

Ecological Opportunities & Constraints Report

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U. S. Army Corps of Engineers
Tulsa District



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1.0 INTRODUCTION

The Greater Tulsa Area communities recognize that the Arkansas River Corridor is an important natural resource that could be developed to stimulate immense private investment and greatly improve the quality of life for current and future generations.

The Phase I study addressed privately and publicly owned property within the river corridor and identified potential conservation, development, and redevelopment sites. The current study will assess the feasibility of specific sites, identify funding measures and mechanisms, and continue the public relations effort to develop a Master Plan. The following report includes a general description of the project area, habitat constraints and opportunities, and additional studies that will be required.

2.0 PROJECT AREA

The project area is described as a 42 mile portion of the Arkansas River from the Keystone Dam at Hwy 151, southward to the Tulsa/Wagoner County line. The study area within the corridor includes resources from the Arkansas River and up to ½ mile from the center of the river. The following chapter includes a general description of the project ecoregion, major vegetation associations within the corridor, land use patterns and general habitat types found in the corridor.

2.1 GENERAL ECOREGION DESCRIPTION

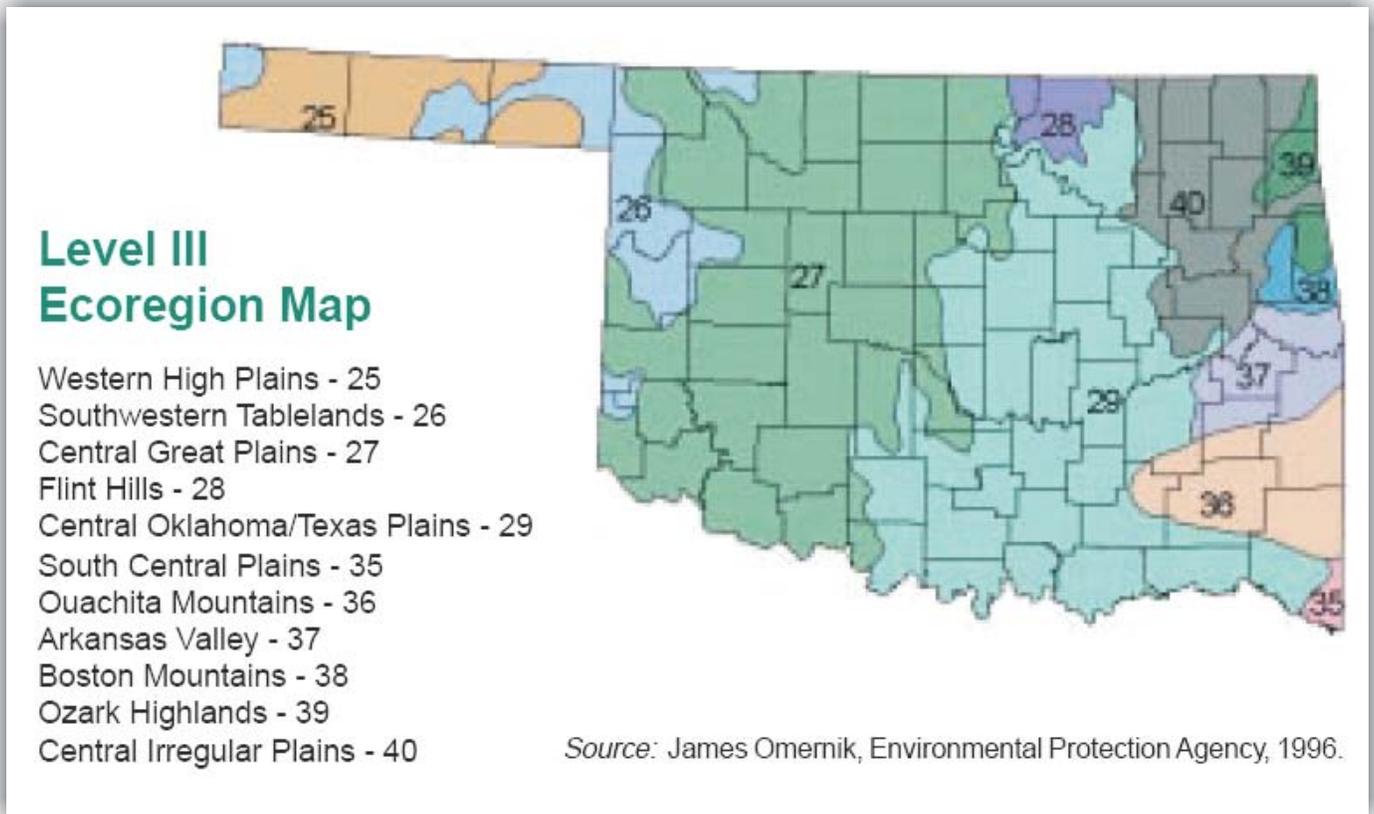
The Arkansas River Corridor lies within the Central Oklahoma/Texas Plains ecoregion (Figure 1). Throughout the central part of the ecoregion, dry upland forests blanket the hills and bottomland forests occur along streams. Prairies are scattered throughout this ecoregion. Upland forests occurring in this ecoregion are called crosstimbers. Unburned stands may develop into dense forests of post oak and blackjack oak. Grasslands composed of big and little bluestem, Indiangrass, and switchgrass are predominant in this ecoregion. In more open sites, cottonwoods, willows, sedges, and rushes line rivers and streams. Bottomland forests of this ecoregion also serve as a transition from eastern to western natural communities. Bottomland forests in eastern Oklahoma, where rainfall is abundant, are very diverse in the number of species. Willows and cottonwoods dominate bottomland forests in the west. Also, more sunlight reaches the forest floor at some western sites, resulting in greater amounts of herbaceous vegetation development. A few sandstone caves are scattered throughout the ecoregion (OSU, 1998).

2.2 VEGETATION ASSOCIATIONS IN THE PROJECT CORRIDOR

Field assessments were completed in the project corridor to determine the general vegetative cover associated with undisturbed areas in the project corridor. Two general vegetative associations were identified and are described below.

- **Cottonwood /Willow Association**

Cottonwood (*Populus deltoides*), and black willow (*Salix nigra*) were found to be the dominant cover of the areas adjacent to the river. The hackberries (*Celtis occidentalis*, *Celtis laevigata*) also comprised a large part of this association. These areas are confined to the lowlands, where subsurface hydrology dictates the floral component of the corridor. Snag trees provide bald eagle nesting and perching opportunities.



- **Oak/Hickory Association**

Dominated by oaks, this forest system is comprised of a high diversity of hardwood trees. The following is a list of species found therein: Chinkapin oak (*Quercus muhlenbergii*), post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), northern red oak (*Quercus rubra*), winged elm (*Ulmus alata*), white ash (*Fraxinus Americana*), persimmon (*Diospyros virginiana*), hickory (*Carya spp.*), cedar (*Juniperus spp.*), hackberry (*Celtis occidentalis*), sugarberry (*Celtis laevigata*), redbud (*Cercis Canadensis*), cottonwood (*Populus deltoids*), black willow (*Salix nigra*), and black walnut (*Juglans nigra*).

2.3 LAND USE

Existing land use along the corridor is a mix of urban and rural utility. Land use in the northern half is primarily associated with urban land use practices including: residential (2966 acres), commercial (493 acres), industrial (1641 acres) and deciduous forest land (3745 acres). Land use in the southern portion of the project corridor is primarily agricultural with croplands and pasture dominating (9176 acres). Table 2 provides acreage for each land use type identified in the project corridor.

Table 2
Land Use within the Project Corridor

| Land Use Type | Acreage |
|--|---------|
| Residential | 2966 |
| Commercial and Services | 493 |
| Industrial | 1641 |
| Transportation, Communications and Utilities | 372 |
| Other Urban or Built-up Land | 132 |
| Cropland and Pasture | 9176 |
| Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas | 19 |
| Deciduous Forest Land | 3745 |
| Streams and Canals | 3948 |
| Reservoirs | 2514 |
| Beaches | 100 |
| Sandy Areas Other than Beaches | 164 |
| Strip Mines, Quarries, and Gravel Pits | 267 |
| Transitional Areas | 260 |

2.4 ARKANSAS RIVER CORRIDOR HABITATS

The Arkansas River Corridor aquatic and terrestrial habitats are discussed below.

2.4.1 AQUATIC HABITATS

Aquatic habitats include perennial streams, rivers, floodplain wetlands, and sand bars of the Arkansas River. A brief summary of the aquatic habitats found in the corridor are described below.

- Open Water Habitats – Open water habitats include both pooled and flowing water resources. Open water habitat provides valuable resources for numerous fish, insect, amphibian, reptile, bird and human uses.
- Sandbars – Sandbar habitats in the project corridor are important resources for migratory birds such as the interior least tern, spawning fish, and the reproductive cycle of numerous mussels and river invertebrates.
- Wetlands - Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin, 1979). Wetland function includes protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods.

2.4.2 TERRESTRIAL HABITATS

Terrestrial habitats in the project area include riparian and uplands habitats. A brief summary of the terrestrial habitats found in the project corridor are described below.

- Riparian habitats – Riparian habitats occur in bands adjacent to river channels and on deposits from past floods or meanderings of the watercourse. Riparian buffers preserve the natural breeding, foraging, and resting areas of native wildlife species.
- Upland habitats – Unlike riparian habitats, upland habitats occur outside of the natural floodplain. Upland habitats provide natural buffers to riparian areas and aquatic resources.

3.0 BIOLOGICAL RESOURCES

The following chapter provides a summary of protected species/habitats of the project area. The information includes a summary of agency coordination, methods of data collection, and individual species descriptions. Each species is addressed with regard to life history, habitat usage, constraints and mitigation opportunities. Additional ecological constraints and mitigation opportunities are discussed in detail in Chapter 4.0.

3.1 AGENCY COORDINATION

The U.S. Fish and Wildlife Service (Brabander, Martinez, Stubbs, 2004), Oklahoma Department of Wildlife Conservation (Gordon, 2004), and the U.S. Army Corps of Engineers (Clyde, 2004; Knack, 2004; Nolen, 2004; Sturdy, 2004) were contacted regarding threatened and endangered species in the project corridor. Solicitation letters were forwarded to: the U.S. Geological Survey, the Oklahoma Conservation Commission, the U.S. Department of Agriculture, the U.S. Fish and Wildlife Service (USFWS), and the Oklahoma Department of Environmental Quality. Future agency coordination and comments will be included in the refinement of ecological constraints involving impacts to threatened and endangered species and the development of restoration opportunities in the project area.

A windshield survey was completed of the entire project corridor. The project boundaries have been defined as land and water resources within ½ mile from the centerline of the river. This survey identified the major regions of the corridor, the areas of development, vegetation associations, and the significant landmarks that are necessary for communicating with local agencies about the project. The following information comes from telephone interviews, a review of existing literature, and existing project studies.

3.2 PROTECTED SPECIES

The Endangered Species Act provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered in the U.S. or elsewhere. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. Section 7 of the Endangered Species Act requires Federal agencies to insure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

The USFWS cited that there are four threatened or endangered species within the Tulsa County project area (Brabander 2004). Federally protected species include the Interior Least Tern (*Sterna antillarum*; FE), the Bald Eagle (*Haliaeetus leucocephalus*; FT, SE), the Piping Plover (*Charadrius melodus*; FT, ST), and the American Burying Beetle, (*Nicrophorus americanus*; FE) (Table 3).

Table 3
Threatened and Endangered Species in Tulsa County

| Common Name | Scientific Name | Federal Status | State Status |
|-------------------------|---------------------------------|----------------|--------------|
| BIRDS | | | |
| Bald Eagle | <i>Haliaeetus leucocephalus</i> | T | E |
| Interior Least Tern | <i>Sterna antillarum</i> | E | |
| Piping Plover | <i>Charadrius melodus</i> | T | T |
| INSECTS | | | |
| American Burying Beetle | <i>Nicrophorus americanus</i> | E | |

3.2.1 BALD EAGLE

The Bald Eagle is a federally threatened and state endangered species which prefers wintering in deciduous woodland habitat adjacent to aquatic environments. The Eagle prefers large trees (>12-inches dbh) for perching and roosting. Two areas have been previously identified as Bald Eagle nesting habitat within the project corridor. They are both riparian areas that have access to extensive exposed sandbars. These are the Keystone Dam outlet park and the Mackey Sandbar. Areas of high quality riparian forests should be identified and preserved. The nest incubation and fledgling period (January 1 through May 15) is a sensitive time for this species and human disturbance to known nesting areas should be limited during this stage.

Mitigation opportunities which would benefit this species were discussed with the USFWS (USFWS, 2004). The construction of the proposed dams will have little impact on the Bald Eagles nesting and feeding requirements. Mitigation opportunities exist within the project area which would benefit this species. Agricultural fields adjacent to the river are potential riparian forest restoration areas which could be purchased and preserved. The dominant trees in these forests are cottonwoods. These trees are fast growing and are thus able to provide habitat in a short amount of time.

3.2.2 INTERIOR LEAST TERN

The Interior Least Tern is a federally endangered species. The common name refers to the interior population of the Least Tern, defined as the members of the species which nest greater than 50 miles from the ocean. Interior Least Terns migrate in small, loose flocks arriving in Oklahoma in the spring and leaving in the fall. Terns nest in colonies and begin laying eggs in late spring. Nests are small scrapes in sand and contain 1-4 eggs. Both parents feed the young and remain with them until fall migration. Terns will travel four or more miles from their breeding colonies to find small fish that are a major part of their diet. Terns prefer shallow water for fishing. Terns historically nest on shallow sandbars of shallow pools within the Arkansas River

corridor. Terns prefer island surface area to be about 0.8 to 1.2 ha (2 to 3 acres) in size. Aside from minimum size, the following island criteria are required for Tern breeding habitat:

- Concentrated in the center of the channel
- Island should have gently sloping, sandy beaches
- Less than 10% vegetation
- Withstand high flows

The creation of the Keystone Dam has affected the amount of nesting and foraging habitat that can be used by the Interior Least Tern. The daily flow patterns are created when water is released to generate electricity. Flow patterns inundate significant areas of shallow sandbars, making them unavailable to the terns. Thus, ecological impacts regarding the loss of nesting habitat for the tern should only consider those areas which occur above the high water line for power generation and below the elevation the pool would inundate.

Impacts to least tern were discussed with the USACE (USACE, 2004), USFWS (USFWS, 2004) and ODWC (ODWC, 2004). Artificial islands have been created as mitigation projects to offset the loss of habitat. Zink Island, associated with the low water dam at 31st street, has supported nesting terns. Terns prefer native fish species which occur in shallow braided settings. Pools support less desirable fish for terns which may affect nesting success. Low water dam pools may also support striped bass populations which would compete for food available to the terns. Islands offer protection from predators and human disturbance but require maintenance.

Studies indicate that areas covered by as little as 10-20% vegetation become unsuitable habitats for Terns (Crawford et al. 2003). It was concluded that islands whose height allows for yearly flooding at the 30,000-40,000 cubic feet/second will be naturally scoured of vegetation to an acceptable minimum coverage for terns. It is suspected that even these improved islands will eventually support significant vegetation over time and will require maintenance. Nesting occurs in the area of the proposed Creek Turnpike Low Water Dam.

3.2.3 PIPING PLOVER

The Piping Plover is listed as a federally threatened species. Historically, piping plovers breed along the Atlantic Coast, around the Great Lakes, and on the Northern Great Plains. Piping Plovers winter along the southern Atlantic and Gulf Coasts. They can also winter in the Bahamas and West Indies (Peterson, 1980). Although drastically reduced, remnant populations occur throughout their historic range. Piping Plovers migrate through Oklahoma each spring and fall. This species could use the Arkansas River as a waypoint between its breeding grounds in the Northern Great Plains and wintering grounds on the Gulf Coast (USFWS, 2004). Migration periods include April-May, and August-September. As they migrate they use mudflats, sandbars, and wet open fields for resting. Plovers feed on beetles, spiders, crustaceans, mollusks and other small aquatic animals.

3.2.4 AMERICAN BURYING BEETLE

Critical habitat for this insect has not been designated. It is thought to be a habitat generalist, occurring from oak forests and open grasslands to edge habitat. This beetle buries small vertebrate carcasses in the ground. Eggs are then laid adjacent to the carcass and upon hatching feed upon this food source. Any terrestrial habitat which supports small vertebrates could possibly support the Burying Beetle.

3.3 SPORT FISHERIES

The Arkansas Rive Corridor project area supports a variety of sport fish. Striped bass, paddlefish, sand bass, largemouth bass, catfish, and sunfish are the major sport fish pursued. The ODWC would like to ensure the current role of the states sport fisheries program within the project area (ODWC, 2004). Project designs which jeopardize the striped bass collection point at Keystone Dam may meet resistance from the ODWC. Project designers are encouraged to coordinate with the ODWC to develop a system that protects this states' resource.

3.3.1 Striped Bass

This species is native to the Atlantic Ocean and adapted to reservoirs of the central United States. Serving as an excellent sport fish, the striped bass has been aggressively stocked in reservoirs within the region of the project. The striped bass prefers to feed in large schools in open water and can weigh as much as 40 lbs. but are generally much smaller. Their diet consists of shad, minnows, and insects. Although these fish can be stocked in reservoirs, they require moving water for successful reproduction. Striped bass move upstream to lay their eggs. The eggs then tumble down river, absorbing oxygen until the embryo matures and the fry can swim on their own. If an egg gets stranded in a pooled water habitat, it will sink to the bottom and suffocate. Successfully reproducing populations of striped bass occur in Keystone Lake and Lake Texoma, and in the Arkansas River Navigation System (ODWC, 2004).

Striped bass within the project corridor respond to positive flows and travel upstream in the spring to lay their eggs. Without a fish passage to allow for continued upstream migrations, the Keystone Dam has become a collection point for this species (ODWC, 2004). Collected fish are used to live stock bodies of water throughout Oklahoma and for hatchery operations which require eggs and milt. Lake Texoma has been an alternative site for collecting this species. However, Lake Texoma has suffered harmful algal blooms (HABs) caused by the species known as the golden alga. These HABs result in localized fish kills due to toxins produced by the abundance of the golden alga. The Keystone Dam location is now the primary collection area for this species.

Fish sampling data from the existing Zink Lake has revealed no striped bass. This would indicate that striped bass habitat needs are not met and the dam is inappropriately designed for striped bass usage and fish passage. The ODWC recommends that a study of fish passage and

future spawning practices be completed for the assessment of low water dams within the corridor.

The ODWC offers a cost-share plan that would match 25% of the installation of an angling access point. If dams are designed with angling access points, this would be a good source for funding (ODWC, 2004).

3.3.2 PADDLE FISH

In 1989 the USFWS was petitioned to list the paddlefish, (*Polyodon spathula*), as threatened under the Endangered Species Act. Lack of information for this petition resulted in no action taken. Currently the paddlefish is a "species of concern" within Oklahoma. Paddlefish run the Arkansas River in spring and have been collected from the Keystone Dam area. These fish are termed "living fossils." Having changed little from their fossilized imprints dating back to the age of dinosaurs, these fish are cartilaginous, like a shark, but feed on zooplankton. Historically, they occur in the big river regions of the Mississippi and its tributaries. In springtime, the paddlefish swims up tributaries of the larger bodies of water they reside in to find gravel bars for spawning. After spawning, they return to deeper, slower moving water for the remainder of the year (ODWC, 2004).

The Arkansas River supports a population of paddlefish which are termed as "self-sustaining" (ODWC, 2004). This means that the paddlefish are naturally reproducing within this river system. This is of importance because many populations of paddlefish in the Midwest are not able to sustain themselves and rely on put and take methods of population control. Paddlefish can weigh up to 100 pounds and can be trapped in the pooled environments when the Keystone Dam in releasing little or no water

3.3.3 GOLDEN ALGAE

The Golden Alga (*Prymnesium parvum*) is a microscopic flagellated algae that typically occurs in estuarine waters around the world. It is unknown whether it is native to inland bodies of freshwater. Since 1985 Texas has documented this organism occurring in reservoirs. Under certain environmental stresses, this alga can produce toxins which can cause massive fish and bivalve kills. There is no evidence these toxins harm other wildlife or humans. It is not known whether pooled water created by the dams will accommodate this species or exactly what triggers the harmful algal blooms (HABs).

3.3.4 ZEBRA MUSSELS

An invasive species, this mussel can quickly populate an area causing a variety of problems. This species (*Dreissena polymorpha*) can cluster together at densities of thousands per square

meter. Zebra mussels can clog water inlet pipes of municipal or industrial facilities. Native species of mussels are displaced and species diversity is lowered. The zebra mussel has been documented to occur in Lynn Lane Lake, Tulsa, OK. It is unknown whether the creation of dams will support a population of zebra mussels.

3.4 OTHER SPECIES

This section will focus on those peripheral species which have prevalent economic and recreational benefits. Birds seem to comprise the bulk of these peripheral species, including shorebirds, migratory fowl, and neotropical migrants.

Tulsa lies within the Central Flyway of the U.S. This is described as the land lying between the Mississippi Valley and the Rocky Mountains. The flyway is utilized by three main groups of bird species; shore birds, migratory waterfowl and neotropical migrants. An active chapter of the Audubon Society is located in Tulsa County. The Chapter's Christmas Bird Count Survey from 2003 documented 107 species utilizing the Arkansas River Corridor and project area.

3.4.1 SHORE BIRDS

These birds are known for their formidable distances traveled during migration. Wintering on the coastal range of the southern U.S. and even in South America, the summer range of these birds lies in the northern reaches of Canada. They lay a few eggs, usually in shallow depressions on the ground. Feeding mainly on invertebrates that live on mudflats, these birds require non-vegetated expanses in which to nest and feed on. The complex of sandbars offered by the Arkansas River may be used by a variety of migrating shore birds. Loss of this habitat would affect this group of birds the most. Although sandy expanses are locally common, similar habitats of this magnitude are few and far between and should be viewed as "stepping stones" for these migrating birds.

3.4.2 MIGRATORY WATERFOWL

Economically important to most states hunting programs, these birds' migration routes are a little less dramatic than those of the shorebird. The Central Flyway is the conduit through which the waterfowl of Oklahoma pass. The diet of waterfowl ranges from invertebrates, to plant seeds, to fish. Usually nests are created, either on the ground or in hollow trees, and about half a dozen eggs are laid. A variety of aquatic habitats are used by migrating waterfowl. Ponds and wetlands are their preferred choice, backwaters of river systems.

3.4.3 NEOTROPICAL MIGRANTS

Neotropical migrants are described as birds that breed in the United States and Canada during spring/summer and winter in Mexico, Central America, South America and the Caribbean. These include over 160 species of songbirds found in the U.S. There are recreational activities

associated with this group of birds including bird feeding and bird watching. They make nests in trees and lay about four eggs per clutch. Their diet consists of insects, fruits, seeds, etc. Dense stands of vegetation, undisturbed grasslands, forests, etc. provide habitat for these birds. The riparian corridor in the project area is used for resting, nesting and feeding.

4.0 OPPORTUNITIES AND CONSTRAINTS

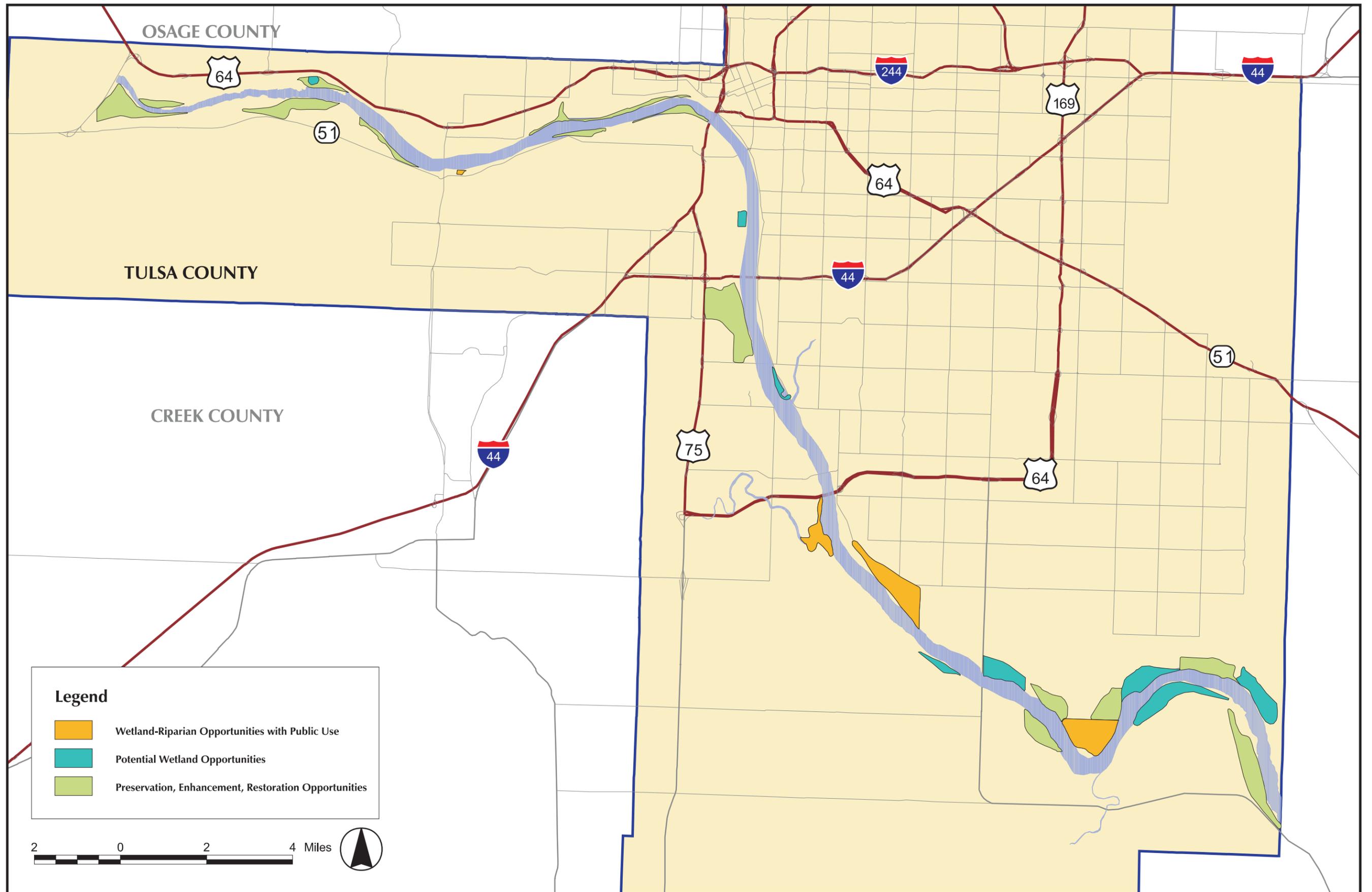
The following is a discussion of the ecological opportunities and legal constraints in the project area. Ecosystem restoration, mitigation, and recreational opportunities have been identified (Table 4). Ecological constraints include impacts to threatened and endangered species, and flora and fauna impacts that may be associated with project implementation (Table 5). Legal constraints discussed include the regulatory permits that may be required for impacts to ecological resources (Table 6).

4.1 MITIGATION OPPORTUNITIES

Ecosystem restoration opportunities in the Arkansas River Master Plan project area include the creation of aquatic habitats, riparian corridor enhancement, and wetland restoration. Recreational opportunities such as trails and river access are also discussed. Table 4 addresses restoration activities. Figure 2 depicts the location of potential restoration and enhancement opportunities.

Table 4
Restoration Opportunities in the Project Corridor

| Resource Opportunity | Restoration Measure | Benefits |
|-----------------------|---|--|
| Recreation | Construction of trails, boat ramps, wildlife viewing observation points, whitewater kayaking rapids, riverside picnic, parking and camping areas. | General public use including; boating, kayaking, fishing, birding, and educational opportunities |
| Wetlands | Restoration, enhancement and creation of wetlands adjacent to 3,948 acres of existing water resources and within the existing 9,176 acre floodplain of the river. | Floodwater runoff detention, nutrient recycling and waste assimilations, and filtration of sediments into the Arkansas River |
| Aquatic Habitat | 1) Creation of pools with up to eight potential low water dams and pedestrian crossings. 2) Creation of in-stream island and sandbar habitats. | Improved sport fish opportunities and the development of island habitat for use by least tern and migrating shorebirds |
| Riparian Enhancements | 1) Preserve and enhance approximately 3,700 acres of existing riparian corridor. 2) Restoration opportunities within 9,200 acres of floodplain. | Stream shading, contaminant filtration, reduced nutrient load to adjacent aquatic resources, reduced erosion, increased riparian wildlife habitat, improved aquatic food webs and recreational opportunities |



RESTORATION OPPORTUNITIES

FIGURE 2



4.1.1 AQUATIC HABITAT

Eight potential low water dams were identified in the Phase I Vision Plan. Creation of pools, sandbar islands, and fish passage through low water dams could benefit area wildlife. The creation of sandbar islands may result in nesting habitat for interior least tern and usage by migrating piping plover. Fish passage through the low water dams would provide continuation of the annual paddle fish spawn and other fish species interactions.

4.1.2 RIPARIAN CORRIDOR RESTORATION

The project area consists of approximately 3,700 acres of existing forested riparian corridor. Enhancements to the riparian areas along the corridor may include; enhancements to the existing 3,700 acres of existing riparian bottomland hardwoods and/or restoration of historic riparian bottomland hardwoods. Riparian corridor restoration could be accomplished in the 9,200 acres of floodplain currently used for agricultural purposes. Riparian enhancements would provide stream shading, contaminant filtration, reduced nutrient load to adjacent aquatic resources, reduced erosion, increased riparian wildlife habitat, improved aquatic food webs and recreational opportunities. Riparian corridor restoration/enhancement should provide nesting and roosting benefits to the federally threatened bald eagle.

4.1.3 WETLANDS

Restoration, enhancement and creation of wetlands adjacent to 3,948 acres of existing water resources and within the existing 9,200 acre floodplain of the river may provide the benefits of floodwater runoff detention, nutrient recycling and waste assimilations, and filtration of sediments into the Arkansas River.

4.1.4 RECREATION

Construction of trails, boat ramps, wildlife viewing observation points, whitewater kayaking rapids, riverside picnic, parking and camping areas may all be components of project mitigation. Incorporation of these amenities would provide a unique opportunity to incorporate nature-related recreational and aesthetic benefits to Tulsa County.

4.2 ECOLOGICAL CONSTRAINTS

Ecological constraints for protected species, sport fishes, and introduced species are discussed below. Table 5 identifies potential ecological constraints.

Table 5
Ecological Constraints in the Project Corridor

| Constraint / Species | Design Considerations |
|--|--|
| Impacts to Sensitive Species in the Project Area | May require Section 7 Consultation and issuance of an Incidental Take Permitting by the U.S.F.W.S. |

| | |
|---|--|
| Bald Eagle (Federally Threatened) | Many acres of bald eagle nesting habitat are known to exist in the corridor |
| Interior Least Tern (Federally Endangered) | Construction of dams removes the sandbar habitat from within the corridor |
| Piping Plover (Federally Threatened) | Construction of dams removes the mudflats and sandbars that the piping plover may frequent during winter and summer migrations through the area |
| Paddle Fish (Species of Concern) | Construction of dams restricts the annual spawn of paddlefish below the Keystone Dam. The current spawning impediment. |
| Golden Algae Blooms | Has the potential for mass fish kills in impounded areas. |
| Zebra Mussels | Known to occur in Tulsa County. May clog municipal and industrial intake structures and reduce species diversity in impounded areas. |
| Striped Bass | Increased numbers resulting from dam construction may impact native fish populations |
| Floodplain/Floodway Alterations | Extensive alterations to the floodplain/floodway resulting from the construction of dams could result in substantial habitat, species and human impacts. |

4.3 LEGAL CONSTRAINTS

The Arkansas River Corridor project should be completed in full compliance with applicable environmental statutes and regulations. Table 6 includes a summary of the applicable environmental statutes and regulations that may be required for project implementation (USACE, 2000).

Table 6
Applicable Environmental Statutes and Regulations

| |
|--|
| Archaeological and Historic Preservation Act, 1974, as amended, 16 U.S.C. 469 |
| Clean Air Act, as amended, 42 U.S.C. 7609 |
| Clean Water Act, 1977, as amended (Federal Water Pollution Control Act), 33 USC 1251 |
| Endangered Species Act, 1973, as amended, 16 USC 1531 |
| Farmland Protection Policy Act, 7 USC 4201 |
| Federal Water Project Recreation Act, as amended, 16 USC 460-1-12 |
| Fish and Wildlife Coordination Act, as amended, 42 USC 661 |
| Land and Water Conservation Fund Act, 1965, as amended, 16 USC 4601 |
| National Historic Preservation Act, 1966, as amended, 16 USC 470a |
| National Environmental Policy Act, as amended, 42 USC 4321 |
| Rivers and Harbors Act, 33 USC 401 |

| |
|--|
| Watershed Protection and Flood Prevention Act, 16 USC 1001 |
| Wild and Scenic Rivers Act, 16 USC 1271 |
| Water Resources Planning Act, 1965 |
| Floodplain Management (E.O. 11988) |
| Protection of Wetlands (E.O. 11990) |
| Environmental Health and Safety (E.O. 13045) |

5.0 ADDITIONAL STUDIES REQUIRED

In conversations with various state and federal agency representatives, a variety of project studies were discussed. These studies, to be completed by their respective agencies, would measure the ecological impact of the dams before their construction. This assists in all aspects of avoidance, minimization, and mitigation. Such studies include the following topics:

- Habitat Assessments for existing planned restoration projects.
- Fish movement up the corridor according to the dams design to accommodate fish passage.
- The effects of dams on the creation of new sand bars down river.
- Angling benefits of stripped bass fisheries in the pools.
- Golden Alga blooms in the pools.
- Amount of food available to terns nesting on artificial islands.
- Paddlefish – concerns and design constraints.
- Impact on stripped bass collection point at Keystone Dam.
- How would a series of dams affect flood capacity in the corridor?
- How will maintenance be funded?
- Locations for angling access areas.

6.0 REFERENCES

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