

APPENDIX D
MONITORING PLAN

Criterion Wind Project Monitoring Study Plan

MONITORING STUDY PROTOCOL

The following monitoring study protocol is similar to those methods recommended for wind-energy facility monitoring (e.g., WTGFAC 2010, USFWS 2012) and protocols used at wind-energy facilities in the region and throughout the U.S. (Erickson *et al.* 2000; Johnson *et al.* 2000; FPL *et al.* 2001; Erickson *et al.* 2003a, 2003b; Young *et al.* 2003; Kerns and Kerlinger 2004; Arnett *et al.* 2005; Jain *et al.* 2007; Young *et al.* 2009, 2010; Arnett *et al.* 2009, 2010). While the focus of the HCP monitoring plan is to evaluate potential take of Indiana bats and determine the effectiveness of minimization measures, monitoring conducted under this plan will also provide information on impacts for other bat species, and birds including eagles and migratory birds.

CPP has conducted three years of post-construction monitoring, using methods recommended for wind-energy facilities (e.g. WTGAC 2010, USFWS 2012), during the first three years of full project operations (2011-2013). The monitoring occurred during the period April 1 through November 15 which is the period when bats could potentially be active in the project. The goal of the first year of monitoring was to estimate mortality rates of bats and birds including an estimate of Indiana bat mortality, demonstrate compliance with the estimated take, and establish baseline fatalities rates by which the effectiveness of the HCP turbine operations plan can be evaluated. The goal of the second and third year of monitoring was to estimate mortality rates of bats (and birds) and demonstrate the effectiveness of the proposed minimization measures (turbine operational constraints) of this conservation plan. While several studies and monitoring reports have documented the reduction in overall bat mortality with turbine curtailment at low wind speeds (Arnett *et al.* 2011, Baerwald *et al.* 2009, Young *et al.* 2011), comparison of year 1 results to those in years 2 and 3 will provide an estimate of bat mortality reduction from curtailment at the Project, and thus demonstrate the effectiveness of the minimization measures. The monitoring reports for the Project include a comparison of the effectiveness of the turbine operation changes in reducing bat (and bird) mortality.

Monitoring Objectives

The CPP HCP includes measures to minimize impacts to bats through changes in the operations of the turbines. Specifically the turbine blades will be pitched so that the turbine rotation is minimized in winds under 5.0 m/s during the night time period from July 15 to October 15 each year. The intent of this measure is to slow down the turbine blade rotation to approximately 1 rpm or less during low wind speed nights so that risk of collision for bats is minimized.

The following monitoring study protocol is designed to determine compliance with the ITP and effectiveness of the minimization measures at the Project to reduce impacts to bats. The overall predicted impact to Indiana bats is low and the ability to actually measure Indiana bat mortality associated with the project is difficult. However, measures that are intended to reduce impacts to

all bats are believed to also be effective at reducing impacts to Indiana bats. Available information suggests that curtailing turbine rotation under wind speeds of 5.0 m/s will achieve at least a 50% reduction in bat mortality. A reduction of all bat mortality is assumed to have a reduction in Indiana bat mortality by 50% as well, thus reducing Indiana bat mortality to less than one per year on average. Because measuring the rare event of an Indiana bat take is difficult, a reduction in all bat mortality against the baseline conditions (measured in year 2011) of at least 50% during the fall curtailment period will insure that the project is in compliance with the ITP¹.

Permits

Federal and state collecting/salvaging permits will be acquired prior to commencement of the study to enable field technicians to collect and handle carcasses in compliance with laws pertaining to the possession of wildlife and migratory birds.

Casualty handling

Collection of any federal or state endangered, threatened, or protected species found during the monitoring study will be coordinated with the USFWS and MDNR Natural Heritage Program. Criterion will notify the USFWS and MDNR within 24 hours of positive identification of any endangered or threatened species injury or fatality. All federally-listed endangered or threatened species carcasses or eagle carcasses will be transferred to the USFWS. State-listed species carcasses will be transferred to MDNR or their designee. A chain of custody memo indicating the date, carcass identity, and signatures of personnel responsible for the transfer of any wildlife carcasses, including threatened and endangered species and eagles, will accompany the carcasses at the time of the transfer. A copy of the chain of custody memo will be maintained in the project file.

All carcasses found, regardless of species, will be recorded and a cause of death determined, if possible, based on field inspection of the carcass. All carcasses found will be photographed to show field conditions and how the carcass appeared at first detection and to show diagnostic characteristics used for species identification. Any carcass requiring additional study for identification (e.g., feather spot, bat wing) will be labeled with a unique identification number, bagged, and retained for future reference. All non-Indiana bat *Myotis* bats will be collected and held by CPP until USFWS determines the carcasses are no longer needed for inspection and identification verification. Carcasses will be disposed of as directed by the permits; however, it

¹ Currently, the state of the science regarding turbine curtailment studies has shown this measure to be highly effective at reducing all bat mortality. Generally, however, bat mortality at wind projects is composed primarily of migratory tree bats. The ability to distinguish the effectiveness of turbine curtailment measures on other species of bats, which comprise much less of the overall bat mortality, is difficult. It is however, a valid assumption that turbine curtailment is beneficial to all bat species because the act of controlling the rotation of turbine rotors in low wind speeds reduces risk posed by turbine blades by minimizing their speed. Under this assumption it is valid to use all bat mortality as a surrogate measure of the effectiveness of the proposed turbine operational curtailment (the minimization measures) in reducing potential mortality of Indiana bat and little brown bats (which served as the surrogate species in the Indiana bat take calculations for this project), and therefore, compliance with the ITP through achieving a 50% reduction in bat mortality during the fall curtailment period.

will be requested via permit that carcasses suitable for additional use in the study (e.g., searcher efficiency or carcass removal trials) will be used in the study and those not suitable will be disposed of by burial.

Migratory birds will be disposed of at the direction of the USFWS according to permit conditions; non-protected or state-managed bird (e.g., European starling, upland game birds) carcasses will be disposed of according to permit conditions. All intact bat carcasses will be saved or frozen for potential use in the study or in studies independent of this monitoring program related to bat population sizes on a national level. Bat carcasses will be disposed of according to permit conditions if they are not used in the study or for other research.

Any injured bird or bat found during the study will be treated as a casualty for the purposes of the data analysis and reporting, however, injured wildlife will be evaluated for potential rehabilitation. A qualified wildlife rehabilitation facility for injured birds and bats will be determined by CPP. All injured wildlife collected during the study will be transferred and released to the designated facility along with any pertinent information to facilitate rehabilitation.

Incidental finds

Wind-energy facility casualties (fatalities or injured wildlife) may potentially be found by Project personnel or others not conducting the formal searches. These casualties found in non-search areas or during periods outside of the standardized carcass searches will be treated as incidental finds. When non-study personnel discover a casualty, a digital photograph will be taken (if possible), the casualty will be marked in the field, and a study biologist will be notified to identify and record the casualty. Any incidental discovery found within search plots, but not during scheduled searches, will be included in the estimate of mortality as if it would have been found during the next scheduled search. Incidental discoveries made outside search areas will be recorded in the overall data set, but not included in the statistical analysis of overall mortality. Carcass handling, collection, and storage procedures as described above will be followed for incidental finds.

STUDY DESIGN

The monitoring study contains three primary field components: (1) standardized carcass searches, (2) searcher efficiency trials, and (3) carcass removal trials. The number of bird and bat fatalities attributable to collision with the wind turbines will be estimated based on the number of fatalities found in search plots around turbines, whose death appears related to these structures, and adjustments for removal bias (e.g., scavenging), searcher efficiency bias, and casualty distribution. Carcasses where the cause of death is not apparent will also be included in the fatality estimate.

The monitoring will include weekly searches of 14 turbines (50%) from April 1 to November 15 (Table 1). A sampling approach is widely recommended for monitoring studies at wind projects (PGC 2007, NYSDEC 2009, USFWS 2012). This level of effort will provide data sufficient to assess all bat mortality for comparison across all years of monitoring. In addition, an evaluation

will be made each monitoring year utilizing all previous monitoring study results to ensure that the study design for that monitoring year is sufficient to meet the objectives.

Table 1. Criterion Wind Project ITP monitoring program.

Monitoring Type	Objective	Season	Frequency
On-site Monitoring	Assess take of Indiana bats		
2011	Assess take of Indiana bats and determine total bat mortality and seasonality of bat fatalities.	April 1 - Nov 15, 2011	Daily searches of all 28 turbines
2012 and 2013	Assess take of Indiana bats and total bat mortality with curtailment plan	April 1 – Nov 15, 2012 and 2013	Weekly surveys of 14 turbines
Incidental Monitoring of Bird and Bat Casualties	To amplify the monitoring and provide a more complete assessment of project related casualties.	All year	Coincident with routine operations and maintenance activities
Follow-up Monitoring (2018, 2023, 2028)	To insure that total bat mortality with curtailment has not increased and remains within expected levels	April 1 – Nov 15 2018, 2023, 2028	Weekly surveys of 14 turbines, unless new information suggests a better approach.
Adaptive Management Monitoring	If the monitoring or the Follow-up Monitoring ever suggests that take of Indiana bats is occurring at a rate that might result in exceeding the ITP limit, CPP will implement additional operational changes to reduce that rate and then implement an additional year of monitoring to demonstrate effectiveness of the additional measures.	To be determined based on previous information. But April 1 – Nov 15 is the expected study period.	To be determined, but this monitoring is expected to be more intensive than the follow-up monitoring described above.

Follow-up Monitoring

In addition to and following the first three year period, CPP will also conduct monitoring studies at five-year increments, years 2018, 2023, and 2028, for the life of the ITP (Table 1). The purpose of these additional monitoring studies will be compliance monitoring for the ITP. The objectives of these compliance monitoring studies will be to measure all bat mortality and compare to the first three years of monitoring to determine if impacts from the project have changed significantly.

The level of effort for the compliance monitoring in years 2018, 2023, and 2028 will be sufficient to estimate mortality of all bats and allow comparison back to the initial monitoring in years 1-3 of project operations. Based on current information, CPP anticipates that the monitoring in these years will involve weekly surveys at a minimum of one-half of the turbines (14) and will be conducted between April 1 and November 15. If new information becomes available to suggest otherwise, improved ways of assessing Indiana bat mortality directly or better ways of assessing bat mortality as a surrogate measure for Indiana bat mortality, CPP will implement those methods in consultation with the USFWS and MDNR. The final study design for the additional compliance monitoring studies will be determined in consultation with the USFWS and based on results of the initial monitoring years and the most current information related to study of wind turbine and wildlife interactions at the time.

FIELD METHODS

Timing and Duration

Monitoring will occur from April 1 to November 15, roughly corresponding to the spring (April 1 - June 15), summer (June 16 - August 15), and fall (August 16 - November 15) seasons. These periods include the peak of spring raptor and songbird migration (April-May), the peak of spring bat dispersal (April-May), and fall bat (August-September) and bird (September-October) migration periods. In addition, the summer months of June through July are included, when resident birds and bats will be active. The sample of turbines (50%) selected for the monitoring will be searched weekly for the entire study period.

Selection and Delineation of Search Plots

Results from post-construction fatality studies at other wind-energy facilities have shown that bat casualties tend to fall closer to the turbine than bird casualties (*e.g.*, Arnett *et al.* 2005; Arnett *et al.* 2008; Young *et al.* 2009, 2011). Young *et al.* (2011) found approximately 80% of bird and 91% of bat fatalities within 40 m (~130 ft) of the turbines; while studies at Mountaineer, WV found that most fatalities fell within 30 m (~98 ft) of the turbine (Kerns and Kerlinger 2004). During the first year of monitoring at the site approximately 85% of bird carcass and 89% of bat carcasses fell within 40 m of the turbine (Young *et al.* 2012). To the extent possible, the area within 40 m of each turbine will be delineated as the search plot. It is expected that plot shape will be variable, but each plot will not be greater than an 80 m x 80 m square (40 m radius) centered on the turbine. Because the habitat within the Project is a mosaic of forested and cleared

areas, search plots will be delineated as the area around each turbine that is clear of thick vegetation and is not forested, excessively steep, or with waste rock spoils. This allows the search area to be as clear as possible to enable detection of bird and bat carcasses. Plot boundaries and vegetation visibility classes (see description below) within each search plot will be mapped using a handheld GPS.

Standardized Carcass Searches

Search plots will be systematically searched for bird and bat fatalities that are attributable to the turbines, either by collision or as a result of barotraumas (Baerwald *et al.* 2008). Field technicians (searchers) trained in proper search techniques will conduct the carcass searches. Transects will be spaced approximately 5 m (~16 ft) apart within the search plot and delineated with colored flagging. Searchers will walk at a rate of approximately 45-60 m/min (~150-200 ft/min) along each transect searching both sides out to approximately 2-3 m (~7-10 ft). If a casualty is found, its condition will be recorded using the following categories:

- **Live/Injured** – a live or injured bird or bat.
- **Intact** – a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.
- **Scavenged** – an entire carcass which shows signs of being fed upon by a predator or scavenger, a portion(s) of a carcass in one location (e.g., wings, skeletal remains, legs, pieces of skin, etc.), or a carcass with heavy insect infestation.
- **Feather Spot** - 10 or more feathers or 2 or more primary feathers at one location indicating predation or scavenging.

For all casualties found, data recorded will include: species, sex and age when possible, date and time collected, GPS coordinates, condition category, estimated time of death, and any other comments that may help determine cause or time of death. All casualties located will be photographed as found and the location plotted on a search plot schematic included on the data sheet. Dominant vegetation cover and visibility index within a 1-m radius of the carcass location will also be recorded.

Searcher Efficiency Trials

Searcher efficiency trials will be conducted to estimate the percent of bird and bat casualties found by searchers. These trials will be conducted in the same search plots and during the same periods as standardized carcass searches. Searcher efficiency will be estimated for bats, small birds, and medium/large birds separately, and for each vegetation visibility class². Estimates of searcher efficiency will be used to adjust the number of casualties found, correcting for detection bias.

² Visibility classes: Easy: ~80% or more bare ground (e.g., road, turbine pad, dirt); less than ~20% vegetation cover, vegetation less than 6 inches tall (generally ankle height or below); Moderate: between ~20%-80% bare ground and ~20%-80% vegetation cover; vegetation 6 to 12 inches (generally between ankle and knee); Difficult: less than 20% bare ground, greater than 80% vegetation cover; vegetation usually greater than 12 inches high (generally knee high or above).

During the study period (April 1 through November 15), approximately 200 bat, 200 small bird, and 100 large bird carcasses will be used for the searcher efficiency trials. This number of trial carcasses will provide sample sizes recommended for estimation of search efficiency by each size/type class and each visibility class (Huso 2010). Trial carcasses will be distributed approximately equally between each of the three visibility classes. Species such as house sparrows (*Passer domesticus*), coturnix quail (*Coturnix coturnix*), and European starlings (*Sturnus vulgaris*) may be used to represent small-sized birds; rock doves (*Columba livia*) and commercially raised hen mallards (*Anas platyrhynchos*) or hen pheasants (*Phasianus colchicus*) may be used to represent medium to large-sized birds. Carcasses of non-*Myotis* bat species recovered during the study will be used in the searcher efficiency trials, if allowed by collection permits. Brown house mouse (*Mus musculus*) carcasses may be used to represent bats if bat carcasses are not available. Other fresh bird carcasses recovered during the study may also be used in the trials if allowed by collection permits.

All trial carcasses will be placed at pre-determined, randomly-selected locations within search plots prior to the standardized carcass search on the same day. If avian scavengers (e.g., ravens [*Corvus corax*]) appear to be attracted by carcass placement, carcasses will be placed before dawn. Carcasses will be dropped from shoulder or waist height to simulate a falling bird or bat.

Each trial carcass will be discreetly marked (e.g., a small piece of tape around a leg) so that it can be identified as a trial carcass. The number and location of trial carcasses found during a standardized carcass search will be recorded. The number of carcasses available for detection during each trial will be determined immediately after the daily round of searches by the person responsible for distributing the carcasses. The presence or absence of each carcass (i.e. whether it was available for detection) will be determined each day immediately after the daily round of searches is complete.

Carcass Removal Trials

Carcass removal trials are conducted to determine the length of time a bird or bat casualty remains in the search plot and is available for detection by the searcher(s). Carcass removal includes removal by predation or scavenging, or by other means such as mowing. Estimates of carcass removal rates will be used to adjust the number of casualties found, correcting for removal bias.

During the study period (April 1 through November 15), approximately 200 bat, 200 small bird, and 100 large bird carcasses will be used for the carcass removal trials. This number of trial carcasses will provide sample sizes recommended for estimation of carcass removal by each size/type class and each visibility class (Huso 2010). Trial carcasses will be distributed approximately equally between each of the three visibility classes. Trial carcasses will be similar to those used for the searcher efficiency trials (see above).

A typical carcass removal trial will occur over a 7 to 14-day period unless all trial carcasses are removed sooner. For each trial, between 10 and 15 carcasses will be placed within 40 m (~130

ft) of randomly selected turbines. Carcasses will be checked for a maximum of 14 days as follows: once a day for the first five days and then on approximately day seven, day 10, and day 14. After the 14-day period, or when all carcasses have been removed, any remaining evidence of the carcass will be removed, and the next set of carcasses will be placed. Using this method of staggered carcass placement, removal trials will be spread throughout the study period to incorporate the effects of varying weather conditions and scavenger abundance. Trial carcasses will be marked discreetly (e.g., tape on a leg) for recognition by searchers and other personnel. If a significant number of carcasses remain after the 14-day period, the trial period will be extended for an additional seven days to allow carcass removal rates to be estimated more accurately.

STATISTICAL METHODS

Data analysis will be conducted according to industry standard methods for wind-energy facility monitoring studies (e.g., Shoenfeld 2004, Arnett *et al.* 2008, Jain *et al.* 2009, Huso 2010), with consideration for new methods that may be developed in the interim between issuance of the ITP and completion of the field studies. It is proposed to use the statistical formulas of Shoenfeld (2004), which has been used at numerous wind-energy facility monitoring studies across the U.S., including regional studies at Mountaineer, Myersdale, and Mount Storm. Since this is not the only method of analyzing monitoring data, CPP will evaluate, with the USFWS, the most appropriate estimator for the study and apply it at the time of the data analysis and reporting. The final method chosen will provide a total estimate of fatalities for the Project, accounting for searcher and removal biases, as well as, variability in visibility classes and proportion of the searchable area with the study plots.

The estimate of the total number of wind-energy facility-related fatalities will be based on four components: 1) observed number of casualties, 2) searcher efficiency expressed as the proportion of trial carcasses found by searchers, 3) removal rates expressed as the length of time a carcass is expected to remain in the study plot and be available for detection by searchers, and 4) the estimated percent of casualties that fell in unsearched areas based on the distribution of discovered casualties and percent of area searched within the 40-m radius search plot around the turbines.

Observed Number of Carcasses

The average number of carcasses detected per turbine is:

$$\bar{c} = \frac{\sum_{i=1}^k c_i}{k}$$

where c_i is the number of carcasses detected at turbine i for the period of study, and k is the number of turbines searched.

Estimation of Searcher Efficiency

Searcher efficiency is expressed as p , the estimated proportion of trial carcasses found by

searchers. The variance of the estimate, $v(p)$, is calculated by the formula:

$$v(p) = \frac{p(1-p)}{d}$$

where d is the total number of carcasses placed. Carcass detection rates will be estimated by major vegetation visibility class (easy, moderate, difficult), carcass type/size (bat, small bird, medium/large bird), and season (spring, summer, fall). Data will be pooled across seasons if detection rates are not significantly different between seasons.

Estimation of Carcass Removal

The length of time a carcass remains in the study area before it is removed is denoted as t_i . Mean carcass removal time is expressed as \bar{t} :

$$\bar{t} = \frac{\sum_{i=1}^s t_i}{s}$$

where s is the number of carcasses used in the scavenging trials and i denotes each carcass. Modifications to the estimator will be made if there are trial carcasses that remain at the end of the 14-day trial period (Barnard 2000, Erickson *et al.* 2003a, Shumway *et al.* 1989).

Estimation of Casualty Distribution

Since not all of the area within 40 m of the turbine will be searchable on every turbine, adjustments will be made to account for carcasses that fell in unsearched areas, A . Casualty density is modeled as a function of distance to turbine for fresh carcasses within 2-m distance bands radiating from the center of the turbine (Arnett *et al.* 2008). A will be approximated using the following formula:

$$A = \frac{\sum_{k'=1}^7 \frac{c_{k'}}{p_{k'} s_{k'}}}{\sum_{k'=1}^7 \frac{c_{k'}}{p_{k'}}$$

where $c_{k'}$ is the observed number of casualties found in the k^{th} 2-m distance band from the turbine, $p_{k'}$ is the estimated observer detection probability in the k^{th} 2-m distance band from the turbine, and $s_{k'}$ is the proportion of the k^{th} 2-m distance bands that was sampled across all turbines.

Estimation of the Total Number of Fatalities

For equal sampling effort among turbines and seasons, and assumed equal observer detection and scavenging rates among seasons, the total number of facility-related fatalities (M) is calculated

by dividing the observed fatality rate by $\hat{\pi}$, an estimate of the probability a casualty is not removed and is detected and then adjusting for searchable area by multiplying by A.

$$M = A * \frac{N * \bar{c}}{\hat{\pi}}$$

where N is the total number of turbines in the Project. The estimated mortality per turbine per year m is determined by M/N.

Differences between observers and scavenging rates between seasons will be determined prior to analysis. If significant differences exist between seasons, separate estimates for each season will be calculated and summed for the overall estimate.

The estimate of the probability a casualty is not removed and is detected is calculated for each visibility class. The sum of the estimates for each visibility class provides an overall estimate of Project-related mortality.

The estimate of the probability a casualty is not removed and detected, $\hat{\pi}$, is calculated by:

$$\hat{\pi} = \frac{\bar{t} \cdot p}{I} \cdot \left[\frac{\exp\left(\frac{I}{\bar{t}}\right) - 1}{\exp\left(\frac{I}{\bar{t}}\right) - 1 + p} \right]$$

where I is the interval between searches and p and \bar{t} are as defined previously. This formula has been independently verified by Shoefeld (2004).

The final reported estimates of *m* and associated standard errors and 90% confidence intervals will be calculated using bootstrapping techniques (Manly 1997) based on a computer program written in SAS. For each iteration of the bootstrap, the turbines and associated mortality data, searcher efficiency carcasses and associated data, and the scavenging removal carcasses and associated data are sampled with replacement. Estimates of \bar{c} , \bar{t} , p, and m are calculated for each of 5,000 bootstrap samples. The final estimates of \bar{c} , \bar{t} , p, and m, and associated bootstrap percentile confidence intervals, are calculated from the 5,000 bootstrap estimates.

REPORTING

CPP will implement this monitoring plan in consultation with the USFWS and will meet with the USFWS to discuss the study results following completion of the monitoring studies as described. The purpose of these meetings will be to evaluate the efficacy of monitoring methods, compare the results of monitoring to the authorized take, evaluate the success of any on-site avoidance/minimization strategies relative to the Indiana bat, and, if applicable, develop recommendations for future research, monitoring, and mitigation. These annual meetings will

also provide opportunity to discuss the effectiveness of the conservation plan, and to evaluate the status of the mitigation project to be implemented as a part of the HCP.

CPP will submit a draft monitoring report to the USFWS prior to the meetings, but no later than January 31 of the years following monitoring studies (approximately 75 days following completion of the monitoring studies). Reports will be presented in standard scientific format, providing an Introduction, Methods, Results, Discussion, and Conclusions and Recommendations. A final annual report will be prepared following review by the USFWS and the annual meeting to discuss the monitoring plan. This report will also be provided to the MDNR Natural Heritage Program. In the event that the monitoring studies indicate that the Project has exceeded the authorized level of take of Indiana bat, CPP will promptly notify USFWS, and comply with the terms of the HCP as outlined in the Adaptive Management Program (Section 5.6). In addition, for compliance with the Special Purpose Utility Permit for the CWP, monthly reports of migratory bird fatalities found and accompanying data as described in the permit will be submitted to the USFWS.

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