore vegetated (RUS5)	15.8
Total	1,084.9

The wetland and riparian elevational distributions were sampled on October 22, 1991 with a total of 4 transects; 2 at the upstream end of the chute and 2 in the middle. The transects were standardized around RM 174.4. The water surface elevation of the

EXHIBIT 690 022322

Missouri River was recorded at 553.0 at the upper end of the study site at RM 174.4. Elevations ranged from RUS and RUS5 at 554.4 to RF at 572.5 (Table EB-2).

Wildlife species observed at the Eagle Bluff study site included: rough-legged hawk, great blue heron, crow, wild turkey, blue jay, killdeer, frog, garter snake, box turtle, and white-tailed deer.

EXHIBIT 690 022323

Table EB-2. Distribution of sampling points by elevation.

Missouri River - Eagle Bluff Study Site
River Mile 174.4 - All Transects Combine

Elevation	PEMF	PEMC	PEMA	RG	PSSA	RUBH	RS	RF	RUS5	PSSC	RUS
534.0	0	0	0	0	0	1	0	0	0	0	0
534.5	0	0	0	0	0	1	0	0	0	0	0
535.0	0	0	0	0	0	1	0	0	0	0	0
535.5	0	0	0	0	0	1	0	0	0	0	0
536.0	0	0	0	0	0	1	0	0	0	0	0
536.5	0	0	0	0	0	1	0	0	0	0	0
537.0	0	0	0	0	0	1	0	0	0	0	0
537.5	0	0	0	0	0	1	0	0	0	0	0
538.0	0	0	0	0	0	1	0	0	0	0	0
538.5	0	0	0	0	0	1	0	0	0	0	0
539.0	0	0	0	0	0	1	0	0	0	0	0
539.5	0	0	0	0	0	1	0	0	0	0	0
540.0	0	0	0	0	0	1	0	0	0	0	0
540.5	0	0	0	0	0	1	0	0	0	0	0
541.0	0	0	0	0	0	1	0	0	0	0	0
541.5	0	0	0	0	0	1	0	0	0	0	0
542.0	0	0	0	0	0	1	0	0	0	0	0
542.5	0	0	0	0	0	1	0	0	0	0	0
543.0	0	0	0	0	0	1	0	0	0	0	0
543.5	0	0	0	0	0	1	0	0	0	0	0
544.0	0	0	0	0	0	1	0	0	0	0	0
544.5	0	0	0	0	0	1	0	0	0	0	0
545.0	0	0	0	0	0	1	0	0	0	0	0
545.5	0	0	0	0	0	1	0	0	0	0	0
546.0	0	0	0	0	0	1	0	0	0	0	0
546.5	0	0	0	0	0	1	0	0	0	0	0
547.0	0	0	0	0	0	1	0	0	0	0	0
547.5	0	0	0	0	0	1	0	0	0	0	0
548.0	0	0	0	0	0	1	0	0	0	0	0
548.5	0	0	0	0	0	1	0	0	0	0	0
549.0	0	0	0	0	0	1	0	0	0	0	0
549.5	0	0	0	0	0	1	0	0	0	0	0
550.0	0	0	0	0	0	1	0	0	0	0	0
550.5	0	0	0	0	0	1	0	0	0	0	0
551.0	0	0	0	0	0	1	0	0	0	0	0
551.5	0	0	0	0	0	1	0	0	0	0	0
552.0	0	0	0	0	0	1	0	0	0	0	0
552.5	0	0	0	0	0	1	0	0	0	0	0
553.0	0	0	0	0	0	1	0	0	0	0	0
553.5	0	0	0	0	0	0	0	0	0	0	0
554.0	0	0	0	0	0	0	0	0	0	0	0
554.5	0	0	0	0	0	0	0	0	1	0	1
555.0	0	0	0	0	0	0	0	0	1	0	1
556.0	0	0	0	0	0	0	0	0	1	0	1
557.5	0	0	0	0	0	0	0	0	1	0	1
558.0	0	0	0	0	0	0	0	0	1	0	1
559.0	0	0	0	0	0	0	0	0	1	0	1
559.5	0	0	0	0	0	0	0	0	1	0	1
560.0	0	0	0	0	0	0	0	0	0	0	0
560.5	0	0	0	0	0	0	0	0	1	0	1
561.0	2	0	0	0	0	0	0	0	0	0	0
561.5	4	0	0	0	0	0	0	0	0	0	0
562.0	2	9	0	0	0	0	0	0	0	9	0

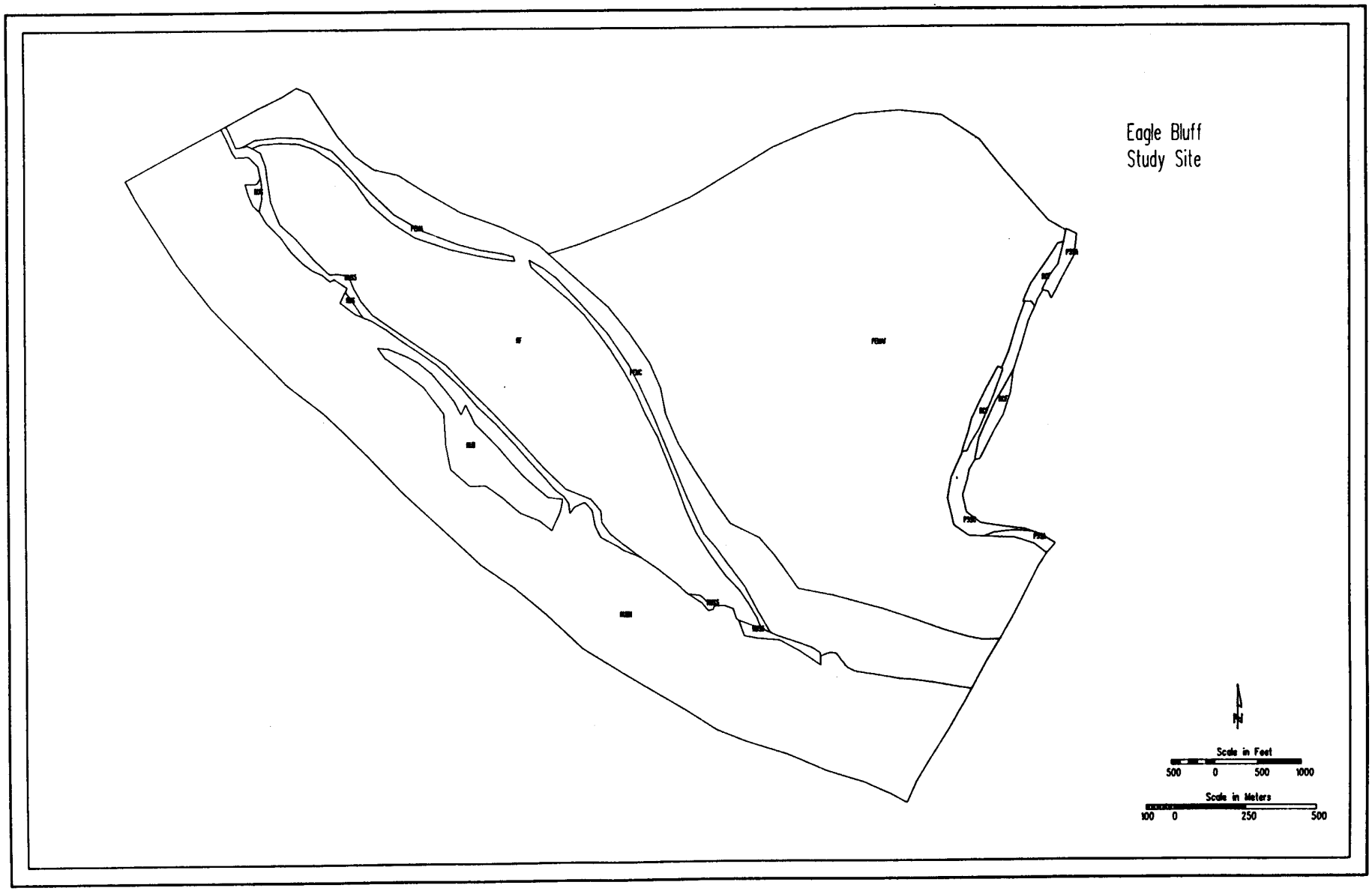
EXHIBIT 690 022324

Table EB-2. Distribution of sampling points by elevation.

Missouri River - Eagle Bluff Study Site
River Mile 174.4 - All Transects Combine

Elevation	PEMF	PEMC	PEMA	RG	PSSA	RUBH	RS	RF	RUS5	PSSC	RUS
562.5	0	10	0	0	0	0	0	0	1	10	1
563.0	0	5	0	0	0	0	0	0	0	5	0
563.5	0	3	1	1	0	0	0	0	0	3	0
564.0	0	1	0	1	0	0	0	0	0	1	0
564.5	0	1	2	1	0	0	0	0	0	1	0
565.0	0	1	1	1	0	0	0	0	0	1	0
565.5	0	0	2	0	0	0	0	2	0	0	0
566.0	0	0	1	1	0	0	0	3	0	0	0
566.5	0	0	0	1	0	0	0	6	0	0	0
567.0	0	35	0	1	14	0	0	6	0	35	0
567.5	0	66	0	1	4	0	0	5	0	66	0
568.0	0	0	1	0	0	0	1	2	0	0	0
568.5	0	0	1	0	0	0	1	3	0	0	0
569.0	0	0	1	0	0	0	1	1	0	0	0
569.5	0	0	0	0	0	0	2	3	0	0	0
570.0	0	0	0	0	0	0	1	4	0	0	0
570.5	0	0	0	0	0	0	2	2	0	0	0
571.0	0	0	0	0	0	0	1	2	0	0	0
571.5	0	0	0	0	0	0	2	0	0	0	0
572.0	0	0	0	0	0	0	0	1	0	0	0
572.5	0	0	0	0	0	0	0	2	0	0	0
TOTAL	8	131	10	8	18	39	11	42	9	131	9

EXHIBIT 690 022325


Eagle Bluff
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-199

Morrison Bend

The Morrison Bend study site was located on the left bank of the Missouri River, approximately 1 mile downstream of Portland, Missouri and adjacent to Paradise Lake. It consisted of 1 major chute that was blocked at the upstream end by a dike, and several side chutes that connected to the river. The Big Tavern Creek emptied into the main chute and there were several small ponds that occurred adjacent to the main levee. The Morrison Bend study site was part of the St. Joseph to St. Louis reach in the lower river.

The Morrison Bend study site was dominated by riparian vegetation (422.6 acres or 45.6 percent) (Table MB-1). Riparian forest (RF) accounted for the majority of the cover types (407.3 acres or 43.9 percent) and was characterized by sycamore, silver maple, and black willow trees. Wetlands were mainly limited to RUS and RUS5 with pioneering species including: flat sedge, pigweed, foxtail, and lovegrass. The emergent wetlands occupied only 1.5 acres, or less than 1 percent, of the study area.

Table MB-1. Wetland and riparian acreages mapped in the Morrison Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	0.5
Palustrine emergent seasonally flooded (PEMC)	1.0
Palustrine scrub-shrub temporarily flooded (PSSA)	1.0
Riparian grassland (RG)	5.6
Riparian shrub (RS)	9.7
Riparian forest (RF)	407.3
Riverine unconsolidated bottom permanently flooded (RUBH)	411.2
Riverine unconsolidated shore (RUS)	19.0
Riverine unconsolidated shore vegetated (RUS5)	16.7
Palustrine unconsolidated bottom permanently flooded (PUBH)	52.2
Total	926.8

The Morrison Bend study site was sampled on October 23, 1991. At that time, both the main chute and the side chutes held water and the water surface elevation at RM 113.0 was 499.0 (Table MB-2). Six transects, standardized around RM 113.0, were run at the study site, 4 at the upstream end of the chute and 2 at the lower end. The elevational distribution of the wetland and riparian cover types ranged from 499.0 to 524.0.

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Several species of birds were observed at the Morrison Bend study site, including: rough-legged hawk, great blue heron, yellow-rumped warbler, kinglet, downy woodpecker, and long-eared owl. Deer and raccoon tracks were also noted.

EXHIBIT 690 022328

Table MB-2. Distribution of sampling points by elevation.

Missouri River - Morrison Bend Study Site
River Mile 113.0 - All Transects Combined

Elevation	PEMC	PEMA	RG	PSSA	PUBH	PFOA	RS	RF	RUS	RUS5	RUBH
484.0	0	0	0	0	0	0	0	0	0	0	1
484.5	0	0	0	0	0	0	0	0	0	0	1
485.0	0	0	0	0	0	0	0	0	0	0	1
485.5	0	0	0	0	0	0	0	0	0	0	1
486.0	0	0	0	0	0	0	0	0	0	0	1
486.5	0	0	0	0	0	0	0	0	0	0	1
487.0	0	0	0	0	0	0	0	0	0	0	1
487.5	0	0	0	0	0	0	0	0	0	0	1
488.0	0	0	0	0	0	0	0	0	0	0	1
488.5	0	0	0	0	0	0	0	0	0	0	1
489.0	0	0	0	0	0	0	0	0	0	0	1
489.5	0	0	0	0	0	0	0	0	0	0	1
490.0	0	0	0	0	0	0	0	0	0	0	1
490.5	0	0	0	0	0	0	0	0	0	0	1
491.0	0	0	0	0	0	0	0	0	0	0	1
491.5	0	0	0	0	0	0	0	0	0	0	1
492.0	0	0	0	0	0	0	0	0	0	0	1
492.5	0	0	0	0	0	0	0	0	0	0	1
493.0	0	0	0	0	0	0	0	0	0	0	1
493.5	0	0	0	0	0	0	0	0	0	0	1
494.0	0	0	0	0	0	0	0	0	0	0	1
494.5	0	0	0	0	0	0	0	0	0	0	1
495.0	0	0	0	0	0	0	0	0	0	0	1
495.5	0	0	0	0	0	0	0	0	0	0	1
496.0	0	0	0	0	0	0	0	0	0	0	1
496.5	0	0	0	0	0	0	0	0	0	0	1
497.0	0	0	0	0	0	0	0	0	0	0	1
497.5	0	0	0	0	0	0	0	0	0	0	1
498.0	0	0	0	0	0	0	0	0	0	0	1
498.5	0	0	0	0	0	0	0	0	0	0	1
499.0	0	0	0	0	1	0	0	0	15	0	1
499.5	0	0	0	0	2	0	0	0	11	0	1
500.0	0	0	0	0	4	0	0	0	7	1	0
500.5	0	0	0	0	1	0	0	0	6	11	0
501.0	0	0	0	0	0	0	0	0	3	12	0
501.5	0	0	0	0	0	0	0	0	3	13	0
502.0	0	0	0	0	0	0	0	0	18	15	0
502.5	3	0	0	0	0	0	0	0	15	32	0
503.0	2	0	0	0	0	0	0	0	1	46	0
503.5	0	0	0	0	0	0	0	0	8	84	0
504.0	0	0	0	0	0	0	0	0	0	83	0
504.5	0	1	0	0	0	0	0	0	0	21	0

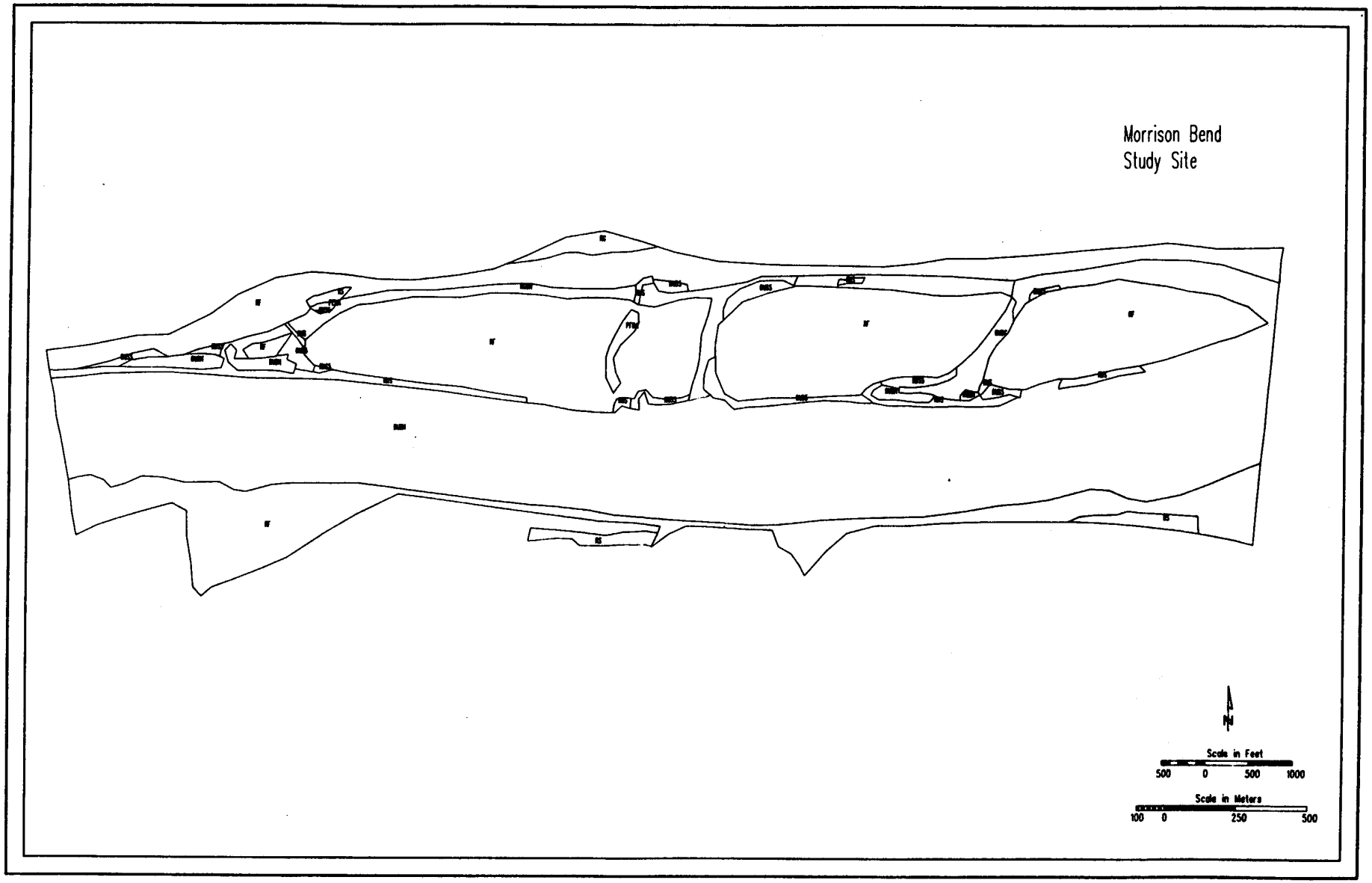
EXHIBIT 690 022329

Table MB-2 (Continued).

Missouri River - Morrison Bend Study Site
River Mile 113.0 - All Transects Combined

Elevation	PEMC	PEMA	RG	PSSA	PUBH	PFOA	RS	RF	RUS	RUS5	RUBH
505.0	0	5	0	0	0	0	0	0	0	10	0
505.5	0	7	0	0	0	0	0	0	0	8	0
506.0	0	3	0	0	0	0	0	0	0	8	0
506.5	0	1	0	0	0	0	1	0	0	9	0
507.0	0	1	0	0	0	0	0	0	0	80	0
507.5	0	1	0	0	0	0	1	0	0	2	0
508.0	0	1	1	0	0	0	0	0	0	2	0
508.5	0	0	0	0	0	0	2	0	0	2	0
509.0	0	0	0	0	0	0	1	0	0	2	0
509.5	0	0	1	0	0	0	2	0	0	2	0
510.0	0	0	0	0	0	0	1	0	0	2	0
510.5	0	0	1	0	0	0	2	0	0	2	0
511.0	0	0	0	0	0	0	0	0	0	2	0
511.5	0	0	0	0	0	0	2	0	0	2	0
512.0	0	0	1	1	0	0	1	0	0	0	0
512.5	0	0	0	1	0	0	3	0	0	0	0
513.0	0	0	1	1	0	0	1	0	0	0	0
513.5	0	0	0	1	0	0	3	0	0	0	0
514.0	0	0	0	1	0	0	1	0	0	0	0
514.5	0	0	0	1	0	0	3	0	0	0	0
515.0	0	0	1	0	0	0	0	0	0	0	0
515.5	0	0	0	1	0	0	3	0	0	0	0
516.0	0	0	0	1	0	0	0	1	0	0	0
516.5	0	0	0	1	0	14	1	1	0	0	0
517.0	0	0	0	1	0	1	1	8	0	0	0
517.5	0	0	1	0	0	0	8	7	0	0	0
518.0	0	0	0	0	0	0	15	8	0	0	0
518.5	0	0	0	0	0	0	3	2	0	0	0
519.0	0	0	0	0	0	0	2	1	0	0	0
519.5	0	0	1	0	0	0	0	1	0	0	0
520.0	0	0	0	0	0	0	1	0	0	0	0
520.5	0	0	0	0	0	0	1	0	0	0	0
521.0	0	0	0	0	0	0	1	0	0	0	0
521.5	0	0	0	0	0	0	1	1	0	0	0
522.0	0	0	0	0	0	0	1	0	0	0	0
522.5	0	0	0	0	0	0	1	0	0	0	0
523.0	0	0	0	0	0	0	1	0	0	0	0
523.5	0	0	0	0	0	0	1	0	0	0	0
524.0	0	0	0	0	0	0	1	0	0	0	0
TOTAL	5	20	8	10	8	15	66	30	87	451	32

EXHIBIT 690 022330


Morrison Bend
Study Site
N
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-204

Berger Bend

The wetlands in the Berger Bend study site were associated with several old chutes in a large bend on the right bank of the river just outside of Berger, Missouri. The Berger Bend study site was part of the St. Joseph to St. Louis reach in the lower river.

Riparian vegetation was the dominant cover type, representing 309.7 acres (39.0 percent) (Table BB-1), of the study site. The soils in the riparian cover types were sandy and dry, with no mottles. Riparian forest (RF) covered 296.0 acres and was, by far, the most prevalent cover type. Black willow, sycamore, and mulberry trees characterized RF stands. Some of these RF stands may have actually been wetland but similar species composition and drought conditions precluded distinguishing between PFOA and RF.

It appeared that only 1 relatively short backwater chute contained water for part of the year. The remaining chutes were either barren (RUS) or dominated by pioneering species (RUS5), such as pigweed, smartweed, and lovegrass. Forested and scrub-shrub wetlands were restricted to the old chutes that were located farther away from the river channel. Soils in these areas were moist with oxidized root zones and mottles within 3 to 4 inches below ground. Forested wetlands (PFOA), represented 21.7 acres (2.7 percent), and were dominated by black willow. Scrub-shrub wetlands (14.1 acres or 1.7 percent) consisted mainly of cottonwood and sandbar and black willow. Emergent wetlands were only found near the ends of the old chutes or surrounding the few ponds that formed from as a result of dikes and levees.

Table BB-1. Wetland and riparian acreages mapped in the Bullard Bend study site.

Wetland/Riparian Cover types	Acres
Palustrine emergent temporarily flooded (PEMA)	2.6
Palustrine emergent seasonally flooded (PEMC)	0.7
Palustrine scrub-shrub temporarily flooded (PSSA)	0.9
Palustrine scrub-shrub seasonally flooded (PSSC)	13.4
Palustrine forest temporarily flooded (PFOA)	21.7
Riparian grassland (RG)	12.7
Riparian shrub (RS)	1.0
Riparian forest (RF)	296.0
Riverine unconsolidated bottom permanently flooded (RUBH)	341.6
Riverine unconsolidated shore (RUS)	57.4
Riverine unconsolidated shore vegetated (RUS5)	39.6
Palustrine unconsolidated bottom permanently flooded (PUBH)	6.8
Total	794.5

EXHIBIT 690 022332

The Berger Bend study site was sampled on October 24, 1992 with a total of 9 transects, ranging in length from 55 feet to 2,000 feet. The transects were standardized around RM 90.0. The water surface elevation at RM 90.0 was 480.0 feet (Table BB-2) and sampled elevations ranged from RUS at 480.0 feet to RF at 502.2 feet.

Wildlife species observed at the Berger Bend study site included: killdeer, yellow legs, rough-legged hawk, and frog. Deer, raccoon, and mink tracks were also noted.

EXHIBIT 690 022333

Table BB-2. Distribution of sampling points by elevation.

Missouri River - Berger Bend Study Site
River Mile 90.0 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	RUS	RUS5	RUBH	PFOA	RS	RF	RG	PUBH
463.0	0	0	0	0	0	0	1	0	0	0	0	0
463.5	0	0	0	0	0	0	1	0	0	0	0	0
464.0	0	0	0	0	0	0	1	0	0	0	0	0
464.5	0	0	0	0	0	0	1	0	0	0	0	0
465.0	0	0	0	0	0	0	1	0	0	0	0	0
465.5	0	0	0	0	0	0	1	0	0	0	0	0
466.0	0	0	0	0	0	0	1	0	0	0	0	0
466.5	0	0	0	0	0	0	1	0	0	0	0	0
467.0	0	0	0	0	0	0	1	0	0	0	0	0
467.5	0	0	0	0	0	0	1	0	0	0	0	0
468.0	0	0	0	0	0	0	1	0	0	0	0	0
468.5	0	0	0	0	0	0	1	0	0	0	0	0
469.0	0	0	0	0	0	0	1	0	0	0	0	0
469.5	0	0	0	0	0	0	1	0	0	0	0	0
470.0	0	0	0	0	0	0	1	0	0	0	0	0
470.5	0	0	0	0	0	0	1	0	0	0	0	0
471.0	0	0	0	0	0	0	1	0	0	0	0	0
471.5	0	0	0	0	0	0	1	0	0	0	0	0
472.0	0	0	0	0	0	0	1	0	0	0	0	0
472.5	0	0	0	0	0	0	1	0	0	0	0	0
473.0	0	0	0	0	0	0	1	0	0	0	0	0
473.5	0	0	0	0	0	0	1	0	0	0	0	0
474.0	0	0	0	0	0	0	1	0	0	0	0	0
474.5	0	0	0	0	0	0	1	0	0	0	0	0
475.0	0	0	0	0	0	0	1	0	0	0	0	0
475.5	0	0	0	0	0	0	1	0	0	0	0	0
476.0	0	0	0	0	0	0	1	0	0	0	0	0
476.5	0	0	0	0	0	0	1	0	0	0	0	0
477.0	0	0	0	0	0	0	1	0	0	0	0	0
477.5	0	0	0	0	0	0	1	0	0	0	0	0
478.0	0	0	0	0	0	0	1	0	0	0	0	0

Table BB-2 (Continued).

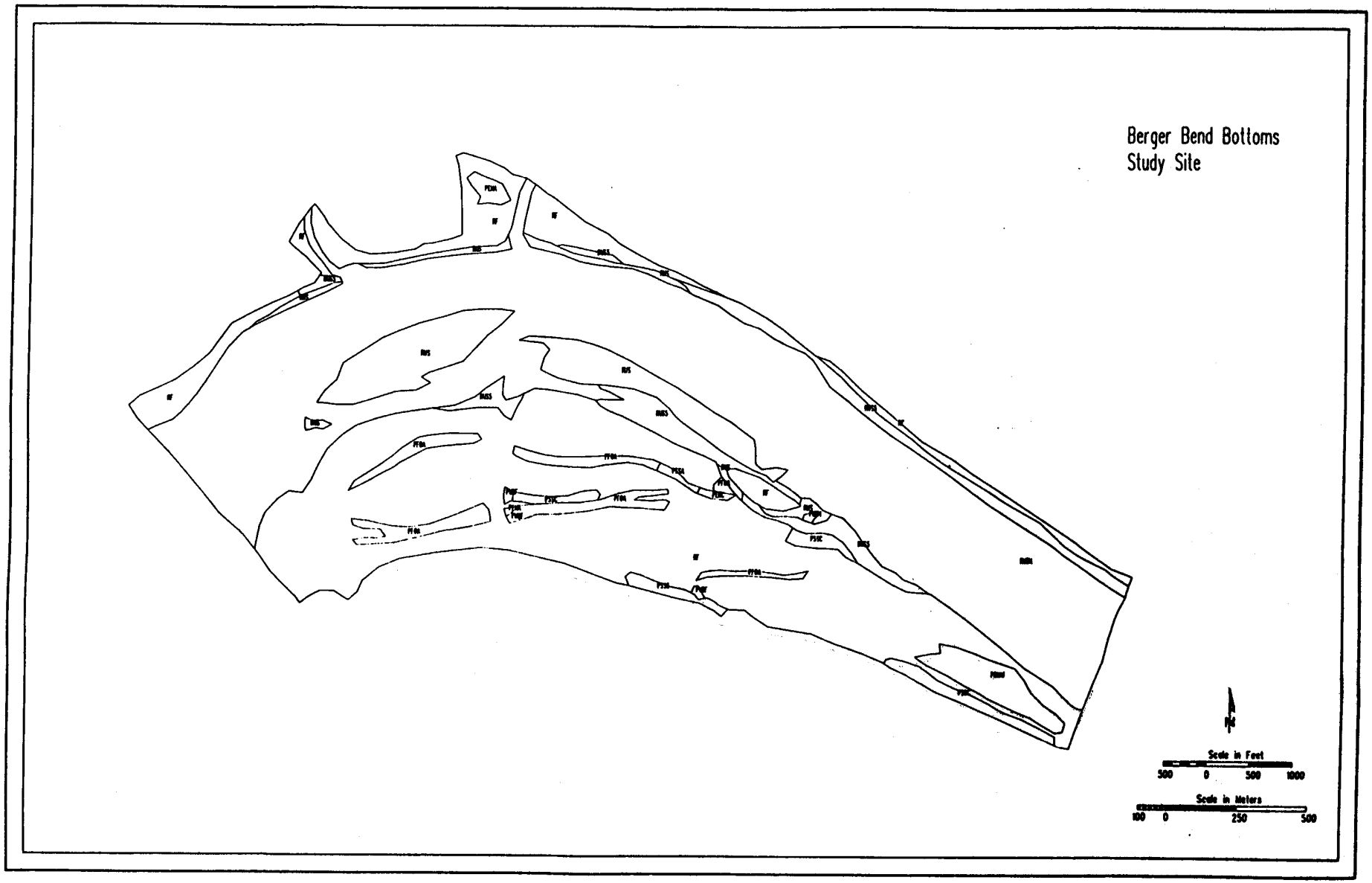
Missouri River - Berger Bend Study Site
River Mile 90.0 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	RUS	RUS5	RUBH	PFOA	RS	RF	RG	PUBH
478.5	0	0	0	0	0	0	1	0	0	0	0	0
479.0	0	0	0	0	0	0	1	0	0	0	0	7
479.5	0	0	0	0	13	0	1	0	0	0	0	22
480.0	1	0	0	0	360	0	1	0	0	0	0	0
480.5	0	0	0	0	341	0	0	0	0	0	0	0
481.0	1	0	0	0	24	1	0	0	0	0	0	0
481.5	1	0	0	0	19	2	0	0	0	0	0	0
482.0	1	0	0	0	18	2	0	0	0	0	0	0
482.5	1	0	0	0	18	2	0	0	0	0	0	0
483.0	0	0	0	0	34	4	0	0	0	0	0	0
483.5	1	0	0	0	25	4	0	0	0	0	0	0
484.0	1	0	0	0	1	4	0	0	0	0	0	0
484.5	0	0	0	0	0	4	0	0	0	0	0	0
485.0	0	0	0	0	0	3	0	0	0	0	0	0
485.5	0	0	0	0	48	111	0	0	0	0	0	0
486.0	0	0	0	0	4	111	0	0	0	0	0	0
486.5	0	0	1	1	4	68	0	0	0	0	0	0
487.0	0	0	1	6	6	56	0	0	0	0	0	0
487.5	2	0	1	10	7	50	0	0	0	0	0	0
488.0	1	0	1	13	0	5	0	0	0	0	0	0
488.5	1	3	1	9	0	3	0	0	0	0	0	0
489.0	0	5	1	4	0	3	0	0	0	2	0	0
489.5	0	4	1	0	0	3	0	0	0	1	0	0
490.0	0	2	1	0	0	2	0	0	0	5	0	0
490.5	0	1	1	0	0	2	0	0	0	4	0	0
491.0	0	2	2	0	0	1	0	0	0	6	0	0
491.5	0	1	3	0	0	0	0	0	0	4	0	0
492.0	0	2	2	0	0	1	0	0	0	6	0	0
492.5	1	1	3	1	0	0	0	0	0	1	0	0
493.0	8	0	2	5	0	0	0	0	0	0	0	0
493.5	7	1	3	6	0	0	0	0	1	1	1	0

Table BB-2 (Continued).

Missouri River - Berger Bend Study Site
River Mile 90.0 - All Transects Combined

Elevation	PEMC	PEMA	PSSC	PSSA	RUS	RUS5	RUBH	PFOA	RS	RF	RG	PUBH
494.0	5	0	7	6	0	0	0	0	0	5	0	0
494.5	1	1	6	2	0	0	0	0	1	5	1	0
495.0	0	0	3	0	0	0	0	3	0	3	0	0
495.5	0	0	2	0	0	0	0	4	1	3	1	0
496.0	0	0	0	0	0	0	0	5	0	3	0	0
496.5	0	0	1	0	0	0	0	0	1	0	1	0
497.0	0	0	0	0	0	0	0	0	1	1	1	0
497.5	0	0	0	0	0	0	0	0	2	3	2	0
498.0	0	0	0	0	0	0	0	0	1	0	1	0
498.5	0	0	0	0	0	0	0	0	2	2	2	0
499.0	0	0	0	0	0	0	0	0	4	9	4	0
499.5	0	0	0	0	0	0	0	0	5	15	5	0
500.0	0	0	0	0	0	0	0	0	0	5	0	0
500.5	0	0	0	0	0	0	0	0	0	1	0	0
501.0	0	0	0	0	0	0	0	0	0	2	0	0
501.5	0	0	0	0	0	0	0	0	0	1	0	0
502.0	0	0	0	0	0	0	0	0	0	2	0	0
TOTAL	33	23	43	63	922	442	35	12	19	90	19	29


Berger Bend Bottoms
Study Site
Scale in Feet
500 0 500 1000
Scale in Meters
100 0 250 500

B-210