Appendix F: U.S. Fish and Wildlife Service Section 7 Consultation

Attachment F-1

Biological Assessment for the Monarch Warren County Wind Turbine Project

Department of Energy
Washington, DC 20585

February 22, 2011

Richard C. Nelson
U.S. Fish and Wildlife Service
Rock Island Field Office
1511 47th Avenue
Moline, IL 61265

Subject: Initiation of Formal Consultation under Section 7 of the Endangered Species Act
Monarch Warren County Wind Turbine Project, Lenox Township, Warren County, IL

Mr. Nelson,

Through this letter, the Department of Energy (DOE) is initiating formal consultation pursuant to Section 7 of the Endangered Species Act of 1973 (ESA). The DOE has provided a grant to Monarch Wind Power through Illinois' State Energy Program (administered by the Illinois Department of Commerce and Economic Opportunity), and would authorize the recipient to expend Federal funding to assist with the financing of the design, permitting, and construction of the proposed Monarch Warren County Wind Turbine Project (MWTP). The MWTP consists of twelve 1.6-megawatt wind turbines, for a combined generation capacity of 19.2 megawatts, along with associated electrical collection equipment, access roads, and an electrical substation. The proposed project would be located on approximately 600 acres of land leased in Warren County, IL, 4 miles south of Monmouth. Additional information on the proposed project, including project location figures, can be found in the attached Biological Assessment.

DOE has obtained the list of threatened, endangered, and candidate species for Warren County from the USFWS Midwest Region 3 Section 7(a)(2) Technical Assistance Website. From this list DOE has determined the following species have potential to occur in Warren County: the Indiana bat *(Myotis sodalis)* and the Eastern prairie fringed orchid *(Platanthaera leucophaea)*. Although not included in the list of threatened, endangered, and candidate species that could occur in Warren County, the USFWS Rock Island Field Office stated in a letter dated July 12, 2010, that a nonessential experimental population of whooping crane (*Grus americana*) can occur statewide in Illinois during migration.

DOE has concluded that the proposed project is likely to adversely affect the Indiana bat. Therefore, pursuant to the requirements under Section 7(a)(2) of the ESA and the USFWS implementing regulations (50 CFR Part 402), DOE is submitting the attached Biological Assessment for your review.

Based on previous discussions with your office, DOE respectfully requests that a draft Biological Opinion be provided for DOE's review within 30 days of receipt of this consultation request (approximately March 22, 2011).

Furthermore, DOE is preparing a Draft Environmental Assessment under the National Environmental Policy Act of 1969 for this project. The EA will describe the potential impacts to biological resources, including bats, raptors, and other migratory birds. DOE is seeking this formal consultation process to allow the project, which is being partially funded with American Recovery and Reinvestment Act funds, to move forward in a timely manner. DOE anticipates putting the draft EA out for public comment at the end of February. USFWS will be given the opportunity to review and comment on the Draft EA.

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DOE greatly appreciates your office's assistance in providing timely feedback on the draft BA, and your willingness to work with us in expediting this process. Please contact the DOE Document Manager Caroline Mann at 202-587-5380 or Caroline.Mann@ee.doe.gov, or myself at 513-218-4069 or Pete.Yerace@emcbc.doe.gov with any questions regarding this consultation.

Sincerely,

Pete Yerace
NEPA Compliance Officer
DOE HQ EERE

Enclosures:
Monarch Warren County Wind Turbine Project Biological Assessment

cc: Mr. Jeff Gosse, USFWS Region 3
Ms. Alyson Grady, DCEO

BIOLOGICAL ASSESSMENT

THE MONARCH WARREN COUNTY WIND TURBINE PROJECT

LENOX TOWNSHIP WARREN COUNTY, ILLINOIS

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Golden Field Office

FEBRUARY 2011

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ACRONYMS AND ABBREVIATIONS

ARRA	*American Recovery and Reinvestment Act of 2009*
BMPs	best management practices
CFR	*Code of Federal Regulations*
dBA	decibel on an A-weighted scale, used to approximate the human ear's response to sound
DOE	U.S. Department of Energy
DNR	Illinois Department of Natural Resources
EISA	*Energy Independence and Security Act*
ESA	*Endangered Species Act*
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
HCP	Habitat Conservation Plan
IGBT	insulated-gate bipolar transistor
MISO	Midwest Independent Transmission System Operator
MWP	Monarch Wind Power
MWTP	Monarch Warren County Wind Turbine Project
NEP	nonessential experimental population
SEP	State Energy Program
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
WNS	white nose syndrome

1. INTRODUCTION

1.1 Purpose of Document

The U.S. Department of Energy (DOE) is proposing to provide Federal funding to the Illinois Department of Commerce and Economic Opportunity for the Monarch Warren County Wind Turbine Project (MWTP). Monarch Wind Power (MWP), the operator of the MWTP, in collaboration with GE Energy, is proposing to construct 12 1.6-megawatt wind turbines, for a combined generation capacity of 19.2 megawatts, on approximately 600 acres of land leased in Warren County, Illinois.

DOE has prepared this Biological Assessment in order to comply with the *Endangered Species Act of 1973*, as amended (16 U.S.C. 1531 *et seq*. ESA) and its implementing regulations (50 C.F.R. Part 402). ESA provides for the listing, conservation, and recovery of endangered and threatened species of plants and wildlife. ESA mandates the USFWS to monitor and protect listed species. Section 7(a)(2) of the ESA requires Federal agencies to insure that any action they authorize, fund, or otherwise carry out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Pursuant to ESA and its implementing regulations, where, as here, DOE determines that its proposed funding action may affect listed species or critical habitat, DOE is required to consult with the USFWS to insure that the proposed action is not likely to jeopardize the continued existence of an endangered or threatened species or further destroy or adversely modify its habitat (50 C.F.R. 402.13-14). As a first step in the consultation process, DOE obtained the list of threatened, endangered, and candidate species for Warren County from the U.S. Fish and Wildlife Service (USFWS) Midwest Region 3 Section 7(a)(2) Technical Assistance Website. DOE also reviewed the USFWS Environmental Conservation Online System to determine whether there is critical habitat at the project site. According to the Technical Assistance Website, the following two threatened or endangered species (but no candidate species) could occur in Warren County:

- Indiana bat (*Myotis sodalis*) – endangered
- Eastern prairie fringed orchid (*Platanthaera leucophaea*) – threatened

The eastern prairie fringed orchid occurs in mesic to wet, unplowed tallgrass prairies and meadows, bogs, fens, or sedge meadows with moist soil near the surface (USFWS 1996, 2009). There is no critical habitat designated for this species. There are no existing populations of this species in Illinois (USFWS 2009) and no potential habitat for this species within or near the MWTP site. **DOE, therefore, determined that the project would have *No Effect* on the eastern prairie fringed orchid,** and this species in not further addressed in this Biological Assessment**.**

Although not included in the list of threatened, endangered, and candidate species that could occur in Warren County, the USFWS Rock Island Field Office stated in a letter dated July 12, 2010, that a nonessential experimental population (NEP) of whooping crane (*Grus americana*) (66 FR 33903-33917) can occur statewide in Illinois during migration (Nelson 2010). The NEP migrates from its breeding grounds in Wisconsin to wintering grounds off the Gulf Coast of California. The USFWS summarized Federal agencies' responsibilities for consultation regarding this NEP as follows (66 FR 33904):

> When NEPs are located outside a National Wildlife Refuge or National Park, only two provisions of section 7 [of the Endangered Species Act] would apply: Section 7(a)(1) and section 7(a)(4). Federal agencies are not required to consult with us under section 7(a)(2). Section 7(a)(4) requires Federal agencies to informally confer with the Service on actions that are likely to jeopardize the continued existence of the species for listing. However,

> since we determined that the NEP is not essential to the continued existence of the species, it is very unlikely that we would ever determine jeopardy for a project impacting a species within an NEP.

The nearest wetlands or ponds that might be used as stopover habitat by whooping cranes are 1.3 and 1.5 miles northeast of the MWTP site. **DOE, therefore, determined that the proposed project *would not result in jeopardy* to the NEP of the whooping crane,** and this species is not further addressed in this Biological Assessment**.**

The purpose of this Biological Assessment is to is to determine the effects on the Federally endangered Indiana bat from the construction, operation, and decommissioning of 12 wind turbines in Warren County, Illinois, for the MWTP. By the submittal of this Biological Assessment, DOE is initiating formal consultation pursuant to Section 7 of the Endangered Species Act of 1973.

1.2 Brief Description of DOE's Proposed Action

MWP proposes to construct and operate 12 1.6-MW wind turbines to generate electricity. The project includes turbine installation, underground electrical collection lines, access roads, crane pads, fencing, and an electrical substation. Sixteen acres of cultivated fields would be disturbed to install the turbines and other equipment. MWP plans to begin construction in the spring or summer of 2011, start generating electricity in 2012, and operate the turbines for 20 to 25 years.

The grant for this project would come from money that Illinois has received from DOE pursuant to DOE's State Energy Program (SEP). The purpose of the SEP is to promote the conservation of energy and reduce dependence on imported oil by helping states develop comprehensive energy programs and by providing them with technical and financial assistance. States can use their SEP funds for a wide variety of activities related to energy efficiency and renewable energy (United States Code [U.S.C.] § 6321 *et seq*. and 10 Code of Federal Regulations [CFR] Part 420). In the *American Recovery and Reinvestment Act* of 2009 (Public Law 111-5, 123 Statute 115), Congress appropriated $3.1 billion to DOE's SEP and the State of Illinois received $101 million pursuant to a Federal statutory formula for distributing these funds. A criterion of the Illinois SEP funding from the Recovery Act is that funds must be obligated by September 30, 2010 and expended by April 30, 2012. Following a competitive grant process, Illinois DCEO selected the MWTP to receive $5.0 million of its SEP funds for the design, planning, and construction of this project. The potential use of Federal SEP funds to assist in the financing of this project constitutes a Federal action.

2. PROPOSED PROJECT AND ACTION AREA

The MWTP would involve the construction and installation of twelve 1.6-megawatt wind turbines. MWP has selected the GE 1.6xle model turbine, which has a rotor diameter of 271 feet and a tower height of 328 feet. The turbines would be installed on monopole steel towers and would have a maximum height of 463 feet from the bottom of the tower to the blade tip at its highest point. Underground cables would be installed to conduct electricity from the turbines to a new electrical substation. The facility would connect via the substation to a 69-kilovolt Ameren distribution line that intersects the site on the western side of U.S. Highway 67.

2.1 Monarch Wind Turbine Project

2.1.1 Project Site

The MWTP would be located on 600 acres of land in Lenox Township, Warren County, Illinois (Figure 1). The turbines would be located south and northeast of the intersection of U.S. Highway 67 and 140th Avenue (Figure 2), 4 miles south of Monmouth. Seven turbines would be installed on land leased from private landowners and the remaining five would be installed on land leased from Warren County.

The project site consists of agricultural fields where corn and soybeans are usually grown. The site is bounded on the north by the Burlington Northern Santa Fe railroad line and surrounded by cultivated land in every direction. Route 67, a four-lane highway, intersects the site (Figure 2). Areas of ground disturbance would be limited to approximately 16 acres, including access roads and equipment staging/laydown areas. The approximate center point of the project area is 40º50’1” N, 90º39’29” W.

2.1.2 Construction and Installation

Site construction would include installation of the tower foundation, tower, turbine, transformers, electrical distribution equipment, substation, access roads and road improvements, crane pads, concrete truck staging areas, and fencing.

MWP would survey the site and complete a soil boring at each of the turbine locations prior to construction. The turbine foundations would be about 55 feet in diameter (2,330 square feet) and 15 feet deep. Temporary, 50- by 100-foot crane pads consisting of compacted soil would be created approximately 50 to 100 feet away from the base of each turbine site. Installation of each turbine and crane pad would result in conversion of approximately 0.16 acre of cultivated land. Crane pads would be returned to agricultural use following the installation of the turbines, and the total amount of land permanently converted for each turbine would be 0.05 acre.

Access to each turbine site would be via a new 16-foot-wide access road (Figure 2). A total of approximately 4.4 acres of cultivated land would be converted to create the 2.5 miles of new access roads required for the project.

Construction fencing would be installed around each tower/turbine site during construction and would be removed after the turbines are installed.

Underground electrical cables would be installed to connect each turbine to a new substation to be located near the intersection of U.S. Highway 67 and 140th Avenue (Figure 2). Output from that substation would be connected to the adjacent 69-kilovolt distribution line on the western side of Highway 67.

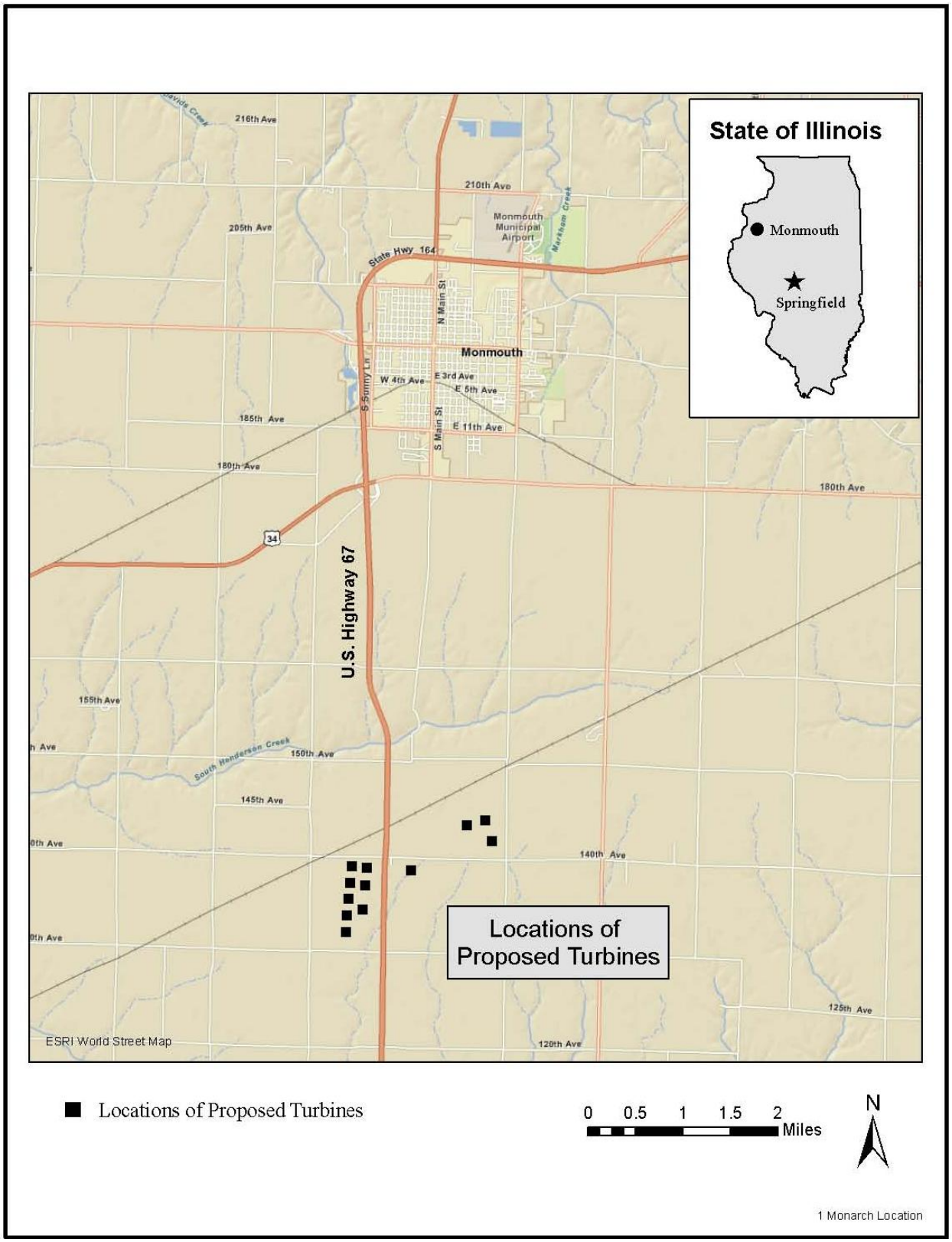

Figure 1. Location of the Monarch Wind Turbine Project in Warren County, Illinois

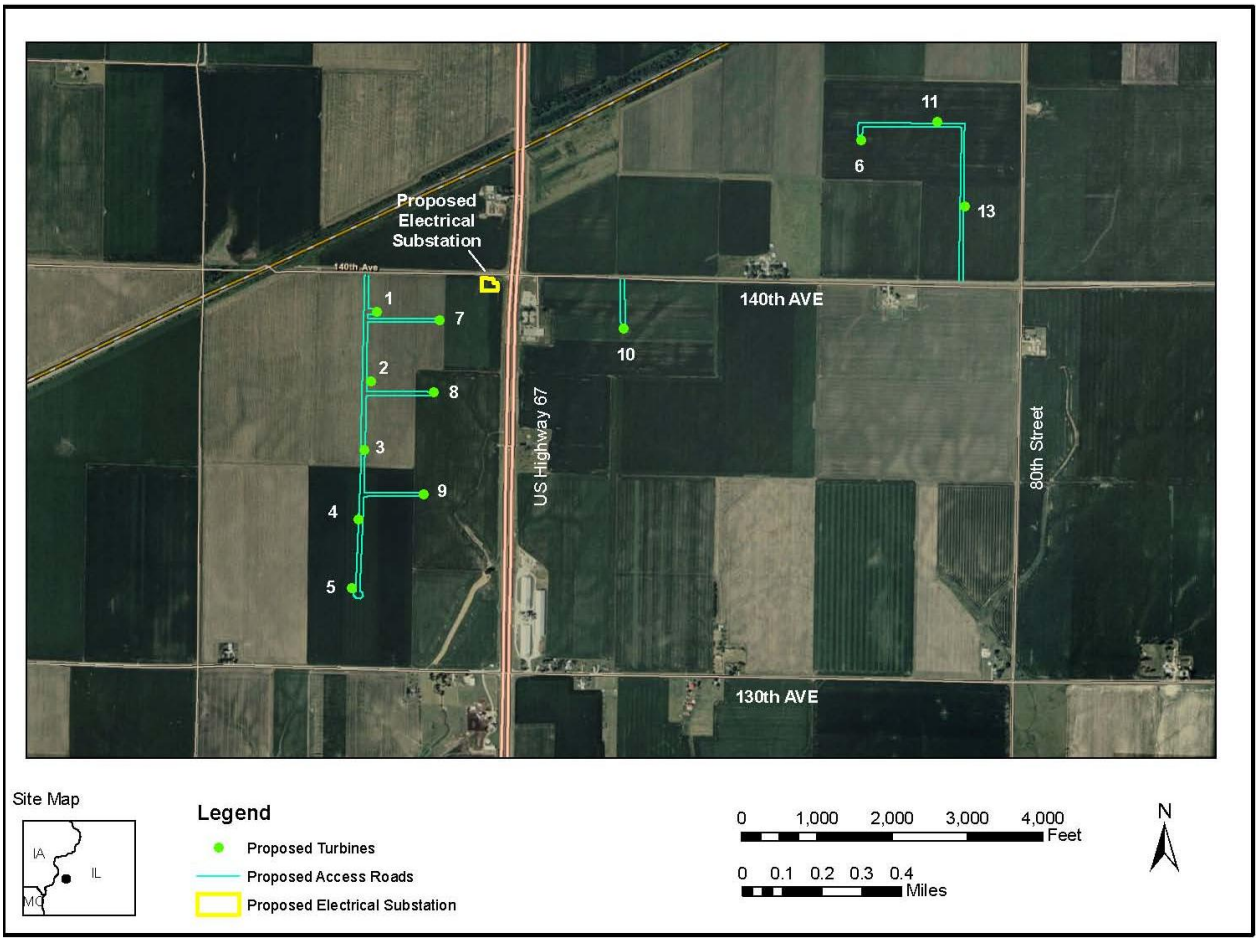

Figure 2. Monarch Wind Turbine Project site layout

After installation of the turbines and associated infrastructure, land not required for operation of the turbines would be graded and returned to agricultural production. Approximately 7 acres would be converted for the MWTP during the lifetime of the project.

Construction would be performed in accordance with a soil and erosion control plan and in compliance with Federal, State, and local requirements. Total ground disturbance at the site would exceed 1 acre; therefore; a National Pollutant Discharge Elimination System permit would be obtained.

MWP anticipates that construction would begin in the spring or summer of 2011 – once all regulatory approvals are obtained and turbine and equipment are procured. The timing of construction activities is contingent on weather conditions, as the turbine nacelles and blades cannot be installed in high winds. MWP estimates that installation of all turbines, underground electrical cables, the substation, and other infrastructure required for this project would take approximately 12 months, and that the project would be operational and generating power in 2012.

2.1.3 Aviation Marking

Aviation marking would be in compliance with the Federal Aviation Administration (FAA) standards (FAA 2007). In accordance with the FAA Determination of No Hazard to Air Navigation for each turbine in the MWTP, synchronized red lights would be used for the eight turbines on the perimeter of the project. Flash intervals of any lighting scheme for these turbines would be synchronized over the entire

project. To minimize visual impacts to nearby receptors, lighting would not be installed on the remaining four turbines. Although daytime lighting of wind turbine farms is not required, FAA recommends that turbines be painted with bright white or light off-white paint. All turbines in the MWTP would be painted in accordance with this standard.

2.1.4 Operations and Maintenance

MWP would operate and maintain the wind turbines and other equipment in accordance with the operating, maintenance, and safety procedures and requirements specifically recommended by the turbine's manufacturer. The GE model 1.6xle turbines would be operated year-round, 24 hours a day (except during maintenance), when wind speeds are suitable. The turbines are designed to start operating at a minimum wind speed of 3 meters per second (6.7 miles per hour) and to shut down when wind speeds exceed 33 meters per second (74 miles per hour). Section 6 of this Biological Assessment describes DOE's proposed plan to evaluate whether increasing the minimum operating wind speed (i.e., the cut-in speed) would result in fewer Indiana bats and other bats killed by the wind turbines during fall migration.

Onsite personnel would monitor each turbine daily by conducting an auditory and visual inspection. In addition, GE would continuously monitor the turbines remotely from the GE facilities in New York. Turbines could be shut down remotely from the New York facilities if necessary. Most servicing would be performed up-tower, without using a crane. In addition, MWP would regularly inspect and maintain all access roads to minimize erosion.

2.1.5 Decommissioning

Megawatt-scale wind turbine generators such as those to be used for the MWTP typically have an operational expectancy of 20 to 25 years. When the turbines have reached the end of their functional operational period, MWP might replace the turbines with newer models or remove the turbines and decommission the project area.

Decommissioning would include the removal of the turbines, towers, and other aboveground structures, as well as removal of below-ground structures (foundations and underground cables). Turbine foundations would be excavated to a depth of 36 inches below grade (48 inches in cultivated fields) or to bedrock, whichever is less, to sufficiently expose and remove anchor bolts, rebar, conduits, and concrete. Excavations would be filled, and disturbed or compacted soil would be decompacted, graded, and restored as appropriate for use in agricultural production or other land uses identified at that time.

2.2 Action Area

The project action area is defined as all areas to be affected directly or indirectly by the proposed project and not merely the area immediately adjacent to the project location. Therefore, the project action area includes the project footprint and geographic extent of area that could be affected by construction or operational activities either directly, indirectly, or through interrelated or interdependent actions.

As described above, about 16 acres of cultivated land would be disturbed within a 600-acre area during development of access roads and installation of the wind turbines, electrical cables, and substation (Figure 2).

Direct effects to Indiana bats during operation of the wind turbines would occur primarily within and very near the rotor-swept area of the turbines. Bats have the potential to collide with the rotating blades or stationary nacelles and towers, or experience pulmonary barotrauma from low air pressure surrounding the spinning blades.

The maximum geographic extent of the MWTP's potential effect on the natural environment during operation of the wind turbines would be the result of noise generated during turbine operation. To identify the area within which noise generated from the operating turbines could be detectable, DOE compared ambient sound measurements taken within or near the project area with modeled predictions of noise at increasing distances from the turbines. Ambient sound levels were measured for 24-hour periods at three locations near the proposed turbine locations in September 2010 and for 1-hour periods at four additional locations (WES Engineering 2010). The sound level exceeded 90 percent of the time (i.e., L_{90}) during the measurement periods ranged from 43.1 to 49.1 decibels on an A-weighted scale (dBA) during the day and 38.6 to 44.4 dBA during the night. Thus, additional sources of noise in the area that are less than about 40 dBA generally would not be detectible, as they would be below ambient noise levels. Noise generated by the operating turbines would decrease to 40 dBA at about 3,000 to 4,000 feet from the turbines, and would decrease to 35 dBA by about 4,500 to 6,000 feet (depending on how many turbines were near a specific location) (WES Engineering 2010).

Rapidly flickering shadows cast by the spinning blades (i.e., shadow flicker) also can be detected at substantial distances from wind turbines under some conditions. Changes in light intensity caused by shadow flicker are greatest near, and immediately to the east and west of, operating turbines. Changes in light intensity decrease with distance and to the north and south of turbines. Shadows caused by spinning turbine blades generally are so diffuse that they cannot be detected at distances of about 10 times the diameter of the rotor blades. At such long distances, any shadows cast by the turbines would only occur for very short periods immediately before sunrise and after sunset. For the MWTP, the rotor blades would have a diameter of about 270 feet; therefore, the maximum distance at which the effects of shadow flicker are likely to occur is about 2,700 feet.

Based on this information, DOE concludes that an action area of 1 mile surrounding the 12 turbines is the maximum geographic extent of areas that could be affected by the construction and operation of the MWTP. This action area includes all sites that would be temporarily or permanently disturbed during construction, as well as areas that may be affected during operations. Figure 3 shows the bounds of the action area.

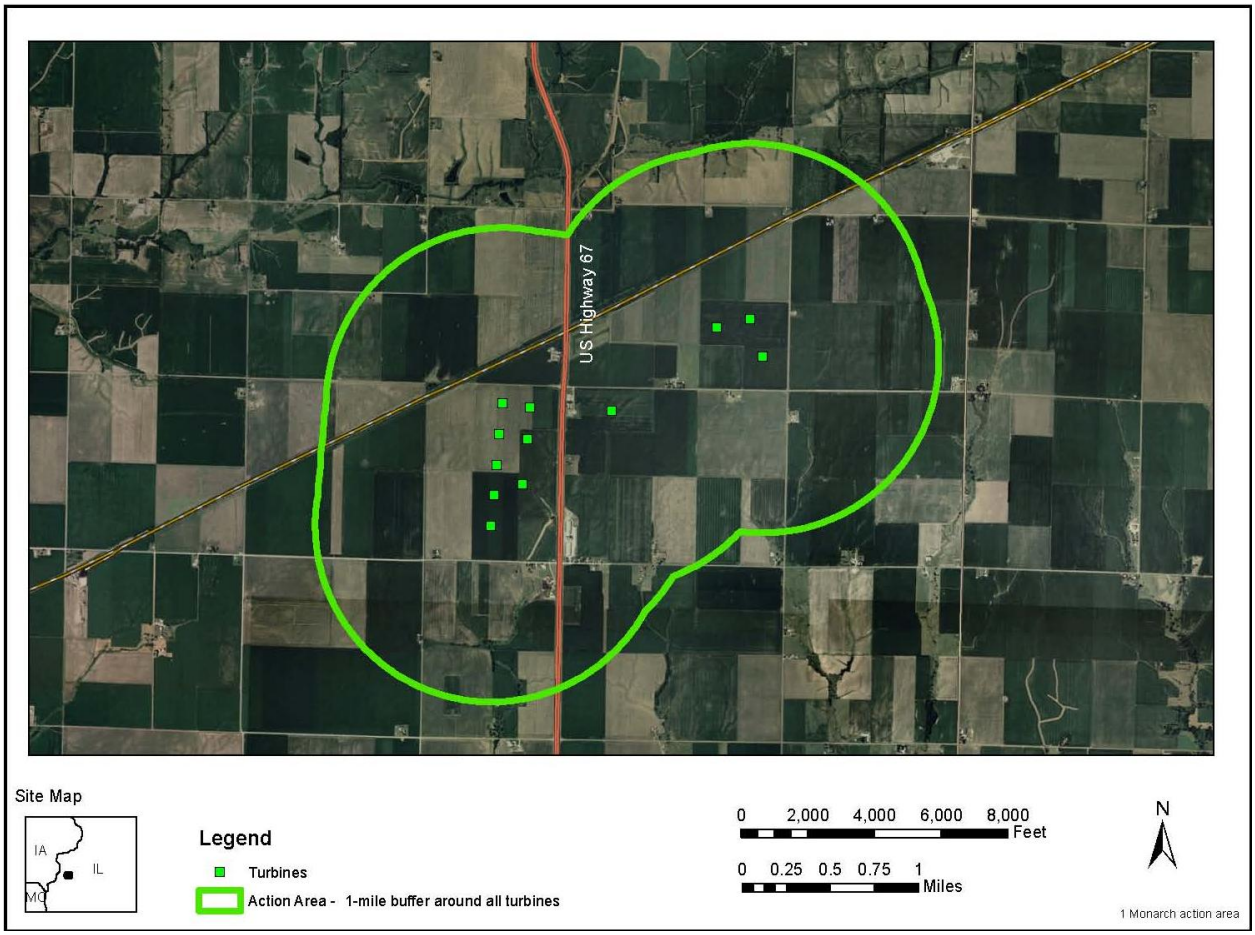

Figure 3. Action Area for the Monarch Wind Turbine Project

3. INDIANA BAT STATUS, HABITAT, AND BEHAVIOR

During informal consultation with the USFWS Rock Island Illinois Field Office, the primary concern identified was with the potential impact of the MWTP on Indiana bats that might migrate through the project area, especially during the fall. Therefore, this Biological Assessment focuses on the potential operational impacts of the wind turbines on migrating Indiana bats. Much of the following review of information on the status and ecology of Indiana bats was taken from the Biological Assessment for the Southern Illinois University Carbondale Wind Energy Project (DOE 2010), which was prepared for DOE by Copperhead Environmental Consulting, Inc.

3.1 Species Description and Status

The Indiana bat was first described by Miller and Allen (1928). The species was originally listed as "in danger of extinction" under the *Endangered Species Preservation Act in 1966* (80 Stat. 926; 16 U.S.C. 668aa[c]) and formally attained endangered species status under the *Endangered Species Act* in March 1967 (32 FR 4001). The Indiana bat is currently listed under the *Illinois Endangered Species Protection Act* (520 ILCS 10/11) as endangered by the Illinois Division of Natural Resources.

The USFWS has assigned the Indiana bat a Recovery Priority of 8 (USFWS 2007), indicating that the species has a moderate degree of threat and high recovery potential. As of October 2006, the USFWS reported records of extant winter populations at approximately 281 hibernacula in 19 states and 269 maternity colonies in 16 states. The 2005 winter census estimate of the range-wide population was 457,374 individuals (USFWS 2007). Its distribution includes most of the eastern United States from Oklahoma, Iowa, and Wisconsin east to Vermont and south to northwestern Florida (Barbour and Davis 1969; Hall 1981; Kurta and Kennedy 2002; USFWS 2007).

The USFWS, in cooperation with the Indiana Bat Recovery Team, developed an Indiana Bat Recovery Plan in 1976, followed by a revised document in 1983. The Plan has since undergone further revisions: one in 1996 and another in 2007. The most recent document, entitled the *Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision*, was published for review in April 2007.

The historic winter range of the Indiana bat likely was restricted to areas of cavernous limestone in the karst limestone regions of the east-central and northeastern United States, including Alabama, Arkansas, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Missouri, New Jersey, New York, North Carolina, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia (Hall 1962; Miller and Allen 1928; Thomson 1982; USFWS 2007). Evidence suggests that vast numbers of Indiana bats "historically converged" at a relatively small number of large cave systems to hibernate, including Wyandotte Cave in Indiana; Bat, Coach, and Mammoth caves in Kentucky; Great Scott Cave in Missouri; and Rocky Hollow Cave in Virginia (Tuttle and Kennedy 1999; USFWS 2007). However, because their winter habitat requirements are so specialized, it is likely that the Indiana bats used most caves that offered suitable habitat, at least on a periodic basis or in small numbers. The disturbance associated with increased human use of many winter hibernacula over subsequent decades has reduced the numbers of available hibernacula and bats that use them.

The historic summer distribution and range for the Indiana bat is poorly documented but is assumed to be at least as expansive as the current range for the species. Changes in land use practices implemented soon after European colonization began a pattern of habitat modification and loss that has continued through the present. Suitable maternity habitat has undoubtedly been excluded, as forest was converted to agriculture or lost to urban development and mineral extraction activities. It wasn't until 1971 that the first maternity colony was discovered when a farmer in Indiana inadvertently felled a roost tree with his tractor (Cope et al. 1974; USFWS 2007).

3.2 Habitat and Behavior

3.2.1 Winter

Indiana bats use caves and abandoned mine portals as winter hibernacula throughout the karst region in the south-central portion of the range (USFWS 1999). They have very specific hibernation requirements and occupy areas in caves that maintain a narrow temperature and humidity range. As such, very few caves provide adequate microclimate for hibernating Indiana bats (USFWS 1999). In addition, a large portion of the population hibernates in large clusters within a handful of sites. Many of the larger Indiana bat hibernacula have been designated as critical habitat.

Winter critical habitat was designated for the Indiana bat in September 1976 (41 FR 41914). The current draft of the recovery plan (USFWS 2007) lists 11 caves and 2 mines in 6 states as critical habitat. The only designated critical habitat for the Indiana bat in Illinois is Blackball Mine (Priority 2), located in LaSalle County.

3.2.2 Spring Emergence/Staging

Spring emergence is a dynamic time for Indiana bats and the onset and duration of this period is highly variable. Depending on local weather patterns, the movement of bats (both inside and in the vicinity of hibernacula) increases during the spring staging period as bats begins to arouse from hibernation. The start of emergence is dependent on latitude and local weather conditions, but evidence suggests that peak emergence occurs some time during late March to early April across the species' range (Butchkoski and Hassinger 2002; Cope and Humphrey 1977; Hall 1962; LaVal and LaVal 1980).

After emerging from hibernation, Indiana bats may loiter near hibernacula for several days, often returning to roost either in the hibernacula or in surrounding trees. While the majority of mating takes place during the fall swarming period, opportunistic males may mate with unfertilized females as they emerge from hibernation (Hall 1962).

Studies characterizing the specific habitat preferences of Indiana bats following emergence from winter hibernacula are limited, but roost choice appears to be influenced by seasons (Britzke et al. 2006; Gumbert 2001). Indiana bats probably use roosts in spring as places to rest as they recover from hibernation. Bats will also forage when prey is available in an effort to replenish fat reserves used over the winter. Britzke et al. (2006) found 39 Indiana bat roost trees for female bats during spring in the Lake Champlain Valley of New York and Vermont. The distance of these trees from their hibernaculum ranged from 9.1 to 24.8 miles. Bats in this study used both live (n = 14) and dead (n = 25) trees and preferentially used shagbark hickories. The mean diameter of live and dead trees in this study was 18.6 ± 1.6 inches and 17.6 ± 2.2 inches, respectively. Gumbert (2001) radio-tracked 13 male Indiana bats to 34 day roosts during spring after hibernation on the Daniel Boone National Forest, Kentucky. During this time, bats used roosts with a range of 0.3 to 2.8 miles from the hibernacula. An increase in crevice roosts and the use of live trees was documented in this study during the spring over other seasons (Gumbert 2001).

3.2.3 Summer

Roosting

Summer habitat preferences of Indiana bats have been studied in detail and can be described in specific terms. For example, Rommé et al. (1995) developed a habitat suitability model for the Indiana bat that identified environmental variables considered indicative of optimal summer habitat. This model suggested that optimal habitat is that within 1 kilometer (0.6 mile) of open water, greater than 30 percent forested

with 60- to 80-percent overstory canopy closure containing trees averaging 39.3 centimeters (15.7 inches) diameter at breast height, at a density greater than 16 stems per acre.

Indiana bats roost in a variety of habitats including riparian zones, bottomland and floodplain habitats, wooded wetlands, and upland communities (USFWS 2007). Humphrey et al. (1977) suggested that floodplain forests were the significant habitat for Indiana bats, but more recent studies indicate that this species also uses upland habitats (Britzke et al. 2003; Gumbert 2001; Kiser and Elliott 1996; MacGregor et al. 1999; Sewell et al. 2007). Carter et al. (2002) found that roosting areas contained more patches of water (e.g., ponds, lakes) than randomly chosen sites. Throughout most of the Indiana bat range, water sources are typically not a limiting factor. In general, sources of drinking water are well within range of resident bats, making the energy expenditures required to fly to such sites insignificant. As such, resident bats probably consider the relative amount of available water sources across the landscape in their choice of home range rather than day-to-day roost locations (USFWS 2007).

Roosts are typically located within canopy gaps, in a fence line, or along wooded edges (USFWS 2007). In the Midwest, maternity colonies are commonly associated with bottomland, riparian, wetland, or other hydric forest types, possibly because these areas have the most numerous snags, or possibly because of restriction to these habitats due to intensive agriculture (Carter 2006). Most maternity roosts have been located in or near wooded areas where some light gap is present allowing full or partial sun exposure to the roost site. Carter et al. (2002) attempted to clarify roost preferences of Indiana bats in Illinois and found that plots centered on roosts differed from random plots by containing fewer and small urban patches as well as more and larger patches of closed-canopy deciduous forest. Roosts typically occurred in highly fragmented forests, and roosting areas contained more patches of bottomland forest and agriculture than randomly chosen plots.

Rangewide, Indiana bats have been found to roost in over 33 species of trees (Kurta 2005). However, summer roost suitability could depend on many factors (USFWS 2007). While Indiana bats probably utilize tree species according to their availability, roost choice is probably more a reflection of roost character (i.e., condition, usable bark, amount of solar exposure, tree size, distance to water resources, elevation) than species (Callahan et al.1997; Gardner et al. 1991a; Humphrey et al. 1977; USFWS 2007). Roosting typically occurs under the exfoliating bark of dead or live trees, but cavities or crevices of live-damaged trees have also been used (Callahan 1993; Gardner et al. 1991a; Gumbert 2001; Kurta and Williams 1992). In rare cases, Indiana bats have also been found using human-made structures as maternity roosts (Butchkoski and Hassinger 2002; GAI and ESI 2006; Ritzi et al. 2005; USFWS 2007). In addition, there is some evidence that suggests Indiana bats exhibit fidelity to summer roosting areas and even specific trees from year to year (Gardner and Gardner 1992; Gumbert et al. 2002; Kurta and Murray 2002).

Foraging

Foraging home ranges of Indiana bats vary by habitat, sex, region, and time of year. During summer, Kurta (1995) found that the home ranges of pregnant females encompassed 52 hectares (128 acres) of foraging habitat. Following birth of young, the ranges increased to 94 hectares (232 acres). More recent surveys by Butchkoski and Hassinger (2002) indicate that females use a minimum of 20 to 39 hectares (50 to 96 acres) for foraging during summer. Documented foraging range for the species varies greatly by population. Gardner et al. (1991a) reported foraging range in Illinois to be 16 hectares (40 acres), while Rommé et al. (2002) reported a foraging range of 61 hectares (151 acres) in Missouri. USFWS (2007) reported the mean summer foraging range for females throughout the range at 68 hectares (167 acres).

Although additional studies are needed to determine the preferred foraging habitat for Indiana bats, foraging is apparently concentrated in wooded areas (Butchkoski and Hassinger 2002; Gardner et al. 1991a; LaVal et al. 1977). LaVal et al. (1976, 1977) found that during summer, females and juveniles

forage within or near the tree foliage of riparian and floodplain areas, but adult males typically forage over densely wooded areas along ridges and hillside forests (Kiser and Elliott 1996). A study in Indiana determined that Indiana bats preferred to forage within upper forest canopy layers where overstory canopy cover ranged from 50 to 70 percent (Rommé et al. 1995). This species also forages over clearings with early successional habitat, such as clearcuts, and along the edges of forest openings (Clark et al. 1987; Gardner et al. 1991b). An early Indiana bat recovery plan (USFWS 1983) states that optimum foraging habitat consists of streams lined on both sides with mature trees that overhang the water by more than 3 meters (9.8 feet). Another study indicated that ideal habitat occurs within 20 meters (65 feet) of permanent water within an area with at least 30 percent forest cover (3D/Environmental 1995). Cope et al. (1978) reported that streams without riparian vegetation do not appear to be suitable. However, Gardner et al. (1991b) and Gardner and Garner (1992) radio-tracked foraging adult females in Illinois and compared foraging habitat with the availability of all habitats. They found that floodplain forest was the most preferred habitat, followed by ponds, old fields, row crops, upland woods, and pastures. Visual observations suggest that foraging over open fields or bodies of water more than 50 meters (150 feet) from a forest edge does occur, although less commonly than in forested sites or along edges (Brack 1983; Menzel et al. 2001). Based on the results of mist net captures and light tagging studies, Indiana bats typically forage at a height of 2 to 30 meters (6.5 to 98 feet) (Humphrey et al. 1977).

The Indiana bat is insectivorous, consuming a variety of small, soft-bodied flying insects. Food sources are predominately *Lepidoptera* (moths), *Coleoptera* (beetles), occasionally *Diptera* (flies), *Tichoptera* (caddisflies), and *Plecoptera* (stoneflies) (LaVal and LaVal 1980; Thomson 1982). While they are known to establish and exhibit fidelity to feeding areas, Indiana bats probably feed opportunistically as they transition to and from these areas. This, coupled with the fact that these bats are highly mobile fliers, often traveling as far as 5 kilometers (3 miles) over a given night, suggests that they likely utilize a number of habitat types during their nightly movements. Although Indiana bats typically forage in the uncluttered understories of forested habitats, along forest edges, and in riparian areas (USFWS 2007), ultimately, where they forage is likely dependent on a number of factors including terrain, weather, densities of competitors and prey, and the location and juxtaposition of available resources.

3.2.4 Migration

Indiana bats are considered a short-distance migratory species, migrating within the United States from winter hibernaculum to summer habitat. In general, migratory patterns of male and female Indiana bats differ. Evidence suggests that males are less migratory and have been shown to remain much closer to their hibernacula during summer (Gardner and Cook 2002; Gumbert 2001; Hawkins et al. 2008; Whitaker and Brack 2002). By comparison, females might migrate much greater distances. Direction of migrating female Indiana bats from winter to summer sites is not well understood, but has long been believed to be generally in a south to north direction (Bowles 1982; Gardner and Cook 2002; Hall 1962; Kurta and Murray 2002; LaVal and LaVal 1980). However, populations of Indiana bats in New York, Pennsylvania, and Vermont tend to travel shorter distances during migration than individuals in the Midwest and move southeast or southwest rather than north in the spring (Butchkoski et al. 2008). Gardner and Cook (2002) suggest that Indiana bats in northeastern states are geographically isolated from major populations in the core range and they encourage increasing the knowledge base of distribution patterns from peripheral populations.

Knowledge of female Indiana bat movement from summer to winter habitat is a result of banded bats being located during winter hibernacula surveys. Despite the small sample size of band recoveries, long distance movements from north to south of 520 to 575 kilometers (323 to 357 miles) have been documented (Gardner and Cook 2002; Kurta and Murray 2002; Winhold and Kurta 2006).

There is evidence that migrating bats fly at lower altitudes than migrating birds (Barclay et al. 2007) and appear to do most of their migration between dusk and 1 AM. John Chenger of Bat Conservation and Management (in Carlisle, Pennsylvania) believes Indiana bats migrate at low altitudes, which he defines as treetop level or lower (Johnson and Strickland 2004). There is also evidence that Indiana bats follow landscape features such as mountain ridges, rivers and streams, roads, and power lines to navigate (Sanders and Chenger 2001, Butchkoski 2004, Hawkins and Gumbert 2009, Gumbert et al. 2010). Another study reported that Indiana bats tend to forage and fly from 2 to 30 meters (6.6 to 98 feet) above ground (Humphrey et al. 1977).

Along with hearing and echolocation, bats use vision to navigate the landscape, likely employing it to assess landscape outlines and silhouettes in low light (Layne 1967; Griffin 1970; Eklof 2003). Loss of vision was shown to reduce the homing performance in Indiana bats and other M*yotis* species (Davis and Barbour 1970). High-frequency sounds attenuate rapidly with distance, so echolocation is limited to a few meters in practice. Background echoes, called clutter, (which arise from many other sources, including other bats) also can limit the utility of sonar alone (Eklof 2003). The frequency of bats crashing into windows of buildings during migration (Timm 1988) suggests that they rely mainly on visual cues when both acoustic and visual cues are available. Bats can use distant low-frequency sounds for orientation of moderate distances, which they would sense through passive hearing (Griffin 1970; Buchler and Childs 1981; Eklof 2003). Recent research in which speaker systems emitting ultrasonic noise were installed on windmills have been shown to reduce bat fatalities 20 to 53 percent, indicating that at some distance, bats respond to high frequency (Curry 2010). There is also evidence that bats possess magnetic material; however, whether it is connected to a sense and whether they use this to navigate during migration is unknown (Buchler and Wasilewski 1985).

Spring Migration

Indiana bats generally emerge from hibernacula in late March to early April and might immediately start migration or remain in the general vicinity of the hibernaculum for several days (USFWS 2007). Some individuals have been documented at maternity trees as early as April 9th (Gumbert et al. 2010). Recent migration studies on Indiana bats have begun to shed light on movement between hibernacula and summer habitat (Butchkoski 2004; Gumbert et al. 2010; Hawkins and Gumbert 2009; Sanders and Chenger 2001). Dr. John Whittaker of Indiana State University reported that they fly in a V formation (Johnson and Strickland 2004). Movements from winter to summer habitat appears to happen quickly; for example, one female released in New York flew 56 kilometers (35 miles) in approximately 85 minutes (Sanders and Chenger 2001). Indiana bats migrating from a cave in Tennessee generally traveled north, but one bat flew 261 kilometers (162 miles) southwest over a three-night period (Gumbert et al. 2010). Bats that have been tracked over multiple nights during spring migration appeared to migrate in the same general direction in which they began from the hibernaculum (i.e., initial azimuths flown upon emergence were maintained), although some minor directional changes have been documented. Nevertheless, Indiana bats appear to leave hibernacula and migrate directly to summer habitat, reducing the time they migrating across the landscape during the spring (Gumbert et al. 2010).

During spring migration, Indiana bats appear to navigate by using natural landscape features and are most likely flying near the top of the forest canopy in order to take advantage of these navigational features. A study based in Pennsylvania, Turner (2007) reported that female Indiana bats migrating during spring went out of their way to follow tree lines, avoiding open areas, and that they may fly at low altitudes, noting that one flew under highway I-80. In addition, manmade structures such as highways and powerline corridors are likely used to aide in navigation (Butchkoski 2004, Sanders and Changer 2001). One female Indiana bat radiotracked during spring migration was documented changing direction abruptly to fly through a gap in a mountain ridge (Gumbert et al. 2010). Sanders and Changer (2001) also documented an Indiana bat using a powerline corridor to cross a mountain ridge during spring migration.

According to studies in New York, female Indiana bats have been shown to avoid urban areas during spring migration (Hicks 2007).

The use of roosts during spring migration is temporary in nature (as bats move on to their maternity grounds) and is probably limited to the provision of shelter and protection from predators. Research documenting the habitat preferences of specific roost trees used during migration is limited, but roost choice probably reflects local forest community composition. Because bats are yet to be saddled with the care of offspring, migrating Indiana bats may be less choosy of roosts along migratory routes.

Fall Migration and Swarming

Although Indiana bats might migrate in a direct path from winter to summer habitat, evidence suggests that the same may not occur while migrating from summer to winter habitat. In late summer/early fall, maternity colonies begin to break up and disperse (USFWS 2007). Some male bats arrive at hibernacula as early as July, with females typically arriving later, and both sexes present in equal numbers by September (Cope and Humphrey 1977). Fall is the swarming season for Indiana bats. During that period, bats migrate toward their hibernacula where both sexes gather in large numbers at the entrance to mate. Cope and Humphrey (1977) described swarming as "…a phenomenon in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in the caves during the day." During this time, they forage to build up fat reserves to sustain them during the winter hibernation and they mate (Thomson 1982). Cryan (2008) postulates that bats in general are drawn to the tallest tree in the area where they engage in mating behaviors. The dynamics of swarming are not fully understood, but it appears that not all hibernacula experience the same amount of swarming activity within a given year or between years (pers. obs. M. Gumbert, Copperhead Environmental Consulting, Inc.).

Swarming is a dynamic time for Indiana bats that must meet and mate before hibernation. It is likely that weather and social factors play a major role in the timing of swarming behavior in Indiana bats. Parsons et al. (2003) suggest that swarming sites function as "stop-offs" during migration or between hibernacula. At many caves, individual bats arrive as the swarming season progresses but depart at intervals to recuperate from the stress of mating and/or to sample other swarming caves for prospective mates. Cope and Humphrey (1977), citing studies of the Indiana bat at Wind Cave in Kentucky and Wyandotte Cave in Indiana, iterated that "…waves of migratory *M. sodalis* arrived at predictable times each year in response to changing seasonal conditions, were active in the vicinity of the cave to mate and feed, and then either entered hibernation or moved elsewhere." It is possible that Indiana bats visit one or more hibernacula as they move through to their winter hibernacula in an effort to find mating partners along the way. This behavior can serve to ensure optimal outbreeding and also provide bats with alternative choices of where and when to hibernate.

Although swarming occurs at the entrances of caves and mines, it does not occur at every known Indiana bat hibernaculum. Thus, migration from the maternity colony might not be in a direct line to a single hibernaculum but could be more sporadic as the female visits several known hibernacula to participate in swarming activity. Male Indiana bats might also make several stops to visit multiple hibernacula during the fall swarming period (Cope and Humphrey 1977; LaVal and LaVal 1980). During this time, temperature correlates with nightly activity, as both bats and their prey become increasingly constrained by colder temperatures (USFWS 2007). By late September, many females have begun their hibernation, but males may continue swarming well into October (Thomson 1982).

Swarming and migration have not been studied extensively and are poorly understood (USFWS 2007). However, research has shown that Indiana bats travel hundreds of miles between maternity colony sites and their winter hibernacula. Twelve female Indiana bats migrated an average of 477 kilometers (296 miles) to their hibernacula in Indiana and Kentucky. Kurta and Murray (2002) tracked Indiana bats from

summer habitat in southeastern Lower Michigan to hibernacula in southern Indiana and northern Kentucky, a maximum of 532 kilometers (331 miles).

In some instances, bats have been reported to switch hibernacula from one winter to the next (Barbour and Davis 1969) and evidence suggests that Indiana bat winter populations might operate through some form of metapopulation (Hanski 1998 and Cronin 2003 in USFWS 2007). After mating occurs, females generally enter the hibernacula, storing the sperm through the winter and inseminating themselves in the spring prior to migration (Barbour and Davis 1969).

3.2.5 Causes of Decline

The largest declines in numbers of Indiana bats can be attributed to a variety of human activities, including: (1) commercialization of roosting caves, (2) vandalism of hibernating colonies, (3) disturbance by spelunkers, (4) bat banding programs, (5) use of bats as laboratory experimental animals, and (6) installation of improper cave gates (Reynoldsburg Ohio Ecological Services 2007; Thomson 1982).

Secondary causes of population declines are associated with: (1) pesticides, (2) summer habitat loss/degradation, and (3) natural disasters (Thomson 1982). Although no studies have documented the role of pesticides in population declines, some scientists have hypothesized that both quality and quantity of the food supply could be impacted by these chemicals. In addition, drinking contaminated water could contribute to Indiana bat population declines. Summer habitat loss/degradation impacts maternity colonies. Reduction in numbers of suitable roosting trees can negatively impact reproductive success and, subsequently, population levels. Loss/degradation of winter hibernacula has resulted from natural geological events such as ceiling collapse, cave flooding, and other negative changes to mine/cave structure. In addition, white nose syndrome (WNS), which was first documented near Albany, New York in 2006 (Blehart et al. 2009) is also a relatively recent contributor to the decline of Indiana bats.

As of June 2010, WNS had been documented in 11 U.S. states, 3 Canadian provinces, and is considered likely in an additional 3 U.S. states (Butchkoski 2010). The causal agent of WNS is widely accepted to be a newly described, cold-loving fungus (*Geomyces destructans*) and is thought to be European in origin. Although no cases of WNS have been reported or are suspected in the state of Illinois or in the states surrounding the MWTP site, it is suspected in caves south of Illinois in Kentucky (USFWS 2010). Given the distance that Indiana bats have been documented migrating (up to 357 miles), it is possible that Indiana bats in Illinois could migrate that far (Kurta and Murray 2002; Winhold and Kurta 2006; Gardner and Cook 2002). The syndrome causes erosion of the epidermis of the ears and wings, and bat mortality within infected hibernacula has been documented between 80 and 97 percent of a cave's hibernating population (Blehert et al. 2009). Biologists have estimated that bat mortality from WNS likely exceeds one million animals since 2007, representing the largest wildlife mortality from an infectious disease in recorded history (Sleeman 2009). While bats are believed to be the primary mode of transmission, evidence also supports the probability of spread of the fungus by humans (by movement of conidia on infected caving gear and clothing) who are thought to be responsible for some of the major "jumps" in the spread of the disease (Dixon 2010).

3.2.6 Effects of Wind Farm Operations on Bats

Information on bat mortalities at wind energy project has been summarized by Arnett et al. (2008) and Kunz et al. (2007a, 2007b). While early studies of impact to biological resources at wind farms focused on avian mortality, recent studies have shown that bats are more at risk than birds at most installations. Bat mortality varies from 15 to 41 bats per megawatt per year depending on the habitat type and time of year (Kunz et al. 2007a). The highest mortality was recorded at a mountaintop installation in a forested

area where 0.24 bats per night per turbine was found dead, or about 90 bats per year per turbine (Kerns and Kerlinger 2004).

Arnett et al. (2008) reviewed 21 post-construction wind turbine mortality studies in the United States and Canada and identified five key unifying patterns associated with bat fatalities at wind facilities: (1) fatalities were heavily skewed toward migratory bats and were dominated by lasiurine species in most studies; (2) studies consistently reported peak turbine collision fatalities in midsummer through fall from all studies in North America; (3) fatalities were not concentrated at individual turbines (i.e., fatalities were distributed among turbines at facilities), and current studies have not identified consistent relationships with habitat variables (e.g., distance to water); (4) red strobe lights recommended by the FAA did not influence bat fatality; and (5) bat fatalities were highest during periods of low wind speed, and they were related to weather variables associated with the passage of weather fronts.

A review of information on bat mortalities at wind energy projects identified late summer and early fall as the peak period for bat mortalities (Arnett et al. 2008):

- Iowa – Bat fatalities peaked in August, with a substantial number of fatalities also occurring in July and September (Arnett et al 2008).

- Alberta –The number of bat fatalities increased in early August, peaked in late August, and ended in early October (Arnett et al 2008).

- Buffalo Mountain Tennessee – 75 percent of bat fatalities occurred between August 1st and September 15th. In 2005, the peak was very pronounced, with 61 percent of fatalities occurring between August 15th and 30th, whereas fatalities were more dispersed during 2000 to 2003, with 96 percent occurring during an 88-day period centered on August 22nd and 23rd (Fiedler et al. 2007). Trends in bat activity during 2002 and 2003, measured using acoustic detectors, supported seasonal patterns of fatality: bat activity levels quadrupled by mid-August, after beginning to increase in mid-July to early August, and then decreased to previous levels by early to mid-September (Fiedler 2004).

- New York – Bat fatalities were low in June, peaked from mid-July to mid-August, and then declined precipitously through mid-November (Arnett et al 2008).

Conversely, very few bats have been killed at wind energy facilities during spring migration. The following review of mortality data collected during spring through fall at wind energy facilities in the Midwestern U.S. indicates that mortality rates are substantially less during spring migration than during the fall.

- Of 475 bat fatalities documented during 2003 at the Mountaineer Backbone Mountain Facility in West Virginia, 17 were found in the spring. All others were found during August through November (Kerns and Kerlinger 2004).

- At the Blue Sky Green Field Wind Energy Center, Fond du Lac County, Wisconsin, 242 bats were killed during fall of 2008 and 5 were killed during the spring of 2009 (Gruver et al. 2009).

- At the Top of Iowa facility, Worth County, two of 75 bat mortalities during 2003 and 2004 occurred during the spring (Jain 2005).

- Three of 44 bats killed during 2009 at the Forward Energy Center, Fond du Lac and Dodge Counties, Wisconsin, were killed during the spring (Drake et al. 2010).

In addition, in a supplement to the Biological Assessment for the NedPower Mount Storm Wind Project, Grant County, West Virginia, Johnson and Strickland (2003) tabulated the timing of bat mortalities at nine wind energy projects in the U.S. prior to 2003. They concluded that "Of 1,021 bat collision mortalities reported at wind plants across the U.S., only 27 (2.6%) were killed in April and May. The only wind plant studied in the U.S. with several bat fatalities in the spring is the Backbone Mountain site in West Virginia…".

This pattern generally is consistent with findings reported from wind facilities in Europe (Du¨ rr and Bach 2004 and Brinkmann 2006 in Arnett et al. 2008). The most consistent theme is that fatalities of bats at wind farms were heavily skewed toward migratory bats and a dominance of lasiurine species killed during midsummer through fall in North America, coinciding with the timing of fall migration (Cryan 2003 in Arnett et al. 2008).

Three species of lasiurine bats (hoary bat, *Lasiurus cinereus*; red bat, *Lasiurus borealis*; and silver-haired bat, *Lasionycteris noctivagans*) comprise the bulk of mortalities at wind turbine sites (Kunz et al. 2007b). It is unknown why this group is more vulnerable, but multiple studies have shown that these migratory, tree-roosting bats are much more likely to be killed (Johnson et al. 2003, 2004). At a Minnesota wind farm, 76 percent of bats killed were hoary bats; 90 percent were hoary or red bats. However, other bat species also are affected. For instance, Arnett et al. (2008) note that at one Iowa site, 25 percent of bat mortality was composed of big brown bats (*Eptesicus fuscus*). In general, bat activity is lower over crop and Conservation Resource Program land (Johnson et al. 2004) and shows no relationship to distance of turbines from nearby woodlots. Mortality rates were about 1 to 3 bats per turbine per year. Reynolds (2006) reported that most foraging bat activity is below the height of turbine towers (but see Horn et al. 2008 below). Reynolds (2006) reinforces the supposition that migrating bats are most at risk.

Cryan and Brown (2007) offer clues to conditions under which migrating bats may be more vulnerable in their study of hoary bat migration past an island stopover point on their migration route in California. Numbers of migrating bats increased with increasing cloud cover and decreasing wind speeds and moonlight. Migration peaked in autumn, a fact that corresponds with information on bat mortality data from wind turbine installations that also peaked in the late summer and early fall (Johnson et al. 2004; Kunz et al. 2007a). Reynolds (2006) also noted that spring bat migration was higher on days with lower wind speeds and warmer weather.

Migration research projects have helped increase the understanding of spring migration including altitude of migrating Indiana bats. Although altitudes used by migrating Indiana bats are not specifically known, evidence suggests that Indiana bats fly within close proximity to canopy height (Butchkoski 2004; Gumbert et al. 2010; Sanders and Chenger 2001), which is similar to where Indiana bats forage during the summer (LaVal et al. 1976, 1977). Migrating at or near tree canopy height supports the idea that Indiana bats may be using landscape features to navigate during spring migration. This would place Indiana bats at a lower altitude while migrating than species typically killed at wind facilities (Arnett et al. 2008). The documentation of short duration and relatively straight migration pathways (Butchkoski 2004; Gumbert et al. 2010; Sanders and Chenger 2001) may also contribute to the reduced likelihood of Indiana bat fatalities at wind farms during the spring simply because of the reduced amount of time they are actively migrating.

Barclay et al. (2007) showed that at turbine tower heights above 65 meters (213 feet), bat mortality increased exponentially. The diameter of the rotor had no effect on mortality rates. Horn et al. (2008) used thermal imaging to conclude that bats foraged between 20 and 111 meters (66 to 324 feet) off the ground but were concentrated in the rotor-swept zone (nacelle at 70 meters). Two-thirds of the bats observed foraging near the towers entered the rotor-swept zone and some individual bats had repeated near misses with the blade, suggesting they were returning to investigate the blade, possibly attracted by the sound.

Lighting on towers had no effect on bat activity or mortality. No bats struck a stationary blade, the nacelle, or the monopole, but bats investigated all aspects of the turbine towers, even alighting briefly on the monopole and stationary blades. Horn et al. (2008) suggest that bats were sometimes trapped in the vortices of the blade as they flew nearby and determined that slower rotor speeds increased mortality rates, a fact confirmed by other studies (Arnett et al. 2008, Kunz et al. 2007b).

In summary, most bat mortality occurs among tree-roosting lasiurine species during migration and in late summer through early fall, and few mortalities occur during spring migration. However, foraging bats are also at risk, particularly in forested areas on mountain ridges. Both birds and bats are most vulnerable during periods of bad weather during migration; resident species are at lower risk but foraging bats do fly in the rotor-swept zone and are most threatened by towers over 65 meters high.

Bat mortality is affected by turbine height, geographic location, seasonality, weather, and wind speed, with high mortality on nights with low wind speeds. Why bats may be attracted to the turbines is not well understood; they may simply be foraging or they may see the structures as potential roosting sites and have come to investigate.

It has been suggested that noise generated by operation of the turbines may affect the behavior of bats. For example, Arnett et al. (2008) speculated that collisions with turbines for species such as big brown bats and little brown myotis may be due to, among other things, sound attraction. However, Anabats® placed at turbines have not been found to pick up any ultrasonic sounds (Johnson et al. 2003b), indicating that the turbines do not emit any ultrasonic noises that might confuse or attract bats. In Szewczak and Arnett 2006, it was found that any ultrasonic sounds generated by wind turbines have a very low likelihood of attracting bats as ultrasonic sounds are barely detectable above ambient levels as close as 10 meters (33 feet) away, and were not detectable past 20 or 25 meters (66 to 82 feet). At this time, no definitive conclusions have been made regarding bats and noise as an attractant, but it not does appear to have an important influence on bat mortalities at wind turbines.

In Johnson et al (2003b), it was suggested that bats may also be attracted to turbines, as aerial insects upon which bats feed may take advantage of lower wind speeds on the lee side of wind turbines.

The proposed project is in cultivated agriculture, a habitat type that has generally shown the lowest risk to bats compared with other sites. However, the proposed height of the towers does increase potential that bats in the area would be susceptible to collisions, and the risk of bat mortality exists. The presence of wind turbines, especially taller than 213 feet, are known to cause mortality to bats due to collisions with rotors and other structures associated with the wind turbine. The proposed turbine would have a 328-foot tower height and rotor diameter of 271 feet, for a maximum height of 463 feet above ground level at its tallest extent. Higher turbine heights are related to increased bird mortality (Winegrad 2004) and turbine tower heights above 213 feet are associated with an exponential increase in bat mortality (Barclay et al. 2007). The proposed wind turbines do have a relatively large rotor and such large diameters appear to be associated with higher mortality of raptors (Smallwood and Thelander 2004), though rotor diameter does not appear to relate to bat mortality (Horn et al. 2008). Rotor speed appears to be an important factor in bat mortality as well. In general, very low rotor speeds are associated with high bat mortality. In fact, more bat fatalities occur at low wind speeds, which may be explained by new evidence suggesting that bats die from barotrauma, in which their lungs burst due to a sudden drop in air pressure as they arrive within a meter or two (3 to 7 feet) of the moving turbine without actually being struck by the turbine (Baerwald et al. 2008).

4. ENVIRONMENTAL BASELINE

4.1 Project Setting

MWP proposes to install 12 wind turbines in central Warren County, Illinois. The County consists of gently rolling upland plains, resulting from glacial deposition, and dissected valley sides and flood plains, which resulted from postglacial stream erosion. The turbines would be installed in an area heavily utilized for agriculture that is approximately 16 miles east of the Mississippi River and 45 miles west of the Illinois River. Both of these major rivers are situated roughly north-to-south (flowing generally southward) and are important landscape features for resident and migratory wildlife, despite their heavy historical use by humans.

As with much of Warren County, the MWTP site is in the Western Forest-Prairie Natural Division, Galesburg Section, one of 14 natural divisions in Illinois based on rainfall and water availability, the kinds of native animals and plants present, topography, and types of geologic materials visible near the surface. This division is typified by a strongly dissected glacial till plain with open woodland as predominant vegetation and considerable prairie on undisturbed level uplands. The division is characterized by well-developed natural drainage systems consisting of major streams that have significant floodplains. Native vegetation consists of forest in the river and creek valleys with open forest patches of trees, including oaks and hickories, and prairie on the uplands. Currently, large forested areas in the County generally are restricted to the major drainages.

4.2 PROJECT ACTION AREA

The project action area and surrounding land is dominated by developed agricultural land. Most of the action area, including the locations where the turbines would be installed, is cultivated fields. Most of the fields are used to grow corn and soybean. Agricultural conversion and development of the area have eliminated historical native prairie and forest vegetation. There are less than 20 acres of non-cultivated pastures and small drainages within the area. Other vegetation within the action area consists of a mowed mixture of grasses and other roadside herbaceous plants (Edge Consulting 2010).

There are no floodplains, perennial streams, or other vegetated drainage channels in the action area. Henderson Creek is the nearest stream to the action area. It is located just to the north of the action area, about 1.1 miles north of the northern-most turbine location.

The only stand of trees and shrubs within the action area is along the Burlington Northern Santa Fe railroad line, approximately 0.4 mile from the nearest turbine location. That stand of trees and shrubs is narrow (about 300 feet wide and 4,500 feet long) and is isolated from forested areas, such as those located along Henderson Creek, by more than 4,000 feet. There also is a small, isolated stand of trees along Henderson Creek just north of the action area; there are very few other trees along the creek within 1 mile of this stand. Almost all other trees in the action area are at or near residences or barns.

4.3 Indiana Bat Habitat in Action Area

Although Warren County is within the range of the Indian bat, there is no suitable roosting, foraging, or hibernating habitat within the MWTP site or surrounding action area. No summer or winter records, hibernacula, or summer reproductive records of Indiana bats have been identified in Warren County (USFWS 2007). It should be noted that lack of summer reproductive records may reflect lack of surveys and not necessarily that the species is not present in the county.

The closest and only designated critical habitat for the Indiana bat in Illinois is the Blackball Mine (Priority 1), located in LaSalle County, over 90 miles east-northeast of the MWTP site (USFWS 2007). The closest known Indiana bat hibernacula is a Priority 4 cave, Burton Cave, 72 miles southwest of the project site in southern Adams County, Illinois (USFWS 2007). The Illinois State Geological Survey (2010) identified a cave site in adjacent Henderson County, approximately 13 miles west-northwest of the project site. Even though USFWS has not identified this cave as providing hibernacula, its potential for use as a hibernaculum cannot be ruled out.

The action area is dominated by developed agricultural land. The only stand of trees within or near the area is small and distant from other isolated stands (Section 4.2). The nearest forested areas with connectivity to the larger riparian forests in the region are more than 2 miles to the southeast along Cedar Creek and about 2 miles to the northwest along Henderson Creek. The USFWS (Nelson 2010) describes suitable summer habitat for the Indiana bat in Illinois as areas within a 0.5-mile radius of a project site that have forest cover of 15 percent or greater, permanent water, and potential roost trees with 10 percent or more peeling or loose bark. Based on this information, **DOE concludes that there is no suitable roosting or foraging habitat within or immediately adjacent to the action area that would be affected by the MWTP and that the only time that Indiana bats are likely to be present within the area is during migration**.

This conclusion is supported by a review of habitat within and near the project site conducted by the USFWS Rock Island Field Office (Nelson 2010):

> The project boundary is located less than 2.5 miles (average maximum foraging distance of summering Indiana bats) away from the nearest potential maternity habitat and contains other suitable habitats that could be used by Indiana bats. Nonetheless, no continuity exists between these habitats and the nearest maternity habitat, providing no pathway for take of this endangered species during the summer. Current literature indicates open expanses greater than 1000 feet are not typically spanned by foraging Indian bats. Therefore, even if suitable habitat exists in the project vicinity, it is unlikely the habitat will be utilized as it is part of a non-contiguous landscape. However, because of the seasonal life history characteristics of migratory bats, the Monarch wind farm may affect the Indiana bat during spring and fall migrations.

In subsequent discussions between DOE and the USFWS, the Service indicated that the MWTP was most likely to result in adverse effects to Indiana bats during the fall migration period (Pers. Comm. with Rick Nelson, Matt Sailor and Jody Miller, November 2010). **Based on this input from the USFWS; the lack of suitable roosting, foraging, or winter habitat in the vicinity of the MWTP area; the timing of bat mortalities documented at other wind energy facilities in the Midwest (see Section 3.2.6); and the lack of documented occurrences of Indiana bats in Warren County, DOE concludes that the only bats likely to be affected are those that are migrating through the action area, and such impacts are most likely to occur during the fall migration**.

DOE has not conducted any field investigations to determine the presence of Indiana bats at the MWTP site because the likelihood of capturing a migrating Indiana bat in a mist net during migration is very low. Furthermore, acoustic monitoring cannot be used to reliably differentiate between Indiana bats and other *Myotis* bats. Therefore, in lieu of carrying out a bat survey, DOE assumes that migrating Indiana bats could be present in the action area.

5. EFFECTS ANALYSIS

This section describes and justifies DOE's conclusions of the direct, indirect, interrelated and independent, and cumulative effects of the MWTP on Indiana bats. Information on the effects of wind energy project on bats that is relevant to this analysis is in Section 3.2.6.

5.1 Direct Effects

Direct effects are defined as the direct or immediate effects of the project. Direct effects include all immediate impacts (negative and beneficial) from project-related actions (e.g., construction-related impacts such as loss of habitat) and those disturbances that are directly related to project elements that occur very close to the time of the action itself (e.g., sedimentation). Direct effects typically are considered to occur during the construction or habitat-disturbance phase of a project, with indirect effects occurring later in time. However, because the MWTP involves the long-term operation of wind turbines that might directly kill or injure Indiana bats, DOE has included mortality of bats during operation of the project in the following consideration of direct effects.

- Construction of the MWTP, including installation of the wind turbines, electrical distribution lines, substation, and other required infrastructure would not result in any disturbance or loss of habitat used by Indiana bats for hibernating, foraging, or roosting.

- Construction activities would not result in morality, modification of behavior, or other adverse impacts to migrating or other Indiana bats because construction activities would not occur during nighttime hours when bats are active.

- During the operation phase of the MWTP, migrating Indiana bats could be directly affected when struck or otherwise harmed by spinning turbine blades, as has been documented at many other wind energy projects (see Section 3.2.5).

- Migrating bats may change their behavior in response to the operating turbines. For example, it has been suggested that bats may modify their flying pattern, for example, due to sound generated by operating turbines (Arnett et al. 2008). However, as discussed in Section 3.2.5, wind turbines do not appear to emit ultrasonic sounds that might confuse or attract bats. In addition, although aerial insects upon which Indiana bats feed are known to take advantage of windbreaks on the lee side of wind turbines, the MWTP action area does not include suitable foraging habitat. Therefore, the abundance of insects near turbines would not be a contributing factor to risks to the Indiana bat from the MWTP.

- Because there are no hibernacula and no roosting or foraging habitat within or near the action area, DOE concludes that the possibility of Indiana bats being harmed or killed by operation of the turbines at any time other than during migration is discountable.

- As summarized in Section 3.2.6, a very small portion of bat mortalities has occurred during the spring at other wind energy projects. Although the reasons for a substantially higher number of mortalities in the fall is not fully understood, it has been suggested that more direct flights to breeding areas during the spring, differences in flight altitude and/or flight patterns, and behavior associated with swarming and breeding, may make bats more vulnerable to wind turbines during fall.

Based on this information, DOE concluded that the only likely direct effects to Indiana bats would occur during the fall migration. Specifically, migrating Indiana bats may be adversely affected during operation of the MWTP from: (1) collisions with operating turbines; (2) changes in migration behavior due to the presence of operating turbines or the noise they generate; and (3) pulmonary barotrauma, a fatal condition caused by low pressure zones near turbines that cause the lungs of bats to hemorrhage.

As described in Section 5.5, a relatively large number of bats have been killed at some wind energy projects. Most bats killed were three species of lasiurine bats (hoary bat, red bat, and silver-haired bat,). Substantially fewer *Myotis* bats have been found dead at wind energy project sites, and DOE is aware of only two documented mortalities of Indiana bats killed by wind turbines. In both of these cases, Indiana bats were found during fall migration under wind turbines located in cultivated fields. Because bat mortalities are monitored at only a small percentage of the wind energy projects within the range of the Indiana bat, and because not all bats killed are detected during those surveys, it is likely that substantially more individuals of this species are killed annually by wind turbines. **Nonetheless, given the lack of forested areas near the project site and the small number of turbines to be installed for the MWTP, DOE anticipates that few or no bats would be killed each year by this project. This low rate of mortality would have a negligible effect on population dynamics or the regional abundance of Indiana bats.**

Because a very small portion of bat moralities at wind energy facilities occur during the spring, and because DOE anticipates that few or no bats would be killed each year by this project, **DOE also concludes that it is possible, but very unlikely, that an Indiana bat would be killed by the MWTP during spring migration.**

Although methods have been suggested and used to model and predict the annual and total incidental take of Indiana bats from wind energy projects, those methods likely would not be meaningful or accurate for the MWTP because no bat habitat (other than airspace using during migration) would be disturbed, there is very little data about the relative abundance of Indiana bats and other bats in the vicinity of the project, and because the probability of a bat being harmed in any year is low. DOE has therefore used the information presented in this Biological Assessment to qualitatively estimate that no more than three Indiana bats are anticipated to be incidentally taken during a year, and no more than ten Indiana bats are anticipated to be incidentally taken over the 20- to 25-year life of the project. The annual estimate of three bats accounts for a low-probability event of more than one Indiana bat being killed at the same time or close in time (for example, while migrating together through the project area following a storm front). Because such an event would not occur often, the total amount of take is anticipated to be less than the annual take estimate extended over the life of the project

5.2 Indirect Effects

Indirect effects include those effects that are caused by or would result from the proposed project and are later in time, but are still reasonably certain to occur. **DOE does not anticipate any indirect effects to Indiana bats from the MWTP**. Because there are no hibernacula and no roosting or foraging habitat within or near the action area, the project would not cause Indiana bats to avoid any important winter or summer habitat or otherwise adversely modify their behavior in response to noise, shadow flicker, or other effects of turbine operation. No air pollutants would be released during operation of the project and the release into the environment of lubricants and other hazardous materials used during operation is very unlikely; thus, there would be no indirect adverse harm to Indiana bats or their habitat.

5.3 Effects of Interrelated and Interdependent Actions

Interdependent actions have no independent utility apart from the proposed project and interrelated actions are part of a larger action and depend on the larger action for their justification. No interdependent or interrelated actions would be associated with the proposed project. **The proposed project would be a single and complete action; therefore, no effects from interdependent or interrelated actions would occur.**

5.4 Effects from Cumulative Actions

As defined under the implementing regulations of the *Endangered Species Act*, cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (USFWS and NMFS 1998).

There are no other planned non-Federal (or Federal) actions that are reasonably certain to occur within the action area shown in Figure 3. However, two additional wind projects are proposed for Warren County, each with 134 wind turbines and a capacity of 134 megawatts. The Coldbrook-Alexis Wind Farm would be located in Coldbrook Township, over 10 miles northeast of the proposed MWTP site. The EcoPoint Wind Farm would be located in Point Pleasant, Swan, and Sciota townships, over 10 miles south and southwest of the MWTP site (Illinois State University 2010).

No cumulative impacts within the action area are anticipated, as no other reasonably foreseeable projects are planned to occur within its boundaries. The potential exists for cumulative impacts to occur outside the action area from installation of wind turbines in the region.

6. AVOIDANCE AND MINIMIZATION MEASURES

As discussed in Section 5, DOE concludes that Indiana bats would be in the project area only when migrating. Further, because a very small portion of bat moralities at other wind energy facilities have occurred during the spring (see Section 3.2.6), and because the probability of any Indiana bats being killed by the MWTP during a year is low, DOE concludes that it is possible, but very unlikely, that an Indiana bat would be killed during spring migration. The following avoidance and minimization measures, therefore, focus on the fall migration period.

DOE and MWP, the operator of the MWTP project, propose a three-year evaluation of the effectiveness of modifying the operational cut-in speed for reducing mortalities of Indiana bats. At the end of the three-year study, MWP and USFWS would use the results of the study to develop an operating scheme, and mortalities during fall migration would be monitored for an additional two years.

The following is a summary of the proposed evaluation. MWP will develop the study in cooperation with USFWS staff and will prepare a detailed study design for review and approval by the USFWS prior to installation of the facility. This approach will allow the USFWS and MWP an opportunity to maximize the amount of useful information to be obtained from the monitoring effort.

Cut-in Speeds

A subset of turbines would be operated with a cut-in speed of 5 meters per second (11 miles per hour), with the remaining turbines operated at the manufacturer's recommended operational wind speed. The modified cut-in speed would be used from 0.5 hour before sunset until 0.5 hour after sunrise during the fall migration period. It should be noted the MWTP would generate a substantial portion of the electricity used by local residents and businesses, including nearby grain elevators whose peak power usage occurs in the spring and fall. As a result, cut-in speeds greater than 5 meters/second would neither be consistent with the utilities' requirement of continuous operations for the facility, especially during peak load periods, nor economically feasible for MWTP.

Study Period

Use of cut-in speeds, and monitoring of mortality, will be conducted initially from 15 July through 30 September. Terminating use of cut-in speeds at the end of September is proposed for the following reasons. First, mortality studies have shown that most bat fatalities occur in August into September with a spike in mid to late July to early August (Arnett et al 2008). Second, because the project site is distant from Indiana bat hibernacula, it is likely that there will be few swarming or migrating Indiana bats in the vicinity of the MWTP turbines late in the migration period and thus a very low probability of mortality during that time. And finally, October is a very important time financially for electricity generation for the MWTP.

Carcass Searches

MWP would conduct searches for dead bats at all turbines at least three times a week from July 15 through October 1 for five years. The study design and searches will developed and conducted under the direction of staff from the Biology Department of Monmouth College, or other similarly qualified personnel. The detailed protocol for searches, training of personnel, and measuring searcher efficiency and carcass removal rates would be presented in the study design and reviewed and approved by the USFWS.

Reporting

MWP would prepare a report summarizing and interpreting the results of the study by the end of each year and submitted to USFWS and DOE. Any changes in the design of the study for the following year would be proposed in the report.

Long-term Use of Cut-in Speeds

At the end of the third year of the study, MWP and USFWS would examine the data collected on mortalities of Indiana bats to determine whether a 5 meter per second cut-in speed should be used during fall migration for the remainder of the operational life of the MWTP. MWP would propose a long-term operations plan in the third annual report and request feedback and approval from USFWS. USFWS would then provide feedback to MWP by April 1st, which would give MWP time to prepare for the operation of the project in advance of the fall migration period.

7. CONCLUSION

The information and analysis presented in this Biological Assessment indicates that Indiana bats may migrate through the action area and was the basis for the finding by DOE that the proposed project warrants an effect determination of **May Affect** for the Indiana bat.

DOE concludes that a determination of **Likely** to **Adversely Affect** is warranted based on the following rationale:

- Migrating Indiana bats might be present in the action area.
- During operation of the MWTP, migrating Indiana bats could be directly affected when struck or otherwise harmed by spinning turbine blades.

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Attachment F-2

USFWS Biological Opinion on the Monarch Warren County Wind Turbine Project

BIOLOGICAL OPINION

ON THE

EFFECTS OF THE MONARCH WARREN COUNTY WIND TURBINE PROJECT

IN LENOX TOWNSHIP, WARREN COUNTY, ILLINOIS

ON THE FEDERALLY ENDANGERED INDIANA BAT (*Myotis sodalis*)

U.S. Fish & Wildlife Service
1511 47th Ave
Moline, IL 61265

Submitted to the
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Golden Field Office

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Introduction

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) on the effects of the Monarch Wind Turbine Project (MWTP) on the federally endangered Indiana bat (*Myotis sodalis*). Monarch Wind Power (MWP), the operator of the MWTP and recipient of a Department of Energy (DOE) and Illinois Department of Commerce grant, in collaboration with GE Energy, is proposing to construct twelve 1.6-megawatt wind turbines, for a combined generation capacity of 19.2 megawatts, on approximately 600 acres of land leased in Warren County, Illinois.

This BO is based on our review of the Biological Assessment (BA) submitted by DOE on behalf of MWP. It will evaluate the project's effects to listed species and considers the direct and indirect impacts of turbine construction, operation, and maintenance on migratory Indiana bats for the life of the MWTP (up to 25 years).

Species Covered in this Consultation

This consultation covers the federally listed endangered Indiana bat (*Myotis sodalis*). During informal consultation, the Service concurred with DOE's determination that the project may adversely affect the Indiana bat and would have no effect on the eastern prairie fringed orchid (*Platanthera leucophaea*).

Consultation History

9 November 2010 - DOE submitted MWP information packet to the Service.

11 November 2010 - Conference call to discuss MWTP information packet.

9 December 2010 - Conference call between DOE and Service discussing outline for BA.

18 January 2011 - DOE submits Draft BA to the Service.

21 January 2011 - Service provides DOE with comments and recommendations on draft BA.

28 January 2011 - Conference Call with between DOE, Service, and MWP to discuss draft BA.

22 February 2011 - DOE submits final BA and provides a written request for formal consultation.

2 March 2011 - Service provides written acceptance of BA and initiates formal consultation.

21 April 2011 - Service provides draft BO to DOE

Biological Opinion

1. Description of the Proposed Action

The MWTP would involve the construction and installation of twelve 1.6-megawatt wind turbines. MWP has selected the GE 1.6xle model turbine, which has a rotor diameter of 271 feet and a tower height of 328 feet. The turbines would be installed on monopole steel towers and would have a maximum height of 463 feet from the bottom of the tower to the blade tip at its highest point. Underground cables would be installed to conduct electricity from the turbines to a new electrical substation. The facility would connect via the substation to a 69-kilovolt Ameren distribution line that intersects the site on the western side of U.S. Highway 67.

1.1 Project Site

The MWTP would be located on 600 acres of land in Lenox Township, Warren County, Illinois (Figure 1, p.24). The turbines would be located south and northeast of the intersection of U.S. Highway 67 and 140th Avenue (Figure 2, p.25), 4 miles south of Monmouth, Illinois. Seven turbines would be installed on land leased from private landowners and the remaining five would be installed on land leased from Warren County.

The project site consists of agricultural fields where corn and soybeans are usually grown. The site is bounded on the north by the Burlington Northern Santa Fe railroad line and surrounded by cultivated land in every direction. Route 67, a four-lane highway, intersects the site (Figure 2). Areas of ground disturbance would be limited to approximately 16 acres, including access roads and equipment staging/laydown areas. The approximate center point of the project area is 40º50’1” N, 90º39’29” W.

MWP will site all infrastructure within a previously disturbed landscape, particularly within tilled agricultural fields, and will site infrastructure more than 2.5 miles away from all suitable Indiana bat maternity habitat and more than 1,000 feet from potential bat habitat (i.e., wooded corridors, ponds, etc.).

1.2 Project Description

The description of the MWTP provided in the BA contains detailed information regarding construction and installation, aviation marking, operations and maintenance, and decommissioning of the facility. In general, the MWTP will undergo construction beginning the spring-summer 2011 and be fully operational within 12 months. This includes the construction of both above and below-ground infrastructure within the action area. MWP will operate and maintain all components of the wind energy facility throughout the duration of the project, 25 years, and be responsible for decommissioning and/or replacement of turbines that have reached the end of their functional lives.

1.3 Action Area

The project action area is defined as all areas to be affected directly or indirectly by the proposed project and not merely the area immediately adjacent to the project location. Therefore, the project action area includes the project footprint and geographic extent of area that could be affected by construction or operational activities either directly, indirectly, or through interrelated or interdependent actions.

As described above, about 16 acres of cultivated land would be disturbed within a 600-acre area during development of access roads and installation of the wind turbines, electrical cables, and substation (Figure 2). The Service concurs with the conclusion in the BA that an action area of one mile surrounding the 12 turbines is the maximum geographic extent of areas that will be affected by the construction and operation of the MWTP (Figure 3, p. 26). This action area includes all sites that would be temporarily or permanently disturbed during construction, as well as areas that may be affected during operations.

2. Status of the Species

2.1 Species Description

The Indiana bat is a temperate, insectivorous, migratory bat that hibernates in caves and mines in the winter, and spends the summer in wooded areas. It is a medium-sized bat, having a wing span of 9 to 11 inches and weighing only one-quarter of an ounce. The fur is described as dull pinkish-brown on the back and somewhat lighter on the chest and belly. The ears and wing membranes do not contrast with the fur (Barbour and Davis 1969). The Indiana bat closely resembles the little brown bat (*Myotis lucifugus*) and the northern long-eared bat (*Myotis septentrionalis*). It is distinguished from these species by its shortened feet and toe hairs and a slightly keeled calcar.

2.2 Regulatory Status

The Indiana bat was officially listed as an endangered species on March 11, 1967 (Federal Register 32[48]:4001), under the Endangered Species Preservation Act of October 15, 1966 (80 Stat. 926; 16 U.S.C. 668aa[c]). In 1973, the Endangered Species Preservation Act was subsumed by Endangered Species Act and the Indiana bat was extended full protection under this law.

Critical habitat was designated for the species on September 24, 1976 (41 FR 14914). Thirteen hibernacula, including 11 caves and two mines in six states, were listed as critical habitat including Blackball Mine in LaSalle County, Illinois.

2.3 Life History

In winter (typically October through April), Indiana bats hibernate in caves or mines, often with other species (USFWS 2007). In spring, males and non-reproductive females may migrate long distances to their summer habitat (Kurta and Rice 2002). Likewise, reproductive females may migrate long distances to summer habitat – (up to 357 miles based on data from Winhold and

Kurta 2006) or they may form maternity colonies only a few miles from their hibernaculum. Both males and females return to hibernacula in late summer or early fall to mate (swarm) and store up fat reserves for hibernation. By mid-November, male and female Indiana bats have entered hibernation. They typically reemerge in April, at which time they again seek their summer habitat. A brief chronology of the Indiana bat's life cycle is given in Figure 4 below and the Indiana Bat Draft Recovery Plan (USFWS 2007) provides a comprehensive summary of Indiana bat life history.

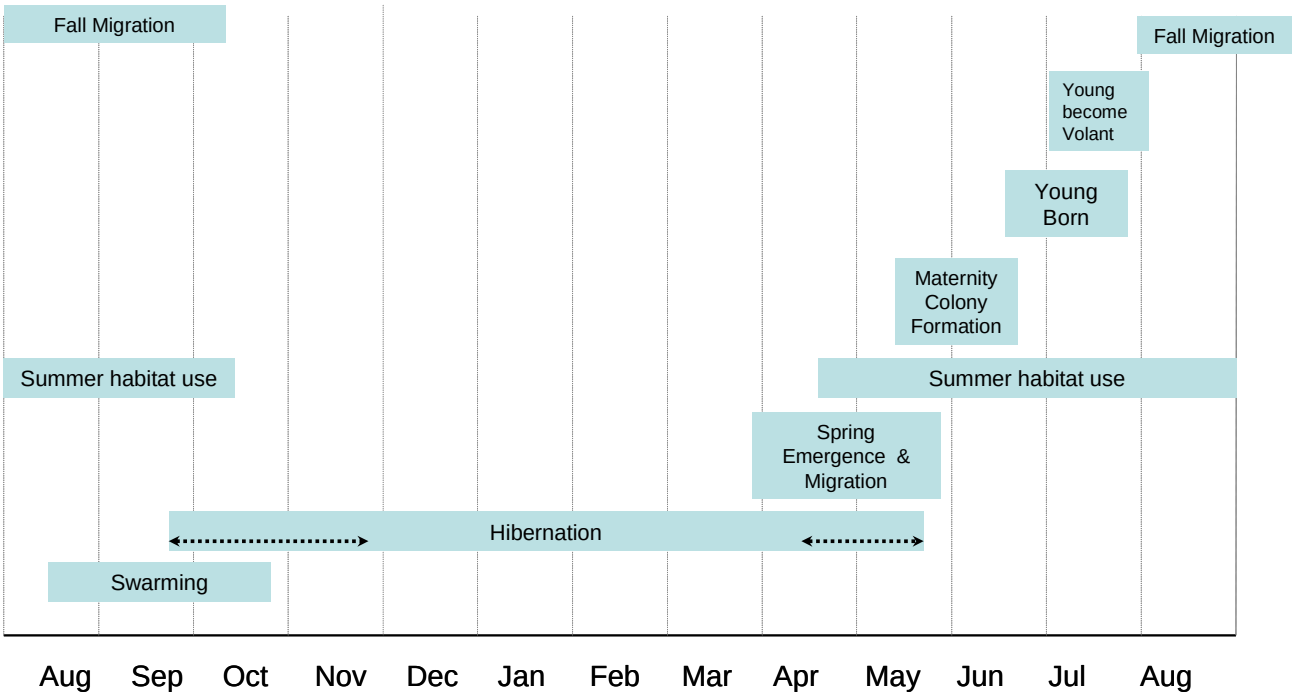

Figure 4. Indiana bat annual chronology.

After hibernation ends in late March or early April, most Indiana bats emerge, and forage for a few days or weeks near their hibernaculum before migrating to their traditional summer roosting areas. Female Indiana bats emerge first from hibernation in late March or early April, followed by the males. The timing of annual emergence may vary across their range, depending on latitude and annual weather conditions. Shortly after emerging from hibernation, the females become pregnant via delayed fertilization from the sperm that has been stored in their reproductive tracts through the winter (USFWS 2007). Most populations leave their hibernacula by late April. Migration is stressful for the Indiana bat, particularly in the spring when their fat reserves and food supplies are low. As a result, adult mortality may be the highest in late March and April.

Most bats migrate to the north for the summer, although other directions have been documented (USFWS 2007, Gardner and Cook 2002). A stronger homing tendency has been observed along a north-south axis, than the east-west direction in release studies. Females can migrate hundreds of miles north of the hibernacula. Less is known about the male migration pattern, but many

males summer near the hibernacula (Whitaker and Brack 2002, USFWS 2007).

Females arrive in summer habitat as early as April 1. Temporary roosts are often used during spring until a maternity roost with large numbers of adult females is established. Female Indiana bats exhibit strong site fidelity to summer roosting and foraging areas; that is, they return to the same summer range annually to bear their young. Trees in excess of 16 inches diameter at breast height (dbh) with exfoliating bark are considered optimal for maternity colony roost sites, but trees in excess of 9 inch dbh appear to provide suitable maternity roosting habitat (Romme et al. 1995). Cavities and crevices in trees may also be used for roosting. In Illinois, Gardner et al. (1991) found that forested stream corridors and impounded bodies of water were preferred foraging habitats for pregnant and lactating Indiana bats.

Most documented maternity colonies have 50 to 100 adult bats (USFWS 2007). Fecundity is low with female Indiana bats producing only one young per year in late June to early July. Young bats can fly between mid-July and early August, at about 4 weeks of age. Mortality between birth and weaning was found to be about 8% (Humphrey et al. 1977).

Many males stay near hibernacula (i.e., caves and mines) and roost individually or in small groups during the summer (Whitaker and Brack 2002). The later part of the summer is spent accumulating fat reserves (USFWS 2007). Males have been observed roosting in trees as small as 3 inch dbh.

Return to the hibernacula begins for some males as early as July. Females typically arrive later and by September numbers of males and females are almost equal. By late September many females have entered hibernation, but males may continue swarming well into October in what is believed to be an attempt to breed with late arriving females. Swarming is a critical part of the life cycle when Indiana bats converge at hibernacula, mate, and forage until sufficient fat reserves have been deposited to sustain them through the winter (Cope et al. 1977, USFWS 1983). Swarming behavior typically involves large numbers of bats flying in and out of cave entrances throughout the night, while most of the bats continue to roost in trees during the day. Swarming continues for several weeks and copulation occurs on cave ceilings near the cave entrance during the latter part of the period (USFWS 2007). Adult females store sperm through the winter and become pregnant via delayed fertilization soon after emergence from hibernation. Young female bats can mate in their first autumn and have offspring the following year, whereas males may not mature until the second year. Limited mating activity occurs throughout the winter and in late April as the bats leave hibernation (Hall 1962).

2.4 Species Range and Population Status

The species range includes much of the eastern half of the United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. The Indiana bat is migratory, and the above described range includes both winter and summer habitat. The winter range is associated with regions of well-developed limestone caverns. Major populations of this species hibernate in Indiana, Kentucky, and Missouri. Smaller winter populations have been reported from Alabama, Arkansas, Georgia, Illinois, Maryland, Mississippi, New York, North Carolina,

Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia, and West Virginia. More than 85% of the entire known population of Indiana bats hibernates in only nine caves.

The 2009 range-wide population estimate of Indiana bats is 387,835 based on winter hibernacula survey information compiled by the Service. The 2009 survey results show a 17.2 % population decline from the 2007 estimates, some of which is attributed to white-nose syndrome (WNS) (see "New Threats" section). Table 1 provides a detailed breakdown of the range-wide population estimates by Fish and Wildlife Service Region and by State from 2001 to 2009 (USFWS 2010). Illinois hibernacula support about 13.7 % of the entire population.

Recovery Unit	2001	2003	2005	2007	2009
Ozark – Central (AR, IL, MO, OK)	43,151	63,631	73,337	71,819	68,430
Midwest (AL, IN, KY, MI, OH, TN, SW. VA)	238,739	246,673	285,729	320,300	258,733
Appalacian Mtns. (E. TN, PA, NC, VA, WV)	16,384	19,659	23,672	22,295	27,458
Northeast (NY, NJ, VT)	30,252	34,097	42,667	53,767	33,214
Totals:	328,526	364,060	425,405	468,181	387,835

Table 1. Range-wide population total estimates, and breakdown of population by Recovery Unit.

The abundance of Indiana bats in the northeast has declined to 2003 population levels due to WNS, and the threat to the continued existence of the species from WNS remains high. Recovery efforts are primarily focused on the WNS investigation at this time and its source. As of the fall of 2009, the Service considers the overall Indiana bat population trend to be declining as WNS continues to spread.

The Ozark-Central Recovery Unit is the second largest of the Indiana bat recovery units and includes the project area. There were 71,819 bats estimated from hibernacula counts for 2009 for this recovery unit. WNS has not yet impacted population numbers in this recovery unit. However, the Service anticipates that future declines to the Ozark-Central Recovery Unit are likely as a result of WNS spreading into major hibernacula in Illinois and Missouri.

Blackball Mine is the fourth largest hibernaculum for Indiana bats (Table 2) in the Ozark-Central Recovery Unit. It is an abandoned dolomite limestone mine encompassing 211 acres and is owned by the Illinois Department of Natural Resources. Indiana bats migrating from Blackball Mine have been documented as using maternity sites to the southeast and to the southwest (Gardner and Cook 2002).

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	20011
1,562		1,648		1,804		2,513		2,513		

Table 2. Winter Population Estimate for Blackball Mine, LaSalle Co., IL 2001-2009. Mine was not surveyed in 2009, previous survey's results applied and projected red.

Known summer occurrences cover a broader geographic area than its winter distribution including southern Iowa, northern Missouri, much of Illinois and Indiana, southern Michigan, Wisconsin, western Ohio, and Kentucky.

2.5 Reasons for Listing

The original recovery plan (USFWS 1983) and the 2009 Five-Year Review (USFWS 2009) identified threats as natural hazards (i.e., flooding, freezing, mine ceiling collapse), human disturbance and vandalism at hibernacula, deforestation and stream channelization, pesticide poisoning, indiscriminate scientific collecting, handling and banding of hibernating bats by biologists, commercialization of hibernacula, exclusion of bats from caves by poorly designed gates, man-made changes in hibernacula microclimate (blocking or adding entrances and/or by poorly designed gates), and flooding of caves by reservoir developments.

Several of the original threats listed above have largely been addressed and are no longer adversely affecting the species to the extent they once had (i.e., human disturbance at hibernacula, indiscriminate scientific collecting, banding of hibernating bats, commercialization of hibernacula, and poorly designed cave gates). The 2007 agency draft recovery plan (USFWS 2007) identified additional threats including: quarrying and mining operations (summer and winter habitat), loss and degradation of summer, migration, and swarming habitat, loss of forest habitat connectivity, some silvicultural practices and firewood collection, disease and parasites, predation, competition with other bat species, environmental contaminants, climate change, and collisions with man-made objects (i.e., wind turbines, communication towers, airstrikes with airplanes, and roads). With few exceptions, all of these identified threats are still affecting the species to varying degrees.

2.6 New Threats

WNS is killing cave-dwelling bats in unprecedented numbers in the northeastern United States and is associated with the fungus *Geomyces destructans* (Gargas *et al*. 2009). It was first documented at four sites in eastern New York in the winter of 2006-07. The most obvious symptom of WNS is the presence of a white fungus on the face, wing, or tail membranes of many, but not all, affected animals. Behavioral changes are also indicative of WNS affliction, characterized by a general shift of animals from traditional winter roosts to colder areas, or to roosts unusually close to hibernacula entrances. Affected bats are generally unresponsive to human activity in the hibernaculum, and may even fail to arouse from torpor when handled. Bats at affected sites are regularly observed flying across the mid-winter landscape, and on occasion, carcasses of little brown bats by the hundreds to thousands have been found outside affected hibernacula with more found inside. Affected animals appear to be dying as a result of depleted fat reserves, and mortalities are first apparent months before bats would be expected to emerge from hibernation.

Overall mortality rates (primarily of little brown bats) have ranged from 81% to over 97% at several of the sites where data have been collected for at least two years (Hicks *et al*. 2008).

WNS has now been documented in 11 states, and the degree of impact to bats appears to vary greatly by site and species. Based on observations of continued mass-mortality at several sites in the Northeast and mid-Atlantic regions, we anticipate that WNS will continue to spread rapidly, moving into and through the Midwest, South and eventually Great Plains over the next couple of years. If current trends for spread and mortality at affected sites continue, WNS threatens to

drastically reduce the abundance of many species of hibernating bats in much of North America. Population modeling indicates a 99% chance of regional extinction of the little brown bat within the next 16 years due to WNS (Frick *et al*. 2010). The closely-related Indiana bat may be equally vulnerable due to its smaller range-wide population and social behavior traits that increase the risk of bat-to-bat transmission. European *myotis* species are apparently resistant to *Geomyces destructans*, which suggests some level of resistance has developed. This resistance in European bats may hold the key to preventing bat extinctions in North America due to WNS.

The proliferation of commercial-sized wind turbines across the landscape of the United States poses a new threat to the Indiana bat. An injunction by Federal court issued to Beech Ridge wind energy project underlined the need for project proponents to seriously consider impacts to the federally listed endangered bats when developing such projects. Many project developers, including MWP, are now reviewing project alternatives to minimize harm to bats from project operation.

2.7 Recovery Criteria and Recovery Units

Since the Indiana bat's initial listing, the recovery program has largely been focused on protection of important hibernacula (USFWS 1983). The proposed recovery program outlined in the draft Recovery Plan (USFWS 2007) has four broad components: (1) range-wide population monitoring at the hibernacula with improvements in survey techniques; (2) conservation and management of habitat (hibernacula, swarming, and summer); (3) further research into the requirements of and threats to the species; and (4) public education and outreach. This recovery program continues to have a primary focus on protection of hibernacula but also increases the focus on summer habitat and proposes use of Recovery Units.

The Service's proposed delineation of Recovery Units (RUs) relied on a combination of preliminary evidence of population discreteness and genetic differentiation, differences in population trends, and broad-level differences in macrohabitats and land use (USFWS 2007). The Indiana Bat Draft Recovery Plan proposes four RUs for the species: Ozark-Central, Midwest, Appalachian Mountains, and Northeast (USFWS 2007).

MWTP falls within the proposed Ozark Central RU, which in the winter of 2008-2009 contained less than one fifth (18%) of the range-wide Indiana bat population (Table 2).

In 2009, there were 2,400 maternity colonies estimated rangewide for the Indiana bat. The 2,400 maternity colonies is an estimate based on 269 known locations. Thus, 11% of all estimated colonies are known. In addition, about 10% of all known maternity colonies are located in Illinois (USFWS 2009).

2.8 Environmental Baseline

The BA adequately describes the status of the Indiana bat in the project area. No known maternity colonies occur within the project area or within a two and one-half mile diameter outside the project circumference. Maternity colonies are known to occur in the county directly adjacent and west of the project area in Henderson County (FWS 2007). Thus, we do not

anticipate impacts to summering Indiana bats at this project site since there is no summering habitat in the project vicinity and Indiana bats tend to limit their foraging within two and one half miles of their maternity colony based on expert information provided to the Service.

However, the location of the known maternity colonies to the west of the project county may influence the presence of migrating Indiana bats in the vicinity of the project area. The project area appears to be within the general line of flight for Indiana bats using Blackball Mine as a hibernaculum and bearing young in maternity colonies to the south and west. Gardner and Cook (2002) reported Indiana bat migration from Blackball Mine to a Missouri maternity roost just west of Adams County, Illinois. Although the exact flight path is unknown, it is likely that similar migrations occur from Blackball Mine west and south to maternity colonies in suitable habitat along tributaries of the Mississippi River. Indiana bats migrating out of Blackball Mine have also been documented moving east and south to maternity habitat in west central Kentucky (Gardner and Cook 2002). Since no occupied maternity habitat is known north of Blackball Mine or south within one hundred miles, it appears that the most likely direction Indiana bats fly out of Blackball Mine seeking maternity habitat is west and southwest, and east and southeast. Thus, it is not unreasonable to assume that a proportion of the bats hibernating in Blackball Mine migrate near or through the project area during their biannual migrations between their summer and winter habitats.

Blackball Mine is listed as critical habitat and is located about 100 miles east northeast of the project site. Indiana bat use of Blackball Mine has almost doubled in the past ten years with an estimated 2,500 Indiana bats hibernating there in 2009. At this time, however, Blackball Mine remains a Priority 2 hibernaculum (FWS 2007) and its population contributes less than 4 % of the total estimated population of the Ozark Central Recovery Unit.

3. Effects of the Action

"Effects of the action" refers to the direct and indirect effects of an action on listed species or critical habitat, together with the effects of other activities interrelated and interdependent with that action which will be added to the environmental baseline. The Endangered Species Act defines indirect effects as those caused by the proposed action and that are later in time, but are still reasonably certain to occur (50 CFR §402.02). Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

Our effects analysis considered each of the five stages of the Indiana bat’s annual cycle: hibernation, spring migration, summer period, fall migration, and swarming. No summer, winter, swarming habitat, or critical habitat are located within or adjacent to the project area, so no adverse effects are anticipated to these habitats from the MWTP. The effects of this action are direct effects, occurring while the turbines are in operation during bat migration periods. Below we have assessed the various project components and their anticipated effects on Indiana bats. Minimization measures are considered part of the proposed action, so the effects of these measures in reducing or partially offsetting effects on Indiana bats are considered as well.

3.1 Direct Effects

Direct effects are defined as the direct or immediate effects of the project. Direct effects include all immediate impacts (negative and beneficial) from project-related actions and those disturbances that are directly related to project elements that occur very close to the time of the action itself. It is important to note for the MWTP, the action area contains no suitable Indiana bat habitat within 2.5 miles and there are no known collection records for this county.

3.1.1 Project Construction

- Construction of the MWTP, including installation of the wind turbines, electrical distribution lines, substation, and other required infrastructure will not result in a modification of Indiana bat behavior. The construction of the MWTP will occur entirely during daylight hours within a cultivated agricultural landscape primarily used to grow corn and soybeans.

- The creation of airborne dust by construction equipment is likely to occur in all earth moving projects, but the magnitude is dependent on many factors, including humidity, wind velocities and direction, and location of soil disturbances. Dust will be created during autumn when Indiana bats will be traversing through the project area; however, this is not expected to exceed the dust created by routine autumn agricultural activities in this area of Illinois.

3.1.2 Project Maintenance and Operation

- Project maintenance is expected to include periodic maintenance of transmission lines, roads, turbines, turbine pads, transmission line right-of-ways, and road right-of-ways. Maintenance will occur during daylight hours throughout the life of the project. Daytime activities should have no adverse effect on the Indiana bat during any part of its life cycle.

- No air pollutants would be released during operation of the project and amounts of lubricants and other hazardous materials released into the environment during operation will likely be insignificant.

- Road use during project operation is not expected to harm Indiana bats because vehicle traffic will be restricted to the time between sunrise and sunset, when Indiana bats are inactive.

- Eight perimeter turbines will be outfitted with synchronized flashing red lights as required by the Federal Aviation Administration (FAA) and used during nighttime hours only. Studies indicate there is no statistical difference in bat mortality rates between turbines lit according to FAA standards and unlit turbines (Arnett *et al*. 2008, Horn *et al*. 2008).

3.1.3 Turbine Operation

- During the turbine operation phase of the MWTP, migrating Indiana bats could be killed or injured during their migration period by spinning turbine blades, as has been documented at other wind energy projects (e.g. Fowler Ridge Wind Farm).

- Migrating bats may be struck by the spinning blades or experience pulmonary hemorrhaging by the significant pressure difference surrounding an operating turbine, a condition known as barotrauma. Baerwald et al. (2008) found internal hemorrhaging in 92% of bats that were necropsied, indicating that internal injury is common at wind facilities.

- Traumatic injuries (sheared off wings, headless bodies, head injuries, gashes on the body, etc.) are consistently reported by researchers. At the Buffalo Mountain, Minnesota wind farm, for example, 43.3% of the 522 bodies had evidence of a major injury (Johnson et al. 2003, Johnson pers. comm.). Thus, data indicate that collision with moving turbine blades is a major contributor of bat fatalities.

- Project siting has avoided close proximity to summer, winter or swarming habitats. Thus, Indiana bats are not expected to be adversely affected by MWTP during these periods.

3.1.3.1 Mortality Risk

Operating wind turbines pose a risk of killing and injuring bats, including Indiana bats. Risk appears to be a complex interplay between turbine characteristics, environmental conditions, and bat behavior. Turbine characteristics that influence risk include turbine height, rotor diameter, and rotor swept area, all of which are positively correlated with bat mortality (Arnett *et al*. 2008). It is the spinning turbine blades that pose the mortality risk; no bat fatalities have been reported due to non-operational turbines (Arnett 2005, Kerns and Arnett 2005). Environmental factors that appear to influence risk include geographic location, wind speed, weather patterns, surrounding habitat, and insect activity (Arnett *et al*. 2008, Horn *et al*. 2008). Some Midwestern studies have documented significant levels of bat mortality (Drake *et al.* 2009, Johnson *et al.* 2009, BHE Environmental 2010, Johnson *et al.* 2010, Good *et al.* 2011). Additionally, mortality appears to be highest on low wind nights after storms (Kerns *et al*. 2005).

Bat behavior also appears to have a significant influence on mortality risk. While bats should be able to use echo-location to both detect and avoid collisions with wind turbines, this does not appear to be always the case. During studies at the Mountaineer wind facility with an average detection of 99 bats per night, bats were frequently observed near operating wind turbines, with the majority of bats foraging and flying at the range of altitudes at which the turbine blades were operating. Bats were also observed to investigate moving blades with repeated fly-bys, take evasive maneuvers near moving blades, succumb to being stricken by moving blades, and investigate and alight on turbine monopoles and stationary blades (Horn *et al*. 2008). Horn *et al*. (2008) noted that many of the instances of avoidance behavior involved multiple passes. Bats

often appeared to investigate the turbine blades after a near miss, rather than fly off quickly. This often resulted in several additional near misses in a row, with the bat appearing to be repeatedly buffeted by turbulence close to the blade surface. Bats exhibiting the above behavior were not identified down to the species level; and thus, it is not yet determined whether the behavior observed in this study represents Indiana bat behavior in response to wind turbines.

This tendency of bats to forage and fly within the rotor swept area, and to investigate monopoles and moving turbine blades, makes the bats highly susceptible to mortality through a direct strike by a moving blade or through the fatal effects of barotrauma. Studies have found that the pressure differential near spinning turbine blades is so significant that it causes pulmonary hemorrhaging (barotrauma) in bats (Baerwald *et al*. 2008). While direct contact with turbine blades was evident in about half of the examined bats, over 90% of the fatalities involved internal hemorrhaging consistent with barotrauma. Approximately 57% of the bats had internal hemorrhaging, but no external signs of injury (Baerwald *et al*. 2008).

The potential for interactions between operating wind turbines and Indiana bats is present on the MWTP during the bat's spring and fall migratory periods. Spring migration in northwest Illinois typically occurs during the entire month of April, a shorter time frame than fall migration. The shortened migration during spring may make bats less vulnerable to collision at the MWTP during this time period. To date, the number of fatalities during the spring migration period significantly lags behind those in reported in summer and fall (Arnett *et al.* 2008), and no known mortalities of Indiana bats have occurred during spring migration (Johnson *et al.* 2010, Good *et al.* 2011, and others).

Fall migration may start as early as late July (for males) to mid-August (females) and may extend through mid-October. Two Indiana bat fatalities have been documented at Fowler Ridge Wind Farm (northwest Indiana) in habitat types similar to the MWTP; and thus, it is reasonable to conclude the MWTP poses a similar mortality risk to Indiana bats during fall migration throughout its functioning life.

3.1.3.2 Estimating Mortality

The Service estimates the MWTP will cause bat mortality at rates similar to other wind developments in highly agricultural areas of the Midwest within the range of the Indiana bat. Two of the most complete and thorough studies conducted to date in the Midwest occurred at Fowler Ridge Wind Farm in west-central Indiana (Good *et al.* 2011), and Twin Groves Wind Farm in central Illinois (Johnson *et al.* 2010). The results of these studies were used to ascertain a baseline bat mortality prediction for this action because of landcover similarities between the MWTP and the above farms and, because the metrics and protocols used were nearly identical between studies. The most robust data sets attained from the Fowler Ridge (136 of 355 turbines surveyed) and Twin Groves (39 of 240 turbines surveyed) Wind Farms were collected in their second year of study, and documented 774 and 378 bat fatalities for this one year period, respectfully. Dividing the bat fatalities by the number of turbines studied yields an average bat mortality at these

sites to be 5.69 (Fowler Ridge Wind Farm) and 9.69 (Twin Groves Wind Farm) bats/turbine/study period. However, these data only represent the number of bat fatalities found near surveyed turbines during a limited period of searching time. Adjusted fatality estimates are necessary to account for the likelihood of scavenging, searcher efficiency, wounded individuals that may remove themselves from the search plot, bats that may fall outside the search plot, and fatalities that occur outside the study window. The final adjusted fatality estimates for the Fowler Ridge and Twin Groves Wind Farms, accounting for the above, are 22.20 and 19.47 bats/turbine/year, respectively.

The annual mortality rate per turbine for the MWTP will assumedly be near the mean of the Fowler Ridge Wind Farm and Twin Groves Wind Farm data, 20.84 bats. To calculate the average yearly mortality of bats at the MWTP we multiplied the predicted mortalities per turbine, 20.84, by the total number of turbines, 12. The anticipated number of mortalities of all bats per year at the MWTP is therefore 251 bats. Indiana bat take over the life of the project was projected by multiplying the yearly mortality rate of the MWTP by the life of the project (result: 6,275 bats), and then assuming Indiana bats comprise a small percentage of these mortalities.

Indiana bat occurrence was estimated by again using bat fatality data from the Fowler Ridge Wind Farm and Twin Groves Wind Farm. Out of 1152 (774 Fowler Ridge Wind Farm and 378 Twin Groves Wind Farm) total bat fatalities from the second year of study from both projects, one Indiana bat was killed. The resulting proportion of Indiana bat to non-Indiana bat fatalities was 0.087% (1/1152 = 0.00087). Given the that 251 bats are projected to be killed yearly at MWTP, we estimate 0.087% of these bats will be Indiana bats, or about one Indiana bat taken every five years, with a total projected take over the 25 year life of the MWTP of about six, all of which are assumed to be taken during the fall migratory period.

3.1.3.3 Risks to Local Bat Populations, Maternity Colonies, and Hibernacula

Indiana bats taken by the MWTP are presumed to be non-reproductive juveniles as well as adult female and male Indiana bats. Because both sexes of Indiana bats appear to be equally susceptible to risk of collision, the take of Indiana bats at wind turbines is assumed to be equal for males and females (USFWS 2007). In addition, there is no evidence that suggests either juveniles or adults are more susceptible to collision than the other. Thus, we assume that all fatalities will be evenly distributed across all age classes and sexes.

Given that migratory corridors for Indiana bats in the Midwest remain generally unknown, we believe that any females being taken as a result of this action are most likely to originate from differing maternity colonies at irregular intervals. Maternity colony size has been documented in literature as typically hosting fewer than 100 individuals with an average of 60-80 breeding females (Whitaker and Brack 2002, Kurta 2005, USFWS 2007). Although it is likely that Indiana bats migrating in through the project area will be from more than one hibernaculum and more than one maternity colony, we cannot predict with a high level of certainty from which hibernating populations or maternity colonies these bats will originate. We assume if a relatively

small number of bats abandoned a colony, that affected maternity colony would experience either no impacts or only a short-term reduction in reproductive output. In the event that all the female Indiana bat fatalities for MWTP originated from the same maternity colony, we estimate that the impact would not adversely affect the maternity colony as the take is not likely to exceed one individual in any five years and is not likely to exceed three females over the 25 year life of the project. Thus, the impact from take of Indiana bats at the MWTP is not expected to result in permanent loss of reproductive potential of a maternity colony or the maternity colony itself. In addition, the very low quantity of take is not expected to directly or indirectly cause an appreciable reduction in the reproduction, numbers or distribution of the Indiana bat as a species.

The estimated total amount of take (six Indiana bats) only represents 0.01% of the estimated 2009 winter population within hibernacula in the State of Illinois (53,276 Indiana bats). Loss of this small number of bats will not be sufficient to adversely impact any hibernating populations to which these individuals belong. It will also have no adverse impact on the Blackball Mine Critical Habitat hibernaculum since loss of no more than six individuals over a 25 year span will not impair population numbers and will not impact constituent elements of the critical habitat.

3.2 Indirect Effects

Indirect effects include those effects that are caused by or would result from the proposed project and are later in time, but are still reasonably certain to occur. Because there are no known hibernacula, maternity, roosting, or foraging habitats within or near the action area, no indirect take of Indiana bats is anticipated.

3.3 Effects of Interrelated and Interdependent Actions

Interdependent actions have no independent utility apart from the proposed project and interrelated actions are part of a larger action and depend on the larger action for their justification. No interdependent or interrelated actions are known to be associated with the proposed project.

The proposed project would be a single and complete action; therefore, no effects from interdependent or interrelated actions are anticipated.

3.4 Cumulative Effects

As defined under the implementing regulations of the Endangered Species Act, cumulative effects are those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation. There are no other planned non-Federal (or Federal) actions that are reasonably certain to occur within the action area shown in Figure 3. However, two additional wind projects are proposed for Warren County, each with 134 wind turbines and a capacity of 134 megawatts. The Coldbrook-Alexis Wind Farm would be located in Coldbrook Township, over 10 miles northeast of the proposed MWTP site. The EcoPoint Wind Farm would be located in Point Pleasant, Swan, and Sciota Townships, over 10 miles south and southwest of the MWTP.

No cumulative impacts within the action area are anticipated, as no other reasonably foreseeable projects are planned to occur within its boundaries. The potential exists for cumulative impacts to occur outside the action area from installation of wind turbines in the region.

3.5 Conclusion

The analysis of the possible effects indicates that Indiana bat take may potentially occur during the spring and fall migration period. However, the best available scientific information presented above indicates that the likelihood of take during spring migration is low due to the short duration of the migration period and the small number of turbines located in the project area. Take during the fall migration period remains likely though limited (no more than six Indiana bats over the 25-year life of the project) due to the small number (12) of turbines.

The proposed action will have minimal, short-term effects on these bats' respective maternity colonies and hibernating populations. It will have no adverse impact on the Blackball Mine Critical Habitat since, in the worst case where all Indiana bats taken were from the same hibernaculum, a loss of no more than six individuals over a 25 year span will not detectably reduce population numbers and will not impact constituent elements of any critical habitat. Similarly, loss of these individuals will have no adverse effect on the viability of any single maternity colony in the vicinity of the project area due to the low numbers predicted to be lost over a relatively long time period. Nor will this project result in a detectable difference in reproduction, numbers, or distribution of Indiana bats in the Ozark-Central Recovery Unit level or in the species' overall range.

After reviewing the current status of the Indiana bat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that granting funds for this project as proposed is not likely to jeopardize the continued existence of the Indiana bat or adversely modify critical habitat.

4. Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. 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. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by Fish and Wildlife Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Department of Energy so that they become binding conditions of the grant issued to MWP for the exemption in section 7(o)(2) to apply. The DOE has a continuing duty to regulate the activity covered by this incidental take statement. If the DOE: (1) fails to assume and implement the terms and conditions; or (2) fails to require the grantee adherence to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse.

4.1 Extent of Take

We estimate direct take of Indiana bats will result incidental to operation of the MWTP. The take of Indiana bats will be difficult to detect because: (1) dead or injured bats are difficult to locate due to the bat's small body size and the scavenging rate of their carcasses is high; (2) the number of bats occupying a particular area at a particular time is highly variable and difficult to determine; and (3) the finding of dead Indiana bats among all bats killed at a wind farm is rare. For the MWTP, we estimate that six Indiana bats will be taken over the life of the project (25 years).

4.2 Effect of the Take

In the accompanying BO, the Service determines that this level of expected take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat. Given that no reductions are anticipated in the reproduction, numbers, or distribution of Indiana bats within the Ozark-Central Recovery Unit or in the species' overall range, the action is not likely to jeopardize the continued existence of the Indiana bat.

5. Reasonable and Prudent Measures

The Service has concluded, based on the best information available, that Indiana bats may be present during the spring migration period, and will likely be present within the project area during fall migration. The likelihood of take during spring is low and during fall take is considered likely to occur. No take is expected to occur during the summer or winter due the absence of suitable seasonal habitat in and near the action area. Therefore, the minimization measures below focus on the fall migration period only.

The most effective way known to date to reduce the number of fatalities at wind turbine sites is through the implementation of operational curtailment. Recent studies that have raised cut-in speeds from the factory standards (typically 3.5 - 4.0 meters/second (m/s)) to 5.0 - 6.5 m/s during the fall migratory period (1 August – 1 October) have resulted in a 57-82% reduction in overall fatalities (Baerwald *et al.* 2009, Arnett *et al.* 2010) with relatively small impacts to energy production. The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of Indiana bats.

5.1 Operational Curtailment

Raising cut-in speeds is the measure most likely to reduce Indiana bat mortality at wind farms. MWP will implement an operational curtailment regime of 5.0 m/s for the life of the project that will seek to reduce overall bat mortality and minimize take of Indiana bats. Bat mortality is projected to be reduced by 57-82% (Baerwald *et al.* 2009, Arnett *et al.* 2010) during the fall migration period and we assume that higher cut-in speeds are equally effective at reducing fatalities for Indiana bats. Turbine blades will be feathered until wind speeds capable of generating power are present, thus eliminating any potential for take from blade rotation at wind speeds lower than 5.0 m/s.

6. Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the Act, the DOE or its grantee must comply with the following terms and conditions, which implement the reasonable and prudent measures. These terms and conditions are non-discretionary.

6.1 Raised Cut-in Speeds and Feathering

In an effort to obtain a significant reduction in bat fatalities at the MWTP, all turbines will operate using a raised cut-in speed of 5.0 m/s, during the fall migration period. To achieve the full effectiveness of higher cut-in speeds, MWP will also feather turbine blades to minimize the number of turbine rotations at lower wind speeds.

1. The MWTP will implement cut-in speeds of 5.0 m/s for the life of the project or until new information becomes available to adjust the curtailment regime with approval of this Service.

2. Turbine blades will be feathered at wind speeds below 5.0 m/s for the life of the project or until new information becomes available to adjust the curtailment regime with approval of this Service.

3. Raised cut-in speeds and blade feathering will be used from 0.5 hours before sunset until 0.5 hours after sunrise during the fall migration period, from August 1 to September 30 unless new information becomes available to adjust these times and dates.

4. Spring fatality monitoring will occur in operation years 1, 2, and 3 using protocols designed in conjunction with the Service and incorporating requirements outlined in Sections 6.1 and 6.2. If any Myotid bats are taken during these surveys, MWP will immediately coordinate with the Service to determine if addition years of spring fatality monitoring are necessary.

5. Fall fatality monitoring will occur in operation years 1, 2, 3, 8, 13, 18, and 23 using the protocol designed in conjunction with the Service and incorporating requirements outlined in Sections 6.1 and 6.2.

6. Any alteration to the proposed curtailment regime will be followed by an additional year fall mortality monitoring.

6.2 Requirements for Monitoring

The following is a list of surveying requirements necessary to ensure the anticipated take is not exceeded for this Federal action. This office should be contacted prior to each year's mortality search for coordination purposes. At a minimum, each survey should include the following parameters.

1. ***Frequency*** — Monitoring for all-bat and Indiana bat fatalities is required during the first 3 years of operation for the MWTP during the spring (April 1 – April 30) and fall (August 1 – September 30) migratory periods. Thereafter, mortality monitoring will be required during the fall migratory period only every fifth year unless otherwise agreed upon in writing by this office.

2. ***Intensity*** — Mortality searches should be conducted twice per week throughout the entire migratory season at each turbine within the MWTP complex. Surveys should begin one half-hour after sunrise and turbine survey order should be randomized to eliminate any avoidable searcher and field biases.

3. ***Number of Turbines*** — All 12 turbine sites should be surveyed during the same day, twice weekly.

4. ***Search Area and Protocol*** — Fall migratory period (pre-harvest): Prior to the fall crop harvest, the search area is limited to the immediate area surrounding the turbine and will contain the gravel turbine pad and access road, and other permanent auxiliary infrastructure near the turbine base. Fall (post-harvest) and spring migratory periods: If crops are harvested prior to the completion of the Indiana bat fall migratory period (August 1 – September 30) an 80 meter (m) x 80 m search plot should be established, searched in its entirety, and assigned its own visibility/detectability index. Likewise, an 80 m x 80 m plot should be established during the spring migratory period at those croplands that are cleared.

5. ***Field Bias and Error Assessment*** — Searcher efficiency and scavenger removal trials should be performed the first 3 years of operation only in conjunction spring and fall mortality searches to determine level of scavenging, searcher efficiency, wounded individuals that may remove themselves from the search plot, bats that may fall outside the search plot, and fatalities that occur outside the study window.

6. ***Specimens*** — Non-listed non-myotid bats, once documented as a fatality and removed from the survey area, may be re-used in searcher efficiency and scavenger removal trials.

7. ***Federally Listed Indiana bats, similar Myotids, and Migratory Birds*** — Any dead Myotid bats or migratory birds located at any time within the MWTP boundaries should be reported within 48 hours to the Rock Island Field Office (phone: 309-757-5800). Any

such dead specimens found should be placed in plastic bags and refrigerated as soon as possible following discovery. If fatality estimates for protected species are nearing the maximum permitted take specified in this BO, this office should be contacted and re-initiation of consultation may be necessary.

Federal agencies have a continuing duty to monitor the impacts of incidental take resulting from their activities (50 CFR 402.14(i)(3)). In doing so, the Federal agency or its grantee must report the progress of the action and its impact on the species to the Service as specified below.

In addition to the immediate verbal report of any mortality, the DOE, or its grantee, must supply the Service with written reports, due by December 31 of each year. These reports should specify the progress and results of any terms and conditions that were required, identify the site-specific project, include the number of live or dead Indiana bats encountered, and age, sex, and reproductive status of the bats handled, provide locations and numbers of all-bat mortalities found, provide the appropriate field bias and error assessment for that year, and provide an overall fatality estimate for Indiana bats and all bats. Additionally, the required data (date, species, etc.) for fatality records should be submitted electronically in an Excel spreadsheet. Reports should also attempt to identify a positive correlation between weather patterns and bat movement, or any other weather dependent variable that has the potential to alter the proposed curtailment regime.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take (i.e., accidental death or injury) that might otherwise result from the proposed action.

The Service anticipates that no more than six individual Indiana bats will be incidentally taken as a result of this proposed action over the life of the project in the form of accidental death or injury. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring re-initiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

7. Re-initiation Notice

This concludes formal consultation with the DOE on the effects of the wind development project at MWTP on the federally endangered Indiana bat. As provided in 50 CFR §402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion (i.e., a significant increase in military training activity levels or significantly more night training vs. daytime); or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the

amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

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Figure 1. Location of the Monarch Wind Turbine Project in Warren County, IL

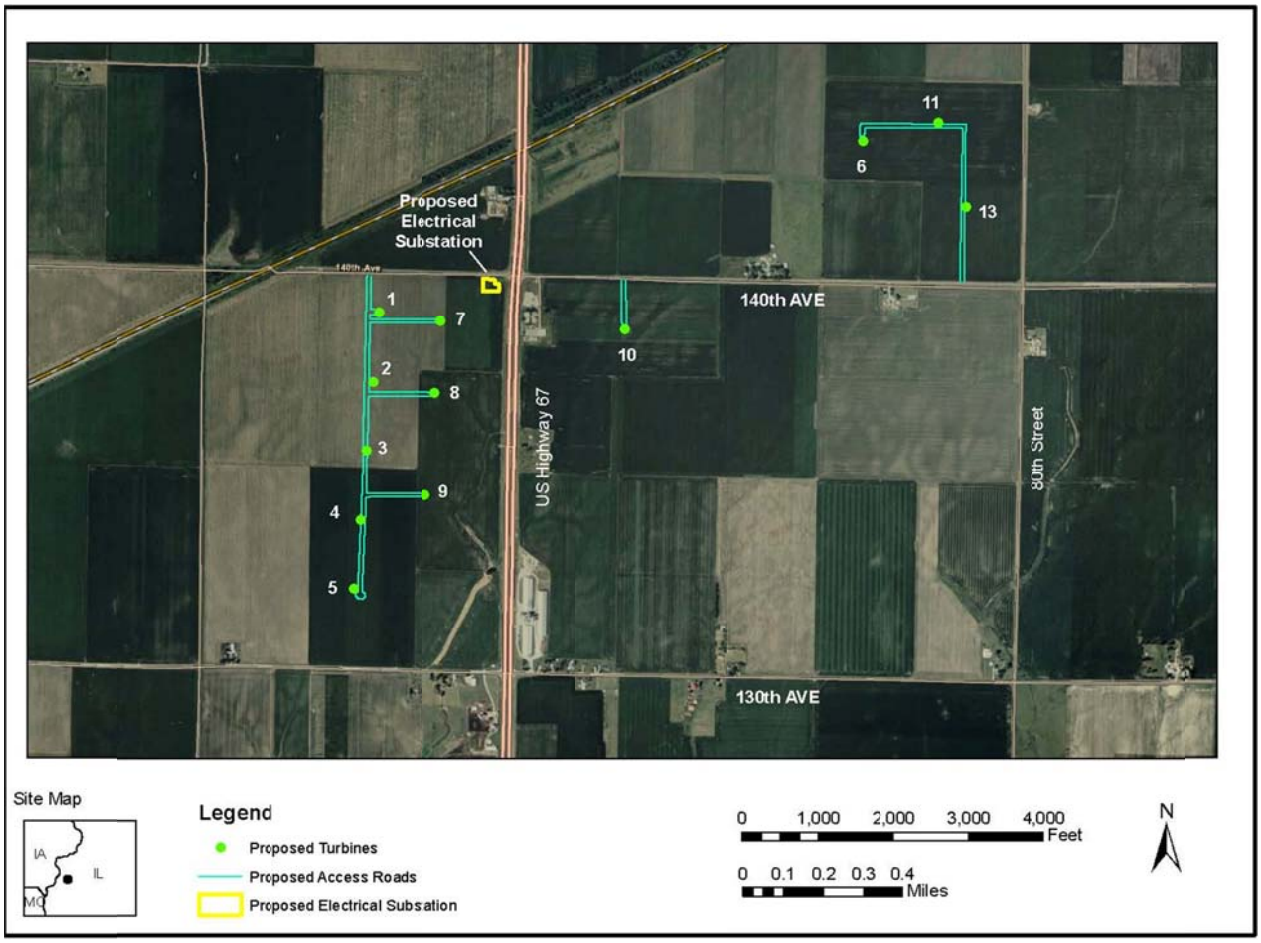

Figure 2. Monarch Wind Turbine Project site layout

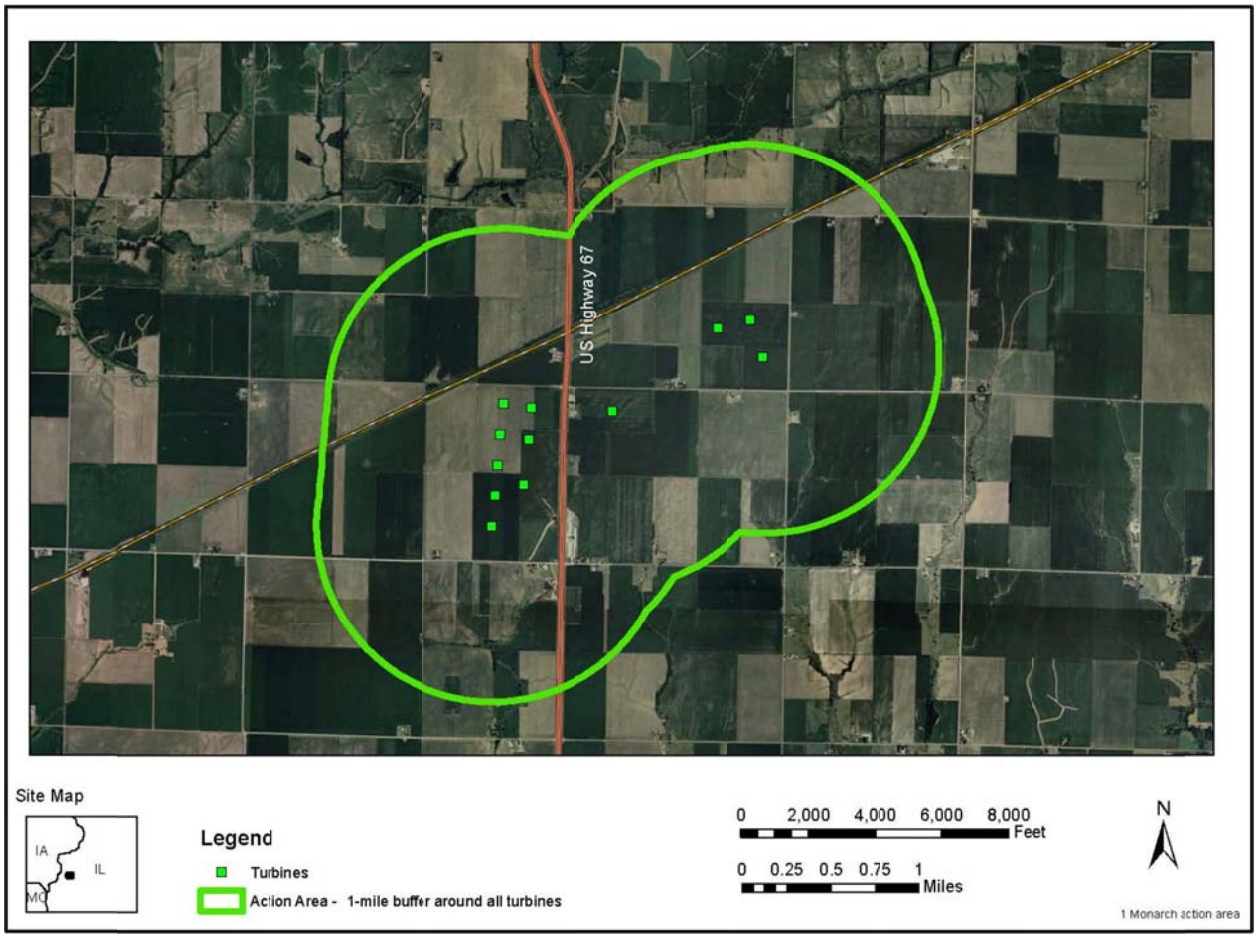

Figure 3. Action Area for the Monarch Wind Turbine Project