APPENDIX 7
BATS

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A7-1 INTRODUCTION

Following the historic flood of 1927, Congress passed a Flood Control Act of 1928, as amended committing the Federal Government to a comprehensive program of flood control and authorized the Mississippi River and Tributaries project (MR&T). The project is designed to control a "project flood" with a discharge of 3 million cubic feet per second in the alluvial valley of the lower Mississippi River (U.S. Army Corps of Engineers 1987).

In 1998 with the SEIS I, staff biologists with the Memphis, Vicksburg, and New Orleans Districts of the U.S. Army Corps of Engineers (USACE) examined the impacts from Work Items and borrow excavations for the MR&T Project and important environmental resources, which included, among others, bats (U.S. Army Corps of Engineers 1998). The 1998 assessment compared the potential impacts of various alternatives for borrow source site selection for the construction of the Work Items included in SEIS I. For each alternative, the abundance of land cover types relevant to bats and associated habitats were estimated pre- and post-construction. The results of the analysis showed that all structural alternatives would have some impact on bats, but those impacts would be species-specific. Bat species that use open upland or forested habitats for foraging or roosting would experience a small negative impact, but species that forage over open water would benefit from an overall increase in post-construction habitat.

Since 1998, new threats to bat populations have emerged. White-nose Syndrome (WNS) is a fungal disease that causes mortality in bats (U.S. Fish and Wildlife Service 2020d). This emerging disease was first detected in the United States in 2006. It has since spread to 33 States and seven Canadian provinces and has caused severe decline in bat populations (Frick et al. 2010, Thogmartin et al. 2012). For example, WNS is the primary cause of declines in the once common northern long-eared bat (*Myotis septentrionalis*), which was listed as threatened under the Endangered Species Act (ESA) in 2015 (U.S. Fish and Wildlife Service 2020b). Additionally, the status of the little brown bat (*M. lucifugus*) and the tri-colored bat (*Perimyotis subflavus*) currently are under review for listing under the ESA (U.S. Fish and Wildlife Service 2020a, U.S. Fish and Wildlife Service 2020c). Wind energy production also is a serious emerging threat to bats. Bat fatality rates at wind energy facilities are approximately 4.9-11 bats per megawatt of generating capacity (Arnett et al. 2016) and these fatalities are believed to have a negative impact on populations (Frick et al. 2017). Because of the emerging threats to bats and significant changes in the conservation status of some bat species, it is necessary to update the 1998 assessment to incorporate these changes.

The second supplemental environmental impact statement (SEIS II) and this appendix assess the impacts of the proposed construction and operation, maintenance and repair of the Work Items, including the selection of borrow site locations under Alternatives 2 and 3, and the excavation of borrow sites on certain bat species and habitat located in the areas of the Work Items. Additional information on federally listed threatened and endangered species is at Appendix 9, including the endangered Gray bat (*Myotis grisescens*), endangered Indiana bat (*Myotis sodalis*), and threatened northern long-eared bat (*Myotis septentrionalis*).

A7-2 PROJECT AREA AND METHODS

This analysis was conducted by Wildlife Biologists with the U.S. Army Engineer Research and Development Center-Environmental Laboratory (ERDC-EL). The Mississippi River levees project area runs along the Mississippi River from Cape Girardeau, MO to Head of Passes, LA. Potential areas affected by the project will include lands and waters between the mainline Mississippi River levees and the lands and waters within 3,000 feet landside of the landside toe of the levees in each district.

Evaluation Species

The project area encompasses the distribution of 16 bats species (Figure A7-1). These species include:

- hoary bat (*Aeorestes cinereus*)
- Rafinesques big-eared bat (*Corynorhinus rafinesquii*)
- northern yellow bat (*Dasypterus intermedius*)
- big brown bat (*Eptesicus fuscus*)
- silver-haired bat (*Lasionycteris noctivagans*)
- eastern red bat (*Lasiurus borealis*)
- Seminole bat (*Lasiurus seminolus*)
- Southeastern myotis (*Myotis austroriparius*)
- gray bat (*Myotis grisescens*)
- eastern small-footed bat (*Myotis leibii*)
- little brown bat (*Myotis lucifugus*)
- northern long-eared bat (*Myotis septentrionalis*)
- Indiana bat (*Myotis sodalis*)
- evening bat (*Nycticeius humeralis*)
- tri-colored bat (*Perimyotis subflavus*)
- Brazilian brazilian free-tailed bat (*Tadarida brasiliensis*)

Figure A7-1. Distribution of bat species occurring in the project area. Solid black lines show boundary of (north to south) Memphis, Vicksburg, and New Orleans Districts. Bat species distribution is shaded gray.

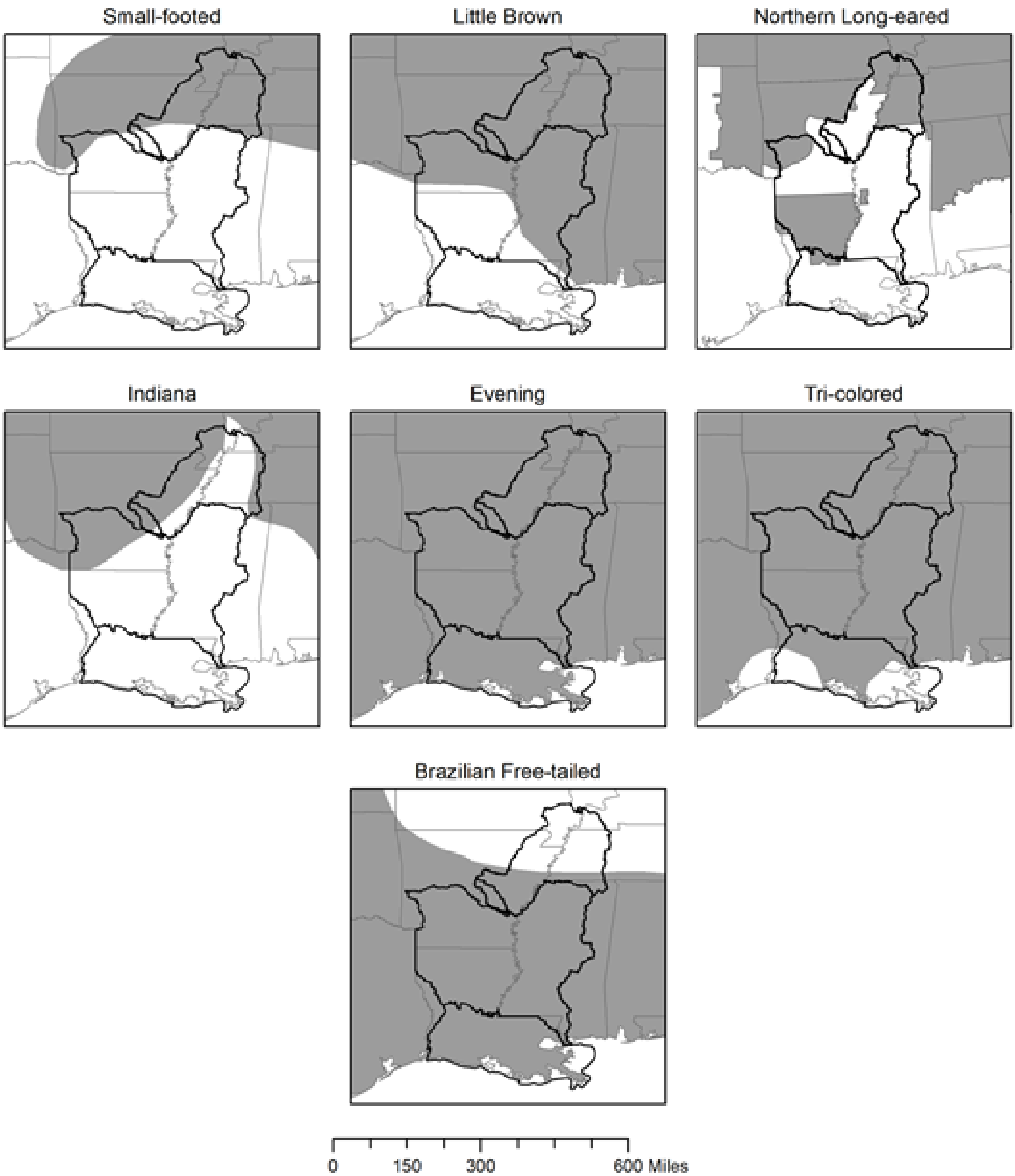

Figure A7-1 continued. Distribution of bat species occurring in the project area. Solid black lines show boundary of (north to south) Memphis, Vicksburg, and New Orleans Districts. Bat species distribution is shaded gray.

A7-3 GENERALIZED LIFE HISTORY OF BATS

Although individual species may differ in their life histories, there are broad habitat-use patterns applicable to all bat species. Bats of the eastern United States are nocturnal insectivores that capture their prey on the wing (Barbour and Davis 1969) or by gleaning insects off vegetation or water (Norberg and Rayner 1987, Ratcliffe and Dawson 2003). Bats forage in a variety of habitat types, including riparian habitat, forest openings, agricultural fields, and urban (other) areas (Geggie and Fenton 1985, Furlonger et al. 1987, Sparks et al. 2004, Brooks et al. 2017). The habitat in which a species prefers to forage is related to its wing morphology and echolocation call structure (Aldridge and Rautenbach 1987, Norberg and Rayner 1987). Therefore, altering foraging habitat may have a negative, positive, or neutral effects on bat activity.

During the day, bats roost in structures such as snags (Carter and Feldhamer 2005), exfoliated bark (Foster and Kurta 1999), foliage (Mager and Nelson 2001), tree cavities (LaVal et al. 1977, Kurta et al. 1993, Decher and Choate 1995) or buildings (Kurta and Baker 1990). These structures can also serve as maternity roosts for females to rear their young.

In the fall, bats either enter a hibernacula or migrate to warmer climates (Barbour and Davis 1969). Many species hibernate in caves (Caceres and Barclay 2000), although some species will enter torpor in tree foliage (Mager and Nelson 2001). During the hibernation season, bats will occasionally emerge to forage and drink, especially in warmer climates farther south (Barbour and Davis 1969). Migratory bats do not enter caves for hibernation, but instead travel hundreds of miles to forage in warmer climates. These species may also enter torpor during cold conditions, but they do not enter caves or remain in torpor for long periods of time.

Species-specific Considerations

Habitat requirements for individual species are summarized in Table A7-1.

A7-4 METHODS

Baseline bat habitat conditions were established by determining land cover types within a half-mile buffer surrounding all Work Item locations for Alternative 1 (No Action), Alternative 2 (Traditional Construction), and the preferred Alternative 3 (Avoid and Minimize). The 0.5 mile buffer was selected to remain consistent with the environmental impact analyses for other affected species evaluated in the SEIS II. However, it is important to note that bats use landscapes at a much larger scale than a 0.5 mile buffer. For example, maximum foraging commute distance for Indiana bats in Missouri was 4.85 km (Womack et al. 2013) and hoary bats in Manitoba commuted as far as 20 km to foraging areas (Barclay 1989). By using a 0.5 mile buffer, this analysis will likely overestimate the impact of construction and the operation, maintenance, and repair of the Work Items on bat habitat. This appendix further outlines life history requirements for bats and how bat species utilize features across a larger landscape.

Land cover types within the 0.5 mile buffers were obtained from USDA's Cropscape (USDA National Agricultural Statistics Service Cropland Data Layer 2018) GIS dataset. A total of 39 land cover types were defined within the project boundaries; however, many of these land cover types have similar significance to bats. Therefore, the land cover classes were summed to create four land cover categories: open, forest, urban (other), and water (Table A7-2a-b).

Table A7-1 - Summary of life history and habitat by bat species in the Mississippi Alluvial Valley

Species	Diurnal Roost	Foraging	Hibernation/ Migration	References
Hoary Bat	Foliage	Open habitat	Migratory	Constantine 1966; Heinrich et al. 1999; Sparks et al. 2005; Andrusiak 2009; Cryan et al. 2014
Rafinesque's Big-eared Bat	Tree hollows	Forest interiors	Cave hibernator	Hurst and Lacki 1999; Lance et al. 2001; Trousdale and Beckett 2005
Northern Yellow Bat	Foliage, Spanish moss	Open habitat	Tree hibernator/migratory	Hutchinson 2006; Chapman 2007; Coleman et al. 2012
Big Brown Bat	Buildings, tree hollows	Open habitat	Cave hibernator	Duchamp et al. 2004; Brooks and Ford 2005; Reimer et al. 2014
Silver-haired Bat	Snags, tree crevices	Open habitat	Migratory	Barclay 1985; Parsons et al. 1986; Barclay et al. 1988; Crampton and Barclay 1998; Cryan 2003; Patriquin and Barclay 2003
Eastern Red Bat	Foliage	Forest edge	Tree hibernator/ migratory	Shump and Shump 1982; Furlonger et al. 1987; Mager and Nelson 2001
Seminole Bat	Foliage	Forest edge	Tree hibernator/migratory	Wilkins 1987; Menzel et al. 1998; Perry and Thill 2007
Southeastern Myotis	Tree hollows	Riparian habitat/bottomland	Cave hibernator	Barbour and Davis 1969; Carver and Ashley 2008
Gray Bat	Caves	Riparian habitat	Cave hibernator	LaVal et al. 1977; Decher and Choate 1995

Eastern Small-footed Bat	Rocky outcropings, caves	Forest interiors	Cave hibernator	Furlonger et al. 1987; Best and Jennings 1997; Roble 2004; Johnson and Gates 2008; Johnson et al. 2009
Little Brown Bat	Tree hollows	Riparian habitat/ bottomland	Cave hibernator	Humphrey 1971; Fenton and Barclay 1980; Furlonger et al. 1987; Crampton and Barclay 1998; Psyllakis and Brigham 2006; Grieneisen et al. 2015; Nelson and Gillam 2017
Northern Long-eared Bat	Tree hollows	Forest interiors	Cave hibernator	Caceres and Barclay 2000; Patriquin and Barclay 2003; Brooks and Ford 2005; Timpone et al. 2010; Pauli 2014
Evening Bat	Tree hollows	Forest edge	Migratory	Watkins 1972; Duchamp et al. 2004
Tri-colored Bat	Tree foliage/Tree hollows	Forest edge	Cave hibernator	Veilleux et al. 2003; Vincent and Whitaker 2007; Morris et al. 2010
Brazilian Free-tailed Bat	Caves	Open habitats	Migratory	Bernardo and Cockrum 1962; Wilkins 1989; Best and Geluso 2003; Russell et al. 2005
Indiana Bat	Snags/tree hollows/exfoliated bark	Forest interiors/ bottomland	Cave hibernator	LaVal et al. 1977; Murray and Kurta 2004; Carter and Feldhamer 2005; Ford and Chapman 2007; Timpone et al. 2010

For USACE to determine how the construction and operation, maintenance and repair of the Work Items would impact and/or alter baseline bat species and the associated bat habitat conditions for the various alternatives, land cover classes within the Work Item areas were identified using the same method as that was used by USACE to establish the 0.5 mile buffers surrounding all Work Item locations.

For purposes of this evaluation, USACE assumed that all borrow pit areas would be converted from their present land cover class to water. To date, USACE has not observed evidence of landowners filling in borrow areas prior to them naturalizing and becoming jurisdictional under Section 404 of the Clean Water Act. Some borrow pit areas were classified as water in the Crop Data Layer (Table A7-2a-b) and this was likely due to the 30 m resolution of the dataset. Borrow pit areas classified as water comprised 10 percent of the total borrow pit area and 0.05 percent of the total project area. Considering the relatively small proportion of area misclassified, the effect of misclassification was considered negligible and borrow pit areas classified as water were assumed to remain inundated.

The area of each land cover class within borrow pits, not including water, was subtracted from its respective land cover class within the 0.5 mile buffer (Table A7-2a-b). This area was then added the water class to arrive at the change in land cover type.

A7-5 IMPACT ANALYSIS

Net Change in the Extent of Habitat

At the project level, the land cover class with the greatest loss as a result of the construction and operation, maintenance and repair of the Work Items will be open land under Alternative 3 and forested land under Alternative 2 (Table A7-3a-b). For the Vicksburg District, the land cover class with the greatest loss will be to open land under Alternative 3 and forested land under Alternative 2. For the Memphis District, the greatest loss will be to open land under Alternative 3 and forested land under Alternative 2. For the New Orleans District, the greatest loss will be to forested land Alternatives 2 and 3.

Changes in land cover due to construction and operation, maintenance and repair of the Work Items would be small compared to the overall assessment area (i.e., 0.5 mile buffers surrounding the Work Items). The greatest change in land cover would occur in the Vicksburg District, with riparian habitat increasing 6.55 percent and 6.60 percent with Alternatives 3 and 2, respectively.

A7-6 IMPACTS TO BAT SPECIES

Considering the small area impacted by Work Item activities compared to the surrounding lands, the negative impacts of bat habitat loss will be small. Species that roost in tree cavities, exfoliated bark, or snags will be most negatively impacted. These species include the Indiana bat, the northern long-eared bat, Rafinesque's big-eared bat, silver-haired bats, southeastern myotis, little brown bats, evening bats, and tri-colored bats. However, a number of factors will further reduce the impacts of forested habitat loss. The greatest loss of forested habitat would occur in the Vicksburg District, which is largely outside the distributions for Indiana bats, northern long-eared bats, and small-footed bats.

For purposes of this analysis, USACE also assumed that all lands classified as forest are suitable bat habitat. However, much of this habitat consists of stands of small diameter trees, which does not provide preferred roosting habitat. These stands also are dominated by tree species not used by bats. Additionally, evidence suggests that northern long-eared bats will switch roosts if one is removed (Silvis et al. 2015). Considering the amount of forested habitat remaining in the project area, it is likely that any affected bats will relocate to other favorable roost trees.

Table A7-2a. Area of land cover class by USACE District for Alternative 3 within the 0.5 mile buffers of Work Items and potential borrow areas.

Half-mile Buffer

	Area (acres)		
Cover Type	**Vicksburg**	**Memphis**	**New Orleans**
Open	13,378.5	57,316.7	32,160.2
Forest	11,269.2	19,021.9	24,262.6
Urban (other)	2,332.7	6,747.1	40,794.1
Water	7,057.8	10,008.9	55,473.2

Borrow Areas

Cover Type	**Area (acres)**		
	Vicksburg	**Memphis**	**New Orleans**
Open	271.2	509.2	142.1
Forest	187.1	34.7	108.4
Urban (other)	4.0	6.9	7.2
Water	95.0	5.8	30.6

Table A7-2b. Area of land cover class by USACE District for Alternative 2 within the 0.5 mile buffers of Work Items and potential borrow areas.

Half-mile Buffer

	Area (acres)		
Cover Type	**Vicksburg**	**Memphis**	**New Orleans**
Open	12,765.0	56,575.0	30,732.9
Forest	11,673.4	19,693.8	25,152.4
Urban (other)	2,299.1	6,780.0	40,479.0
Water	7,220.0	10,193.3	55,970.0

Borrow Areas

Cover Type	Area (acres)		
	Vicksburg	Memphis	New Orleans
Open	190.6	56.3	51.0
Forest	281.1	488.0	190.9
Urban (other)	4.9	9.2	5.9
Water	81.0	3.8	40.5

Table A7-3a - Land cover changes (acres) resulting from Alternative 3 within Vicksburg District, Memphis District, and New Orleans District.

All Districts

Cover Type	Before	Change	After	Percent Change
Open	102,855.4	-922.5	101,932.9	-0.90
Forest	54,553.7	-330.1	54,223.6	-0.61
Urban (other)	49,873.9	-18.1	49,855.8	-0.04
Water	72,539.9	+1,270.7	73,810.6	+1.75

Vicksburg

Cover Type	Before	Change	After	Percent Change
Open	13,378.5	-271.2	13,107.3	-2.03
Forest	11,269.2	-187.1	11,082.1	-1.66
Urban (other)	2,332.7	-4.0	2,328.7	-0.17
Water	7,057.8	+462.3	7,520.1	+6.55

Memphis

Cover Type	Before	Change	After	Percent Change
Open	57,316.7	-509.2	56,807.5	-0.89
Forest	19,021.9	-34.7	18,987.2	-0.18
Urban (other)	6,747.1	-6.9	6,740.2	-0.10
Water	10,008.9	+550.8	10,559.7	+5.50

New Orleans

Cover Type	Before	Change	After	Percent Change
Open	32,160.2	-142.1	32,018.1	-0.44
Forest	24,262.6	-108.4	24,154.2	-0.45
Urban (other)	40,794.1	-7.2	40,786.9	-0.02
Water	55,473.2	+257.7	55,730.9	+0.46

Table A7-3b - Land cover changes (acres) resulting from Alternative 2 within Vicksburg District, Memphis District, and New Orleans District.

All Districts

Cover Type	Before	Change	After	Percent Change
Open	10,0072.9	-297.9	99,775.0	-0.30
Forest	56,519.5	-960.0	55,559.5	-1.70
Urban (other)	49,558.1	-20.0	49,538.0	-0.04
Water	73,383.3	+1277.9	74,661.2	+1.74

Vicksburg

Cover Type	Before	Change	After	Percent Change
Open	12,765.0	-190.6	12,574.4	-1.49
Forest	11,673.4	-281.1	11,392.3	-2.41
Urban (other)	2,299.1	-4.9	2,294.2	-0.21
Water	7,220.0	+476.6	7,696.6	+6.60

Memphis

Cover Type	Before	Change	After	Percent Change
Open	56,575.0	-56.3	56,518.7	-0.10
Forest	19,693.8	-488	19,205.8	-2.48
Urban (other)	6,780.0	-9.2	6,770.8	-0.14
Water	10,193.3	+553.5	10,746.8	+5.43

New Orleans

Cover Type	Before	Change	After	Percent Change
Open	30,732.9	-51	30,681.9	-0.17
Forest	25,152.4	-190.9	24,961.5	-0.76
Urban (other)	40,479.0	-5.9	40,473.1	-0.01
Water	55,970.0	+247.8	56,217.8	+0.44

Bat species that roost in foliage or leaf litter, including the hoary bat, northern yellow bat, eastern red bat, and Seminole bat, may also experience a small negative impact from the loss of forested habitat. However, this loss is expected to have minimal impact on these bat species and their habitat. Bat species in the *Lasiurus* and *Dasypterus* genera have much larger maximum foraging distances compared to those in the genus *Myotis*. For example, the maximum foraging distance for hoary bats can be up to 20 km (Barclay 1989). This will dilute the effect of habitat loss. Furthermore, tree and leaf litter roosting species are less sensitive to WNS and have experienced little change in population status.

Species that do not use forests for roosting habitat will experience no significant impact from construction and operation, maintenance and repair of the Work Items. Gray bats use caves for diurnal roosting and their distribution is mostly outside the project area. See also Appendix 9, regarding threatened and endangered species for additional information. Species that primarily roost in buildings, such as the big brown bat and Brazilian free-tailed bat, will also experience no impact from the loss of forested habitat to borrow pits. Big brown bats and Brazilian free-tailed bats tend to forage in open habitat; therefore, borrow pit excavation is not likely to have a significant negative impact on their foraging ability.

Loss of forest habitat construction and operation, maintenance and repair of the Work Items at sites surrounded by extensive forest may reduce foraging habitat for bat species adapted to forage in forest interiors. These species include the Rafinesque's big-eared bat, small-footed bat, northern long-eared bat, and Indiana bat. However, considering the small proportion of forested habitat being lost and the high mobility of bats, these species (if present) likely would be able to relocate to new foraging areas.

Excavation of borrow pits may have positive impacts for species that forage in open areas, along edges, or over water. By excavating borrow pits in forested habitat, open areas and edge will be created. When borrow pits fill with water, riparian habitat also will become available. Species that will benefit from creation of foraging habitat by borrow pit excavation include the hoary bat, northern yellow bat, big brown bat, silver-haired bat, eastern red bat, Seminole bat, southeastern myotis, gray bat, little brown bat, evening bat, tri-colored bat, and the Brazilian free-tailed bat.

The impact of construction and operation, maintenance and repair of the Work Items on cave hibernating species will be minimal because while some could pass through portions of the project area during migration, there are no caves in the proposed Work Item footprints and few (if any) caves occur near the proposed Work Items. While the impact will be minimal to cave hibernating species, the Districts will follow the guidance outlined in Appendix 9 to ensure compliance with the Endangered Species Act. Migratory bats use similar habitats in both their summer and winter ranges, so the impacts on these species will be similar to the impacts on roosting and foraging habitat.

A7-7 SURVEY FRAMEWORK

Before construction and operation, maintenance and repair of the Work Items commences, USACE personnel will review the Range-wide Indiana Bat Survey Guidelines (U.S. Fish and Wildlife Service 2019). This document provides details on the process for determining if presence/absence surveys for Indiana bats are necessary and how the survey must be conducted. At this time, the Indiana bat protocol also applied to northern long-eared bats. See also Appendix 9, regarding the Endangered Species Act for additional information. District personnel will also contact their respective U.S. Fish and Wildlife Ecological Services Field Office. They can provide additional guidance specific to each Work Item.

Briefly, the survey process begins by assessing the need for presence/absence surveys. If incidental take is already under a habitat conservation plan (HCP) or biological opinion (BO), then additional surveys may not be required. Next, a habitat assessment would be conducted as specified in the survey protocol. USACE anticipates these surveys will be needed for several Work Items. See also Appendix 9, regarding the Endangered Species Act for additional information.

If surveys are required, it will be necessary to determine if the Work Item qualifies as a linear or non-linear project. Based on their preliminary review, the authors believe the Work Item activities would qualify as non-linear, but final determination would be made after reviewing the protocol and consulting with the U.S. Fish and Wildlife Service.

Surveys can be conducted using mist nets or acoustical detectors. If mist netting is selected, the required survey effort would be nine net nights per 123 acres of suitable habitat (under the current guidance). If acoustical detectors are used, a survey effort of eight detector nights per 123 acres of suitable habitat would be used (under the current guidance). Both methods require that surveys be distributed across a minimum of two nights. Indiana bats are considered present if any individuals are captured in a mist net. Recordings from acoustical detectors must be identified using an approved auto-identification program. Calls from sites where Indiana bats are likely to be present can then be manually verified by a qualified biologist. All surveys must be conducted by a permitted biologist in accordance with the procedures laid out in the survey guidelines.

Determination of survey effort will depend on the amount of suitable habitat within the Work Item. Because of the large geographic scale of this project, consultation with the U.S. Fish and Wildlife Service will determine the amount of land within suitable habitat.

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