APPENDIX C

Post-construction Fatality Monitoring Protocol

PROPOSED STANDARDIZED POST-CONSTRUCTION FATALITY MONITORING

The following sections describe the protocol for standardized fatality monitoring. This monitoring framework consists of standardized carcass searches conducted at a sample of the Project turbines. The number of fatalities found during searches represents a minimum number of fatalities at a project because not all fatalities that occur are found by observers. Therefore, carcass persistence trials and searcher efficiency trials will be conducted concurrently with standardized fatality monitoring to account for the bias attributable to carcass removal by scavengers and searcher efficiency. Fatality rates (e.g., birds/turbine/year and birds/operational MW/year) will then be estimated using statistical methods that adjust the number of carcasses found for detection biases. Per-turbine and per-megawatt estimates provide different ways of scaling fatality information to be comparable to other projects. Annual fatality rates will be calculated for all bird species combined, small (less than or equal to 10 inches) and large (greater than10 inches) birds, raptors, and sensitive species (collectively). In some cases, the sample size for a species group of interest, such as eagles or other sensitive species, may be too small to allow for the calculation of accurate fatality estimates. In these cases, numerical counts of total fatalities detected during standardized and operational searches for each of these species or species groups will be substituted in place of rate estimates.

The field and analytical methods described below are consistent with post-construction fatality monitoring being conducted, or proposed, for other wind projects elsewhere in the United States (Johnson et al. 2003; Young et al. 2003; Jain et al. 2007; Huso 2011; Strickland et al. 2011).

Methods and timing outlined here may be modified over the course of the study as Project-specific information is gained to maximize the effectiveness and efficiency of the monitoring program (e.g., search interval, number of turbines searched, plot size).

STANDARDIZED CARCASS SEARCHES

The objective of the fatality monitoring is to identify the bird and bat species found as fatalities at the Project and to statistically estimate fatality rates. This section outlines the methods for the standardized carcass searches, which constitutes the initial step in generating the fatality estimate (i.e. finding the carcasses under the turbines). These values then will be adjusted to account for detection bias (see below). The methods for standardized carcass searches include the sampling duration and intensity, search plot size and configuration, and fatality documentation.

SAMPLING DURATION AND INTENSITY

Standardized post-construction fatality monitoring will consist of standardized searches of approximately 30 percent of the turbines and will be conducted for the first year of operation. To avoid bias in the fatality estimate, turbines will be selected in a stratified random manner based on habitat type and topography. To do this, habitat and topography will be determined for each turbine location and the sample turbines randomly selected from the habitat and topography categories in proportion to how often they occur in these categories. The same turbines will be searched the entire year of the baseline monitoring period to avoid confounding effects from individual turbines.

The survey year will be divided into seasons to allow for the inclusion of season-specific searcher efficiency probabilities and carcass persistence times. Searches at each of the designated turbines will initially be conducted every 2 weeks. However, search frequency may be adjusted based on the results of seasonal carcass persistence trials in order to ensure that on average, the search interval minimizes the bias associated with carcass removal by scavengers (see below).

Seasonal sampling intervals will be as follows:

- Spring: March 16–June 15
- Summer: June 16–September 14
- Fall/Winter: September 15–December 15

SEARCH PLOT SIZE AND CONFIGURATION

It is anticipated that the turbine and roads will remain clear of vegetation. The search area will consist of a square search plot centered on the turbine. The minimum distance from the turbine to the perimeter of the square will be eighty (80) percent of the turbine height. The search plot size is based on recommendations from the USFWS (2012). Search areas will include maintained turbine pads and access roads, as well as adjacent unmaintained areas. The actual area searched will ultimately be dependent on the configuration of the maintained areas, as well as the portion of the unmaintained area that can be realistically searched as determined during the initial surveys.

Linear transects will be established within the search plots approximately 6 meters (20 feet) apart (USFWS 2012). The searchers will walk along each transect searching both sides out to 3 meters (10 feet) for fatalities. Personnel trained and tested in proper search techniques will conduct the carcass searches.

FATALITY DOCUMENTATION

During the set-up for carcass surveys, a sweep survey will be conducted to remove any fatalities that occurred before the study is initiated. These carcasses will be documented in the same manner as those found during the standardized carcasses searches; however, they will not be included in the statistical analysis because the statistical analysis requires a known search interval (i.e. an estimate of when fatalities occurred).

Searchers will assume that carcasses found are a result of turbine collisions unless the cause of death can be clearly attributed to a non-turbine cause. Although an unknown number of fatalities may result from natural predation, disease, or anthropogenic events (e.g., shooting), the condition of the carcasses when found rarely facilitates determining the cause of death.

Carcasses found during standardized carcass searches will be assigned a unique number, and species, sex, age, date, time found, location (global positioning system [GPS] coordinate, and distance/direction from the turbine), condition (e.g., intact, scavenged, feather spot), observer, turbine number, and any comments that may indicate cause of death will be collected. All carcasses will be photographed in situ. Once documented, carcasses will be marked in a standardized fashion (e.g., clipping of primary flight feathers) to indicate they have already been recorded. Carcasses will be left in place unless otherwise specified by Project-specific collection permits, if applicable.

Searchers may discover carcasses incidental to standardized carcass searches (e.g., outside of a search plot or of a scheduled survey date). For each incidentally discovered carcass, the searcher will identify,

photograph, and record data for the carcass, as would be done for carcasses found during standardized scheduled searches but will code these carcasses as incidental discoveries. Incidental discoveries will not enter into the statistical calculation of fatality rate for reasons noted above for carcasses found during initial set-up.

All native birds in North America are protected under the MBTA and cannot be salvaged without a permit from the USFWS. In addition to a federal permit, a South Dakota Scientific Collectors permit is needed from SDGFP to handle native wildlife. This plan assumes that bird carcasses will be left in place and will not be salvaged unless otherwise directed by the appropriate agencies after discovery. If the carcass of a federally listed species is found, searchers will follow procedures identified within the Wildlife Response and Reporting System (Appendix C).

BIAS CORRECTION TRIALS

Carcass persistence time estimates the amount of time a carcass remains on-site prior to its disappearance from the search area due to scavenging or other means (e.g., due to forces such as wind and rain or decomposition beyond recognition). The objective of the carcass persistence trials is to document the length of time carcasses remain in the search area. Carcass persistence trials will be conducted in multiple seasons to evaluate seasonal differences in carcass persistence (i.e. due to changes in scavenger population density or type) and possible differences in the size of the animal being scavenged.

Carcasses used in the trials will be selected to represent a range of species sizes, including bats. For large birds, carcasses may include domestic waterfowl, pheasant, or similar species legally obtained from game farms. For small birds and bats, carcasses may include European starlings, house sparrows, or other non-native species not legally protected. For bats, we may also use mice.

Assuming adequate carcass availability, one carcass persistence trial will be conducted during each of the spring, summer, and fall/ winter seasons with at least 15 carcasses of each bird size class (large bird, small bird, and bat) placed per season.

Each carcass used for the carcass persistence trial will be placed randomly within the area used for the trials. Random locations will be generated and loaded into a GPS as waypoints to allow the accurate placement of the carcasses by field personnel. Carcasses will be dropped from waist height and allowed to land in a random posture. Each trial carcass will be discreetly marked (e.g., small tag or wire wrapped around one leg) prior to dropping so that it can be identified as a study carcass if it is found by other searchers or wind facility personnel. Personnel will monitor the trial carcasses on days 1, 2, 3, 4, 7, 10, 14, 21, and 30. When checking the carcass, searchers will record the condition as intact (normal stages of decomposition), scavenged (feathers pulled out, chewed on, or parts missing), feather spot (only feathers left), or gone (cannot be found). Changes in carcass condition will be cataloged with pictures and detailed notes; photographs will be taken at placement and any time major changes have occurred. At the end of the 30-day period, any evidence of carcasses that remain will be removed and properly disposed of.

Estimates of the probability that a carcass persisted between search intervals and therefore was available to be found by searchers, will be used to adjust carcass counts for bias using methods presented in Huso 2011 or similar analysis method. To date, Huso (2011) presents the most bias-free equation for determining the average probability of persistence, which takes into account the length of the search interval and the carcass persistence time:

$$\hat{r} = \frac{\hat{\bar{t}}(I - e^{-I/\hat{\bar{t}}})}{I}$$

Where t is the estimated mean persistence time and I is the length of the interval. A bootstrapped estimate and 90 percent confidence interval will be calculated based on 5,000 iterations for carcass persistence time. Bootstrapping is a statistical re-sampling procedure where the data are re-sampled with replacement to obtain an estimate and confidence interval.

SEARCHER EFFICIENCY TRIALS

The ability of searchers to detect carcasses is influenced by a number of factors including the skill of an individual searcher in finding the carcasses, the vegetation composition within the search area, and the characteristics of individual carcasses (e.g., body size, color). The objective of searcher efficiency trials is to estimate the percentage of bird and bat fatalities that searchers are able to find. Estimates of searcher efficiency are then used to adjust carcass counts for detection bias. Searcher efficiency trials will be conducted in all seasons to account for seasonal differences in searcher efficiency. Carcass species used in the trials and marking and placement techniques will be the same as those in the carcass persistence trials.

Searcher efficiency trials will begin when standardized carcass searches start. Personnel conducting the searches will not know when trials are conducted or the location of the efficiency-trial carcasses. Trials will be conducted multiple times throughout each season and will incorporate testing of each member of the field crew. Assuming adequate carcass availability, at least 15 carcasses of each bird size class (large bird, small bird, and bat) will be placed per season for searcher efficiency trials. A minimum of 10 carcasses per size and season are needed to estimate searcher efficiency. Searcher efficiency trials will be conducted at the monitored turbines. The number of carcasses placed prior to the search (i.e. the number available for detection during each trial) will be verified immediately after the trial by the person responsible for distributing the trial carcasses. Any carcasses not found by searchers will be collected after the trial.

The probability of a carcass being observed is expressed as p, the proportion of trial carcasses that are detected by searchers in the searcher efficiency trials. The probability will be estimated by carcass size class (large bird, small bird, bat) and season. A bootstrapped estimate and 90 percent confidence interval will be calculated based on 5,000 iterations for searcher efficiency.

FATALITY RATE ESTIMATION

To calculate the Project-wide fatality rate (fatalities/turbine/year and fatalities/MW/year) and the total Project fatalities, the Huso estimator (Huso 2011) or other appropriate statistical methods will be used. The fatality rate can be calculated for subgroups, including large birds, small birds, raptors (including eagles), bats, or sensitive species (including BCC and state species of conservation priority) if at least 5 fatalities within the subgroup are found.

The estimation of fatality rates will incorporate fatalities documented during standardized carcass searches adjusted for bias. Specifically, fatality estimates will take into account:

- Search interval;
- Observed number of carcasses found during standardized searches during the monitoring year for which operation of the facility cannot be ruled out as the cause of death;
- Carcass persistence, expressed as the probability that a carcass is expected to remain in the study area (persist) and be available for detection by the searchers during carcass persistence trials; and

- Searcher efficiency, expressed as the probability of trial carcasses found by searchers during searcher efficiency trials.

The Huso estimator (2011) uses the following equation to estimate fatalities:

$$\hat{f}_{ijk} = \frac{c_{ijk}}{\hat{p}_{jk*}\,\hat{r}_{jk*}\,\hat{v}_{jk}}$$

Where f^_ijk is the estimated fatality at the ith turbine during the jth search in the kth category and cijk is the observed number of carcasses at the ith turbine during the jth search in the kth category. The variable r^_jk is a function of the average carcass persistence time, which was described earlier, and the length of the search interval preceding a carcass being discovered. The variable r^_jk is calculated using the lower value of I, the actual search interval when a carcass is found or (I,)˜ ^the effective search interval, and is estimated through searcher efficiency trials previously described. v^_jk is the proportion of the effective search interval sampled where v^= min (1, Ĩ/I). p^_jk is the estimated probability that a carcass in the kth category that is available to be found will be found during the jth search. The variables p^_(jk,) r^_(jk,) and v^_jk are assumed not to differ among turbines but can differ with carcass type, size class, and season. To obtain an estimate of the number of fatalities per turbine the following equation is used:

$$\hat{f} = \frac{\sum_{i=1}^{u}\sum_{j=1}^{n_i}\sum_{k=1}^{2}\hat{f}_{ijk}}{t}$$

Where ni is the number of searches at turbine i (i = 1…u) and t is the effective number of turbines searched. A bootstrapped estimate and 90 percent confidence interval will be calculated based on 5,000 iterations for the fatality estimate. The 90 percent confidence interval represents the upper and lower bounds of the range of fatality rates that has a 90 percent probability of containing the true fatality rate. The 90 percent confidence interval is useful in a management context as a means of assessing the range of fatality rates that are probable given the number of carcasses that were detected. It should be noted that the upper 90 percent confidence limit corresponds to 95 percent probability that the true fatality rate is lower than the upper 90 percent confidence limit.