United States Department of the Interior

FISH AND WILDLIFE SERVICE
Tennessee ES Office
446 Neal Street
Cookeville, Tennessee 38501

April 13, 2015

Mr. John T. (Bo) Baxter
Manager, Endangered Species Compliance
Tennessee Valley Authority
400 West Summit Hill Drive, WT 11D-K
Knoxville, Tennessee 37902-1499

Re: FWS# 15-F-0212. Formal consultation for Duck River bank stabilization, River Mile 176.8 in Marshall County, Tennessee

Dear Mr. Baxter:

The enclosed biological opinion is in response to the Tennessee Valley Authority's (TVA) revised January 16, 2015, request to the U.S. Fish and Wildlife Service (Service) to initiate formal consultation for the proposed Duck River bank stabilization project at River Mile 176.8 in Marshall County, Tennessee. The biological opinion addresses potential effects of this project to the federally endangered oyster mussel (*Epioblasma capsaeformis*)=Duck River darter snapper (*Epioblasma ahlstedti*), Cumberland monkeyface (*Quadrula intermedia*), birdwing pearlymussel (*Lemiox rimosus*), slabside pearlymussel (*Lexingtonia dolabelloides*), federally threatened rabbitsfoot (*Quadrula cylindrica cylindrica*), and federally designated critical habitat for the oyster mussel, slabside pearlymussel, Cumberlandian combshell (*Epioblasma capsaeformis*), fluted kidneyshell (*Ptychobranchus subtenum*), per section 7 of the Endangered Species Act (Act).

Prohibitions against take in section 9 of the Act do not apply until a species is federally listed as threatened or endangered, or critical habitat is federally designated. Therefore, in response to TVA's request for a *conference review* of the potential effects of the action on proposed critical habitat for the rabbitsfoot (included with your revised January 16, 2015, request for formal consultation), the Service has addressed those potential effects in a *conference report*, independent of this biological opinion, which will be provided to you under separate cover.

This biological opinion is based on information provided in a revised biological assessment, received by the Service on January 16, 2015, and other sources of information.

A complete administrative record of this consultation is on file and available for review at the Tennessee Ecological Services Field Office, 446 Neal Street, Cookeville, Tennessee 38501.

If you have any questions or concerns about this consultation, please feel free to contact myself or Todd Shaw of this office at 931/525-4985, or at *ross_shaw@fws.gov*.

Sincerely,

for Mary E. Jennings
Field Supervisor

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Tennessee ES Office
446 Neal Street
Cookeville, Tennessee 38501

April 13, 2015

Mr. John T. (Bo) Baxter
Manager, Endangered Species Compliance
Tennessee Valley Authority
400 West Summit Hill Drive, WT 11D-K
Knoxville, Tennessee 37902-1499

Re: FWS# 15-I-0387. Conference report regarding proposed rabbitsfoot mussel critical habitat for Duck River bank stabilization, River Mile 176.8 in Marshall County, Tennessee

Dear Mr. Baxter:

We are providing this conference report in response to your revised January 16, 2015, request for a *conference review* of the potential effects of the proposed Duck River bank stabilization project at River Mile 176.8 in Marshall County, Tennessee, on proposed critical habitat for the rabbitsfoot mussel (*Quadrula cylindrica cylindrica*) (included with your request for formal consultation related to this action, FWS 15-F-0212).

The U.S. Fish and Wildlife Service (Service) concurs with the Tennessee Valley Authority's (TVA) assessment that the proposed action, with the measures included to avoid adverse effects to proposed critical habitat for the rabbitsfoot in your revised January 16, 2015, Biological Assessment: Duck River Bank Stabilization, River Mile 176.8 (Marshall County, Tennessee), would not adversely modify the proposed critical habitat for the rabbitsfoot. We have no further recommendations at this time for reducing adverse effects to proposed critical habitat for the rabbitsfoot.

Prohibitions against take in section 9 of the Endangered Species Act (Act) do not apply until a species is federally listed as threatened or endangered, or critical habitat is federally designated. A conference is required only when the proposed action is likely to jeopardize the continued existence of a proposed species or result in the destruction or adverse modification of proposed critical habitat. However, action agencies may request a conference on any proposed action that may affect proposed species or proposed critical habitat. Therefore, we do appreciate that you have requested to conference on proposed critical habitat for the rabbitsfoot.

All recommendations provided in this conference report are advisory because TVA (the action agency) is not prohibited from destroying or adversely modifying proposed critical habitat until the critical habitat is designated. However, once listed, the prohibition against adverse modification applies, regardless of the action's stage of completion. Therefore, TVA should utilize the conference report's recommendations (i.e., implementing the measures included in your

biological assessment to avoid adverse effects to proposed critical habitat for the rabbitsfoot) to avoid likely future conflicts.

If you have any questions or concerns about this consultation, please feel free to contact myself or Todd Shaw of this office at 931/525-4985, or at *ross_shaw@fws.gov*.

Sincerely,

for Mary E. Jennings
Field Supervisor

BIOLOGICAL OPINION

Duck River Bank Stabilization, River Mile 176.8

Marshall County, Tennessee

April 13, 2015

Executive Summary

The U.S. Fish and Wildlife Service (Service) has completed this biological opinion to determine the effects of a proposed riverbank stabilization project at River Mile (rmi) 176.8 on the Duck River in Marshall County, Tennessee, to the federally endangered oyster mussel (*Epioblasma capsaeformis*)=Duck River darter snapper (*Epioblasma ahlstedti*), Cumberland monkeyface (*Quadrula intermedia*), birdwing pearlymussel (*Lemiox rimosus*), slabside pearlymussel (*Lexingtonia dolabelloides*), federally threatened rabbitsfoot (*Quadrula cylindrica cylindrica*), and federally designated critical habitat for the oyster mussel, slabside pearlymussel, Cumberlandian combshell (*Epioblasma capsaeformis*), fluted kidneyshell (*Ptychobranchus subtenum*), per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

The proposed federal action would occur on private property. The project proponents are the Natural Resources Conservation Service (NRCS) and the Tennessee Nature Conservancy (TNC). The "Description of Proposed Action" section of this biological opinion includes a "Project Overview" and detailed descriptions of the "Action Area", "Project Components and Activities" and "Conservation Measures".

The Tennessee Valley Authority (TVA) is serving as the federal action agency for the proposed action. TVA submitted a request for formal consultation to the Service, which included a biological assessment indicating that the proposed action would likely adversely affect the above listed species, on December 8, 2014. On December 22, 2014, the Service reviewed the biological assessment, determined it was incomplete, and requested additional information from TVA to initiate formal consultation as outlined in the regulations governing interagency consultations (50 CFR §402.14). TVA provided a revised biological assessment, addressing the Service's concerns, on January 16, 2015. The Service initiated formal consultation on that date and determined that this biological opinion would be provided to TVA no later than June 7, 2015.

The Service has concluded in this biological opinion that the proposed action is not likely to jeopardize the continued existence of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and is not likely to destroy or adversely modify designated critical habitat (DCH) for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidneyshell. The Service reached this conclusion by examining the current status of the species, the environmental baseline for the action area, and various possible effects to the species and their DCHs (including direct, indirect, interrelated and interdependent effects of the proposed federal action, and cumulative effects of other non-federal future actions that may occur in the action area, including state, tribal, local or private activities,

and are reasonably certain to occur in the project area). Our analysis was then measured against the definition of jeopardy. Under the Act, *jeopardy occurs when an action is reasonably expected, directly or indirectly, to diminish a species' numbers, reproduction or distribution, so that its likelihood of survival and recovery in the wild is appreciably reduced* (50 CFR §402.02).

In this biological opinion, the Service has determined that the proposed action may adversely affect the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and DCH for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidneyshell. The Service has further determined that the action, as proposed, would result in incidental take of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot. For this biological opinion, the incidental take would be exceeded when the take exceeds 131 oyster mussel, 690 Cumberland monkeyface, 173 birdwing pearlymussel, 867 slabside pearlymussel and 498 rabbitsfoot throughout 3,727-ft^2 of aquatic habitat, which is what has been exempted from the prohibitions of section 9 by this biological opinion. Reasonable and prudent measures (RPMs) to minimize the take, and terms and conditions (T&Cs), that must be observed when implementing those RPMs, have been included in this biological opinion.

Consultation History

March 31, 2014	TNC sent an e-mail to the Service's Tennessee Ecological Services Field Office (TFO) and NRCS discussing project design considerations to avoid impacts to federally protected mussel species (Corey Giles [TNC] via e-mail to Peggy Shute [TFO] and Terry Horne [NRCS]).
March 31, 2014	The TFO sent an e-mail to TNC and NRCS, in response to TNC's March 31, 2014 e-mail, recommending formal consultation given the number of listed species and critical habitat designations for the Duck River reach where the proposed work would take place (Peggy Shute via e-mail to Corey Giles, Mandy Cash [NRCS] and Terry Horne).
April 2, 2014	The TFO met with TNC and NRCS at the proposed Duck River project site in Marshall County, Tennessee (Peggy Shute and Stephanie Chance [TFO] met with Mandy Cash and Corey Giles).
April 2, 2014	NRCS requested an example of a biological assessment from the TFO; in response, the TFO provided a biological assessment format and guidance to them (e-mail exchange between Mandy Cash and Peggy Shute).
April 8, 2014	TVA received a TVA 26A Permit Application for the proposed riverbank stabilization project, accompanied by a cover letter from TNC stating the project would be funded through a TNC grant and discussions regarding consultation had begun with the TFO (letter from Corey Giles to John (Bo) Baxter [TVA]).
April 30, 2014	The TFO sent an example of a biological assessment by email to TNC and NRCS (Brad Bingham [TFO] via email to Corey Giles and Mandy Cash).
June 4, 2014	The TVA agreed to prepare a biological assessment, in addition to processing a TVA 26A Permit for the proposed riverbank stabilization project (Bo Baxter communication with Fred Bennett [TVA]).
July 8, 2014	The TVA met with TNC at the proposed project site to inquire about project specifics and discuss formal consultation and timelines (Andrew Henderson [TVA] met with Corey Giles).
July 21, 2014	The TVA contacted the TFO to let them know that TVA would be preparing the biological assessment, provided a project description, site map and NRCS's engineered drawings, and requested feedback on project history (Andrew Henderson via telephone conversation and e-mail communication with Bryan Watkins [TFO]).
July 21, 2014	The TFO provided examples of biological assessments to TVA (Todd Shaw [TFO] and Bryan Watkins via e-mail to Andrew Henderson).

December 9, 2014 — TVA's December 8, 2014, letter and biological assessment arrived at the TFO in Cookeville, Tennessee. TVA determined that the proposed bank stabilization project may affect and is likely to adversely affect the federally endangered oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel, and federally threatened rabbitsfoot, and may affect DCH for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidneyshell (letter from Bo Baxter to Mary Jennings [TFO]).

December 22, 2014 — The TFO confirmed receipt of the biological assessment, indicated that it had not received all necessary information to initiate formal consultation, and requested specific additional information, regarding the proposed project, as outlined in the regulations governing interagency consultations (50 CFR §402.14). The TFO further indicated that the formal consultation process for the project would not begin until the Service received all of the information, or a statement explaining why that information was not available (e-mail sent by Todd Shaw to Andrew Henderson).

January 16, 2015 — The TVA revised and resubmitted their biological assessment to address TFO's December 22, 2014 request, for additional information and initiate the formal consultation process (e-mail with revised biological sent by Andrew Henderson to Todd Shaw).

January 16, 2015 — The TFO responded to TVA, indicating that that its initiation of formal consultation under section 7 of the Act was complete and that a biological opinion would be provided to TVA no later than June 7, 2015 (Mary Jennings signed the letter; it was addressed and mailed to Bo Baxter).

FWS Log No: 2015-F-0212 ***Application No***: N/A
Date Started: January 23, 2015 ***Ecosystem:*** Lower Tennessee-Cumberland
Applicant: Natural Resources Conservation Service and Tennessee Nature Conservancy
Action Agency: Tennessee Valley Authority
Project Title: Duck River Bank Stabilization, River Mile 176.8
County: Marshall

Table 1. **Species and critical habitat evaluated for effects and those where the Service has concurred with a "not likely to adversely affect" determination.**

SPECIES or CRITICAL HABITAT	PRESENT IN ACTION AREA	PRESENT IN ACTION AREA BUT "NOT LIKELY TO BE ADVERSELY AFFECTED"
Indiana Bat (*Myotis sodalist*)	-----	X
Grey Bat (*Myotis grisescens*)	-----	X
Northern Long-eared Bat (*Myotis septentrionalis*)	-----	X
Birdwing Pearlymussel (*Lemiox rimosus*)	X	-----
Cumberland Monkeyface (*Quadrula intermedia*)	X	-----
Oyster Mussel (*Epioblasma capsaeformis*)= Duck River Darter Snapper (*Epioblasma ahlstedti*)	X	-----
Rabbitsfoot (*Quadrula cylindrica cylindrica*)	X	-----
Slabside Pearlymussel (*Lexingtonia dolabelloides*)	X	-----
Cumberlandian combshell (*Epioblasma capsaeformis*) Designated Critical Habitat	X	-----
Fluted Kidneyshell (*Ptychobranchus subtenum*) Designated Critical Habitat	X	-----
Oyster Mussel Designated Critical Habitat	X	-----
Slabside Pearlymussel Designated Critical Habitat	X	-----

DESCRIPTION OF PROPOSED ACTION

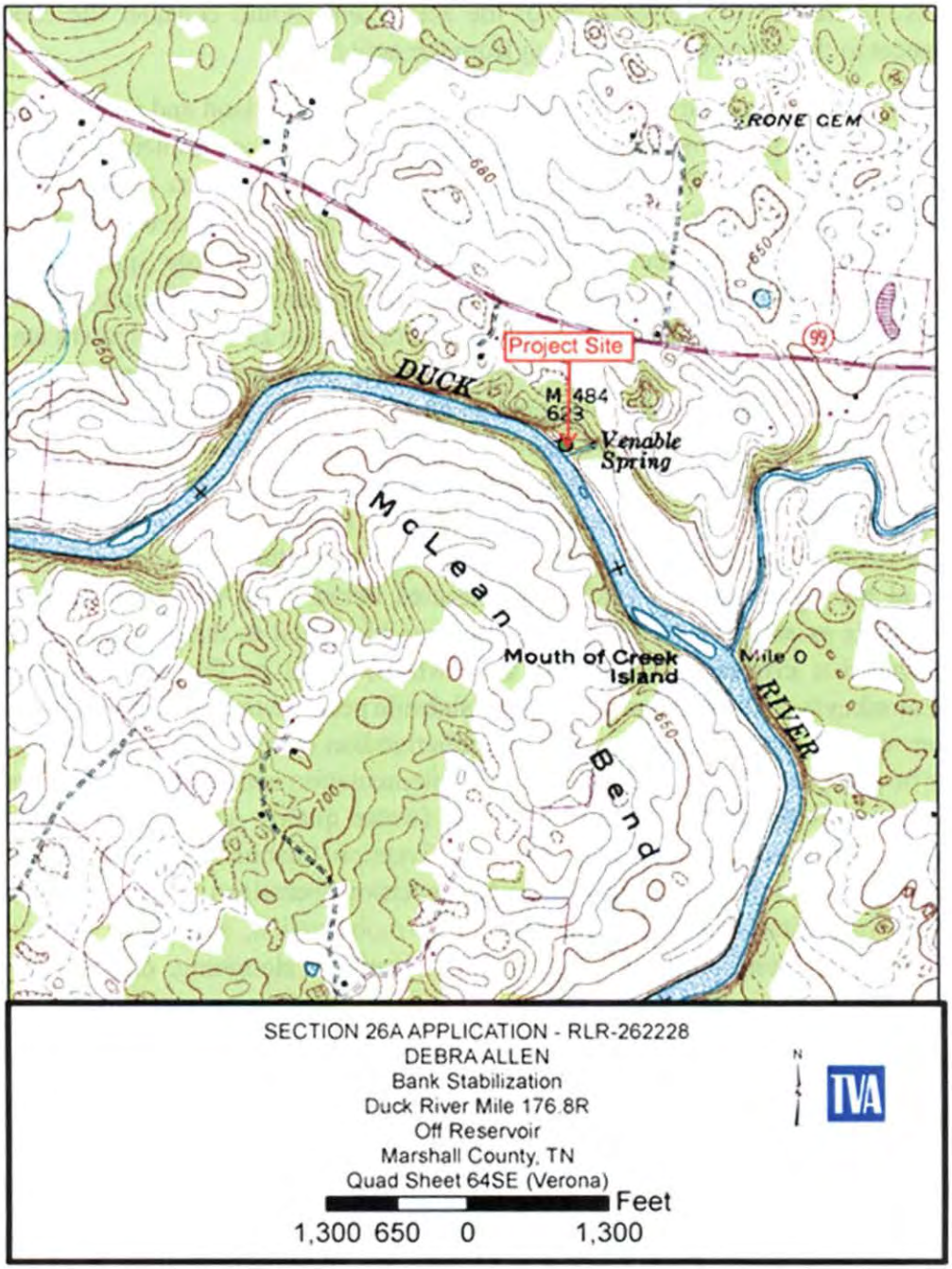
Project Overview

The proposed Duck River Bank Stabilization Project would be located on the right descending bank of the Duck River, immediately downstream of Venable Spring, in north-central Marshall County, Tennessee. A map of the project vicinity is included below (see Figure1).

The purpose of the proposed action is to stabilize eroding soils in the floodplain and on the right descending bank of the Duck River at approximately rmi 176.8 in Marshall County, Tennessee. The total project area would be comprised of less than 1 acre (ac) of aquatic habitat, and adjacent riverbank and floodplain including: (1) two sections of eroded riverbank, (2) one eroded conveyance, and (3) the construction area of a diversion channel to direct surface runoff from the upland area of the property to the conveyance. The proposed soil stabilization work would take place between August 1 and September 1, 2015, during late summer low-flow periods, and outside of known reproductive periods for federally protected mussel species in the vicinity of the proposed project (Tennessee Valley Authority 2015a). NRCS engineering drawings of the bank stabilization project have been included in Appendix A; photographs of the project site have been included in Appendix B; and NRCS Conservation Practice Standard Stream Bank and Shoreline Protection Code 580 have been included in Appendix C).

The proposed construction activities would use best management practices (BMPs) to be implemented in accordance with NRCS Streambank and Shoreline protection Code 580 (Appendix C) (Tennessee Valley Authority 2015a), and TVA 26a Standard Permit Conditions (Tennessee Valley Authority 2015b). These BMPs would be designed to control potential stormwater pollutants. In addition, BMPs would be implemented in phases so that the correct BMP selection and implementation would occur with the appropriate stage of construction and site development activities. The proposed plans and BMPs would limit sediment runoff and direct effects to aquatic habitat, and impacts from storm water runoff would be within allowable state standards (Tennessee Valley Authority 2015a).

Figure 1. Duck River Bank Stabilization Project Vicinity.



Action Area

By definition, the project action area encompasses an area where proposed activities can cause measurable or detectable changes in land, air and water or to other measurable factors that may elicit a response in the species or critical habitat addressed under the consultation. The project action area is not limited to the footprint of the action and should consider the chemical and physical impacts to the environment resulting from the action.

The action area for the proposed project would include all areas on land and in water directly and indirectly impacted by pre-project implementation activities, project implementation and post-implementation operations. The Service has estimated the action area to include a total of approximately 774,897 ft^2 (17.8 ac), containing the following areas: (1) a terrestrial area, beginning on the right descending bank of the Duck River in the vicinity of Venable Spring and extending downstream approximately 125 linear ft, which would encompass approximately 30,417 ft^2 (0.7-ac) of the riparian zone and floodplain (including an approximate 270-ft^2 equipment staging area, portions of an existing access road, portions of two riprap revetments above the ordinary high water line (OHW), a 95-ft stormwater diversion channel, a 110.4-ft riprap chute, fill stockpile sites and spoil deposition sites), and (2) a 744,480 ft^2 (17.1 ac) aquatic area, beginning in the Duck River, immediately downstream of Venable Spring and extending across the approximate 141-ft average wetted-channel width, to a point approximately 5,280 ft (1 rmi) downstream (including sites where freshwater mussels would be collected and relocated, portions of the two riprap revetments and the riprap chute would be constructed below the OHW and suitable instream habitat for mussels exists). This 17.8-ac area has been identified as the action area because the Service believes that effects of the action, as a whole, could be felt by the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and DCH for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidney shell would likely be affected as a result of pre-project implementation activities (mussel translocations and equipment staging), implementation activities (water quality and habitat impacts due to construction of riprap revetments, a stormwater diversion channel and a riprap chute, and associated equipment mobilization) and post-implementation operations (water quality and habitat impacts following project completion [equipment de-mobilization, suspended sediments, etc.] and/or as a result of potential project failures [i.e., riverbank sloughing, etc.]) throughout the entirety of this area.

Project Components and Activities

(1) Pre-project Implementation:

a) Translocation of Mussels – Mussels would be translocated from the project vicinity prior to proposed project implementation activities to minimize lethal take and direct impacts. TVA, Service and Tennessee Wildlife Resources Agency (TWRA) personnel would conduct pre-project translocations of the adjacent and downstream impact areas to move individuals of listed species (oyster mussel, birdwing pearlymussel, slabside pearlymussel, Cumberland monkeyface and rabbitsfoot) out

of areas that would be directly impacted by the proposed project (Tennessee Valley Authority 2015a).

b) Equipment Staging and Transport; Fill Stockpiling - Equipment, to be used in land clearing and construction activities, would be stored and fueled within an approximate 270-ft² equipment staging area at a previously cleared upland site (existing campsite) in the action area. An existing access road would be used as a haul road to transport equipment and materials to the staging area. Any stockpile areas used for fill would be located in upland areas in the action area away from the Duck River (Tennessee Valley Authority 2015a).

(2) Project Implementation:

a) Riprap Revetments, Bank Sloping and Revegetation – The two revetments would be constructed from D50 limestone (50 percent [%] of the mixture of rock by weight would be smaller than the 15-inch [in] diameter specified), ranging in diameter from 6- to 24-in. Class 1, nonwoven, 8 ounce (oz) per (/) square yard (yd²) geotextile would be installed under both revetments (see page 2 in Appendix A). The revetments would be constructed in a manner to match the grade of the surrounding riverbanks. The total volume of rock necessary for bank stabilization, including revetments and associated keyways, is estimated to be approximately 188.2 cubic yards (310.4 tons) (Tennessee Valley Authority 2015a; Henderson, personal communication, 2015a).

The first revetment would be constructed adjacent to an existing private boat ramp and have a total length of 28 ft. It would have a height of 5-13 ft at a 1.5:1 slope over a 10-linear ft length. The remaining 18 linear ft of the revetment's length would be 13 ft in height and have a slope of 2:1. A track hoe would be used to excavate a 2-ft by 2-ft keyway at the toe of the riverbank. The subgrade excavation at the site would consist of 17.8 cubic yards ($yd^{3)}$ of keyway excavation and 22 yd^3 of excavated material for placement on the riverbank, resulting in 39.4 yd^3 total volume of excavation (Tennessee Valley Authority 2015a).

The second riprap revetment would be constructed 23 ft downstream from the first revetment, and be 21 ft long, 13 ft high and have a 2:1 slope. A track hoe would be used to excavate a 2-ft by 2-ft keyway along the toe of the riverbank. The subgrade excavation at the second site would consist of 13.1 yd^3 for the keyway and 16.5 yd^3 of excavated material for slopes, resulting in 29.6 yd^3 total volume of excavation (Tennessee Valley Authority 2015a).

The slope above the riprap for both revetments would be constructed at a 2:1 slope, stabilized by planting shrub seedlings (smooth alder [*alnus serrulata*], silky dogwood [*Cornus amomum*] and buttonbush [*Cephalanthus occidentalis*]) or other

suitable alternatives specified by NRCS at a rate of 680 stems/ac (Tennessee Valley Authority 2015a; Henderson, personal communication, 2015b).

b) Riprap Chute - The riprap chute would be 110.4 ft long and have a 21 ft top-width, requiring a total of 257.6 cubic yards (425 tons) of rock (see page 3 in Appendix A). The distance from the end of the second revetment to the midpoint of the riprap chute would be 23 ft. The riprap chute would have Class 1, nonwoven, 8 oz/yd^2 geotextile placed under it. The riprap chute would be 4-ft wide (bottom-width), 2 ft deep and 2. 3415 ft thick, and have 2:1 side slopes. The body of the chute would total 1 yd^2 and be constructed over a 90.4-ft length on a 4:1 slope; an additional 20 ft of chute length would include the chute entrance and exit. Riprap the chute would be comprised of D50 limestone have a D50 of 15 in, ranging in diameter from 6- to 24-in (Tennessee Valley Authority 2015a; Henderson, personal communication, 2015a).

c) Stormwater Diversion Channel - There would be a 95-ft long stormwater diversion channel constructed from the existing access road to the entrance of the riprap chute (see page 5 in Appendix A). The diversion would be a minimum of 2 ft deep, have a minimum top-width of 13.8 ft and be constructed on a 1% slope. Soils, excavated during construction of the riprap chute and bank stabilization revetments, would be utilized in construction of the diversion channel. All areas of soil disturbed during construction would be stabilized with a critical area seeding, limed, fertilized and mulched with small-grained straw mulch at the rate of 2.5 tons/ac as specified by the local NRCS District Conservationist. Because the diversion would receive concentrated stormwater flows, an Erosion Control Blanket (ECB) would be installed to minimize erosion until vegetation would be well established. The 12-month straw ECB would be North American Green's S75 product or a comparable product (Tennessee Valley Authority 2015a).

(3) Post-implementation Operations:

a) Riprap Revetments – Flow patterns would not be significantly altered as a result of construction and operation of riprap revetments and keyways. Therefore, potential erosion of the riverbank or sedimentation of substrate in the near vicinity of the structures would be minor. However, a zone on the riverbank, surrounding the riprap revetments, would be subject to some short-term indirect impacts occurring later in time, including increased suspended sediments and instream sedimentation due to runoff. It is estimated that a zone approximately 15 ft riverward and 50 ft downstream of the proposed project area may currently be indirectly affected as a result of current recreational usage (Tennessee Valley Authority 2015a).

b) Floodplain – Post project impacts could occur as a result of previous activities which occurred in the floodplain during the project implementation phase

(construction of portions of the two riprap revetments above the OHW, the stormwater diversion channel and riprap chute, and spoil deposition and leveling). However, the proposed construction activities would include implementation of BMPs in accordance with NRCS Streambank and Shoreline protection Code 580 and TVA 26a Standard Permit Conditions (Tennessee Valley Authority 2015b). The BMPs would be designed to control potential stormwater pollutants, limiting sediment runoff and effects to aquatic habitat. Spoil materials would be deposited and leveled in the project area at sites above the 100-year flood elevation during the implementation phase. Because the project footprint would be under 1-ac, a general National Pollutant Discharge Elimination System (NPDES) Permit for stormwater discharge at a construction site would not be required by the Tennessee Department of Environment and Conservation (TDEC) (Tennessee Valley Authority 2015a).

Conservation Measures

The following conservation measures were discussed and offered in the biological assessment to offset potential adverse effects of the proposed action on the federally listed oyster mussel, slabside pearlymussel, Cumberland monkeyface, birdwing pearlymussel and rabbitsfoot, DCH for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidneyshell, and proposed critical habitat for the rabbitsfoot (Tennessee Valley Authority 2015a):

(1) All project partners, including the contractor and landowners, will uphold the environmental engineering and construction standards in the NRCS construction plan and all other conservation measures (Appendices A and C).

(2) Individual mussels collected for relocation would be released upstream of the project area in suitable habitats for mussel survival. Personnel surveying for and collecting these federally protected species would possess appropriate state and federal permits for this activity. Any federally protected mussels, collected for relocation, would be closely monitored to prevent stress during collection and holding, transported as quickly as possible to relocation sites, and appropriately acclimated to conditions (water temperatures, dissolved oxygen [DO], etc.) at release sites. Catch per unit effort (CPU) and/or densities of individuals collected would be documented and the deposition of relocated species would be reported to the Service's TFO. Details reported would include habitat conditions such as water temperatures, depths, substrate types and percentages, flow levels, numbers of individuals collected and relocated and locations (latitudes and longitudes) of pre-approved release sites.

(3) The proposed project construction would take place between August 1 and September 1, 2015, during the late summer low-flow period. Because this period falls outside of known reproductive periods for federally protected mussel species in the vicinity of the proposed project, this would minimize adverse effects to the species. The amount of disturbance to DCH would also be minimized because riverbank excavations and land

clearing activities would occur during the low-flow period, when the potential for erosion and runoff would be reduced.

(4) The equipment staging area would be sited a minimum of 100 ft from the OHW of the Duck River, Venable Spring and any wetlands. All equipment within the floodplain would carry absorbent boom pads, or have truck diapers and absorbent pads attached at all times during both operational and non-operational activities to prevent the introduction of oils, coolants and/or other petroleum products into aquatic areas.

(5) An existing access road would be used as a haul road to transport equipment and materials to the staging area.

(6) Any stockpile areas used for fill would be located in upland areas in the action area away from the Duck River.

(7) BMPs would be implemented in accordance with NRCS Streambank and Shoreline protection Code 580 (Appendix C), and TVA 26a Standard Permit Conditions (Tennessee Valley Authority 2015b).

(8) Spoil materials would be deposited and leveled in the project area at sites above the 100-year flood elevation.

(9) An NRCS representative, as well as a TVA biologist, would make at least one site visit during active construction to ensure that BMPs and water quality control measures are in place and properly functioning. The site visit(s) would entail onsite inspections and findings would be made available to the TFO and/or permitting agency(s) upon request.

(10) Any construction activity that could result in introduction of potentially toxic materials into the Duck River would be stopped immediately by the project inspector, the resource agencies would be contacted and corrective action(s) implemented prior to resuming work.

(11) There would be no tree or shrub removal along the Duck River except within project limits, and then only if essential. When possible, trees and shrubs on the riverbank would be cleared to allow roots to remain, rather than removal by mechanized methods. All areas disturbed during construction would be stabilized as soon as possible by use of riprap, seeding or mulching, in compliance with permit specifications.

STATUS OF THE SPECIES/CRITICAL HABITAT

Species description

Birdwing pearlymussel

The birdwing pearlymussel (*Conradilla caelata* [=*Lemiox rimosus*]) was listed as an endangered species on June 14, 1976 (41 FR 24062). A recovery plan addressing the birdwing pearlymussel was approved on July 9, 1984 (U.S. Fish and Wildlife Service 1984a). Critical habitat has not been designated for this species.

The birdwing pearlymussel is a small mussel, seldom growing to a length of more than 2 in. Shells are subtriangular in shape, very thick and solid, and slightly inflated. A well-developed posterior ridge is present. The surfaces of the shells are marked by strong, irregular lines, and the posterior half or two-thirds is roughened by corrugated sculpture. Shells of the male have a broad, shallow depression in front of the posterior ridge; those of the female are sometimes inflated with a weakly developed marsupial swelling along the posterior-ventral margin. The periostracum is dull green or yellowish-green with indistinct rays; older adult individuals' shells are dark brown to black. The nacre is white and iridescent posteriorly (Parmalee and Bogan 1998).

Oyster mussel

The oyster mussel (*Epioblasma capsaeformis*) was listed as an endangered species on January 10, 1997 (62 FR 1647-1658). A recovery plan addressing the oyster mussel was approved on May 4, 2004 (U.S. Fish and Wildlife Service 2004a).

The oyster mussel is a medium-sized species, growing to a maximum length of approximately 3 in. Shells are elliptical in shape and are covered with irregular growth lines; the anterior end is regularly rounded and the posterior end is slightly protruding in males and broadly rounded in females. The ventral margin of males is slightly curved; in females, it is straight with a pronounced rounded marsupial swelling posteriorly. The swelling is thin and slightly inflated, is offset from the rest of the shell by an anterior and posterior sulcus, and is sometimes toothed. The periostracum is yellowish-green with fine green rays over the entire shell; nacre color is creamy to bluish-white (U.S. Fish and Wildlife Service 2004a; Parmalee and Bogan 1998).

Cumberland monkeyface

The Cumberland monkeyface (*Quadrula intermedia*) was listed as an endangered species on June 14, 1976 (41 FR 24062). A recovery plan addressing the Cumberland monkeyface was approved on July 9, 1984 (U.S. Fish and Wildlife Service 1984b). Critical habitat has not been designated for this species.

The Cumberland monkeyface pearlymussel is a medium-sized species, growing to a length of approximately 3.5 in. The shells are elliptical or square, and are slightly inflated. The anterior end and ventral margin are rounded; the posterior end is rounded dorsally, but has an indentation near the ventral margin. The posterior ridge of males is slightly elevated above the outline of the shell; in females, there is a wide, deep radial depression along the posterior-dorsal margin. The surface of the shells is covered with numerous, large elevated tubercles, except on the anterior one-third of the shell. The outer surface is greenish-yellow in color, darkening to brownish in some individuals. Fine, angular green spots, chevrons, or zigzags or broken green rays may be present. Nacre color is typically white and is often tinted with salmon coloration in the posterior areas of the shell (Parmalee and Bogan 1998).

Rabbitsfoot

The rabbitsfoot (*Quadrula cylindrica cylindrica*) was listed as a threatened species on October 17, 2013 (78 FR 57076-57097). A recovery plan addressing the rabbitsfoot has not yet been written. Critical habitat for the rabbitsfoot was proposed for listing in the proposed rule to list the rabbitsfoot as a threatened species on October 16, 2012 (77 FR 63440), including approximately 146.2 rmi of the Duck River from the Interstate 40 crossing at approximately rmi 32.8 in Hickman County, Tennessee, upstream to Lillard's Mill at approximately rmi 179 in Marshall County, Tennessee. However, the final critical habitat designation not yet been published.

The rabbitsfoot is a medium to large mussel, elongate and rectangular, reaching a length of 6 in (Oesch 1984). Parmalee and Bogan (1998) describe the beaks as moderately elevated and raised only slightly above the hinge line. Beak sculpture consists of a few strong ridges or folds continuing onto the newer growth of the umbo (raised or domed part of the dorsal margin of the shell) as small tubercles (small, rounded projection on surface of the shell). Shell sculpture consists of a few large, rounded, low tubercles on the posterior slope, although some individuals will have numerous small, elongated pustules (small raised spots) particularly on the anterior. The periostracum is generally smooth and yellowish, greenish, or olive in color becoming darker and yellowish-brown with age and usually covered with dark green or nearly black chevrons and triangles pointed ventrally (Say 1817). These patterns are absent in some individuals. Internally, the color of the nacre is white and iridescent, often with a grayish-green tinge in the umbo cavity. Specimens from the southern periphery of its range are occasionally purplish. Soft parts generally have an orange coloration (Oesch 1984; Parmalee and Bogan 1998). However, Vidrine (1993) noted that the rabbitsfoot in the Ouachita River system in Louisiana had black soft parts. Aspects of the soft anatomy are described by Ortmann (1912), Utterback (1915), Davis and Fuller (1981), and Oesch (1984).

The rabbitsfoot was originally described as *Unio cylindricus* (Say, 1817). The type locality is the Wabash River (Parmalee and Bogan 1998), probably in the vicinity of New Harmony, Posey County, Indiana, and adjacent Illinois. Parmalee and Bogan (1998) summarize the following synonymy of the rabbitsfoot. The rabbitsfoot has been considered a member of the genera *Unio, Mya,* Margarita, *Margaron*, and *Orthonymus* at various times in history. It was first considered a member of the genus *Quadrula* by Lewis (1870). The description of *Unio cylindricus strigillatus* (B.H. Wright 1898) (=*Quadrula cylindrical strigillata*, the federally endangered rough rabbitsfoot; Turgeon et al. 1998), rendered the rabbitsfoot, *Quadrula cylindrica cylindrica*, a subspecies for *Quadrula cylindrica*. Davis and Fuller (1981) and Sproules et al. (2006) conducted taxonomic and genetic studies on the rough rabbitsfoot (*Quadrula cylindrical strigillata*) and rabbitsfoot (*Quadrula cylindrical cylindrica*).

Slabside pearlymussel

The slabside pearlymussel (*Lexingtonia dolabelloides*) was listed as an endangered species on September 26, 2013 (78 FR 59269-59287). A recovery plan has not yet been completed for the slabside pearlymussel.

The slabside pearlymussel is a moderately-sized mussel that reaches a length of about 3.5 in. The shape of the shell is subtriangular, and the very solid, heavy valves are moderately inflated. The periostracum is smooth and somewhat shiny in young specimens, becoming duller with age. The color of the periostracum is greenish yellow, becoming brownish with age, with a few broken green rays or blotches, particularly in young individuals. The color of the nacre is white, or rarely, more straw-colored (Parmalee and Bogan 1998).

Designated critical habitat description

Cumberlandian combshell designated critical habitat

Critical habitat was designated for the Cumberlandian combshell on August 31, 2004 (69 FR 53136-53180), and includes the following:

1. **The Duck River (Unit 1) from rmi 133 in Maury County, Tennessee, to rmi 179 in Marshall County, Tennessee.**
2. Bear Creek (Unit 2) from rmi 23 in Colbert County, Alabama, through Tishomingo County, Mississippi to the Alabama/Mississippi boundary.
3. The Powell River (Unit 4) from rmi 65.3 (U.S. 25E Bridge) in Claiborne County, Tennessee, to rmi 159 in Lee County, Virginia.
4. The Clinch River (Unit 5) from rmi 159 in Hancock County, Tennessee, to its confluence with Indian Creek in Tazewell County, Virginia.
5. The Nolichucky River (Unit 6) from rmi 9 to rmi 14 in Cocke and Hamblen counties, Tennessee.
6. The Big South Fork Cumberland River (BSFCR) (Unit 9) from the confluence of the New River and Clear Fork in Scott County, Tennessee, to its confluence with Laurel Crossing Branch in McCreary County, Kentucky. This unit also includes White Oak Creek from its confluence with the BSFCR in Scott County, upstream to its confluence with Panther Branch in Fentress County, Tennessee; the New River from its confluence with Clear Fork, upstream to Highway (Hwy) 27 in Scott County, Tennessee; Clear Fork from its confluence with the New River upstream to its confluence with the North Prong of Clear Fork in Morgan and Fentress counties, Tennessee; White Oak Creek from its confluence with Clear Fork upstream to its confluence with Bone Camp Creek in Morgan County, Tennessee; Bone Camp Creek from its confluence with White Oak Creek upstream to its confluence with Massengale Branch in Morgan County, Tennessee; Crooked Creek from its confluence with Clear Fork upstream to its confluence with Buttermilk Branch in Fentress County, Tennessee; and the North Prong of Clear Fork from its confluence with Clear Fork upstream to its confluence with Shoal Creek in Fentress County, Tennessee.
7. Buck Creek (Unit 10) from the State Route (SR) 92 bridge upstream to the SR 328 Bridge in Pulaski County, Kentucky.

Fluted kidneyshell designated critical habitat

Critical habitat was designated for the fluted kidneyshell (*Plychobranchus subtentum*) on September 26, 2013 (78 FR 59555-59620) and includes the following:

1. Horse Lick Creek (Unit FK1) in Rockcastle and Jackson counties, Kentucky, from its confluence with the Rockcastle River, upstream approximately 12 rmi to Clover Bottom Creek.

2. The Middle Fork of the Rockcastle River (Unit FK2) from its confluence with the Rockcastle River upstream approximately 7.7 rmi to its confluence with Indian Creek and Laurel Fork in Jackson County, Kentucky.

3. The Rockcastle River (Unit FK3) from the backwaters of Lake Cumberland near its confluence with Cane Creek along the Laurel and Pulaski county line, Kentucky, upstream approximately 43 rmi to its confluence with Horse Lick Creek along the Laurel and Rockcastle county line, Kentucky.

4. Buck Creek (Unit FK4) from SR 192, upstream approximately 38 rmi to SR 328 in Pulaski County, Kentucky.

5. Rock Creek (Unit FK5) from its confluence with White Oak Creek, upstream approximately 12 rmi to the low water crossing at rmi 15.9 in McCreary County, Kentucky.

6. The Little South Fork of the Cumberland River (Unit FK6) from its confluence with the BSFCR, where it is the dividing line between Wayne and McCreary counties, Kentucky, upstream approximately 40.7 rmi to its confluence with Dobbs Creek in Wayne County, Kentucky.

7. The BSFCR (Unit FK7) from its confluence with Laurel Crossing Branch downstream of Big Shoals in McCreary County, Kentucky, upstream approximately 28 rmi to its confluence with Clear Fork and New River in Scott County, Tennessee, and BSFCR tributaries including: Clear Fork from its confluence with the BSFCR and New River in Scott County, Tennessee, upstream approximately 20 rmi to its confluence with Crooked Creek along the Fentress and Morgan county line, Tennessee; the New River from its confluence with the BSFCR upstream approximately 9.1 rmi to the Hwy 27 Bridge crossing in Scott County, Tennessee.

8. The Wolf River (Unit FK8) from its inundation at Dale Hollow Reservoir, upstream approximately 25.5 rmi to its confluence with Delk Creek in Fentress County, Tennessee, and Town Branch from its confluence with Wolf River upstream approximately 2 rmi to its headwaters in Pickett County, Tennessee.

9. The West Fork Obey River (Unit FK9) from the Hwy 52 Bridge crossing, upstream approximately 12 rmi to its confluence with Dry Hollow Creek in Overton County, Tennessee.

10. Indian Creek (Unit FK10) from its confluence with the Clinch River, upstream approximately 4.2 rmi to the fourth Norfolk Southern Railroad crossing at Van Dyke in Tazewell County, Virginia.

11. The Little River (Unit FK11) from its confluence with the Clinch River in Russell County, Virginia, upstream approximately 31 rmi to its confluence with Liberty and Maiden Spring creeks in Tazewell County, Virginia.

12. The North Fork Holston River (Unit FK12) from its confluence with Beaver Creek, upstream of Saltville in Smyth County, Virginia, upstream approximately 42 rmi to Ceres in Bland County, Virginia.

13. The Middle Fork Holston River (Unit FK13) from its inundation at South Holston Reservoir in Washington County, Virginia, upstream approximately 55 rmi to its headwaters in Wythe County, Virginia.

14. Big Moccasin Creek (Unit FK14) from the Hwy 71 Bridge crossing in Scott County, Virginia, upstream approximately 33 rmi to the Rt 612 Bridge crossing near Collinwood in Russell County, Virginia.

15. Copper Creek (Unit FK15) from its confluence with the Clinch River upstream approximately 34.5 rmi to the Hwy 71 Bridge crossing in Scott County, Virginia.

16. The Clinch River (Unit FK16) from immediately below Grissom Island in Hancock County, Tennessee, upstream approximately 163 rmi to its confluence with Indian Creek near Cedar Bluff in Tazewell County, Virginia.

17. The Powell River (Unit FK17) from the U.S. 25E Bridge in Claiborne County, Tennessee, upstream approximately 95 rmi to rmi 159 above Rock Island in the vicinity of Pughs in Lee County, Virginia.

18. The Nolichucky River (Unit FK18) from rmi 9, approximately 0.4 rmi upstream of Enka Dam, where it divides Hamblen and Cocke counties, Tennessee, upstream approximately 32 rmi to its confluence with Pigeon Creek, just upstream of the Hwy 321 Bridge crossing in Greene County, Tennessee.

19. The Holston River (Unit FK19) from its confluence with the French Broad River in Knox County, Tennessee, upstream approximately 53 rmi to the base of Cherokee Dam at Holston rmi 52.3 along the Grainger and Jefferson counties, Tennessee, line.

20. The French Broad River (Unit FK20) from its confluence with the Holston River in Knox County, Tennessee, upstream approximately 35 rmi to the base of Douglas Dam at French Broad rmi 32.3 in Sevier County, Tennessee.

21. The Hiwassee River (Unit FK21) from the Hwy 315 Bridge crossing, upstream approximately 15 rmi to the Hwy 68 Bridge crossing in Polk County, Tennessee.

22. The Elk River (Unit FK22) from its inundation at Wheeler Reservoir in Limestone County, Alabama, upstream approximately 102 rmi to its confluence with Farris Creek at the Franklin and Moore county line in Tennessee.

23. **The Duck River (Unit FK23) from its inundation at Kentucky Lake in Humphreys County, Tennessee, upstream to its confluence with Flat Creek near Shelbyville in Bedford County, Tennessee.**

24. The Buffalo River (Unit FK24) from its confluence with the Duck River in Humphreys County, Tennessee, upstream approximately 31 rmi to its confluence with Cane Creek in Perry County, Tennessee.

Oyster mussel designated critical habitat

Critical habitat was designated for the oyster mussel on August 31, 2004 (69 FR 53136-53180), and includes the following:

1. **The Duck River (Unit 1) from rmi 133 in Maury County, Tennessee, to rmi 179 in Marshall County, Tennessee.***

2. Bear Creek (Unit 2) from rmi 23 in Colbert County, Alabama, through Tishomingo County, Mississippi, to the Alabama/Mississippi state line.

3. The Powell River (Unit 4) from rmi 65.3 (U.S. 25E Bridge) in Claiborne County, Tennessee, to rmi 159 in Lee County, Virginia.

4. The Clinch River (Unit 5) from rmi 159 in Hancock County, Tennessee, to its confluence with Indian Creek in Tazewell County, Virginia.

5. The Nolichucky River (Unit 6) from rmi 9 to rmi 14 in Cocke and Hamblen counties, Tennessee.

6. The BSFCR (Unit 9) from the confluence of the New River and Clear Fork in Scott County, Tennessee, to its confluence with Laurel Crossing Branch in McCreary County, Kentucky. This unit also includes White Oak Creek from its confluence with the BSFCR in Scott County, Tennessee, upstream to its confluence with Panther Branch in Fentress County, Tennessee; the New River from its confluence with Clear Fork upstream to Hwy 27 in Scott County, Tennessee; Clear Fork from its confluence with the New River upstream to its confluence with North Prong Clear Fork in Morgan and Fentress counties, Tennessee; White Oak Creek from its confluence with Clear Fork upstream to its confluence with Bone Camp Creek in Morgan County, Tennessee; Bone Camp Creek from its confluence with White Oak Creek upstream to its confluence with Massengale Branch in Morgan County, Tennessee; Crooked Creek from its confluence with Clear Fork upstream to its confluence with Buttermilk Branch in Fentress County, Tennessee; and North Prong Clear Fork from its confluence with Clear Fork upstream to its confluence with Shoal Creek in Fentress County, Tennessee.

7. Buck Creek (Unit 10) from the SR 192 bridge upstream to the SR 328 Bridge in Pulaski County, Kentucky.

8. Copper Creek (Unit 5) from its confluence with the Clinch River upstream to the SR 72 bridge in Scott County, Virginia.

* Based on extensive phenotypic data (e.g., shell morphology, mantle-lures, fish host specificity) and molecular data (e.g., mitochondrial DNA, nuclear DNA microsatellites), mussels formerly thought to be oyster mussels in the Duck River were reclassified as a new species, the Duck River darter snapper (*Epioblasma ahlstedti*), in 2010 (Jones and Neves 2010). However, DCH for the oyster mussel in the Duck River was preserved as the Service has not separated this taxon from previously listed taxon.

Slabside pearlymussel designated critical habitat

Critical habitat was designated for the slabside pearlymussel on September 26, 2013 (78 FR 59555-59620), and includes the following:

1. The North Fork Holston River (Unit SP1) from its confluence with Beaver Creek, upstream of Saltville in Smyth County, Virginia, upstream approximately 42 rmi to Ceres in Bland County, Virginia.

2. The Middle Fork Holston River (Unit SP2) from its inundation at South Holston Reservoir in Washington County, Virginia, upstream approximately 55 rmi to its headwaters in Wythe County, Virginia.

3. Big Moccasin Creek (Unit SP3) from the Hwy 71 Bridge crossing in Scott County, Virginia, upstream approximately 33 rmi to the Rt. 612 Bridge crossing near Collinwood in Russell County, Virginia.

4. The Clinch River (Unit SP4) from immediately below Grissom Island in Hancock County, Tennessee, upstream approximately 163 rmi to its confluence with Indian Creek near Cedar Bluff in Tazewell County, Virginia.

5. The Powell River (Unit SP5) from the U.S. 25E Bridge in Claiborne County, Tennessee, upstream approximately 95 rmi to rmi 59 above Rock Island in the vicinity of Pughs in Lee County, Virginia.

6. The Nolichucky River (Unit SP6) from rmi 9, approximately 0.4 rmi upstream of Enka Dam, where it divides Hamblen and Cocke counties, Tennessee, upstream approximately 32 rmi to its confluence with Pigeon Creek, just upstream of the Hwy 321 Bridge crossing in Greene County, Tennessee.

7. The Hiwassee River (Unit SP7) from the Hwy 315 Bridge crossing upstream approximately 15 rmi to the Hwy 68 Bridge crossing in Polk County, Tennessee.

8. The Sequatchie River (Unit SP8) from the Hwy 41, 64, 72, 2 Bridge crossing in Marion County, Tennessee, upstream approximately 94 rmi to the Ninemile Cross Road Bridge crossing in Bledsoe County, Tennessee.

9. The Paint Rock River (Unit SP9) from the Hwy 431 Bridge crossing along the Madison and Marshall county line in Alabama, upstream approximately 53 rmi to the confluence of Estill Fork and Hurricane Creek in Jackson County, Alabama, and Paint Rock river tributaries including: Larkin Fork from its confluence with the Paint Rock River, upstream approximately 7 rmi to its confluence with Bear Creek in Jackson County, Alabama; Estill Fork from its confluence with the Paint Rock River, upstream approximately 8 rmi to its confluence with Bull Run in Jackson County, Alabama; Hurricane Creek from its confluence with the Paint Rock River, upstream approximately 10 rmi to its confluence with Turkey Creek in Jackson County, Alabama.

10. The Elk River (Unit SP10) from its inundation at Wheeler Reservoir in Limestone County, Alabama, upstream approximately 102 rmi to its confluence with Farris Creek at the Franklin and Moore county line in Tennessee.

11. Bear Creek (Unit SP11) from its inundation at Pickwick Reservoir (Bear Creek Mile [BCM] 23) in Colbert County, Alabama, upstream approximately 26 rmi through Tishomingo County, Mississippi, and ending at the Mississippi-Alabama State Line.

12. **The Duck River (Unit SP12) from its inundation at Kentucky Reservoir in Humphreys County, Tennessee, upstream approximately 216 rmi to its confluence with Flat Creek near Shelbyville in Bedford County, Tennessee.**

13. The Buffalo River (Unit SP13) from its confluence with the Duck River in Humphreys County, Tennessee, upstream approximately 31 rmi to its confluence with Cane Creek in Perry County, Tennessee.

Life history

Freshwater Bradytictic Mussels

Birdwing pearlymussel

Gravid female birdwing pearlymussels with mature glochidia have been observed in mid-September with brooding occurring the following spring or summer (Ortmann 1916), indicating that the species is bradytictic (a long-term brooder). Jones et al. (2010) have indicated that females are typically gravid from October to May. Glochidia are contained in the outer gills and are released in association with a mantle-lure that resembles a small freshwater snail (Jones et al. 2010). Laboratory trials have confirmed that the Tennessee snubnose darter (*Etheostoma simoterum*), redline darter (*Etheostoma rufilineatum*), greenside darter (*Etheostoma blennioides*), banded darter (*Etheostoma zonale*) and bluebreast darter (*Etheostoma camurum*) serve as glochidial hosts for the birdwing pearlymussel (Tennessee Valley Authority 1986; Watson and Neves 1998; Jones et al. 2010). Estimated fecundity (capacity of abundant production), based on

eight gravid females collected from the Clinch and Duck rivers, ranged from 4,132 to 58,700 glochidia/mussel (Jones et al. 2010).

Similar to other riverine mussel species, the birdwing pearlymussel is a filter feeder, consuming algae, diatoms, detritus, and zooplankton drifting in the water column. It is sedentary; unless its habitat is dewatered, it likely spends its entire life within a small area of the river bottom. Mature glochidia are released when suitable host fishes are attracted to the conglutinate and attempt to feed from the lure. They develop on fish gills and metamorphose into juveniles before dropping from the fish.

Although individuals have been found in water up to 6-7 ft deep, the birdwing pearlymussel is typically found in shallow, fast-flowing water in riffle and shoal areas. It generally occurs in gravel substrates, usually with some interstitial sand (U.S. Fish and Wildlife Service 1984a; Parmalee and Bogan 1998; Williams et al. 2008).

Based on aging of shells, the maximum age observed in either the Clinch or Duck river birdwing pearlymussel populations was 15 years for males and 11 years for females (Jones et al. 2010). Females attain maturity at four to five years of age (Jones et al. 2010).

Oyster mussel

The oyster mussel is a long-term brooder, gravid from late summer or autumn until the following summer (Williams, et al. 2008). Males and females of this species have been reported to emerge from the substrate during May and June, when females display paired microlures against bluish white pads within their extrapallial swellings. This behavior in females is presumed to attract glochidial hosts. However, that does not explain the behavior in males, since long-term brooders generally spawn during autumn. The display has been described as rhythmic movements, with the microlure of the left mantle pad rotating in a clockwise, circular manner and that of the right mantle pad rotating counterclockwise (Jones et al. 2006). Females have been observed to snap their valves together on darters that were investigating the lure and trap them between the valves (Jones et al. 2006). This behavior may facilitate infestation (Williams et al. 1993).

Spawning probably occurs in the lampsiline oyster mussel in late spring or early summer, as glochidia have been observed in the marsupia during May, June, and July (Gordon and Layzer 1989). In the Powell River, Yeager and Saylor (1995) found 58% of the females gravid in May at water temperature ranging from 59.0 degrees (°) to 64.0° Fahrenheit (F). Fecundity of a Clinch River population of oyster mussels has been reported to average 13,008 glochidia/female annually and range from 7,780 to 16,876 glochidia/individual (Jones et al. 2006). The glochidia are likely released in early summer (Gordon and Layzer 1989).

Based on laboratory trials, the following fish species have been identified as glochidial hosts: the greenside darter, fantail darter (*Etheostoma flabellare*), snubnose darter, wounded darter (*Etheostoma vulneratum*), redline darter, bluebreast darter, dusky darter (*Percina sciera*), banded sculpin (*Cottus carolinae*), black sculpin (*Cottus baileyi*) and mottled sculpin (*Cottus bairdi*) (Yeager and Saylor 1995; Jones and Neves 2000; Jones et al. 2006). The glochidia of oyster

mussels in the Clinch River transformed in the greatest numbers on the greenside darter (Jones et al. 2006). Transformation took from 19 to 34 days, at 60.4° to 62.4°F (Yeager and Saylor 1995).

Similar to other riverine mussel species, the oyster mussel is a filter feeder, consuming algae, diatoms, detritus, and zooplankton drifting in the water column. It is sedentary; unless its habitat is dewatered, it likely spends its entire life within a small area of the river bottom. Mature glochidia are released when suitable host fishes are attracted to the conglutinate and attempt to feed from the lure. They develop on fish gills and metamorphose into juveniles before dropping from the fish.

This species inhabits small to medium-sized rivers (Dennis 1985), and sometimes large rivers, in areas with coarse sand to boulder substrate (rarely in mud) and moderate to swift currents (Gordon 1991). It is sometimes found associated with water-willow (*Justicia americana*) beds (Ortmann 1924; Gordon and Layzer 1989) and in pockets of gravel between bedrock ledges in areas of swift current (Neves 1991). Gordon (1991) reported that this species, like other freshwater mussels, can bury itself below the substrate surface, but females have been observed to lie on top of the substrate while displaying and releasing glochidia.

Freshwater Tachytictic Mussels

Cumberland monkeyface

The Cumberland monkeyface pearlymussel is tachytictic (a short-term brooder); gravid females have been observed in May and June and are very prone to aborting glochidia when disturbed (U.S. Fish and Wildlife Service 2011). Fishes determined to serve as glochidial hosts of the Cumberland monkeyface in laboratory trials include the streamline chub (*Erimystax dissimilis*) and blotched chub (*Erimystax insignis*) (Yeager and Saylor 1995); the Tennessee shiner (*Notropis leuciodus*) may also serve as a host (U.S. Fish and Wildlife Service 2011).

Similar to other riverine mussel species, the Cumberland monkeyface is a filter feeder, consuming algae, diatoms, detritus, and zooplankton drifting in the water column. It is sedentary; unless its habitat is dewatered, it likely spends its entire life within a small area of the river bottom. Mature glochidia are released into the water column, and those that attach to suitable host fishes metamorphose into juveniles and drop from the fish.

The Cumberland monkeyface typically occurs in shallow shoal and riffle areas in free-flowing streams of high to moderate gradient. Substrate preferences include firm rubble, gravel and sand and the species most often remains buried with only siphons visible (U.S. Fish and Wildlife Service 1984b; Virginia Fish and Wildlife Information Service 2003). The Cumberland monkeyface has been found in waters ranging from 6-in to 2 ft in depth (Bogan and Parmalee 1983). The species has never been found in small streams (Virginia Fish and Wildlife Information Service 2003).

The age of gravid females, using the external growth ring method (Chamberlain 1931; Crowley 1957) was estimated at seven to ten years. Jones and Neves (2011) estimated the age of gravid females at five to ten years, but indicated they may be as young as four years (Jones and Neves 2011).

Rabbitsfoot

The rabbitsfoot is a short–term brooder, with females brooding between May and late August (Fobian 2007). Rabbitsfoot exhibit seasonal movement towards shallower water during brooding periods, a strategy to increase host fish exposure but one that also leaves them more vulnerable to predation and fluctuating water levels, especially downstream of dams (Fobian 2007; Barnhart, 2008, personal communication, as stated in the proposed rule for threatened status for the rabbitsfoot and designation of critical habitat [77 FR 63444]). Female rabbitsfoot release glochidia as conglutinates which mimic flatworms or similar fish prey. Fecundity in river basins west of the Mississippi River ranged from 46,000 to 169,000 larvae/female (Fobian 2007).

Known fish hosts for rabbitsfoot in streams in the western portion of its range include blacktail shiner (*Cyprinella venusta*), cardinal shiner (*Luxilus cardinalis*), red shiner (*Cyprinella lutrensis*), spotfin shiner (*Cyprinella spiloptera*), and bluntface shiner (*Cyprinella camura*), but host suitability information is lacking for the eastern range (Fobian 2007), including the Duck River population. However, several species found in the Duck River have also been identified as hosts for the rabbitsfoot. These include rosyface shiner (*Notropis rubellus*), striped shiner (*Luxilus chrysocephalus*), and emerald shiner (*Notropis atherinoides*) (Fobian 2007).

Similar to other riverine mussel species, the rabbitsfoot is a filter feeder, consuming algae, diatoms, detritus, and zooplankton drifting in the water column. It is sedentary; unless its habitat is dewatered, it likely spends its entire life within a small area of the river bottom. Mature glochidia are released when suitable host fishes are attracted to the conglutinate and attempt to feed from the lure. They develop on fish gills and metamorphose into juveniles before dropping from the fish.

The rabbitsfoot is primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along banks and adjacent runs and shoals with reduced water velocity. Specimens also may occupy deep water runs, having been reported in 9 to 12 ft of water. Bottom substrates generally include gravel and sand (Parmalee and Bogan 1998). This species seldom burrows but lies on its side (Watters 1988; Fobian 2007).

Heavy-shelled species, such as rabbitsfoot, grow slowly relative to thin-shelled species (Coon et al. 1977; Hove and Neves 1994). Rabbitsfoot populations west of the Mississippi River reach sexual maturity between the ages of four to six years (Fobian 2007). Watters et al. (2009) reported that the rabbitsfoot lives at least 20 years.

Slabside pearlymussel

The slabside pearlymussel is a short-term brooder. Females brooding glochidia have been reported from mid-May through early August (Ortmann 1921; Neves 1991). Glochidia have been reported in stream drift from mid-June to mid or late August in the North Fork Holston River, southwestern Virginia (Kitchel 1985). Fish hosts for the slabside pearlymussel include the popeye shiner (*Notropis ariommus*), rosyface shiner, saffron shiner (*Notropis rubricroceus*), silver shiner (*Notropis photogenis*), telescope shiner (*Notropis telescopus*), Tennessee shiner, whitetail shiner (*Cyprinella galactura*), white shiner (*Luxilus albeolus*) and eastern blacknose dace (*Rhinichthys atratulus*) (Kitchel 1985; 78 FR 59556-59620).

Similar to other riverine mussel species, the slabside pearlymussel is a filter feeder, consuming algae, diatoms, detritus, and zooplankton drifting in the water column. It is sedentary; unless its habitat is dewatered, it likely spends its entire life within a small area of the river bottom. Mature glochidia are released into the water column, and those that attach to suitable host fishes metamorphose into juveniles and drop from the fish.

The slabside pearlymussel is primarily a large creek to large river species, inhabiting sand, fine gravel, and cobble substrates in relatively shallow riffles and shoals with moderate current (Parmalee and Bogan 1998).

The maximum age for the species is known to exceed 40 years (J. Jones, unpublished data, as stated in Grobler et al. 2006); the species longevity is considered to be 40-55 years (77 FR 60811).

Designated critical habitat

Cumberlandian combshell and oyster mussel designated critical habitat

The following primary constituent elements (PCEs), which are those physical and biological features essential for the conservation of the species, were determined for the Cumberlandian combshell and oyster mussel at the time critical habitat was designated and included in the final DCH listing rule (69 FR 53136-53180):

1. Permanent, flowing stream reaches with a flow regime (i.e, the magnitude, frequency, duration, and seasonality of discharge over time) necessary for normal behavior, growth, and survival of all life stages of the Cumberlandian combshell and oyster mussel and their host fish;

2. Geomorphically stable stream and river channels and banks (structurally stable stream cross section);

3. Stable substrates, consisting of mud, sand, gravel, and/or cobble/boulder, with low amounts of fine sediments or attached filamentous algae;

4. Water quality (including temperature, turbidity, oxygen content, and other characteristics) necessary for the normal behavior, growth, and survival of all life stages of the Cumberlandian combshell and oyster mussel and their host fish; and

5. Fish hosts with adequate living, foraging, and spawning areas for them.

Fluted kidneyshell and slabside pearlymussel designated critical habitat

The following PCEs, which are those physical and biological features essential for the conservation of the species, were determined for the fluted kidneyshell and slabside pearlymussel at the time critical habitat was designated and included in the final DCH listing rule (78 FR 59556-59620):

1. Riffle habitats within large, geomorphically stable stream channels (channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation);

2. Stable substrates of sand, gravel, and cobble with low to moderate amounts of fine sediment and containing flow refugia with low shear stress;

3. A natural hydrologic flow regime (the magnitude, frequency, duration, and seasonality of discharge over time) necessary to maintain benthic habitats where the species are found, and connectivity of rivers with the floodplain, allowing the exchange of nutrients and sediment for habitat maintenance, food availability for all life stages, and spawning habitat for native fishes;

4. Water quality with low levels of pollutants and including a natural temperature regime, pH (between 6.0 to 8.5), oxygen content (not less than 5.0 milligrams/liter [mg/L]), hardness, and turbidity necessary for normal behavior, growth, and viability of all life stages;

5. The presence of abundant fish hosts, which for the fluted kidneyshell may include the barcheek darter (*Etheostoma obeyense*), fantail darter, rainbow darter (*Etheostoma caeruleum*), redline darter, bluebreast darter, dusky darter and banded sculpin and for the slabside pearlymussel may include the popeye shiner, rosyface shiner, saffron shiner, silver shiner, telescope shiner, Tennessee shiner, whitetail shiner, white shiner and eastern blacknose dace, necessary for recruitment of the two species.

Population dynamics

Birdwing pearlymussel

The birdwing pearlymussel was first described by Rafinesque (1831) from the Cumberland River; however, it was never again reported from that river system (Wilson and Clark 1914; U.S. Fish and Wildlife Service 1984a). Hence, the locality information for the original collection record may be erroneous (Jones et al. 2010). Historically, this species was widespread throughout the Tennessee River drainage (Parmalee and Bogan 1998). It was reported from the Tennessee River (Tennessee); Paint Rock River and Flint River (Alabama); Elk River, Duck River, Holston River and Nolichucky River (Tennessee); North Fork Holston River and North Fork Clinch River (Virginia); and the Clinch River and Powell River (Tennessee and Virginia) (U.S. Fish and Wildlife Service 1984a; Ortmann 1918, 1924, 1925). Although the species was once widespread throughout the drainage, it was never considered abundant at any location (Ortmann 1918).

The birdwing pearlymussel's current known range includes the Duck and Elk rivers in Tennessee, and the Clinch and Powell rivers in Tennessee and Virginia (U.S. Fish and Wildlife Service 1984a; Parmalee and Bogan 1998). Reproducing populations of the species are now restricted to the Clinch and Powell rivers in Virginia and Tennessee, and in the Duck River, which is considered to have the largest population (U.S. Fish and Wildlife Service 1984a; Parmalee and Bogan 1998).

Historical densities of the birdwing pearlymussel in the Clinch and Duck rivers from 1979–2004 reported by Ahlstedt et al. (2005) indicated stable or increasing population trends in both of these rivers. More recently, Jones et al. (2010) reported that while the Clinch River population has been

at low densities for several decades, both the Clinch and Duck river populations of birdwing pearlymussel are currently experiencing recruitment and are considered stable.

On the Elk River, two fresh-dead specimens were collected during a 1980 TVA survey in the Tennessee reaches of the river (Ahlstedt 1983, 1986). Since then, no other birdwing pearlymussels have been collected from the Elk River.

A remnant birdwing pearlymussel population still persists in the Powell River in Tennessee and Virginia; individuals occur at very low densities at sites of occurrence, but gravid females and young adults have recently (2004–2009) been observed in the river (Jones et al. 2010; Johnson et al. 2010; Johnson 2011). The viability of this population is unknown, but evidence of gravidity and recruitment is encouraging (Jones et al. 2010).

Oyster mussel

The oyster mussel historically was one of the most widely distributed and common Cumberlandian mussel species, especially in the Tennessee River system (Johnson 1978). Its range included four physiographic provinces (Interior Low Plateau, Cumberland Plateau, Ridge and Valley and Blue Ridge) and six states (Alabama, Georgia, Kentucky, North Carolina, Tennessee and Virginia) (U.S. Fish and Wildlife Service 2004a). In the Cumberland River, it occurred from the base of Cumberland Falls, McCreary and Whitley counties, Kentucky, downstream to Stewart County, Tennessee (U.S. Fish and Wildlife Service 2004a). Wilson and Clark (1914) stated that it was "fairly common" in the BSFCR, but that it was found "sparingly" in the mainstem of the Cumberland River. Neel and Allen (1964) found it to be rare to abundant in the mainstem of the Cumberland River. It was reported as being abundant throughout the Tennessee River system, particularly in the upper portion (Ortmann 1918, 1925). In the Tennessee River, it occurred throughout the mainstem, from headwaters in southwestern Virginia downstream to Colbert and Lauderdale counties, Alabama (Ahlstedt 1991a, 1991b; Parmalee and Bogan 1998; Jones et al. 2006; U.S. Fish and Wildlife Service 2004a). Dozens of tributaries in the Cumberland and Tennessee river systems also harbored this species (U.S. Fish and Wildlife Service 2004a). The most downstream site known from the Cumberland River represents an archeological record (Parmalee, personal communication, 1997), indicating that at least in pre-modern times this species occurred further downstream from the area strictly defined as the Cumberlandian Region (U.S. Fish and Wildlife Service 2004a).

Many streams and rivers no longer harbor populations of the oyster mussel. Populations have been totally eliminated from the Cumberland and Tennessee mainstems and are probably extirpated from the entire Cumberland River system, including the Rockcastle River, Beaver Creek, Obey River, Caney Fork and Harpeth River (U.S. Fish and Wildlife Service 2004a). Mussels currently in the BSFCR, once thought to be oyster mussels, are now considered to be tan riffleshells (*Epioblasma florentina walkeri*) (Jones, personal communication, 2014). Populations have apparently been extirpated from the following Tennessee River tributaries: Little River (Clinch River tributary in Virginia), Wallen Creek, Poplar Creek, North Fork Holston River, Big Moccasin Creek, South Fork Holston River, Holston River, French Broad River, Little Pigeon River, West Prong Little Pigeon River, Little River (tributary to the Tennessee River in Tennessee), Little

Tennessee River, Hiwassee River, South Chickamauga Creek, Lookout Creek, Sequatchie River, Paint Rock River, Estill Fork, Larkin Fork, Hurricane Creek, Flint River, Limestone Creek, Elk River, Richland Creek, Shoal Creek, Bear Creek and Buffalo River) (U.S. Fish and Wildlife Service 2004a). The oyster mussel has also been extirpated from large portions of additional Cumberlandian streams and rivers (e.g., Clinch and Duck rivers), from the entire Blue Ridge Physiographic Province, and is apparently no longer found in the States of Alabama, Georgia and North Carolina (U.S. Fish and Wildlife Service 2004a).

Although reported from Copper Creek (Clinch River tributary in Virginia) in 1980 (Ahlstedt 1981a, 1991a, personal communication, 1997), survey efforts in 1998 (Fraley and Ahlstedt 2000) and 2005 (Hanlon et al. 2009) failed to find even a relic shell of the oyster mussel in this stream. Although the species recovery plan (U.S. Fish and Wildlife Service 2004a) considered the oyster mussel "possibly still extant in Copper Creek", more recent survey efforts indicate that the oyster mussel has likely been extirpated from this stream.

Recent Tennessee River system records include the Clinch River (Russell and Scott counties, Virginia, and Hancock County, Tennessee), Powell River (Lee County, Virginia), North Fork Holston River (a reintroduced population in Scott County, Virginia) and Nolichucky River (Cocke and Hamblen counties, Tennessee) (U.S. Fish and Wildlife Service 2004a). Neves (1991) considered the oyster mussel to be "extremely rare" throughout the upper Tennessee River system, an observation based partially on the work of Dennis (1987) who documented the recent decline of this once abundant species in the Clinch River. However, since 1996, biologists have documented evidence of recruitment of the oyster mussel at certain localities in the Clinch River in both Virginia and Tennessee (Koch, personal communication, 1997; Ahlstedt, personal communication, 1997; Jones et al. 2014).

Mussels in the Duck River (Marshall County, Tennessee), formerly considered to be oyster mussels, were reclassified as a separate species, the Duck River darter snapper, in 2010 (Jones and Neves 2010). During a 2010 quantitative mussel survey at six sites in the Duck River, the species was found to be the most abundant mussel at one site (comprising 21% of all mussel species at Venable Spring), the third most abundant mussel at another site (comprising 13% of all mussel species at Lillard's Mill) and the 16th most abundant at a third site (comprising 1% of all mussel species at Hooper Island). Species density was higher during the 2010 survey than observed during prior surveys of the Duck River (Hubbs et al. 2010).

Cumberland monkeyface

Historically, this species was widespread in the upper Tennessee River system (Tennessee River, Elk River, Duck River, Holston River, North Fork Holston River, South Fork Holston River, Nolichucky River, French Broad River, Tellico River, Clinch River and Powell River) (Simpson 1914; Ortmann 1918) in Tennessee, Alabama and Virginia, and possibly, in the Cumberland River system (Cumberland River, BSFCR and Caney Fork River) in Kentucky and Tennessee, where its former occurrence remains uncertain because the closely related rough rockshell (*Quadrula tuberosa*) was also reported there (U.S. Fish and Wildlife Service 1984b). It is likely that

Ortmann's 1918-1925 records for the Cumberland River system were rough rockshell, recognized as a synonym of Cumberland monkeyface (U.S. Fish and Wildlife Service 1984b).

Current populations of this species exist in the Powell River (Virginia) and the Duck River (Tennessee) (Parmalee and Bogan 1998). It appears to be extirpated from Alabama, although reintroduction efforts are underway (Mirarchi et al. 2004). During a 120-rmi TVA float survey of the Elk River in 1980, one live and five fresh-dead specimens of this species were collected from five sites (Ahlstedt 1983, 1986). These records are thought to represent the last time an extant population of the species was verified in this river (U.S Fish and Wildlife Service 2011). Recent sampling of the Elk River between 1990 and 2012 did not locate any live specimens or fresh-dead shells of the Cumberland monkeyface (U.S. Fish and Wildlife Service 1999; Tennessee Valley Authority 2006, 2012a, 2012b). No live Cumberland monkeyface mussels have been collected from the Clinch River in over 30 years; Dick Neves collected a relatively fresh-dead individual with both valves from the Clinch River at Kyles Ford in 1994 (Jones, personal communication, 2013).

Systematic surveys have been conducted on the Duck River over the past 30 years by TVA and others (Ahlstedt 1981b, 1991b; Jenkinson 1988; Hubbs and Jones 2000). From 2000-2003, 112 sites were surveyed throughout the Duck River watershed (Ahlstedt et al. 2004; Hubbs et al. 2010). Status information gathered on the Cumberland monkeyface clearly indicates that this population has increased, and its range has expanded in the Duck River over the past 20 years (U.S Fish and Wildlife Service 2011). Nineteen individuals were found live during qualitative sampling at 11 sites in a 22-rmi reach of the Duck River downstream from Lillard Mill Dam. This represents a seven-fold increase in Duck River numbers compared to TVA sampling conducted in 1988 and an expansion of its range in the river from 16 to 22 rmi (U.S Fish and Wildlife Service 2011). In September 2010, a total of 43 individuals were found at three sites (Hubbs et al. 2010). There was evidence of recent recruitment over both recent sampling periods (early 2000s and 2010), and the population is considered viable (U.S Fish and Wildlife Service 2011). The Duck River population of this species has clearly become the best rangewide and represents the last functional population remaining (U.S Fish and Wildlife Service 2011).

Rabbitsfoot

The rabbitsfoot historically occurred in 141 streams within the lower Great Lakes subbasin and Mississippi River basin (78 FR 57076-57097), which included the states of Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, and West Virginia. Rabbitsfoot populations are considered to be extant in 51 streams in 13 states (Butler 2005; Boeckman, personal communication, 2008, as cited in 77 FR 63440–63536), representing a 64% decline (51 extant streams of 141 historical populations) (78 FR 57076-57097). In streams where it remains extant, populations are highly fragmented and restricted to short reaches.

The final listing rule (78 FR 57076-57097) described the species as extant over at least 170 rmi of the Duck River, between rmi 37 and rmi 207, and identified it as one of the best known remaining populations of the species rangewide. Additional data (Schilling and Williams 2002; Ahlstedt et

al. 2004; Tennessee Department of Environment and Conservation 2015; Tennessee Valley Authority 2015c) suggests that the rabbitsfoot may occur over approximately 175 rmi of the Duck River (between rmi 33.1 and rmi 208.0). Because of its longevity, small populations of this long-lived species may persist for decades despite total recruitment failure. However, the population in the Duck River is apparently one of the best remaining, based on distribution, abundance, and evidence of recruitment (77 FR 63440–63536).

Ahlstedt et al. (2004) reported 403 live or fresh-dead rabbitsfoot specimens in samples at 31 of 78 Duck River sites sampled during 2000-2001, with an average of 13 individuals collected or observed at a site. They further indicated that the species primarily occurred between rmi 130 and rmi 179, and was scattered throughout the lower portion of the river.

Slabside pearlymussel

Based on collections made in the early 1900s, the slabside pearlymussel was historically fairly widespread and common in many Cumberlandian Region streams. However, its decline in certain streams may have begun before European colonization (77 FR 60811). The slabside pearlymussel was considered rare by mussel experts as early as 1970 (Stansbery 1971), in the first attempt to compile such a list. The extirpation of this species from numerous streams within its historical range indicates that substantial population losses and range reductions have occurred (77 FR 60811).

Historically, the slabside pearlymussel occurred in the lower Cumberland River mainstem from the vicinity of the Kentucky state line downstream to the Caney Fork River, Tennessee, and in the Tennessee River mainstem from eastern Tennessee to western Tennessee (77 FR 60810). Records are known from two Cumberland River tributaries, the Caney Fork River (Tennessee) and Red River (Kentucky). In addition, it is known from 30 Tennessee River system tributaries, including the South Fork Powell River (Virginia), Powell River (Tennessee, Virginia), Puckell Creek (Virginia), Clinch River (Tennessee, Virginia), North Fork Holston River (Tennessee, Virginia), Big Moccasin Creek (Virginia), Middle Fork Holston River (Virginia), South Fork Holston River (Tennessee), Holston River (Tennessee), Nolichucky River (Tennessee), West Prong Little Pigeon River (Tennessee), French Broad River (Tennessee), Tellico River (Tennessee), Little Tennessee River (Tennessee), Hiwassee River (Tennessee), Sequatchie River (Tennessee), Larkin Fork (Alabama), Estill Fork (Alabama), Hurricane Creek (Alabama), Paint Rock River (Alabama), Flint River (Alabama), Flint Creek (Alabama), Limestone Creek (Alabama), Elk River (Alabama, Tennessee), Sugar Creek (Alabama), Bear Creek (Alabama, Mississippi), North Fork Creek (Tennessee), Big Rock Creek (Tennessee), Buffalo River (Tennessee) and Duck River (Tennessee) (Gordon and Layzer 1989; Winston and Neves 1997; Parmalee and Bogan 1998).

Extant populations remain in the Powell River (Tennessee, Virginia), Clinch River (Tennessee, Virginia), North Fork Holston River (Virginia), Nolichucky River (Tennessee), Big Moccasin Creek (Virginia), Middle Fork Holston River (Virginia), Hiwassee River (Tennessee River), Sequatchie River (Tennessee), Paint Rock River (Alabama), Larkin Fork (Alabama), Estill Fork (Alabama), Hurricane Creek (Alabama), Elk River (Alabama, Tennessee), Buffalo River

(Tennessee), Duck River (Tennessee) and Bear Creek (Alabama, Mississippi) (77 FR 60811-60812).

The Service considers 13 of 30 populations of the slabside pearlymussel to be extant. The slabside pearlymussel has been eliminated from more than 50% of streams and rivers from which it was historically known. The extant occurrences in the Tennessee River system represent 11 isolated populations. Data on population sizes, gathered during the past two decades, indicate that the slabside pearlymussel is rare (experienced surveyors may find four or fewer specimens/site of occurrence) in about half of its extant populations (77 FR 60812).

In 2008-2009 surveys of the Powell River, four slabside pearlymussels were collected at two sites between rmi 120.2 and rmi 123 (representing 0.03% of all mussels collected) during qualitative survey efforts (Johnson et al. 2010; Johnson 2011).

The slabside pearlymussel is uncommon to rare in the Clinch River, with only a few individuals found during survey efforts (Ahlstedt et al. 2005). Eckert and Pinder (2010) collected one individual in quantitative samples and five individuals in semi-quantitative samples in the Clinch River at Cleveland Island, Virginia, during 2008, and two individuals in quantitative samples and 13 individuals in semi-quantitative samples in the Clinch River at Cleveland Island in 2002. One slabside pearlymussel was collected in the Tennessee reaches of the Clinch River (rmi 172.2 upstream to Wallen Bend at rmi 192.4) during quantitative surveys, conducted from 2004 to 2009 (Jones et al. 2014). Recruitment of the species in the Clinch River is questionable (Jones et al. 2014).

In the Duck River, the slabside pearlymussel is known to be extant between rmi 208 in Bedford County, Tennessee, downstream to approximately rmi 15.7 (Ahlstedt et al. 2004; Schilling and Williams 2002). While little data are available to describe the population size and structure of the slabside pearlymussel population in the Duck River, Ahlstedt et al. (2004) noted that the species was reported in all previous surveys of the Duck River, and sometimes was reported as abundant (Ortmann 1924). Ahlstedt et al. (2004) described the species as common, with 314 individuals collected, comprising almost 3% of the total of all mussel species collected at 42 of the 112 sampling localities, during their 2000-2001 surveys. They confirmed the species extant at surveyed stations between rmi 208 downstream to rmi 128.2. Schilling and Williams (2002) confirmed the species extant downstream to approximately rmi 15.7.

The Duck and Paint Rock rivers appear to have the best populations remaining rangewide based on population size and the evidence of recent recruitment. The slabside pearlymussel is found at numerous sites in the Duck River throughout a nearly 200-rmi reach of river, and is found at numerous sites within a 45-rmi reach of the Paint Rock River (Ahlstedt et al. 2004; Fobian et al. 2008).

ENVIRONMENTAL BASELINE

Physiography

The 17.8-ac project action area is located within the Nashville Basin (also known as the Central Basin), an approximate 3,520,000-ac (5,500-square mile [mi²]) subdivision (Corlew et al. 1990) of the Interior Plateau ecoregion, which extends from southern Indiana and Ohio to northern Alabama (Omernik and Griffith 2008). The Central Basin consists of an oval depression with a gently rolling surface (city-data.com. 2015), which is encircled by the 6,816,000-ac (10,650-mi²) Highland Rim (Littman 2014), another subdivision of the Interior Plateau ecoregion (city-data.com. 2015).

Geology and Soils

Mississippian to Ordovician-age limestone, chert, sandstone, siltstone and shale compose the landforms of open hills, irregular plains and tablelands in the Interior Plateau ecoregion (Omernik and Griffith 2008). Soils of the Interior Plateau formed in residuum from a variety of sedimentary rocks overlain by varying amounts of loess (Whitaker et al. 2012).

Within the Central Basin, Udalfs are the most extensive soils, but Udults also occupy a large acreage. These soils have a thermic temperature regime, an udic moisture regime and a clayey subsoil. Well drained, fine textured Hapludalfs are on hillsides in the outer or phosphatic part of the Central Basin (Mimosa and Hampshire series) and on low hills in the inner Central Basin (Tablott series). Well drained Paleudalfs (Lomond and Cumberland series) occupy a sizable acreage in the inner Basin, where there are deposits of alluvium or of alluvium and loess. Dark brown loamy, cherty Hapludults (Dellrose series) are on steep, deeply dissected hills that extend around the rim of the Central Basin. A small acreage of Rendolls (Gladeville series) occur in the inner Central Basin; rock is at or near the surface on these lands. Hapludolls (Arrington, Lynnville and Egam series) and Haplaquolls (Roellen and Godwin series) are on the inextensive bottom lands. Outcrops of limestone are common (U.S. Department of Agriculture 1981).

Water Resources

The Duck River watershed covers approximately 3,500 mi² (U.S. Army Corps of Engineers 2012). From its origin near the town of Manchester, Tennessee, in the eastern Highland Rim, the 270-rmi long Duck River crosses the Central Basin and continues flowing west across the western Highland Rim, passing through six Tennessee counties (Coffee, Bedford, Maury, Marshall, Hickman and Humphreys), before emptying into Kentucky Lake on the Tennessee River at rmi 110.8. (Reeves 2015). Other than the presence of Normandy Dam and Reservoir, completed in the mid - 1970s near Tullahoma, Tennessee, not far from its headwaters, and three low-head dams at Shelbyville, Lillard Mill, and Columbia, Tennessee, the Duck River is primarily free-flowing (Reeves 2015; Tennessee Valley Authority 2015a).

The reach of the Duck River that flows through the action area is generally low gradient. Venable Spring is a small tributary to the mainstem Duck River, located directly upstream of the project site (Tennessee Valley Authority 2015a). Venable Spring is one of many spring tributaries to the

Duck River exhibiting a relatively small amount of fluctuation in temperature, generally a long residence time (Knight and Kingsbury 2007). Within the proposed project area, Venable Spring and Duck River substrates are comprised of coarse cobble, acidic chert, shale rock and gravel mixed with sand (Knight and Kingsbury 2007).

Climate

The climate for the Duck River watershed is temperate, warm and humid during summer and fall months. From 1971-2000, the average annual air temperature for southern Middle Tennessee was 57.8° F. Annual precipitation for Middle Tennessee averages 55.3 in, with the wettest month typically being March at 5.9 in and the driest month being August at 3.4 in. Stream flows vary with rainfall. Runoff averages approximately 55-60 in/year. Instream temperatures and flow conditions are influenced by regulated releases from Normandy Dam, springs, wastewater discharge, tributary inflows, and the three previously mentioned low-head dams (Knight and Kingsbury 2007).

Land Use

With its rich soils, the Central Basin has attracted people from the earliest days of European settlement and is more densely populated than any other area in the state of Tennessee (city-data.com 2015). Most of the Central Basin consists of small and medium-size farms. However, much farmland has been converted to residential use and to small estate-type farms. Hay, pasture and grain for beef and dairy cattle are the principal crops. Some large rocky sites exist in eastern redcedar (*Juniperus virginiana*) forest or in eastern redcedar-deciduous brush (U.S. Department of Agriculture 1981).

TVA completed Normandy Dam on the Duck River at rmi 248.6 in 1976 to provide flood control, water supply and recreation. The dam is the only large water resource project in the basin. The 110-ft high, 2,807-ft long dam provides a flood storage capacity of 62,400 acre-feet (U.S. Army Corps of Engineers 2012). The reach of river downstream of the dam has been classified by the TDEC as supporting the following designated uses: domestic water supply, industrial water supply, fish and aquatic life, recreation, irrigation, livestock watering and wildlife (Tennessee Department of Environment and Conservation 2014). The Duck River is the sole water source for 250,000 people in Middle Tennessee (Knight and Kingsbury 2007).

Approximately 37 rmi of the Duck River within Maury County were designated as a Class II State Scenic River in 2001. This scenic section, begins at Iron Bridge Road near Columbia and extends upstream to the Maury and Marshall County Line (Reeves 2015). This reach of river flows through 12,800 ac of land, designated as the Yanahli Wildlife Management Area (WMA), owned by the State of Tennessee and managed by the TWRA (Higher Pursuits 2014). Six natural areas, covering over 2,000 ac of ecologically significant lands, occur within the Yanahli WMA and are collectively known as the Duck River Complex State Natural Area (Reeves 2015; Higher Pursuits 2014).

Popular recreational activities on the Duck River and adjacent lands include boating, paddling and fishing. Henry Horton State Park, developed and operated by Tennessee State Parks, is located near Chapel Hill at approximately rmi 186 in Marshall County. The park offers the following

amenities: streamside access from both sides of the river; cabin and inn lodging with a restaurant; various camping provisions; hiking trails; a picnic area; a trap and skeet range; a paved public boat ramp; and a golf course. In Maury County, the Yanahli WMA also offers numerous boat access points and campsites (Tennessee Valley Authority 2015a).

The proposed project site currently supports pasture grass for livestock. A relatively small portion of forested land in the action area serves as a riparian buffer along the mainstem Duck River and Venable Spring (Tennessee Valley Authority 2015a).

Vegetation

Natural vegetation found in the Interior Plateau ecoregion primarily consists of oak-hickory (*Quercus – Carya spp.*) forest, with some areas of bluestem (*Schizachyrium scoparium* and *Andropogon gerardii*) prairie and cedar (*Cedrus*) glades (U.S. Environmental Protection Agency 2000).

As the Duck River passes through the Eastern and Western Highland Rims, its banks are primarily dominated by steep to gentle slopes and dense forests. These forests are generally comprised of oak, hickory, maple (*Acer spp.*) and tulip poplar (*Liriodendron tulipifera)* trees. In the Middle Tennessee counties of the Central Basin, the river passes through relatively flat to gently rolling terrain, with areas of shallow soils, where the forests are often dominated by eastern redcedar and oak species, associated with outcroppings of limestone cedar glades and dense shrubby thickets (Reeves 2015). In floodplain areas adjacent to the river, the most commonly encountered tree species include boxelders (*Acer negundo*), red maples (*Acer rubrum*), sweetgums (*Liquidambar styraciflua*), river birches (*Betula nigra*), sycamores (*Platanus occidentalis*), willow oaks (*Quercus phellos*) and water oaks (*Quercus nigra*) (Palmer 2005). Many species of common wildflowers can also be found, such as trilliums (*Trillium spp.*), phlox (*Phlox spp.*), cardinal flower (*Lobelia cardinalis*), buttonbush (*Cephalanthus occidentalis*), lobelia (*Lobelia spp.*) and foamflower (*Tiarella spp.*) (Reeves 2015). Uncommon plant species found in the Duck River basin include the limestone blue star (*Amsonia tabernaemontana* var. *gattingeri*), limestone fame-flower (*Talinum calcaricum*), Tennessee milk-vetch (*Astragalus tennesseensis*), Tennessee glade cress (*Leavenworthia exigua* var. *exigua*), the Duck River bladderpod (*Lesquerella densipila*) and the federally endangered leafy prairie clover (*Dalea foliosa*) (Tennessee Valley Authority 2015a).

The proposed project area slopes toward the Duck River and includes vegetative (physiognomic) classes, dominated by herbaceous vegetation with deciduous forest occurring in the vicinity of Venable Spring and the Duck River, while the riverbank is generally non-vegetated. Herbaceous vegetation on and in the vicinity of the project area is primarily comprised of pasture grasses and hay fields. The most common tree species occurring on the project site are sycamores, water oaks and river birches (Tennessee Valley Authority 2015a). Although the federally endangered leafy prairie clover is known to occur in Marshall County, there are no known occurrence records for the plant species on or adjacent to the project site. Lands adjacent to the proposed project site were previously agricultural fields that are currently undergoing secondary vegetative succession (Tennessee Valley Authority 2015a).

The proposed project site is located on a property where native vegetation has been extensively altered as a result of historic land uses. Common terrestrial invasive plant species occurring in the project area include Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*) and Japanese stiltgrass (*Microstegium vimineum*) (Tennessee Valley Authority 2015a). These invasive species are Rank 1 (severe threat) (James 2002). No invasive aquatic plant species are known to occur on or adjacent to the project site (Tennessee Valley Authority 2015a).

Aquatic and Terrestrial Animal Life

According to the U.S. Geological Survey, the Duck River is one of three hot spots for fish and mussel diversity in the entire world. It is generally considered to be the richest river in varieties of freshwater animals on the North American continent. The Duck River contains more species of fish than are found in all the rivers of Europe, combined, and more fish varieties/mile than any other river in North America. Overall, the Duck River supports a remarkable diversity of freshwater animals in its waters, including 151 species of fish, 60 freshwater mussel species, and 22 species of aquatic snails. In addition, the river harbors a number of larger mammals, reptiles, and birds, including river otters (*Lontra canadensis*), beavers (*Castor canadensis*), mink (*Neovison vison*), hawks (Buteonines and Accipitrines), osprey (*Pandion haliaetus*) and herons (Ardeidae) (The Nature Conservancy 2015).

The Duck River is of particular significance to freshwater mollusks of the Cumberlandian mussel fauna, and it serves as a source and repository for state and federally listed species in need of conservation (Cumberlandian Region Mollusk Restoration Committee 2010). Recent (Hubbs et al. 2010; Ahlstedt et al. 2004), and historic (Ahlstedt 1991b; Jenkinson 1988; Isom and Yokley 1968; Ortmann 1924) survey efforts, of the Duck River indicate the system supports a relatively high density and a diverse native mollusk community, when compared to other rivers and streams within the Tennessee River drainage.

Recent reintroductions of federally endangered mussel species thought to be extirpated from the Duck River, including the Cumberlandian combshell, snuffbox (*Epioblasma triquetra*) and fluted kidneyshell have apparently been successful (Hubbs et al. 2010). Reintroductions of other endangered mussel species into the Duck River have included the rayed bean (*Villosa fabalis*), winged mapleleaf (*Quadrula fragosa*) and pale lilliput (*Toxolasma cylindrellus*) (Moles and Layzer 2009; U.S. Fish and Wildlife Service 2013; Johnson and Hubbs 2014). The pale lilliput reintroductions recently occurred just upstream of Venable Spring (Johnson and Hubbs 2014).

Although the proposed project site lies between two impoundments, created by low-head dams on the Duck River, Lillard Mill upstream and Columbia Dam downstream, the riverine habitat at this site supports a diverse mussel community (Tennessee Valley Authority 2015a). A 2010 mussel survey estimated the total mussel community size in the vicinity of Venable Spring (rmi 176.8), at 37,800 mussels (95% confidence interval [CI], 37,284 – 38,315) (Hubbs et al. 2010). A total of 252 individuals were collected among 25 mussel species during that September 2010 survey using quantitative sampling methods (Hubbs et al. 2010). The survey found that the mussel community was dominated by the endangered oyster mussel (21%), endangered birdwing pearlymussel (16%), purple wartyback (*Cyclonaias tuberculate*) (8%), spike (*Elliptio dilatata*) (8%) and painted

creekshell (*Villosa taeniata*) (7%). Additional federally listed species encountered during the survey included the endangered slabside pearlymussel (3%), threatened rabbitsfoot (5%) and endangered Cumberland monkeyface (4%) (Hubbs et al. 2010). Mussel densities and species richness, measured from this survey, are shown in Table 1 in Appendix D.

Within a 10-mi radius of the proposed project site, 17 rare federally listed or federal candidate species currently occur and/or were historically present (see Table 2 below) (Tennessee Valley Authority 2015a). The proposed project area is comprised of early successional habitats and supports a variety of bird, mammal and reptile species. The deciduous forest habitat in the project vicinity also provides habitat for numerous birds, reptiles and amphibians. The Duck River basin also supports foraging habitat for three bat species, the Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*) and northern long-eared bat (*Myotis septentrionalis*), three of the 17 rare species, included in Table 2 (Tennessee Valley Authority 2015a).

Table 2. Rare species status within 10-miles of the proposed action[1].

Species by Common Name (*Scientific Name*)	Rank[2]
Mammals:	
Indiana Bat (*Myotis sodalist*)	E
Grey Bat (*Myotis grisescens*)	E
Northern Long-eared Bat (*Myotis septentrionalis*)	E
Mussels:	
Birdwing Pearlymussel (*Lemiox rimosus*)	E
Cumberland Monkeyface (*Quadrula intermedia*)	E
Cumberlandian Combshell (*Epioblasma brevidens*)	E
Fluted Kidneyshell (*Ptychobranchus subtentum*)	E
Orangefoot Pimpleback (*Plethobasus cooperianus*)	H
Oyster Mussel (*Epioblasma capsaeformis*)=Duck River darter snapper (*Epioblasma ahlstedti*)	E
Pale Lilliput (*Toxolasma cylindrellus*)	E
Slabside Pearlymussel (*Lexingtonia dolabelloides*)	E
Rabbitsfoot (*Quadrula cylindrica cylindrical*)	E
Rayed Bean (*Villosa fabalis*)	E
Snuffbox (*Epioblasma triquetra*)	H
Tan Riffleshell (*Epioblasma florentina walkeri*)	H
Tuberculed Blossom Pearlymussel (*Epioblasma torulosa torulosa*)	X
Plants:	
Leafy Prairie-Clover (*Dalea foliosa*)	E

[1] Modified from Biological Assessment: Duck River Bank Stabilization, River Mile 176.8 (Marshall County, Tennessee) (Tennessee Tennessee Valley Authority 2015a).

[2] Tennessee Valley Authority Natural Heritage Database Element Occurrence Rank; E = extant record ≤ 25 years old; H = historical record > 25 years old; X = Extirpated.

Past and Present Impacts

The Duck River faces a variety of threats. The most immediate stresses have to do with water quality. Increases in storm-water runoff, sewage treatment outflows and chemical and nutrient loading from farmland can all have significant and negative impacts on freshwater creatures (The Nature Conservancy 2015). Various reaches of the mainstem Duck River have been placed on TDEC's 303(d) list as impaired (e.g., not fully supporting its designated uses) due to bacteria (*Escherichia coli*) from septic tanks, loss of biological integrity due to siltation, mercury, total phosphorus and low DO (Tennessee Department of Environment and Conservation 2014).

According to Ahlstedt et al. (2004), 75 mussel species once occurred in the Duck River, however, six of those species are now presumed extinct (Hubbs et al. 2010). Extirpation of those species was a result of loss of riverine habitat from construction of impoundments and water quality issues (Ahlstedt et al. 2004; Jenkinson 1988).

Invasive exotic aquatic plants known to occur in the Duck River basin include alligator weed (*Alternanthera philoxeroides*), parrot feather (*Myriophyllum aquaticum*) and purple loosestrife (*Lythrum salicaria*) (Tennessee Valley Authority 2015a). As mentioned under "Vegetation", no invasive aquatic plant species are known to occur on or adjacent to the project site, but terrestrial invasive plant species (Chinese privet, Japanese honeysuckle and Japanese stiltgrass) are present on the site (Tennessee Valley Authority 2015a).

Improvements

Studies have documented recent aquatic faunal recovery in the Duck River from past disturbances in the watershed (Ahlstedt et al. 2004; Hubbs et al. 2010). This recovery is attributed to land protection and restoration efforts, water quality improvements in TVA's Normandy Reservoir releases, aggradation of historic channel destabilizing events, removal of historic phosphate and iron ore mining point and nonpoint pollution sources, wastewater treatment plant upgrades at Shelbyville, and natural hardness and abundance of groundwater inputs to the system (Johnson and Hubbs 2014; Palmer 2005).

TVA began operational changes at Normandy Dam as part of its Reservoir Release Improvement (RRI) program in 1993. These changes have had beneficial effects on the aquatic fauna of the Duck River (Ahlstedt et al. 2004). Populations of native mussels and their fish hosts have increased as a result of water quality improvements, attributed to the RRI program, including increases in DO levels and water temperatures (Hubbs et al. 2010).

TVA has monitored the ecological health of the Duck River at various locations every two years since 1990, as part of its Vital Signs Monitoring Program, using indicator parameters as a measure of overall ecological health. Vital signs monitoring activities focus on benthic macroinvertebrate community sampling, fish assemblage sampling, and physical and chemical characteristics of waters and sediments. Each indicator is evaluated separately and then individual ratings are combined into a single, composite score. In TVA's 14 years of monitoring the Duck River watershed from 1990 through 2014, sites on the mainstem have consistently rated "good", indicating healthy ecological conditions. Fish and benthic macroinvertebrate communities rated

"good" or "excellent" in the Duck River at White Ford (rmi 195.7), the TVA monitoring location closest to the proposed project site, from 1997 through 2009 (Tennessee Valley Authority 2015a).

Additionally, TWRA has completed community-level fish sampling in the watershed (Tennessee Valley Authority 2015a).

TWRA has established mussel sanctuaries to protect commercially important species, as well as federal- or state-listed mussel species and their habitats. The Duck River mainstem upstream of Cold Branch Bridge at rmi 11.7 has been designated as a state freshwater mussel sanctuary by TWRA. This designation prohibits the taking of mussels by any means and/or willful destruction of their habitat. The mussel fauna in this general area of the Duck River has improved over the past 30 years (Hubbs et al. 2010).

Invasive exotic aquatic plants (alligator weed, parrot feather and purple loosestrife) have been closely monitored and efforts undertaken to effectively control their potential to spread within the Duck River system (Tennessee Valley Authority 2015a).

Status of the Species within the Action Area

The oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel, rabbitsfoot occur within the action area and could be affected by the proposed action. The most recent survey effort in the vicinity of the action area occurred at Venable Spring (rmi 176.8) and immediately upstream of the spring site in 2010 (Hubbs et al. 2010). The survey yielded 25 mussel species, totaling 252 individuals, with recent recruitment being evident for nearly all species collected (Hubbs et al. 2010). Mean mussel density at this location had increased 655% since a 1979 TVA survey (Ahlstedt 1981b), but had declined 35.7% since a 2002 survey at this site (Ahlstedt et al. 2004). Total mussel population size at the Venable Spring survey site was estimated at 37,800 individuals (Hubbs et al. 2010).

Birdwing pearlymussel

The birdwing pearlymussel was the second most abundant mussel species encountered at Venable Spring during the 2010 survey (Hubbs et al. 2010), with an estimated population size of approximately 6,000 individuals and a relative abundance of 16%. Birdwing pearlymussel density had increased 251% at this site since 1988 (Jenkinson 1988).

Oyster mussel

The oyster mussel was the most abundant species of the 25 species encountered at Venable Spring during the 2010 survey (Hubbs et al. 2010), with an estimated population size of approximately 7,950 individuals and a relative abundance of 21%. The Venable Spring sampling site represented the best sampling location in the Duck River of six sampling localities during the 2010 survey (Tennessee Valley Authority 2015a). Oyster mussels in the Duck River, were reclassified as a separate species, the Duck River darter snapper, in 2010 (Jones and Neves 2010); the Duck River is the only system where the Duck River darter snapper occurs (Hubbs et al. 2010).

Cumberland monkeyface

The Cumberland monkeyface was the ninth most abundant mussel species encountered at Venable Spring during the 2010 survey (Hubbs et al. 2010), with an estimated population size of approximately 1,500 individuals and a relative abundance of 4%. Cumberland monkeyface density had increased 189% at this site since 1988 (Jenkinson 1988).

Rabbitsfoot

The rabbitsfoot was the seventh most abundant mussel species encountered at Venable Spring during the 2010 survey (Hubbs et al. 2010), with an estimated population size of approximately 2,100 individuals and a relative abundance of 6%.

Slabside pearlymussel

The slabside pearlymussel was the tenth most abundant mussel species encountered at Venable Spring during the 2010 survey (Hubbs et al. 2010), with an estimated population size of approximately 1,200 individuals and a relative abundance of 3%.

Status of Critical Habitat in the Action Area

The action area includes portions of the following DCHs in the Duck River: (1) Unit 1 for the Cumberlandian combshell and oyster mussel (69 FR 53136-53180), Unit FK23 for the fluted kidneyshell (78 FR 59555-59620) and Unit SP12 for the slabside pearlymussel (78 FR 59555-59620). DCH for the oyster mussel and slabside pearlymussel is currently occupied by these species in the Duck River within the vicinity of the project action area (Hubbs et al. 2010). Although there is DCH for the Cumberlandian combshell and fluted kidneyshell in the Duck River mainstem near the project action area, these species have not been collected within the action area in recent surveys (Ahlstedt et al. 2004; Hubbs et al. 2010).

PCEs for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel were previously described in the "Life history" section under "Status of the Species/Critical Habitat". All five of the PCEs for the Cumberlandian combshell and oyster mussel are present within and adjacent to the project action area (Tennessee Valley Authority 2015a). PCEs 2,3,4 and 5 for the fluted kidneyshell and slabside pearlymussel are present within and adjacent to the project action area; PCE 1 (riffle habitats within large, geomorphically stable stream channels) for these species is not present within the project action area, but present upstream of Venable Spring on the Duck River (Tennessee Valley Authority 2015a).

Factors Affecting Species Environment within the Action Area

A dairy farm was maintained for over a century on the property surrounding Venable Spring and the project action area (Giles, personal communication, 2014). A primitive campsite and private boat ramp, accessed by a road from SR 99, are used and maintained by the landowners in the action area. Venable Spring drains into the Duck River immediately upstream of the project site. The spring is located on the northeast side of the boat ramp; the area on the south side of the boat ramp is where the proposed action would be implemented (Tennessee Valley Authority 2015a).

The dairy farm likely contributed to some level of historic impacts in the action area (e.g., bank erosion due to livestock trailing to the Duck River, decreased regeneration of riparian vegetation because of continual grazing in the riparian area, water quality impacts as a result of cattle manure being deposited in the river, etc.). However, the property is no longer used for dairy production.

TNC has had the proposed project site enrolled under a conservation easement with the land owners for several years (Tennessee Valley Authority 2015a). The easement is intended to enhance instream habitat and the riparian area and improve natural floodplain processes (aquifer recharge, etc.). Such improvements should benefit aquatic species, including the listed oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and DCH for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidneyshell. At the proposed project site, riverbank erosion, gully erosion and stormwater runoff from upland areas continue to adversely affect these listed species and DCH. The proposed action is intended to address these impacts.

In portions of the action area beyond the project footprint, other threats exist to the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and DCH for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidneyshell. Agriculture is the predominant land use in the action area, and the primary factors affecting these species in this area are likely the result of improper agricultural practices. Erosion of cropland fields and associated runoff is a common problem in Marshall County due to lack of conservation measures including, no plant cover on soil for extended periods, not practicing conservation tillage on slopes, absence of terraces and diversions to reduce the length of lower slopes, not implementing contour farming, and failure to retain crop residue (Natural Resources Conservation Service 1999). Lack of grasses and legumes in the cropping sequence on livestock farms also contributes to lack of soil tilth (soils with good tilth allow infiltration of water and are granular and porous) and erosion (Natural Resources Conservation Service 1999). Unrestricted livestock access to the river on properties adjacent to the subject property may also contribute some level of impact (e.g., sedimentation of instream habitat, loss of riparian vegetation, etc.). However, according to the most recent State of Tennessee's 303(d) List (Tennessee Department of Environment and Conservation 2012), the reach of the Duck River where the action area is located is not listed as impaired, suggesting that water quality in this reach is good. Therefore, any affects to species or impacts to DCH, resulting from agricultural land uses within the action area, appear to be minor.

EFFECTS OF THE ACTION

Factors to be considered

This section includes an analysis of the direct and indirect effects of the proposed action on the species and/or critical habitat and its interrelated and interdependent activities.

Proximity of the action:

The proposed action would occur at rmi 176.8 on the mainstem Duck River in north-central Marshall County, Tennessee. The action area is comprised of the mainstem Duck River, Venable Spring, the riparian corridor and portions of the floodplain. Pastures, croplands, small wood lots

and secondary roads lie within and adjacent to the action area. Specific individual components of the action (mussel translocations; equipment staging and transport; fill stockpiling; construction of riprap revetments/keyways, bank sloping and revegetation; construction of a riprap chute; construction of a stormwater diversion channel; post-project operations) have been included and described under "Components and Activities" in the "Description of the Proposed Action".

The action is located within the known, occupied range for the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot. DCH exists in the action area for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel. In the action area, DCH for the oyster mussel and slabside pearlymussel is currently occupied, while DCH for the Cumberlandian combshell and fluted kidneyshell is unoccupied.

The Service has defined the 17.8-ac project action area based on information included in the Biological Assessment: Duck River Bank Stabilization, River Mile 176.8 (Marshall County, Tennessee) (Tennessee Valley Authority 2015a), our assessment of where direct effects would occur, and the estimated distance that indirect effects would extend downstream of the proposed action.

Distribution:

Direct project effects to the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel would occur in the proposed project's footprint, including locations where: (1) mussels would be collected and relocated during translocation, (2) portions of riprap revetments (below OHW) and the associated keyways would be constructed, (3) deposition of sediment or pollutant spills (petroleum products from hydraulic, fuel and power systems) would occur, and (4) loss of PCEs would take place. Indirect project effects to these species and DCHs could potentially transpire throughout the action area, but would generally occur: (1) in the near vicinity of the action's proposed terrestrial activities (equipment staging and transport; fill stockpiling; bank sloping and revegetation; construction of a riprap chute; and construction of a stormwater diversion channel), (2) where mussels would be collected and relocated during translocation, and (3) downstream of the project site.

Timing:

The proposed action can be divided into essentially three periods, a pre-project implementation phase, a project implementation phase and a post-implementation (operations) phase.

The listed mussels (oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot), included under this opinion, could be adversely affected during the pre-project implementation phase as a result of collecting and relocating them from the project footprint. Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel DCH would not be affected during the pre-project implementation phase.

The listed mussels, their host fish species and DCH for listed mussels could be adversely affected during the project implementation phase as a result of water quality impacts (suspended sediments

and potential spills of petroleum products) created by construction activities. Listed mussels, inadvertently not collected during relocation efforts in the pre-project implementation phase, could also potentially be crushed or injured as a result of construction activities during the implementation phase.

The post-implementation phase of the proposed action would occur year-round into the foreseeable future. If any of the proposed project components failed (e.g., riprap revetments washed out, the riverbank sloughed, etc. from not being properly engineered, BMPs not being correctly installed, etc. during the implementation phase), listed mussels at various life stages, their host fish species and DCH for listed mussels could be adversely affected as a result of water quality impacts (increased erosion, runoff and, in turn, suspended sediments).

Nature of the effects:

The proposed action could potentially result in the following effects to individual listed mussels (oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot): (a) direct injury or mortality as a result of handling and holding during relocation efforts (i.e., stressing individuals from physical handling, which might include roughly removing them from substrate, leaving them out of water for extended periods, holding them in warm or stagnant water, and/or repositioning them in an unnatural position in substrate, (b) direct injury or mortality as a result of inadvertently not being collected during relocation efforts and being crushed or becoming physically impaired by instream construction activities (construction of riprap revetments and keyways), (c) direct injury or mortality as a result of turbidity and/or deposition of sediment, created by instream construction activities and/or project activities adjacent to the river (equipment staging and transport; fill stockpiling; bank sloping and revegetation; construction of the riprap chute; and construction of the stormwater diversion channel), obstructing their gills, and reducing their ability to feed or respire, (d) direct injury or mortality as a result of pollutants (spills of petroleum products from hydraulic, fuel and power systems) accidently entering the river, affecting water quality and food sources, and in turn respiration and feeding capabilities of individuals, (e) indirect injury as a result of elevated levels of suspended sediments, caused by post-project failures, reducing their ability to feed and/or respire, and/or increasing their vulnerability to disease, (f) indirect injury as a result of loss of suitable habitat from impacts caused by project construction and/or project component failures, (g) effects (b), (c), (d), (e) and (f) would also be applicable to fish-host species, and (h) indirect injury as a result of relocating individuals to areas already fully occupied by other mussels, displacing individuals at the translocation site and stressing the relocated individuals due to potential crowding (insufficient feed, host fish populations, and/or habitat available for occupancy, etc.), and (i) indirect benefits to suitable habitat because water quality and host fish populations should be improved as a result of stabilizing the riverbank, arresting erosion in the surface water conveyance and improving stormwater delivery.

The proposed action would potentially result in the following effects to DCH for listed mussels (Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel DCH): (a) indirect loss of PCE 2 for the Cumberlandian combshell and oyster mussel because the geomorphic stability of the river channel might be affected, as a result of fill placed on and keyed

into the riverbank, altering channel form and function at the site, including the bankfull width, bankfull mean and maximum depth, entrenchment ratio, width/depth ratio, bankfull cross-sectional area, discharge, velocity, flow pattern, and potentially other morphological characteristics, (b) indirect loss of PCE 4 for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel because impacts resulting from project construction and/or project component failures would affect water quality necessary for the normal behavior, growth, and survival of all life stages of these species and their fish hosts, (c) indirect beneficial effects to PCE 4 for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel because water quality, currently impacted by an eroding riverbank and surface water conveyance and unmanaged/unfiltered stormwater, would be improved as a result of stabilizing the riverbank, arresting erosion in the surface water conveyance and improving stormwater delivery, and (d) indirect loss of PCE 5 for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel because impacts resulting from project construction and/or project component failures would affect living, foraging and spawning areas of fish hosts.

Duration:

During the pre-project implementation phase, potential effects to listed mussels (oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot) would be temporary because collection, handling, holding and relocation of these species would only occur over a several hour period.

During the implementation phase, potential project effects to listed mussels and DCH for listed mussels (Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel DCH) in the action area are anticipated to be temporary in nature. Such effects would be associated with construction of riprap revetments and keyways under the proposed action and accidental spills of petroleum products from hydraulic, fuel and power systems, etc. of equipment utilized during construction. These effects should cease within several days of completed construction work.

The post-implementation phase could potentially include a combination of temporary, long-term duration and/or permanent effects to the listed mussels at various life stages and DCH for listed mussels in the action area. Temporary effects might include, increased turbidity levels and sediment deposition downstream of the project site during the first several days following instream work. Whereas, long-term or permanent effects might include changes in river hydraulics and channel stability, as a result of the riprap revetments being placed and keyed into the riverbank, loss of DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel or absence of available fish hosts. Beneficial effects to habitat (stabilization of the riverbank and surface water conveyance and improved stormwater delivery) should be long-term upon completion of construction.

Project failures would be caused by flawed project design, incorrect installation of BMPs and/or lack of project effectiveness monitoring. Project failures during the post-implementation phase could result in either: (1) temporary effects (e.g., the riverbank sloughing and/or riprap revetments washing out during high flow events, and/or the surface water conveyance or stormwater diversion eroding) resulting in brief episodes of turbidity and/or sedimentation to downstream locations over

several hours or days, until naturally resolved or repaired), (2) long-term effects (e.g., continued turbid conditions and flushes of sediment covering DCH downstream of the project site due to ongoing riverbank, river channel, surface water conveyance and/or stormwater diversion stability issues at the project site not being addressed over a period of months or years), or (3) permanent effects (e.g., the character of the river channel would be permanently changed due to catastrophic bank failures), resulting in loss of DCH's PCE components for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel, and/or including potential loss of host fish species and their habitat, which as a result would no longer inhabit all or portions of the action area.

The effects of potential operational changes would not be known until sufficient post-implementation monitoring were conducted to determine if installed project components had affected listed mussels or DCH for listed mussels.

Disturbance frequency:

Disturbances to listed mussels (oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot) during the pre-implementation phase would be a one-time occurrence over a several hour period, restricted to the time required to collect mussels from the project footprint and relocate them to nearby suitable habitat.

Any disturbances to listed mussels, DCH for listed mussels (Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel) and/or effects to host fish species, during the project implementation phase would be restricted to the proposed construction window. Instream work activities (implemented between August 1 and September 1, 2015) would have the greatest potential to disturb listed mussels, DCH for listed mussels and host fish species during this phase. Proposed construction activities have the potential to temporarily increase turbidity levels and sediment deposition, and/or accidentally result in accidental spills of petroleum products into the river, but overall would likely only produce these effects over a short-time period. Individual listed mussels, inadvertently not collected during relocation efforts, and their fish hosts could also be injured or killed by heavy equipment operating in the river during the proposed instream work period.

Disturbances during the post-project implementation phase could vary in frequency from a one-time event, multiple occurrences, frequent occurrences or be continuous, depending upon the nature of the disturbance (e.g., disturbance frequency associated with bank failure and subsequent downstream turbidity and sedimentation could be continuous if bank sloughing was ongoing).

Disturbance intensity:

Disturbance intensities during the pre-implementation phase would be highest in the project footprint where listed mussels (oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot) would be collected and relocated.

During the implementation phase, disturbance intensities would be highest in the project footprint because proposed instream activities would have the greatest potential to affect listed mussels,

inadvertently not collected for relocation during the pre-implementation phase, resulting in individuals being crushed or becoming physically impaired by instream construction activities and/or their habitat being adversely impacted (including DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel). Such activities could result in mortality or injury to listed mussels and/or their host fish. Disturbance intensity during the implementation phase would progressively decrease downstream from the project site because habitat for listed mussels would be greater distances from project construction, and therefore, there would be less risk of mortality or injury to mussels and/or their host fish.

Because intrusive instream construction activities and their effects (increased turbidity and/or deposition of sediment, potential petroleum product spills, etc.) would no longer be occurring during the post-project implementation phase (unless there would be post-project failures resulting in increased erosion and/or sediment delivery to the river), the disturbance intensity at the project site would be anticipated to be much lower during the post-implementation phase than during the implementation phase. Properly functioning, post-construction BMPs would also be expected to minimize and stabilize project-related disturbances to listed mussels, their host fish and DCH for listed mussels, during the post-project implementation phase. However, for any disturbances that might potentially occur during the post-project implementation phase, as a result of post-project failures, disturbance intensities would diminish and dissipate further distances downstream from the project site.

Disturbance severity:

The disturbance severity of the pre-construction phase (collection, handling, holding and relocation of listed mussels, including the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot) would be minimal since it would be temporary and only occur within the project footprint. DCH for listed mussels (Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel), included under this consultation, should not be affected during the pre-construction phase; therefore, the action's disturbance severity would not be applicable to them.

The disturbance severity of the project implementation phase would be minimal because the total area of direct disturbances would be minor, relative to the overall range-wide geographic distribution of the listed mussel species and DCH for listed mussels covered by this consultation.

The disturbance severity of the post-implementation phase would be minimal because: (a) the total area of disturbance, related to operational aspects of the proposed project, would be small (i.e., no more than a 1-rmi-reach of the Duck River, in the vicinity and downstream of the proposed project site), relative to the overall range-wide geographic distribution of the listed mussel species and DCH for listed mussels covered by this consultation, and (b) over the long-term, the completed action should benefit the listed mussel species, their host fish and DCH for listed mussels, covered by this consultation, because stabilizing the riverbank and surface water conveyance and improving stormwater delivery into the river is anticipated to arrest erosion and improve water quality at a site currently impacted by unstable conditions.

Taken as a whole, the overall disturbance severity is minor to populations of oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, currently occupying the action area and range-wide, and Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel DCH within the action area, and range-wide.

Analyses for effects of the action

Beneficial effects:

The proposed action is intended to stabilize eroding soils and improve the quality of stormwater runoff entering the Duck River at the proposed project site. Therefore, the action should result in beneficial indirect effects to the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel, and host fish species within the action area.

Direct effects:

Based on the "Factors to be considered" under "EFFECTS OF THE ACTION", the Service has determined the following direct effects are possible as a result of the proposed action to the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot:

1. injury or mortality to individuals as a result of inappropriate handling and holding during relocation efforts;
2. injury or mortality to individuals (inadvertently not collected from the project footprint during relocation efforts) and/or their host fish as a result of being crushed or becoming physically impaired due to instream construction activities;
3. injury or mortality to individuals and/or their host fish as a result of turbidity and/or deposition of sediment, created by instream construction activities and/or construction activities adjacent to the Duck River;
4. injury or mortality as a result of pollutants (spills of petroleum products from hydraulic, fuel and power systems) accidently entering the Duck River, affecting water quality and food sources, and in turn respiration and feeding capabilities of individuals and/or their host fish.

Interrelated and interdependent actions:

No interrelated and interdependent actions have been identified for this project.

Indirect effects:

Based on the "Factors to be considered" under "EFFECTS OF THE ACTION", the Service has determined the following indirect effects are possible as a result of the proposed action to:

1. the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot:

(a) injury to individuals and/or host fish as a result of elevated levels of suspended sediments, caused by post-project failures, reducing their ability to feed and/or respire, and/or increasing their vulnerability to disease;

(b) injury to individuals and/or host fish as a result of loss of suitable habitat from impacts caused by project construction and/or project component malfunctions;

(c) injury as a result of relocating individuals to areas already fully occupied by other mussels, displacing individuals at the translocation site and stressing the relocated individuals due to potential crowding (insufficient feed, host fish populations, and/or habitat available for occupancy, etc.).

2. DCH for the Cumberland elktoe, Cumberlandian combshell, fluted kidneyshell and oyster mussel:

(a) loss of PCE 2 for the Cumberlandian combshell and oyster mussel because the geomorphic stability of the river channel might be affected, as a result of fill placed on and keyed into the riverbank;

(b) loss of PCE 4 for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel because impacts resulting from project construction and/or project component failures would affect water quality necessary for the normal behavior, growth, and survival of all life stages of these species and their fish hosts;

(c) beneficial effects to PCE 4 for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel because water quality, currently impacted by an eroding riverbank and surface water conveyance and unmanaged/unfiltered stormwater, would be improved;

(d) loss of PCE 5 for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel because impacts resulting from project construction and/or project component failures would affect living, foraging and spawning areas of fish hosts.

Species' response to a proposed action

Numbers of individuals/populations in the action area affected:

The oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot are all known to occur within the action area. Population estimates of these species (based on 2010 survey data) in the near vicinity of the action area at Venable Spring have been previously discussed in the "Status of the Species within the Action Area" section.

While these species are generally rare, based upon available survey data and species occurrence records, these five species collectively comprised 50% of the relative abundance of 25 species

collected at the Venable Spring sampling site (Hubbs et al. 2010). As mentioned previously in the "Status of Critical Habitat in the Action Area" section, DCH for the oyster mussel and slabside pearlymussel is currently occupied within the vicinity of the action area, whereas DCH for the Cumberlandian combshell and fluted kidneyshell within the vicinity of the action area is presently considered to be unoccupied because these species have not been collected in recent surveys (Ahlstedt et al. 2004; Hubbs et al. 2010).

Sensitivity to change:

The degree to which the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot are sensitive to change when disturbed is unknown. The proposed implementation activities could result in increased turbidity, deposition of sediment and/or accidental releases of pollutants within the action area, interfering with the ability of individual listed mussels and host fish to respire or feed. However, freshwater mussels typically burrow deeper into substrate in attempt to avoid such disturbances, and fish have the ability to swim to other areas to avoid potential effects from such disturbances, under most circumstances.

Resilience:

Resilience relates to the characteristics of populations or a species that allow them to recover from different magnitudes of disturbance. The resiliency of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot is unknown. While these species are generally considered to be rare, based on prior surveys (Hubbs et al. 2010; Ahlstedt et al. 2004; Ahlstedt 1991b; Jenkinson 1988; Isom and Yokley 1965; Ortmann 1924), the Duck River and the action area supports a relatively high density of rare mussel species, including these five species.

In regards to the proposed action, the total area of direct and indirect effects could potentially occur throughout an estimated 17.8-ac area, including approximately 1-rmi of the mainstem Duck River. However, any project effects felt by these species would typically be in the immediate vicinity of the project site (including where instream construction of riprap revetments and keyways and terrestrial construction of the surface water conveyance would occur), a small area relative to the overall range-wide geographic distributions of these species.

Project implementation would be temporary in duration. Post-project failures would only occur if project components were improperly engineered or constructed, and/or if the appropriate BMPs were not in place. Effectiveness monitoring should minimize or prevent effects to the listed species covered under this consultation, in addition to mussel fish host species and areas of DCH.

Overall, assuming that habitat conditions in the action area would not appreciably change as a result of construction and operation of the proposed project, the magnitude of disturbance would likely be low and oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot resilience would not be expected to change from its current level. However, this could only be determined through monitoring the populations and habitats over time.

Recovery rate:

In this biological opinion, the recovery rate relates to the time required for the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot populations to return to equilibrium after exposure to a disturbance. While levels of successful recruitment are unknown, it is unlikely that those levels would differ significantly from current conditions because the proposed action is anticipated to affect only a very small number of individuals of each species inhabiting the action area, relative to their range-wide distributions. Provided measures would be undertaken to minimize and avoid disturbances to these species, recovery rates for them in the action area are not anticipated to change. Such measures would include proper project design, installation of appropriate BMPs and assurance they were functioning as intended following their installation, and adequate project monitoring (to assess riverbank and channel stability, and riverbank and channel functionality during operations [post-project implementation]).

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act.

No new actions are anticipated near the proposed action. The proposed action would be located on a private property that has been enrolled under a conservation easement with the land owners for several years. The purpose of the easement is to enhance instream habitat and the riparian area and improve natural floodplain processes (aquifer recharge, etc.). We are reasonably certain that this easement will remain in place and continue to benefit aquatic species, including the listed oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and DCH for the oyster mussel, slabside pearlymussel, Cumberlandian combshell and fluted kidneyshell, covered under this opinion.

Potential future effects from agriculture could potentially occur in the action area, downstream of the proposed project site. However, based on existing agriculture practices within the action area, water quality within this reach of the Duck River is currently not listed as impaired (Tennessee Department of Environment and Conservation 2012), suggesting that any effects to species or DCH as a result of future agricultural activities within the action area would likely be minor, at most.

Therefore, we are not aware of any non-federal actions that are reasonably certain to occur as a result of the project, and cumulative effects, as defined by the Act, are not expected to occur.

CONCLUSION

(NOTE: This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR §402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat. ***Under the statutory provisions of the Act, we determine destruction or adverse modification on the basis of whether, with implementation of the proposed federal action, the affected critical habitat would continue to serve its intended conservation role for the species.*** **Our analysis follows the guidance provided in Service Memorandum FWS/AES/DCHRS/019634, dated December 9, 2004 [U.S. Fish and Wildlife Service 2004b]).**

After reviewing the current status of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel, the environmental baseline for the action area, and the effects of stabilizing eroding soils in the floodplain and on the right descending bank of the Duck River at rmi 176.8, it is the Service's biological opinion that the project in Marshall County, Tennessee, as proposed, is not likely to jeopardize the continued existence of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, and is not likely to destroy or adversely modify DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel because: 1) the action area would be small relative to individual range-wide distributions of these species and DCHs, and therefore, only small fractions of the individual species populations and DCHs would be affected by the action, 2) potential effects to these species and DCHs, as a result of construction activities during the project implementation phase, would be temporary and of short duration, 3) the likelihood of these species being affected would be low with properly engineered and correctly installed project components, adherence to BMPs, effectiveness monitoring to ensure the project is functioning as intended (i.e., with minimal or no apparent effects to any of the species), and maintenance, as needed, 4) the likelihood of fish host species being impacted would be low with properly engineered and correctly installed project components, adherence to BMPs, effectiveness monitoring to ensure the project is functioning as intended (i.e., with minimal or no apparent effects to suitable habitats for the Cumberland monkeyface, birdwing pearlymussel and rabbitsfoot DCHs for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel), and maintenance, as needed, and 5) the proposed action would provide beneficial effects to habitat for the listed mussel species, covered under this consultation, because water quality necessary for the normal behavior, growth, and survival of all life stages of the mussels and their host fish species, should be improved as a result of stabilizing eroding soils in the floodplain and on the riverbank.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation under 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 the 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 T&Cs of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the TVA, so that they become binding conditions of any grant, permits or contracts, as appropriate, for the exemption in section 7(o)(2) to apply. The TVA has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the TVA: (1) fails to assume and implement the T&Cs or (2) fails to adhere to the T&Cs of the Incidental Take Statement through enforceable terms that are added to the grant, permit or contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the TVA must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement. [50 CFR § 402.14 (1)(3)].

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service believes that incidental take of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, as a result of the action, will be difficult to detect for the following reasons: (1) they may be buried beneath substrate and not be visible, or only their siphons would be visible, (2) finding a dead or impaired specimen would be unlikely because such individuals would either remain buried beneath substrate or experience rapid decomposition, (3) losses could be masked by natural seasonal fluctuations in their numbers, and (4) carcasses of injured individuals, shells or fresh-dead mussels could be washed downstream with currents.

However, incidental take of oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot individuals can be anticipated from: (1) collecting and relocating individuals, (2) construction activities resulting in degradation of suitable habitat (water quality impacts causing turbidity, deposition of sediment, and/or petroleum pollutant spills), and (3) instream construction activities crushing or physically impairing individuals. Therefore, the Service believes if oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot individuals are present in the impact area of the proposed action, collection and relocation efforts, alteration of habitat, and/or crushing or physically injury would result in incidental take of the species. It should be noted that those listed mussels would not likely all be lethally taken, but rather a percentage of the take would be in the form of harm and harassment, resulting from habitat impacts and their collection and relocation. We have attempted

to quantify such take, below, and request that TVA and its contractors monitor removal and relocation sites and levels of habitat disturbance with the following assumptions:

Oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot individuals would be collected for relocation from approximately 125 linear ft of river length (based upon the combined bank length of where instream and terrestrial activities would transpire) in the mainstem Duck River construction area and approximately 300 linear ft of river length immediately downstream of the construction area (as recommended by the Service); these combined river lengths (125 linear ft + 300 linear ft) = 425 linear ft. The Service has determined that the OHW of the Duck River averages approximately 141 ft throughout the 425-linear ft river length. Therefore, the total area where Oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot individuals would be collected for relocation in the Duck River is estimated to be approximately 59,925 ft^2 (425 linear ft x 141 linear ft).

Based upon recent survey data (Ahlstedt et al. 2004; Hubbs et al. 2010), the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot are well represented as part of the overall mussel community immediately upstream of the project site (in the vicinity of Venable Spring), indicating that their host fishes are present, sufficient habitat and water quality and quantity (substrate, water temperatures, pH, DO, calcium concentrations, flow characteristics and gradient) exist, and there are no threats (higher accessibility to predators than normal, etc.) present that would affect their survival. However, we do not know what effects relocation of the collected individuals to this vicinity would have on rare or endemic taxa, currently inhabiting the sites, or to the individuals to be stocked at this locality. The relocations could potentially displace existing oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot individuals at the translocation site and stress the relocated individuals due to potential crowding, dependent upon the strength of host fish populations, amount of habitat available for occupancy, etc. The Service estimates that the size of the translocation site would be similar to that of the collection site, an area of approximately 59,925 ft^2.

The Service estimates that all oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot in approximately 3% of the removal and reintroduction areas [(59,925 ft^2 + 59,925 ft^2) x 0.03] or 3,596 ft^2 would be taken in the form of lethal, harm or harass. Therefore, the combined lethal, harm and harass take, as a result of collection and relocation activities, would be all oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot in 3,596 ft^2 of aquatic area.

The Service estimates that approximately 2,625 ft^2 of aquatic area [(75 linear ft of the riverbank, where bank stabilization measures would transpire) x (35 linear ft of river channel width, approximately 25% of the total channel width)] would be directly exposed to instream construction activities, within the proposed project's footprint. The Service believes that all oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot within approximately 5% of this aquatic area (2,625 ft^2 x 0.05) or approximately 131 ft^2 would inadvertently not be collected during relocation efforts and would be taken in the form of lethal take during instream construction activities.

Assuming that habitat quality and quantity is relatively homogenous (similar percentages of riffle, pool and shoal habitats, comparable substrate, etc.) between the 2010 Venable Spring sampling site (Hubbs et al. 2010), immediately upstream of the project site (where mussels collected from the project site would be relocated) and the 425 linear ft of river length (approximately 59,925 ft^2 area) from where mussels would be collected, approximate mean densities for the five listed mussels in the collection area would be as follows (based upon Hubbs et al. 2010, survey data): (1) oyster mussel, 2.65 m^2 (28.5 ft^2); (2) Cumberland monkeyface, 0.5 m^2 (5.4 ft^2); (3) birdwing pearlymussel, 2 m^2 (21.5 ft^2); (4) slabside pearlymussel, 0.4 m^2 (4.3 ft^2); and (5) rabbitsfoot, 0.7 m^2 (7.5 ft^2). Using these densities, the Service has extrapolated that within the previously estimated 3,596 ft^2 area, where these five species would be taken in the form of lethal, harm or harass, as a result of collection and relocation activities, the following numbers would be taken: approximately 126 oyster mussels (estimated 3,596 ft^2 area for lethal, harm or harass take/an oyster mussel density of approximately 28.5 ft^2); 666 Cumberland monkeyface mussels (estimated 3,596 ft^2 area for lethal, harm or harass take/a Cumberland monkeyface density of approximately 5.4 ft^2); 167 birdwing pearlymussels (estimated 3,596 ft^2 area for lethal, harm or harass take/a birdwing pearlymussel mussel density of approximately 21.5 ft^2); 836 slabside pearlymussels (estimated 3,596 ft^2 area for lethal, harm or harass take/a slabside pearlymussel mussel density of approximately 4.3 ft^2); and 480 rabbitfoots (estimated 3,596 ft^2 area for lethal, harm or harass take/a rabbitsfoot density of approximately 7.5 ft^2). Based on best professional judgment, the Service has determined that of the five species occurring in the combined 3,596 ft^2 lethal, harm or harass area during collection and relocation activities (126 oyster mussels, 666 Cumberland monkeyfaces, 167 birdwing pearlymussels, 836 slabside pearlymussel, and 480 rabbitsfoots), approximately 10% would be taken as a result of lethal take, approximately 45% would be taken as a result of harm and approximately 45% would be taken as a result of harass.

Using the above densities (oyster mussel [28.5 ft^2]; Cumberland monkeyface [5.4 ft^2]; birdwing pearlymussel [21.5 ft^2]; slabside pearlymussel [4.3 ft^2]; and rabbitsfoot [7.5 ft^2]), we further estimate that within the previously estimated 131 ft^2 area, where the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot would inadvertently not be collected during relocation efforts and would be taken in the form of lethal take during instream construction activities, the following numbers would be taken: approximately 5 oyster mussels (estimated 131 ft^2 area for lethal take during instream construction activities/an oyster mussel density of approximately 28.5 ft^2); approximately 24 Cumberland monkeyfaces (estimated 131 ft^2 area for lethal take during instream construction activities/a Cumberland monkeyface density of approximately 5.4 ft^2); approximately 6 birdwing pearlymussels (estimated 131 ft^2 area for lethal take during instream construction activities/a birdwing pearlymussel density of approximately 21.5 ft^2); approximately 31 slabside pearlymussels (estimated 131 ft^2 area for lethal take during instream construction activities/a slabside pearlymussel density of approximately 4.3 ft^2); and approximately 18 rabbitfoots (estimated 131 ft^2 area for lethal take during instream construction activities/a rabbitsfoot density of approximately 7.5 ft^2).

Table 3 provides a summary of how incidental take will be monitored for the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot in regards

to: (1) lethal, harm or harass take, as a result of collection and relocation activities, and (2) lethal take, as a result of instream construction activities in the project footprint.

Table 3. How incidental take will be monitored in the action area for the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot.

AREA OF TAKE	ACTIVITY	TYPE TAKE	SPECIES AND LEVEL OF TAKE (# individuals)
Approximately 3,596 ft² of habitat	Collection/Relocation	Lethal	Oyster mussel (13); Cumberland monkeyface (67); birdwing pearlymussel (17); slabside pearlymussel (84); rabbitsfoot (48)
Approximately 3,596 ft² of habitat	Collection/Relocation	Harm	Oyster mussel (57); Cumberland monkeyface (300); birdwing pearlymussel (75); slabside pearlymussel (376); rabbitsfoot (216)
Approximately 3,596 ft² of habitat	Collection/Relocation	Harass	Oyster mussel (57); Cumberland monkeyface (300); birdwing pearlymussel (75); slabside pearlymussel (376); rabbitsfoot (216)
Approximately 131 ft² of habitat	Instream Construction	Lethal	Oyster mussel (5); Cumberland monkeyface (24); birdwing pearlymussel (6); slabside pearlymussel (31); rabbitsfoot (18)
TOTAL TAKE *Totals may vary slightly from figures in above paragraphs due to rounding.			**A total of 131 oyster mussel, 690 Cumberland monkeyface, 173 birdwing pearlymussel, 867 slabside pearlymussel and 498 rabbitsfoot in 3,727-ft² of habitat.**

In the "Analyses for Effects of the Action" section, the Service determined that the action resulted in incidental take of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, covered in this opinion, in several forms including:

(a) lethal from: 1) inappropriate handling and holding during relocation efforts, 2) instream construction activities crushing individuals, 3) instream construction activities and/or construction activities adjacent to the river creating turbidity and/or deposition of sediment, obstructing their

gills, and, in turn, affecting their ability to respire, 4) pollutants (spills of petroleum products from hydraulic, fuel and power systems) accidently entering the river, affecting water quality and food sources, and in turn their respiration, and 5) elevated levels of suspended sediments, due to post-project failures, reducing their ability to respire;

(b) harm from: 1) inappropriate handling and holding injuring individuals during relocation efforts, 2) instream construction activities injuring or killing their host fishes, 3) instream construction activities and/or construction activities adjacent to the river, obstructing their gills and reducing their ability to feed, 4) pollutants from the project's construction equipment accidentally entering the river, affecting water quality and food sources, and in turn their feeding capabilities, and/or the respiration and feeding capabilities of their host fishes, and 5) elevated levels of suspended sediments, due to post-project failures, reducing the ability of individuals and/or their host fishes to feed, and/or increasing their vulnerability to disease;

(c) harassment from: 1) inappropriate handling and holding stressing and disrupting normal behavior patterns of individuals during relocation efforts, 2) loss of their habitat and/or their host fishes habitat from impacts due to project construction and/or project component malfunctions, and 3) relocating individuals to areas already fully occupied by these species, displacing individuals at the translocation site and stressing the relocated individuals due to potential crowding (insufficient feed, host fish populations, and/or habitat available for occupancy, etc.).

EFFECT OF THE TAKE

In the accompanying biological opinion, we determined that this level of expected take is not likely to result in jeopardy to any of the species and would not result in destruction or adverse modification of critical habitat.

Previous biological opinions, completed for populations of oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot within Tennessee, which identified incidental take, have been included in Table 1 in Appendix E.

REASONABLE AND PRUDENT MEASURES

The Service believes the following RPMs are necessary and minimize impacts of incidental take of the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot:

1. The TVA must ensure that the proposed action will occur as designed, planned, and documented in the biological assessment, all supporting information provided by TNC and NRCS and their consultants, and this biological opinion.

2. The TVA must ensure that TNC and NRCS implement measures to minimize or eliminate effects from pre-implementation, implementation and post-implementation activities.

3. The TVA must ensure that TNC and NRCS adequately monitor the level of oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot take associated with the proposed action.

4. The TVA must ensure that TNC and NRCS adequately monitor the effectiveness of the proposed riverbank stabilization project and document any potential changes to suitable habitat and water quality, resulting from the action.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the TVA, TNC and NRCS must comply with the following T&Cs, which carry out the RPMs described above. While these T&Cs were specifically designed to address potential effects to the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot, we believe that implementation of these measures would also minimize potential for impacts to DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel. These T&Cs are non-discretionary.

1. TNC and NRCS will agree to implement the proposed action as described in the biological assessment, the environmental engineering and construction standards in the NRCS construction plan, and this biological opinion.

2. Individual mussels, collected for relocation, will be released upstream of the project area in suitable habitats for mussel survival. Personnel surveying for and collecting these federally protected species will possess appropriate state and federal permits for this activity. All collected federally listed mussels will be closely monitored to prevent stress during collection and holding, transported as quickly as possible to relocation sites, and appropriately acclimated to conditions (water temperatures, DO, etc.) at release sites. CPU and/or densities of individuals collected will be documented, and the deposition of relocated species will be reported to the Service's TFO within 90 days of project completion. Details reported will include habitat conditions such as water temperatures, depths, substrate types and percentages, flow levels, numbers of individuals collected and relocated and locations (latitudes and longitudes) of pre-approved release sites.

3. Collection and translocation of mussels must occur no sooner than 15 days prior to instream construction activities.

4. The proposed instream construction would take place between August 1 and September 1, 2015.

5. All rock materials transported to the work site will be durable and free of excessive fines.

6. All fill materials, either excavated on-site or transported to the project site during project implementation, must be placed outside of the active flow channel at a minimum distance of the first terrace to minimize the potential for runoff from these materials into the Duck River; storage of fill materials on the project site will be temporary and cease upon completion of all construction.

7. All spoil materials would be deposited and leveled in the project area at sites above the 100-year flood elevation.

8. All heavy equipment and trucks will be cleaned, refueled and stored, when not in use, in a designated staging area, located a minimum of 100 ft from the OHW of the Duck River, Venable Spring and any wetlands.

9. An existing access road will be used as a haul road to transport equipment and materials to the staging area.

10. All equipment within the floodplain will carry absorbent boom pads with no less than 15-gallon absorbency capacity, or have truck diapers and absorbent pads attached at all times during both operational and non-operational activities to prevent the introduction of oils, coolants and/or other petroleum products into aquatic areas.

11. The project shall be completed expeditiously, and the river bottom, riverbank, riparian corridor and any areas disturbed with the floodplain (including the staging areas, where equipment storage, cleaning and fueling, and other work would occur, and equipment access points) shall be restored as close to pre-implementation conditions as possible.

12. There will be no tree or shrub removal along the Duck River except within project limits, and then only if essential. If trees and shrubs on the riverbank are removed, every attempt will be made to allow roots to remain intact. All areas disturbed during construction will be immediately stabilized by use of riprap, seeding or mulching, in compliance with permit specifications. Every attempt should be made to replant disturbed areas with native tree and shrub species, and/or native or close equivalent grass species. All banks disturbed by project activities will be inspected, and replanted as needed, until vegetation is successfully reestablished.

13. BMPs will be implemented in accordance with NRCS Streambank and Shoreline protection Code 580 and TVA 26a Standard Permit Conditions.

14. Any construction activity that could result in introduction of potentially toxic materials into the Duck River will be stopped immediately by the project inspector, the resource agencies will be contacted and corrective action(s) implemented prior to resuming work.

15. An NRCS representative, as well as a TVA biologist, will make at least one site visit during active construction to ensure that BMPs and water quality control measures are in place

and properly functioning. The site visit(s) will entail onsite inspections and findings would be made available to the TFO and/or permitting agency(s) upon request.

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the Fish and Wildlife Service Law Enforcement Office at 220 Great Circle Rd, Nashville, Tennessee (telephone: 615/736-5532). Additional notification must be made to the Fish and Wildlife Service, TFO at 446 Neal Street, Cookeville, Tennessee (telephone: 931/528-6481). Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

The RPMs, with their implementing T&Cs, are designed to minimize the effect of incidental take that might otherwise result from the proposed action. The Service believes that no more than 131 oyster mussel, 690 Cumberland monkeyface, 173 birdwing pearlymussel, 867 slabside pearlymussel and 498 rabbitsfoot throughout 3,727-ft^2 of total area in the Duck River will be incidentally taken due to project-related disturbances. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs provided. The TVA, TNC and NRCS must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or DCH, to help carry out recovery plans, or to develop information.

We offer the following conservation recommendation for consideration:

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification if any of the above conservation recommendations were to be carried out.

1. The TVA, TNC and NRCS should continue to collaborate on projects providing benefits to the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel in the Duck River watershed, and develop conservation banks and other measures to assist in recovery of these species and their habitats, whenever possible.

2. The TVA, TNC and NRCS should continue to provide outreach materials to the local public to educate them about the sensitivity of natural resources in the Duck River, including the oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and DCH for the Cumberlandian combshell, oyster mussel, fluted kidneyshell and slabside pearlymussel, included in this opinion.

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the consultation request. As written in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary TVA involvement or control over the action have 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 TVA action that may affect listed species or critical habitat in a manner or to an extent not considered in this biological opinion; (3) the TVA action is later modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion; 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 until reinitiation.

For this biological opinion, the incidental take would be exceeded when the take exceeds 131 oyster mussel, 690 Cumberland monkeyface, 173 birdwing pearlymussel, 867 slabside pearlymussel and 498 rabbitsfoot throughout 3,727-ft^2 of aquatic habitat, which is what has been exempted from the prohibitions of section 9 by this biological opinion. The Service appreciates the cooperation of the TVA during this consultation. We would like to continue working with you and your staff regarding this project. For further coordination please contact Todd Shaw of my staff at 931/525-4985.

Peggy W. Shute — April 13, 2015

for Mary E. Jennings, Field Supervisor — Date

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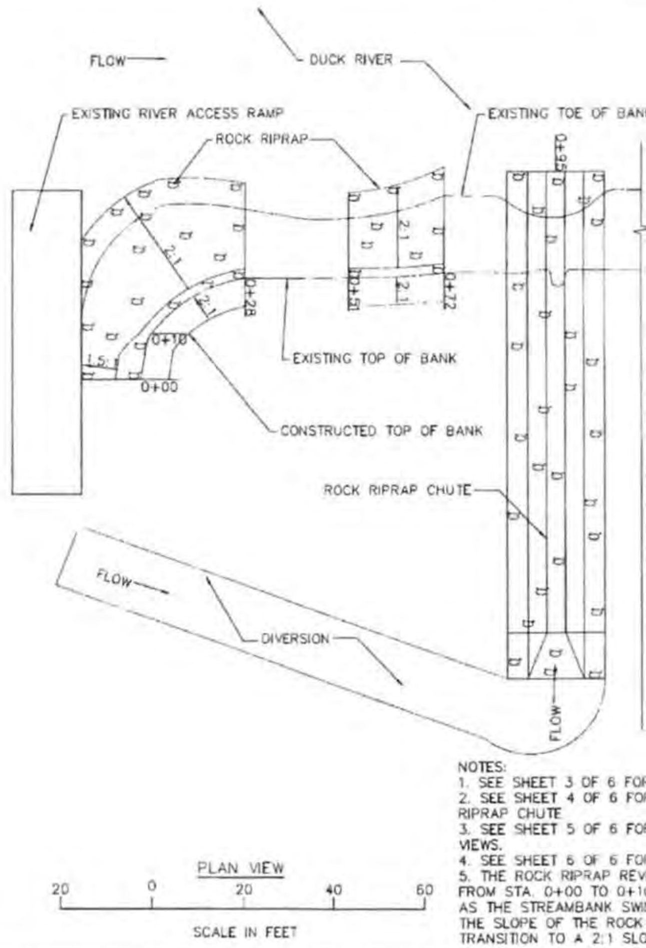
APPENDIX A

NRCS engineering drawings of Duck River Bank Stabilization Project



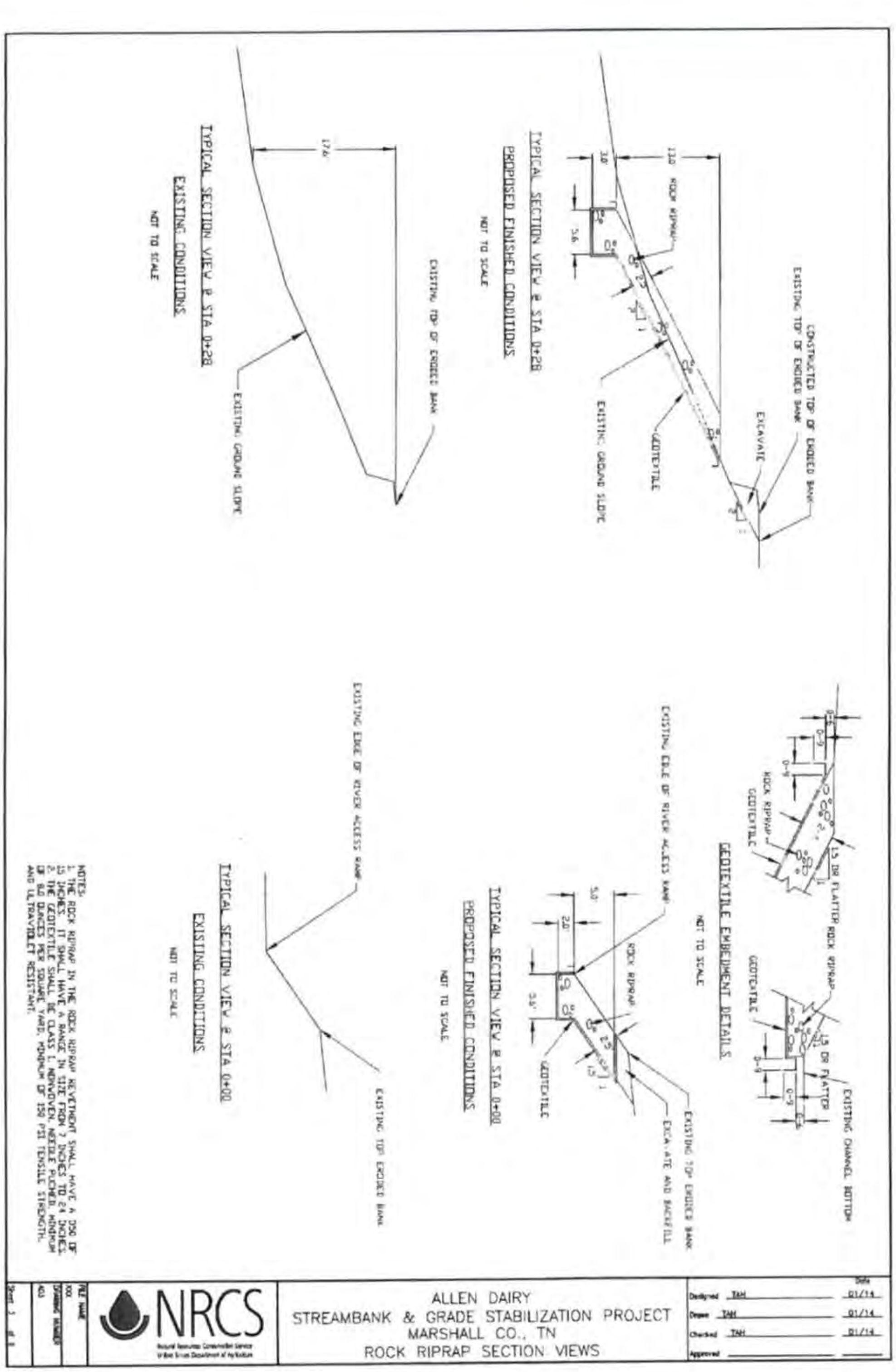
NOTES:

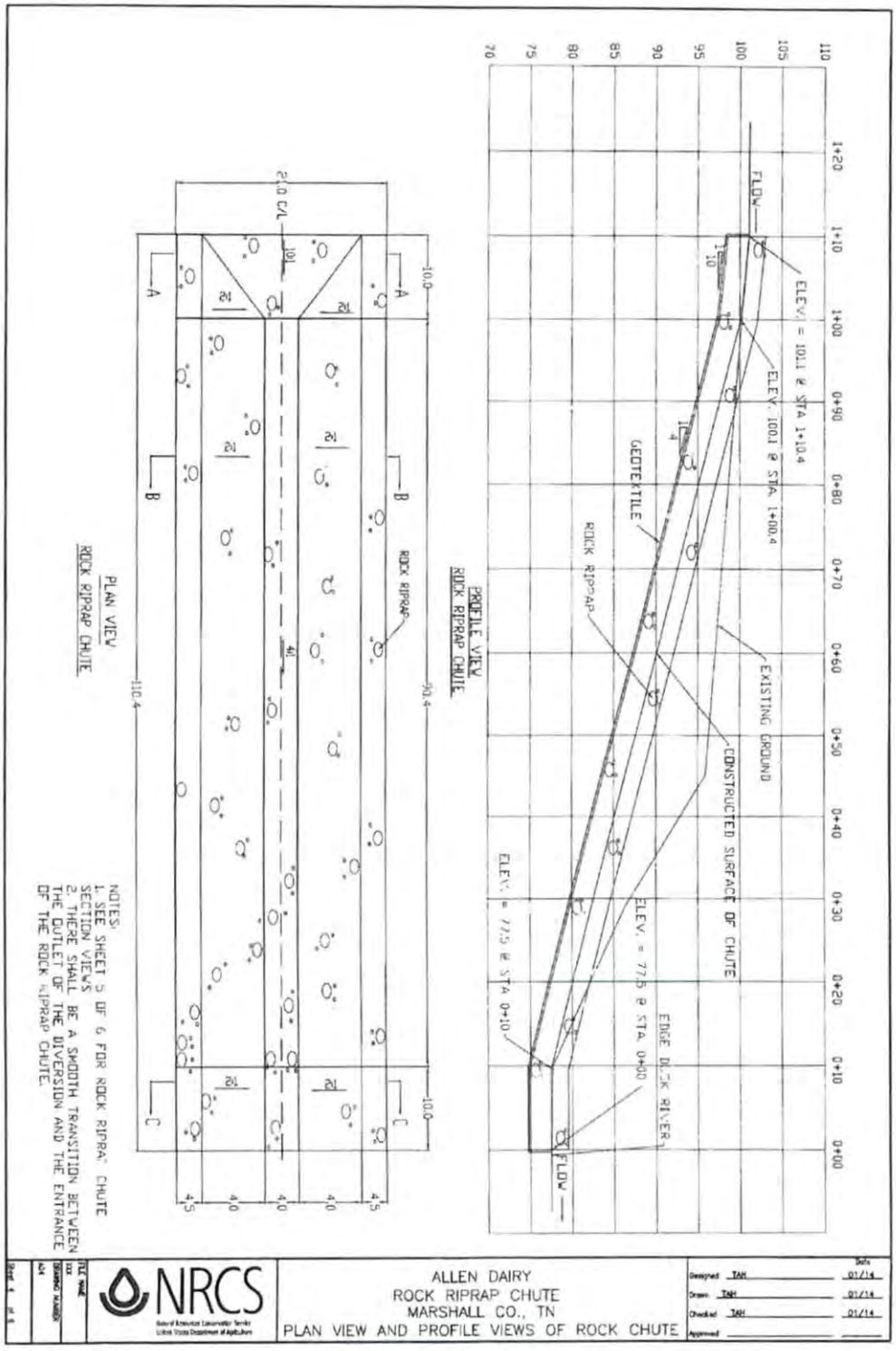
1. SEE SHEET 3 OF 6 FOR ROCK RIPRAP REVETMENT DETAILS.
2. SEE SHEET 4 OF 6 FOR PLAN AND PROFILE VIEW OF ROCK RIPRAP CHUTE.
3. SEE SHEET 5 OF 6 FOR ROCK RIPRAP CHUTE SECTION VIEWS.
4. SEE SHEET 6 OF 6 FOR TYPICAL DIVERSION DETAILS.
5. THE ROCK RIPRAP REVETMENT SHALL HAVE A 1.5:1 SLOPE FROM STA. 0+00 TO 0+10 ADJACENT TO THE ACCESS RAMP. AS THE STREAMBANK SWINGS AWAY FROM THE ACCESS RAMP, THE SLOPE OF THE ROCK RIPRAP REVETMENT SHALL TRANSITION TO A 2:1 SLOPE FOR THE REST OF THE SITE.

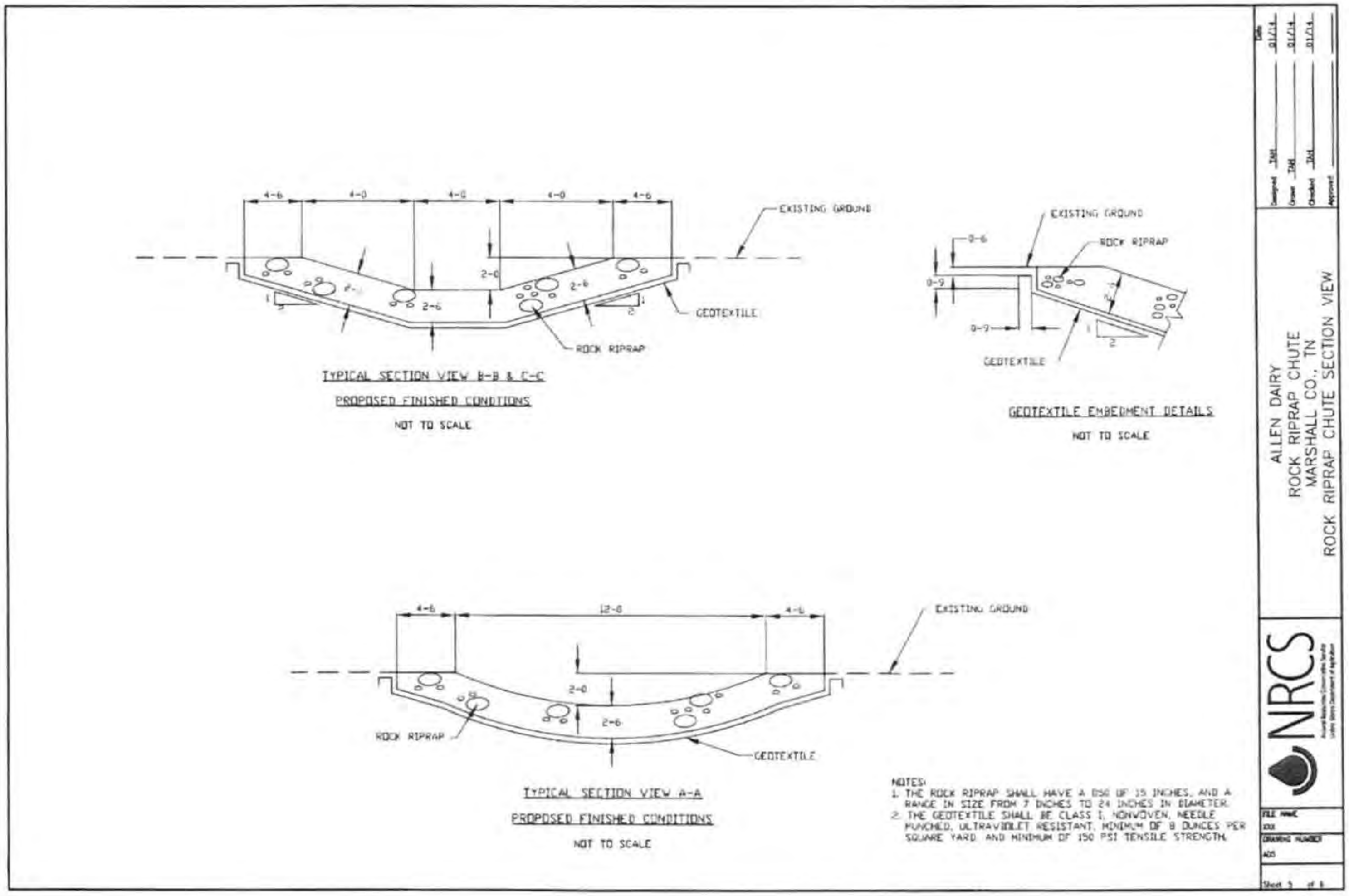
ALLEN DAIRY
STREAMBANK & GRADE STABILIZATION PROJECT
MARSHALL CO., TN
PLAN VIEW

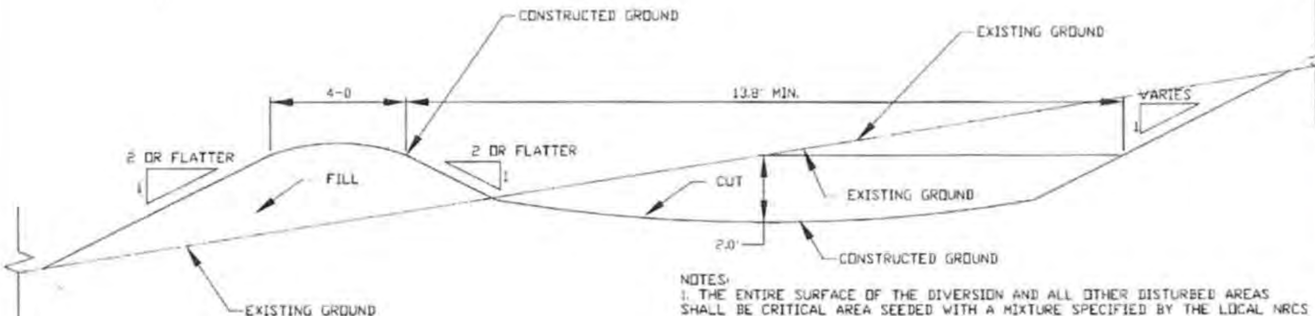
NRCS

Sheet 2 of 6


CONSTRUCTED TOP OF ERODED BANK
EXISTING TOP OF ERODED BANK
EXCAVATE
13.0'
ROCK RIPRAP
GEOTEXTILE
3.0'
5.6'
EXISTING GROUND SLOPE
TYPICAL SECTION VIEW @ STA 0+28
PROPOSED FINISHED CONDITIONS
NOT TO SCALE
EXISTING TOP OF ERODED BANK
17.6'
EXISTING GROUND SLOPE
TYPICAL SECTION VIEW @ STA 0+28
EXISTING CONDITIONS
NOT TO SCALE
1.5 OR FLATTER
ROCK RIPRAP
EXISTING CHANNEL BOTTOM
0-9
ROCK RIPRAP
GEOTEXTILE
GEOTEXTILE
GEOTEXTILE EMBEDMENT DETAILS
NOT TO SCALE
EXISTING TOP ERODED BANK
EXISTING EDGE OF RIVER ACCESS RAMP
EXCAVATE AND BACKFILL
ROCK RIPRAP
5.0'
2.0'
5.6'
GEOTEXTILE
TYPICAL SECTION VIEW @ STA 0+00
PROPOSED FINISHED CONDITIONS
NOT TO SCALE
EXISTING TOP ERODED BANK
EXISTING EDGE OF RIVER ACCESS RAMP
TYPICAL SECTION VIEW @ STA 0+00
EXISTING CONDITIONS
NOT TO SCALE
NOTES:
1. THE ROCK RIPRAP IN THE ROCK RIPRAP REVETMENT SHALL HAVE A D50 OF 15 INCHES. IT SHALL HAVE A RANGE IN SIZE FROM 7 INCHES TO 24 INCHES.
2. THE GEOTEXTILE SHALL BE CLASS I, NONWOVEN, NEEDLE PUCHED, MINIMUM OF 8.0 OUNCES PER SQUARE YARD, MINIMUM OF 150 PSI TENSILE STRENGTH, AND ULTRAVIOLET RESISTANT.
ALLEN DAIRY
STREAMBANK & GRADE STABILIZATION PROJECT
MARSHALL CO., TN
ROCK RIPRAP SECTION VIEWS
NRCS
Designed TAH 01/14
Drawn TAH 01/14
Checked TAH 01/14
Approved
FILE NAME XXX
DRAWING NUMBER A03


PLAN VIEW
ROCK RIPRAP CHUTE
PROFILE VIEW
ROCK RIPRAP CHUTE
NOTES:
1. SEE SHEET 5 OF 6 FOR ROCK RIPRAP CHUTE SECTION VIEWS
2. THERE SHALL BE A SMOOTH TRANSITION BETWEEN THE OUTLET OF THE DIVERSION AND THE ENTRANCE OF THE ROCK RIPRAP CHUTE
ROCK RIPRAP
GEOTEXTILE
EXISTING GROUND
CONSTRUCTED SURFACE OF CHUTE
EDGE OF OK RIVER
FLOW
ELEV. = 1011 @ STA 1+04
ELEV. 1001 @ STA 1+00.4
ELEV. = 775 @ STA 0+00
ELEV. = 775 @ STA 0+10
NRCS
ALLEN DAIRY
ROCK RIPRAP CHUTE
MARSHALL CO., TN
PLAN VIEW AND PROFILE VIEWS OF ROCK CHUTE
Designed TAH 01/14
Drawn TAH 01/14
Checked TAH 01/14
Approved


4-6
4-0
4-0
4-0
4-6
EXISTING GROUND
2-0
2-6
2-6
GEOTEXTILE
ROCK RIPRAP
TYPICAL SECTION VIEW B-B & C-C
PROPOSED FINISHED CONDITIONS
NOT TO SCALE
EXISTING GROUND
ROCK RIPRAP
0-6
0-9
0-9
GEOTEXTILE
GEOTEXTILE EMBEDMENT DETAILS
NOT TO SCALE
4-6
12-0
4-6
EXISTING GROUND
2-0
2-6
ROCK RIPRAP
GEOTEXTILE
TYPICAL SECTION VIEW A-A
PROPOSED FINISHED CONDITIONS
NOT TO SCALE
NOTES:
1. THE ROCK RIPRAP SHALL HAVE A D50 OF 15 INCHES, AND A RANGE IN SIZE FROM 7 INCHES TO 24 INCHES IN DIAMETER.
2. THE GEOTEXTILE SHALL BE CLASS I, NONWOVEN, NEEDLE PUNCHED, ULTRAVIOLET RESISTANT, MINIMUM OF 8 OUNCES PER SQUARE YARD AND MINIMUM OF 150 PSI TENSILE STRENGTH.
ALLEN DAIRY
ROCK RIPRAP CHUTE
MARSHALL CO., TN
ROCK RIPRAP CHUTE SECTION VIEW
NRCS
Designed TAH 01/14
Drawn TAH 01/14
Checked TAH 01/14
Approved
FILE NAME
XXX
DRAWING NUMBER
A05



TYPICAL SECTION VIEW

DIVERSION

NOT TO SCALE

NOTES:

1. THE ENTIRE SURFACE OF THE DIVERSION AND ALL OTHER DISTURBED AREAS SHALL BE CRITICAL AREA SEEDED WITH A MIXTURE SPECIFIED BY THE LOCAL NRCS REPRESENTATIVE.
2. THE FILL MATERIAL USED TO CONSTRUCT THE DIVERSION SHALL BE COMPACTED IN LIFTS NOT TO EXCEED 1' IN THICKNESS. EACH LIFT SHALL BE COMPACTED BY TRACK TYPE EQUIPMENT WALKING OVER THE ENTIRE SURFACE AREA A MINIMUM OF 2 TIMES PER LIFT.
3. THE DIVERSION AND ADJACENT AREAS SHALL BE FINISHED IN A RELATIVELY SMOOTH CONDITION READY FOR SEEDING. ALL ROCKS AND ROOTS 3" IN DIAMETER OR LARGER SHALL BE REMOVED FROM THE DIVERSION.
4. AFTER CONSTRUCTION, CARE SHALL BE TAKEN TO PROTECT THE DIVERSION FROM DAMAGE BY FARM EQUIPMENT, VEHICLES, AND LIVESTOCK UNTIL VEGETATION BECOMES PERMANENTLY ESTABLISHED. DO NOT USE THE DIVERSION AS A ROAD, A WALKWAY FOR LIVESTOCK, AND BE CAREFUL WHEN CROSSING TO PREVENT WHEEL TRACKS.
5. FERTILIZE DIVERSION ACCORDING TO SOIL TESTS THE FIRST SPRING OR FALL AFTER SEEDING, AND AS NECESSARY THEREAFTER TO MAINTAIN A VIGOROUS STAND OF GRASS.
6. ALL DISTURBED AREAS WITHIN THE DIVERSION CHANNEL AND BERM SHALL BE STABILIZED WITH NORTH AMERICAN GREEN EROSION CONTROL BLANKET S75, OR EQUIVALENT. ALL OTHER DISTURBED AREA SHALL BE MULCHED BY INSTALLING SMALL GRAIN STRAW MULCH AT A RATE OF 2.5 TONS PER ACRE (APPROXIMATELY 125 BALES PER ACRE). .
7. THE DIMENSIONS ON THE DRAWING ARE THE MINIMUM TO MEET NRCS STANDARDS. THERE WILL PROBABLY BE AN AREA CLOSE TO THE ACCESS ROAD THAT WILL NEED TO BE BROADER AND FLATTER TO ALLOW FOR VEHICLE TRAFFIC. ALTHOUGH NOT REQUIRED, THE DIVERSION MAY NEED TO BE 25' TO 30' OF TOP WIDTH IN THE AREAS THAT REQUIRE VEHICLE CROSSINGS.
8. THE DIVERSION CHANNEL SLOPE SHALL BE 1%.
9. THE DIVERSION SHALL TRANSITION SMOOTHLY INTO THE ENTRANCE TO THE ROCK RIPRAP CHUTE.
10. I'VE ATTACHED NORTH AMERICAN GREEN MATERIAL SPECIFICATIONS FOR THE ECB, AND I'VE INCLUDED STAPLE PATTERN DRAWINGS AND ANCHORING DRAWINGS TO ASSIST WITH CONTRUCTION.

ALLEN DAIRY
DIVERSION
MARSHALL CO., TN
TYPICAL SECTION VIEW DETAILS

NRCS

APPENDIX B

Photographs of the Duck River Bank Stabilization Project Site

A. Photo of the Duck River looking upstream from the private boat ramp.

B. Photo of the Duck River facing downstream of the private boat ramp. This is the aquatic habitat where the project action area is located.

C. Photo of private boat ramp. Bank Stabilization would start on the right side of the boat ramp.

D. Photos of eroded riverbank at the proposed project site.

E. Photo of existing terrestrial vegetation in the project action area where rock riprap would be placed. Photo is taken from the top of the bank facing down to the Duck River.

F. Photo of Venable Spring run adjacent to where bank stabilization activities would occur.

APPENDIX C

NRCS Conservation Practice Standard Stream Bank and Shoreline Protection Code 580

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

STREAMBANK AND SHORELINE PROTECTION

(Ft.)

CODE 580

DEFINITION

Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.

PURPOSE

This practice may be applied as part of a conservation resource management system to support one or more of the following purposes:

- Prevent the loss of land or damage to land uses or other facilities adjacent to the banks, including the protection of known historical, archaeological, and traditional cultural properties.
- Maintain the flow or storage capacity of the streams or channels.
- Reduce the off-site or downstream effects of sediment resulting from bank erosion.
- Improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, and recreation.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to streambanks of natural or constructed channels and shorelines of lakes, reservoirs, or estuaries where they are susceptible to erosion. It applies to controlling erosion where the problem can be solved with relatively simple structural measures, vegetation, or upland erosion control practices. It does not apply to erosion problems on main ocean fronts, beaches, and similar areas of complexity not normally within the scope of NRCS authority or expertise. While it does apply to localized streambank erosion problems within a stream corridor or a watershed, it does NOT apply to Stream Restoration activities.

CRITERIA

General Criteria Applicable to All Purposes

All Federal, State and local requirements shall be addressed in the design.

All streambank and shoreline protection conservation practices are required to apply for and receive U S. Army Corps of Engineers (USACE) permits (404), Tennessee Department of Environment and Conservation (TDEC) permits (ARAP), Tennessee Valley Authority (TVA) permits (26a – if located within the Tennessee River drainage area), and any permits that may be required by local units of government. All conditions listed within the permits shall be followed during the installation of the practice. There is an exception to the TDEC permit (ARAP) requirement. This conservation practice is exempt from obtaining coverage under TDEC's ARAP permits as long as the project length is 50 feet or less. This exemption does not apply to the USACE or to the TVA permitting requirements.

Measures must be installed according to a site-specific plan.

The following references provide guidance in planning and designing streambank and shoreline protection measures:

- NRCS, National Engineering Handbook (NEH), Part 650: National Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard contact your Natural Resources Conservation Service Staté Office, or download it from the electronic Field Office Technical Guide for your state.

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- NRCS, NEH, Part 653, Stream Corridor Restoration: Principles, Processes, and Practices.
- NRCS, NEH, Part 654, Stream Restoration Design Handbook.

An assessment of unstable streambank or shoreline sites shall be conducted in sufficient detail to identify the causes contributing to the instability, such as:

- Livestock access.
- Watershed alterations resulting in significant modifications of discharge or sediment production.
- In channel modifications, such as:
    - Gravel mining.
    - Channel bed instability – degradation or aggradation.
    - Water level fluctuations.
    - Boat generated waves, etc.

Protective measures to be applied shall be compatible with other improvements planned or being implemented by others.

Protective measures shall be compatible with the bank or shoreline materials, water chemistry, channel or lake hydraulics, and slope characteristics both above and below the water line.

End sections of treatment areas shall be adequately bonded to existing measures, terminate in stable areas, or be otherwise stabilized to prevent flanking of the measure.

Protective measures shall be installed that result in stable slopes. Bank or shoreline materials and type of measure installed shall determine maximum slopes.

Designs will provide for protection of installed measures from overbank flows that are the result of upslope runoff and flood return flows.

Internal drainage for bank seepage shall be provided when needed. Geotextiles or properly designed filter bedding shall be used on structural measures where there is the potential for migration of material from behind the measure.

Measures applied shall not adversely affect threatened, endangered, candidate species or species of special concern and their habitats as defined by the appropriate state and federal agencies. Measures applied where these species are present or are possibly present require notification and collaboration with the U.S. Fish and Wildlife Service (USFWS) and the Tennessee Wildlife Resources Agency TWRA).

Measures applied shall seek to avoid adverse effects to archaeological, historic, structural, and traditional cultural properties, whenever possible.

Measures shall be designed for anticipated ice action, wave action, and fluctuating water levels.

All disturbed areas around protective measures shall be protected from erosion. Disturbed areas that are not to be cultivated shall be protected as soon as practical after construction.

Vegetation shall be selected that meets the intended purpose(s), is best suited for the soil/moisture regime, and shall be in accordance with NRCS conservation practice standard Critical Area Planting (Code 342).

Additional Criteria for Streambanks

Stream segments that are incised or that contain the 5-year return period (20 percent probability) or greater flows shall be evaluated for further degradation or aggradation.

The site assessment shall be performed to determine if the causes of instability are local (e.g. poor soils [non-cohesive, soft, and/or high sand or gravel content], high water table in banks, alignment, obstructions deflecting flows into bank, unrestricted livestock access, etc.) or systemic in nature (e.g. aggradation due to increased sediment from the watershed, increased runoff due to urban development in the watershed, degradation due to channel modifications, etc.). Systemic instability will require a much deeper knowledge and

evaluation of the watershed and what factors will potentially impact streambank stability. The systemic instability due to watershed alterations shall be completed by a qualified professional using professional judgment with knowledge of engineering, hydrology, hydraulics, sediment transport, soils, experience with these types of projects, etc. The assessment need only be to the extent and detail necessary to provide a basis for design of the bank stabilization measures and reasonable confidence that the treatments will perform adequately for the design life of the measure.

Bank protection measures shall not be installed in stream systems undergoing rapid and extensive changes in streambed grade and/or alignment unless the treatments are designed to control or accommodate the changes. The channel grade shall be stable based on a field assessment before any permanent type of bank protection can be considered feasible, unless the protection can be constructed to a depth below the anticipated lowest depth of streambed scour.

Bank toe erosion shall be stabilized by structural measures that redirect the stream flow away from the toe or by structural treatments that armor the toe following an evaluation of the streambed and bank stability. Additional design guidance is found in NRCS, NEH, Part 650 – National Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection.

Structural measures may include:

- Tree revetments (in combination with bioengineering and other vegetative components).
- Rock riprap revetments.
- Various types of retaining walls (concrete blocks, gabion baskets, rail piles, etc.).
- Coconut fiber rolls (in combination with bioengineering and other vegetative components).
- Rock riprap jetties, barbs, vanes, weirs, cross vanes (in combination with bioengineering and other vegetative components).
- Turf reinforcement mats, erosion control fabrics, etc.

Where toe protection alone is inadequate to stabilize the bank, the upper bank shall be shaped to a stable slope and revegetated, or shall be stabilized with structural or soil-bioengineering measures. Non-structural methods may include: A mixture of tree, shrub, and deep rooted native grass plantings, live stakes, live fascines, branch packing, brush mattress, etc. Where non-structural measures are installed, it is extremely important to time the harvest, transportation, storage, and installation of the vegetative materials during the dormant season. It's also very important to plant all grasses during the correct seeding dates.

Channel clearing to remove stumps, fallen trees, debris, and bars shall only be done when they are causing or could cause detrimental bank erosion, flow restriction, or structural failure. Habitat forming elements that provide cover, food, pools, and water turbulence shall be retained or replaced to the extent possible.

Changes in channel alignment shall not be made unless the changes are based on an evaluation that includes an assessment of both upstream and downstream fluvial geomorphology that evaluates the affects of the proposed alignment. The current and future discharge-sediment regime shall be based on an assessment of the watershed above the proposed channel alignment.

Measures shall be functional for the design flow and sustainable for higher flow conditions based on acceptable risk. Measures shall be designed to avoid an increase in natural erosion downstream.

At a minimum, the analysis and designs for all streambank stabilization practices shall be designed to withstand flows from a 2-year return interval (50 % probability) and to function for the lifespan of the conservation practice (20 years for this conservation practice).

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Measures shall not limit stream flow access to the floodplain.

Where flooding is a concern, the effects of protective measures shall not increase flow levels above those that existed prior to installation.

Additional Criteria for Shorelines
All revetments, bulkheads, or groins are to be no higher than 3 feet above mean high tide, or mean high water in non-tidal areas.

Structural shoreline protective measures shall be keyed to a depth to prevent scour during low water.

For the design of structural measures, the site characteristics below the waterline shall be evaluated for a minimum of 50 feet horizontal distance from the shoreline measured at the design water surface.

The height of the protection shall be based on the design water surface plus the computed wave height and freeboard. The design water surface in tidal areas shall be mean high tide.

When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation.

Additional Criteria for Stream Corridor Improvement
Stream corridor vegetative components shall be established as necessary for ecosystem functioning and stability. The appropriate composition of vegetative components is a key element in preventing excessive long-term channel migration in re-established stream corridors. The establishment of vegetation on channel banks and in the floodplains immediately adjacent to the banks shall be in accordance with conservation practice standard Critical Area Planting, Code 342, and Riparian Forest Buffer, Code 391.

Measures shall be designed to achieve any habitat and population objectives for fish and wildlife species or communities of concern as determined by a site-specific assessment or management plan. Objectives shall be based on the survival and reproductive needs of populations and communities, which include habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors, and native plant communities. The type, amount, and distribution of vegetation shall be based on the requirements of the fish and wildlife species or communities of concern to the extent possible.

Measures shall be designed to meet any aesthetic objectives as determined by a site-specific assessment or management plan. Aesthetic objectives shall be based on human needs, including visual quality, noise control, and microclimate control. Construction materials, grading practices, and other site development elements shall be selected and designed to be compatible with adjacent land uses.

Measures shall be designed to achieve any recreation objectives as determined by a site-specific assessment or management plan. Recreation objectives are based on type of human use and safety requirements.

CONSIDERATIONS

An assessment of streambank or shoreline protection needs should be made in sufficient detail to identify the causes contributing to the instability (e.g., watershed alterations resulting in significant modifications of discharge or sediment production). Due to the complexity of such an assessment, use of an interdisciplinary team should be considered.

When designing protective measures, consideration should be given to the changes that may occur in the watershed hydrology and sedimentation over the design life of the measure.

Consider utilizing debris removed from the channel or streambank into the treatment design when it is compatible with the intended purpose to improve habitats for fish, wildlife, and aquatic systems.

Use construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, climate controls, buffers, etc. Avoid excessive

disturbance and compaction of the site during installation.

Consider designing streambank stabilization measures adjacent to infrastructure or other improvements, e.g. roads, bridges, utilities, homes, buildings, businesses, cultural resources, etc., for storm flows that reach to the top of the streambank.

Consider designing streambank stabilization measures that are NOT adjacent to infrastructure or other improvements for the 2-year return period (50% probability) storm flows. Rock riprap revetments that don't extend to the top of the bank, rock riprap jetties, rock riprap weirs, coconut fiber rolls, barbs, vanes, cross vanes, turf reinforcement mats, erosion control fabrics, etc. that incorporate vegetation to stabilize the rest of the constructed slope above and between these structural measures are considered by TDEC to be a bioengineering stabilization alternative. Projects that use one of these alternatives are normally eligible (not always eligible due to general permit conditions) for an ARAP General Permit. This General Permit does not have a length limit restriction. If a rock riprap revetment is designed to the top of the constructed bank, this chosen alternative is normally (not always eligible due to general permit conditions) eligible for an ARAP General permit as long as the project doesn't extend beyond 300 feet in length. If the rock riprap revetment to the top of the bank alternative is longer than 300 linear feet, then an Individual ARAP Permit is required.

Rock riprap revetments and other structural measures can often be terminated at the 2-year return period elevation while using bioengineering, erosion control blankets, turf reinforcement mats, native grasses, tree and shrub plantings, etc. on the rest of the slope.

Consider using conservation practice designs that extend rock riprap revetments and other structural measures beyond the 2-year return period elevation if soil conditions are encountered where:

- It is very difficult to establish vegetation;
- The site has overland flow problems;
- The site is located below a hydroelectric flood control dam;
- The frequent discharges make it very difficult to establish vegetation; or,
- Watershed changes have caused extreme watershed discharges (urbanization, clear cutting, etc.).

In these cases, the structural measures will frequently extend to the top of the constructed bank.

Consider using conservation practice designs that extend rock riprap revetments and other structural measures beyond the 2-year return period elevation if the project site has a small bank height, and it will make it difficult or unpractical to construct the measures at or below the 2-year return period elevation.

The designer of the streambank stabilization measures should consider the knowledge, experience, abilities, and availability of knowledgeable project inspectors to ensure that the measure is constructed as designed, or make themselves or others on their staff available for construction inspection and instruction.

The designer of the streambank stabilization measures should consider the typical type of contractor (or landowner) that will be installing the stabilization measures. This should be especially considered if lesser experienced inspectors shall be providing the construction inspection for projects.

Utilize vegetative species that are native and/or compatible with local ecosystems. Avoid introduced, invasive, noxious, or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests. Species on noxious plant lists should not be used.

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Select plant materials that provide habitat requirements for desirable wildlife and pollinators. The addition of native forbs and legumes to grass mixes will increase the value of plantings for both wildlife and pollinators.

When vegetative plantings are a component of stabilization measures, consider the use of shrub species from the water line to the constructed top of slope. Consider the use of larger trees from the top of bank out into the floodplain area.

Livestock exclusion should be considered during establishment of vegetative measures and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative measures. Temporary and local population control methods should be used with caution and within state and local regulations.

Measures that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered.

Consider maintaining or improving the habitat value for fish and wildlife by including measures that provide aquatic habitat in the measure design and that may lower or moderate water temperature, and improving water quality.

Consideration should be given to protecting side channel inlets and outlets from erosion.

Consider aquatic habitat when selecting the type of bank stabilization.

Consider using toe rock that is large enough to provide a stable base and graded to provide aquatic habitat. The stone required for aquatic habitat may be larger stone than would normally be required of a stabilization measure.

Consider maximizing adjacent wetland functions and values with the project design and minimize adverse effects to existing wetland functions and values.

When appropriate, establish a buffer strip and/or diversion at the top of the bank or shoreline protection zone to help maintain and protect installed measures, improve their function, filter out sediments, nutrients, and pollutants from runoff, and provide additional wildlife habitat.

Consider conservation and stabilization of archaeological, historic, structural, and traditional cultural properties when applicable.

Measures should be designed to minimize safety hazards to boaters, swimmers, or people using the shoreline or streambank.

Protective measures should be self-sustaining or require minimal maintenance.

Consider using NRCS-TN *Field Data-Entry Form for Streambank Erosion Severity* as part of the initial site assessment. If needed, this form can help prioritize which project sites are the most severe. This form does not replace or reduce the need for a thorough evaluation of a project site and the watershed by a qualified professional that will be responsible for the design of the streambank stabilization measures.

PLANS AND SPECIFICATIONS

Plans and specifications for streambank and shoreline protection shall be prepared for specific field sites based on this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Plans shall include treatments to minimize erosion and sediment production during construction and provisions necessary to comply with conditions of any environmental agreements, biological opinions, or other terms of applicable permits.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for use by the owner or others responsible for operating and maintaining the system. The plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components or erosion.

REFERENCES

Natural Resources Conservation Service (NRCS), Conservation Practice Standard (CPS), Critical Area Planting, Code 342.

NRCS, CPS Riparian Forest Buffer, Code 391.

NRCS, National Engineering Handbook (NEH), Part 650 - National Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection.

NRCS, NEH, Part 653, Stream Corridor Restoration: Principles, Processes, and Practices.

NRCS, NEH, Part 654, Stream Restoration Design.

NRCS-TN, *Field Data-Entry Form for Streambank Erosion Severity*.

U.S. Geological Survey – Stream Stats. Available at http://streamstats.usgs.gov/.

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APPENDIX D

2010 Duck River, Venable Spring Site Mussel Survey Summary Statistics

Table 1.[1]

Venable Spring site summary statistics of 80, 0.25 m2 quadrat samples.

Total	Mean Density per m2	Standard Deviation	Standard Error	CV of SE (Precision)	Lower 95% CI	Upper 95% CI	Total Population per Site (3000 m2)	Lower 95% CI	Upper 95% CI	Species
5	0.25	0.9743547	0.108939479	0.435757918	0.03647862	0.46352138	**750**	-1812.25656	3312.256555	*Amblema plicata*
21	1.05	2.27200909	0.254026061	0.241929582	0.55210892	1.54789108	**3150**	1727.454057	4572.545943	*Cyclonaias tuberculata*
19	0.95	2.03699953	0.227750395	0.239737258	0.503609226	1.396390774	**2850**	1440.344925	4259.655075	*Elliptio dilatata*
53	2.65	3.76223742	0.420643718	0.158733479	1.825538312	3.474461688	**7950**	7016.647146	8883.352854	*Epioblasma ahlstedti*
8	0.4	1.50610572	0.168392857	0.420982144	0.069949999	0.730050001	**1200**	-1275.375	3675.375004	*Fusconaia barnesiana*
2	0.1	0.6284399	0.070263853	0.702638529	-0.037717152	0.237717152	**300**	-3831.51455	4431.514553	*Lampsilis cardium*
4	0.2	0.87728003	0.098085871	0.490429356	0.007751693	0.392248307	**600**	-2283.72461	3483.724611	*Lampsilis fasciola*
3	0.15	0.76472879	0.085501878	0.570012517	-0.01758368	0.31758368	**450**	-2901.6736	3801.6736	*Lampsilis ovata*
12	0.6	1.43729704	0.16069958	0.267832633	0.285028824	0.914971176	**1800**	225.1441185	3374.855882	*Lasmigona costata*
40	2	2.91656118	0.326091366	0.163045683	1.360860922	2.639139078	**6000**	5041.291383	6958.708617	*Lemiox rimosus*
8	0.4	1.20757105	0.135014653	0.337536632	0.135371281	0.664628719	**1200**	-784.715393	3184.715393	*Lexingtonia dolabelloides*
3	0.15	0.76472879	0.085501878	0.570012517	-0.01758368	0.31758368	**450**	-2901.6736	3801.6736	*Leptodea fragilis*
1	0.05	0.4472136	0.05000152	1.000030401	-0.048002979	0.148002979	**150**	-5730.17876	6030.17876	*Megalonaias nervosa*
16	0.8	2.32977426	0.2604846	0.32560575	0.289450185	1.310549815	**2400**	485.4381922	4314.561808	*Obovaria subrotunda*
2	0.1	0.6284399	0.070263853	0.702638529	-0.037717152	0.237717152	**300**	-3831.51455	4431.514553	*Pleurobema oviforme*
3	0.15	0.76472879	0.085501878	0.570012517	-0.01758368	0.31758368	**450**	-2901.6736	3801.6736	*Pleurobema rubrum*
14	0.7	1.65659404	0.185218474	0.264597821	0.33697179	1.06302821	**2100**	544.1648149	3655.835185	*Quadrula c. cylindrica*
10	0.5	1.33122196	0.148839664	0.297679328	0.208274258	0.791725742	**1500**	-250.354451	3250.354451	*Quadrula intermedia*
3	0.15	0.76472879	0.085501878	0.570012517	-0.01758368	0.31758368	**450**	-2901.6736	3801.6736	*Quadrula pustulosa*
1	0.05	0.4472136	0.05000152	1.000030401	-0.048002979	0.148002979	**150**	-5730.17876	6030.17876	*Strophitus undulatus*
3	0.15	0.76472879	0.085501878	0.570012517	-0.01758368	0.31758368	**450**	-2901.6736	3801.6736	*Truncilla truncata*
1	0.05	0.4472136	0.05000152	1.000030401	-0.048002979	0.148002979	**150**	-5730.17876	6030.17876	*Toxolasma lividus*
1	0.05	0.4472136	0.05000152	1.000030401	-0.048002979	0.148002979	**150**	-5730.17876	6030.17876	*Utterbackia imbecillis*
18	0.9	1.90668378	0.213180208	0.236866898	0.482166792	1.317833208	**2700**	1307.222641	4092.777359	*Villosa taeniata*
1	0.05	0.4472136	0.05000152	1.000030401	-0.048002979	0.148002979	**150**	-5730.17876	6030.17876	*Villosa vanuxemensis*
252	**12.6**	**9.88234585**	**1.104913445**	**0.087691543**	**10.43436965**	**14.76563035**	**37800**	**37284.37373**	**38315.62627**	**Population**
Species richness = 25										

[1] Data from Hubbs, D.W., S.A. Chance, L. Colley, and R.S. Butler. 2010. *Duck River Quantitative Mussel Survey*. Tennessee Wildlife Resources Agency Fisheries Division Report 11-04. 48 pp.

APPENDIX E

Previous biological opinions, issued for adverse effect within Tennessee, which identified incidental take

Table 1. The following list includes previous biological opinions, issued for adverse impacts and completed for oyster mussel, Cumberland monkeyface, birdwing pearlymussel, slabside pearlymussel and rabbitsfoot mussel populations within Tennessee, which identified incidental take:

SPECIES	OPINIONS (year/number)	INCIDENTAL TAKE NUMBERS	CRITICAL HABITAT	SUITABLE HABITAT
Oyster mussel	2006/1	4,753 individuals in the Clinch River	23,013 ft^2 in the Clinch River	N/A
	2009/1	Not Specified	Excess of one-one hundredth per year in the Tennessee and Cumberland Rivers	N/A
	2012/1	Mortality of all glochidia and juvenile mussels; 5% of subadult and adult mussels incidentally taken rangewide, including Tennessee	Not Specified	Not Specified
	2014/1	9,629 individuals within 15.2 ac of aquatic habitat in the Clinch River	9,629 individuals within 15.2 ac of aquatic habitat in the Clinch River	N/A
	2015/1	1% of individuals in a 21.4-rmi reach of the Big South Fork Cumberland River	Not Specified	Not Specified
Cumberland monkeyface	2006/1	Not Specified	N/A	3 mi of suitable river habitat throughout the Tennessee River basin

	2012/1	Mortality of all glochidia and juvenile mussels; 5% of subadult and adult mussels incidentally taken rangewide, including Tennessee	Not Specified	Not Specified
	2013/1	All individuals within 1.2 mi of suitable habitat in the Elk River	N/A	All individuals within 1.2 mi of suitable habitat in the Elk River
	2014/1	1 individual within 15.2 ac of aquatic habitat in the Clinch River	N/A	1 individual within 15.2 ac of aquatic habitat in the Clinch River
Birdwing pearlymussel	2006/1	634 individuals within 23,013 ft^2 of aquatic habitat in the Clinch River	N/A	634 individuals within 23,013 ft^2 of aquatic habitat in the Clinch River
	2006/1	Not Specified	N/A	3 mi of suitable river habitat throughout the Tennessee River basin
	2012/1	Mortality of all glochidia and juvenile mussels; 5% of subadult and adult mussels incidentally taken rangewide, including Tennessee	N/A	Not Specified
	2013/1	All individuals within 0.3-mi of suitable habitat in the Elk River	N/A	All individuals within 0.3-mi of suitable habitat in the Elk River

	2014/1	609 individuals within 15.2 ac of aquatic habitat in the Clinch River	N/A	609 individuals within 15.2 ac of aquatic habitat in the Clinch River
Slabside pearlymussel	2012/1	Mortality of all glochidia and juvenile mussels; 5% of subadult and adult mussels incidentally taken rangewide, including Tennessee	N/A	Not Specified
	2013/1	All individuals within 14.46 ac of aquatic habitat in the Duck River	Not Specified	All individuals within 14.46 ac of aquatic habitat in the Duck River
	2014/1	148 individuals within 15.2 ac of aquatic habitat in the Clinch River	148 individuals within 15.2 ac of aquatic habitat in the Clinch River	N/A
Rabbitsfoot	2012/1	Mortality of all glochidia and juvenile mussels; 5% of subadult and adult mussels incidentally taken rangewide, including Tennessee	N/A	Not Specified
	2013/1	All individuals within 14.46 ac of aquatic habitat in the Duck River	N/A	All individuals within 14.46 ac of aquatic habitat in the Duck River