Appendix B – U.S. Fish and Wildlife Service Biological Opinion

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, TN 38501

April 21, 2014

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

Lt. Colonel John L. Hudson
District Engineer
U.S. Army Corps of Engineers, Regulatory Branch
3701 Bell Road
Nashville, Tennessee 37214
Attention: Lisa Morris

Re: FWS #2014-F-0181. TVA Section 26A and USACE Section 10 Permits for City of Waverly Effluent Force Main and Outfall in the Tennessee River, River Mile 94.5, RDB, Humphreys County, Tennessee.

Dear Mr. Baxter and Colonel Hudson:

This document is the biological opinion of the U.S. Fish and Wildlife Service (Service) based on our review of the City of Waverly's proposed construction of an effluent force main and diffuser structure, and subsequent wastewater effluent discharge at Tennessee River Mile (TRM) 94.5, right descending bank, in Humphreys County, Tennessee, and their effects to 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 December 11, 2013, request for formal consultation was received on December 12, 2013.

The Tennessee Valley Authority's (TVA) issuance of a Section 26a permit and a permanent land easement to the City of Waverly constitutes a federal agency action subject to compliance with Section 7(a)(2) of the Endangered Species Act of 1973 (and as amended; ESA). The U.S. Army Corps of Engineers (USACE) CE is a cooperating federal agency and a permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 is also required for the project. This biological opinion is based on information provided in the TVA December 2013 Biological Assessment (BA). A complete administrative record of this consultation is on file and available for review at the Tennessee Ecological Services Field Office, 446 Neal Street, Cookeville, Tennessee 38501.

Consultation History

February 20, 2006	Tennessee Department of Environment and Conservation (TDEC) issues Public Notice MMVI-004 which contains the draft NPDES Permit TN 0078808 for the Waverly Lagoon municipal wastewater discharge to TRM 94.0
May 15, 2007	Received formal correspondence from Mr. Jason Griffin, Gresham, Smith & Partners (GS&P), to Dr. Lee A., Barclay, regarding the application for an easement from TVA. TVA expressed concerns about the potential relocation of the City of Waverly's wastewater lagoon effluent discharge from Trace Creek RM 8.3 to TRM 94.0.
July 3, 2007	Formal Service correspondence from Dr. Lee A. Barclay containing recommendations on the proposed project submitted to Mr. Jason Griffin, GS&P.
December 12, 2007	Correspondence received from Community Development Partners to Dr. Lee A. Barclay regarding an application for Community Development Block Grant (CDBG) funding for the City of Waverly from the Department of Housing and Urban Development (HUD) for the construction of an effluent force main from the Waverly lagoon to the Tennessee River at RM 94.0.
December 12, 2008	USACE, Nashville District, Public Notice 08-79 for proposed outfall received. Draft permit issuance held in abeyance pending results of mussel survey and water quality modeling of the project area.
January 15, 2008	Wastewater effluent modeling results for winter discharge scenarios received from Mr. Jason Griffin, GS&P.
January 17, 2008	Formal Service correspondence from Dr. Lee A. Barclay to Community Development Partners regarding HUD CDBG application.
February 21, 2008	Telephone conversation between Mr. Jason Griffin, GS&P, and Mr. Steve Alexander to discuss water quality modeling efforts. Requested additional modeling runs reflecting actual ammonia concentrations of the Waverly lagoon effluent, summer discharge scenarios, in-stream water quality reflective of the proximate existing wastewater discharge from the Temple Inland Paperboard & packaging facility, and actual Tennessee River low flow and recirculating flow data from TVA operations at Kentucky Dam.

July 9, 2009	At the City of Waverly and GS&P's request, a meeting with federal and state agencies on the proposed project was held at the USACE Regulatory Branch Office in Nashville, Tennessee. TVA, USACE, Service, Tennessee Wildlife Resources Agency (TWRA) and TDEC personnel attended the meeting. TWRA offered to complete the required mussel survey for the City of Waverly.
July 14, 2009	Mussel survey of TRM 94.0 received from Mainstream Commercial Divers, Inc. (Mainstream)
July 21, 2009	Conference call with the City of Waverly, GS&P, TVA, TWRA, and Service personnel to follow-up on the July 9. 2009, meeting and to discuss plans for mussel survey and water quality sampling at the proposed project site.
August 4, 2009	Conference call with the City of Waverly, GS&P, TVA, TWRA, TDEC, and Service personnel to follow-up on the July 9. 2009, meeting and July 21, 2009, conference call to further discuss requirements for mussel survey and water quality sampling at the proposed project site.
October 2, 2009	Formal correspondence to Ms. Mary Jennings from Mr. Jason Griffin, GS&P, received for the proposed relocation of Waverly's wastewater lagoon effluent outfall from Trace Creek to the Tennessee River at RM 94.0.
December 16, 2009	Service comments on proposed water quality sampling plan submitted by Mr. Steve Alexander to Mr. Charles Howard, TVA, via e-mail..
October 26, 2010	"*In situ* Water Testing Plan, Tennessee River Near Waverly, Tennessee," prepared by AquAeTer, submitted by Jason English, GS&P to Mr. Charles Howard, TVA.
March 7, 2011	Telephone conversation between Mr. Jason English, GS&P, and Mr. Steve Alexander inquiring of the status of the proposed TVA water quality sampling plan.
March 25, 2011	Mr. Charles Howard, TVA, submits draft water quality sampling plan to Mr. Jason English, GS&P.
April 19, 2011	Formal water quality sampling plan for TRM 94.5 prepared by Mainstream received by Mr. Steve Alexander.
July 8, 2011	Mr. Charles Howard, TVA, transmits final water quality sampling plan to Mr. Jason English, GS&P. All parties agree to the collection of the required data in order to finalize the pre-project mussel survey and post-operation plans for water quality and mussel monitoring.

September 23, 2011 — E-mail from Ms. Alenda Johnson, U.S. Environmental Protection Agency (USEPA), to Mr. Steve Alexander providing first formal notification of USEPA's and TDEC's enforcement action against the City of Waverly for water quality degradation from existing discharge in Trace Creek. USEPA requests to have a conference call on the status of the proposed project.

October 12, 2011 — USEPA Show Cause Hearing Conference Call. Participants included representatives of the City of Waverly, GS&P, Bass Berry and Sims Attorneys, TDEC, and TVA. Discussed July 11, 2011, letter from City of Waverly to USEPA and GSP-prepared timeline of events for project, status of proposed water quality and mussel sampling events, and remedial actions at the wastewater lagoon to correct the nitrogen (ammonia) loading to Trace Creek.

May 18, 2012 — Meeting regarding TVA easement request and water quality data and alternatives related to ESA compliance held at TVA offices in Knoxville. Representatives from the City of Waverly, Jacobs Engineering, TVA, TWRA, and the Service were in attendance. Previous requests for adequate data to review from the applicant and Jacobs Engineering were re-iterated. Multiple action items for the City of Waverly and Jacobs Engineering were agreed upon. Seven miles of the effluent force main have been constructed without having a TVA right-of-way agreement in place.

June 15, 2012 — E-mail from Mr. Jason Griffin, Jacobs Engineering, to Mr. Steve Alexander requesting that the Service offer thoughts on how to keep the process moving for the City of Waverly to have federal funding in place to complete the proposed project.

July 12, 2012 — Copy of e-mail from Mr. Jason Griffin, Jacobs Engineering, to Mr. Barry Burgess (U.S. Department of Agriculture, Rural Development Agency (RD)) received by Mr. Steve Alexander inquiring of the status of federal funding for the project. Mr. Griffin stated all technical issues with TVA and the Service had been resolved. Mr. Burgess responded to Mr. Griffin that RD is waiting on a formal approval letter from the Service. The Service transmitted a formal letter from Ms. Mary E. Jennings to Mr. Brian Sutherland, RD, stating that appropriate compliance procedures will be completed in the near future that will satisfy the section 7 compliance requirements of the Endangered Species Act. The Service also expressed concerns about potential expansion of the existing Waverly wastewater service area and potential increases in wastewater discharges before capacity and treatment improvements are completed at the City of Waverly wastewater lagoon.

October 31, 2012 — Final CORMIX plume modeling report transmitted by Mr. Jason English, Jacobs Engineering, to Mr. Steve Alexander.

December 19, 2012 Copy of e-mail from Mainstream to TVA received by Mr. Steve Alexander regarding winter mussel survey considerations at TRM 94.5.

February 27, 2013 Non-invasive mussel survey in project action area completed by Mainstream.

April 30, 2013 TDEC re-issuance of Waverly Lagoon NPDES Permit No. TN0078808 authorizing a discharge to TRM 98.5 and NPDES Permit No. TN0024830 (Trace Creek), dated December 6, 2012. Both permit applications characterize effluent discharges from the aerated lagoon.

December 12, 2013 Formal TVA BA of proposed project transmitted by Mr. John T. Baxter, TVA, to Ms. Mary E. Jennings.

January 13, 2014 Formal Service correspondence regarding adequacy of section 7 consultation package transmitted to Mr. John T. Baxter, TVA.

FWS Log No: 2014-F-0181 ***Application No***: TBD
Date Started: January 9, 2013 ***Ecosystem:*** Lower Tennessee-Cumberland
Applicant: City of Waverly ***Action Agency:*** Tennessee Valley Authority
Project Title: Proposed Construction of an Effluent Force Main Header and Diffuser Structure and Wastewater Discharge at Tennessee River Mile 94.5
County: Humphreys

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

SPECIES or CRITICAL HABITAT	SPECIES PRESENT IN ACTION AREA	PRESENT IN ACTION AREA BUT "NOT LIKELY TO BE ADVERSELY AFFECTED"
Pink Mucket (*Lampsilis abrupta*)	X	-----
Orangefoot Pimpleback (*Plethobasus cooperianus*)	-----	X
Ring Pink (*Obovaria retusa*)	-----	X
Rough Pigtoe (*Pleurobema plenum*)	-----	X
Sheepnose (*Plethobasus cyphyus*)	-----	X
Spectaclecase (*Cumberlandia monodonta*)	-----	X

Interior Least Tern (*Sterna antillarum*)	-----	X
Piping Plover (*Charadrius melodus*)	-----	X
Pygmy Madtom (*Noturus stanauli*)	-----	X
Gray Bat (*Myotis grisescens*)	-----	X
Indiana Bat (*Myotis sodalis*)	-----	X

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Service was approached by the City of Waverly's consultant, Gresham, Smith, & Partners (GS&P) on numerous occasions during the 2007 to 2009 timeframe regarding a potential discharge in the Tennessee River near river mile (RM) 94.0. Initially, limited information and data on the scope of the project were provided by GS&P, TDEC, and USEPA. Recommendations regarding mussel survey and water quality modeling data needs were provided by the Service to GS&P and TVA.

The proposed project is part of the implementation of a Cooperative Action Plan (CAP) to comply with an Agreed Order with TDEC. The CAP evaluated four alternatives to improve the Waverly lagoon effluent discharge, including 1) Construct a new effluent force main and outfall at the Tennessee River, 2) Upgrade the existing treatment process, 3) Land apply the effluent discharge, and 4) construct a new wastewater treatment facility. The alternatives were evaluated based on numerous factors, including probable cost and 20-year life cycle cost. Alternative 1 was selected and detailed in the CAP, which was approved by TDEC in 2005 (Jacobs 2013).

A. *Project Construction*

Waverly's proposed improvements to its wastewater treatment plant (WWTP) include a new wet well, a new pump station adjacent the existing wastewater lagoon, approximately seven miles of 16-inch diameter force main, and an outfall diffuser with five 8-inch ports measuring a total of about 20 feet long. The effluent line would cross Trace Creek and two first-order streams along its seven-mile length that would require trenching and stabilization using riprap. Phase I of the pipeline has already been constructed along a pre-existing right-of-way and Phase II of the route is pending final approval of the outfall plans. The proposed Phase II-B route would follow an easement for an existing water line so that limited trees would need to be cleared for construction.

Additionally, construction traffic using existing roads near the outfall would use the western-most route to ensure a 200-meter (660-foot) buffer around an existing osprey nest.

The proposed outfall pipe would extend into the Tennessee River (Kentucky Reservoir) approximately 140 meters (450 feet) from the shoreline, exiting from the slope of the navigational channel and anchored to the riverbed. The terminal section of the effluent force main would be installed using a directional boring method underneath the riverbed between the bank and the outfall location to avoid or minimize potential impacts to benthic fauna of the river, particularly freshwater mussel resources. The outfall diffuser port would occur at an elevation of 333 feet above mean sea level (msl) as required by the USACE for navigation purposes. Boring and construction of the terminal portion of the force main header and diffuser structure would occur during low pool elevation (i.e., winter) for Kentucky Reservoir.

B. *Project Operation*

The most relevant information on the receiving waters and up-to-date description of the proposed project operations are effectively described in Waverly's "Final Plume Modeling Report" (Jacobs 2013); this report should be referenced for information on the anticipated discharge, existing conditions/data utilized for modeling assimilative capacity in the Tennessee River, and effluent/mixing zone modeling assumptions and results. Relevant excerpts from that report are briefly described below. Once installed, the project does not expect any maintenance activities unless the diffuser is damaged by debris or some unforeseeable occurrence.

Ambient (Kentucky Reservoir/Tennessee River) Water Quality Data:

The Kentucky Reservoir elevation is controlled by TVA to follow, as closely as possible, a flood damage reduction rule curve while maintaining the navigational channel. The water elevation, or "pool," typically is held near 359 ft during the summer months, and is dropped near 354 ft in the fall and winter to allow for stormwater run-off storage. However, at any point in time, the elevation may exceed the target pool elevation.

The water quality monitoring data from TRM 94.5 collected over the course of three events indicated a maximum ammonia concentration of 0.393 mg/L. Nine of the twelve samples were below the detection limit of 0.100 mg/L. The maximum Total Kjeldahl Nitrogen (TKN) concentration observed was 0.880 mg/L. Since the sample size was less than twenty ($n < 20$), the geometric mean of the receiving water value was multiplied by a factor of 2 to estimate the 90th percentile. Samples below the detection limit were treated as zero. The 12 in-stream water quality samples collected during January and August 2012 yielded an estimated background concentration of ammonia of 0.130 mg/L. The temperature of the ambient water controls the density of the ambient water and the relative density differences between the ambient receiving water and the effluent dictate plume behavior and the overall degree of mixing and dilution. The temperature of Kentucky Reservoir varies seasonally, with a typical low winter temperature of 42 degrees Fahrenheit (°F) and a summer high temperature of approximately 86°F. These temperatures were used in the modeling. Because the summer daily average temperature of the effluent is expected to be around 78°F, a similar ambient temperature also was used for modeling some conditions.

Ambient Low Flow, Peak Discharge Conditions, and Theoretical Dilution Factors:

The theoretical Dilution Factor (DF) was calculated using the 1Q10 flow from the Tennessee River of 5,000 cfs, a projected future peak discharge (3.5MGD= 5.42cfs), and average pump design (2.0 MGD = 3.09cfs) discharge rates from the effluent pump station. The theoretical DF was calculated using the 95th percentile flow for average hourly discharge from the Tennessee River of 187,800 cfs and the average and future peak discharge rates. Average theoretical DFs ranged from 924:1 to 1,619:1. Theoretical DFs ranged from 34,650:1 to 60,778:1at peak discharges.

Diffuser Design, Modeling Objectives, and Plume Dynamics:

The elevation of the diffuser was subject to three considerations: first, the diffuser had to be designed so the plume does not rise to a height that would hit the water surface; second, navigation dictated a maximum diffuser elevation; and third, the dilutions achieved downstream in the far-field were limited by the depth of the water column. For the purposes of the diffuser design, the lower "winter" elevation of 354 ft is the critical pool elevation that was used to ensure the criteria listed above were met.

The initial single port outfall configuration was an 8-inch open pipe, aligned at 85° with the mean river channel flow direction. This configuration was modeled with USEPA's Visual Plume modeling software. This port configuration resulted in velocities out of the diffuser port between 15.5 ft/sec at current peak discharge flow (3.5 MGD) with one pump running and 22.1 ft/s at future peak discharge flow (5.0 MGD) with two pumps running. At the request of the Service, summer conditions with the single port configuration were evaluated with the CORMIX model. This modeling effort determined that the peak velocity needed to be reduced to achieve a hydro-dynamically stable plume. A stable plume prevents high concentration effluent from contacting the substrate and resulting in potential benthic impacts. The design discharge rate was revised to establish the normal peak discharge flow (2.0 MGD) with one pump running and future peak discharge flow (3.5 MGD) with two pumps running.

The multi-port port outfall configuration that was modeled was a 16-inch pipe header with seven 8-inch diffusers, aligned at 90° with mean river channel flow direction. The vertical angle is approximately 78°with the outfall installed along the slope near the channel bottom. This port configuration resulted in velocities out of the diffuser port between 1.77 ft/sec at normal peak discharge flow (2.0 MGD) with one pump running and 3.10 ft/s at future peak discharge flow (3.5 MGD) with two pumps running.

According to the Waverly Lagoon Monthly Operating Reports (MORs), the effluent discharge temperature from the lagoon was 11° C on January 5, 2012 and on January 27, 2012, the temperature was 12° C. MORs also indicated a discharge temperature of 25° C on August 30, 2012. Ammonia nitrogen concentrations in the treated effluent from the Waverly wastewater lagoon were estimated to be 16.1 mg/L, which is the 95th percentile exceedance value for ammonia (as nitrogen). The maximum ammonia discharge concentration over the past 8 years is 21.8 mg/L, which occurred in August 2008. Since the CORMIX model does not accommodate background

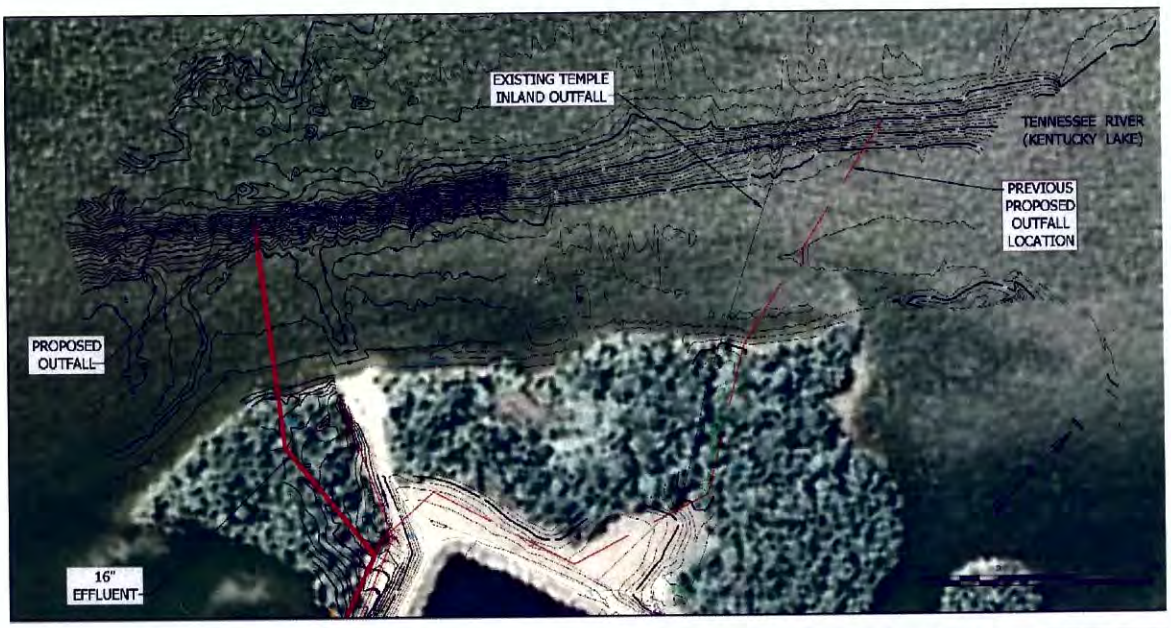
pollutant concentrations, the estimated background concentration was subtracted from the discharge concentration and the corresponding water quality criteria adjusted accordingly. The discharge concentration used in the model was 15.97 mg/L in all eight scenarios.

The discharge from the diffuser structure would create a "plume", which could behave in various ways depending on mixing that would occur with the ambient receiving water. In the optimized diffuser design case described above, the plume, upon exiting the vertical nozzles, would rise several feet into the ambient water column, arc in the downstream direction and sink back to the river bed. The point where the plume would initially intersect the river bed would first interact with benthic organisms, such as mussels. The modeling indicated that the plume is positively buoyant during all of the winter scenarios.

The multi-port diffuser was modeled with five 8-inch nozzle diffusers pointed upward and the plume does not contact the bank or bottom under any scenario. The ammonia concentration falls below the Criterion Continuous Concentration (CCC) of 1.0 mg/L in all four scenarios at downstream distances ranging from 14 to 24 ft. The modeling demonstrates that the CCC will be met in the channel and the plume will not contact the river bank or river bottom under any of the winter scenarios.

For summer discharge scenarios, the plume is non-buoyant and the pH and temperature adjusted Criterion Maximum Concentration (CMC) and CCC are lower than the winter scenarios. The same multi-port diffuser design was modeled as was used in the winter scenarios. The modeling indicated the plume is diluted below the CMC under all conditions on the upward trajectory and does not contact the river bottom above this concentration under any summer scenario. However, the plume did contact the river bottom prior to reaching the CCC under peak and average discharge scenarios at a minimum river flow of 12,000 cfs. Notably, with a river flow of 42,400 cfs as was observed in August 2012, the plume is diluted below the CCC before contacting the river bottom under both peak and average pumping rates.

Multiple designs were considered to meet the wide range of river flows and temperatures while attempting to achieve plume stability by a single fixed design. The proposed design provides a stable plume under all conditions above 12,000 cfs for the full range of temperature variations. However, the plume makes contact with the river bottom above the CCC under the low river flow summer condition, but is diluted below the CCC between 27 m and 48 m downstream depending on discharge pumping rate. The mixing zone that comes into contact with the riverbed surface could be toxic to freshwater mussels over areas of approximately 198 m^2 in modeled Scenario 5 and 618 m^2 in modeled Scenario 6 (Jacobs 2013).



JACOBS JACOBS ENGINEERING GROUP ONE VANTAGE WAY, SUITE B-400 NASHVILLE, TN. 37228 (615) 254-6002	CITY OF WAVERLY HUMPHREYS COUNTY, TN.	PROJECT NO.: C6A00001 DATE: 04/24/12 SCALE: N.T.S.
	PROPOSED EFFLUENT OUTFALL LOCATION TENNESSEE RIVER, MILE 94.5, WAVERLY, TENNESSEE	FIGURE NO.: 2

Pollutant Concentrations and Loadings for Wastewater Discharge:

TDEC re-issued the National Pollutant Discharge Elimination System (NPDES) permit (TN0078808) for the City of Waverly on March 7, 2014. To comply with terms of Agreed Order #04-0292, the City of Waverly is relocating its discharge from Trace Creek, RM 8.3, to TRM 94.5 (referenced as TRM 94.0 in final TDEC NPDES permit). Upon completion of the effluent force main and diffuser, this permit will replace TN0024830 which authorized the wastewater discharge with water quality-based limits to Trace Creek. That permit was re-issued on June 3, 2013. The existing discharge has resulted in significant impairments to Trace Creek and resulted in the stream being listed as impaired on the state's list of impaired waters (TDEC 2012 Section 303(d) List 2014).

TDEC did not specifically evaluate ammonia or develop ammonia-related effluent limits for the discharge to TRM 94.5. No specific water quality monitoring requirements were placed on the applicant/permittee for ammonia or other nitrogenous species. Instead, TDEC relied on a generic evaluation of technology-based limits for biochemical oxygen demand (BOD) in deriving permitted effluent limits and monitoring schedules for the Waverly Lagoon discharge. The rationale for the Waverly Lagoon NPDES Permit No. TN0078808 is excerpted below:

BOD, is a measure of the oxygen used when biological processes break down organic pollutants in wastewater. The amount of oxygen used is more specifically referred to as the five-day biochemical oxygen demand, or BOD5. This parameter is used in the wastewater industry to measure both the strength of wastewater and the performance of waste water treatment processes.

Limits on the oxygen demand remaining in the treated wastewater is often necessary to prevent pollutants in the wastewater from driving oxygen in the receiving stream down below the levels necessary to support fish and aquatic life. With a dilution ratio of 19,000 to 1 at the critical river flow and design flow of the proposed treatment facility, the Tennessee River contains more than enough ambient oxygen to assimilate organic matter and ammonia wastes in a relatively small municipal discharge without driving down ambient oxygen below the fish and aquatic life standard of 5.0 mg/l. Therefore, estimation of water quality based limitations for BOD5 using a wasteload allocation model such as the Streeter-Phelps using default model assumptions is unnecessary. In such cases, a treatment facility is simply required to achieve limits established by law to be the minimum standards for the treatment process. A minimum oxygen level of 1.0 mg/l is necessary in a lagoon treatment system to prevent nuisance conditions associated with anaerobic conditions. Because this level is not established to protect water quality standards, D.O. may be sampled prior to entering the effluent force main. The treatment facility is required to remove 65 % of the BOD5 and TSS that enter the facility on a monthly basis. This is part of the minimum requirement for all municipal treatment facilities contained in Code of Federal Regulations 40 Part 133.102. The reasons stated by the USEPA for these requirements are to achieve these two basic objectives:

(1) To encourage municipalities to correct excessive inflow and infiltration (I/I) problems in their sanitary sewer systems, and
(2) To help prevent intentional dilution of the influent wastewater as a means of meeting permit limits.

TDEC has not utilized recent USEPA guidance on ammonia criteria and sensitive mussel species (USEPA 2013) for developing water quality-based effluent limits in the mainstem Tennessee River. Due to water quality/ammonia concerns from existing NPDES discharges (e.g., Temple Inland Paperboard and Packaging) near TRM 94.0, the decision was made by the City of Waverly to relocate the proposed outfall to TRM 94.5 (Figure 2). More stringent ammonia limits in NPDES permits for existing discharges in this highly industrialized reach of the Tennessee River are needed.

C. *Conservation Measures*

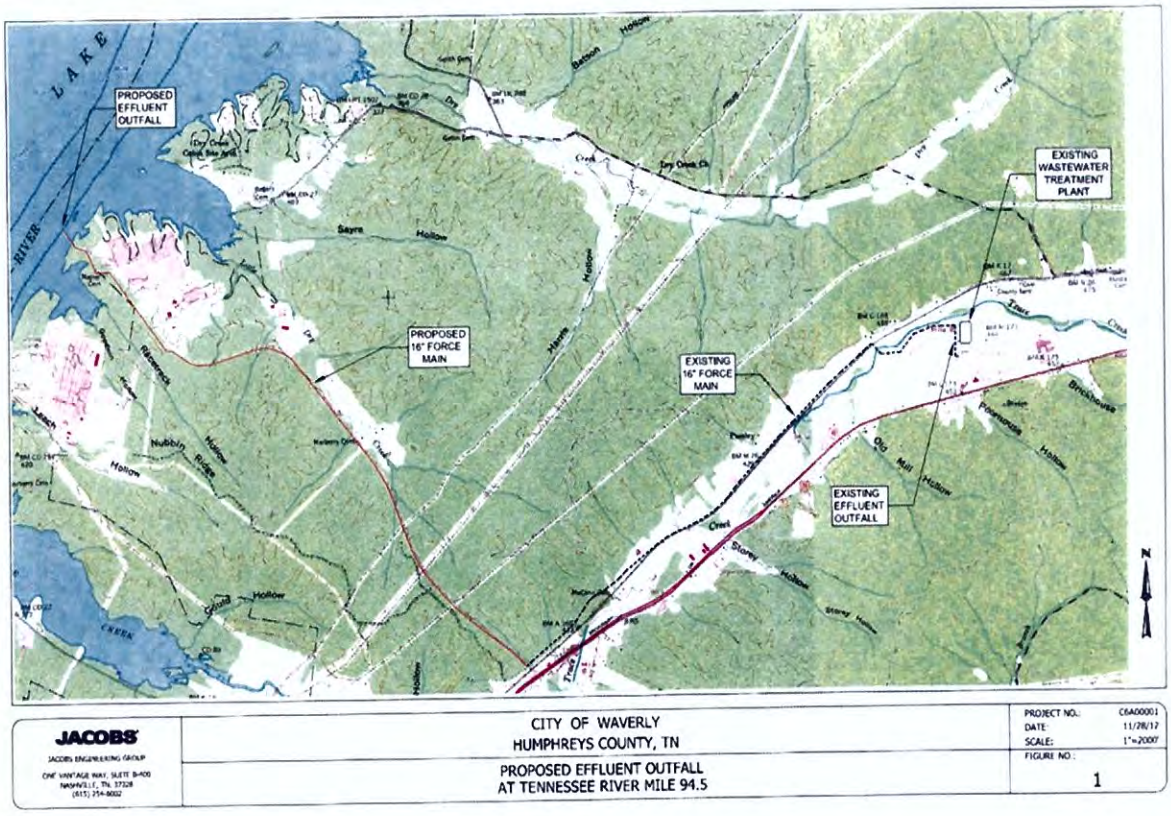
Short-term and long-term impact conservation measures included by the City of Waverly within the project action area are listed below:

1. Using directional boring to install the 16-in effluent force main header to avoid disturbance of benthic habitat that would be caused by the more cost-effective method of trenching and burying the effluent line. Therefore, the only river bottom disturbance from force main header construction would occur where the bore exits the river bottom, any area affected by drilling mud (i.e., bentonite), and the area affected during the installation of the force main header. Best Management Practices (BMPs) would be utilized to reduce the amount of drilling mud impacting the river bottom.

2. Installing a multi-port effluent diffuser system, designed to facilitate mixing of the effluent plume with ambient receiving waters and to minimize the plume size and potential adverse effects to freshwater mussels.

D. *Action Area*

The project action area includes the footprint of the new effluent pump station, area impacted by the trenching of the effluent line along seven miles, the location of the effluent diffuser, and the effluent mixing zone (Jacobs 2013).



STATUS OF THE SPECIES/CRITICAL HABITAT

Species/critical habitat description

The pink mucket mussel (*Lampsilis abrupta*) was listed as an endangered species on June 14, 1976 (41 FR 24062-24067). 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 - 5 in. 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 large river reaches with swift currents, depths of 1.6 - 26.2 ft, and mixed sand, gravel and cobble substrate. While it is not necessarily reservoir tolerant, the pink mucket appears to have also adapted to reservoir-type conditions in the upper reaches of some impoundments. It is commonly found in reservoir tailwaters supporting good riverine-quality habitat (generally rocky substrates swept free of excessive fine sediment deposits by adequate currents). Reservoir conditions, characterized by slackwater, low dissolved oxygen (DO), and heavy silt deposition, are not conducive for its survival and population sustainability (Butler 2010).

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.

This species is a long-term brooder with an average life span greater than 20 years. Females become gravid by age three and brood glochidia from August through June of the following year (Hubbs, Tennessee Wildlife Resources Agency, pers. comm. 2010). Its reproduction is likely similar to other freshwater mussels: males release sperm into the water column, and 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 to encyst and metamorphose into juvenile mussels.

The host fishes for pink muckets tend to be habitat generalists, commonly found in reservoir, tailwater and riverine habitats (Butler 2010). 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*) (Layzer and Madison 2008). Once fully developed, juvenile pink muckets drop from their fish host and settle to the river bottom.

Host fishes can potentially convey attached glochidia across long distances, including across habitats unsuitable for the fishes' host organism. 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 such as the Paint Rock and Bourbeuse rivers and Bear Creek. It is possible that these 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 (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, Missouri, suggests that the pink mucket can live up to 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 probability of underestimating its 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, Tennessee) shed light on aspects of its early life history. 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 in length at the time of translocation to a range of 2.2 - 2.7 in, 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 in, while the males were larger at 3.1 and 3.2 in (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, the pink mucket has apparently always been an uncommon species (Ortmann 1919, Johnson 1980, U.S Fish and Wildlife Service 1985). 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 ten specimens. All 11 of these OSUM lots represented collections from commercial sheller's cull piles from 1980 in the lower Tennessee and middle Cumberland rivers, meaning the records represented protracted spatial and temporal collections from harvesting along several mile (mi) river reaches over extended collecting periods (Koch, U.S. Fish and Wildlife Service, pers. comm. 2009).

Pink muckets 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. The tendency of the pink mucket to inhabit larger streams and oftentimes deeper water habitats may partially account for its apparent rareness, since most collectors have been unable to effectively sample these habitats. However, recruitment rates may play a significant role in dictating relative population size.

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 the pink mucket. Current pink mucket recruitment rates would appear to be very low given the scant evidence available to indicate presence of juveniles in many populations and despite considerable effort expended conducting quadrat sampling. If the species' rate of recruitment is characteristically very low (there is no empirical data to support this theory), this would at least partially explain the typical lack of evidence for recruitment that most populations exhibit. It is entirely possible that many populations now considered extant have recruitment rates that are below population maintenance levels if they don't suffer from outright recruitment failure. A population below its maintenance level indicates that it is below the threshold of sustainability and is in decline. If the rate of recruitment is low, it would make populations inherently more susceptible to extirpation when factors act in concert to further compromise the already low recruitment level. Considering the advanced age pink muckets attain (36+ years), non-recruiting populations may take decades to become extirpated. Therefore, it may not be known whether most populations are viable for many years (Butler 2010).

What obviously makes the 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 alteration. 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 sizes for this species, either historically or currently (Butler 2010).

Status and distribution

Although it once 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, gravel dredging, 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, which likely included loss of glochidial hosts for the pink mucket.

The pink mucket is an Ohioan species with possibly the widest range known for a listed mussel. It is a rare large-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 (U.S. Fish and Wildlife Service 1985; Parmalee and Bogan 1998). Of these extant populations,

only a few have shown recent evidence of recruitment. Some taxonomists have recently postulated that reproducing populations west of the Mississippi River are not pink muckets, 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 the pink mucket 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 has been documented to occur in low numbers.

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 amount of seemingly suitable habitat in many streams. Furthermore, over one-third of the populations 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 16 RMs or less. A majority of populations are essentially limited to discrete reaches, rendering the species highly susceptible to elimination from catastrophic stochastic events in those particular streams (Butler 2010).

In the Tennessee River mainstem, live pink muckets have been collected recently from below the following TVA dams: Wheeler Dam, Wilson Dam, Pickwick Landing Dam (from the dam to the headwaters of Kentucky Reservoir), 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 upstream of Norris Reservoir, in Claiborne County, and below Bear Creek Dam (Tennessee Valley Authority 2003).

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 sizes for pink mucket, although undetermined, appear to be relatively small based upon 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 (Butler 2010).

In summary, with few exceptions its 29 extant populations are: 1) invariably small (rarely are more found than one or two individuals/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) usually limited in linear extent (less than 30 RMs), and (5) typically lacking evidence of 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 (Butler 2010).

Given its highly mobile hosts and history of localized occurrences, new extant pink mucket records will undoubtedly turn up in historical or potentially new streams of occurrence. However, the Service does not foresee a scenario in which the overall status of the species would be improved by such events. Therefore, 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 (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. A 9 year old female was recovered from poachers at approximately TRM 105 in 1995, approximately 10 miles upstream of the proposed project site (Tennessee Department of Environment and Conservation 2012). **Based on TVA Regional Heritage Database records near the proposed action, historical records for ten federally listed species and one species proposed for listing are known within Humphreys County and/or the vicinity of the project. Based on our review of that data and on pink mucket presence within the Tennessee River, and information about the mussel community**

and habitat in the vicinity of the proposed project, it is likely that the pink mucket inhabits the proposed project's action area and is, therefore, likely to be adversely affected by the proposed action. An effects analysis is presented in the next section.

No critical habitat was designated for the pink mucket. **Therefore, the proposed action would not adversely modify or destroy any designated critical habitat for the federally listed pink mucket.**

ENVIRONMENTAL BASELINE

The Tennessee River is the largest tributary to 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 and Holston rivers. It flows southwest from Knoxville through east Tennessee and crosses into northern Alabama, forming a small part of that state's border with Mississippi, before reentering Tennessee and flowing north. The lower Tennessee River continues to flow north into Kentucky and enters the Ohio River at Paducah, Kentucky.

Kentucky Dam is 22 miles upstream from the Tennessee River's confluence with the Ohio River. The dam is the longest in the TVA system, and Kentucky Reservoir, which stretches for 184 miles across the states of Kentucky and Tennessee, covers an area of 40,200 square miles (mi^2) and is the largest in the eastern United States.

Kentucky Reservoir is a mainstem, multipurpose, storage project located on the Tennessee River. The proposed dock modification and effluent outfall line project is located at approximately TRM 98.1 on Kentucky Reservoir. Kentucky Reservoir is TVA's largest reservoir in terms of useful controlled storage of water (Tennessee Valley Authority 2006). In addition to supporting navigation, the reservoir provides significant flood damage reduction benefits for downstream locations on 6,000,000 (six million) ac of the lower Ohio and Mississippi rivers and reduces flooding frequency on an additional 4,000,000 (four million) ac.

The reservoir pool has a planned seasonal fluctuation between 354 and 359 ft above msl. An additional 17 ft of pool fluctuation is available for storage from December through May and 7 ft is available from June through November. Spring fill begins on April 1 and the summer level is targeted by May 1. The fall drawdown begins on July 5 and is targeted for completion by December 1 (Tennessee Valley Authority 2006). Operations within this reach of the Tennessee River mainstem are very similar to a riverine habitat while occasional experiencing reverse flows due to operations at Kentucky Dam.

Status of the species within the action area

The action area for the project is defined as the protrusion of the effluent force main header and diffuser structure in the river channel and the areal extent of the wastewater plume. The length of the effluent force main header and diffuser structure is 20' to 30' and, under worst case scenarios, the area of river substrate potentially exposed to the wastewater plume downstream of the diffuser structure would vary from approximately 198 m^2 to 618 m^2 (Jacobs 2013).

The pink mucket occurs throughout the entire length of the Tennessee River, but it is rare, and typically, one pink mucket might be collected for every 10,000 mussels sampled. The most recent record of a live pink mucket collected in the vicinity of the proposed action is that of a 9 year old female recovered from poachers at approximately TRM 105 in 1995, approximately 7 mi upstream of the proposed project site (TDEC 2012).

A mussel and habitat survey was conducted adjacent to the TVA Johnsonville Fossil Plant's Ash Disposal Area No. 2 (Johnsonville Island) between TRM 99 and TRM 100 in November 2009; a total of 1,951 mussels representing 16 species were collected during this effort (Third Rock Consulting 2009). A maximum sample density of 25.6 mussels/11ft^2 was realized [*note: density estimates from this study were likely biased by semi-quantitative collection methods; therefore, probably under-estimating actual mussel density*]. The mean catch/hour was 289 mussels/hour and reached a maximum of 655 mussels/hour at some locations. No live federally listed mussels were collected during this survey, but one relic pink mucket shell was collected. Since rare mussel species, such as pink mucket, tend to be found in areas of high quality mussel habitat with high community species richness (*e.g.*, >15 species) and high whole substrate density (*e.g.*, >10 mussels/11ft^2), it was assumed that the pink mucket occurred within portions of the survey area (Tennessee Valley Authority 2010). These numbers were derived from other Tennessee River mussel surveys (Dinkins Biological Consulting, LLC 2008; Lewis Environmental Consulting, Inc. 2008; Tennessee Valley Authority 2009) which identified the pink mucket's presence where overall mussel community parameters were at or higher than these values.

A survey was performed on June 1 – 3, 2010, to determine if suitable mussel habitat was present, if concentrations of mussels occurred, and if the potential existed for federally listed endangered, threatened or candidate mussel species to be present in an area surrounding two federal mooring cells on the Tennessee River at TRM 97.4 that were proposed for removal and replacement (Lewis Environmental Consulting, LLC 2010). During the survey and mussel relocation effort, a total of 735 live mussels from 21 unionid mussel species were encountered. Juvenile mussels (less than or equal to [≤] 5 years of age) were collected for 14 species. Overall, the survey demonstrated high species diversity, low density, and evidence of recent recruitment with a wide age range (3 to over 20 years old) of mussels. Suitable pink mucket or other federally endangered Tennessee River mussel habitat did not exist at that location. No listed species were found during the survey. Mussel species collected were characteristic of species collected from silt substrate with moderate to low flows under normal conditions.

A survey at TRM 98.1 was conducted between October 20 and 25, 2011 (Mainstream Commercial Diving 2011). A total of 3,494 live mussels representing 23 species were encountered, including juvenile mussels (≤1.20 in) collected for 14 of the 23 species. No live or dead individuals of federally listed or candidate species were collected. The species diversity (Shannon-Weiner Index) for the mussel community was 2.1998. Based on the age range of mussels found in the action area, it appears that successful recruitment has occurred for many species while the existing DuPont plant and outfall have been in place. Given the high densities and species richness at TRM 98.1 (Mainstream Commercial Divers, Inc. 2011), which is consistent with mussel community characteristics and values where pink muckets have been collected from the Tennessee River during previous surveys (Dinkins Biological Consulting, LLC 2008; Lewis Environmental

Consulting, Inc. 2008; Tennessee Valley Authority 2009), the Service assumed that the species is likely to occur in this reach of the river.

During the surveys for this project conducted at TRM 94.0 on June 18, 2009 (Mainstream Commercial Divers 2009), a total of 1,454 live mussels from 20 unionid species were encountered. The mussel species located at the site included *Amblema plicata*, *Cyclonaias tuberculata*, *Ellipsaria lineolata*, *Elliptio crassidens*, *Fusconaia ebena*, *Fusconaia flava*, *Lampsilis teres*, *Leptodea fragilis*, *Megalonaias nervosa*, *Obliquaria reflexa*, *Plectomerus dombeyanus*, *Potamilus alatus*, *Quadrula apiculata*, *Quadrula nodulata*, *Quadrula pustulosa*, *Quadrula quadrula*, *Tritogonia verrucosa*, *Truncilla donaciformis*, *Truncilla truncata*, and *Utterbackia imbecillis*. The species diversity for the mussel community was 1.5437 and the evenness was 0.5153. Overall, *Fusconaia ebena* was the dominant species, representing 57.29% of the mussel community, at this site. *Amblema plicata*, *Quadrula quadrula*, and *Megalonaias nervosa* also comprised significant portions of the mussel community, representing 14.31%, 7.77%, and 5.78% respectively. Other species occurring in significant numbers included *Fusconaia flava* (3.85%), *Potamilus alatus* (2.89%), and *Plectomerus dombeyanus* (2.41%). The other 13 species each comprised less than 2% of the sampled community. The area at approximate TRM 94 along the right descending bank contained a moderate to high density mussel community comprised of at least 20 species. Within the area at approximate TRM 94.0, juvenile mussels (<5 years old) were located for *Leptodea fragilis*, *Obliquaria reflexa*, *Plectomerus dombeyanus*, *Quadrula pustulosa*, and *Utterbackia imbecillis*, indicating that recruitment has been successful in recent years.

In February 2013, Mainstream conducted a non-invasive mussel survey at the proposed project site (TRM 94.5R) during winter conditions. Since handling mussels at cold water and air temperatures can stress or kill freshwater mussels, the survey concentrated on characterizing riverbed substrate, which is one of the best indicators for suitable mussel habitat. Additionally, mussels at the riverbed surface were counted without removal from the substrate to provide a coarse measure of mussel abundance. Given the constraints of the survey, the area was still characterized as quality habitat for mussels given the heterogeneous substrate mixtures and good surface mussel densities ranging from 1.2 to 2.7 mussels/m2 at the site (Mainstream 2013).

At nearby locations, 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 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 the federally endangered 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 (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 monodonta*; endangered), orangefoot pimpleback (*Plethobasus cooperianus*, endangered), and rabbitsfoot (*Quadrula c. cylindrica*, threatened) (TWRA 2008).

Factors affecting species environment within the action area

The immediate action area includes the river channel where the effluent force main header and diffuser structure penetrates the river substrate (~20 – 30 foot long) and where the Waverly Lagoon operational discharge plume contacts aquatic habitats in Kentucky Lake in Humphreys County, Tennessee.

The area of Kentucky Reservoir surrounding the Waverly Outfall project action area is influenced by a vast number of features and existing projects, including commercial river navigation, wildlife refuge management, private land use, agriculture, roads, parks and various types of industry (Table 2). While some of these features and existing projects occur outside of the project action area, activities associated with them may potentially affect the pink mucket within the action area.

Table 2. Major features and projects along the Tennessee River near the Waverly Effluent Force Main and Diffuser Project[1, 2, 3, 4]

TRM (bank)	County	Feature or Project	Description
120.0–104.0	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.
117.8R	Benton	Benton – Decatur Special Sewer District	Municipal wastewater discharge.
116.1	Humphreys	Interstate 40 Bridge	In-stream piers and stormwater runoff.
110.0R	Humphreys	Mouth of Duck River	Tributary supporting high aquatic biodiversity and rare species.
103.0R	Humphreys	Vanguard Services	Barge construction / repair.
102.1R	Humphreys	New Johnsonville Marine Services	Terminal specializing in ship building and repair of vessels.
101.9R	Humphreys	Erachem-Comilog	Industrial wastewater discharge.
101.6R	Humphreys	City of New Johnsonville	Municipal wastewater discharge.
101.0R	Humphreys	Rockwood Lithium	Industrial wastewater discharge (Indian Creek embayment)
100.6R	Humphreys	City of New Johnsonville	Municipal water intake.
100.5	Humphreys	Highway 70 and Seaboard Systems Railroad Bridges	In-stream piers and stormwater runoff.
100.4R	Humphreys	Herbert Sangravl Company, Inc., New Johnsonville Docks/Tennessee River Port Facility	Terminal specializes in the shipment of wood in the rough; receipt of sand and gravel.

100.3L	Benton	City of Camden	Municipal water intake.
100.3R	Humphreys	Continental Grain Company, New Johnsonville Elevator Dock/Tennessee River Port Facility	Terminal specializes in the shipment (barging) of grain and logs in the rough; receipt of salt and dry bulk fertilizer; mooring barges for fleeting.
100.2-99.1R	Humphreys	TVA Johnsonville Fossil Plant	Industrial wastewater discharges; stormwater discharges; fly ash ponds in channel and discharges; coal unloading; tow activity.
98.5R	Humphreys	E.I DuPont De Nemours	Water intake.
98.2R	Humphreys	E.I DuPont De Nemours	Industrial wastewater discharge.
98.0R	Humphreys	Occidental Chemical	Industrial wastewater discharge.
95.3R	Humphreys	Scepter, Inc.	Aluminum processing, water discharge, water intake.
94.4R	Humphreys	Hood Container, Inc.	Paper mill, water intake, wastewater discharge.

[1] U.S. Army Corps of Engineers 1997
[2] U.S. Army Corps of Engineers 2012
[3] Find the Data - Continental Grain Co., New Johnsonville Elevator Dock 2012
[4] Find the Data - Herbert Sangravl Company, Inc., New Johnsonville Docks 2012
5 TDEC WPC Permits in TN Data Viewer

A number of municipalities withdraw water from the Tennessee River and tributary streams and discharge treated wastewater and stormwater into the Tennessee River within several miles of the proposed action at TRM 94.5 (Table 2). While discharges of treated effluents are typically permitted by TDEC via a NPDES permit with specific limits on the constituent pollutant concentrations for the effluent, released effluent may not always meet permitted levels, may not be limited in all cases, or may not be protective of all organisms. For example, recent research on freshwater mussel ecology has provided 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 (U.S. Environmental Protection Agency 2008). EPA limits for acute and chronic ammonia concentrations in effluent were 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, in 2009 (USEPA 2009). An August 2013 revision to the recommended freshwater ammonia criteria protective of aquatic life indicated that levels below 17 mg total ammonia/L (1-hour average) as an acute limit and below 1.9 mg total ammonia/L (30-day rolling average) as a chronic threshold (FR 78 52192 – 52194). The State of Tennessee has not formerly adopted the 2009 or 2013 USEPA ammonia criteria recommendations (TDEC 2013). Therefore, some NPDES permitted discharges near the proposed action may have negatively impacted aquatic organisms, such as freshwater mussels, for many years or even decades.

Illegal commercial mussel harvesting has been observed in the past by the TWRA within the Johnsonville Fossil Plant boat harbor from TRM 99.0 to TRM 100.0R (this area is closed to commercial harvest) (Hubbs, Tennessee Wildlife Resources Agency, pers. comm. 2009). This area is one to two miles upstream of the project action area and likely supports pink muckets, which could be affected by illegal harvest activities. Poaching of the pink mucket has also been observed in the vicinity of TRM 105.0 (TDEC 2012). Host fishes may transport glochidia from these other locations into the project action area. Therefore, illegal harvest and poaching of pink muckets (diminishment of brood sources) near the action area has the potential to affect recruitment rates of pink muckets within the action area.

Zebra mussels (*Dreissena polymorpha*) are an exotic fauna that were introduced to the United States in the 1980s, allegedly via ballast waters of European ships entering the Great Lakes. Zebra mussels compete directly with native mussels for food and DO, as well as attach directly to native mussels via byssal threads and potentially interfere with siphoning and opening/closing of the native mussels shell. In addition, zebra mussels may interfere with reproduction of native mussels by ingesting gametes released by the native mussel (Watters et al. 2009). Zebra mussels were first reported from the Tennessee River in 1992. While densities in the Tennessee River haven't appeared to reach levels detrimental to native mussel communities (presumably due to drainage-specific water quality conditions), they may pose a serious threat to the pink mucket within the action area should favorable conditions develop (Tennessee Valley Authority 1994; Tennessee Wildlife Resources Agency 2008). Zebra mussels are present in Kentucky Reservoir and are expected to be continually reintroduced by barge and recreational boat traffic (Tennessee Valley Authority 1994). TWRA (2008) reported a 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 a density of about 2 - 27 zebra mussels/square meter (m^2) or 0.2 – 2.4 zebra mussels/ft^2 between TRM 195 and 203. However, very few zebra mussels were encountered during a 2010 mussel survey associated with TVA's dike stabilization of the Johnsonville ash storage pond project between approximately 100-99R (Third Rock Consulting 2010) near the currently proposed action.

EFFECTS OF THE ACTION

Factors to be considered

Proximity of the action:

The proposed action would occur on the right descending bank (east shoreline) and in the Tennessee River channel in the vicinity of TRM 94.5 within the Kentucky Reservoir impoundment in Humphreys County, Tennessee.

Waverly's proposed improvements to its wastewater lagoon currently include a new wet well, a new pump station adjacent the existing lagoon, approximately seven miles of 16-inch diameter force main , and an outfall diffuser with five 8-inch ports measuring a total of about 20 feet long.

The effluent force main would cross Trace Creek and two first-order streams along its seven-mile length that would require trenching and stabilization using riprap. Phase I of the pipeline has already been constructed along a pre-existing right-of-way, while Phase II of the route is pending final approval of the outfall plans. The proposed Phase II-B route would follow an easement for an existing water line so that limited trees would need to be cleared for construction. Additionally, construction traffic using existing roads near the outfall would use the western-most route to ensure a 200-meter (660-foot) buffer around an existing osprey nest (TVA 2013).

The proposed effluent force main header and diffuser structure would extend into the Tennessee River (Kentucky Reservoir) approximately 140 meters (450 feet) from the shoreline, exiting from the slope of the navigational channel and anchored to the riverbed. The terminal section of the effluent force main would be installed using a directional boring method underneath the riverbed between the bank and the outfall location to avoid or minimize potential impacts to benthic fauna of the river, particularly freshwater mussel resources. The outfall diffuser port would occur at an elevation of 333 feet above mean sea level (msl) as required by the USACE for navigation purposes. Boring and construction of the terminal portion of the force main and diffuser would occur during low pool elevation (i.e., winter) for Kentucky Reservoir. The total area of physical disturbance from construction activities to aquatic habitats in the Tennessee River would be where the diffuser would protrude in the channel and be approximately 20-30 feet in length.

Distribution:

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; however, continuing routine encounters of low numbers of this species suggest that most populations are relatively stable. A 5-year review status for pink mucket has been completed (USFWS 2008). 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 with relatively more riverine flow conditions (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 391.0-392.0 (Guntersville Reservoir) in 2007 (Mainstream) found a mussel community with 12 species and density of 0.81 mussels/m2, but no pink mucket were found. However, a during a snail survey of the same location in 2009 (Dinkins 2009), one pink mucket was inadvertently found during the survey. A 2008 survey in the Nickajack Dam tailwater (TRM 424.0; 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/m2 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 202.0 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 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. A 2009 survey of the boat harbor adjacent to Johnsonville Island 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).

Third Rock (2010) discovered high-quality mussel habitat at 150 - 200 m west of Johnsonville Island (TRM 99.0 -100.0) at the north spillway site and 80 - 200 m at the south spillway site, which is presumably capable of supporting pink mucket (Lewis 2008, Dinkins 2008). Based on other studies (Lewis 2008, Dinkins 2008) pink mucket occurs at a community frequency of 0.1% when suitable habitat for pink mucket is present. Although no pink mucket were found during the 2010 survey, TVA and was thus presumed to occur in high-quality mussel habitats west of Johnsonville Island at a similar frequency.

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 likely that pink mucket could inhabit the proposed project's action area. No critical habitat exists in the action area for the pink mucket or any other federally listed species.

Timing:

The proposed action can be divided into essentially two periods, a construction phase and an operations (post-construction) phase. The biological assessment indicates that proposed project construction would commence sometime in fall 2014. Operation of the effluent force main and diffuser structure would be expected to occur throughout the year and into the foreseeable future.

Pink muckets are long-term brooders (bradytictic). Long-term brooders usually spawn from August through September and release glochidia the following April through June (U.S. Fish and Wildlife Service and Virginia Department of Game and Inland Fisheries 2008). Sensitive periods for adult males include the period when they release sperm into the water column and, for females, the period when eggs are fertilized (August – September) and brooding of larvae occurs as they transform into glochidia. Another sensitive period for female mussels is the time of release of glochidia (April – June) and their attachment onto the fish host. Sensitive periods for the juveniles include their attachment to excystment from the fish host as they drop to the riverbed and establish themselves in the substrate.

The pink mucket could potentially be impacted from fall and winter construction activities because the species would be present in the action area during a sensitive period of its life cycle. The pink mucket could potentially be impacted during the operational phase because the effluent discharge is anticipated to occur year-round, and the species would be present in the action area throughout the year; this would include during its reproductive cycle. In addition, the pink mucket could potentially be impacted if fish host behavior and presence are affected by the construction and operation phases of the proposed action.

Nature of the effects:

It is possible that the proposed action could have a variety of effects on individual pink muckets. Any period of the pink mucket's life cycle could potentially be disturbed or disrupted by construction and/or operation activities. The construction phase would be expected to result in temporary effects, whereas the operation phase of the proposed project could result in ongoing effects.

These effects to the pink mucket may include: (a) injury or mortality as a result of turbidity and/or deposition of sediment, created by in-stream construction activities and/or drilling mud escaping during horizontal boring to install the effluent force main header in the river bottom restricting their respiration, and interfering with their ability to feed and/or reproduce; (b) injury as a result of construction activities adjacent to the river (erosion and runoff from operated heavy equipment disturbing soils in the floodplain to install the terrestrial portion of the effluent force main) restricting their respiration, and interfering with their ability to feed and/or reproduce; (c) injury or mortality as a result of contaminant releases (i.e., spills of petroleum products from hydraulic, fuel and power systems, etc.) accidently entering the river from construction equipment, affecting water quality and food sources, and in turn respiration and feeding capabilities in the immediate project vicinity; (d) injury as a result of a reduction or other modification in the availability of fish hosts due to degradation/alteration of fish host habitat from the placement of the effluent force main and diffuser structure; and (e) injury or mortality from ammonia and other priority pollutants

in the effluent plume, which could cause direct mortality or change ambient water quality conditions, interfering with respiration, feeding and reproduction of individuals.

Duration:

During the construction phase, construction activities would be restricted to the project footprint and potential effects to the pink mucket would be temporary. In-stream areas, impacted by placement of new structures and brief episodes of turbidity and/or deposition of sediment as a result of construction activities, would improve when construction ceased and flows flushed those areas.

The effects of the operations phase would be difficult to determine, but any effects would most likely be of a temporary duration or include a combination of long-term duration and/or permanent effects to the pink mucket. Temporary effects from sporadic discharges of poor water quality with ammonia concentrations exceeding the recommended acute criterion may affect the pink mucket. Long-term or permanent effects would include: loss of a small amount of suitable habitat due to the protrusion of the effluent force main header and diffuser anchors residing in areas previously supporting suitable habitat and impacts to habitat and poor water quality from discharges with ammonia concentrations above the recommended chronic criterion being discharged into Kentucky Reservoir. Under worst case scenarios, the area of river substrate potentially exposed downstream of the diffuser would vary from approximately 198 m^2 to 618 m^2. Potential effects to the pink mucket and/or impacts to its habitat or its fish host habitat from operational changes would not be known without sufficient post-project monitoring.

Disturbance frequency:

Any disturbances to the pink mucket during the construction phase are anticipated to occur only once (over a several week period). The proposed construction activities have the potential to temporarily alter conditions like flow, turbidity and sediment deposition, but overall would only produce these effects over a short-time period.

Disturbances to pink muckets during the operations phase involve routine discharges of wastewater from the Waverly Lagoon. The proposed discharge volume averages 0.985 mgd. Typical disturbances during the operations phase could also result from a treatment upset/failure at the Waverly Lagoon increasing the volume of untreated wastewater into Kentucky Reservoir. Under worst case operational scenarios, modeling indicated that the mixing zone at the riverbed surface could be toxic to pink mucket over an area of approximately 198 m^2 to 618 m^2. No other water quality parameters would exceed levels known to be harmful to aquatic life or mussels. Waverly Lagoon treatment failures or effluent force main rupture could vary from one-time events, multiple occurrences or frequent occurrences, but most likely should never occur or occur on an infrequent basis.

Disturbance intensity:

The disturbance intensity would be highest in aquatic portions of the project construction footprint (aquatic impact area), where the effluent force main and diffuser structure would be constructed, because such activities potentially have the greatest risk of mortality or injury to the pink mucket, due to being located within or near mussel habitat. The disturbance intensity during the construction phase would be lower in terrestrial portions of the project construction footprint (terrestrial impact area) where the proposed temporary equipment staging area where the effluent force main would be constructed because such activities are a greater distance from aquatic mussel habitat, the majority of land-based effluent force main installation would be in previously disturbed area (minimizing disturbance), and standard industry BMPs for controlling stormwater and sediment runoff would be installed.

It is anticipated that the operational disturbance intensity from the proposed project would be slightly higher and more sporadic than existing ambient conditions. The operational disturbance intensity may occasionally create unfavorable habitat conditions for the pink mucket. Modeling results of the effluent plume indicated the mixing zone interface at the riverbed surface may exhibit ammonia toxicity to pink mucket over an area of approximately 198 m^2 to 618 m^2. Based on the applicants modeling, no other water quality parameters exceeded toxicity thresholds known to be harmful to aquatic life or mussels.

Disturbance severity:

The disturbance severity of the project construction phase would be minimal because: (a) it would be temporary, (b) the majority of land-based construction would be implemented in areas previously disturbed, (c) the total area of direct disturbances (project construction footprint) would be a very small area relative to the range-wide geographic distribution of the species, and (d) adequate and properly functioning BMPs would be expected to minimize disturbance to the pink mucket.

The disturbance severity of the operations phase would be minimal because (a) the anticipated magnitude of disturbance relative to prior and existing conditions at the site would be infrequent and (b) with the exception of an unforeseen accident or failure, the amount of wastewater effluent discharged from the Waverly Lagoon would have minimal effect on the pink mucket population because of the small volume of total effluent to be released, the potential for ammonia concentrations to exceed applicable water quality criteria for extended periods, and the low densities of pink muckets expected to occur within the action area. No other water quality parameters appeared to exceed levels known to be harmful to aquatic life or mussels.

The overall disturbance severity is expected to be minor relative to the population of pink muckets, in Kentucky Reservoir and range-wide.

Analyses for effects of the action

Beneficial effects:

No elements of the action, as proposed, would result in beneficial effects to the pink mucket or its habitat. After construction has been completed, biological and physical conditions within the action area would not be similar to current ambient conditions.

Direct effects:

The effluent pump station and existing three miles of effluent force main would alter existing land conditions in project footprints and adjacent buffer areas around each; however, these areas were previously altered for development by the existing Waverly Lagoon and along roadways and utility rights-of-way. Although habitat likely to support federally listed species occurred in these areas, avoidance during the completed terrestrial construction phase did not affect federally listed species. Phase 1 of the constructed pipeline crossed Trace Creek, but this stream is an impaired stream (TDEC 2014) and would not provide suitable habitat for federally listed aquatic species in its current state. Similarly, the remaining four miles of proposed effluent pipeline (Phase 2) would be constructed mostly along pre-existing utility rights-of-way. Construction would not include removal of any trees that could provide habitat for listed bats. Moreover, construction of the Phase 2B section of pipeline would occur during winter months outside of periods where federally listed bats or bald eagles could be roosting or nesting nearby, respectively. The Phase 2 pipeline would cross two unnamed, first-order streams that are not large enough to support most freshwater mussels, particularly the federally endangered pink mucket.

Direct impacts to the riverbed during construction would be minimized by horizontal directional boring methods to place the effluent force main beneath the riverbed between the bank and the diffuser. A small area at the point of protrusion by the effluent force main header and diffuser structure along the slope of the navigational channel (450 feet from the bank) would be affected. Given the very small footprint of this area (~20-30 feet long), it is extremely unlikely that pink mucket would occur there and be affected. Therefore, pink mucket may be affected but is not likely to be affected by direct impacts from construction.

Without significant improvements to capacity and treatment efficiencies, routine discharges from the Waverly Lagoon will further contribute to nutrient and pollutant loading in the Tennessee River. The project could directly affect pink mucket where the effluent plume mixing zone interacts with the riverbed surface where mussels live. Impacts would occur only when the environmental conditions are such that total ammonia concentrations rise above the chronic or acute threshold levels (and periods of time) that are likely to adversely affect aquatic life, including mussels such as the pink mucket. Other constituents of the effluent mixing zone that were modeled, including chlorine, pH, dissolved and suspended solids were not reported to reach concentrations or levels that would presumably harm pink mucket (Jacobs 2013). The applicant evaluated the Waverly Lagoon mixing zone effects on mussels utilizing the 2009 USEPA recommended criteria for ammonia toxicity, the most up-to-date recommendations at the time of the analysis. In 2009, USEPA data indicated juvenile mussels could be adversely affected by acute ammonia concentrations of 2.9 mg/L and chronic ammonia concentrations of 0.26 mg/L, which were lower than the existing Tennessee water quality criteria for ammonia (TDEC 2013). Although the EPA has since published revised recommended levels of ammonia toxicity

thresholds to protect freshwater life (FR 78 52192 – 52194), TVA relied on the 2009 recommended criteria for the Waverly WWTP effects analysis because of the extensive evaluation and inter-agency consultation that had been developed using the previous criteria, which are more environmentally conservative than the 2013 USEPA recommendations. Moreover, although common native mussel species were used during the testing and development of both the 2009 and 2013 recommended criteria, ammonia tolerances of federally listed species such as pink mucket are still unknown.

Jacobs (2013) modeled eight scenarios that estimated areas where acute and/or chronic ammonia toxicity levels could interact with the riverbed and mussels under different environmental conditions known for the Tennessee River near the site. Water quality data from TVA and Mainstream (2012), including Acoustic Doppler Current Profiling (ADCP) data, were utilized to develop the modeling assumptions for the receiving waters and habitat. Modeling used the 1Q10 (the 1-day observed low flow with a 10-year recurrence interval) flow from the Tennessee River measuring 5,000 cfs, as well as future peak discharges of 5.42 cfs and an average pump rate of 3.09 cfs. Scenarios 1-4 modeled river temperatures at 9.38°C, and Scenarios 5-6 used ambient temperatures of 29°C to simulate winter and summer environmental conditions, respectively. Temperature and pH adjusted values for chronic and acute ammonia values were also used for estimated background values. Two cases of environmental conditions (Scenarios 5 and 6) modeled using CORMIX could result in effluent plume contacting the riverbed where chronic and/or acute ammonia toxicity levels exceeded protective criteria. Results of the modeling indicated that the mixing zone at the riverbed surface could be toxic to pink mucket over areas of approximately 198 m^2 in Scenario 5 and 618 m^2 in Scenario 6.

Based on these interaction areas where chronic and acute ammonia criteria are below known thresholds for Unioid mussels, as well as local estimated mean mussel density from nearby studies (~ 2.5 mussels/m2), and an assumed community frequency of 0.1% for pink mucket, the adverse impacts from excessive levels of ammonia on pink mucket is estimated to statistically result in the harm of <1 pink mucket during Scenario 5 conditions and 1.5 pink mucket during Scenario 6 conditions (TVA 2013). Given the exceptionally small direct impact areas relative to the available mussel habitat in Kentucky Reservoir near the project, the potential impacts to pink mucket and its habitat are extraordinarily small. Although host fish, and presumably encysted mussel larvae, could potentially be affected by elevated level of ammonia in the mixing zone, it is presumed that any potential impacts would be temporary and insignificant since fish would likely avoid areas inducing physiological stress. The pink mucket would need to be present in the immediate vicinity of the proposed project site in order to be directly affected by the proposed action.

In summary, the following direct effects to the pink mucket are possible:

1. Injury or mortality as a result of being crushed or becoming physically impaired due to in-stream construction activities.

2. Injury or mortality as a result of turbidity and/or deposition of sediment, created by in-stream construction activities and construction activities adjacent to Kentucky

Reservoir, restricting their respiration, limiting their ability to feed and/or interfering with their reproduction.

3. Injury as a result of drilling fluids and other pollutants from construction equipment accidentally entering Kentucky Reservoir, affecting water quality and food sources, and in turn respiration and feeding capabilities.

4. Injury as a result of routine discharges from the Waverly Lagoon and subsequent exposure to toxic pollutants.

The Service estimates that it is probable that pink muckets could be directly affected by the proposed action because collection records indicate that a pink mucket was collected within 10 miles of the proposed project site in the recent past (Tennessee Department of Environment and Conservation 2012) and the mussel community and habitat in the vicinity of the proposed project is consistent with other areas where pink muckets have been collected from the Tennessee River (Fortenbery 2012). Therefore, based upon this information, we assume that the species would be likely to occur in the direct effect area at low densities.

Interrelated and interdependent actions:

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

Indirect effects:

Indirect impacts from the project that could affect listed mussels and their habitat may include temporary increases in suspended sediment during construction at that the point of protrusion of the effluent force main header and diffuser structure in the channel. Since pink mucket and other native mussels filter water near the rivberbed surface, elevated levels of suspended sediment can interfere with respiration, feeding, and reproductive activities (Watters 2000). Once constructed, the diffuser structure and effluent currents may change existing flow patterns in the vicinity of the diffuser; this in turn could alter specific habitat (substrate) conditions caused by erosion and/or sedimentation. These changes in substrate and flows could adversely affect habitat suitability of mussels as well as host fish they interact with during reproductive periods. Since the effluent force main header and diffuser structure extend only 20-30 feet out from the navigation channel slope, the affected area is relatively small relative to the available surrounding habitat. Probabilities that the area affected indirectly by altered currents and substrate changes harbor pink mucket would be minimal. Any pink muckets in the action area could potentially be indirectly affected during the project operations phase.

Effluent releases in the vicinity of the diffuser could increase total suspended solids, nutrients, ammonia, and biochemical oxygen demand resulting in lower DO levels. These conditions may interfere with respiration, feeding and reproduction of pink muckets, resulting in injury or mortality to the species. Without significant improvements to capacity and treatment efficiencies,

routine discharges from the existing Waverly Lagoon will further contribute to nutrient and pollutant loading in the Tennessee River.

In summary, the following indirect effects to the pink mucket are possible:

1. Harm or harassment as a result of in-stream structures eliminating pink mucket and/or host fish habitat, and/or routine operations compelling host fish to relocate outside of the action area. These post-construction and operational conditions (decreased habitat and reductions in host species) could affect the reproductive potential of the pink mucket in the action area.

2. Injury or mortality as a result of effluent releases in the vicinity of the diffuser interfering with the respiration, feeding and reproduction of individuals.

The Service believes that indirect effects from the proposed action could potentially lead to individual pink muckets being affected within the action area. However, those indirect effects would not significantly reduce the pink mucket population in the action area or reduce recovery of the species.

Species' response to a proposed action

Numbers of individuals/populations in the action area affected:

No pink muckets were encountered in the 2009 and 2013 surveys of the action area at TRM 94.0 and TRM 94.5, respectively (Mainstream Commercial Divers, Inc.). However, based on the mussel assemblage and habitat conditions recorded during that survey, it is likely pink muckets occur in the action area; the highest probability of their presence would be in the upstream portion of the action area, where the most suitable habitat was noted and the highest densities of mussels were observed. It is difficult to estimate the number of pink muckets in the action area because rare mussels tend to not be evenly distributed, habitat conditions within the action area vary, and juveniles may have not been found or their presence documented. The Service has assumed that the species likely occurs at a low density within the action area.

Sensitivity to change:

The degree to which pink muckets are disturbed by change is unknown. Mussels are thought to be relatively sedentary within the substrate. As a result, they are likely unable to respond to change by moving great distances; however, it is possible they could move several yards. When disturbed, mussels, in general, tend to close their valves for a period of time; however, this response would vary depending upon the disturbance. Pink muckets exposed to increased sediment/turbidity levels and contaminants would likely close their valves and keep them closed until those levels decrease. They would not be likely to move out of the area of disturbance on their own because of their inability to move great distances in a short period of time and because their valves would likely remain closed.

Resilience:

Resilience relates to the characteristics of populations or a species that allow them to recover from different magnitudes of disturbance. The pink mucket is believed to not be a very resilient species; it is typically found only in small remaining patches of suitable habitat throughout its historical range. Assuming that flow characteristics and habitat conditions in the action area would not appreciably change, the magnitude of disturbance would likely be low and pink mucket resilience would not be expected to change from its current level.

Recovery rate:

In this biological opinion, the recovery rate relates to the time required for a pink mucket population to return to equilibrium after exposure to a disturbance. Current population data shows that pink muckets throughout the Tennessee River system are actively recruiting, but are rare and widely dispersed throughout the system, including within Kentucky Reservoir where the proposed action area would be located. Therefore, the recovery rate for any impacts associated with construction would be expected to be long relative to the life-span of the pink muckets within and in the near vicinity of the action area. However, since the proposed action area is small relative to the entire species range, the project would not be expected to produce conditions appreciably different than current conditions throughout its range, as a whole.

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.

The proposed project is located within a reach of the Tennessee River which includes multiple municipal and industrial water intakes and wastewater outfalls, port facilities and transportation networks (highways and bridges). Because this infrastructure currently exists, the Service believes that future developments are likely to occur within the immediate or near vicinity of the proposed project, involving expansion, modification or maintenance to existing developed sites, similar to the proposed project.

Future developments may also include construction and operational components which could further affect the pink mucket and its habitat within the currently proposed project's action area (comparable to those previously described in this opinion under "Effects of the Action"). Such developments could also increase wastewater discharges and stormwater runoff into Kentucky Reservoir within the action area. Therefore, cumulative effects, as defined by the Act, are 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 Endangered Species Act 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, it is the Service's biological opinion that the proposed project at approximately TRM 94.5 near New Johnsonville in Humphreys County, Tennessee, as proposed, is not likely to jeopardize the continued existence of the pink mucket because: 1) the proposed action area is small relative to the species range, and therefore, includes only a small fraction of their overall population, 2) potential direct effects would be temporary and of short duration, and 3) the likelihood of lethal take would be low with properly engineered and correctly installed structures, an appropriate spill plan in place and adherence to construction BMPs. No critical habitat has been designated for this species; therefore, none would be affected.

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 TVA and USACE, so that they become binding conditions of any grant, permits or contracts, as appropriate, for the exemption in section 7(o)(2) to apply. The TVA and USACE have a continuing duty to regulate the activity covered by this Incidental Take Statement. If the TVA and USACE (and ultimately their Permittee, the City of Waverly): (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the grant, permit or contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the effect of incidental take, the TVA must report

the progress of the action and its effect on the species to the Service as specified in the Incidental Take Statement. [50 CFR § 402.14 (1)(3)].

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service expects the level of incidental take of pink muckets will be difficult to determine and cannot anticipate the exact extent of incidental take of the species as a result of the proposed action for the following reasons: 1) they frequently inhabit deeper water habitats where observation can be problematic, particularly observation of juveniles; (2) finding a dead or injured individual and attributing death or injury to project-related activities would be difficult.

In summary, total incidental take of pink muckets as a result of the proposed action would be 1 to 1.5 individuals, construction and from operational effects.

In the "Analyses for Effects of the Action" section, the Service determined that the proposed action would result in incidental take of the pink mucket in several forms including:

(a) lethal from: 1) turbidity and/or deposition of sediment as a result of in-stream construction activities restricting their respiration (inability to purge sediment from gills) and 2) effluent releases in the vicinity of the diffuser that exhibit acute toxicity from ammonia;

(b) harassment from: 1) turbidity and/or deposition of sediment as a result of in-stream construction activities and terrestrial construction activities adjacent to Kentucky Reservoir, restricting their respiration, limiting their ability to feed and/or interfering with their reproduction, 2) pollutants accidentally entering Kentucky Reservoir as a result of spills of drilling fluids and petroleum products from construction equipment in staging areas and the terrestrial project construction footprint, affecting water quality and food sources, and in turn respiration and feeding capabilities, and 3) effluent releases in the vicinity of the diffuser that exhibit chronic toxicity from ammonia or interfere with their respiration, feeding and reproductive capabilities;

(c) harm from: 1) becoming physically impaired as a result of in-stream construction activities (horizontal directional boring to install the effluent force main header and diffuser structure, 2) turbidity and/or deposition of sediment as a result of in-stream construction activities and terrestrial construction activities adjacent to Kentucky Reservoir, restricting their respiration, limiting their ability to feed and/or interfering with their reproduction, 3) drilling fluids and pollutants accidentally entering Kentucky Reservoir as a result of spills of petroleum products from construction equipment in staging areas and the terrestrial project construction footprint, affecting water quality and food sources, and in turn respiration and feeding capabilities, and 4) effluent releases in the vicinity of the diffuser that

exhibit chronic toxicity from ammonia or interfere with their respiration, feeding and reproductive capabilities.

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

SPECIES	INDIVIDUALS	TAKE TYPE
Pink mucket	2	Lethal
Pink mucket	2	Harass
Pink mucket	2	Harm

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 and would not result in 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 Table 4 below.

Table 4. The following list includes previous biological opinions, issued for adverse impact and completed for pink mucket populations within Tennessee, which identified incidental take:

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-ac 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-mi reach of suitable habitat**	**N/A**	**----------**
2009/1	**All individuals within a 22,206 ft^2 area**	**N/A**	**----------**
2009/1	**3**	**N/A**	**----------**
2010/1	**151**	**N/A**	**----------**
2011/1	**45**	**N/A**	
2012/1	**116**	**N/A**	**----------**
TOTAL	**325 pink mucket**	**N/A**	**7.6 ac and a 5-mi stream reach**

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and minimize effects of incidental take of the pink mucket:

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

2. The TVA and USACE must ensure that the City of Waverly implements measures to minimize or eliminate effects from construction and operational activities. This includes that proposed increases in permitted discharges from the Waverly Lagoon above what is projected in this Biological Opinion or expansions of the City of Waverly Sewerage Service Area will not be allowed or permitted until improvements in capacity and treatment efficiencies at the lagoon are completed.

3. The TVA and USACE must ensure that the City of Waverly adequately monitors the level of pink mucket take associated with the proposed action.
4. The TVA and USACE must ensure that the City of Waverly adequately monitors the proposed action to document changes in water quality and in-stream habitat conditions resulting from the project.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the TVA, USACE, and City of Waverly must comply with the following terms and conditions, which carry out the RPMs described above. These terms and conditions are non-discretionary.

1. The TVA, USACE and/or the City of Waverly must agree to implement the proposed action as described in the biological assessment, the biological assessment's supporting documentation, and this biological opinion. On-the-ground construction compliance monitoring must occur, be documented and available for the Service to review upon request. This Term and Condition supports RPMs 1 and 4.

2. The City of Waverly will conduct post-project mussel surveys by qualified biologists to determine any reductions in native mussel densities, changes in native mussel diversity and/or modifications to aquatic habitat conditions using the pre-project mussel surveys conducted by Mainstream Commercial Divers, Inc. (2009 and 2013) as a baseline. If the native mussel assemblage or habitat conditions notably change (as determined by the Service), the estimated population of pink muckets in the action area needs to be reassessed and the amount of take re-evaluated. Post-project monitoring will occur twice, at two year and four year intervals after project completion to insure that the level of take identified in the biological opinion is not exceeded. Changes in the number of pink muckets estimated to be present will be used as an indicator to determine whether the identified level of take is exceeded. The TVA, USACE and/or the City of Waverly shall provide two mussel monitoring reports to the Service on or before January 31st of the years following project monitoring. This Term and Condition supports RPMs 3 and 4.

3. The TVA, USACE and/or the City of Waverly shall restore all substrate where the effluent force main will be buried to suitable habitat conditions for the pink mucket, to the greatest extent possible. This Term and Condition supports RPM 2.

4. The TVA, USACE and/or the City of Waverly shall closely monitor construction and post-project maintenance activities and any impacts to water quality or mussel populations, particularly pink muckets, as a result of these activities; any impacts shall be duly noted and reported to the Service. 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. Any new information learned from monitoring project construction and maintenance activities shall be documented and reported to the Service. This Term and Condition supports RPMs 2 and 4.

5. All heavy equipment and trucks will be cleaned and refueled in a designated staging area, located a minimum of 450 ft from the normal winter pool level of 354ft msl for Kentucky Reservoir. This Term and Condition supports RPM 2.

6. As much as possible, effluent force main installation to and from the Waverly Lagoon and associated pumping stations will occur in existing rights-of-way to minimize project-related disturbances. This Term and Condition supports RPMs 1 and 2.

7. The 16-in effluent force main will be installed by horizontal directional boring to avoid disturbance of benthic habitat; the only river bottom disturbance from effluent force main construction will occur where the bore exits the river bottom, any area encompassed by drilling mud and the area affected during installation of the diffuser structure. BMPs will be utilized to reduce the amount of drilling mud impacting the river bottom. This Term and Condition supports RPMs 1 and 2.

8. Monthly Waverly Lagoon effluent samples will be collected and analyzed for ammonia, chlorine, total dissolved solids, total suspended solids, and BOD/CBOD with results submitted to the federal and state agencies involved in this project. Copies of TDEC's required MORs for Waverly Lagoon effluent discharges will be submitted to all agencies. Resulting data will be used to re-calculate effluent plume behavior and concentrations for pollutant parameters, identified in the biological assessment, and compared to current Cormix predicted concentrations in a report to be submitted to federal and state agencies. This information will be validated by the permitting agencies. This Term and Condition supports RPMs 1, 2 and 4.

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the U.S. Fish and Wildlife Service Law Enforcement Office at 220 Great Circle Rd, Nashville, Tennessee (telephone: 615/736-5532). Additional notification must be made to the U.S. Fish and Wildlife Service, Tennessee 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 RPMs, with their implementing terms and conditions, are designed to minimize the effect of incidental take that might otherwise result from the proposed action. The Service believes that no more than 2 pink muckets 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 re-initiation of consultation and review of the RPMs 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 RMPs.

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:

- The TVA, USACE, USEPA, and TDEC should conduct a comprehensive evaluation of ambient water quality conditions in this reach of the Tennessee River, including pollutant loadings associated with existing NPDES permits. The applicability of water quality-based effluent limits or site-specific water quality criteria to reduce existing pollutant loadings should be considered. Coordination with other entities requiring federal Clean Water Act Permits in the Tennessee River drainage well in advance of proposed projects should occur to develop protective measures, conservation banks, and/or other actions necessary to assist in recovery of federally listed mussels and their habitats.

- The TVA, USACE, USEPA, and TDEC should provide funds to study the pink mucket's life history and ecological requirements. Information obtained from such studies would be valuable in determining protective measures for the species and its habitat, and contribute toward recovery of the species.

- The TVA, USACE, USEPA, and TDEC 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, potentially driving 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 aquatic habitat in the Tennessee River drainage.

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.

RE-INITIATION NOTICE

This concludes formal consultation on the actions outlined in the consultation request. As written in 50 CFR Section 402.16, re-initiation of formal consultation is required where discretionary TVA and Corps involvement or control over the action have been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the TVA and Corps actions that may affect listed species or critical habitat in a manner or to an extent not considered in this biological opinion; (3) the TVA and Corps action is later modified in

a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease until reinitiation.

For this biological opinion the incidental take would be exceeded when the take exceeds 112 pink muckets, which is what has been exempted from the prohibitions of section 9 by this biological opinion. The Service appreciates the cooperation of the TVA and USACE during this consultation. We would like to continue working with you and your staff regarding this project. For further coordination please contact Steve Alexander of my staff at 931/525-4980.

Mary E. Jennings

Mary E. Jennings, Field Supervisor

4/23/14

Date

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