United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, TN 38501

February 1, 2010

Ms. Peggy W. Shute
Manager, Biological Permitting and Compliance
Endangered Species Act Compliance Officer
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902-1499

Re: FWS #2010-F-0152

Dear Ms. Shute:

This document is the biological opinion of the Fish and Wildlife Service (Service) based on our review of the proposed stabilization of the northeast dike partially enclosing the Johnsonville Fossil Plant (JOF) Ash Disposal Area No. 2 (Johnsonville Island) between Tennessee River Mile (TRM) 99 and TRM 100 within the Kentucky Reservoir impoundment in Humphreys County, Tennessee, and its effects on the endangered pink mucket (*Lampsilis abrupta*) per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your January 6, 2010, request for formal consultation was received on January 12, 2010.

This biological opinion is based on information provided in the January 7, 2010, biological assessment and other sources of information. A complete administrative record of this consultation is on file and available for review at the Cookeville Ecological Services Field Office, 446 Neal Street, Cookeville, Tennessee 38501.

Consultation History

November 11, 2009 — The Tennessee Valley Authority (TVA) discussed proposed project with the Tennessee Wildlife Resources Agency (TWRA) to help evaluate potential of impacts to listed mussels (Phone conversation between Chuck Howard [TVA] and Don Hubbs [TWRA]).

November 18, 2009 — TVA notified Service and TWRA of proposed project and requested comments on a survey plan for mussels and habitat near the project site (Email from Chuck Howard [TVA] to Jim Widlak [Service] and Rob Todd [TWRA]).

November 20, 2009 — Service agreed that survey plan was appropriate to characterize mussels and habitat near the proposed project (Email from Jim Widlak [Service] to Chuck Howard [TVA]).

November 25, 2009 — Mussel and habitat survey near the proposed project was completed by Third Rock Consulting and Mainstream Commercial Diving.

December 9, 2009 — TVA provided Service report from JOF dike mussel survey and met with Service and Stantec Consulting at Service's Tennessee Ecological Services Field Office in Cookeville, Tennessee, to discuss project details and results of mussel survey.

January 12, 2010 — Service received Biological Assessment (BA) from TVA, requesting formal consultation under provisions of the Act, section 7.

FWS Log No: 10-F-0152 ***Application No:*** *N/A*
Date Started: January 12, 2010 ***Ecosystem:*** Lower Tennessee/Cumberland
Applicant: N/A ***Action Agency:*** TVA
Project Title: Dike Stabilization of the Johnsonville Ash Storage Pond
County: Humphreys

Table 1. Species and critical habitat evaluated for effects and those where "no effect" was determined or the Service has concurred with a "not likely to adversely affect" determination.

SPECIES or CRITICAL HABITAT	PRESENT IN ACTION AREA	PRESENT IN ACTION AREA BUT "NO EFFECT" OR "NOT LIKELY TO BE ADVERSELY AFFECTED"
Pink mucket (*Lampsilis abrupta*)	X	
Gray bat (*Myotis grisescens*)	X	X
Orangefoot pimpleback (*Plethobasus cooperianus*)	X	X

Piping plover (*Charadrius melodus*)	X	X
Pygmy madtom (*Noturus stanauli*)	X	X
Ring pink (*Obovaria retusa*)	X	X
Rough pigtoe (*Pleurobema plenum*)	X	X

The slabside pearly mussel (*Lexingtonia* [=*Pleuronaia*] *dolabelloides*), a federal candidate species for listing, was also identified by TVA as being potentially present in the project action area. Candidate species are not afforded protection under the Act. However, the Service does appreciate that this species was included in their review and concur with TVA that the project will not result in impacts on this species.

BIOLOGICAL OPINION

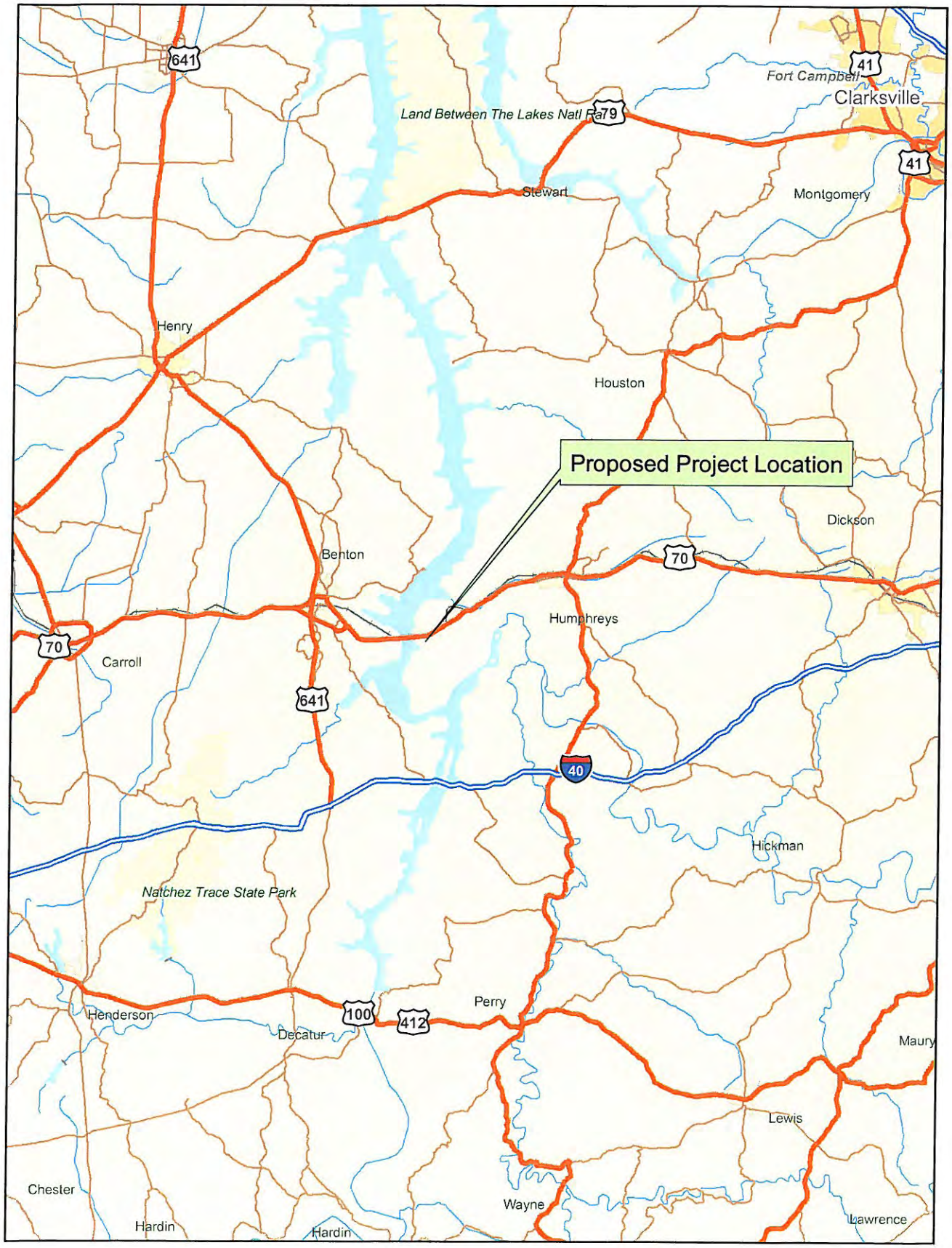
DESCRIPTION OF THE PROPOSED ACTION

The proposed project is located between TRM 99 and TRM 100 within the Kentucky Reservoir impoundment in Humphreys County, Tennessee (refer to Figure 1).

The proposed action is to enhance the slope stability of the northeast dike of the JOF Ash Disposal Area No. 2 (see Figure 1, Appendix A), as well as make it possible to perform proper routine slope maintenance on the northeast dike so as not to affect dike stability. 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, Appendix A). 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, Appendix A). Seepage collection filters 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. 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). General descriptions of the existing dike conditions and preliminary evaluation (Phase I) assessment of the JOF ash pond dike stability was reported by Stantec (2009); available online at http://www.tva.gov/power/stantec/).

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 best management practices (BMPs). Newly flattened

Figure 1. Johnsonville Ash Storage Pond Dike Stabilization Project



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 separately 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 Act analysis would be completed to address the potential environmental effects of ash pond closure.

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 mean sea level (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 (square feet), 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; 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 is 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 may be indirectly affected.

The pink mucket is the only species identified in this biological opinion that is likely to occur in the action area, and, thus, is the only federally listed species likely to be adversely affected by the proposed action. Because the pink mucket is a rare species (one individual may be found for every 10,000 mussels collected), TWRA has been culturing this species to augment population levels to the point where the species can again sustain itself. TVA has committed funding research efforts to support additional propagation and recovery of the Tennessee River population of pink mucket in an amount of at least $10,000 (TVA 2010). These funds would be provided to the Service or a Service designated agent within one year of completing the proposed action. Cultured pink muckets shall be out-planted to augment existing populations in Tennessee River sanctuary areas as identified by TWRA.

The Service has described the action area to include the 2,350-ft length of the proposed dike stabilization project, including the proposed riprap buttress and 5-ft buffer, and an area extending from the normal winter pool level along the dike eastward approximately 100ft (Figure 2) for reasons that will be explained and discussed in the **"EFFECTS OF THE ACTION"** section of this consultation.

STATUS OF THE SPECIES/CRITICAL HABITAT

Species/critical habitat description

The pink mucket, *Lampsilis abrupta*, was listed as an endangered species on June 14, 1976 (Code of Federal Regulations 1976). No critical habitat has been designated for this species.

The pink mucket is a medium-sized mussel, growing to a length of approximately 4.5 to 5 inches. The shells are subquadrate or circular in shape and become thick and heavy in mature individuals. Anterior edges of the shells are rounded, with slightly curved dorsal and ventral margins. The posterior margins of the shells in females are slightly rounded to straight; shells of the males are rounded or bluntly pointed. A well-defined posterior ridge is present in the males. Color of the outer shell surface (periostracum) varies from light yellow or yellowish-brown to dark brown, occasionally marked with broken fine to fairly wide dark green rays. The color of the inner shell surface (nacre) varies from white to pink to salmon in color, with the posterior margin being iridescent (Parmalee and Bogan 1998).

Life History

The pink mucket inhabits areas in large rivers with swift currents, depths of 1.6 feet to 26.2 feet, and mixed sand/gravel/cobble substrate. Notwithstanding this, the pink mucket appears to have adapted to reservoir-type conditions in the upper reaches of some impoundments. Life history aspects of this species are presently unknown. Reproduction is likely similar to other freshwater mussels. Males release sperm into the water column; the sperm are taken in by females during normal siphoning activity. Fertilized eggs are retained in specially modified gills (marsupia) until the larvae (glochidia) are fully developed. Once released, the glochidia must attach to the gills or fins of an appropriate fish host. They encyst and metamorphose into juvenile mussels.

Fully developed juveniles drop from the fish host and settle to the river bottom. The pink mucket is probably a long-term breeder, as are other *Lampsilis* species. The glochidia are undescribed. Freshwater mussels feed by siphoning food items that drift in the water column. The pink mucket likely feeds on items similar to other mussel species including algae, zooplankton, diatoms, and detritus.

Host fishes identified through laboratory induced infections include largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), spotted bass (*Micropterus punctulatus*), and walleye (*Sander vitreus*) (Barnhart et al. 1997) as well as white crappie (*Pomoxis annularis*) and sauger (*Sander canadense*) (J.B. Layzer and L.M. Madison, USGS, pers. comm., in Williams et al. 2008). The use of large piscivorous fishes for hosts is consistent with the presence of a fish-like mantle lure in pink mucket (Barnhart et at. 1997). Freshwater drum (*Aplodinotus grunniens*) was erroneously cited as being a host by Fuller (1974) (Williams et al. 2008) and Schulz and Marbain (1998) (probably based on the Fuller record).

Pink mucket often inhabit regulated rivers, particularly those navigational waters modified by locks and dams. Although not reservoir tolerant *per se*, it is found in tailwaters having good riverine-quality habitat (generally rocky substrates swept free of excessive fine sediment deposits by adequate currents). Reservoir conditions (characterized by slackwater, low oxygen, and heavy silt deposition) are not conducive for its survival and population sustainability. However, its host fishes are more habitat generalists, being commonly found in reservoir, tailwater, and riverine habitats. Host fishes can potentially convey attached glochidia across long distances, including across habitats unsuitable for the fishes' host organism (Bob Butler 2010).

The mobility of its hosts and/or host fish tolerance for habitats unsuitable for pink mucket may partially account for sometimes seemingly disjunct records of the mussel in streams like Paint Rock and Bourbeuse Rivers and Bear Creek. It is possible that these highly sporadic occurrences in otherwise well-sampled streams do not actually represent populations but are merely occurrences of low-probability events (e.g., having a highly mobile host fish carry juveniles spawned from a nearby source population shed post-metamorphosed pink mucket into suitable habitat). Without a readily accessible source population (Tennessee River, Guntersville Dam tailwaters for Paint Rock River; Tennessee River, Wilson Dam tailwaters for Bear Creek; and Meramec River for Bourbeuse and Big Rivers), relatively recent records for pink mucket would probably not exist in these streams. Conversely, relative close proximity of a source population in no way guarantees that these populations are or can naturally become sustainable (Bob Butler 2010).

Using the growth ring method, qualitative age estimations from external shell growth-rest ring counts (Neves and Moyer 1988) from 36 individuals collected from Osage River, MO suggests that pink mucket has a lifespan of at least 36 years (Ecological Services Inc. 2003). It is probable the species lives several years longer considering that the growth ring method typically underestimates age compared to quantitative age determinations (thin sectioning shells) and that the older the specimen the greater the underestimate of age (Neves and Moyer 1988). Unfortunately, no empirical age data exists from thin sectioning pink mucket shells.

An experimental pond propagation study that took place in early 2006 using Pink Mucket stock from Pickwick Landing tailwaters (Tennessee River, TN) shed light on aspects of its early life history (Don Hubbs 2009a). Host fish (largemouth bass) were infested with mature glochidia teased out of a gravid female pink mucket and contained in a small pond enclosure. By late summer 2006, six juvenile individuals that had survived post-metamorphosis were released into an enclosure in their parent tailwaters to monitor survival, growth, and sexual activity. After approximately 20 months, they had all survived and grown from approximately 0.9 inches length at the time of translocation to a range of 2.2-2.7 inches, and were beginning to develop sexual dimorphic shell characters (apparently four females and two males). A reassessment of the grow-out experiment in March 2009 when the mussels were approaching age 3 found 100% survival and that there were indeed four females and two males. The females all had charged gills (whether with eggs or glochidia was unknown) and had grown to a length range of 2.4-2.8 inches, while the males were larger at 3.1 and 3.2 inches (Bob Butler 2010).

From this age and growth data it appears that at least female pink mucket reach sexual maturity at age 2+. Growth is rapid for the first few years, especially in males. In general, mussel growth slows considerably after the first few years, presumably when individuals become fully mature, with energy instead going towards gamete production and development (Baird 2000).

Population Dynamics

Despite its wide range in historical times, pink mucket has apparently always been an uncommon species (Ortmann 1919, Johnson 1980, Recovery Plan). Most literature records report very low population numbers. In addition, only 11 of 232 Ohio State University Museum of Zoology (OSUM) Pink mucket records rangewide over several decades contained more than 10 specimens. All 11 of these OSUM lots represented collections made ca. 1980 from commercial sheller's cull piles in lower Tennessee and middle Cumberland Rivers, meaning the records represented protracted spatial and temporal collections from harvesting along several mile river reaches over extended collecting periods (L.M. Koch 2009).

Pink mucket collected during surveys tend to be large, old adult animals. Smaller juveniles or subadults are rarely if ever found in the vast majority of populations, despite recent quantitative quadrat sampling in several streams. If the species' rate of recruitment is characteristically very low (which there is no empirical data to support), this would at least partially explain the typical lack of evidence for recruitment that most populations exhibit. It is entirely possible that many of the populations now considered extant have recruitment rates that are below population maintenance levels if they don't suffer from outright recruitment failure. Below population maintenance levels indicate that a population is below the threshold of sustainability and that the population is in decline. Unless this downward population trend is arrested or reversed, the ultimate result will be extirpation. Considering the advanced age pink mucket attains (36+ years), non-recruiting populations may take decades to become extirpated. Therefore, it may not be known whether most populations are viable or not for many years to come (Bob Butler 2010).

The tendency of pink mucket to inhabit larger streams and oftentimes deeper water habitats may partially account for apparent rareness, since most collectors historically were unable to sample these habitats effectively. But recruitment rates may play a significant role in dictating relative population size. Current pink mucket recruitment rates would appear to be very low given the scant evidence we have for the presence of juveniles in many populations and despite considerable effort expended conducting quadrat sampling. Considering the species longevity and the fact that it has always appeared to be an uncommon species, it may stand to reason that recruitment rates are naturally low for pink mucket. If true, having a low rate of recruitment would make populations inherently more susceptible to extirpation when factors act in concert to further compromise the already low recruitment level (Bob Butler 2010).

What clearly makes pink mucket a very rare species today is the fact that although it appears to have always been uncommon and may have naturally low recruitment levels, its inhabited range is a fraction of what it was historically (over a 100 years ago), having lost several thousand miles of larger river habitat to habitat degradation. Considering the huge loss of range, it is likely the current total population size of pink mucket represents a small proportion of its historical numbers. Unfortunately, very little quantifiable information is available for estimating population size for this species either historically or currently (Bob Butler 2010).

Status and Distribution

The pink mucket is an Ohioan species with possibly the widest range known for a listed mussel. It is a rare larger-stream mussel that was widely distributed historically in at least 48 large rivers in 12 states. Presently, known populations occur in the Barren River, Big River, Black River, Clinch River, Cumberland River, Current River, Gasconade River, Green River, Kanawha River, Little Black River, Meramec River, Ohio River, Osage River, Paint Rock River, and Tennessee River (USFWS 1985; Parmalee and Bogan 1998). Of these extant populations, only a few have shown recent evidence of recruitment. Some taxonomists have recently postulated that the reproducing populations west of the Mississippi River are not *Lampsilis abrupta*, but rather are more closely related to another endangered species, the Higgins eye pearly mussel (*Lampsilis higginsi*). If this is true, then there are fewer known reproducing populations of *L. abrupta* than originally thought. Although it has a relatively wide distribution and is apparently more tolerant of reservoir-type habitat conditions than other listed mussel species, the pink mucket is reported to occur in low numbers where it occurs.

Currently, 29 populations are considered extant. With few exceptions the 29 extant populations are extremely small and occur in relatively short river reaches despite the extent of seemingly suitable habitat in many streams. Further, over one-third of its populations deemed extant are very sporadic in occurrence and known from only one or two individuals collected over approximately the past 25 years (e.g., Licking, French Broad, Clinch, Paint Rock, Sac, Bourbeuse, St. Francis, Current, Eleven Point Rivers; Bear Creek). Sixteen populations (55%) are restricted to over 16 river miles (RMs). Accordingly, a majority of populations are essentially limited to discrete reaches making the species in these streams highly susceptible to elimination from catastrophic stochastic events (Bob Butler 2010).

In the Tennessee River drainage, live pink muckets have been collected recently from below the following TVA dams: Wilson Dam, Pickwick Landing Dam (from the dam to the headwaters of Kentucky Lake), Kentucky Dam, Guntersville Dam, Nickajack Dam, Chickamauga Dam, Fort Loudon Dam, and Watts Bar Dam. Individuals were also found recently in the Holston River below Cherokee Dam, in the French Broad River below Douglas Dam, in the Clinch River below Melton Hill Dam and in Claiborne County, and below Bear Creek Dam and Wheeler Dam in Alabama.

Although it had a wide distribution, the pink mucket has never been considered to be a common species. It was listed as a result of reduction in range due to destruction and alteration of its habitat from impoundment, sedimentation from various land uses, and pollution from point and non-point industrial, municipal, and agricultural sources. Loss and alteration of habitat also resulted in changes in native fish populations and likely loss of glochidial hosts for the pink mucket.

Currently, the vast majority of the pink mucket's historical range has been altered and no longer offers suitable habitat (approximately an 80% loss). Despite the relatively large number of extant populations for a federally listed mussel, the total population size for pink mucket, although undetermined, appears to be relatively small based on significant loss of total range, infrequent occurrence in otherwise suitable habitat, very low relative abundance compared to other mussels, and overall rarity of the species). With few exceptions its 29 extant populations are: 1) invariably small (rarely are more than one or two individuals found per sample and a third of its populations are known from only one or two animals collected over the past 25 years), 2) characteristically rare (having low relative abundance), 3) sporadically or occasionally distributed (despite the extent of seemingly suitable habitat it is very patchy in distribution and occurrence), 4) generally limited in linear extent (most less than 30 RMs), and typically lacking evidence for recent recruitment (despite considerable quantitative quadrat sampling efforts). With many disjunct populations and its overall scarcity, the species is highly susceptible to localized extirpations from the genetic implications of extremely low population size and because of threats that are extremely difficult if not impossible to control. Stochastic events are a real concern for all populations, particularly reach-limited ones and those associated with navigation channels and other major transportation arteries (Bob Butler 2010).

Given its highly mobile hosts and history of localized occurrences, new pink mucket records will undoubtedly turn up in extant, historical, or potentially new streams of occurrence. However, we do not foresee a scenario in which the overall status of the species would be improved from such events. In summary, due to the factors highlighted in this section, the Service believes that the pink mucket should remain an endangered species (Bob Butler 2010).

A recovery plan was approved for the pink mucket on January 24, 1985. This species will be considered recovered when:

1. Two additional viable populations are found in any two rivers other than the Tennessee River, Cumberland River, and Meramec River. Populations in those two rivers will be distributed such that a single catastrophic event would likely not result in elimination of the population. Survey data must show at least five

viable populations with each having a minimum of two year classes between four and ten years of age.

2. Additional mussel sanctuaries must be established or expanded in river systems containing known populations of the pink mucket.

3. An education program must be established for the public with major emphasis toward commercial mussel harvesters.

4. The species and its habitat are protected from present and foreseeable human-related and natural threats that might interfere with survival of any of the populations.

The recovery criteria language implies that the pink mucket populations in Tennessee, Cumberland, and Meramec Rivers be widely distributed enough to prevent a single stochastic event from eliminating the population in order to meet this aspect of the criterion. Current status suggests that the linear extent of these three populations meets this aspect of the criterion. Eleven other extant pink mucket populations (total = 14 or 48%) are distributed widely enough (over 20 RMs) in individual rivers to probably be considered safe from single stochastic events potentially eradicating their populations (e.g., Ohio, Elk, Clinch, Osage, Gasconade, White, Black, Spring, Ouachita, Little Missouri, Saline Rivers). The significant but reach limited pink mucket population in Kanawha River is particularly susceptible to this threat (Bob Butler 2010).

Analysis of the species/critical habitat likely to be affected

The pink mucket is the only species that will be addressed in this biological opinion because it is the only federally listed species likely to occur in the action area, and, thus, is the only listed species likely to be adversely affected by the proposed action. In the Tennessee River, live pink muckets and relic pink mucket shells have been collected recently downstream of Kentucky Dam and upstream within Kentucky Lake. Based on TVA Regional Heritage Database records near the proposed action, data on pink mucket presence within the Tennessee River, and information about the mussel community and habitat specifically adjacent to the proposed project, it is likely that pink mucket inhabit the area adjacent to the proposed project. **Thus, pink mucket may be affected by the JOF dike project, and an effects analysis is presented in the next section.**

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.**

ENVIRONMENTAL BASELINE

The Tennessee River is the largest tributary of the Ohio River. It is approximately 652 miles in length and forms on the east side of Knoxville, Tennessee at the confluence of the French Broad River and Holston River. It flows southwest from Knoxville through east Tennessee and crosses into Alabama. It drains through northern Alabama, forming a small part of the state's border with Mississippi, before returning to Tennessee. The lower Tennessee River flows into Kentucky and enters the Ohio River at Paducah, Kentucky.

Kentucky Dam is 22 miles upstream from the confluence of the Tennessee River with the Ohio River. The dam is the longest in the TVA system, and the reservoir, which stretches for 184 miles across the states of Kentucky and Tennessee, is the largest in the eastern U.S. The reservoir drains the entire Tennessee Valley watershed, which covers an area of 40,200 square miles.

Kentucky Reservoir is a mainstem, multipurpose, storage project located on the Tennessee River. The proposed dike stabilization project is located between TRM 99 and 100 on Kentucky Reservoir. Kentucky Reservoir is TVA's largest reservoir in terms of useful controlled storage of water (TVA 2006). In addition to supporting navigation, the reservoir provides significant flood damage reduction benefits for downstream locations on six million acres of the lower Ohio and Mississippi Rivers and reduces the frequency of flooding on another four million acres.

The reservoir pool has a planned seasonal fluctuation between 354 and 359ft elevation. An additional 17ft of pool fluctuation is available for storage from December through May and 7ft is available from June through November. Spring fill begins on April 1 and summer level is targeted by May 1. The fall drawdown begins on July 5 and is targeted for completion by December 1 (TVA 2006).

Status of the Species within the Action Area

Pink mucket occur throughout the entire length of the Tennessee River, but are rare; typically one pink mucket may be collected for every 10,000 mussels sampled. 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. Mean catch per hour of pink mucket commercial mussel assessment sites between TRM 141.5 and TRM 202 in Kentucky Reservoir (Pickwick Dam tailwater) was 3.5 pink mucket/hour in 2008 and 2.8 pink mucket/hour in 2009 (Don Hubbs 2009b). A quantitative mussel survey conducted by TWRA in 1995 at TRM 100.6 (approximately 100 yards south of the State Highway 70 bridge) resulted in capture of 17 mussels, but did not include pink mucket (Don Hubbs 2010).

The action area is located between TRM 99 and TRM 100. A mussel and habitat survey of the area adjacent the JOF dike project was conducted in November 2009 (Third Rock Consulting, 2009). A total of 1,951 mussels representing 16 species were collected overall. The majority of these were found within the southern portion of the action area, indicating that this area

specifically contained high quality mussel habitat. Mussel density along the dike averaged 3.5 mussels/11ft^2 and reached a maximum sample density of 25.6 mussels/11ft^2 at 33.66ft off of the bank [*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 varied between 0 mussels/11ft^2 to a maximum of 1.6 mussels/11ft^2. Mean catch per hour in samples along the proposed project was 289 mussels/hour and reached a maximum of 655 mussels/hour at some locations.

No live federally listed mussels were collected, but one relic shell of pink mucket was collected in the southern portion of the survey area. 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/11ft^2), it is assumed that pink mucket would occur within this portion of the study area.

Factors Affecting Species Environment within the Action Area

The area of Kentucky Reservoir surrounding the JOF project is influenced by a vast number of activities and features, including commercial river navigation, wildlife refuge management, private land use, agriculture, roads, parks, and various types of industry (refer to Table 2).

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 (and potentially the pink mucket) are likely affected by effluent release from the JOF facility and tow activity associated with coal delivery via barge. TVA is in the process of converting to dry ash storage and is currently removing coal combustion products (CCPs) (fly ash and bottom ash) from the JOF facility and Johnsonville Island to an offsite location. TVA anticipates capping and closing Johnsonville Island by 2016.

One of three Tennessee National Wildlife Refuge units, the Duck River Unit, is located immediately upstream of the JOF project site from TRM 120 downstream to about TRM 104. The Duck River Unit covers 26,738 acres of the overall 51,358 acres that make up the entire refuge. The refuge was established in 1945, the year after Kentucky Dam was completed to create the reservoir. The primary use for the refuge is sustainable habitat for wildlife, which is primarily managed for migratory birds. The area now known as Duck River Bottoms was dewatered by TVA with pumping until 1965 for mosquito control. Farming was the primary management tool used on the unit until 1983, when a series of 12 sub-impoundments were constructed to enhance natural food production for waterfowl. In 1992, the refuge, in partnership with TVA and E. I. Dupont Company, restored the pumping capability of the unit. Through a balanced mix of providing agricultural and natural foods and sanctuary, Duck River Bottoms continues to be one of the most important wintering areas for waterfowl and eagles in the region (source: www.fws.gov/tennesseerefuge).

A number of municipalities withdraw water and discharge processed wastewater from the Tennessee River and tributary streams within 20 miles of the JOF project (see Table 2). While temperature and many chemical constituents of treated effluents are typically permitted by the

Tennessee Department of Environment and Conservation via National Pollutant Discharge Elimination System (NPDES). released effluent may not always meet permitted levels. may not be limited in all cases, or may not be protective of all organisms.

Recent research on freshwater mussel ecology has provided an array of evidence that mussels (depending on species, life stage, and environmental conditions) are particularly sensitive to known toxicants affecting aquatic life, such as ammonia, heavy metals, chlorine, and some biocides (EPA 2008 and references therein). Consequently, the Environmental Protection Agency (EPA) has recently proposed significantly reduced limits on ammonia levels in permitted discharges based on evidence that juvenile freshwater mussels are much more sensitive to ammonia than other organisms used in standardized toxicity bioassays (Federal Register 2009). Current EPA limits of acute and chronic ammonia concentration in effluent are proposed to be lowered from 5.6 mg/l (acute) and 1.2 mg/l (chronic with early life stages of fish present) to 2.9 mg/l (acute where mussels present) and 0.26 mg/l (chronic where mussels present), respectively. Thus, some NPDES permitted discharges near the JOF project may have negatively impacted aquatic organisms, such as freshwater mussels, for many years or even decades.

Illegal commercial mussel harvesting within the JOF boat harbor (this area is closed to commercial harvest) has been observed by TWRA in the past (Don Hubbs 2009b), which indicated that this area likely supports some level of mussel harvesting. Tow activity may also diminish habitat suitability for pink mucket in the boat harbor.

According to the Tennessee Commercial Musseling Regulation Summary (TWAR 2009; see http://www.state.tn.us/twra/fish/mussels/musreg09.pdf) commercial mussel harvesting is permitted year-round (except the weekends of Memorial Day, Independence Day, and Labor Day) in all areas of Kentucky Reservoir, except the JOF Plant boat harbor (TRM 99-100R) and the following areas:

- That section of the Tennessee River between TRM 140 (mouth of Elkins Branch, Decatur County, TN) and TRM 141.5 (mouth of Cedar Creek, Perry County, TN).

- That section of the Tennessee River between TRM 206.7 (Pickwick Dam) and the downstream Tennessee Gas Pipeline located at TRM 201.9.

- Areas within 1,000 yards downstream of any TVA or USACE dam (including wing walls and lock walls).

- Areas within 100 yards of any commercial dock or pearl culture facility.

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. 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 may pose a serious threat to the pink mucket within the action area should favorable conditions develop (TVA, 1994; TWRA, 2008). Zebra mussels are present in Kentucky Reservoir and are expected to be continually reintroduced by

barge and recreational boat traffic (TVA, 1994); however, no zebra mussels were observed on the substrate or attached to native mussels during the 2009 survey (Third Rock Consulting 2009).

Table 2. Major features and projects along the Tennessee River near the JOF dike project[1].

TRM (bank)[2]	County	Feature / Project	Description
120 - 104	Humphreys, Benton	Tennessee National Wildlife Refuge (Duck River Unit)	Mixed land-use and broad aquatic habitat area supports and protects habitat for diverse fauna, recreation, and education; however, commercial mussel harvesting is allowed.
116.1	Humphreys	Interstate 40 Bridge	In-stream piers and stormwater runoff.
110R	Humphreys	Mouth of Duck River	Tributary supporting high aquatic biodiversity and rare species.
106R	Humphreys	Wildlife Cove Resort	Riparian development.
103R	Humphreys	Vanguard Services	Barge construction / repair.
100.6R	Humphreys	New Johnsonville Municipal Water Intake	Water intake.
100.5	Humphreys	Highway 70 and Seaboard Systems Railroad Bridges	In-stream piers and stormwater runoff.
100.3L	Benton	City of Camden Intake	Water intake.
100.3R	Humphreys	TVA Industrial Intake	Water intake.
100.2R	Humphreys	Sangravel Company / Merchants Grain and Transportation	Barge deliveries.
100-99R	Humphreys	TVA Johnsonville Fossil Plant, Boat Harbor, Ash Storage / Dewatering Cells	Water discharge, coal unloading, tow activity.
98.5R	Humphreys	Du Pont Industrial Intake	Water intake.
98.0R	Humphreys	Sewer outfall	Water discharge.
96.5 - 94.5L	Benton	Nathan Bedford Forrest State Park	Recreation
95.3R	Humphreys	Scepter, Inc.	Aluminum processing, water discharge, water intake?.
94.4R	Humphreys	Temple-Inland Container, Inc.	Paper products mill, water intake, water discharge.
94.4R	Humphreys	City of Waverly Proposed Wastewater Discharge	Proposed water discharge.

[1] Source: US Army Corps of Engineers Tennessee River Navigation Charts (USACE 1997)

[2] TRM = Tennessee River mile (USACE 2007)

EFFECTS OF THE ACTION

Factors to be considered

All work near the water would be done when the lake level is at or within 2ft of normal winter pool (elevation 354ft above 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.

The proposed action would occur in aquatic habitat below the 354ft msl winter pool elevation 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. The margins of these areas are generally 25ft or further from areas supporting 49,615ft^2 of high quality mussel habitat.

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. The degree and longevity of increased suspended sediment and sedimentation resulting from the above processes at the JOF site are unclear. Vibration disturbance and altered flow and water quality would be completed within the two month period for construction (February through March, 2010).

Maintenance of the JOF dike after initial construction would primarily involve trimming of vegetation to prevent the establishment of large woody vegetation by use of physical and chemical means and mowing approximately every two weeks between spring and fall.

Analyses for effects of the action

The stream environments of the pink mucket have been affected by various factors. Commercial harvest continues to occur in several streams with extant populations of pink mucket (e.g., Ohio, Cumberland, Tennessee, St. Francis, White, Black, Spring Rivers). Since the Recovery Plan was written, the threat from commercial harvest has been greatly diminished (Bob Butler 2010).

Construction of dams resulted in significant changes in the aquatic environment. Large hydropeaking and flood control dams contributed directly to the extirpation of its populations in certain streams (e.g., Obey River, Caney Fork, Little Tennessee River, Limestone Creek) and reduced extant population reaches in several others (e.g., Cumberland, Clinch, Osage, White, Black, Ouachita, Little Missouri Rivers) (Bob Butler 2010). Free-flowing stream habitat was changed to a non-flowing environment with deeper water, altered temperature, and lower

dissolved oxygen levels near the bottoms of the reservoirs. Operation of the dams has resulted in fluctuations in water levels in the downstream reaches, seasonal deficits of dissolved oxygen, and changes in water temperature. Several extant populations continue to be influenced by these dams due to their close proximity downstream from these facilities (e.g., Licking, Cumberland, Holston, French Broad, Osage, Sac, Ouachita Rivers) and the long distances necessary to overcome the effects of large impoundments on mussel populations (Vaughn and Taylor 1999). What remains of other stream populations may persist far enough downstream from hydro and flood control dams to be relatively unaffected by tailwater conditions (e.g., Kanawha, Elk, Green, Barren, White, Little Missouri Rivers). Unless tailwater conditions are modified to improve Pink Mucket habitat, populations below hydro dams will continue to be threatened by their operations (Bob Butler 2010).

Runoff into some of the reservoirs likely contains contaminants such as heavy metals. These materials settle to the bottom and some attach to the sediment. Release of water from the bottom of the reservoir may result in elevated levels of those contaminants downriver. Releases from the dams also act to dilute pollutants that enter the river below the dams. Reduced releases or total lack of release from dams at times prevents dilution and assimilation of those pollutants, allowing for potential accumulation of contaminants to levels that may be acutely or chronically toxic to aquatic fauna in the tailwater.

Activities such as mining, dredging, agriculture, logging, and highway construction conducted without regard for protection of aquatic habitats typically contributes significant amounts of sediment to adjacent streams. Sediment increases turbidity, decreases light penetration, and blankets the stream bottom. As sediment accumulates, it can smother juvenile mussels. Unless it is flushed downstream by flood events, the sediment fills the interstitial spaces in the sand, gravel, and cobble over time, compacting and "cementing" the substrate and eliminating habitat for species that burrow into the stream bottom.

Discharges from various industrial, municipal, and agricultural sources have also affected the environment of the pink mucket. Effects to the environment and the organisms involved depend on the type of contaminant involved, the magnitude (i.e., the concentration of the contaminant) introduced into the stream, duration (i.e., how long the contaminant remains in the water column), and the frequency of input of the contaminant. Some contaminants or pollutants cause immediate effects; for example, a large spill of sulfuric acid into the upper Clinch River killed aquatic organisms for approximately 15 miles downriver. Others, such as heavy metals, accumulate in the tissues of fish, mussels, and other aquatic species, and result in long-term chronic effects.

Any potential leaking of fly ash from the Johnsonville Ash Storage Pond could adversely affect aquatic organisms in the vicinity of the JOF facility and Johnsonville Island. As a result of an accidental release of fly ash to the Emory River, Tennessee from TVA's Kingston Fossil Plant in December 2008, a study was conducted to evaluate the potential toxicity of fly ash in whole-sediment or fly ash in elutriate toxicity tests in 2009 with benthic invertebrates (amphipods, *Hyalella azteca*), two juvenile mussels (rainbow mussel, *Villosa iris* and wavy-rayed lampmussel, *Lampsilis fasciola*), and midge (*Chironomus dilutus*). Results from that study indicate that fly ash can be chronically toxic to some sediment-dwelling organisms, possibly due

to elevated metal concentrations. Concentrations of arsenic, copper, cadmium, and nickel in the ash samples were at or above the threshold effect level for amphipods. Concentrations of arsenic in the ash samples were above the empirically based sediment probable effect concentration and U.S. Environmental Protection Agency chronic water quality criterion for arsenic. The survival or growth of amphipods and the growth of wavy-rayed lampmussel and midge exposed to ash samples were reduced significantly relative to the controls. The differences in the survival or growth of rainbow mussel were not significant between the ash and control sediment samples (Wang et al. 2009).

The proposed project will have no beneficial effects or interrelated and interdependent effects on pink mucket. Direct and indirect effects of the proposed action have been identified and are described in the following paragraphs. similar

Data from the 2009 survey (Appendix B) 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 Figures 1 and 2, and Table 2, Appendix B). 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.

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 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. TVA used ArcGIS (v.9.3) software and GPS coordinates of the project elements, an estimated area of 238,570ft^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) $\geq$5 mussels/m^2 and/or catch per hour rates of $\geq$300 mussels/hr (see 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 33ft and 66ft from the bank. This area was measured using ArcGIS (v.9.3) and estimated that 49,670ft^2 of high quality mussel habitat capable of supporting pink mucket could be indirectly affected by the proposed project.

Species' response to a proposed action

Using data from the 2009 study (Appendix B), the mussel density from samples between 33ft and 66ft from the bank along Transects 1 - 8 was 10.9 mussels/11 ft^2. 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/11ft^2. If the size of the high quality mussel habitat is 49,675ft^2, then we estimate that 150,911 mussels inhabit this area.

Based on corrected estimates of 2009 survey data, TVA assumes that actual mussel density within the high quality habitat near the IOF dike is 32.7 mussels/11ft^2 and further estimate that 150,911 mussels inhabit this area. Furthermore, TVA estimates that pink mucket, based on frequency within high quality mussel communities from other studies in the Tennessee River, 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 present in this area.

These 151 individuals could 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.

CUMULATIVE EFFECTS

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

No new actions are anticipated near the proposed 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. The project is located in an area that is developed primarily for residential and recreational purposes. We are not aware of any non-Federal actions that are reasonably certain to occur as a result of the project. Cumulative effects, as defined by the Endangered Species Act are, therefore, not expected to occur.

CONCLUSION

(NOTE: This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.)

After reviewing the current status of the pink mucket, the environmental baseline for the action area, the effects of the proposed dike stabilization, and the cumulative effects, it is the Service's biological opinion that the dike stabilization between TRM 99 and TRM 100 within the Kentucky Reservoir impoundment, as proposed, is not likely to jeopardize the continued existence of the pink mucket, and is not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated for this species; therefore, none will be affected.

The Service has determined that the proposed project is not likely to result in jeopardy to the species addressed in this biological opinion because the project (i.e., stabilization of an existing dike in Kentucky Reservoir and on the adjacent shoreline) will not directly affect high quality mussel habitat in the river. Pink Mucket are rare and likely do not exist in large numbers in the impact area. Only one relic shell of pink mucket was collected during a 2009 survey of the proposed project site; no live pink muckets were collected at that time. Also, project construction effects will be of relatively short duration.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation under section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

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

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service expects approximately 151 pink mucket could be taken as a result of this proposed action (refer to Table 3). This incidental take is expected to be in the form of harass.

Harass: 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. These disturbances could contribute to reduced pink mucket growth, feeding rates, oxygen consumption, and nitrogen excretion. In addition, altering the topography of the streambank along the levee may effectively shift near-bank mussel habitat toward the boat harbor when water (pool) elevation is above the normal winter pool level (354ft msl). This may result in a shift in the range of conditions that shape the high quality mussel habitat between 33ft and 66ft off the bank in the southern two-thirds of the project area. Therefore, the proposed JOF dike stabilization project could indirectly alter high quality mussel habitat over the long-term.

Using data from the 2009 study (Appendix B), the mussel density from samples collected between 33ft and 66ft from the bank along Transects 1 - 8 was 10.9 mussels/11ft^2 (the highest quality mussel habitat, capable of supporting pink mucket). Since this mussel density estimate is likely biased from sampling only the substrate surface along transects, TVA corrected 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, they assumed that actual mussel density within the high quality habitat near the JOF dike is 10.9 X 3 = 32.7 mussels/11ft^2. If the size of the high quality mussel habitat is 49,675ft^2, it is estimated that 150,911 mussels inhabit this area. Furthermore, based on estimates of pink mucket frequency within high quality mussel communities from other studies in the Tennessee River, TVA assumed 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 incidentally taken by the proposed project.

Table 3. The estimated number of individuals and amount of critical habitat affected for the proposed project, based on the best available commercial and scientific information.

SPECIES	INDIVIDUALS	TAKE TYPE
Pink mucket	151	Harass

EFFECT OF THE TAKE

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

Previous biological opinions, completed for pink mucket populations within Tennessee, which identified incidental take have been included in a table in Appendix C.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and minimize impacts of incidental take of the pink mucket:

RPM1. Adaptive management. Identify ways to minimize harm during project construction and implementation of operations and maintenance activities.

RPM2. Monitoring. Monitor the level of take associated with the proposed dike stabilization project and evaluate ways to minimize take by studying the distribution and abundance of the mussels in the action area.

RPM3. Sediment control and water quality. Minimize siltation of aquatic habitat and impacts to water quality in the action area.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Tennessee Valley Authority must comply with the following terms and conditions, which carry out the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

Adaptive management (RPM1). Construction and post-project maintenance activities will be closely monitored and any impacts to water quality or mussel populations, particularly pink mucket, as a result of these activities, duly noted. Such information will be useful in adjusting management for this particular project, as necessary, and to provide direction to avoid and minimize take during similar future efforts in the Tennessee River. TVA shall report any new information learned from monitoring project construction and maintenance activities and include this information in mussel monitoring reports (see RPM2 Monitoring below).

Monitoring (RPM2). As habitat conditions change, the population of pink mucket in the action area needs to be assessed and the amount of take evaluated relative to any new information. TVA shall conduct post-project mussel surveys to determine presence and estimate total abundance of pink mucket in the action area and determine the fraction of the population that is located in habitats that are vulnerable to project impacts. Monitoring will occur every two years over a five year period (twice, post-project) beginning in 2011, to insure that the level of take identified in the biological opinion is not exceeded. Since no live pink mucket were found during the 2009 survey of the action area, changes in overall mussel species densities (based on the criteria used to determine current pink mucket populations and estimated take) will be used as an indicator to determine whether the identified level of take is exceeded. TVA shall provide two mussel monitoring reports to the Service on or before January 31, 2012 (survey to be conducted during the 2011 calendar year) and on or before January 31, 2014 (survey to be conducted during the 2013 calendar year) documenting compliance with RPM2 to determine whether the identified level of take is exceeded.

Sediment control and water quality (RPM3). BMPs that have proven to be effective and are commonly accepted throughout the region for sediment control and protection of water quality will be implemented and strictly enforced. BMPs will be implemented during all phases of riverbank and island shoreline stabilization efforts. These practices have been developed to avoid or minimize adverse, project-related impacts to mussels and other aquatic organisms. When properly implemented, these practices have been shown to prevent excessive sedimentation of streams to maintain water quality to the maximum extent possible. When barges and tugboats are utilized, reduce the extent of prop wash stirring up the bottom substrates and habitats that may contain pink mucket.. TVA shall also utilize appropriate preventive measures to minimize the potential for hazardous materials (e.g., hydraulic fluid, oils, lubricants, fuel) from spilling on the ground or into the water and have in-place a Hazardous Material/Fluid Spill Prevention Plan to address accidental spills/leaks.

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

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that no more than 151 individuals of the pink mucket will be incidentally taken. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

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

We offer the following conservation recommendation for consideration:

1. The TVA should provide funds to study the pink mucket's life history and ecological requirements. Information obtained from such monitoring and studies will be valuable in directing actions and measures that will provide protection to the species and its habitat during future construction projects and will contribute toward recovery of the species.

2. The TVA should make a concerted effort to utilize existing programs to raise awareness and promote protection of the pink mucket among private landowners, permit applicants, and non-Federal entities carrying out actions in the Tennessee River drainage. The Tennessee River and its tributaries are under heavy pressure from development that could destroy much of the aquatic habitat in the drainage and could potentially drive the species to extinction. Outreach activities would be invaluable in making residents and developers in the drainage aware of the pink mucket and the need to protect the aquatic habitat in the Tennessee River drainage. Without these efforts, recovery of the pink mucket is likely not possible.

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

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the consultation request. As written in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary Tennessee Valley Authority involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; if take exceeds three individuals of the pink mucket or orangefoot pimpleback; (2) new information reveals effects of the Tennessee Valley Authority action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the Tennessee Valley Authority action is later modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease until reinitiation.

For this biological opinion the incidental take would be exceeded when the take exceeds 151 individual pink muckets which is what has been exempted from the prohibitions of section 9 by this opinion. We appreciate the cooperation of the Tennessee Valley Authority during this consultation. We would like to continue working with you and your staff regarding the Dike Stabilization of the Johnsonville Ash Storage Pond State Route project. For further coordination please contact Todd Shaw of my staff at 931/528-6481, ext. 215.

Mary E. Jennings, Field Supervisor — Date 2/1/10

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APPENDIX A

Project Description – Project Elements and Impact Areas

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

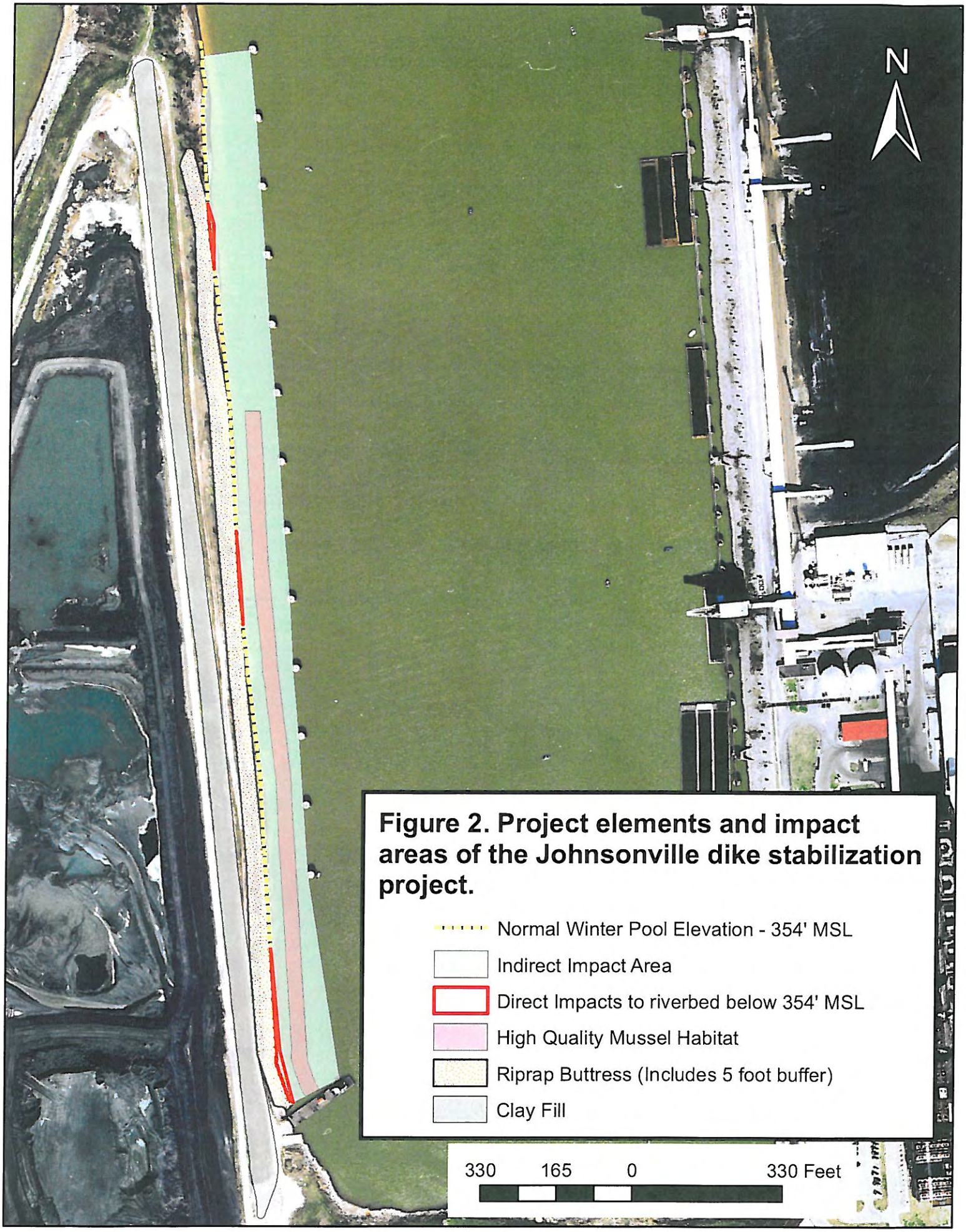
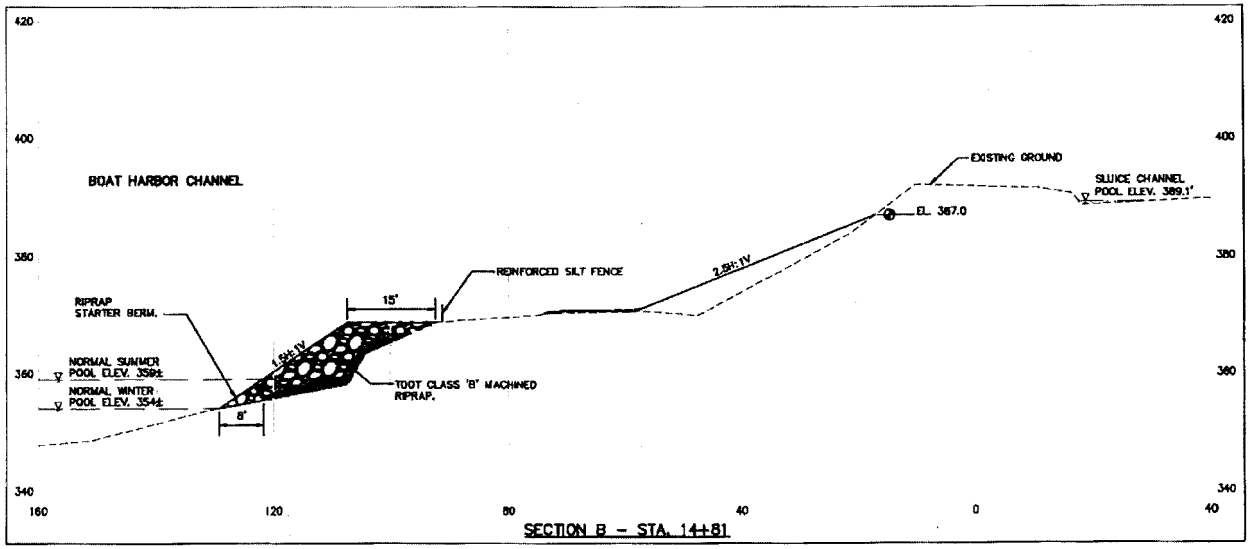


Figure 2. Project elements and impact areas of the Johnsonville dike stabilization project.

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



APPENDIX B

2009 Mussel Survey Data - Johnsonville Fossil Plant Embayment Survey

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	Species Name	Amblema plicata	Megalonaias nervosa	Fusconaia ebena	Quadrula apiculata	Quadrula pustulosa	Quadrula nodulata	Potamilus alatus	Elliptio crassidens	Quadrula quadrula	Fusconaia flava	Obliquaria reflexa	Elipsaria lineolata	Plectomerus dombeyanus	Leptodea fragilis	Arcidens confragosus	Lampsilis teres	TOTAL	Density per transect(mussels/sq meter)	Density/10-meter segment (mussels/sq meter)	Catch per hour/transect
	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				
1	0-10					11		5											16		1.6	
	10-20		44	19	4	7	40		4	2	17	2							139	5.4	13.9	220
	20-30		3	2															5		0.5	
Q1			33	17	7	5	67		2		13	2			1				147			588
2	0-10																		0		0	
	10-20		61	21	16	8	43	6	1		23		2	2	1				184	7.5	18.4	271
	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		0	
	10-20		84	23	32	26	38		5		35	1	8	2	1	1			256	12	25.6	655
	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		0	
	10-20		33	12	26	3	26		3		1	3				1			108	5	10.7	171
	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	
	10-20		12	3	2		6	1			1		1						26	0.9	2.6	62
	20-30																		0		0	
Q5			31	17	1	2	12	10	1		8	2			1				85			340
6	0-10																		0		0	
	10-20		58	9	7		27		1		10	2	3	1					118	4.2	11.8	381
	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	
	10-20		9	1			8	2	1			1							22	0.8	2.2	63
	20-30																	1	1		0.1	
Q7			27	5	1	1	7	7	1		2	1				1			53			212
8	0-10		1																1		0.1	
	10-20		7	3	1		2	1	1		1								16	0.6	1.6	45
	20-30		1																1		0.1	
Q8			3	4		2	4	2	1		1	2							19			76
9	0-10		1																1		0.1	
	10-20		16	7			6	3	1		6								39	1.5	3.9	145
	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		0.1	
	10-20		10	6		1	1		1										19	0.7	1.9	75

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	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	Plectomerus dombeyanus	Leptodea fragilis	Arcidens confragosus	Lampsilis teres	TOTAL	Density per transect(mussels/sq meter)	Density/10-meter segment (mussels/sq meter)	Catch per hour/transect
	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				
	20-30																		0			
11	0-10																		0			
	10-20			1				1	2		2								6	0.2	0.6	18
	20-30																		0			
Q10																						0
12-18	0-10																		0			
	10-20																		0	0	0	0
	20-30																		0			
Q11																						0
Q12																						0
Q13																						0
19	0-10																	1	1		0.1	
	10-20																		0	0	0	3
	20-30																		0		0	
Q14			2																2			8
20	0-10																		0		0	
	10-20		1																1	0	0.1	3
	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

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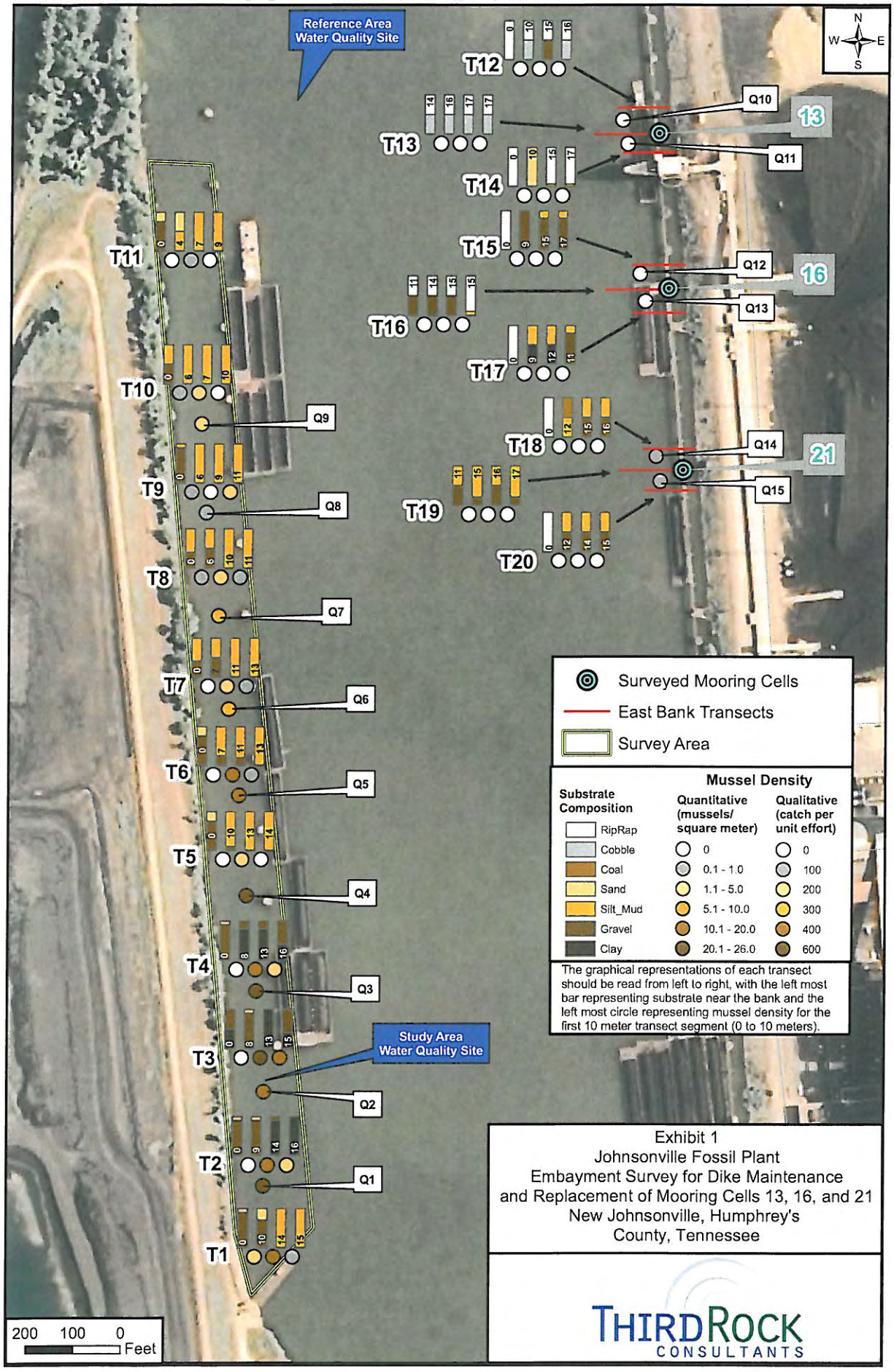

Exhibit 1
Johnsonville Fossil Plant
Embayment Survey for Dike Maintenance
and Replacement of Mooring Cells 13, 16, and 21
New Johnsonville, Humphrey's
County, Tennessee

THIRD ROCK CONSULTANTS

APPENDIX C

Previous Biological Opinions Completed For Pink Mucket Populations Within Tennessee Which Identified Incidental Take

The following list includes previous biological opinions completed for the pink mucket populations within Tennessee which identified incidental take:

Biological opinions within TN that have been issued for adverse impact to the pink mucket

OPINIONS (year/number)	PINK MUCKET (numbers)	HABITAT	
		Critical Habitat	Habitat
1991/1	2	N/A	----------
1993/1	1	N/A	----------
1994/1	2	N/A	----------
1996/1	3	N/A	----------
1999/1	25% of individuals estimated to be present within a 7-acre area	N/A	----------
2000/1	All individuals within a 1,742 ft^2 area	N/A	----------
2001/1	All individuals within project area	N/A	----------
2002/1	All individuals within project area	N/A	----------
2002/2	3	N/A	----------
2003/1	1	N/A	----------
2004/1	Decline of 25% in surrogate invertebrates	N/A	----------
2006/1	All individuals within a 5-mile reach of suitable habitat	N/A	----------
2009/1	All individuals within a 22,206 ft^2 area	N/A	----------
2009/1	3	N/A	----------
TOTAL	13 pink mucket	N/A	7.6 acres and a 5-mile stream reach