Whooping Crane Likelihood of Occurrence Report

Cimarron Wind Energy Project – Phase 1
Gray County, Kansas

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1.0 INTRODUCTION

CPV Cimarron Renewable Energy Company, LLC (CPV) is currently developing plans for a wind energy facility in Gray County, Kansas (Figure 1). One environmental element that is investigated when developing wind energy facilities in parts of the Great Plains is the likelihood of the federally endangered whooping crane (*Grus americana*) to be present in or migrate through a project area. The whooping crane migrates through portions of Kansas during spring and fall. Whooping cranes have been killed by collisions with power lines, and the International Whooping Crane Recovery Plan (hereafter, Recovery Plan) lists construction of power lines, fences, and other structures in the migration corridor as a threat to the species (Canadian Wildlife Service [CWS] and United States Fish and Wildlife Service [USFWS] 2007). Thus, prior to the construction of wind turbines, an investigation of whooping crane likelihood should be conducted.

CPV contracted Tetra Tech EC, Inc. (Tetra Tech) to conduct a landscape-scale analysis to assess the potential occurrence of whooping cranes within the Cimarron Wind Energy Project – Phase 1 (WEP). The objective of this likelihood of occurrence analysis is to evaluate the biological and landscape features within the WEP to determine the potential for whooping cranes to occur. Certain landscape features may increase the likelihood of whooping crane occurrence during migration. Thus, Tetra Tech developed a likelihood index to evaluate the WEP based on its location in the migration corridor, the availability of habitat within the WEP compared to the surrounding landscape, and the presence of feeding and roosting sites. The likelihood index does not predict how many whooping cranes will occur in the WEP; rather it scores the site based on a suite of variables that are related to whooping crane occurrence. Higher scores denote higher potential likelihood of occurrence. This assessment tool is not intended to replace field surveys. However, given the low probability of detecting a whooping crane during field surveys, thereby minimizing their utility to document presence or absence from a given area, this assessment tool was designed to take advantage of available data.

2.0 LEGAL STATUS OF THE WHOOPING CRANE IN THE UNITED STATES

The whooping crane is protected by both state and federal laws in the United States. It was considered endangered in the United States in 1970 and the endangered listing was 'grandfathered' into the Endangered Species Act (ESA) of 1973, which prohibits "take" (CWS and USFWS 2007). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. §1532(19)). "Incidental take" occurs when take of an ESA-listed species occurs as an unintended consequence of an otherwise legal activity, as would be the case in the event of a fatality occurring at a wind farm. To Tetra Tech's knowledge, no wind power developer or utility has been prosecuted for crane collisions with transmission lines, despite at least 46 known fatalities or serious injuries. The whooping crane is also considered a state-endangered species by the Kansas Department of Wildlife and Parks (KDWP 2008).

If the potential for take exists, the first step is to consult with the USFWS to assess the potential risk and discuss strategies to minimize risk. If it is determined that project development may affect whooping cranes, formal consultation will need to be initiated with the USFWS under Section 7 of the ESA if the Project has a federal nexus or under Section 10 of the ESA if there is no federal nexus. Under a Section 7 consultation, the USFWS must have a finding of no jeopardy in order to concur with the ESA. Under a Section 10 consultation, the applicant develops mitigation and conservation plans to offset losses due to the proposed project by way of a habitat conservation plan (HCP), at which point the USFWS will issue an incidental take permit if they are in agreement. Currently, there are no incidental take permits or habitat conservation plans for the whooping crane. The USFWS is working with the American Wind Energy Association and a group of wind developers, including CPV, to develop a bi-regional HCP.

The whooping crane population in North America has experienced sharp declines and disappearance from most of its historic range (CWS and USFWS 2007). The number of whooping cranes in North America prior to 1870 is estimated to have been between 500 and 1,400 individuals (Allen 1952, Banks 1978), but some biologists suggest that the population may have numbered as many as 10,000 individuals (CWS and USFWS 2007). Activities such as habitat destruction, hunting, and displacement due to anthropogenic activities likely lead to widespread population declines (CWS and USFWS 2007). One self-sustaining wild population of whooping cranes currently exists in the world. Members of this population breed primarily within the boundaries of Wood Buffalo National Park in Canada and migrate through the central United States in route to the wintering grounds at Aransas National Wildlife Refuge along the Gulf Coast of Texas. This flock is referred to as the Aransas-Wood Buffalo National Park Population. Due to intensive management, this population has increased from 15 birds in 1941 to 263 as of the start of spring migration in 2010 (WCCA 2010).

3.0 PROJECT AREA DESCRIPTION AND ENVIRONMENTAL SETTING

3.1 Project Area Description

The WEP is located on approximately 12,000 acres of privately owned rural land under easement with CPV in Foote Township, an unincorporated portion of Gray County (Figure 1). The WEP area is located southwest of central Kansas, approximately 1.5 miles north of the City of Cimarron (the seat of Gray County), 11 miles northwest of Dodge City, and 14 miles east of Garden City. The WEP area is characteristic of this region, with the majority of the land surface currently covered by agriculture, rangelands, and native prairie. The area contains some small playa wetlands that consist of shallow, vegetated depressions. Residences and abandoned farmsteads are scattered throughout the WEP. Patches of trees and shrubs exist throughout the WEP, and are found primarily between agricultural fields, in drainages, and as shelter belts around homesteads and between agricultural fields.

3.2 Environmental Setting

The proposed WEP is located in southwestern Kansas in Gray County. The regional topography is characterized as relatively flat with some shallow stream drainages and a range in elevation from about 2,700 to 2,800 feet above mean sea level (Tetra Tech 2008). The United States Geological Survey (USGS) 1:100,000 scale quadrangles for the region is the Dodge City Quadrangle. Land use is predominantly dry-land farming of corn and sunflowers interspersed with cattle grazing.

4.0 WHOOPING CRANE BIOLOGY

The whooping crane is a long-lived species that may reach 28 years old in the wild (Binkley and Miller 1983). Individuals reach sexual maturity at 3 to 5 years of age and form life-long breeding pairs while on the wintering grounds or during spring migration (Stehn 1997, CWS and USFWS 2007). Whooping cranes have low annual reproductive output. Females typically lay 2 eggs, but only 10 percent of families arrive on the winter grounds with 2 chicks because the smaller chick usually dies within the first two weeks after hatching (CWS and USFWS 2007). The juveniles become independent of the parents on the wintering ground prior to spring migration. Sexually immature individuals (i.e., subadults) return to the breeding grounds where they may remain solitary or congregate in small groups on the periphery of breeding pairs (CWS and USFWS 2007).

4.1 Reasons for the Population Decline

Populations of long-lived species with low annual reproductive output such as the whooping crane are sensitive to changes in adult survival (Stahl and Oli 2006). Hunting, especially during spring migration, from 1870 to 1930 resulted in 274 documented whooping crane fatalities (Allen 1952). In addition, Hahn (1963) tallied 309 mounts and 9 skeletons in museum collections throughout the world. Because many of these specimens do not contain information regarding the date and location of collection, it is unlikely

that the majority were collected by museum personnel. It is possible that mortality from shooting exceed annual production of juveniles during the early 1900s (CWS and USFWS 2007).

Degradation and loss of breeding habitat eliminated the whooping crane from much of its core breeding range in North America. Whooping cranes once bred from the southern edge of Lake Michigan north through southern Minnesota to northeastern North Dakota through Manitoba, Saskatchewan, and Alberta (Allen 1952). Conversion of prairie and pothole ecosystems to agriculture and ranching made much of the breeding habitat unsuitable (CWS and USFWS 2007). Due to their high degree of site and route fidelity (i.e., the tendency to use the same geographic locations and migratory routes over time), members of the Aransas-Wood Buffalo Population are unlikely to recolonize, without the intervention of humans, parts of the historic whooping crane range in North America that fall outside of the current migratory corridor.

4.2 Threats to Whooping Cranes

Due to its small population size and concentration of all members of the Aransas-Wood Buffalo National Park population at breeding and wintering locations, there are several factors which may threaten the whooping crane (CWS and USFWS 2007). These include human settlement and development, habitat loss, hunting, disturbance, disease, and predation. Threats to the whooping crane that are related to wind power development include collision with power lines, fences, and other structures, and loss and degradation of stopover and wintering habitat (CWS and USFWS 2007; USFWS 2009).

Power lines pose a threat to whooping cranes when they are located in the vicinity of foraging or roosting habitat because individuals often fly at low altitudes (33 to 49 feet above the ground) when moving among sites (CWS and USFWS 2007; Stehn and Wassenich 2008). The majority of documented fatalities during migration are due to collision with power lines. Since 1956, 46 whooping cranes have been killed (91% of collisions) or seriously injured (9% of collisions) as a result of collisions with power lines (Stehn and Wassenich 2008). The majority of confirmed power-line fatalities have occurred within the experimental populations that are maintained by the introduction of captive-reared young; power-line fatalities have also been reported for the Aransas-Wood Buffalo National Park population (at least 7 fatalities and 2 serious injuries).

Although whooping crane mortality has not been attributed to wind turbines, the Recovery Plan considers wind power development within the whooping crane migration corridor a threat because of the construction of power lines and associated structures (CWS and USFWS 2007). It is unknown how whooping cranes will respond to the presence of wind turbines. The USFWS (2009) holds the opinion that whooping cranes will avoid stopping at areas with operational wind turbines; thus, behavioral avoidance of wind farms by whooping cranes may reduce the probability of collision, but may amount to loss of stopover habitat.

5.0 WHOOPING CRANE MIGRATION

Whooping cranes undertake a 5,000-mile round-trip migration from the breeding area in Canada to the wintering area in Texas every year. Individuals depart the breeding ground in Canada and travel south through Alberta, Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and reach the wintering ground on the Texas coast. The migration route is well defined and 94 percent of all observations occur within a 200-mile wide corridor during spring and fall migration (CWS and USFWS 2007, Figure 2).

During migration, whooping cranes can occur where suitable habitat is available. Some sites in the migration corridor are used consistently and have high annual use. Four traditional stop-over sites are found in Nebraska (Platte River), Kansas (Cheyenne Bottoms Wildlife Management Area, Quivira National Wildlife Refuge), and Oklahoma (Salt Plains National Wildlife Refuge). These sites are designated as critical habitat under the Endangered Species Act (CWS and USFWS 2007).

5.1 Fall Migration

Whooping cranes depart the breeding grounds at Wood Buffalo National Park in mid-September. Birds may travel alone, in pairs, in family groups, or in small flocks (Johns 1992). Individuals travel southeast about 300 miles to the major staging area in Saskatchewan, where they may remain for 2 to 4 weeks before resuming migration. During fall migration, birds may stay at traditional stopover sites for 7 to 10 days, but stays as long as 6 weeks have been documented at Quivira National Wildlife Refuge (CWS and USFWS 2007). The majority of whooping cranes reach the wintering grounds by mid-November. In Kansas most sightings occur from early October to mid-November; peak migration occurs around October 27 (Austin and Richert 2001).

5.2 Spring Migration

Whooping cranes depart the wintering ground at Aransas National Wildlife Refuge in late March; the last birds depart in May. Breeding pairs are typically first to depart and migration is facilitated by winds from the southeast. There is no known staging area in spring as there is in fall, and migration is completed in 2 to 4 weeks. Traditional stopover sites that are used in fall are also used in spring. However, individuals spend fewer days at stopover sites during spring migration. Whooping cranes travel through Kansas from late March to early May; peak migration occurs around April 12 (Austin and Richert 2001).

5.3 Migration Flight Behavior

Whooping cranes are diurnal migrants and primarily fly by using static soaring, but low-level flapping flight may be used when conditions dictate. Migration is initiated after the air has warmed and thermal updrafts are present. Individuals spiral upwards on thermals of warm air to heights of 1,000 to 6,000 feet (Kyut 1992), then enter into long, descending glides. This process is repeated throughout the day until suitable habitat is reached. Static soaring is energy efficient as birds seldom flap after they are airborne. Whooping cranes may travel up to 500 miles per day in ideal conditions; during average conditions they may travel 250 miles per day (Stehn and Wassenich 2008). During the end of the diurnal migration flight, individuals will enter long descending glides and use flapping flight at lower altitudes until they reach suitable roosting and feeding habitat. Whooping cranes do not regularly migrate during unfavorable weather conditions such as a strong headwind, rain or other precipitation, or overcast conditions. When visibility is poor, individuals use flapping flight at lower altitudes until they reach suitable roosting or feeding habitat. Poor weather conditions can lengthen stopover duration in a given location (USFWS 2009).

5.4 Stopover Habitat Characteristics

Whooping cranes require roosting habitat when they stop during migration. They often select sites with unobstructed visibility (Austin and Richert 2001). Palustrine wetlands (freshwater wetlands characterized by emergent vegetation) are most often used as roosting sites, but individuals have been found roosting at lacustrine wetlands (wetlands around a lake), and riverine wetlands (wetlands along a river). The size of wetlands used during spring and fall migration ranges from 0.4 hectare (ha) to over 500 ha (1 – 1,200 acres), and no seasonal use patterns are evident (Austin and Richert 2001). It is noted that 75 percent of recorded roost wetlands were smaller than 4 ha (10 acres). Cranes have been observed using wetlands as deep as 10 feet; however, they generally restrict their usage of these wetlands to areas where the water depth is less than 2 feet (Austin and Richert 2005). Southwestern Kansas undergoes annual cycles of very wet to very dry conditions (NOAA 2009). The suitability and amount of roosting sites can vary depending on the amount of precipitation in the region as precipitation can affect the amount of emergent vegetation and size of the wetland which can influence the suitability of a site for roosting.

Whooping cranes forage in wetlands and agricultural fields during migration and may travel between roosting and feeding areas. Palustrine wetlands are used most often when whooping cranes forage in wetlands, but lacustrine and riverine have also been used as feeding sites (Austin and Richert 2001).

Among agricultural crops used as feeding sites, use of winter wheat was higher than other crop types in fall and use of row-crop stubble (comprised mostly of corn) was higher in spring than other crop types (Austin and Richert 2001). Whooping cranes have also been observed feeding in sorghum, sunflower, and soybean stubble (Austin and Richert 2001). Feeding sites are often found adjacent to roosting sites. For example, 94.9 percent and 72.9 percent of roosting sites were within 0.62 mile of feeding sites in spring and fall, respectively (Johns et al. 1997; USFWS 2009).

6.0 ASSESSMENT OF WHOOPING CRANES LIKELIHOOD OF OCCURRENCE

The USFWS (2009) holds the opinion that whooping cranes will avoid stopping at areas with operational wind turbines. The primary threats of wind energy development to whooping cranes are loss of habitat and mortality due to collision with transmission lines and associated structures. Because of the high levels of concern regarding whooping cranes, the ability to evaluate the risk to whooping cranes at individual wind project areas is a critical component to understanding the environmental impacts of a proposed wind facility. If avoidance by the whooping crane of a previously utilized area occurs, the area occupied by the wind facility would constitute stopover habitat loss. Here, Tetra Tech presents a method (one that has been used in multiple ESA-related consultations) to evaluate the likelihood of whooping cranes to occur at the WEP located in southwest Kansas. This evaluation method incorporates the location of the project in the migration corridor, the availability of habitat within the WEP area compared to the surrounding landscape, and the presence of feeding and roosting sites (Table 1). Tetra Tech expects whooping cranes to be more likely to occur over the life of a project at projects with high scores. Tetra Tech calculated scores for each parameter and, based on desktop modeling of variable weights, assigned the following likelihood of occurrence rankings: Low (0-3); Moderate (4-8); High (8+). This assessment tool is not intended to replace field surveys. However, given the low probability of detecting a whooping crane during field surveys, thereby minimizing their utility to document presence or absence from a given area, this assessment tool was designed to take advantage of available data.

6.1 Location of a WEP in the Migration Corridor (L)

Biological Justification

The United States Geological Survey (USGS) has compiled a report documenting the locations and habitat of whooping cranes during migration from 1943-1999 (Austin and Richert 2001). These observations indicate that a whooping crane, or group of whooping cranes, was seen at some point between 1943 and 1999. The USFWS has produced an updated map showing the location of whooping crane observations though 2008 (Figure 2). It is important to note that while these are the best data available, they are largely non-standardized and incidental; as such these data are not suitable for assessing habitat preferences or shifts in migration patterns.

The location of a potential wind facility influences the likelihood of whooping crane occurrence due to the well-defined migratory pattern of the cranes. The median location of all crane observations was statistically derived and was used to describe the migration route from the breeding grounds to the wintering grounds (CWS and USFWS 2007). Buffers were then calculated based on the percentage of observations (Figure 2). For example, 75 percent of all observations occurred within the 75-percent buffer. If two sites are compared, whooping cranes are more likely to stop over at a site within the 75-percent buffer than at a site outside the 95-percent buffer.

Scoring

Tetra Tech developed scores for the location of a WEP based on the percent of observations within each buffer. If a WEP fell within the 75-percent buffer, it was scored 7.5. If a WEP fell between the 75-percent and 95-percent buffers, it was scored 2.0 because 20 percent of all observations occur between these buffers. If a WEP fell outside of the 95-percent buffer, it was scored 0.5 because 5 percent of all observations occur outside the 95-percent buffer.

Assumptions

- The likelihood of whooping crane occurrence in the future will not deviate from the patterns observed through 2008.

- If a portion of the project fell on the boundary of a buffer or in two buffers, the project was assumed to be within the buffer closer to the middle of the migratory corridor.

6.2 Attractiveness on the Landscape (A)

Biological Justification

Wetlands are used by whooping cranes for feeding and roosting and the amount of wetlands within a given area compared to the surrounding landscape may influence whooping crane use of a site during migration. After whooping cranes have descended from migration flight altitudes, they may travel up to 35 miles in search of suitable roosting habitat (USFWS 2008). Therefore, Tetra Tech determined if a project contained a higher proportion of wetlands than was found within the 35 miles surrounding the project to determine if the WEP is more attractive than the surrounding area.

Scoring

Tetra Tech used National Wetlands Inventory (NWI) data (USFWS 2006) and National Land Cover Database data (USGS 2007) to determine the total acreage of wetlands within the WEP and within 35 miles of the WEP. The use of multiple data sources will help avoid the limitations of any one data source (e.g., Stahlecker 1992). Tetra Tech then calculated the proportion of the total acreage of the project that was comprised of wetlands and the proportion of the total acreage of a 35-mile area around the WEP that was wetlands (excluding the WEP). Tetra Tech divided the proportion of the WEP that was wetlands by the proportion of the 35-mile buffer that was wetlands to determine if the project contained more wetlands than the surrounding area. Tetra Tech used the ratio as the score in the likelihood index equation. If the ratio was greater than 1, the project contained more wetlands and is more attractive than the surrounding 35-mile buffer. If the ratio was equal to 1, the project contained a similar proportion of wetlands and is as attractive as the surrounding 35-mile buffer. If the ratio was less than 1, the project contained less wetlands and is less attractive than the surrounding 35-mile buffer.

Assumptions

- The distribution of wetlands in the Geographic Information System (GIS) data is an accurate representation of the location of wetlands in the project area.
- 35 miles is an appropriate scale to examine whooping crane habitat use.

Field verification

To better assess the habitat of the WEP, Tetra Tech made a two-day visit to the WEP on October 31 and November 1, 2008. The purpose of this visit was to ground truth the desktop-identified wetland locations and to evaluate the quality of the wetlands with respect to whooping crane foraging and roosting requirements. Tetra Tech made a second site visit in April 2010 to assess whether the 2008 conditions were still valid. The field verification effort ground-truthed a number of mapped wetlands previously used in the analysis and determined that many were in fact non-existent. As a result, 181 acres of wetlands were removed from the analysis as a result of these field visits.

6.3 Presence of Foraging and Roosting Sites (W)

Biological Justification

Whooping cranes often make low altitude flights between roosting and foraging habitat and are thus at risk of collision with power lines and other structures (CWS and USFWS 2007, Stehn and Wassenich 2006). Austin and Richert (2001) found that agricultural crops, especially corn, sorghum, and winter

wheat were the habitat most often contiguous to roosting areas and that most cranes traveled 0.62 mile from a roosting site to a foraging site. Therefore, wetlands located within 0.62 mile of agricultural crops form a wetland-habitat matrix that is often used by whooping cranes during migration (Austin and Richert 2001). Tetra Tech determined the proportion of the WEP that was comprised of wetland-agricultural matrix. Tetra Tech included waterbodies of any type (hereafter wetlands), but restricted the analysis to wetlands greater than 1 acre because most observations of cranes occurred at areas >1.0 acre (Austin and Richert 2001). Tetra Tech limited the analysis to crop agriculture because it is most often used for feeding habitat and restricted the analysis to agriculture >1 acre because most observations of cranes occurred in agriculture >1.0 acre (Austin and Richert 2001).

Scoring

To quantify the amount of roosting and foraging habitat in a project area, Tetra Tech used National Land Cover Database data (USGS 2007). Water features and the spatial extent of waters were verified with NWI data (*sensu* Stahlecker 1992). The GIS analysis was designed to calculate the total area of wetland-agricultural matrix, which may include other habitat types between patches of wetlands and agriculture. Thus, based on the size restrictions and spatial configuration, the total acres of wetland-agricultural matrix could be greater or less than the sum of the acres of wetland and agriculture. Tetra Tech calculated the proportion of the WEP that was wetland-agricultural matrix by dividing the total acres of wetland-agricultural matrix by the total acres of the WEP. Tetra Tech used the proportion as the score in the likelihood index; therefore, scores may range from 0 to 1.

Assumptions

- The optimal distance of foraging habitat from roosting habitat is 0.62 mile.
- Habitats not classified as suitable wetlands or agriculture are of neutral value and do not influence the availability of suitable wetlands or agriculture on the landscape.

6.4 Likelihood Index Formula (LI)

The likelihood index of whooping cranes occurring at the WEP was calculated by evaluating the landscape features in and around the WEP. Tetra Tech used the following formula to calculate the likelihood index:

$$LI_i = (L_i \times A_i) + W_i$$

Where:

- L_i = location of project in relation to the migration corridor score;
- A_i = attractiveness score, or the ratio of suitable wetlands in a project to suitable wetlands in a 35-mile area around a project; and
- W_i = wetland-agricultural matrix score.

The equation places the most weight on the location in the migration corridor because of the wide range of scores. Thus, a project within the 75-percent corridor will tend to score higher than a project within the 95-percent corridor unless the attractiveness score for the project within the 75-percent corridor is low (e.g., <0.50) or the attractiveness score for the project within the 95-percent corridor is high (>4.0), when other values are equal. Projects located outside of the 95-percent corridor will tend to score low unless the attractiveness score is high because the location score is less than 1.0.

7.0 WEP ASSESSMENT AND SUMMARY

The likelihood index score for the Cimarron Phase 1 WEP was 1.9 implying a low likelihood of occurrence, relative to the surrounding landscape (Table 2). The Cimarron WEP is located between the 75-percent and 95-percent buffers (Figure 3); therefore the Location (*L*) parameter was 2.0. A grand total of 19 historical records of 68 adults and 7 juveniles (including the sightings already mentioned) were

recorded within the 35-mile buffer (Figure 4). The percentage of suitable wetlands within the WEP is lower than the surrounding 35-mile buffer area, with a calculated Attractiveness on the Landscape (*A*) value of 0.55. Eighty-one percent of the Cimarron WEP consists of suitable wetland-agriculture matrix habitat; therefore the Presence of Feeding and Roosting Sites (*W*) value was 0.81 (Figure 4).

The annual precipitation pattern in southwestern Kansas suggests a cycle that can influence the amount and distribution of suitable whooping crane habitat in the WEP and surrounding area (Figure 5). According to the Palmer Drought Severity Index (PDSI), above average wet years in the southwestern Kansas occur during the whooping crane migration every 2-3 years. The likelihood for whooping cranes to occur on the ground in the WEP is affected by the amount of suitable habitat available. During dry seasons when habitat is not available whooping cranes, if present in the area, are more likely to fly over the WEP than land, thus avoiding the risk of collision with project facilities. The region was experiencing a relatively wet period during October-November 2008 and April 2010 during the field verification visits, suggesting that conditions were close to their maximum suitability for cranes.

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TABLES

Table 1. Parameters used in the likelihood index calculation.

Parameter	Score	Justification
Location in the Migration Corridor (L)		
Within the 75-percent buffer	7.5	75% of all whooping crane observations occur within the 75-percent buffer
Between the 75-percent and 95-percent buffers	2.0	20% of all observations occur between 75-percent and 95-percent buffers
Outside the 95-percent buffer	0.5	5% of observations occurred outside the 95-percent buffer
Attractiveness on the Landscape (A)		
Ratio of wetlands per total acreage for the WEP/ wetland per total acreage for 35-mile area not including the WEP	Actual ratio	Indicates if the WEP is similar (=), less (<), or more (>) attractive than the surrounding landscape to migrating cranes searching for roosting habitat
Presence of Foraging and Roosting Habitat (W)		
Proportion of the WEP that is a wetland-agricultural matrix	Actual proportion	Indicates the proportion of the WEP that is favored by cranes for foraging and roosting habitat

Table 2. Likelihood index score for the Cimarron WEP.

Location in the Migration Corridor (*L*)	Attractiveness on the Landscape (*A*)	Presence of Foraging and Roosting Habitat (*W*)	Likelihood Index Score (*LI*)
2.0	0.55	0.81	1.9

FIGURES

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TETRA TECH EC, INC.

Finney

FINNEY CO
HODGEMAN CO

BENTON

Hodgeman

SOUTH ROSCOE

F O O T E

GRAY CO
HODGEMAN CO
FORD CO

R O Y A L

Arkansas River

C I M A R R O N

GRAY CO
FORD CO

Arkansas River

L O C A T I O N M A P

L E G E N D

- WEP Boundary
- Highway
- State Boundary
- County Boundary

0 0.5 1 2 3 4
Miles

Scale 1:500000
(when printed on tabloid size paper)

Data Sources:
ESRI Streetmap 9.3

Figure 1.
Vicinity Map of Cimarron WEP
Phase 1

Kansas

Gray County
Kansas

CPV RENEWABLE ENERGY COMPANY, LLC

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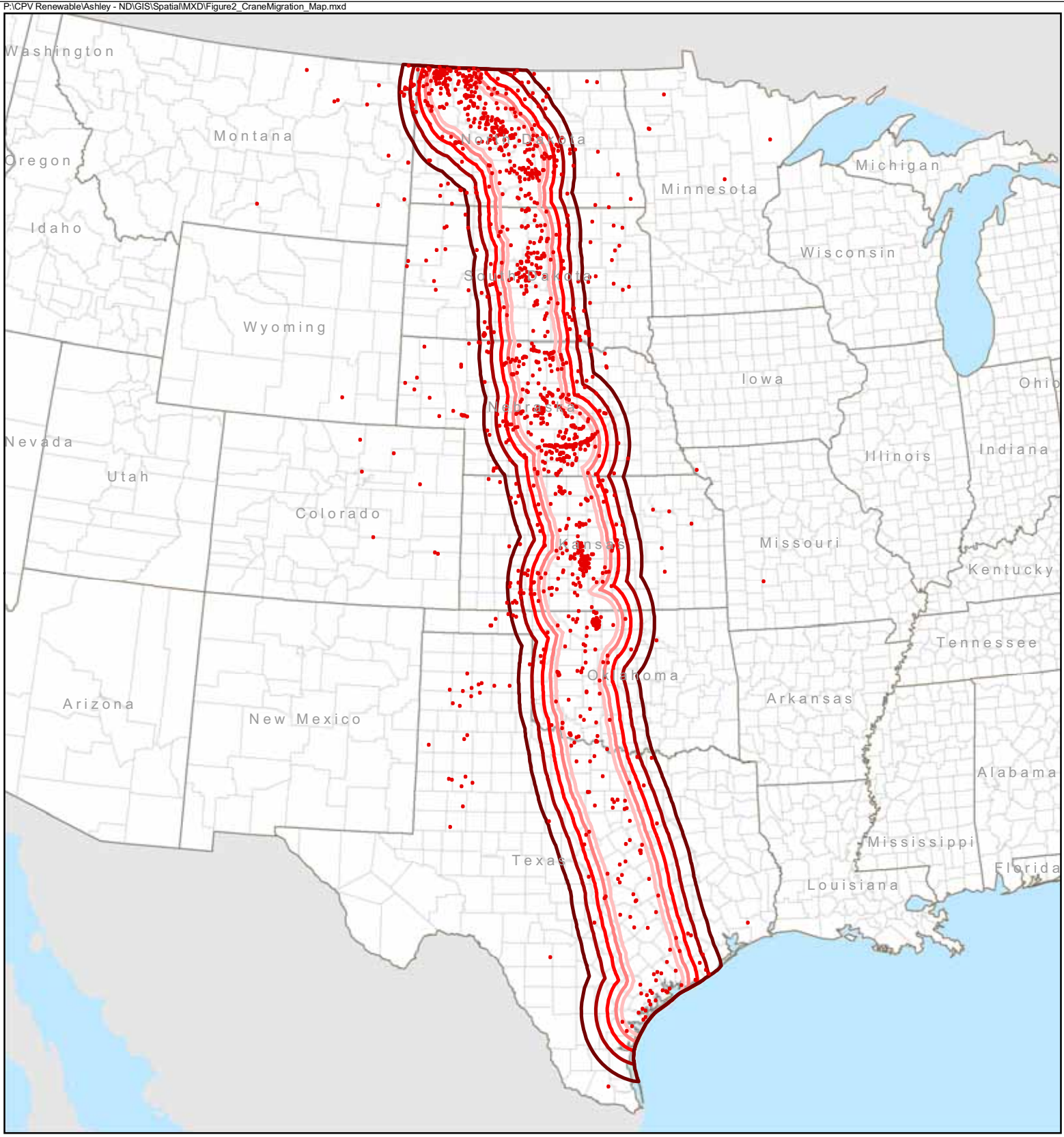

L E G E N D

State Boundary

County Boundary

Whooping Crane Sighting

Percentage of Sightings

- 75.08%
- 79.44%
- 85.04%
- 89.83%
- 94.83%

N
W E
S

0 40 80 160 240 320
Miles

Data Sources:
USGS National GAP Analysis Program
ESRI Streetmap 9.2

Figure 2.
Whooping Crane Migration Route in the United States

Competitive Power Ventures, Inc.

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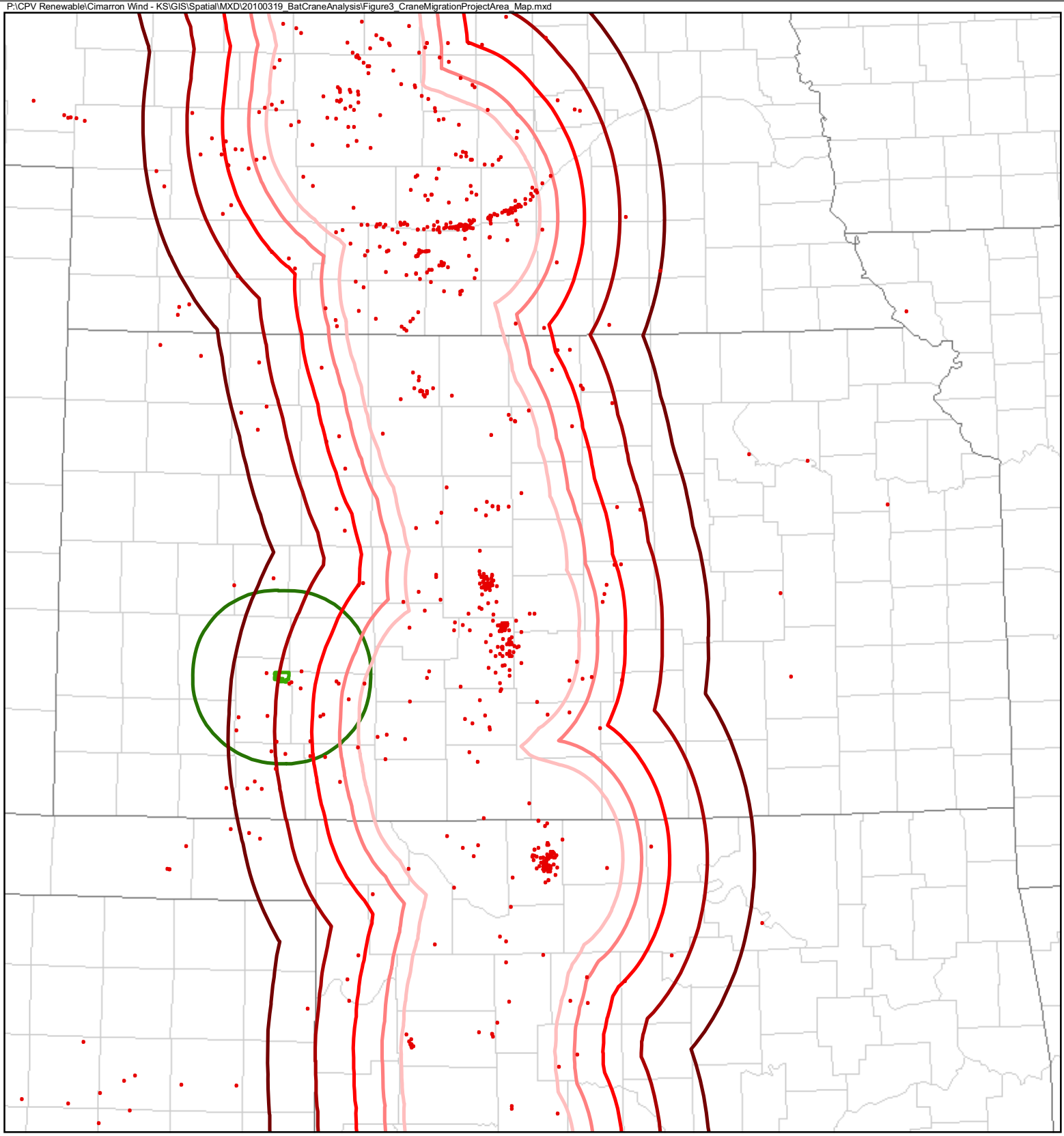


L E G E N D

Whooping Crane Sighting (1942-2007)

Percentage of Sightings

- 75.08%
- 79.44%
- 85.04%
- 89.83%
- 94.83%

WEP Boundary

35-Mile Buffer

State Boundary

County Boundary

N
W E
S

0 12.5 25 50 75 100

Miles

Data Sources:
USFWS Crane Sighting Data
ESRI Streetmap 9.3

Figure 3.
Cimarron Wind Energy Project
Phase 1
Whooping Crane Migration Map

ID	Adults	Juveniles	Total	Start Date	Site	Distance (miles)
75A-9	2	0	2	04/00/75	LAND,WATER,AIR	6.43
78A-4	0	1	1	04/03/78	LAND,AIR	29.90
78A-22	6	1	7	04/20/78	LAND,AIR	25.79
80A-20	8	0	8	04/15/80	LAND,AIR	33.37
81A-18	2	0	2	04/19/81	LAND,AIR	5.53
83B-20	2	0	2	10/20/83	LAND,WATER,AIR	3.48
83B-27	7	0	7	10/28/83	LAND,WATER,AIR	21.50
87A-5	2	1	3	04/13/87	LAND,WATER,AIR	32.52
87A-10	2	0	2	04/13/87	LAND	27.40
90B-29	3	0	3	10/28/90	LAND	20.44
90B-32	4	0	4	11/08/90	LAND,WATER,AIR	15.35
91A-8	3	0	3	04/20/91	LAND,WATER,AIR	22.34
93A-10	4	0	4	04/20/93	LAND	21.15
93A-14	13	1	14	04/13/93	LAND	20.79
95A-10	3	0	3	04/16/95	LAND,WATER,AIR	27.02
98A-2	1	0	1	02/19/98	WATER	30.79
03B-36	2	1	3	11/05/03	LAND,AIR	1.77
06B-38	2	0	2	10/30/06	LAND, WATER	1.47
06B-52	2	2	4	10/31/06	LAND, WATER	27.25

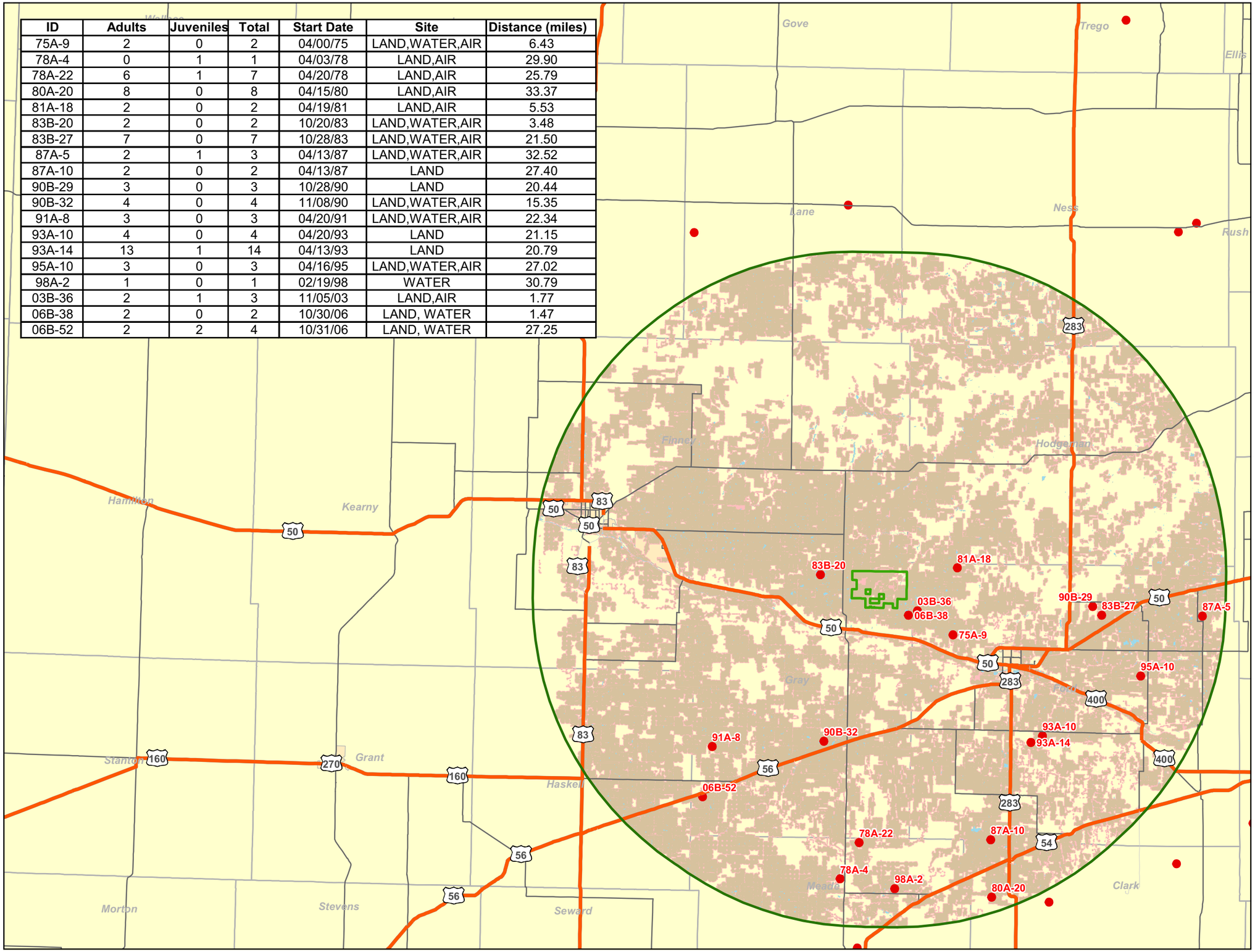


Figure 4.
Cimarron Wind Energy Project
Phase 1
Whooping Crane
Habitat Map

Gray County
Kansas

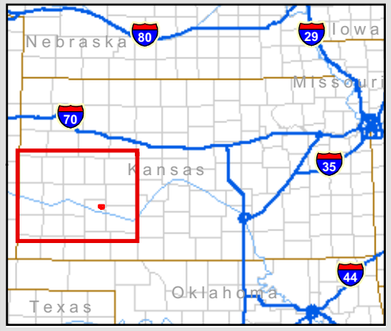
L E G E N D

- Wetland/Agricultural Matrix
- Wetland Suitable for Cranes
- Agricultural Land
- WEP Boundary
- 35-Mile Buffer
- Whooping Crane Sighting (1942-2007)
- Highway
- Major Road
- Local Road

Data Sources:
NLCD Data
NWI Wetlands
USFWS Whooping Crane Data
ESRI Streetmap 9.3

0 1 2 4 6 8
Miles

L O C A T I O N M A P



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Prepared By: william.scales
Coordinate System: NAD 1927 UTM Zone 14N

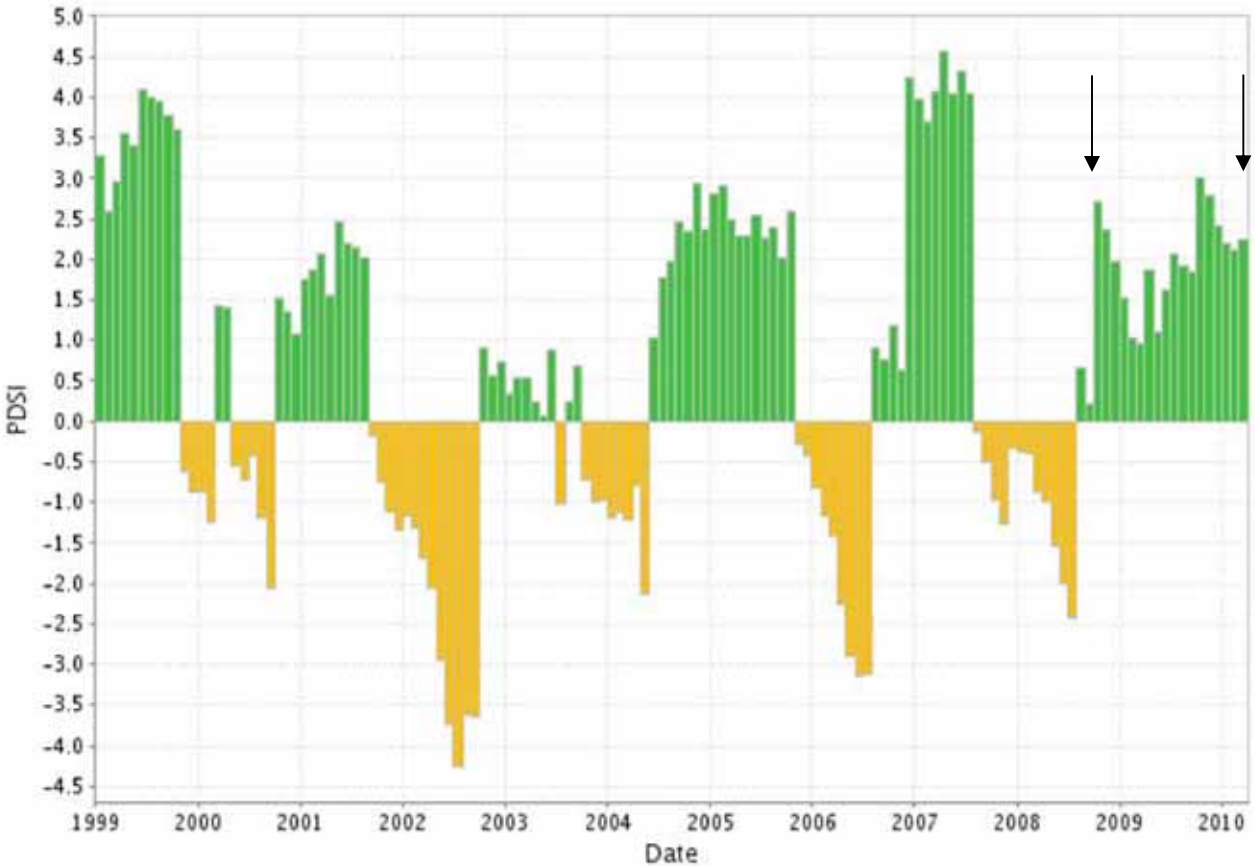

Figure 5. Palmer Drought Suitability Index (PDSI) for southwestern Kansas from January 1999 through April 2010. PHDI values 0 to -0.5 = normal; -0.5 to -1.0 = incipient drought; -1.0 to - 2.0 = mild drought; -2.0 to -3.0 = moderate drought; -3.0 to -4.0 = severe drought; and greater than -4.0 = extreme drought. Similar adjectives are attached to positive values of wet spells. The black arrows indicates the timing of the wetland field verification visits.