BIOLOGICAL ASSESSMENT:

DIKE STABILIZATION OF THE JOHNSONVILLE ASH STORAGE POND

PREPARED BY:
TENNESSEE VALLEY AUTHORITY
OFFICE OF ENVIRONMENT AND TECHNOLOGY
BIOLOGICAL AND HISTORIC RESOURCES

COOPERATING AGENCY:
U.S. ARMY CORPS OF ENGINEERS
NASHVILLE DISTRICT

DIRECT COMMENTS TO:
MS. PEGGY SHUTE, MANAGER
BIOLOGICAL PERMITTING & COMPLIANCE
TENNESSEE VALLEY AUTHORITY
400 W. SUMMIT HILL DR., WT-11C
KNOXVILLE, TENNESSEE 37902
PHONE: 865.632.2418
FAX: 865.632.4223

JANUARY 07, 2010

This Page Intentionally Blank

TABLE OF CONTENTS

LIST OF FIGURES ii

LIST OF TABLES ii

LIST OF APPENDICES ii

LIST OF PREPARERS AND CONTACTS iii

1.0 INTRODUCTION 5

2.0 DESCRIPTION OF PROPOSED PROJECT 7

2.1 PROJECT CONSTRUCTION 7

2.1.1 Site Preparation, Work Conditions, and Timeline 7
2.1.2 Phase I Construction 8
2.1.3 Phase II Construction 8

2.2 PROJECT OPERATIONS AND MAINTENANCE 9

2.3 PROJECT ACTION AREA 10

2.4 HISTORY OF PROPOSED PROJECT 11

3.0 BASELINE CONDITIONS NEAR PROPOSED PROJECT 12

3.1 EXISTING ENVIRONMENTAL CONDITIONS NEAR THE PROJECT SITE 12

3.1.1 Vegetation 12
3.1.2 Rivers and Streams 12
3.1.3 Fish and Wildlife 13

3.2 ONGOING ACTIVITIES NEAR PROPOSED PROJECT SITE 17

3.2.1 Land Management 17
3.2.2 TVA Reservoir Operations - Kentucky Reservoir 17
3.2.3 TVA Johnsonville Fossil Plant 17
3.2.4 Commercial Navigation 17
3.2.5 Commercial Mussel Harvesting 17
3.2.5 Recreation 18

4.0 CRITICAL HABITAT AND FEDERALLY LISTED SPECIES POTENTIALLY AFFECTED BY THE PROPOSED PROJECT 19

4.1 DETERMINATION OF CRITICAL HABITAT AND FEDERALLY LISTED SPECIES AFFECTED BY ACTION 19

4.2 DESIGNATED CRITICAL HABITAT 19

4.3 FEDERALLY LISTED SPECIES 19

4.3.1 Birds 19

4.3.2 Fish....21
4.3.3 Mammals....21
4.3.4 Mussels....21

5.0 PROJECT EFFECTS ANALYSIS....26

5.1 DIRECT EFFECTS....26

5.2 INDIRECT EFFECTS....26

5.3 CUMULATIVE EFFECTS....28

6.0 PROJECT EFFECT DETERMINATIONS AND CONCLUSIONS....30

6.1 EFFECT DETERMINATIONS....30

6.2 CONCLUSIONS AND REQUEST FOR TAKE OF FEDERALLY LISTED SPECIES .30

7.0 LITERATURE CITED....31

LIST OF FIGURES

Figure 1. General location of the proposed Johnsonville dike project in Humphrey's County, Tennessee.

Figure 2. Project elements and impact areas of the Johnsonville dike stabilization project.

Figure 3. Example cross-section view of dike properties and stabilization actions.

LIST OF TABLES

Table 1. Federally listed species and critical habitat reported from Humphreys County, Tennessee and potentially found near the Johnsonville dike project.

LIST OF APPENDICES

Appendix A. Report for Mussel and Habitat Survey of the Johnsonville Dike Stabilization Project, December 2009.

LIST OF PREPARERS AND CONTACTS

TENNESSEE VALLEY AUTHORITY (Primary Preparers in alphabetical order)

John (Bo) T. Baxter

Position:	Aquatic Biology Specialist
Education:	M.S. and B.S., Zoology
Experience:	18 years in Protected Aquatic Species Monitoring, Habitat Assessment, and Recovery; 9 years in Environmental Review
Involvement:	Interagency Consultation; Document Preparation and Review

Charles S. Howard

Position:	Aquatic Endangered Species Biologist
Education:	M.S. Zoology; B.S. Biology
Experience:	16 years in Research and Consulting in Aquatic Ecology Focusing on Impact Assessment of Freshwater Mussels; 1 year with TVA Environmental Resources.
Involvement:	Interagency Consultation; Document Preparation

Craig Phillips

Position:	Aquatic Biologist Contractor
Education:	M.S. Wildlife and Fisheries Science
Experience:	2 years in Environmental Reviews for TVA
Involvement:	Assistance with Document Preparation

Peggy W. Shute

Position:	Environmental Permitting and Compliance - Biological Resources, Manager
Education:	M.S. Zoology; B.A. Biology
Experience:	27 years in Protected Aquatic Species Monitoring, Habitat Assessment, and Recovery; 17 years Environmental Review and Endangered Species Consultation
Involvement:	Interagency Consultation; Document Preparation and Review

PROJECT CONTACTS (in alphabetical order)

Mr. Stephen Bickel, PE, Senior Principal
Stantec Consulting Services, Inc.
1901 Nelson Miller Parkway
Louisville KY 40223-2177
502- 212-5075

Mr. Gerry Fister
Third Rock Consultants
2526 Regency Road, Suite 180

Lexington, Ky 40503
859-977-2000

Mr. Craig Fortenberry, President
Mainstream Commercial Divers, Inc.
322 C.C. Lowry Drive
Murray, KY 42071
270-753-9654

Mr. Don Hubbs, Mussel Program Coordinator
Tennessee Wildlife Resources Agency
P.O. Box 70
3905 Highway 641 South
Camden, TN 38320
731-584-9032

Ms. Mary Jennings, Field Supervisor
U.S. Fish and Wildlife Service
446 Neal Street
Cookeville, TN 38501
931-528-6481

Mr. Josh Kopp - Project Engineer
Stantec Consulting Services, Inc.
1901 Nelson Miller Parkway
Louisville KY 40223-2177
502-212-5053

Mr. Robert M. Todd, Assistant Chief
Tennessee Wildlife Resources Agency
Environmental Services Division
Ellington Agricultural Center
Post Office Box 40747
Nashville, Tennessee 37204
615-781-6572

Mr. Jim Widlak, Endangered Species Act - Section 7 Consultation Biologist
U.S. Fish and Wildlife Service
446 Neal Street
Cookeville, TN 38501
931-528-6481 x202

1.0 INTRODUCTION

The Tennessee Valley Authority (TVA) plans to stabilize and re-grade a dike that supports the north-eastern margin of it coal ash storage area (Johnsonville Island) at the Johnsonville Fossil Plant (JOF) near New Johnsonville (Humphreys County), Tennessee (Figure 1). The dike maintenance is necessary to enhance stability and meet safety standards set by the U.S. Army Corps of Engineers (USACE). The dike faces an embayment of the Tennessee River between the Johnsonville Island and the JOF plant between Tennessee River Mile (TRM) 99 and TRM 100 within the Kentucky Reservoir impoundment (see Figure 1 and Figure 2). The proposed project would include clearing cover (*e.g.*, vegetation and riprap) from the existing dike face; extending the thickness of the dike wall using riprap, various other stone, and clay; and re-stabilizing the surface of the dike with appropriate vegetation (*e.g.*, seeding).

As TVA is a federal agency (TVA Act of 1933), the proposed project constitutes a federal action that is subject to evaluation and regulation by the National Environmental Policy Act (NEPA) and Section 7 of the Endangered Species Act (1973 and as amended; ESA). The project also requires a federal permitting action from the USACE under Section 10 of the River and Harbors Act of 1899 (RHA) and Section 404 of the Clean Water Act (CWA) to allow alteration/construction within a navigable waterway and discharge of dredged or fill material into waters of the U.S., respectively.

The area encompassing the project site in Humphreys County has historically supported numerous terrestrial and aquatic species that are currently considered rare, including one bird species federally listed as threatened (piping plover), one fish species federally listed as endangered (pygmy madtom), one mammal species federally listed as endangered (gray bat), four mussel species federally listed as endangered (orangefoot pimpleback, pink mucket, ring pink, and rough pigtoe), and one mussel species (slabside pearlymussel) that is a candidate for listing by the U.S. Fish and Wildlife Service (USFWS) under provisions of the ESA (Table 1).

The ESA provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend. In particular, Section 7 of the ESA requires federal agencies to ensure that any actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of listed species or modify their critical habitat. The law also prohibits any federal action that would result in jeopardizing the continued existence of any listed species of endangered fish or wildlife. Since the JOF dike project may affect federally

listed species and/or designated critical habitat for listed species, TVA and the USACE has initiated consultation with the USFWS.

The purpose of this Biological Assessment (BA) is to provide a comprehensive description of the construction and maintenance of the JOF dike project elements, define the action area of the project, describe the species and critical habitat that may be affected by the project, provide an analysis of impacts from the proposed project on federally listed species and their habitat, and provide a determination of how the proposed federal actions may affect federally listed species and habitat.

2.0 DESCRIPTION OF PROPOSED PROJECT

The purpose of this project is to enhance the slope stability of the northeast dike of the Johnsonville Fossil Plant (JOF) Ash Disposal Area No. 2 (Johnsonville Island; see Figure 1), as well as make it possible to perform proper routine slope maintenance on the Northeast dike so as not to affect dike stability. General descriptions of the existing dike conditions and preliminary evaluation (Phase I) assessment of the JOF ash pond dike stability was reported in Stantec (2009; available online at http://www.tva.gov/power/stantec/).

The proposed project would include a rock toe buttress to be constructed against the exposed bank along the boat harbor, which would provide additional stabilizing weight at the dike toe and stabilize the steep bank above the water's edge against erosion and shallow sloughs (see Figure 2). The project would also include placing clay to flatten the exterior slope of the dike to a minimum horizontal to vertical (H:V) ratio of 2.5:1 (Figure 3). Seepage collection filters (see Section 2.1 below for description) would be placed along the toe of the dike prior to placing the soil and against the lower bank before placing the riprap. The filters would collect water from seeps, reduce saturation of the new clay fill, and provide safeguard against soil piping. The length of the dike that would be repaired is approximately 2,350 feet (ft) long (or ~ 720 meters [m]). The spatial extent of widening and re-grading the dike would vary somewhat based on existing dike characteristics, but would extend no more than about 30ft in a lateral (eastern) direction from the toe of the existing dike (see Figures 2 and 3).

2.1 PROJECT CONSTRUCTION

2.1.1 Site Preparation, Work Conditions, and Timeline

Prior to construction of the rock toe buttress, all trees on the bank slope along the dike's east face (boat harbor) would be cut, and the remaining trunks, stumps, and root-wads shall be disposed of at an approved disposal site. Best management practices (BMPs) to be implemented during this phase of construction would include stabilizing disturbed areas of the bank slope before the contractor leaves the site each day. To achieve stabilization, all disturbed soil or sand (component of the graded filter) would be covered with a layer of aggregate to prevent erosion.

All work near the water would be done when the lake level is at or within two feet of normal winter pool (elevation 354ft above mean sea level [msl]). Work would be halted when the pool

level is higher or forecasted to be higher during the shift. Proposed start of the project is February 2010, and project completion is intended to be May 2010 (before reservoir levels rise above the normal winter pool level). This timeline includes a few additional days to account for project delays caused by inclement weather, but it is possible that weather could play a larger factor into the overall schedule. TVA has committed to keeping reservoir levels in Kentucky Reservoir at or below the winter pool in the spring to the best of their abilities to help ensure that the proposed project can be completed within the project schedule so that construction will not occur below the water line.

2.1.2 Phase I Construction

All construction would originate from the existing dike infrastructure, and no construction will be conducted from barges in the boat harbor. The first portion of the rock toe buttress to be constructed would be a riprap berm along the water's edge. It would act as a barrier that prevents the material used to construct the graded filter and rock buttress from sliding into the boat harbor during placement. The berm would roughly parallel the existing shoreline and would be approximately eight feet wide and two feet tall. The riprap would be pressed into the soil by a mechanical excavator to ensure that it holds in place.

The second portion of the buttress to be constructed is the graded filter. Sand would be placed and spread by an excavator and/or by hand to a minimum thickness of six inches, followed by a six inch layer of TDOT #57 aggregate and a six inch layer of TDOT #2 aggregate. As stated above, placement of aggregate over the sand would be required by the contractor each day before leaving the site to ensure stabilization and prevent erosion of the finer particles.

The third portion of the rock toe buttress would include placement of the remaining riprap until the dimensions shown on the plans have been met (see Figures 2 and 3). The maximum drop height of riprap would be two feet to ensure that rocks would not roll into water beyond the initial riprap berm. Reinforced silt fence would be installed adjacent to completed sections of the rock toe buttress immediately after a section of toe has been placed (*e.g.,* each day). Clay fill placement on the dike slope would not begin until the silt fence has been installed immediately below the section being worked.

2.1.3 Phase II Construction

The second phase of construction would be the placement of the clay fill on the dike slope (see Figures 2 and 3). Fill placement would be performed concurrently with the construction of the rock toe buttress, but fill placement in a section would not be started until the rock toe buttress

has been completed. Prior to placing fill to create the 2.5H:1V slopes, the existing slope would be cleared of vegetation and top soil. All debris from clearing operations would be disposed of at an approved disposal site. Re-grading of the dike slope would begin along the toe of the slope and progress uphill. Shallow slope serrations/benches would be excavated to provide proper bond between the new fill and existing slope. Slope serrations would be backfilled as soon as practical and all slope serrations would be backfilled before the contractor leaves the job site for the day. Backfill would consist of clay material placed in 8 to 10 inch lifts and compacted to a specific density. Material would be placed on the dike until the new 2.5H:1V slope has been achieved (see Figure 3). Another BMP to be implemented during this phase of construction would be to install erosion control blankets immediately after a section has been completed. The surface of the dike slope will be stabilized to prevent erosion.

2.2 PROJECT OPERATIONS AND MAINTENANCE

Maintenance of the JOF dike after initial construction would primarily involve mowing/trimming of vegetation to prevent the establishment of large woody vegetation by use of physical and chemical means that follow all appropriate BMPs. Newly flattened slopes will be mowed approximately every two weeks between spring and fall. Periodic inspection of the dike's integrity would be performed, but no additional repairs or major actions to maintain the dike are anticipated.

Storage of wet coal ash on Johnsonville Island is currently being changed to dry ash storage at another location. The weir used to drain the ash pond on the southwest side of Johnsonville Island has already been lowered to dewater the top portion of the wet ash. After the dike stabilization project is completed, a surface portion of the ash would be removed, the area would be capped with clay, and the surface of the island would be covered with grass. These additional actions associated with closing the ash storage pond on Johnsonville Island would be considered separate from the proposed dike stabilization action. The active JOF ash storage pond is scheduled to be closed in 2016. A separate National Environmental Policy Act (NEPA) and ESA analysis would be completed to address the potential environmental effects of ash pond closure.

2.3 PROJECT ACTION AREA

The action area for the proposed JOF dike stabilization includes all areas directly and indirectly affected by the project elements (construction and maintenance) on land and in water. Direct impacts from rock toe buttress and clay fill are shown on Figure 2. Along the water's edge, the proposed project would extend for a length of approximately 2,350ft (see Figure 2). The rock toe buttress would be mostly contained above the normal winter pool level of 354ft msl for Kentucky Reservoir. Lateral extent of the new dike slope was delineated in the field by Stantec in December 2009, which showed three areas (North, Middle, and South) that would extend beyond the 354ft msl normal winter pool elevation and directly impact aquatic habitat (see Figure 2). The spatial coverage of the North, Middle, and South areas beyond the normal winter pool (including a 5-ft buffer) would be 725ft^2, 468ft^2, and 2,225ft^2, respectively Thus, the total area of riverbed that provides relatively permanent aquatic habitat that would be directly impacted by the proposed project would be 3,418ft^2 (or 318 square meters [m^2]; see Figure 2).

Indirect impacts from the project could affect aquatic habitat (*i.e*., riverbed and water quality) beyond the direct impact area. If all construction plans and BMPs are used as proposed, impacts from disturbed areas on the adjacent aquatic environment (*e.g.*, storm water runoff and sedimentation) should be within allowable state standards and not significantly impact surrounding waters. However, significant modification of the effective shoreline by the proposed project would alter aquatic habitat available between normal winter pool (354ft msl) and normal summer pool (359ft msl) elevations from spring to fall. Additionally, the proposed project would likely alter existing flow patterns adjacent the project, which could, in turn, modify existing riverbed substrate composition (habitat) as well.

The spatial extent of indirect impacts from the proposed project are difficult to anticipate. For the purpose of this evaluation, TVA assumes that the project could indirectly affect an area in the river extending the length of the project (2,350ft) and from the normal winter pool level along the dike eastward to the barge mooring cells that run parallel with the dike (approximately 100ft; see Figure 2). Calculation of the entire indirect impact area (using ArcGIS v9.3) indicates an area of ~238,570ft^2 (or 22,165m^2) may be indirectly affected.

2.4 HISTORY OF PROPOSED PROJECT

A Draft Environmental Assessment (DEA) for the proposed JOF dike project is currently being prepared by TVA and USACE and is expected to be submitted in early January 2010 to appropriate agencies for review. A summary of important project actions and communications associated with this project to date is presented below (documentation provided upon request):

Date	Project / Consultation Action
November 11, 2009	TVA discusses proposed project with TWRA to help evaluate potential of impacts to listed mussels (Phone conversation between Chuck Howard [TVA] and Don Hubbs [TWRA]).
November 18, 2009	TVA notifies USFWS and TWRA of proposed project and requests comments on a survey plan for mussels and habitat near the project site (Email from Chuck Howard [TVA] to Jim Widlak [USFWS] and Rob Todd [TWRA]).
November 20, 2009	USFWS agrees with TVA that survey plan is appropriate to characterize mussels and habitat near the proposed project (Email from Jim Widlak [USFWS] to Chuck Howard [TVA]).
November 25, 2009	Mussel and habitat survey near the proposed project completed by Third Rock Consulting and Mainstream Commercial Diving.
December 9, 2009	TVA provides USFWS report from JOF dike mussel survey and meets with USFWS and Stantec Consulting at USFWS Cookeville, TN office to discuss project details and results of mussel survey.
January 7, 2010	TVA submits Biological Assessment to USFWS and requests Formal Consultation under provisions of the ESA Section 7.

3.0 BASELINE CONDITIONS NEAR PROPOSED PROJECT

3.1 EXISTING ENVIRONMENTAL CONDITIONS NEAR THE PROJECT SITE

3.1.1 Vegetation

No federally listed plant records occur within a five-mile radius of the project site. Grasses have been planted on the dike and woody vegetation has colonized the dike since its construction.

3.1.2 Rivers and Streams

The proposed project site is within the Kentucky Reservoir impoundment of the Tennessee River, which extends from Kentucky Dam (TRM 23) upstream to Pickwick Dam (TRM 207). Kentucky Reservoir features 2,064 miles of shoreline and about 160,300 acres of water surface. This multi-purpose reservoir supports a variety of uses including flood control, hydropower generation, navigation, and recreation. This reservoir is home to significant recreational and commercial fisheries, commercial mussel operations, and is a major waterfowl hunting destination. To maintain the depth required for navigation, the water level in the reservoir is kept at a minimum winter elevation of 354ft msl. The typical summer target level is 359ft msl. Water temperatures near the proposed project (measured at the JOF intake south of the boat harbor adjacent the dike; see Figure 1) are typically highest in July/August near the mid-80's °F and lowest in February near the mid-40's °F.

Johnsonville Island was initially part of a dike system created by TVA to provide a protected embayment around the Johnsonville Fossil Plant and was eventually expanded for use as a location to store coal combustion products (CCPs) (fly ash and bottom ash). The island has a causeway that extends to the right descending bank, which allows for vehicle access and transport of CCPs (see Figure 1). The causeway prevents otherwise normal upstream-to-downstream flow along the east side of the island; however, the intake for JOF is upstream of the dike and the outfall is downstream of the dike, which does provide for some movement of water east of the dike and along the proposed project area. The effluent is warmer than the receiving reservoir waters, and apparently enough flow is created by the effluent to prevent accumulation of deep silt on the riverbed along the southern portion of the JOF project area (see Figure 1 and Appendix A - Figure 1).

3.1.3 Fish and Wildlife

Terrestrial Ecology

The proposed actions would take place within the Johnsonville Island ash pond area. This area has experienced heavy human disturbances associated with previous construction and operation of the JOF facility. Because of the industrial nature of the site and extensive past disturbance, the area has relatively little value to wildlife. Ash ponds contain open water with emergent vegetation along the edges. They can provide habitat for red fox and some aquatic birds such as ducks, geese, and herons.

No federally listed or state-listed plant terrestrial animal species are known to occur on the project site. No federally listed or state-listed terrestrial animal species were observed during field investigations of JOF in 2005 and 2006. A great egret heronry is located approximately 5 miles south of JOF. A colony of little blue herons approximately 2 miles from JOF is no longer active, based on field observations.

The closest known bald eagle nest site is approximately 4.4 miles from JOF at Tennessee National Wildlife Refuge. The eagles no longer nest at their original site but have moved to an area along the mouth of the Duck River. Several additional bald eagle pairs have recently moved into the vicinity of the Duck River. Although no nests are known from the immediate vicinity surrounding JOF, suitable nesting habitat exists along the Tennessee River and associated embayments near JOF.

Gray bats roost in caves during all seasons and typically forage over open water. No caves used by gray bats are known from the Humphreys County area. The only record known from the county is of a single bat in Camden, which is approximately 6.5 miles from the project site. Due to the presence of gray bats upstream from the project site, they likely forage along the Tennessee River and associated embayments near JOF.

Aquatic Fauna

Fish

The Environmental Protection Agency Region IV guidance to the States for conducting 316(a) studies requires that future alternate thermal limit requests require new data that demonstrate aquatic communities in the vicinity of the JOF plant meet the Balanced Indigenous Population (BIP) standard. In the Tennessee River system, TVA has used a reservoir Vital Signs (VS)

monitoring program since 1990 to evaluate ecological conditions in major reservoirs. A component of this monitoring program is a multi-metric approach to data evaluation for fish communities known as the Reservoir Fish Assemblage Index (RFAI).

The Tennessee Department of Environment and Conservation approved the use of RFAI to demonstrate maintenance of BIP downstream from JOF on September 17, 2001, in response to a letter from TVA Fossil Power Group requesting assessment of adequacy and scope of proposed RFAI studies for continuance of alternate thermal limits. Based on that agreement RFAI samples are taken once every two years to demonstrate that JOF operation is not impacting BIP.

In 2007, fish community RFAI scores of 41 (“Good”) and 44 (“Good”) were observed at the downstream and upstream stations, respectively. The downstream site reached 68% of the highest attainable score while the upstream site reached 73%. Although the downstream site received a lower score, it was still within the six point range of accepted variability within the RFAI metric. These ratings are comparable to the other four VS monitoring locations that TVA maintains on Kentucky Reservoir. The overall ecological health of Kentucky Reservoir rated “Good” in 2007. Kentucky Reservoir has rated “Good” in all years that it was evaluated, except in 1995 when the rating was at the upper end of the fair range. These ratings indicate that a diverse, well-balanced community of reservoir fishes is present in Kentucky Reservoir and near the JOF facility.

Native Mollusks - Mussels

Kentucky Reservoir is known to support a diverse and abundant native mussel community, which is the primary portion of the Tennessee River that continuously supports commercial mussel harvesting activities. TWRA reported a total of 33 species and a mean catch per hour of 428 mussels during monitoring of nine commercial mussel harvesting sites in Kentucky Reservoir during 2007 (TWRA, 2008). TWRA (D. Hubbs pers. comm. 2009) reported a mean catch-per-unit-effort of 10.5 mussels/minute (= 630 mussels/hr) in Kentucky Reservoir in 2009; of these commercial species (*e.g.*, threeridge, washboard, ebonyshell, mapleleaf) were caught at a rate of 6-8 mussels/minute overall and 2-3 mussels/minute for those within legal harvesting size limits. Mean catch per hour of pink mucket (federally listed as endangered) at commercial mussel assessment sites between TRM 141.5 and TRM 202 in Kentucky Reservoir (Pickwick Dam tailwater) was 3.5 pink mucket/hr in 2008 and 2.8 pink mucket/hr in 2009 (TWRA, D. Hubbs, pers. comm., 2009). Other federally listed mussel species collected live at the

commercial mussel harvesting monitoring sites in 2007 included spectaclecase (*Cumberlandia monodonata*; candidate species), fanshell (*Cyprogenia stegaria*, endangered species), orangefoot pimpleback (*Plethobasus cooperianus*, endangered species), and rabbitsfoot (*Quadrula c. cylindrica*, candidate species) (TWRA, 2008).

A mussel and habitat survey of the area adjacent the JOF dike project was conducted in November 2009 (Appendix A; Third Rock Consulting, 2009). A combination of semi-quantitative methods (11 30m-long transects spaced 60m apart) and qualitative methods (15-minute searches between transects) were used to characterize the mussel community potentially affected by the proposed project. A total of 1,951 mussels representing 16 species were collected overall. The survey included some effort along the east portion of the boat harbor near the JOF coal unloading and barge mooring facility, but only five mussels were collected in this area (see Appendix A - Transects 12 - 20)

In the study area adjacent the dike project (i.e., Transects 1 - 11), total of 1,152 mussels representing 16 species were found in semi-quantitative samples along transects. No live federally listed mussels were collected, but one relic shell of pink mucket was collected on Transect 4 in the southern portion of the survey area. Approximately 81% of the mussels collected were found between 10m and 20m (= 30 - 60ft) from the shoreline along the existing dike (Note: reservoir elevation was near the normal winter pool elevation of 354ft msl at the time of the survey, 24-25 Nov 2009). The majority of these were found within the southern portion of the study area (*i.e*., Transects 1 - 8), indicating that this area specifically contained high quality mussel habitat. Since rare mussel species, such as pink mucket, tend to be found in areas of high quality mussel habitat with high species richness (*e.g*., > 15 species) and high density (*e.g*., > 10 mussels/m^2), it is assumed that pink mucket would occur within this portion of the study area.

Mussel density along the dike averaged 3.5 mussels/m^2 and reached a maximum sample density of 25.6 mussels/m^2 at 10-20m off the bank along Transect 3 (see Appendix A - Figure 1) [*Note: density estimates from this study are likely biased by semi-quantitative collection methods; therefore, probably under-estimating actual mussel density*]. Mussel density between 0m and 10m off the bank was 0 mussels/m^2 on seven of the eleven transects, and reached a maximum of 1.6 mussels/m2 at this distance on Transect 1 (see Appendix A) - Figure 1 and Table 2). Relative catch per hour levels appeared to vary similarly with density estimates of adjacent transects. Mean catch per hour in samples along the proposed project was 289

mussels/hr and reached a maximum of 655 mussels/hr between Transects 3 and 4 (see Appendix A - Figure 1 and Table 2).

Riverbed substrate composition where mussels were abundant along the JOF dike (*e.g.*, Transects 1 - 8 at 10-20m from bank) tended to consist of a gravel and clay mixture with some small proportions of silt and sand, whereas substrate was mostly silt/mud or clay in areas where relatively few or no mussels occurred (see Appendix A - Figure 1 and Table 3). Water depth in the study area increased with distance from the bank and reached a maximum of 16ft at 30m (~100ft) off of the bank. Water depth also tended to increase along the dike in a north-to-south direction. The range of water depth where high quality mussel habitat was found (*i.e.*, 10-20m from bank at Transects 1 - 8) was 6 - 14ft (see Appendix A - Figure 1 and Table 3).

Non-native Mollusks - Zebra Mussels

Zebra mussels (*Dreissena polymorpha*) are an exotic fauna that were introduced to the U.S. in the 1980's, allegedly via ballast water of ships from Europe entering the Great Lakes. They are capable of attaching to most solid surfaces using byssal threads, including rocks, wood, man-made objects, shells of other zebra mussels, and shells of native mussels and snails. They are capable of smothering native mollusks, are strong competitors with native mussels for food, and are blamed for the serious depletion of native mussels throughout the Mississippi River basin and Great Lakes (Schloesser et al., 1996; Ricciardi et al., 1998).

Zebra mussels were first reported in the Tennessee River in 1992. While densities in the Tennessee River haven't appeared to reach levels needed to decimate native mussels (presumably because of drainage-specific water quality conditions), they pose a serious threat should favorable conditions develop (TVA, 1994a; TWRA, 2008). Zebra mussels are present in Kentucky Reservoir and are expected to be continually reintroduced by barge and recreational boat traffic (TVA, 1994a); however, no zebra mussels were observed on the substrate or attached to native mussels during the 2009 survey (Third Rock Consulting 2009). TWRA reported zebra mussel mean collection rate for Kentucky Reservoir at 0.8 zebra mussels / minute of search effort at commercial mussel assessment sites during August 2007 and density of about 2 - 27 zebra mussels/m^2 between TRM 195 and 203 (TWRA, 2008). No zebra mussels were encountered during the 2009 survey near the proposed project (Third Rock Consulting, 2009).

3.2 ONGOING ACTIVITIES NEAR PROPOSED PROJECT SITE

3.2.1 Land Management

Land management of the area immediately surrounding the proposed project includes power generation at the JOF facility and associated handling of CCPs.

3.2.2 TVA Reservoir Operations - Kentucky Reservoir

The Kentucky Reservoir impoundment of the Tennessee River extends from Kentucky Dam (TRM 23) upstream to Pickwick Dam (TRM 207). Kentucky Reservoir features 2,064 miles of shoreline and about 160,300 acres of water surface. This multi-purpose reservoir supports a variety of uses including flood control, hydropower generation, navigation, and recreation. To maintain the depth required for navigation, the water level in the reservoir is kept at a minimum winter elevation of 354ft msl. The typical summer target level is 359ft msl. Kentucky Dam was closed on August 30, 1944 with a lock for boat traffic opening on September 12, 1944.

3.2.3 TVA Johnsonville Fossil Plant

The JOF plant first unit came online in 1952 and currently uses about 9,600 tons of coal per day. Waters along the proposed project are likely affected by effluent release from the JOF facility and tow activity associated with coal delivery via barge. TVA is in process of converting to dry ash storage and is currently removing CCPs from the JOF facility and Johnsonville Island to an offsite location. TVA anticipates capping and closing Johnsonville Island by 2016.

3.2.4 Commercial Navigation

Kentucky Reservoir levels are maintained in part to support commercial boating activity. Only tows servicing the JOF plant enter the boat harbor between the JOF coal unloading facility and the proposed dike project. Mooring cells for barges are located about 100ft east of the dike.

3.2.5 Commercial Mussel Harvesting

Kentucky Reservoir is the primary reach of the Tennessee River that still continuously supports commercial mussel harvesting activity, responsible for 98.8% of the 1,253 tons of mussel shell harvested in 2007 (TWRA, 2008). The wholesale value of the 2007 Tennessee mussel harvest was $2,378,398. Commercial mussel harvesting within the JOF boat harbor has been observed by TWRA in the past (D. Hubbs pers. comm., 2009), which indicated that this area likely supports some level of commercial mussel harvesting potential; however, given that the harbor

is generally blocked from normal flow conditions within the reservoir, it is expected that mussel habitat capable of supporting commercial harvesting is relatively lower than that observed in open waters of Kentucky Reservoir. Tow activity may also diminish habitat suitability for mussels in the boat harbor.

3.2.5 Recreation

Kentucky Reservoir supports significant recreational and commercial fisheries and is a major waterfowl hunting destination. The level of recreational activity within the JOF boat harbor is not known, but is suspected to be relatively lower than other areas found throughout the reservoir, which aren't subject to consistent disturbance from tow activity like in the JOF boat harbor.

4.0 CRITICAL HABITAT AND FEDERALLY LISTED SPECIES POTENTIALLY AFFECTED BY THE PROPOSED PROJECT

4.1 DETERMINATION OF CRITICAL HABITAT AND FEDERALLY LISTED SPECIES AFFECTED BY ACTION

TVA's Natural Heritage Program maintains a database of records on all federally listed and stat-listed species, critical habitat, natural areas, caves, and other biologically significant features within its power service area. Information in this database is routinely shared with heritage programs of each of the seven states within TVA's power service area, as well as the USFWS and state natural resource agencies; therefore it serves as a reliable resource on records of endangered species and designated critical habitat.

A list of federally listed species occurring in Humphreys County prepared using the TVA Regional Natural Heritage Database and USFWS data. Initial determinations of which federally listed species could be affected by the proposed project were made from spatial proximity of element occurrence records in the TVA database, as well as evaluation by TVA biologists that specialize in the relevant floral and faunal taxa considered. Spatial criteria used for guiding selected element occurrence records using eMap software (NatureServe) were as follows: aquatic records within 10 miles of project site, plant records within 5 miles of project site, and terrestrial animals and natural areas within 3 miles of project site.

4.2 DESIGNATED CRITICAL HABITAT

A search of the TVA Natural Heritage Database (Accessed November 4, 2009) indicated that no designated critical habitat for endangered species occurs within the project action area. **Therefore, the proposed project would not adversely modify or destroy any designated critical habitat for federally listed species.**

4.3 FEDERALLY LISTED SPECIES

4.3.1 Birds

Piping Plover (*Charadrius melodus*):

The Great Lakes population of piping plover (*Charadrius melodus*) was listed as threatened on December 11, 1985 (Federal Register 1985). Critical habitat was designated for the Great Lakes population of the piping plover on its breeding grounds and for all populations on the wintering grounds on the Gulf of Mexico and Atlantic Ocean coasts (Federal Register 2001,

2001a, 2002; Service 1994, 2003). A recovery plan for the Northern Great Plains and Great Lakes populations of the piping plover was prepared in 1994. Subsequently, a separate recovery plan for the Great Lakes population was approved in September 2003.

Historically, the piping plover ranged over three geographic regions during its breeding season: (1) the northern Great Plains from Alberta and Manitoba (Canada) south to Nebraska; (2) the Great Lakes; and (3) the Atlantic coast from Newfoundland (Canada) south to North Carolina. The winter range is not well described, but the species has been reported from the coast of the Gulf of Mexico from Mexico to Florida, the Atlantic coast from North Carolina to Florida, and on scattered Caribbean islands (Service 1994; 2003). The species current range has not changed, with the exception that the Great Lakes population has been almost completely extirpated (Service 1994; 2003).

Piping plovers consume a variety of invertebrates, including worms, insects, crustaceans, and mollusks. Adults typically feed within 17 feet of the water's edge, while juveniles often feed on firmer sand farther from the water (Service 1994; 2003). Nesting habitat of the piping plover consists of open sand and gravel beaches on islands or the mainland of inland lakes, prairie sloughs, and saline wetlands; on dry salt flats or gravel beaches in permanent to seasonally flooded palustrine wetlands; and on dry sandbars in wide, open river beds. Habitats surrounding nesting habitat consist of forest, pasture, or prairie grassland. Breeding pairs appear to select the widest beaches available; minimum distance from nest to water has been reported to be approximately 130 feet, although piping plover nests have been found on beaches as narrow as 40 feet in areas containing no wider beach habitat; sandbars on which nests have been found are typically one-half of a foot to 3 feet above water level. Lack of vegetative cover and substrate type (i.e., gravel or mixed sand/gravel) are also important components of breeding habitat (Service 1994; 2003). On the wintering grounds, piping plovers inhabit beaches, sand flats, and dunes on coastal beaches and adjacent offshore islands; spoil islands in the Intracoastal Waterway are also used (Service 1994; 2003).

The proposed project area does not include mudflats and sandbars that this species uses for foraging habitat during migration through Tennessee. **Thus, the JOF dike project would have no effect on the piping plover, and this species is not considered further in this BA.**

4.3.2 Fish

The pygmy madtom (*Noturus stanauli*), federally listed as endangered, is reported from the Duck River in Humphreys County. This species is not tolerant of reservoir conditions, and does not occur in the impounded mainstem of the Tennessee River in Kentucky Reservoir within the project area. **This project would have no effect on the pygmy madtom, and this species is not considered further in this BA.**

4.3.3 Mammals

Gray bat (*Myotis grisescens*): Gray bats, federally listed as endangered, roost in caves during all seasons and typically forage over open water. No caves used by gray bats are known from the Humphreys or Benton county area. The only record known from the area is of a single bat in Camden, which is approximately 6.5 miles from the project site. Due to the presence of gray bats upstream from the project site, they likely forage along the Tennessee River and associated embayments near JOF. However, the actions proposed would have no measurable effect on gray bat foraging areas. **TVA has determined that this project would have no effect on gray bats, and this species is not considered further in the BA.**

4.3.4 Mussels

Orangefoot pimpleback (*Plethobasus cooperianus*): a federally endangered species known as a big to medium river species. Orangefoot pimpleback seems to prefer sand, gravel, and cobble substrate in riffles and shoals, with deep water and steady current. This species is restricted to the Tennessee River, Cumberland River and lower Ohio River where it is considered very rare. The USFWS has proposed a rule to reintroduce this species into historical habitat in the free-flowing portion of the French Broad River below Douglas Dam to its confluence with the Holston River near Knoxville, TN (USFWS, Federal Register, 12 September 2007). This species has not been recently collected from this reach of the Tennessee River and is believed to be either extirpated from the area or occur at such low densities that the likelihood of being affected by the proposed project is discountable. **Therefore, the JOF dike project would have no effect on the orangefoot pimpleback, and this species is not considered further in this BA.**

Pink Mucket (Lampsilis abrupta [= orbiculata]): The pink mucket was added to the list of endangered species in 1976 (USFWS, 1976). As of 2000, the U.S. Fish and Wildlife Service considered this species to be declining (USFWS, 2003); however, continuing routine encounters of low numbers of this species suggest that most populations are relatively stable. The USFWS

is currently developing a 5-yr review status for pink mucket. The causes of the decline for this species are not totally understood but may be related to impoundments, siltation, and pollution (USFWS, 1985). Critical habitat has not been designated for this species.
Historically, the pink mucket occurred in the Ohio, Cumberland, Tennessee, and middle Mississippi River systems (Parmalee and Bogan 1998). In recent years, pink muckets have been found at locations scattered across the former range where suitable habitat still exists for a variety of riverine mussel species. These locations extend from the Kanawha River, West Virginia; west to the Gasconade River, Missouri; south to the Black River, Arkansas; and east to the Tennessee and Cumberland River basins (USFWS, 1985).

Within the last 30 years, the pink mucket has been encountered in nearly all tailwaters of the mainstem Tennessee River dams and in parts of Bear Creek and the Clinch, French Broad, and Holston rivers (USFWS, 1985; TVA Heritage database). The pink mucket is known from eight mainstem tailwaters (downstream from Kentucky, Pickwick, Wilson, Guntersville, Nickajack, Chickamauga, Watts Bar, and Fort Loudoun dams), four tributary tailwaters (downstream from Bear Creek, Norris, Cherokee, and Douglas dams), and two mainstem reservoirs (Kentucky and Wheeler). Although always uncommon or rare, this species is encountered most often in the Tennessee River within the flowing mainstem areas downstream from Pickwick Dam (= upstream end of Kentucky Reservoir). Its continued presence in mainstem reservoirs and in tributary dam tailwaters is often limited to sightings of single, often old, individuals.

An extensive survey near TRM 391-392 (Guntersville Reservoir) in 2007 found a mussel community with 12 species and density of 0.81 mussels/m^2, but no pink mucket were found; however, a during a snail survey of the same location in 2009 (Dinkins 2009), one pink mucket was found inadvertently during the survey. A 2008 survey in the Nickajack Dam tailwater (TRM 424; LEC 2008) found one live pink mucket, which comprised 0.11% of the mussel community at that site. TWRA (D. Hubbs pers. comm., 2008) reported finding pink mucket at a rate of 1.5 individuals/hr in the Pickwick Dam tailwater in 2008, while ADCNR (J. Garner, pers. comm., 2008) reported great difficulty in finding pink mucket downstream of Wilson and Guntersville dams; only 0.03 individuals/m^2 were found in Guntersville tailwater in 2008. Mean catch per hour of pink mucket at commercial mussel assessment sites between TRM 141.5 and TRM 202 in Kentucky Reservoir (Pickwick Dam tailwater) was 3.5 pink mucket/hr in 2008 and 2.8 pink mucket/hr in 2009 (D. Hubbs, pers. comm., 2009). In 2009 TWRA (D. Hubbs pers. comm., 2009) reported collecting pink mucket (all ≥12 yr old) in the Cumberland River (downstream of Cordell Hull Dam) at a mean rate of 2.7 individuals/hr in 2008 and 0.92 individuals/hr in 2009.

A 2009 survey in Kentucky Reservoir at TRM 94 (Mainstream Commercial Diving, 2009) found 1,454 mussels representing 20 species, but no pink mucket were collected. A 2008 survey in Kentucky Reservoir at TRM 160.7 (Dinkins 2008) found 10 individuals of pink mucket in 11,090 mussels collected (= 0.1% frequency), which included an assemblage of 17 species. The pink mucket at this site were all found near the slope or toe of the old river channel, and none were found on the overbank. As reported above (Section 3.1.3 and presented in Appendix A), a 2009 survey of the proposed JOF project site at TRM 99-100 found a relic shell of pink mucket, although no live individuals were found live within a collection of 1,951 mussels representing 16 species (Third Rock Consulting, 2009).

Based on TVA Regional Heritage Database records near the proposed project, data on pink mucket within the Tennessee River, and information about the mussel community and habitat specifically adjacent the proposed project, it is possible that pink mucket could inhabit the area adjacent the proposed project. **Thus, pink mucket may be affected by the JOF dike project, and an effects analysis is presented in the next section (Section 5.0) of this BA**. Additional background on the biology of pink mucket is provided below to assist in the effects analysis.

Pink mucket has a shell is that is round to elliptical, solid, and inflated. Anterior end is rounded, and posterior end is bluntly pointed in males and truncated in females. The dorsal margin is straight and the ventral margin is straight to slightly curved. Umbos are turned forward and elevated above the hinge line. Beak sculpture, if visible, consists of three or four double-looped ridges. The shell is generally smooth, yellow or yellowish green and rayless or with faint green rays. Known shell lengths of up to 4in (= 10.2cm) are reported. Pseudocardinal teeth are triangular, thick, and divergent; there are two in the left valve and one in the right valve, occasionally with a smaller tubercular tooth in front. Lateral teeth are short, heavy, and relatively thick. The beak cavity is deep. The nacre lining of the internal shell is pink or white, and often iridescent posteriorly (Cummings and Mayer, 1992; NatureServe, 2008). This species naturally occurs in a variety of cobble, gravel, sand, and other substrate types (preferably free of silt) in medium to large rivers. Pink mucket is a long-term brooder, being gravid from late summer or autumn to the following summer. Fish hosts are necessary to complete the reproductive cycle of this and nearly all unionid mussels. Known hosts for the pink mucket include freshwater drum (*Aplodinotus grunniens*), largemouth bass (*Micropterus salmoides*), sauger (*Sander canadense*), smallmouth bass (*M. dolomieu*), spotted bass (M. punctulatus),

walleye (*Sander vitreus*), and white crappie (*Pomoxis annularis*) (Williams *et al*., 2008, and references therein).

Ring pink (*Obovaria retusa*): The ring pink was listed as an endangered species in 1989 (USFWS, 1989). Typical habitat for this species is gravel and sandy substrates of large rivers. Ring pink once occurred throughout much of the Ohio, Cumberland, and Tennessee River systems in parts of Pennsylvania, Ohio, West Virginia, Indiana, Illinois, Kentucky, Tennessee, and Alabama (USFWS, 1991). Since the 1970s, this species has been found only in the Tennessee River downstream from Kentucky and Pickwick dams, in the middle reach of the Cumberland River in central Tennessee, in the middle reach of the Green River in Kentucky, and in the Kanawha River in West Virginia. During the past 30 years, live specimens of the ring pink have been encountered in the mainstem Tennessee River downstream from Kentucky and Pickwick dams, and in Pickwick Reservoir not far downstream from Wilson Dam. All three of these occurrences represent very few, older individuals. This species has not been collected from this reach of the Tennessee River since at least 1978 and is believed to be either extirpated from the area or occur at such low densities that the likelihood of being affected by the proposed project is discountable. **Therefore, the JOF dike project would have no effect on the ring pink, and this species is not considered further in this BA.**

Rough pigtoe (Pleurobema plenum): The rough pigtoe was added to the list of endangered species in 1976 (USFWS, 1976). This species is typically is found in firmly packed sand and gravel in larger rivers. The original distribution of this species probably included the Ohio, Cumberland, and Tennessee rivers and their larger tributaries; however, records attributed to this species also have been reported from as far west as Kansas and Arkansas (Parmalee and Bogan 1998). Since the early 1970s, the rough pigtoe has been found alive in the Barren and Green rivers in Kentucky, and in the Clinch, Cumberland, and Tennessee Rivers in Tennessee (USFWS, 1984).

The increasing scarcity of encounters with this species (at least in the Tennessee River system) supports the conclusion that it is declining overall (USFWS, 2003). In recent years, the rough pigtoe has been found in the mainstem Tennessee River downstream from Pickwick, Wilson, Guntersville, and Watts Bar dams, as well as in Pickwick and Wheeler Reservoirs. Both of the reservoir records came from the upstream ends, very close to the identified extent of the lotic habitat provided by the dam tailwaters. This species has not been reported near the project site since 1920 and is considered extirpated from the area. **Thus, the proposed project would have no effect on the rough pigtoe, and this species is not considered further in this BA.**

Slabside pearlymussel (Lexingtonia [= Pleuronaia] dolabelloides): The slabside pearlymussel is not presently listed under the ESA; however, it is an identified candidate for potential listing (USFWS, 2002). This species is most often found in sand, fine gravel, and cobbles in areas of small and large creeks with a moderately strong current (Parmalee and Bogan 1998). This species once occurred in the middle part of the Cumberland River system and in most of the Tennessee River system (USFWS, 1999). Since the early 1970s, the slabside pearlymussel has been found in Bear Creek and the Clinch, Duck, Elk, Hiwassee, North Fork Holston, Middle Fork Holston, Paint Rock, and Powell rivers within the Tennessee River basin (USFWS, 1999).

In recent years, the slabside pearlymussel has been encountered in three reaches of the Duck River (downstream from Columbia, Columbia to Shelbyville, and Shelbyville to Normandy Dam), two reaches of the Elk River (downstream from Fayetteville, and Tims Ford tailwater), Bear Creek upstream from Pickwick Reservoir, Hiwassee River between the Appalachia Powerhouse and Appalachia Dam, and the Clinch River just downstream from Norris Dam. Most of these occurrences represent only a few individuals; however, larger populations still persist in the downstream part of Bear Creek, in the Duck River downstream from Shelbyville, and in the Elk River (TVA Heritage database records).

This species appears to be less adaptable or intolerant of impoundment conditions created within the mainstem Tennessee River. Slabside pearly mussel is likely extirpated from the immediate vicinity of the proposed project or found at such low densities that the likelihood of being affected by the project is discountable. **The proposed project would have no effect on the slabside pearlymussel, and this species is not considered further in this BA.**

5.0 PROJECT EFFECTS ANALYSIS

5.1 DIRECT EFFECTS

Direct loss of aquatic habitat below the 354ft msl winter pool elevation would occur in three areas along the dike stabilization project. The spatial coverage of the North, Middle, and South areas (including a 5ft buffer) would be 725ft^2, 468ft^2, and 2,225ft^2, respectively The total area of riverbed directly lost by the proposed project would be 3,418ft^2 (or 318 square meters [m^2]; see Figure 2). As shown by data from the 2009 survey (Appendix A) that characterized the mussel community, mussel distribution, and habitat adjacent the proposed project area, the areas directly impacted (covered) by the proposed project offer poor or unsuitable habitat (*e.g.*, silt/mud) for most freshwater mussel species and currently support relatively few or no mussels (see Figure 2 and Appendix A - Figure 1 and Table 2).

In the absence of actual records of live or recently dead individuals recorded near the project site, TVA assumes that pink mucket may exist in areas with recent nearby records of this species and that currently support high mussel densities (*e.g.*, ≥10 mussels/m^2) and species richness (*e.g.*, ≥15 species). The areas directly affected by the proposed project are immediately adjacent the winter pool elevation and will be carefully and precisely modified during construction. Since the margins of these areas are generally ≥25ft away from the rather well-defined area supporting high quality mussel habitat, it is unlikely that the project will directly affect pink mucket.

5.2 INDIRECT EFFECTS

Indirect effects from the proposed project would primarily include alteration of flow conditions and possibly riverbed substrate conditions adjacent the expanded dike. Due to precise construction methods, boundaries, and BMPs, little impact from storm water runoff and sedimentation are expected to affect the high quality mussel habitat adjacent the proposed project. Nonetheless, some disturbance of the area near the proposed project may include elevated levels of suspended sediment, sedimentation, altered flow patterns, and vibration disturbance from construction activity. Increased turbulence and resuspended silt have been shown to reduce freshwater mussel growth (Yokley, 1976), feeding rates (Miller *et al*., 1988; Aldridge *et al*., 1987), oxygen consumption, and nitrogen excretion (Aldridge *et al*., 1987).

However, the degree and longevity of increased suspended sediment and sedimentation resulting from the above processes at the JOF site are unclear.

Physical disturbance from vibrations of the ground and in the water column during construction could possibly interrupt normal respiration, feeding, and reproductive activity of freshwater mussels, including pink mucket. Responses by mussels could include increased valve closure, increased burial time, or abortion of gametes and/or larvae. Vibrational disturbance and altered flow and water quality may also disturb potential fish hosts for mussels (and pink mucket), which could inhibit fish-mussel interactions necessary to complete the mussel life cycle. However, these disturbances would be completed within the two month period for construction (February through March, 2010). Since the area between the proposed project and mooring cells (100ft from the bank along the dike) is already subject to consistent disturbance from tows (*i.e*., propeller wash) that service the JOF facility, it is unclear if or how these additional disturbances could affect the health and long-term population characteristics of pink mucket and other freshwater mussel species.

Perhaps the greatest potential impact to pink mucket and other mussel species may result from long-term modification of the high quality mussel habitat between the dike and the mooring cells due to an effective shift of the near-bank habitat toward the boat harbor when water (pool) elevation is above the normal winter pool level (354ft msl). Existing substrate conditions adjacent the dike, an important factor used to qualify mussel habitat quality, are the result of natural geomorphology and dike-influenced substrate composition, as well as flow patterns that transport (erode or deposit) sediment particles. These flow patterns are affected by reservoir levels and flow rates, topography and structures near the project (natural or man-made), and anthropogenic effects on flow from tow propeller wash and effluent from the JOF facility. Since the high quality mussel habitat is such a well-defined, narrow band between areas heavily affected by tow wash and flow patterns at the bank, it is possible that a shift of the effective bank toward the boat harbor could cause a shift in the range of conditions that shape the high quality mussel habitat. Therefore, the proposed JOF dike stabilization project could indirectly affect pink mucket by long-term habitat alteration.

The total area that could be indirectly affected by the proposed project is assumed to extend the entire length of project (2,350ft). Indirect effects could extend from the bank along the existing dike (below the 354ft msl normal winter pool elevation) eastward to line of barge mooring cells running parallel with the dike approximately 100ft away. Using ArcGIS (v.9.3) software and

GPS coordinates of the project elements, an estimated area of 238,570ft^2 (= 22,165m^2) could be indirectly affected by the proposed project (see Figure 2). The area of high quality mussel habitat was defined by the locations generally containing mussel densities (as measured in field using surface sampling methods only) ≥5 mussels/m^2 and/or catch per hour rates of ≥300 mussels/hr (see Appendix A - Figure 1). A simplified depiction of the area containing high quality mussel habitat was outlined in Figure 2, essentially outlining an area between Transects 1 and 8 from the 2009 study and between 10m and 20m from the bank. This area was measured using ArcGIS (v.9.3) and estimated that 49,670ft^2 (= 4,615m^2) of high quality mussel habitat capable of supporting pink mucket could be indirectly affected by the proposed project.

Using data from the 2009 study (Appendix A), the mussel density from samples between 10m and 20m from the bank along Transects 1 - 8 was 10.9 mussels/m2. Since this mussel density estimate is likely biased from sampling only the substrate surface along transects, we must correct the estimate using other studies in the Tennessee River that have collected both surface samples and true quantitative samples excavated from a known area. These studies indicated that actual mussel density is often about three times that estimated from surface samples. Therefore, we assume that actual mussel density within the high quality habitat near the JOF dike is 10.9 X 3 = 32.7 mussels/m^2. If the size of the high quality mussel habitat is 4,615m^2, then we estimate that 150,911 mussels inhabit this area.

Based on estimates of pink mucket frequency within high quality mussel communities from other studies in the Tennessee River (see above), we assume that pink mucket constitutes 0.1% of the mussels within the high quality mussel habitat near the project. Therefore, 0.1% of 150,911 mussels or 151 pink muckets may be indirectly affected by the proposed project. These effects would be primarily from disturbance or habitat alteration in areas inhabited by the pink mucket. These effects are not anticipated to result in the death of individuals, but could have effects on pink mucket by reducing the amount of suitable habitat for the species in the affected area.

5.3 CUMULATIVE EFFECTS

An analysis of cumulative effects for the BA, as outlined by the Endangered Species Act Section 7, considers the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Effects of other potential federal actions are not considered since they would require separate ESA consultation. No new actions are anticipated near the proposed project. Pressures associated with tow activity and commercial mussel harvesting on

the local mussel community, including pink mucket, are not expected to vary considerably from the range of past and present conditions.

6.0 PROJECT EFFECT DETERMINATIONS AND CONCLUSIONS

The following effect determinations have been made regarding impacts of the Johnsonville dike stabilization project on endangered species:

6.1 EFFECT DETERMINATIONS

Piping plover: No Effect

Pygmy madtom: No Effect

Gray bat: No Effect

Pink mucket: May Affect, Likely to Adversely Affect

Slabside pearlymussel: No Effect

Ring pink: No Effect

Orangefoot pimpleback: No Effect

Rough pigtoe: No Effect

6.2 CONCLUSIONS AND REQUEST FOR TAKE OF FEDERALLY LISTED SPECIES

The proposed Johnsonville dike stabilization project is likely to adversely affect the federally listed as endangered pink mucket (*Lampsilis abrupta*). The proposed project would have no direct effects on pink mucket, but would likely affect pink mucket by habitat modification caused by a change in the topography of the bank along the dike, which will primarily occur above the normal winter pool (low) elevation of 354ft msl in Kentucky Reservoir.

It is assumed that pink mucket would be found in the area of high quality mussel habitat that covers 4,615m^2 generally located between 10m and 20m off the bank in the southern two-thirds of the project area. Based on mussel density found in this area and assumptions about pink mucket frequency, an estimated 151 pink mucket may be indirectly affected by the project. TVA and the USACE request initiation of formal consultation with the USFWS for the above describe project, and request the take of 151 pink mucket and their habitat.

7.0 LITERATURE CITED

Alabama Department of Conservation and Natural Resources (Mr. Jeff Garner). 2008. Personal communication - email from Jeff Garner to Chuck Howard.

Aldridge, D. W., B. S. Payne, and A. C. Miller. 1987. The effects of intermittent exposure to suspended solids and turbulence on three species of freshwater mussels. Environmental Pollution 45:17-28.

Cummings, K. S. and C. A. Mayer. 1992. Field guide to freshwater mussels of the Midwest. Illinois Natural History Survey, Manual 5. Champaign, Illinois. 194pp.

Federal Register. 1985. Endangered and threatened wildlife and plants; determination of endangered and threatened status for piping plover. 50 CFR 17:50726-50734.

Federal Register. 2001. Endangered and threatened wildlife and plants; determination of critical habitat for the Great Lakes breeding population of the piping plover. 50 CFR 17. 66(88):22938-22969.

Federal Register. 2001a. Endangered and threatened animals and plants; final determination of critical habitat for wintering piping plovers. 50 CFR 17. 66(132):22938-22969.

Federal Register. 2002. Endangered and threatened wildlife and plants; designation of critical habitat for the Northern Great Plains breeding population of the piping plover. 50 CFR 17. 67(176):57638-57717.

Federal Register. 2007. Endangered and threatened wildlife and plants; Establishment of nonessential experimental population status for 15 freshwater mussels, 1 freshwater snail, and 5 fishes in the lower French Broad River and in the Lower Holston River, Tennessee; Final Rule by the U.S. Fish and Wildlife Service, Federal register: 72 FR 52433-52461.

Dinkins Biological Consulting, LLC. 2009. Survey for Anthony's Riversnail (*Athearnia anthonyi*) in the Tennessee River in the Vicinity of Bellefonte Nuclear Power Plant, Jackson, County, Alabama. Prepared for Tennessee Valley Authority, November, 2009. 24pp. + appendices.

Dinkins Biological Consulting, LLC. 2008. Survey for federally protected mussels in the Tennessee River adjacent to proposed Clifton Fuels Terminal project, Decatur County, Tennessee. Prepared for Natural Resource Group, July 2008. 29pp.

Lewis Environmental Consulting (LEC), Inc. 2008. *Report: Mussel survey at Tennessee River miles 423.6 - 423.9 along the left descending bank in Marion County, Tennessee. LEC, September 2008.* Prepared for Thompson Engineering, Inc.

Mainstream Commercial Divers. 2007. Mussel survey between Tennessee River Miles 390.8 – 392.4 for TVA's Bellefonte Power Plant in Jackson County, Alabama. Report prepared for Enercon Services, Inc., Oklahoma City, OK. April 2007.

Miller, A. C., L. Thodes, and R. Tippit. 1984. Changes in the naiad fauna of the Cumberland River below Lake Cumberland in central Kentucky. Nautilus 98:107-110.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version7.0. NatureServe, Arlington Virginia. Available at http://www.natureserve.org/explorer. (Accessed: Pink mucket, September 26, 2008).

Parmalee, P. W. and A. E. Bogan. 1998. The Freshwater Mussels of Tennessee. Knoxville, Tenn.: The University of Tennessee Press.

Ricciardi, A., R. J. Neves, and J. B. Rasmussen. 1998. Impending extinctions of North American freshwater mussels (Unionoida) following the zebra mussel (Dreissena polymorpha) invasion. Journal of Animal Ecology 67:613-619.

Schloesser, D. W., T. F. Nalepa, and G. L Mackie. 1996. Zebra mussel infestation of unionid bivalves (Unionidae) in North America. American Zoologist 36:300-310.

Stantec Consulting Services, Inc. 2009. Report of Phase I Facility Assessment - Coal Combustion Product Impoundments and Disposal Facilities. Prepared for Tennessee Valley Authority, Chattanooga, TN; June 24, 2009. (available at http://www.tva.gov/power/stantec/).

Tennessee Valley Authority. 1994. Tennessee Valley vulnerability to zebra mussels. Prepared by D. J. Rucker and R. D. Urban. TVA/WM-94-004 Water Management Services. 107pp.

Tennessee Wildlife Resources Agency. 2008. 2007 Statewide commercial mussel report. 43pp.

Tennessee Wildlife Resources Agency (Mr. Don Hubbs). 2009. Personal communication via email from Don Hubbs to Chuck Howard.

Third Rock Consultants, LLC. 2009. Embayment survey for dike maintenance - Johnsonville Fossil Plant, Humphreys County, Tennessee. Prepared for Tennessee Valley Authority, December 8, 2009. 5pp + appendices.

U.S. Fish and Wildlife Service. 1976. Endangered status for 159 taxa of animals. Federal Register, 41(115):24062-24067.

U.S. Fish and Wildlife Service. 1984. Recovery plan for the rough pigtoe pearly mussel (Pleurobema plenum). U.S. Fish and Wildlife Service, Atlanta, Georgia, 51 pages.

U.S. Fish and Wildlife Service (prepared by S. Ahlstedt of Tennessee Valley Authority). 1985. Recovery Plan for the pink mucket pearlymussel. 47pp.

U.S. Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants; Designation of the ring pink mussel as an endangered species. Federal Register, 54(188):40109-40112.

U.S. Fish and Wildlife Service. 1991. Recovery Plan for Ring Pink Mussel, (Obovaria retusa). U.S. Fish and Wildlife Service, Atlanta, Georgia, 24 pages.

U.S. Fish and Wildlife Service. 1999. Candidate status being pursued for two Cumberlandian region freshwater mussels. Letter notification from Asheville Field Office, U.S. Fish and Wildlife Service, Asheville, North Carolina, cover letter and 20 pages.

U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; Review of species that are candidates or proposed for listing as endangered or threatened; Annual notice of findings or recycled petitions; Annual description of progress on listing actions. Federal Register 67(114):40657-40679.

U.S. Fish & Wildlife Service. 2003. Summary report to congress on the recovery program for threatened and endangered species, 1998 and 2000. U.S. Fish and Wildlife Service, Washington, DC, 35 pages.

U.S. Fish and Wildlife Service. 2003. Recovery plan for the Great Lakes piping plover (*Charadrius melodus*). U.S. Fish and Wildlife Service, Fort Snelling, MN.

U.S. Fish and Wildlife Service. 1994. Draft revised recovery plan for piping plovers, *Charadrius melodus*, breeding on the Great Lakes and Northern Great Plains of the United States. U.S. Fish and Wildlife Service, Twin Cities, MN.

U.S. Fish and Wildlife Service. 1985. Recovery plan for the pink mucket pearly mussel (*Lampsilis orbiculata* [Hildreth, 1828]). U.S. Fish and Wildlife Service, Atlanta, GA.

Yokley, P. Jr. 1976. The effect of gravel dredging on mussel production. Bulletin of the American Malacological Union, Inc. 1976:20-22.

THIS PAGE INTENTIONALLY LEFT BLANK

FIGURES

Figure 1. Project elements and impact areas of the Johnsonville dike stabilization project.

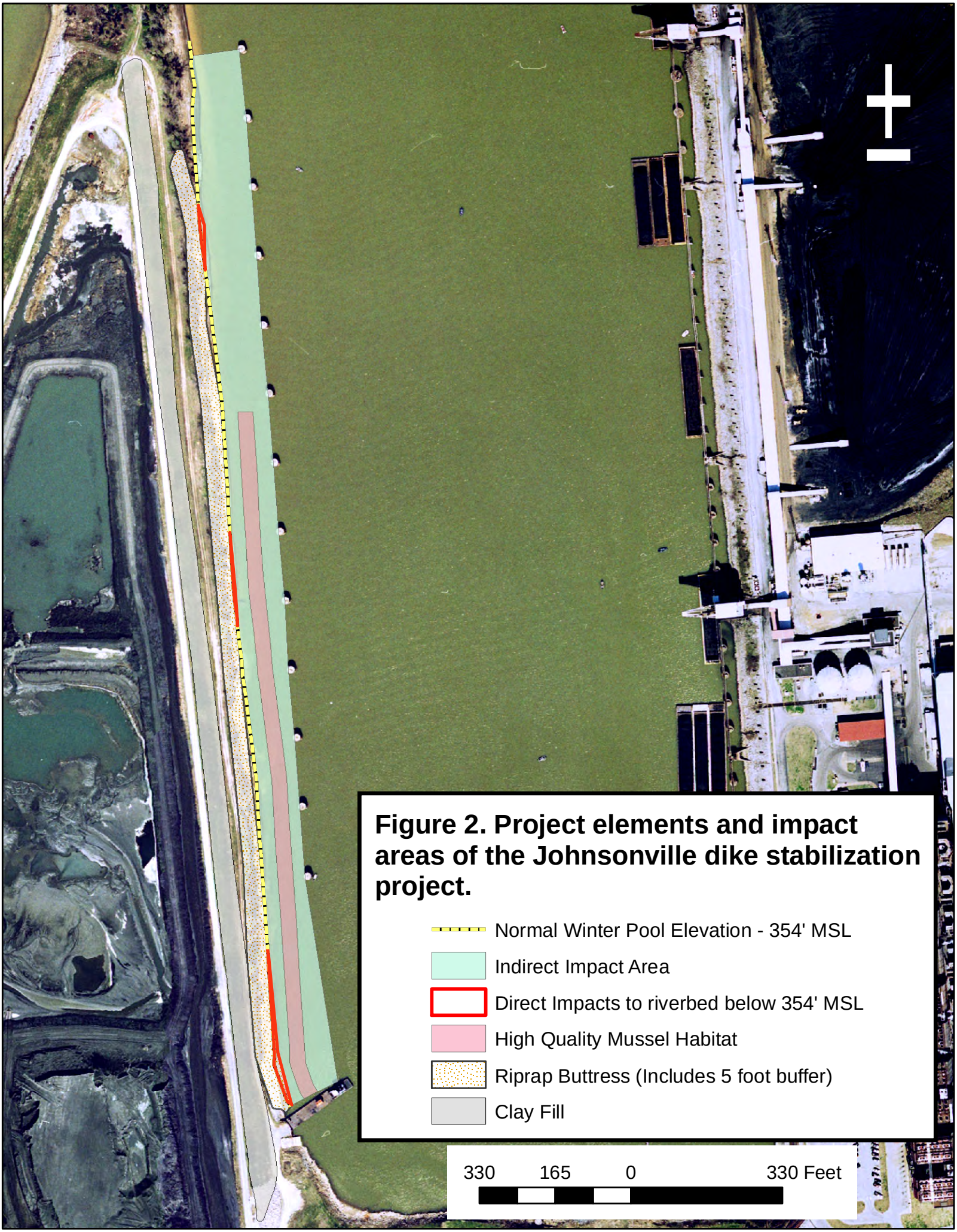
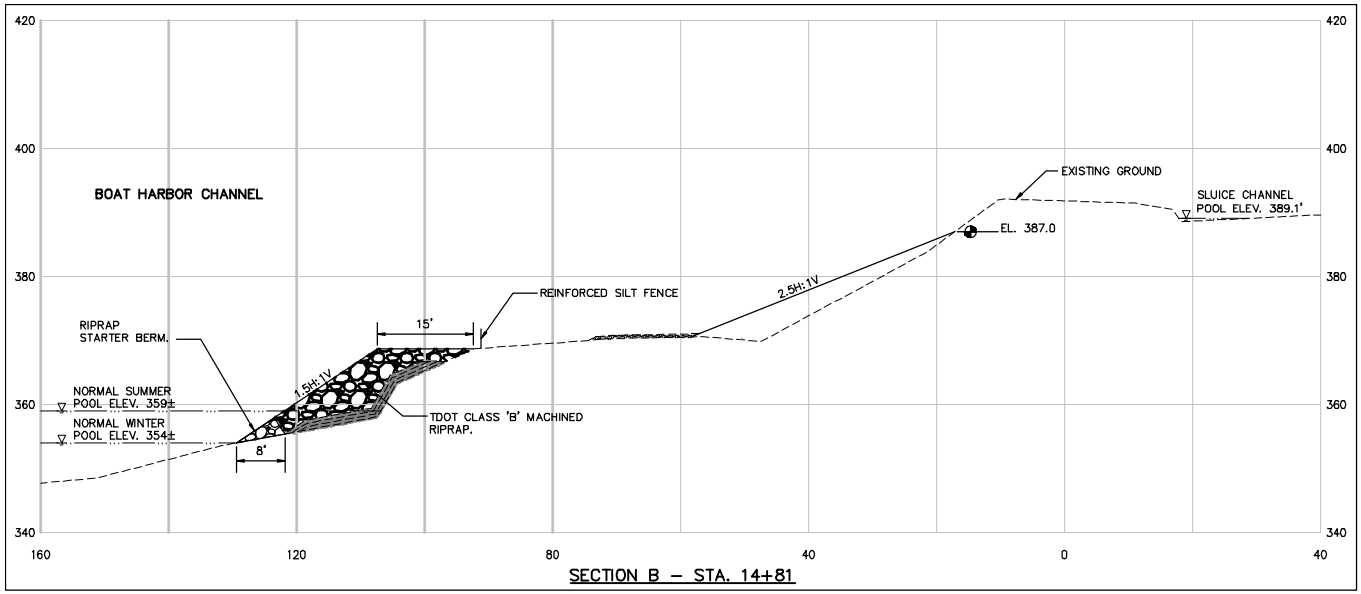


Figure 2. Project elements and impact areas of the Johnsonville dike stabilization project.

Figure 3. Example cross-section view of dike properties and stabilization actions (drawing provided by Stantec).



TABLES

Table 1. Federally listed species and critical habitat reported from Humphreys County, Tennessee and potentially found near the Johnsonville dike project (TRM 99-100)[1].

Species Group	Scientific name	Common name	Federal status[2]	TN status[2]	Status of species record[3]	Presence of Critical Habitat	Affected by proposed action
BIRDS	*Charadrius melodus*	piping plover (Great Lakes watershed)	T	-	-	-	-
		piping plover (all others)	E	(S2)	E	NO	NO
FISH	*Noturus stanauli*	pygmy madtom	E	E	E	NO	NO
MAMMALS	*Myotis grisescens*	gray bat	E	E	E	NO	NO
MUSSELS	*Lampsilis abrupta*	pink mucket	E	E	E	NO	YES
	Lexingtonia dolabelloides	slabside pearlymussel	C	(S2)	E	NO	NO
	Obovaria retusa	ring pink	E	E	H	NO	NO
	Plethobasus cooperianus	orangefoot pimpleback	E	E	H	NO	NO
	Pleurobema plenum	rough pigtoe	E	E	X	NO	NO

[1] Source: TVA Natural Heritage Program Database (aquatic records within 10 miles, plants records within 5miles, terrestrial animals within 3 miles of project site; database reviewed on 10/07/09 for plants, 10/28/09 for terrestrial animals, and 11/04/09 for aquatic animals).

[2] C = candidate, E = endangered, T = threatened; S2 = not a legal status but tracked as an imperiled species in Tennessee.

[3] E = Extant, record <25 years old; H = Historical, record >25 years old; X = Extirpated, presumed gone from the area due to age of historical record and potential loss of habitat.

APPENDIX A

Report for Mussel and Habitat Survey of the Johnsonville Dike Stabilization Project, December 2009.

Embayment Survey for Dike Maintenance

Johnsonville Fossil Plant
Humphreys County, Tennessee

Prepared for
Tennessee Valley Authority

December 8, 2009

Prepared by
Third Rock Consultants, LLC
2526 Regency Road, Suite 180
Lexington, KY 40503
859.977.2000

Prepared by:

Chelsey Olson

Reviewed by:

Gina Morris

THIRD ROCK CONSULTANTS

www.thirdrockconsultants.com

Environmental Analysis & Restoration

Table of Contents

Page

I. PROJECT DESCRIPTION 1
A. Johnsonville Island Dike Maintenance 1
B. Mooring Cells 13, 16, and 21 1

II. BIOLOGICAL RESOURCES 3

III. SURVEY METHODS 3
A. Johnsonville Island Dike Maintenance 3
B. Mooring Cells 13, 16 and 21 4

IV. RESULTS 4

EXHIBIT

Exhibit 1 – Mussel Survey Details 2

APPENDICES

Appendix A – Tables
Appendix B – Field Notes
Appendix C – Photo Log

I. PROJECT DESCRIPTION

A. Johnsonville Island Dike Maintenance

The Tennessee Valley Authority (TVA) plans to conduct maintenance on a dike that supports the eastern margin of a coal ash storage area (Johnsonville Island) at the Johnsonville Fossil Plant (JOF) near New Johnsonville (Humphreys County), Tennessee. The dike faces an embayment of the Tennessee River between the island and the plant near River Mile 99 (Exhibit 1, page 2). The proposed project would include clearing existing cover (*e.g.*, vegetation and riprap) from the dike, extending the thickness of the dike wall both above and below the normal summer and winter pool elevations (approximately 359 ft and 354 ft, respectively), and reinforcing the dike with riprap (machined boulder-sized rock).

West Bank, Coal Ash Storage Dike

Approximately 1,600 ft (or approximately 500 meters [m]; see Exhibit 1, page 2) of the dike will be repaired. Widening and regrading the dike will vary slightly in extent based on existing dike topography but will extend no more than about 30 ft into the embayment. The base of the proposed dike would be extended to a maximum of seven feet below normal winter pool (*i.e.*, 347 ft).

Impacts from the proposed work include direct covering of the riverbed by sediment and riprap above an elevation of 347 ft. Indirect impacts primarily include elevated levels of suspended sediment in the water near the dike and accumulation of sediment on the riverbed adjacent the dike project area. Appropriate streamside best management plans (BMP's) (*e.g.*, silt fences, erosion blankets, and seeding/planting of vegetation) will be used to control sediment runoff from the construction areas into adjacent waters of the Tennessee River.

B. Mooring Cells 13, 16, and 21

Barge mooring cells No. 13, 16, and 21 (Exhibit 1, page 2) are in need of replacement. Construction on these cells is expected to occur in early spring of 2010 during winter pool elevations.

East Bank, Load Out Facility 2

The sheet piling of the existing mooring cells will be cut and removed, and new sheet piling will be driven into the substrate in nearly the same footprint of the existing cells then filled with rock. Since Cell 13 is adjacent the northern coal unloader at the JOF facility, it is likely that the riverbed near the cell is impacted by coal debris from the unloading process.

The areas around these cells are also routinely subjected to disturbance from tow propeller wash, as well as fine sediment accumulation due to very little or no natural river current.

Impacts from the replacement of the mooring cells could include direct impact to the riverbed from falling debris (*e.g.*, sheet pilings and rock fill) and spudding of work barges. Indirect impacts could include temporary increases in levels of suspended sediment and vibration disturbance from construction activity.

II. BIOLOGICAL RESOURCES

The TVA Natural Heritage Database indicates extant records of the federally endangered pink mucket (*Lampsilis abrupta*) and federal candidate slabside pearlymussel (*Lexingtonia dolabelloides*) within 10 miles of the project site. Historical records of the federally endangered orangefoot pimpleback (*Plethobasus cooperianus*), ring pink (*Obovaria retusa*), and rough pigtoe (*Pleurobema plenum*) also exist near the project site, but are assumed to be extirpated or extremely unlikely to occur. Although the project occurs in an embayment that has relatively little flow and may not support quality mussel habitat, the Tennessee Wildlife Resource Agency (Don Hubbs, pers. comm., November 2009) has observed commercial mussel harvesting activity within the embayment, which suggests that portions of the embayment may support habitat suitable for rare species such as pink mucket.

III. SURVEY METHODS

A. Johnsonville Island Dike Maintenance

The survey area included the direct impact area (approximately1,600 ft long by 30 ft wide) along the dike, as well as a buffer area measuring approximately 200 ft north, 200 ft south, and 70 ft east of the work area (Exhibit 1). A combination of semi-quantitative and qualitative sampling methods were used to characterize mussel distribution, species composition, relative abundance, and catch per effort (as density and catch per hour). A total of 11 transects spaced 200 ft (approximately 60 m) apart were sampled by divers. Transects (lines weighted to the riverbed) 100 ft (approximately 30 m) in length were oriented perpendicular to the dike. GPS coordinates (Tennessee State Plane, NAD1927) of the transect endpoints were recorded.

Along each transect, divers collected all mussels (live and dead) within 1 m wide by 10 m long sections. Search time per 10 m^2 section varied with mussel density, although a minimum of five minutes search time was spent per 10 m^2 section. Actual survey time was recorded per 10 m^2 section to enable catch per hour estimates of mussel density. Divers used visual and tactual (disturbing the substrate by hand) search methods, placing all live and dead mussels into a mesh collection bag that was retrieved and processed in the boat.

A qualified malacologist identified and counted all live mussels. Up to 25 individuals of each common species were measured (length in mm) and aged (external annuli count) to document recruitment. Dead unionids (shells only) were scored as either freshly dead (with or without soft tissues, nacre lustrous, valves typically intact, periostracum present; animal likely dead less than one year), weathered dead (no soft tissues, nacre very dull or chalky, valves may or may not be intact, periostracum worn; animal probably dead more than one year), or relict (portion of a shell and/or extremely worn and chalky, valves not intact, little or no periostracum; animal dead from many years to many decades). Only freshly dead shells were quantified to provide an estimate of recent mortality at the time of the study.

When mussel density along any 10-meter transect segment was ≥ 1 mussel/m^2, then an additional qualitative search was conducted between that transect and adjacent transects within areas containing the most suitable mussel habitat and/or highest mussel abundance. Qualitative searches lasted a minimum of 15 minutes.

During processing, mussels were kept within mesh collection bags submersed in the river. Out-of-water time for each mussel was not more than 5 minutes. Non-listed mussel species were returned to the river from the water surface (boat) along each transect in the general area from which they were collected. No live mussels were harmed or removed from the site during the field survey. Copies of current federal and state scientific collecting permits to collect mussels (including pink mucket) were provided by the onsite malacologist to TVA Heritage Resources prior to the survey (*e.g.*, with the cost estimate).

Relative substrate composition (percent total composition of each particle size using the Wentworth Scale - not just generalized descriptions) was visually estimated by the diver at the terminus of each 10-meter increment along transects. Depth was recorded at each 10m section of transect as measured by a pneumatic pressure gage attached to the diver. Water velocity and water chemistry (temperature, dissolved oxygen, pH, and clarity [turbidity or Secchi disk]) were measured within the study area and at a control site outside the project area. GPS coordinates of these locations were recorded, and digital images of the site were recorded.

Field notes are contained in Appendix B.

B. Mooring Cells 13, 16 and 21

The survey area around each mooring cell was delineated by three 100-ft sampling transects oriented perpendicular to the bank and spaced 100ft apart (or within adjacent mooring cells). The middle transect was placed in line with the mooring cell being surveyed. Surveying for mussels, substrate, and depth was conducted as described above for the Johnsonville Island Dike area, except that a minimum of two 15-minute qualitative searches were conducted within the study area around each cell (regardless of mussel densities observed along transects).

IV. RESULTS

A total of 1,951 live mussels were collected during the mussel survey (Table 1, Appendix A), of which all but 5 were collected from the west bank (adjacent to the coal ash storage dike).

Ebonyshells

Highest mussel densities were encountered at the southern end of the project area between transects 1 and 6. Average mussel densities along the 30-meter transects ranged from 0 to 12.0 mussels/m^2 (Exhibit 1, page 2 and Table 2, Appendix A). Each transect was divided into three 10-meter segments. Mussel densities in the 10-meter segments ranged from 0 to 25.6 mussels/m^2. Within these 10-meter segments highest densities were observed between 10 and 20 meters, accounting for 81% of the mussels collected during the survey.

Transects 1 through 10 each had at least one 10-meter segment within which a density greater than 1 mussel/m^2 was realized. Therefore, between each of these transects a timed qualitative search of 15 minutes was conducted in the area of greatest observed mussel density. Catch per unit effort (CPUE) during these qualitative surveys ranged from 0 to 655 mussels per hour. The trend in mussel density observed during the quantitative transects was further supported by the results of the qualitative searches.

A total of 5 mussels were observed during the survey of the east bank (2 from the quantitative transects and 3 from the qualitative transects). Quantitative mussel densities were low (0.1 mussel/square meter or less) and CPUE on qualitative transects ranged from 0 to 3 mussels per hour.

Substrates encountered within the project area included riprap, cobble, coal, gravel, sand, clay, and silt/mud. On the west bank, the concentration of silt/mud increased from south to north and, correspondingly, mussel densities decreased (Exhibit 1). Within the area of highest mussel density (between 10 and 20 meters, transects 1 through 6) substrates were a gravel dominated sand mixture (70 to 90 percent gravel and 10 to 30 percent sand) to a sand or silt/mud dominated gravel mixture (75 to 90 percent sand or silt/mud and 10 to 25 percent gravel). Gravel become less abundant as distance from the bank increased (Table 3, Appendix A).

Water velocity and water quality measurements were taken at two sites – one inside the project area and one at a reference site outside of the project area (Exhibit 1). Measurements at both sites were similar (Table 4, Appendix A). Average water temperature observed during the survey was 62.4°F. Turbidity was the only measured parameter that exhibited some degree of stratification, increasing with depth. Flow within the embayment area was negligible.

The majority of dead unionid shells encountered during the survey were classified as weathered dead, followed by relict. One weathered dead pink mucket was collected from transect 4 (see photo log, Appendix C). Only 7 fresh dead unionids were encountered during the survey (3 threeridge, 2 washboards, and 2 pimplebacks).

No live federally listed mussel species were encountered during the field survey. No zebra mussels were observed in the project area (free or attached to unionids). Extreme air temperatures were not encountered during the field survey as temperatures ranged between 43 and 61 degrees Fahrenheit.

Map Document: (P:\Project_Files\Tennessee\TN9-011_TVA_JohnsonvilleMussels\Mapping\GIS\chelsey_working.mxd) 12/2/2009 -- 8:06:30 AM WCO

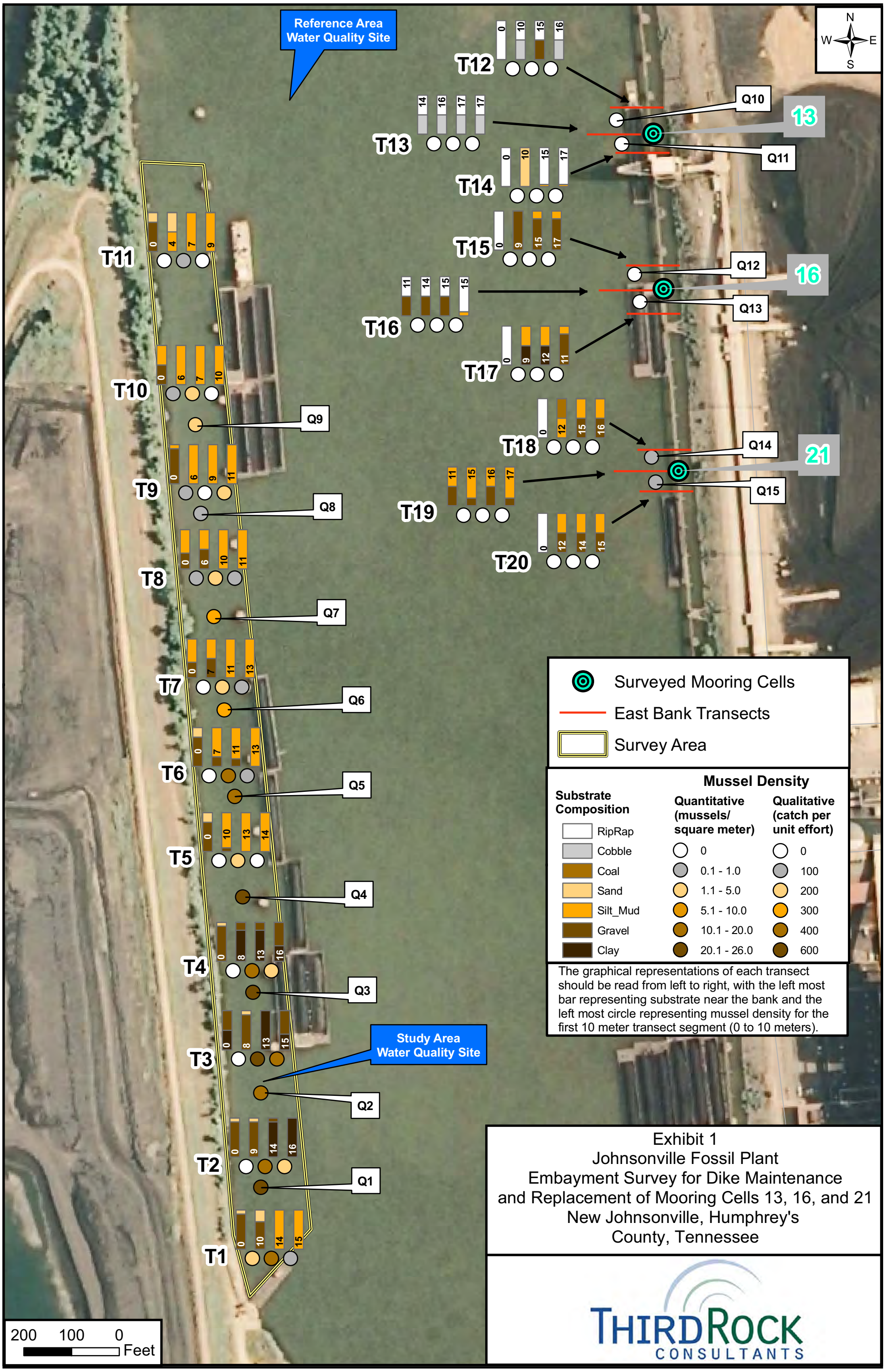


Exhibit 1
Johnsonville Fossil Plant
Embayment Survey for Dike Maintenance
and Replacement of Mooring Cells 13, 16, and 21
New Johnsonville, Humphrey's
County, Tennessee

APPENDICES

APPENDIX A – TABLES

Table 1
Mussel Species Composition
Johnsonville Fossil Plant Embayment Survey

Species Name	Common Name	TOTAL (Quantitative)	TOTAL (Qualitative)	TOTAL (Combined
Amblema plicata	Threeridge	384	261	645
Megalonaias nervosa	Washboard	134	102	236
Fusconaia ebena	Ebonyshell	139	94	233
Quadrula apiculata	Southern mapleleaf	61	29	90
Quadrula pustulosa	Pimpleback	208	169	377
Quadrula nodulata	Wartyback	22	47	69
Potamilus alatus	Pink heelsplitter	23	13	36
Elliptio crassidens	Elephant ear	2	1	3
Quadrula quadrula	Mapleleaf	143	59	202
Fusconaia flava	Wabash pigtoe	11	14	25
Obliquaria reflexa	Threehorn wartyback	14	2	16
Ellipsaria lineolata	Butterfly	5	1	6
Plectomarus dombeyanus	Bankclimber	3	2	5
Leptodea fragilis	Fragile papershell	2	2	4
Arcidens confragosus	Rock pocketbook	1		1
Lampsilis teres	Yellow sandshell	2	1	3
TOTAL		**1154**	**797**	**1951**

Table 2
Mussel Distribution
Density Per Transect, Density Per 10-Meter Segment, Catch Per Hour
Johnsonville Fossil Plant Embayment Survey

Transect (Q# = Qualitative Search	Transect Segment	Common Name	Threeridge	Washboard	Ebonyshell	Southern mapleleaf	Pimpleback	Wartyback	Pink heelsplitter	Elephant ear	Mapleleaf	Wabash pigtoe	Threehorn wartyback	Butterfly	Bankclimber	Fragile papershell	Rock pocketbook	Yellow sandshell	TOTAL	Density per transect(mussels/sq meter)	Density/10-meter segment (mussels/sq meter)	Catch per hour/transect
		Species Name	Amblema plicata	Megalonaias nervosa	Fusconaia ebena	Quadrula apiculata	Quadrula pustulosa	Quadrula nodulata	Potamilus alatus	Elliptio crassidens	Quadrula quadrula	Fusconaia flava	Obliquaria reflexa	Ellipsaria lineolata	Plectomarus dombeyanu	Leptodea fragilis	Arcidens confragosus	Lampsilis teres				
1	0-10					11		5											16	5.4	1.6	220
	10-20		44	19	4	7	40		4	2	17	2							139		13.9	
	20-30		3	2															5		0.5	
Q1			33	17	7	5	67		2		13	2			1				147			588
2	0-10																		0	7.5	0	271
	10-20		61	21	16	8	43	6	1		23		2	2	1				184		18.4	
	20-30		9	2	7		3				11								32		3.2	
Q2			35	12	11	3	11		3	1	11		1						88			352
3	0-10																		0	12	0	655
	10-20		84	23	32	26	38		5		35	1	8	2	1	1			256		25.6	
	20-30		28	16	12	3	4	3	1		34	2			1				104		10.4	
Q3			35	5	67	1	22	2	3		6	3		1					145			580
4	0-10																		0	5	0	171
	10-20		33	12	26	3	26		3		1	3				1			108		10.7	
	20-30		5	5	31		2												43		4.3	
Q4			59	18	6	10	32	8	1		9	1							144			576
5	0-10																		0	0.9	0	62
	10-20		12	3	2		6	1			1		1						26		2.6	
	20-30																		0		0	
Q5			31	17	1	2	12	10	1		8	2			1				85			340
6	0-10																		0	4.2	0	381
	10-20		58	9	7		27		1		10	2	3	1					118		11.8	
	20-30		1	2	1	1	1				2						1		9		0.9	
Q6			28	9	1	4	8	9			6	1				1			67			268
7	0-10																		0	0.8	0	63
	10-20		9	1			8	2	1			1							22		2.2	
	20-30																	1	1		0.1	
Q7			27	5	1	1	7	7	1		2	1				1			53			212
8	0-10		1																1	0.6	0.1	45
	10-20		7	3	1		2	1	1		1								16		1.6	
	20-30		1																1		0.1	
Q8			3	4		2	4	2	1		1	2							19			76
9	0-10		1																1	1.5	0.1	145
	10-20		16	7			6	3	1		6								39		3.9	
	20-30			2		1	1		1										5		0.5	
Q9			8	15		1	6	9			3	2	1					1	46			184
10	0-10								1										1	0.7	0.1	75
	10-20		10	6		1	1		1										19		1.9	

Table 2
Mussel Distribution
Density Per Transect, Density Per 10-Meter Segment, Catch Per Hour
Johnsonville Fossil Plant Embayment Survey

Transect (Q# = Qualitative Search	Transect Segment	Common Name	Threeridge	Washboard	Ebonyshell	Southern mapleleaf	Pimpleback	Wartyback	Pink heelsplitter	Elephant ear	Mapleleaf	Wabash pigtoe	Threehorn wartyback	Butterfly	Bankclimber	Fragile papershell	Rock pocketbook	Yellow sandshell	TOTAL	Density per transect(mussels/sq meter)	Density/10-meter segment (mussels/sq meter)	Catch per hour/transect
		Species Name	Amblema plicata	Megalonaias nervosa	Fusconaia ebena	Quadrula apiculata	Quadrula pustulosa	Quadrula nodulata	Potamilus alatus	Elliptio crassidens	Quadrula quadrula	Fusconaia flava	Obliquaria reflexa	Ellipsaria lineolata	Plectomarus dombeyanu	Leptodea fragilis	Arcidens confragosus	Lampsilis teres				
	20-30																		0		0	
11	0-10																		0	0.2	0	18
	10-20			1				1	2		2								6		0.6	
	20-30																		0		0	
Q10																						0
12-18	0-10																		0	0	0	0
	10-20																		0		0	
	20-30																		0		0	
Q11																						0
Q12																						0
Q13																						0
19	0-10																	1	1	0	0.1	3
	10-20																		0		0	
	20-30																		0		0	
Q14			2																2			8
20	0-10																		0	0	0	3
	10-20		1																1		0.1	
	20-30																		0		0	
Q15									1										1			4
TOTAL			645	236	233	90	377	69	36	3	202	25	16	6	5	4	1	3	1951			

Table 3
Substrate Composition (%)
Johnsonville Fossil Plant Embayment Survey

	Depth (feet)	Rip Rap	Cobble	Coal	Gravel	Sand	Clay	Silt/Mud
Transect 1								
0 meters	-				90	10		
10 meters	10				70	30		
20 meters	14						100	
30 meters	15						100	
Transect 2								
0 meters	-				90	10		
10 meters	9				90	10		
20 meters	14				10		90	
30 meters	16						100	
Transect 3								
0 meters	-				50		50	
10 meters	8				90	10		
20 meters	13						100	
30 meters	15				60		40	
Transect 4								
0 meters	-				90	10		
10 meters	8				20		80	
20 meters	13				20		80	
30 meters	16						100	
Transect 5								
0 meters	-				75	25		
10 meters	10				10			90
20 meters	13							100
30 meters	14							100
Transect 6								
0 meters	-				75	25		
10 meters	7				25			75
20 meters	11				20			80
30 meters	13							100
Transect 7								
0 meters	-				40			60
10 meters	7				50			50
20 meters	11							100
30 meters	13							100
Transect 8								
0 meters	-				40			60
10 meters	6				50			50
20 meters	10							100
30 meters	11							100
Transect 9								
0 meters	-				90			10
10 meters	6							100
20 meters	9							100
30 meters	11							100
Transect 10								
0 meters	-				50			50
10 meters	6							100
20 meters	7							100
30 meters	10							100
Transect 11								
0 meters	-				75	25		

Table 3
Substrate Composition (%)
Johnsonville Fossil Plant Embayment Survey

	Depth (feet)	Rip Rap	Cobble	Coal	Gravel	Sand	Clay	Silt/Mud
10 meters	4					50		50
20 meters	7							100
30 meters	9							100
Transect 12								
0 meters	-	100						
10 meters	10	50	50					
20 meters	15	50	50					
30 meters	16	50			50			
Transect 13								
0 meters	14	50	50					
10 meters	16	50	50					
20 meters	17	50	50					
30 meters	17	50	50					
Transect 14								
0 meters	-	100						
10 meters	10					100		
20 meters	15	95						5
30 meters	17	95						5
Transect 15								
0 meters	-	100						
10 meters	9				100			
20 meters	15				80			20
30 meters	17				80			20
Transect 16								
0 meters	11	50			50			
10 meters	14	50			50			
20 meters	15	50			50			
30 meters	15	90						10
Transect 17								
0 meters	-	100						
10 meters	9						50	50
20 meters	12						50	50
30 meters	11				80			20
Transect 18								
0 meters	-	100						
10 meters	12			50				50
20 meters	15				50			50
30 meters	16				50			50
Transect 19								
0 meters	11				50			50
10 meters	15				20			80
20 meters	16				50			50
30 meters	17				20			80
Transect 20								
0 meters	-	100						
10 meters	12				50			50
20 meters	14				50			50
30 meters	15				50			50

Table 4
Water Chemistry
Johnsonville Fossil Plant Embayment Survey

Site	Parameter				
Project Area (Depth in feet)	Temperature (°F)	DO (mg/L)	pH (Standard Units)	Conductivity (µS)	Turbidity (NTU)
0	62.6	9.45	7.57	147.2	1
3	62.6	9.48	7.6	147.6	1.8
6	62.3	9.47	7.56	147.9	7.6
9	62.1	9.45	7.55	147.6	9.99
12	61.7	9.42	7.54	147.3	8.4
15	61.9	9.41	7.52	147.5	11.4
Reference Area (Depth in feet)					
0	62.7	9.48	7.59	148.6	0.3
3	62.8	9.47	7.7	148.5	5.7
6	62.8	9.42	7.67	148.8	6.1
9	62.5	9.4	7.64	148.7	8.2
12	62.2	9.38	7.63	149.1	12.1
15	62.1	9.15	7.6	149.4	11.6

Table 5		
Geographic Coordinates of Transects and Qualitative Search Areas (Decimal Degrees)		
Transect Number	Latitude	Longitude
1	36.02733476	-87.99091766
2	36.02788109	-87.99105763
3	36.02841862	-87.99119812
4	36.02898725	-87.99116903
5	36.02952965	-87.99132133
6	36.03005343	-87.99133793
7	36.03060194	-87.99144681
8	36.03115515	-87.99151252
9	36.03170416	-87.99141822
10	36.03234571	-87.99158100
11	36.03306513	-87.99163029
12	36.03403710	-87.98914966
13	36.03371238	-87.98891690
14	36.03358171	-87.98874700
15	36.03300453	-87.98858137
16	36.03288383	-87.98879854
17	36.03274805	-87.98863728
18	36.03184959	-87.98858950
19	36.03178027	-87.98860232
20	36.03170886	-87.98851456
Qualitative Search Number		
1	36.02766459	-87.99119880
2	36.02821355	-87.99121255
3	36.02878540	-87.99128566
4	36.02934531	-87.99135848
5	36.02992885	-87.99144659
6	36.03041692	-87.99153231
7	36.03095296	-87.99160453
8	36.03153626	-87.99170734
9	36.03204868	-87.99176427
10	36.03382687	-87.98885258
11	36.03368441	-87.98879013
12	36.03294485	-87.98868330
13	36.03280191	-87.98865028
14	36.03190672	-87.98855428
15	36.03177574	-87.98852156

APPENDIX B – FIELD NOTES

Omitted to reduce size of document. Information is available upon request (TVA 12/22/09).

APPENDIX C – PHOTO LOG

East Bank, Load Out Facility

East Bank, Load Out Facility

East Bank, Load Out Facility

West Bank, Coal Ash Storage Dike

West Bank, Coal Ash Storage Dike

West Bank, Coal Ash Storage Dike

Bankclimber

Butterfly

Ebonyshell

Ebonyshells

Elephant Ear

Mapleleaf

Pink Heelsplitter

Pink Mucket, Weathered Dead

Rock Pocketbook

Three Ridge

Three Ridge, Washboard, Elephant Ear, Pimpleback, Mapleleaf, and Southern Mapleleaf

Threehorn Wartyback

Wabash Pigtoe

Wartyback

Wartybacks and Pimplebacks

Washboard

Yellow Sandshell

LAST PAGE OF DOCUMENT