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Lockhart Power Company, Inc.; Notice of Availability of Draft Environmental Assessment; Notice

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Project No. 13590–001]

Lockhart Power Company, Inc.; Notice of Availability of Draft Environmental Assessment

In accordance with the National Environmental Policy Act of 1969 (NEPA) and the Federal Energy Regulatory Commission's (Commission or FERC) regulations, 18 CFR part 380, the Office of Energy Projects has reviewed Lockhart Power Company, Inc.'s application for license for the Riverdale Hydroelectric Project (FERC Project No. 13590–001), located on the Enoree River, near the town of Enoree, in Spartanburg and Laurens Counties, South Carolina. The project does not occupy federal lands.

Staff prepared a draft environmental assessment (DEA), which analyzes the potential environmental effects of licensing the project, and concludes that licensing the project, with appropriate environmental protective measures, would not constitute a major federal action that would significantly affect the quality of the human environment.

A copy of the DEA is available for review at the Commission in the Public Reference Room or may be viewed on the Commission's Web site at *http://www.ferc.gov* using the ''eLibrary'' link. Enter the docket number excluding the last three digits in the docket number field to access the document. For assistance, contact FERC Online Support at *FERCOnlineSupport@ferc.gov*, at (866)208–3676 (toll free), or, 202–502–8659 (TTY).

You may also register online at *http://www.ferc.gov/docs-filing/esubscription.asp* to be notified via email of new filings and issuances related to this or other pending projects. For assistance, contact FERC Online Support.

Any comments should be filed within 45 days from the date of this notice.

The Commission strongly encourages electronic filing. Please file comments using the Commission's eFiling system at *http://www.ferc.gov/docs-filing/efiling.asp.* Commenters can submit brief comments up to 6,000 characters, without prior registration, using the eComment system at *http://www.ferc.gov/dcos-filing/ecomment.asp.* You must include your name and contact information at the end of your comments. For assistance, please contact FERC Online Support.

In lieu of electronic filing, please send a paper copy to: Secretary, Federal Energy Regulatory Commission, 888 First Street NE., Washington, DC 20426. The first page of any filing should include docket number P–13590–001.

For further information, contact Sarah Salazar by phone at 202–502–6863, or by email at *sarah.salazar@ferc.gov.*

Dated: December 12, 2013.

Kimberly D. Bose,

Secretary.

Draft Environmental Assessment for Hydropower License

Riverdale Hydroelectric Project, FERC Project No. 13590–001, South Carolina

Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing, 888 First Street NE., Washington, DC 20426

December 2013

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Acronyms and Abbreviations

APE area of potential effects
applicant Lockhart Power Company, Inc.
BMPs Best Management Practices
°C degrees Celsius
certificate Water Quality Certificate
cfs cubic feet per second
Commission Federal Energy Regulatory Commission
Conservation Species South Carolina Priority Species
Council Advisory Council on Historic Preservation
Corps U.S. Army Corps of Engineers
CWA Clean Water Act
CZMA Coastal Zone Management Act
DO dissolved oxygen
DOI U.S. Department of the Interior
EA environmental assessment
EPA U.S. Environmental Protection Agency
°F degrees Fahrenheit
fps feet per second
FERC Federal Energy Regulatory Commission
FPA Federal Power Act
FWS U.S. Fish and Wildlife Service
LIP low inflow protocol
Lockhart Power Lockhart Power Company, Inc.
MADF mean annual daily flow
MW megawatt
MWh megawatt-hour
mg/L milligrams per liter

msl mean sea level
National Register National Register of Historic Places
NEPA National Environmental Policy Act
NERC North American Electric Reliability Council
NHPA National Historic Preservation Act
NMFS National Marine Fisheries Service
NPDES National Pollutant Discharge Elimination System
NRCS Natural Resource Conservation Service
NGVD National Geodetic Vertical Datum
PM&E measure protection, mitigation, and enhancement measure
Riverdale LLC Riverdale Development Venture, LLC
ROR run-of-river
ROW rights-of-way
SERC Southeastern Electric Reliability Council
SCORP Statewide Comprehensive Outdoor Recreation Plan
SHPO State Historic Preservation Officer
South Carolina DHEC South Carolina Department of Health and Environmental Control
South Carolina DNR South Carolina Department of Natural Resources
South Carolina DPRT South Carolina Department of Parks, Recreation, and Tourism
South Carolina EPPC South Carolina Exotic Pest Plant Council
South Carolina WRC South Carolina Water Resources Commission
THPO Tribal Historic Preservation Officer
USGS U.S. Geological Survey
Water District Woodruff-Roebuck Water District
Water Plan South Carolina Water Plan

Executive Summary

Proposed Action

On August 31, 2010, Lockhart Power Company, Inc. (Lockhart Power or applicant), filed a license application for the Riverdale Hydroelectric Project (Riverdale Project or project) with the Federal Energy Regulatory Commission (Commission or FERC). Lockhart Power proposes to repair existing facilities and return the project,[1] which has been inoperable since 2001, to operation. The proposed 1.24-megawatt (MW) project is located on the Enoree River near the city of Enoree, in Spartanburg and Laurens Counties, South Carolina. The project does not occupy any federal lands.

Project Description

The Riverdale Project is located at river mile 52 of the 110-mile-long Enoree River in northwestern South Carolina. The proposed project would consist of the following: (1) An existing 425-foot-long, 12-foot-high concrete gravity dam with three evenly spaced, integral sand gates, and 2-foot-high flashboards; (2) an existing 6.6-acre impoundment with a gross storage of 22.0 acre-feet; (3) an existing 85-foot-long, 50-foot-wide concrete headrace canal with an intake structure equipped with trash racks with 2.25-inch bar spacing; (4) an existing 9-foot-diameter, 340-foot-long steel penstock equipped with a second set of trash racks with bar spacing of about 10 inches; (5) an existing wood frame powerhouse containing one 1.24-MW capacity generating unit; (6) an existing 510-foot-long tailrace; (7) an existing 700-foot-long transmission line from the powerhouse to an existing Duke Energy distribution line; (8) an existing approximately 1,376-foot-long, 20-foot-wide paved access road; and (9) appurtenant facilities. Flow diverted to the powerhouse creates a 1,400-foot-long bypassed reach downstream from the dam.

Since the project became in-operable 12 years ago, all flows have passed over the dam and into the 1,400-foot-long bypassed reach. The 2-foot-high flashboards were partially damaged during high flow events in 2012 and 2013.

Proposed Facilities

Because Lockhart Power is not the current licensee or current owner of the project and has not had full access to the project, it plans to spend the first year following license issuance assessing the condition of project facilities and finalizing any engineering design needed to refurbish the project. To make the project operational, Lockhart Power expects it would, at a minimum need to: (1) Repair or replace the sand gates and gate operators; (2) repair or replace the 2-foot flashboards on the dam; (3) replace a 193-foot-long above ground section of the penstock; (4) modify the bar spacing on the penstock trashrack from 10 to 5 inches; (5) refurbish the turbine generator; (6) repair the plant controls and governor; (7) repair the powerhouse roof; and (8) dredge sediment and debris from the tailrace.

Lockhart Power would operate the project using a combination of run-of-river (ROR) and peaking modes. Lockhart Power would typically operate the project in a ROR mode, with project outflow approximately equaling project inflow, such that the impoundment surface elevation stays within 1 foot (+/−10 percent) of the top of the flashboards. When inflows are insufficient to operate the turbine at its maximum hydraulic capacity i.e. of 450 cubic feet per second (cfs) and provide a continuous minimum flow of 50 cfs to the bypassed reach (i.e. when inflow is less than 500 cfs), Lockhart Power would operate the project in a ''peaking'' mode. Peaking events would occur no more than once daily, until either the daily period of increased need for power ends or until the impoundment surface elevation is drawn down a maximum of 4 feet (+/−10 percent) below the top of the flashboards. Following each peaking event, Lockhart Power would suspend operation and store inflow, minus the minimum flow to the bypassed reach, to refill the impoundment (likely overnight) to its normal elevation of within 1 foot (+/−10 percent) of the top of the flashboards, allowing it to return to ROR mode until the next peaking event. Lockhart Power expects that peaking operation would occur less than half of the days in any given year.

Proposed Environmental Measures

Lockhart Power proposes, once the project is operational, the following measures to protect or enhance environmental resources at the project:

- Implement a sediment management plan that consists of using the existing sand gates to draw down the impoundment below the normal operating range for periodic inspections and maintenance and, if possible, avoiding drawdowns from March 15 through June 1 to prevent significant accumulation of sediments in the project impoundment and untimely releases of sediment downstream.
- Monitor water quality as may be required by South Carolina Department of Health and Environmental Council (South Carolina DHEC).
- Maintain a minimum flow of 50 cfs in the bypassed reach and a total minimum continuous flow of 60 cfs, or inflow if less, in the Enoree River downstream from the confluence of the tailrace and the bypassed reach to protect aquatic habitat. The minimum flow in the bypassed reach would be provided through one or more of the three sand gates selected in consultation with South Carolina DNR, Interior, and NMFS, after repairs. Lockhart Power would develop a rating curve for the sand gates and verify it once every 6 years to ensure defined minimum flows are being provided. The remaining 10 cfs would be provided via leakage through the turbine.
- When average daily inflows are less than or equal to 80 cfs (+/−10 percent), release all inflow into the bypassed reach (i.e. low inflow protocol [LIP]) to protect aquatic resources downstream from Riverdale dam, including during the fish spawning season.
- Implement best management practices (BMPs) to protect vegetation

[1] The project was originally licensed to Inman Mills as FERC No. 4362 on September 29, 1982. *Inman Mills,* 20 FERC ¶ 62,586 (1982).

within the project boundary, such as limiting vegetation and ground-disturbing activities and maintaining a minimum 25-foot-wide forested riparian buffer on project shorelines, as long as this does not interfere with Lockhart Power's ability to perform project-related activities.

• Construct and maintain: (1) A canoe take-out located approximately 220 feet upstream of the dam; (2) a canoe put-in located approximately 1,075 feet downstream from the dam; (3) a 1,650-foot-long portage trail connecting the proposed canoe take-out and put-in; (4) a parking area located adjacent to the proposed portage trail; and (5) signage to improve public access at the project and to the Enoree River.

• Provide informal public access for fishing at the project impoundment, tailrace, and bypassed reach.

Alternatives Considered

This draft environmental assessment (draft EA) considers the following alternatives: (1) Lockhart Power's proposal; (2) Lockhart Power's proposal with staff modifications (staff alternative); and (3) the no-action alternative, meaning that Lockhart Power would not refurbish the hydroelectric facilities and resume project operations.

Under the staff alternative, the project would be operated and maintained as proposed by Lockhart Power with the modifications and additional measures described below. Our recommended modifications and additional environmental measures include, or are based on, recommendations made by federal and state resource agencies that have an interest in resources that may be affected by operation of the proposed project, as well as those identified by staff.

The staff alternative includes the following additional measures and modifications to Lockhart Power's proposal:

• Develop and implement a site-specific soil erosion and sediment control plan, which includes the BMPs described in the South Carolina DHEC's Stormwater BMP Handbook, to minimize erosion and sedimentation during soil-disturbing activities associated with project construction and repairs.

• Develop and implement a sediment management plan to (a) test impoundment sediments for heavy metals and other contaminants, prior to beginning in-water construction activities and initial operation to prevent the release of any toxic substances, and (b) annually monitor and manage sediment accumulation in the impoundment to prevent the potential release of large quantities of sediment during maintenance activities.

• Develop and implement a shoreline stabilization plan to identify and stabilize eroding shorelines to minimize potential shoreline erosion from impoundment and flow fluctuations during peaking operation.

• Develop and implement a water quality monitoring plan to monitor dissolved oxygen (DO), temperature, and turbidity and implement corrective actions, if necessary, to protect aquatic resources located downstream of the dam.

• Release a continuous minimum flow of 75 cfs into the bypassed reach to protect aquatic habitat.

• Develop and implement a plan to determine the feasibility of using the sand gates as a mechanism for providing minimum flows to the bypassed reach and to evaluate methods to distribute minimum flows into the bypassed reach to protect aquatic habitat.

• Develop and implement a low inflow protocol/drought contingency plan to define periods of extended drought and low inflow protocols to minimize adverse effects on generation, and fish, wildlife, and water quality in the bypassed reach and downstream from the tailrace.

• Develop and implement an operation compliance monitoring plan to document impoundment fluctuations and minimum flow releases.

• Develop and implement an invasive vegetation monitoring and control plan to prevent the spread of alligatorweed and other invasive non-native plants during project refurbishment, operation, and maintenance activities.

• Determine whether the existing project transmission line is consistent with Avian Power Line Interaction Committee (APLIC) guidelines and identify measures to minimize potential electrocution hazards to birds, if needed.

• Modify Lockhart Power's proposed signage measures to include: (1) Identification of the canoe take-out and put in; (2) directions from the parking area to river access points; and (3) information regarding garbage disposal in order to improve public information available at the project and protect environmental resources.

• Stop work and notify the South Carolina SHPO and the Catawba Indian Nation if any unknown archaeological resources are discovered as a result of project construction, operation, or project-related activities to avoid, lessen, or mitigate potential adverse effects on historic resources.

Under the no-action alternative, the project would continue to be inoperable and no new environmental protection, mitigation, or enhancement measures would be implemented.

Public Involvement and Areas of Concern

Before filing its license application, Lockhart Power conducted a pre-filing consultation process under the traditional licensing process. The intent of the Commission's prefiling process is to initiate public involvement early in the project planning process and to encourage citizens, governmental entities, tribes, and other interested parties to identify and resolve issues prior to an application being formally filed with the Commission. After the application was filed, we conducted scoping to determine what issues and alternatives should be addressed. A scoping document was distributed to interested parties on May 15, 2012. On July 13, 2012, we issued the Ready for Environmental analysis notice, requesting comments, recommendations, terms and conditions, and prescriptions.

The primary issues associated with licensing the project include erosion and sediment control, sediment management, minimum flows to protect aquatic species and shoal habitat in the 1,400-foot-long bypassed reach, a low inflow protocol during extended droughts, invasive vegetation management, and recreation improvements.

Staff Alternative

Geology and Soils

Refurbishing the hydropower facilities, dredging the tailrace, and constructing the recreation improvements would temporarily increase soil erosion. Implementing staff's recommended site-specific soil erosion and sediment control plan would minimize adverse effects on aquatic and terrestrial resources.

Project repairs and the initial operation of the project would likely result in a discharge of a large amount of sediment downstream that could contain heavy metals and other contaminants. Staff's recommended testing of sediment for contaminants and developing a contingency plan, if needed, for removal and proper disposal of any contaminated sediment prior to beginning in-water construction activities and operation would prevent the unexpected release of any toxic substances and potential adverse effects on aquatic resources.

Because the Enoree River is heavily sediment laden, regular management of sediment bed-load from the impoundment may be needed to maintain project operation. Developing and implementing staff's recommended sediment management plan, which would include Lockhart Power's proposal to avoid drawing down the impoundment below the normal operating range for periodic inspections and maintenance from March 15 through June 1, would minimize adverse effects of sediment releases and lower impoundment levels on fish spawning in and downstream from the impoundment. The plan would also ensure that sediment in the impoundment is regularly monitored and managed, preventing excessive sediment accumulation and ensuring that sediment management activities occur when they are least likely to cause adverse effects on downstream resources.

Because of areas of highly erodible soils along the project shoreline, peaking operation could cause bank sloughing and erosion. Developing and implementing a shoreline stabilization plan and maintaining a 25-foot forested buffer around the impoundment as recommended by staff would help prevent bank erosion and loss of riparian habitat.

Aquatic Resources

In addition to the short-term increases in turbidity during project refurbishment, the diversion of flow for project operations would reduce flows in the bypassed reach, which could reduce DO levels and raise water temperatures in the bypassed reach. Monitoring water quality prior to the start of construction, during construction, and for 1 year after beginning operation as recommended by staff, would ensure that erosion control measures and minimum instream flows are adequately protecting water quality and allow for the timely identification of any needed corrective measures.

Lockhart Power's proposed minimum continuous flow of 60 cfs (16 percent of mean annual daily flow [MADF]) downstream from the tailrace and 50 cfs (13 percent of MADF) in the bypassed reach would not maintain aquatic resources in the bypassed reach. As defined by Tennant (1976),[2] such flows provide ''fair or degrading'' conditions, and close to ''poor or minimum'' conditions during the dry and wet seasons, respectively. Compared to Lockhart's proposed flow, staff's recommended year-round minimum flow of 75 cfs (20 percent of MADF) would better protect aquatic resources because this flow represents ''good'' conditions and close to ''fair or degrading'' conditions, as defined by Tennant (1996), during the dry and wet seasons, respectively.

Using the sand gates to release the bypassed reach minimum flows as proposed by Lockhart Power may not be feasible because the sand gates are currently inoperable. Also, sand gates are generally not designed for such activities and may become blocked with debris, preventing the release of specified flows. Developing and implementing staff's recommended minimum instream flow release plan would assess the feasibility of using the sand gates to release the minimum flows, identify which gate(s) best distribute flows across the bypassed reach, and identify alternative means to release minimum flows should using the gates prove impracticable.

Developing a low inflow protocol/drought contingency plan, as recommended by staff, would allow Lockhart Power and the resource agencies to adjust operation and minimum instream flow requirements as specified by the plan during periods of extended drought that minimize adverse effects on generation, and on fish, wildlife, and water quality in the bypassed reach and downstream from the tailrace.

Staff's recommended operation compliance monitoring plan would provide the Commission a mechanism to monitor compliance with Lockhart Power's proposed limits on impoundment fluctuations, minimum instream flow releases, and low inflow operation protocols.

Terrestrial Resources

Limiting disturbances to soil and vegetation and maintaining a minimum 25-foot-wide forested riparian buffer along project shorelines, as proposed by Lockhart Power, would preserve existing vegetation and habitat for wildlife. Staff's recommended invasive plant management plan, would minimize the introduction or spread of non-native invasive vegetation within the project boundary, and would protect native plant communities and the fish and wildlife that depend on them. Implementing staff's recommended avian protection plan would facilitate a determination on whether the project transmission lines pose a risk of avian injury or mortality due to electrocution and identify mitigation measures, if needed.

Recreation and Land Use

Lockhart Power's proposed canoe portage trail, put-in and take-out, parking, and directional signage at the project would enhance recreation amenities on a reach of the Enoree River designated for recreation use and future water trail development. Staff's recommended signage requesting that visitors pack out their garbage would reduce the likelihood that recreation use at the project would negatively affect the surrounding environment. Continued project operation would not affect land use.

Cultural Resources

No historic properties were identified within the project's area of potential effects. The South Carolina SHPO concurred that the proposed project would have no adverse effect on historic properties. Stopping work and notifying the South Carolina SHPO and Catawba Indian Nation if any unknown archaeological resources are discovered during project construction, operation, or other project-related activities, would allow Lockhart Power to define the appropriate treatments necessary to avoid, lessen, or mitigate for potential adverse effects from the inadvertent discovery.

Conclusions

Based on our analysis, we recommend licensing the project as proposed by Lockhart Power, with some staff modifications and additional measures.

In section 4.2 of the EA, we compare the likely cost of alternative power for each of the three alternatives identified above. Under the no-action alternative, the project would not be rehabilitated as proposed; therefore, the project would not produce any electricity. Our analysis shows that during the first year of operating the project as proposed by the applicant, project power would cost $265,378, or $54.21/MWh more than the likely alternative cost of power. Under the staff alternative, project power would cost $297,487, or $68.07/MWh more than the likely alternative cost of power.

We chose the staff alternative as the preferred alternative because: (1) The project would provide a dependable source of electrical energy for the region (4,370 MWh annually); (2) the 1.24 MW of electric energy capacity comes from a renewable resource that does not contribute to atmospheric pollution, including greenhouse gases; and (3) the recommended environmental measures proposed by Lockhart Power, as

[2] The Tennant method establishes streamflow requirements on the basis of a percentage of the mean annual flow, and associates aquatic-habitat conditions with different percentages of mean annual flow.

modified by staff, would protect and enhance environmental resources affected by the project. The overall benefits of the staff alternative would be worth the cost of the proposed and recommended environmental measures.

We conclude that issuing a new license for the project with the staff-recommended measures would not be a major federal action significantly affecting the quality of the human environment.

Environmental Assessment

Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing, Washington, DC

Riverdale Hydroelectric Project, FERC Project No. 13590–001—South Carolina

1.0 Introduction

1.1 Application

On August 31, 2010, Lockhart Power Company, Inc. (Lockhart Power or applicant), filed a license application for the Riverdale Hydroelectric Project (Riverdale Project or project) with the Federal Energy Regulatory Commission (Commission or FERC).[3] The 1.24-megawatt (MW) project is located on the Enoree River near Enoree, in Spartanburg and Laurens Counties, South Carolina (figure 1). The project does not occupy any federal lands. The project is currently inoperable, but as proposed by Lockhart Power, it would generate an average of about 4,895 megawatt-hours (MWh) of energy annually.

1.2 Purpose of Action and Need for Power

1.2.1 Purpose of Action

The purpose of the Riverdale Project is to provide a source of hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue a license to Lockhart Power for the Riverdale Project and what conditions should be placed on any license issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the project will be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, or water supply), the Commission must give equal consideration to the purposes of: (1) Energy conservation; (2) the protection of, mitigation of damage to, and enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

[3] On September 29, 1982, the Riverdale Project was licensed to Inman Mills under FERC Project No. 4362. The project has not operated since January of 2001. Inman Mills' license expired on August 31, 2012, and was subsequently issued an authorization for continued project operation until the Commission issues someone else a license for the project or otherwise orders disposition of the project. Inman Mills did not file a notice of intent to relicense the project. On November 29, 2007, the Commission issued a notice soliciting applications for subsequent license by August 31, 2010. Lockhart Power filed the only timely license application and is therefore the only license applicant for the Riverdale Project.

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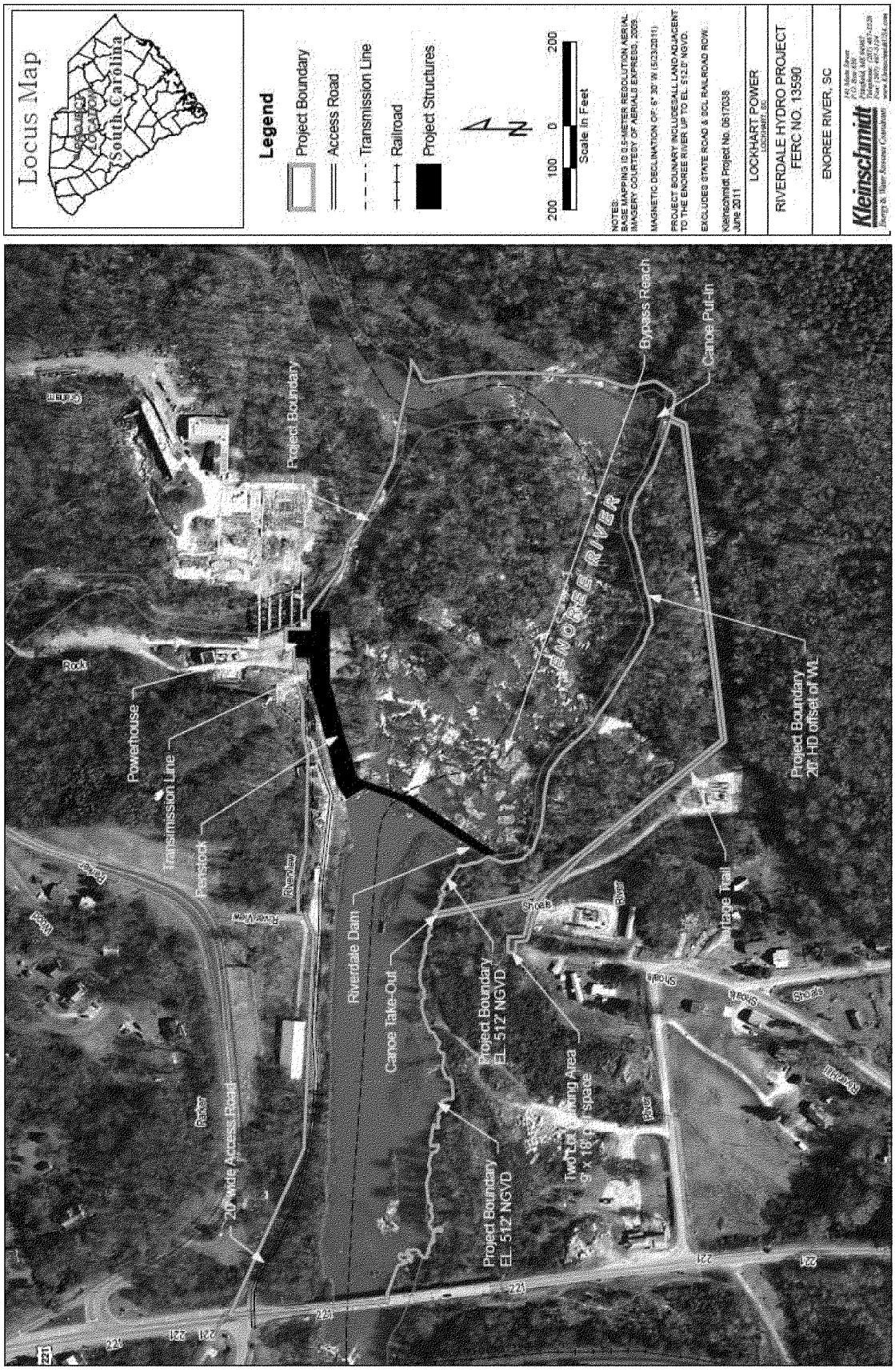

Figure 1. Location of the Riverdale Project. (Source: Lockhart Power Company, Inc., 2010).

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Issuing a license for the Riverdale Project would allow Lockhart Power to generate electricity for the term of a license, making electrical power from a

renewable resource available to the local utility Duke Energy, which would use it to serve its customers' needs.

This environmental assessment (EA) assesses the effects associated with refurbishment, operation, and maintenance of the project and alternatives to the proposed project. It also includes recommendations to the Commission on whether to issue a license, and if so, includes the recommended terms and conditions to become a part of any license issued.

In this EA, we assess the environmental and economic effects of refurbishing and operating the project: (1) As proposed by the applicant; and (2) as proposed with our recommended measures. We also consider the effects of the no-action alternative. Important issues that are addressed include erosion and sediment control, sediment management, minimum flows to protect aquatic species and shoals habitat in the 1,400-foot-long bypassed reach, a low inflow protocol during extended droughts, invasive vegetation management, and recreation improvements.

1.2.2 Need for Power

The Riverdale Project would provide hydroelectric generation to meet part of South Carolina's power requirements, resource diversity, and capacity needs. With staff's recommended measures, the project would have an installed capacity of 1.24 MW and would generate approximately 4,370 MWh per year.

The North American Electric Reliability Council (NERC) annually forecasts electrical supply and demand nationally and regionally for a 10-year period. The Riverdale Project is located in the VACAR sub-region [4] of the Southeastern Electric Reliability Council (SERC), which is one of eight regional reliability councils of NERC. According to NERC's 2012 forecast, annual energy requirement for the VACAR sub-region is projected to grow at a compound annual rate of 1.11 percent, from 2012 through 2022 (NERC, 2012).

The power from the Riverdale Project would help meet a need for power in the VACAR sub-region of the SERC in both the short- and long-term. The project provides low-cost power that may displace non-renewable, fossil-fired generation and contributes to a diversified generation mix. Displacing the operation of fossil-fueled facilities may avoid some power plant emissions and create an environmental benefit.

1.3 Statutory and Regulatory Requirements

A license for the Riverdale Project is subject to numerous requirements under the Federal Power Act (FPA) and other applicable statutes. We summarize the major regulatory requirements in table 1 and describe them below.

TABLE 1—MAJOR STATUTORY AND REGULATORY REQUIREMENTS FOR THE RIVERDALE PROJECT

Requirement	Agency	Status
Section 18 of the FPA (fishway prescriptions).	U.S. Department of the Interior (Interior), National Marine Fisheries Service (NMFS).	Interior and NMFS reserved authority to prescribe fishways on September 10, and September 11, 2012, respectively.
Section 10(j) of the FPA	Interior, NMFS, and South Carolina Department of National Resources (South Carolina DNR).	Interior, South Carolina DNR, and NMFS provided section 10(j) recommendations on September 10, September 10, and September 11, 2012, respectively.
Clean Water Act—Water quality certification (certification).	South Carolina DNR	Application for water quality certification received on October 4, 2012; withdrawn and reapplied on September 20, 2013; due by September 20, 2014.
Endangered Species Act (ESA) Consultation.	Interior, U.S. Fish and Wildlife Service (FWS).	The project would not affect any listed species because none are known to occur in the project vicinity; therefore, further consultation under the ESA is not necessary.
Coastal Zone Management Act (CZMA).	South Carolina Department of Health and Environmental Control (South Carolina DHEC).	South Carolina DHEC indicated by letter filed September 30, 2010, that the project is not located within South Carolina's coastal zone, that the proposed project poses no reasonably foreseeable effects on the coastal zone, and that no consistency certification is needed.
National Historic Preservation Act (NHPA).	South Carolina State Historic Preservation Office (SHPO).	By letter filed August 31, 2010, the South Carolina SHPO concurred with Lockhart Power's determination that no historic properties would be affected by the project.

1.3.1 Federal Power Act

1.3.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA states that the Commission is to require construction, operation, and maintenance by a licensee of such fishways as may be prescribed by the Secretaries of Commerce or the U.S. Department of the Interior. Interior and Commerce through NMFS, by letters filed on September 10 and 11, 2012, respectively, request that a reservation of authority to prescribe fishways under section 18 of the FPA be included in any license issued for the project.

1.3.1.2 Section 10(j) Recommendations

Under section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. The Commission is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

Interior, South Carolina DNR, and NMFS timely filed on September 10, September 10, and September 11, 2012, respectively, recommendations under 10(j), as summarized in table 18 in section 5.4.1, *Recommendations of Fish and Wildlife Agencies.* In section 5.4,

[4] The VACAR sub-region includes the states of Virginia, North Carolina, and South Carolina.

we also discuss how we address the agency recommendations and comply with section 10(j).

1.3.2 Clean Water Act

Under section 401 of the Clean Water Act (CWA), a license applicant must obtain certification from the appropriate state pollution control agency verifying compliance with the CWA. On October 3, 2012, Lockhart Power applied to the South Carolina DHEC for certification of the Riverdale Project. South Carolina DHEC received this request on October 4, 2012. On September 20, 2013, Lockhart Power withdrew and re-filed for certification, and on the same day South Carolina DHEC received this request. South Carolina DHEC has not yet acted on the request. The certification is due by September 20, 2014.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. There are no federally listed endangered or threatened species or critical habitat known to occur in the Riverdale Project vicinity. Therefore, licensing the project would not affect listed species and no further consultation under section 7 is needed.

1.3.4 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), 16 U.S.C. 1456(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The project is not located within the state-designated Coastal Management Zone, which extends to South Carolina's eight coastal counties (Jasper, Beaufort, Colleton, Berkeley, Dorchester, Charleston, Georgetown, and Horry), and the project would not affect South Carolina's coastal resources. Therefore, the project is not subject to South Carolina coastal zone program review and no consistency certification is needed for the action. By letter filed September 30, 2010,[5] the South Carolina DHEC concurred.

1.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) requires that every federal agency ''take into account'' how each of its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register).

Pursuant to section 106, the applicant consulted with the South Carolina SHPO and affected Indian tribes to locate, determine National Register eligibility, and assess potential adverse effects to historic properties associated with the project. By letter filed August 31, 2010,[6] the South Carolina SHPO stated that it concurred with the applicant's assessment that no properties listed in or eligible for listing in the National Register would be affected by the by the federal licensing action. Staff reaffirmed the South Carolina SHPO's concurrence via teleconference on May 23, 2012.[7]

As a result of the findings made by Lockhart Power and the SHPO's concurrence that no historic properties would be affected by the project, the drafting of a programmatic agreement to resolve adverse effects on historic properties will not be necessary.

1.4 Public Review and Consultation

The Commission's regulations (18 CFR, § 4.38) require that applicants consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act, the ESA, the NHPA, and other federal statutes. Pre-filing consultation must be complete and documented according to the Commission's regulations.

1.4.1 Scoping

Before preparing this EA, we conducted scoping to determine what issues and alternatives should be addressed. A Scoping Document 1 was distributed to interested agencies and other stakeholders on December 22, 2011. It was noticed in the **Federal Register** on December 22, 2011. A Scoping Document 2 was issued on May 15, 2012. The following entities provided written comments on Scoping Document 1:

Commenting entities	Date filed
Caitlin Totherow, Catawba Indian Nation Tribal Preservation Officer (THPO)	January 18, 2012.
South Carolina SHPO	January 20, 2012.
Woodruff-Roebuck Water District (Water District)	February 9, 2012.
Greg Sveinsson, Riverdale Development Venture, LLC (Riverdale, LLC)	February 15, 2012.
American Rivers	February 16, 2012
South Carolina DNR	February 21, 2012.
FWS	February 21, 2012.
NMFS	March 6, 2012.

1.4.2 Interventions

On May 7, 2012, the Commission issued a notice that Lockhart Power's application to license the Riverdale Project had been accepted for filing. This notice set July 6, 2012, as the deadline for filing protests and motions to intervene. In response to the notice, the following entities filed notices of intervention or motions to intervene (none opposed issuance of a license):

[5] *See* letter dated September 13, 2010 from W. McGoldrick, Stormwater Permit Coordinator, South Carolina DHEC, Charleston, South Carolina, to S. Boring, Kleinschmidt Associates, Lexington, South Carolina.

[6] *See* letter dated December 7, 2009 from C. Wilson, Review and Compliance Coordinator, South Carolina State Historic Preservation Office, Columbia, South Carolina to J. Seay, Jr., Lockhart Power Company, Lockhart, South Carolina.

[7] *See* FERC. 2012a. Telephone Meeting Summary with the South Carolina State Historic Preservation Office for the Riverdale Hydroelectric Project No. 13590–001. Filed on May 24, 2012.

Intervenors	Date filed
Woodruff-Roebuck Water District	June 12, 2012.
American Rivers	June 19, 2012.
Interior	June 25, 2012.
South Carolina DNR	June 29, 2012.
National Oceanic and Atmospheric Administration (on behalf of NMFS)	July 5, 2012.

1.4.3 Comments on the License Application

The July 13, 2012 notice also stated that the application was ready for environmental analysis, and requested that comments, recommendations, terms and conditions, and prescriptions be filed. The following entities commented:

Commenting agencies and other entities	Date filed
Interior	September 10, 2012.
South Carolina DNR	September 10, 2012.
NMFS	September 11, 2012.
American Rivers	September 12, 2012.

The applicant, Lockhart Power, filed reply comments on October 24, 2012.

2.0 Proposed Action and Alternatives

2.1 No-Action Alternative

We use existing conditions as the baseline environmental condition for comparison with other alternatives. Under the no-action alternative, the project would not be refurbished and operated, the dam and other facilities would remain in place, and all flows would remain in the Enoree River by passing over the spillway or through leaks in the sand gates.

2.1.1 Existing Project Facilities

The Riverdale Project would consist of an existing 425-foot-long, 12-foot-high concrete gravity dam with three evenly spaced, integral sand gates,[8] and 2-foot-high flashboards that form a 6.6-acre impoundment with a gross storage of 22.0 acre-feet. On the north end of the dam is an existing 85-foot-long, 50-foot-wide concrete headrace canal with an intake structure equipped with trash racks with 2.25-inch bar spacing. The canal feeds an existing 9-foot-diameter, 340-foot-long steel penstock,[9] which is equipped with trash racks having bar spacing of about 10 inches. The penstock connects to an existing wood frame powerhouse building containing one 1.24–MW capacity generating unit. An existing 510-foot-long tailrace extends from the powerhouse to the Enoree River, and an existing 700-foot-long transmission line extends from the powerhouse to an existing Duke Energy distribution line. An existing paved access road, approximately 1,376 feet long and 20 feet wide extends from Highway 221 to the project powerhouse.

The project boundary includes about 25.9 acres. The project boundary encloses the project impoundment, the existing hydropower facilities, the bypassed reach (including the braided channels), tailrace, project access road, and the proposed canoe take-out, put-in, portage trail, and parking area. Riverdale, LLC currently owns approximately 2.5 acres of land within Lockhart Power's proposed project boundary which encompasses the project powerhouse, intake structure, penstock, and tailrace. The Water District owns the majority of the remaining lands within the project boundary and retains an option to acquire the dam. Two other private individuals own the remaining parcels which are located on the south side of the impoundment.

2.1.2 Project Safety

The project has been inoperable for more than 12 years under the existing license; nonetheless, during this time, Commission staff has conducted inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the license, and proper maintenance. As part of the licensing process, the Commission would evaluate the adequacy of the proposed project facilities. Special articles would be included in any license issued, as appropriate. Commission staff would continue to inspect the project both during and after construction to repair existing project facilities. Before the project is refurbished, engineers from the Commission's Atlanta Regional Office would review the designs, plans and specifications of the proposed repairs to equipment and structures. Inspections during project refurbishment would concentrate on adherence to Commission-approved plans and specifications, special license articles relating to construction, and accepted engineering practices and procedures. Operational inspections would focus on the continued safety of the structures, identification of unauthorized modifications, efficiency, and safety of operations, compliance with the terms of the license, and proper maintenance.

2.1.3 Existing Project Operation and Environmental Measures

Inman Mills ceased operating the project (under FERC No. 4362) in 2001, when the adjacent textile mill closed. The 2-foot-high flashboards washed out during storm events in 2012 and 2013 and there is currently no practical way to control flows from Riverdale dam. The current owner demolished the original concrete and brick powerhouse and replaced it with a wood frame building. All flows pass over the dam and into the 1,400-foot-long bypassed reach. No environmental measures are currently being implemented at the project.

2.2 Applicant's Proposal

2.2.1 Proposed Project Facilities

Lockhart Power proposes to use the existing hydropower facilities described above, and rehabilitate all equipment rendering the project inoperable. Because Lockhart Power is not the current licensee or current owner of the project and has not had full access to the project, it plans to spend the first year following license issuance

[8] Three low level sand gates are located within three concrete-framed piers along the spillway dam.

[9] Staff used GIS software to estimate the length of the penstock. Current Exhibit F drawings only defined the below ground portion of the penstock as 110 feet long.

assessing the condition of project facilities and finalizing any engineering design needed to refurbish the project. To make the project operational, Lockhart Power expects it would, at a minimum: (1) Repair or replace the sand gates and gate operators; (2) repair or replace the 2-foot flashboards on the dam; (3) replace a 193-foot above ground section of the penstock; (4) modify the bar spacing on the penstock trashrack from 10 to 5 inches; (5) refurbish the turbine generator; [10] (6) repair plant controls and governor; (7) repair the powerhouse roof; and (8) dredge the sediment and debris in the tailrace. There would be a total of 25.9 acres within the proposed project boundary, of which 11.3 acres are land and the remainder is occupied by waters of the impoundment, bypassed reach, and tailrace.

2.2.2 Proposed Project Operations

Lockhart Power would operate the project using a combination of run-of-river (ROR) and peaking modes. The project would operate semi-automatically with an operator on standby. Lockhart Power would remotely monitor impoundment levels and control the water flow through the project's turbine to maintain impoundment levels. The Riverdale impoundment would fluctuate between 1 and 4 feet of the top of the flashboards.

Lockhart Power would typically operate the project in a ROR mode, with project outflow approximately equaling inflow, such that the impoundment surface elevation stays within 1 foot (+/− 10 percent) of the top of the flashboards. When inflows are insufficient to operate the turbine at its maximum hydraulic capacity of 450 cubic feet per second (cfs) and provide a continuous minimum flow of 50 cfs to the bypassed reach (i.e. when inflow is less than 500 cfs), Lockhart Power would operate the project in a ''peaking'' mode. Peaking events would occur no more than once daily, until either the daily period of increased need for power ends or until the impoundment surface elevation is drawn down a maximum of 4 feet (+/− 10 percent) below the top of the flashboards. Following each peaking event, Lockhart Power would suspend operation and store inflow, minus the minimum flow to the bypassed reach, to refill the impoundment (likely overnight) to its normal elevation of within 1 foot (+/− 10 percent) of the top of the flashboards, allowing it to return to ROR mode until the next peaking event. Lockhart Power expects that peaking operation would occur less than half of the days in any given year (Lockhart Power, 2011a).

2.2.3 Proposed Environmental Measures

Lockhart Power proposes to construct and operate the project with the following environmental protection, mitigation, and enhancement (PM&E) measures:

- Implement a sediment management plan that consists of using the sand gates to draw down the impoundment below the normal operating range for periodic inspections and maintenance and, if possible, avoid drawdowns from March 15 through June 1 to prevent significant accumulation of sediments in the project impoundment and untimely releases of sediment downstream.
- Monitor water quality as may be required by the South Carolina DHEC.
- Maintain a minimum flow of 50 cfs in the bypassed reach and a total minimum continuous flow of 60 cfs, or inflow if less, in the Enoree River downstream from the confluence of the tailrace and the bypassed reach to protect aquatic habitat. The minimum flow in the bypassed reach would be provided through one or more of the three sand gates selected in consultation with South Carolina DNR, Interior, and NMFS, after repairs. Lockhart Power would develop a rating curve for the sand gates and verify it once every 6 years to ensure defined minimum flows are being provided.
- When average daily inflows are less than or equal to 80 cfs (+/− 10 percent), release all inflow into the bypassed reach (i.e. low inflow protocol [LIP]) to protect aquatic resources downstream from Riverdale dam, including during the fish spawning season.
- Implement best management practices (BMPs) to protect vegetation within the project boundary, such as limiting vegetation and ground-disturbing activities and maintaining a minimum 25-foot-wide forested riparian buffer on project shorelines, as long as this does not interfere with Lockhart Power's ability to perform project-related activities.
- Construct and maintain: (1) A canoe take-out located approximately 220 feet upstream of the dam; (2) a canoe put-in located approximately 1,075 feet downstream from the dam; (3) a 1,650-foot-long portage trail connecting the proposed canoe take-out and put-in; (4) a parking area located adjacent to the proposed portage trail; and (5) signage to improve public access at the project and to the Enoree River.
- Provide informal public access for fishing at the project impoundment, tailrace, and bypassed reach.
- Notify and consult with the South Carolina SHPO regarding any project-related construction or other ground-disturbing activities.[11]

2.3 Staff Alternative

The staff alternative includes the following additional measures and modifications to Lockhart Power's proposal:

- Develop and implement a site-specific soil erosion and sediment control plan, which includes the BMPs described in the South Carolina DHEC's Stormwater BMP Handbook, to minimize erosion and sedimentation during soil-disturbing activities associated with project construction and repairs.
- Develop and implement a sediment management plan that includes provisions to: (a) Test impoundment sediments for heavy metals and other contaminants prior to beginning in-water construction activities and initial operation; (b) prepare a contingency plan for proper disposal of any contaminated sediments should they be found in the impoundment; (c) monitor sediment accumulation in the impoundment annually to facilitate planning of sediment management activities; (d) develop criteria that would trigger sediment removal from the impoundment (i.e. by opening the sand gates, if appropriate, during high flow events, or via mechanical methods); (e) conduct sediment management activities during the months of November through January except during high rain events (e.g., tropical storms or hurricanes); (f) avoid maintenance activities that would draw down the impoundment below normal operating levels and potentially pass sediment into the bypassed reach from March 15 through June 1, if possible, to minimize adverse impacts to spawning fish; and (g) file annual reports with

[10] Lockhart Power anticipates that significant electrical, mechanical, and hydraulic system improvements and refurbishments will be necessary to restore the project to reliable long term operating condition. Certain improvements, such as turbine refurbishment, may improve the design efficiency of and thereby increase the rated capacity of the turbine-generator to a range of 1.2–1.45 MW.

[11] Although Lockhart Power proposes this measure in its license application, we consider Lockhart Power's consultation requirements under section 106 of the NHPA to be complete because of the SHPO's finding that no properties listed in or eligible for listing in the National Register would be affected by the project (letter from C. Wilson, Review and Compliance Coordinator, South Carolina SHPO, Columbia, South Carolina to J. Seay, Jr., Lockhart Power, Lockhart, South Carolina, December 7 2009). Therefore no further analysis of this measure is necessary.

sediment monitoring results, sediment management activities, and an evaluation of the effectiveness of the plan in minimizing sediment accumulation in the impoundment.

• Develop and implement a shoreline stabilization plan that includes provisions to: (a) Identify eroding or potential project-induced erosion sites on the impoundment shorelines and streambanks downstream from the dam and powerhouse prior to beginning operation; (b) stabilize areas of shoreline erosion using native vegetation, bio-engineering, slope flattening, toe armoring with anchored logs, and/or riprap that incorporates native vegetation plantings; (c) monitor shorelines after resuming operation and implement stabilization measures if project-induced erosion occurs; (d) conduct shoreline stabilization activities from September through February to protect aquatic species and wildlife; and (e) file annual reports describing monitoring results and any implemented shoreline stabilization measures.

• Develop and implement a water quality monitoring plan with provisions to: (a) Monitor dissolved oxygen (DO), temperature, and turbidity prior to the start of construction, during construction, and for 1 year after project operation begins to ensure the levels specified by the current state water quality standards are met and aquatic resources are protected; (b) define sampling methods, timing, and locations for monitoring these parameters in consultation with South Carolina DHEC, FWS, and NMFS; and (c) file a report that presents the monitoring data, describes any project-related effects and identifies corrective actions, if necessary.

• Release a continuous minimum flow of 75 cfs into the bypassed reach to protect aquatic habitat.

• Develop and implement a plan to release required minimum flows into the bypassed reach that includes: (a) A feasibility assessment for using the sand gates as a flow-release mechanism; (b) if found to be feasible, a flow study to determine how the sand gates would be used to distribute flow into the bypassed reach to protect aquatic habitat; (c) if the sand gates are not feasible, a description of how the minimum instream flows would be provided to the bypassed reach; (d) a report documenting the outcome of the feasibility assessment, flow study, and consultation with the agencies; and (e) an implementation schedule.

• Develop and implement a low inflow protocol/drought contingency plan to define periods of extended drought and the low inflow protocols to minimize adverse effects on generation, and on fish, wildlife, and water quality in the bypassed reach and downstream from the tailrace.

• Develop and implement an operation compliance monitoring plan that includes: (a) A rating curve to provide the seasonally defined flows; (b) protocols to monitor and document compliance with required flows; (c) protocols to monitor and document impoundment fluctuations; and (d) an implementation schedule.

• Develop and implement an invasive [12] vegetation monitoring and control plan that includes: (a) Survey methods to determine the extent of alligatorweed in the impoundment and riparian area prior to beginning refurbishment activities; (b) BMPs, as well as monitoring and control methods to prevent the spread of alligatorweed in the impoundment to areas downstream from the dam during project refurbishment; (c) monitoring protocols to detect the introduction or spread of other invasive plants within the project boundary during operation and maintenance; (d) criteria that would determine when control measures would be required; and (e) a schedule for filing monitoring reports and any recommended control measures with the Commission.

• Determine whether the existing project transmission line is consistent with Avian Power Line Interaction Committee (APLIC) guidelines. Identify, in consultation with FWS, measures to minimize potential electrocution hazards to birds and file a report with the Commission describing the results of the evaluation and any measures recommended by FWS.

• Modify the applicant's proposal for signage at recreation sites to include: (1) Identification of the canoe take-out and put in; (2) directions from the parking area to river access points; and (3) information regarding garbage disposal in order to improve public information available at the project and protect environmental resources.

• Stop work and notify the South Carolina SHPO and the Catawba Indian Nation if any unknown archaeological resources are discovered as a result of project construction, operation, or project-related activities to avoid, lessen, or mitigate potential adverse effects on historic resources.

[12] For the purposes of this document, an ''invasive species'' is defined, consistent with Executive Order 13112, as a species that is: (1) Non-native (or alien[/exotic]) to the ecosystem under consideration; and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health (USDA, 2012).

2.4 Alternatives Considered but Eliminated From Further Analysis

2.4.1 Issuing a Non-Power License

A non-power license is a temporary license that the Commission will terminate when it determines that another governmental agency will assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this point, no agency has suggested a willingness or ability to do so. No party has sought a non-power license and we have no basis for concluding that the project should no longer be used to produce power. Thus, we do not consider issuing a non-power license a realistic alternative to relicensing in this circumstance.

2.4.2 Project Decommissioning

Project decommissioning could be accomplished with or without dam removal. Both Interior and American Rivers recommended that the Commission analyze project decommissioning with dam removal as an alternative in this EA. Because Lockhart Power neither owns nor operates the project under the existing license, the Commission cannot require Lockhart Power to remove the dam. Decommissioning the project would involve denial of Lockhart Power's license application and then the surrender or termination of Inman Mills' existing license with appropriate conditions under separate action by the Commission.

Decommissioning with dam removal would remove the only barrier to fish movement in the Enoree River from its confluence with the Broad River to its headwaters, allow for natural sediment movement through the project area, eliminate the need to portage canoes around the project, remove lake recreation, and eliminate a potential source of renewable energy. However, as we explain herein, the project's power would serve to meet regional energy needs. Further, a license can be conditioned to address adverse environmental effects of project operation such that project benefits can be retained with minimal effects on the environment. Considering there is a willing developer of the project, we see no reason not to develop the project power. Therefore, we do not consider project decommissioning with or without dam removal as a reasonable alternative to Lockhart Power's proposal.

3.0 Environmental Analysis

In this section, we present: (1) A general description of the project

vicinity; (2) an explanation of the scope of our cumulative effects analysis; and (3) our analysis of the proposed action and other recommended environmental measures. Sections are organized by resource area. Under each resource area, historic and current conditions are first described. The existing condition is the baseline against which the environmental effects of the proposed action and alternatives are compared, including an assessment of the effects of proposed mitigation, protection, and enhancement measures, and any potential cumulative effects of the proposed action and alternatives.[13] We present the estimated cost of the proposed and recommended measures in section 4.0, *Developmental Analysis.* Our conclusions and recommended measures are discussed in section 5.2, *Comprehensive Development and Recommended Alternative.*

3.1 General Description of the River Basin

Situated within the Piedmont Physiographic Region and encompassing approximately 731 square miles within the lower portion of the Broad River Basin, the Enoree River Basin spans portions of Greenville, Spartanburg, Union, and Newberry Counties in northwestern South Carolina. The Enoree River originates near the city of Travelers Rest and then flows 110 miles to its confluence with the Broad River. The Broad River flows into the Congaree, which merges with the Wateree to form the Santee River. The Santee River flows into the Atlantic Ocean.

The Enoree River is the primary source of water for the project. Tributaries to the Enoree River include Beaverdam Creek [14] as well as Warrior and Duncan creeks. Approximately 29 miles upstream of the project, are the remains of the Pelham dam [15] and Pelham Mills, closed in the 1930's. There are no other dams on the Enoree River upstream of, or downstream from, the Riverdale dam. The nearest dam is Parr Shoals dam (FERC Project No. 1984), located on the Broad River 65 miles downstream from the confluence of the Enoree and Broad rivers.

The Enoree River has a variety of aquatic habitats, including seven shoal reaches and frequent long stretches of riffles and runs separated with short sections of glides and pools. The topography of the basin is generally moderate, varying from steep to rolling hills. Land uses in the basin and surrounding the Riverdale Project are primarily forest or agriculture with small developed areas near the headwaters of the Enoree River and along main roads in the project area.

Climate in the Enoree River Basin is subtropical, marked by high summer humidity and moderate winters that rarely drop below freezing. The average annual temperature is 60 °F to 70 °F. Rainfall is high year-round, with an annual average of 40 to 60 inches, typically greatest during the summer.

3.2 Scope of Cumulative Effects Analysis

According to the Council on Environmental Quality, a cumulative effect under NEPA is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions 40 CFR 1508.7 (2013). Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

Based on our review of the license application, agency and public comments from scoping, and other filings related to the project, we have identified fisheries as a resource that could be cumulatively affected by the proposed project in combination with other actions such as sand mining operations in the Enoree River Basin.

3.2.1 Geographic Scope

The geographic scope of the analysis defines the physical limits or boundaries of the proposed action's effects on the resources. Because the proposed action would affect the resources differently, the geographic scope for each resource may vary. For fisheries, we identified the geographic scope to extend from the remains of the Pelham dam downstream to the mouth of the Broad River.

3.2.2 Temporal Scope

The temporal scope of our cumulative effects analysis in the EA includes a discussion of past, present, and future actions and their effects on these resources. Based on the potential term of license, we will look 30 to 50 years into the future, concentrating on the effect on the resources from reasonably foreseeable future actions. The historical discussion is limited, by necessity, to the amount of available information. We identify the present resource conditions based on the license application, agency comments, and comprehensive plans.

3.3 Proposed Action and Action Alternatives

In this section, we discuss the effect of the project alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure effects. We then discuss and analyze the site-specific environmental issues.

Only the resources that would be affected, or about which comments have been received, are addressed in detail in this EA. We have not identified any substantive issues related to aesthetic resources or socioeconomics associated with the proposed action, and, therefore, these issues are not assessed in this EA.

3.3.1 Geologic and Soil Resources

3.3.1.1 Affected Environment

The Enoree River is located within the greater Broad River Drainage Basin and flows through the geologic region known as the Piedmont. The Piedmont geologic region extends from the Blue Ridge region to the fall line, at Columbia, South Carolina, and consists of stream and river valleys and rolling hills with elevations ranging from 375 to over 1,000 feet mean sea level (msl).[16] Bedrock in this region is dominated by granite which is found mostly below the surface, except at shoals within streams. The Enoree River passes through various geologic formations including the Six Mile Thrust Sheet, the Laurens Thrust Stack, and the Charlotte Terrane before entering the Broad River, approximately 52 miles downstream from the project. Surficial geological material within the project area and within the vicinity of the project consists of fluvial deposited sediments, as well as weathered felsic igneous and metamorphic rocks of the Piedmont uplands.

Dominant soils within the project area and general vicinity of the project include the following series: Cartecay, Congaree, and Enoree (entisols); [17] and

[13] Unless otherwise indicated, our information is taken from the license application for this project (Lockhart Power, 2010a) and Lockhart Power's responses to the Commission staff's additional information requests (Lockhart Power, 2011a; 2011b; 2012).

[14] Beaverdam Creek enters the Enoree River approximately 0.5 mile upstream of the project.

[15] There are no records of a hydroelectric license at the Pelham dam location (Federal Power Commission, 1970).

[16] Elevations in this document are based on the National Geodetic Vertical Datum 1929 (NGVD 29).

[17] Entisols are mineral soils that typically occur in areas where the rate of erosion or deposition of soil parent materials exceeds the rate of soil horizon development (NRCS, 2012).

Cecil, Madison, and Pacolet (ultisols) [18] (NRCS, 2013a). In particular, the northern shoreline of the Riverdale impoundment is composed of Cartecay-Toccoa complex, Pacolet sandy clay loam with 10 to 15 percent slopes, and Pacolet sandy loam with 25 to 40 percent slopes. The southern shoreline of the impoundment consists largely of Enoree soils. Downstream from the dam, bordering the bypassed reach, tailrace, and Enoree River are Madison & Pacolet soils with 15 to 40 percent slopes and wet, mixed alluvial land.[19] Table 2 describes key features of these soils.

TABLE 2—SELECT CHARACTERISTICS OF MAPPED SOIL UNITS AT THE RIVERDALE PROJECT

[Source: Lockhart Power, 2010A]

Soil type	Slope	Landform	Drainage class	Flooding	Capacity to transmit water [1]	Erodibility [2]
Northern Shoreline						
Cartecay-Toccoa complex.	0–2	Floodplain	Somewhat poorly drained.	Occasional	High	0.24
Pacolet sandy clay loam.	15–25	Interfluves [3]	Well drained	None	Mod. high to high	0.20
Pacolet sandy loam	25–40	Interfluves [3]	Well drained	None	Mod. high to high	0.20
Southern Shoreline						
Enoree	0–2	Depressions/floodplain.	Poorly drained	Frequent	Mod. high to high	0.32
Downstream from Riverdale Dam						
Madison & Pacolet	0–2	Floodplain	Moderately well drained.	Frequent	High	0.32
mixed alluvial land	15–40	Interfluves [3]	Well drained	None	Mod. high to high	0.20

[1] Measured as Ksat, or saturated hydraulic capacity, as an indicator of seepage potential in the upper 60 inches.
[2] Measured as the K factor, or the erodibility of soil and other surface substrates, taking into account soil texture, content (e.g., clay, silt, organic matter, minerals, rocks), and structure (NRCS, 2013b). Values range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water. Moderate range is about 0.20–0.40.
[3] Upland landform located between two adjacent valleys containing streams.

The characteristics of dominant soil types along with active local mining operations likely contribute to the load of suspended solids in the Enoree River. According to the Natural Resource Conservation Service (NRCS), the majority of lands in the Enoree watershed, including those of the project, represent a resource concern due to erosion and are classified as 'highly erodible lands.' As shown in table 2, the soils bordering the project impoundment have a K factor that indicates moderate erodibility. In addition, there are several mine sites upstream of the Riverdale Project, including granite, vermiculite, and sand mines (South Carolina DHEC, 2013a; 2013b).

During licensing studies conducted the summer of 2010,[20] Lockhart Power collected qualitative data on substrate content and bank stability at the Riverdale Project.[21] The substrates were dominated by silt and sand in the impoundment and at the confluence of the Enoree River and Two-Mile Creek. Boulders and bedrock occur immediately downstream from the dam. Clay, gravel, pebble, cobble, detritus, and mud were also found in the substrates within the project boundary. The study results indicated areas of stable shorelines and some areas with evidence of erosion and undercutting. The current extent of erosion is not known at this time, but the majority of the project shoreline is forested with portions armored by bedrock.

Heavy metals and other contaminants from an industrial spill are known to occur in the Upper Enoree River watershed. In 1985, a galvanizing facility spilled 75,700 liters of hydrochloric acid, zinc, lead, barium, chromium, and other contaminants from a ruptured waste containment pond. The contaminants infiltrated the soil and seeped into the groundwater at the headwaters of the Enoree River near Travelers Rest, South Carolina. Also in 1985, the U.S. Environmental Protection Agency (EPA) removed contaminated materials from the waste containment ponds, from soil around the facility, as well as drums and other containers of stored hazardous materials, some of which appeared to have leaked (South Carolina DHEC, 2005). Studies conducted in 1999 and 2000 documented the residual adverse effects of these contaminants on salamanders, fish, dragonfly and damselfly larvae, and other aquatic species in the Enoree River (Worthen, *et al.,* 2001; Worthen, 2002). While South Carolina DHEC determined that the surface water, sediment, soils, and groundwater adjacent to the facility pose no public health hazard,[22] a South Carolina DHEC's survey in October 2004 indicated that zinc concentrations in surface water and sediments were above ambient conditions and could negatively impact aquatic species at the headwaters of the Enoree River (South Carolina DHEC, 2005). The type and quantity of contaminants that may have

[18] Ulitsols are highly weathered soils rich in clays and minerals commonly found in mesic forests in the Lower Broad River Basin (Andersen *et al.,* 2001).

[19] Alluvial land is an area such as a portion of a stream channel or floodplain where stream-born sediment has been deposited (Chernicoff and Ramesh, 1995).

[20] The survey report for Carolina heelsplitter, a freshwater mussel species, provided qualitative information on substrate content and compactness, sand and gravel bars, woody debris, beaver activity, bank stability, riparian buffer width and vegetation types, land use, turbidity, and water level.

[21] Survey locations included the impoundment and the Enoree River in the riffle habitat immediately upstream of the impoundment, Two-Mile Creek, the tailrace, the bypassed reach, and the Enoree River downstream from the project near a road (i.e. SC 49) crossing.

[22] According to South Carolina DHEC, the levels of chemicals measured at the spill site do not pose a risk to people who may ingest or come in contact with water and sediment in the area; however, the threshold for adverse effects to aquatic organisms is much lower.

been transported in the Enoree River and deposited within the sediments of the project impoundment since the 1985 industrial spill is unknown at this time.

The Enoree watershed is transport limited, meaning that material, primarily eroding soils, collects at a faster rate than river flows can transport. In small impoundments such as the one at the project, sediments tend to collect seasonally or during low flow periods. This is exemplified by the large amount of fine sediments (e.g., sand, silt, and clay), tree trunks, branches, and other debris that have accumulated within the project impoundment, including in front of the intake structure and the dam spillway (FERC, 2012b; 2013). Some of the sediments and debris in these areas are covered by mats of alligatorweed and other vegetation (Lockhart Power, 2012). Turbidity and thick vegetation growing along the canal between the intake structure and the penstock limited visual inspection during recent project inspections (FERC, 2012b; 2013). The precise volume of sediment deposits in the impoundment and the canal are unknown at this time.

3.3.1.2 Environmental Effects

Construction-Related Effects

At this time, Lockhart Power cannot define exactly what will be required to make the project operable. However, anticipated activities associated with replacing the approximately 193-foot-long section of the penstock, dredging the tailrace, repairing the powerhouse, and constructing the canoe put-in, take-out, portage trail, and parking area would result in soil-disturbing activities that could cause erosion and sedimentation in the impoundment and Enoree River. Soil erosion and subsequent sedimentation of aquatic habitats can adversely affect fish and wildlife habitat and degrade water quality.

To address the issue of erosion and sedimentation at the project, Lockhart Power would limit ground-disturbing activities whenever possible on lands acquired for project purposes. South Carolina DNR recommends Lockhart Power consult with state and federal agencies to implement construction and maintenance [23] BMPs described in the South Carolina DHEC's Stormwater BMP Handbook (South Carolina DHEC, 2005).

Our Analysis

Lockhart Power anticipates that construction and repairs of the hydroelectric facilities and installation of the proposed recreation facilities would be confined to about 2 acres. Ground-disturbing activities would occur predominantly within the footprint of the former textile mill, parking lots, and roadways, minimizing effects to undisturbed areas. Implementing standard industry BMPs for controlling erosion would ensure adverse effects are minor and temporary. Such BMPs could include the use of silt fences, sediment traps, stabilized construction entrances, and alternative techniques that may be approved after consultation with the South Carolina DHEC (South Carolina DHEC, 2013a; 2013b; 2005).

Operation and Maintenance-Related Effects

Heavy sediment loads in the Enoree River and years of in-operation have resulted in significant sediment deposits and the establishment of vegetation in the project impoundment. The exact amount of sediment deposit is unknown. Repairs to the sand gates prior to project operation would likely require lowering the impoundment which could release large quantities of sediments downstream. Any heavy metals and other contaminants that may have been deposited and covered by the sediment over the years could be suspended and released downstream.

Resuming project operation and maintenance activities could affect several geomorphological processes and/or conditions such as stream bank and shoreline erosion, bed scour, and sediment accumulation within the impoundment, and sediment transport to downstream river reaches. Because of the heavy sediment loads and lower velocities in the impoundment, sediments would continue to accumulate in the impoundment during project operation. Periodic maintenance activities, such as inspections or repairs to the sand gates that would require lowering the project impoundment below the normal operating levels, could result in untimely flushing of sediments and the accidental releases of large quantities of sediment. During peaking operation, impoundment fluctuations of up to 4 feet could cause bank erosion and sedimentation in the impoundment.

To prevent significant accumulation of sediments in the project impoundment and untimely releases of sediment downstream, Lockhart Power proposes to implement a sediment management plan, which consists of the following: Lockhart Power would use the sand gates to draw down the impoundment below the normal operating range (i.e. for periodic inspections and maintenance purposes) and avoid drawdowns from March 15 through June 1. These measures are intended to minimize sediment releases that could affect fish spawning in the project impoundment and downstream areas.

South Carolina DNR recommends that Lockhart Power develop and implement a sediment management plan with provisions to: (a) Monitor stream-borne sediment accumulations in the impoundment; (b) regularly flush sediments downstream or remove them from the impoundment; (c) prepare annual reports describing monitoring and management activities and evaluating the overall effectiveness of the plan; (d) conduct sediment management activities from November through January, if possible; and (e) consult with the South Carolina DHEC to address the potential presence of contaminated sediments in the impoundment.

Interior also recommends Lockhart Power develop and implement its sediment management plan with guidelines for periodic inspections and maintenance drawdowns, as well as the following additional provisions: (a) Test impoundment sediment for heavy metals and other contaminants; (b) develop a schedule and criteria that would trigger sediment removal from the impoundment, by opening the sand gates, if appropriate, during high flow events, or via mechanical methods; (c) develop a method to monitor future sediment accumulation in the impoundment; and (d) conduct maintenance drawdowns in late fall and winter to avoid impacts to spawning fish upstream and downstream of the dam.

To protect project shorelines from water level fluctuations associated with peaking operation, Interior recommends Lockhart Power develop and implement a shoreline stabilization plan. As part of the plan, Lockhart Power would be required to identify and address any existing areas of active erosion along the impoundment, as well as areas downstream from the dam with the potential for erosion due to project operation. Interior recommends that Lockhart Power use native vegetation and techniques such as bio-engineering, slope flattening, toe armoring with anchored logs, and/or riprap that

[23] Both Lockhart Power's proposal and South Carolina DHEC's recommendation appear to apply to all future ground-disturbing maintenance activities. While we are not opposed to such protective measures, we cannot analyze the effects of undefined, broad measures. Therefore, this EA only considers the effects of refurbishing the project and general operation and maintenance of the project. Any future modifications that result in ground-disturbing activities may require prior Commission approval.

incorporates native vegetation plantings to stabilize shorelines subject to potential erosion.

Our Analysis

Sediment Management

Refurbishing the dam, sand gates, and intake structures, and beginning initial operation would likely result in the re-suspension and subsequent transport of a large quantity of sediments downstream from the project. High loads of suspended solids [sediment] increase turbidity in riverine habitats leading to reduced light penetration, decreased primary productivity, which then can lead to adverse effects to the rest of the food chain. Sedimentation can modify the substrate surfaces and morphology of a stream channel, reducing habitat availability and smothering and killing aquatic flora and fauna (Wood and Armitage, 1997). If heavy metals and other contaminants are present in the impoundment, they could also be suspended and transported in the water column, harming fish and wildlife.

Conducting an initial test for heavy metals and other contaminants in the impoundment sediments prior to beginning project operations, as recommended by Interior, would determine if such contaminants are in the project impoundment. The test results would also help Lockhart Power, the resource agencies, South Carolina DHEC, and the Commission to identify suitable methods for removing and disposing of any contaminated sediments, preventing the inadvertent re-suspension and release of contaminants. The information would also help to design appropriate methods for short- and long-term sediment management at the project.

Avoiding impoundment draw downs between March 15 and June 1 to initially repair the sand gates and to conduct any maintenance once it is operational, would avoid adverse effects on spawning fish and reproductive success. Limiting any such maintenance actions to the late fall and winter, as recommended by Interior, would also protect a broad range of aquatic species, which undergo less critical life-cycle events during this time of year and are often dormant or less active. In addition, during the fall and winter there would likely be sufficient flows to keep any suspended sediment moving downstream instead of settling in the shoal habitat of the bypassed reach.

Regular management of impoundment sediment loads would help prevent sediment buildup and the accidental release of large quantities of sediment during scheduled and unscheduled maintenance activities that could have adverse effects on downstream resources. Such an event occurred in October of 2011 at the Neal Shoals Hydroelectric Project (FERC Project No. 2315) which is located on the Broad River about 16 miles upstream from the confluence with the Enoree River. About 112,841 cubic yards of sediment was released [24] during a reservoir drawdown associated with the replacement of four sand gates, installation of new trash racks on the sand gates, temporary installation and removal of a bulkhead in the sand gate opening, and the replacement of the controls for the sand gates and trash racks.[25] The Commission was informed that the sediment release resulted in a fish kill and affected water quality in the Broad River.[26] Analysis of the effects the sediment release on aquatic resources downstream from the Neal Shoals Project is ongoing.[27]

Developing a sediment management plan would facilitate detection and timely management of sedimentation at the project, which would protect aquatic and riparian resources at and near the project. The plan would be most effective if it includes regular monitoring of sediment loads, defines criteria for when sediment loads are reaching levels requiring flushing or removal, and establishes a schedule for flushing sediments or mechanically removing the sediments during periods when such releases would be least harmful to aquatic resources. Annual sediment management reports, as recommended by South Carolina DNR, would ensure continued stakeholder involvement in sediment management activities at the project and that sedimentation is managed effectively from year to year. Such report(s) would be most informative if they include sediment monitoring results, sediment management activities that were undertaken, and an evaluation of the effectiveness of the sediment management plan in minimizing adverse effects on downstream resources.

Fluctuating Water Levels

Resuming project operations, as Lockhart Power proposes, would result in impoundment fluctuations of up to 4 feet that could compromise the stability of soils along the project shorelines. The total length of the impoundment shoreline is about 2,394 feet.[28] Since the shoreline contains areas of highly erodible soils, such fluctuations could cause physical weathering through saturation, subsequent drying, exposure to rainfall, runoff, and freeze/thaw conditions. These mechanisms can cause slumping of soils and fracturing of rocks on the shorelines. Bank slumping and erosion is likely to be greatest during the initial years of operation. Identifying and stabilizing areas of active erosion, as well as areas that exhibit the potential for erosion prior to commencing project operation would prevent and/or minimize potential shoreline erosion problems. Annually monitoring the banks for erosion and implementing corrective measures as needed would minimize future adverse effects of bank erosion on fish and wildlife habitat. Using native vegetation and techniques such as bio-engineering, slope flattening, toe armoring with anchored logs, and/or riprap that incorporates native vegetation plantings would effectively stabilize eroding shorelines and provide habitat for wildlife and aquatic species that use the riparian zone, littoral zone of the impoundment, and bank areas of stream reaches in the project area. Monitoring banks and shorelines after Lockhart Power resumes project operation as well as implementing stabilization techniques if erosion is observed, would address any areas of future shoreline erosion. Installing shoreline or bank stabilizers during the fall and winter (i.e. September through February), except under emergency situations, would help minimize potential disturbances to aquatic species and wildlife. As with the sediment management plan discussed above, annual reports documenting the results of monitoring and any shoreline stabilization activities would ensure continued stakeholder involvement in activities to minimize erosion and protect littoral, bank, and riparian areas within the project area over the term of any license issued for the project.

[24] *See* letter from Michael C. Summer, General Manager, Fossil/Hydo Technical Services, South Carolina Electric and Gas Company (SCE&G), Cayce, South Carolina, filed on January 25, 2012.

[25] *See* letter from Michael C. Summer, General Manager, Fossil/Hydo Technical Services, SCE&G, Cayce, South Carolina, to Charles D. Wagner, Regional Engineer, FERC, Atlanta Regional Office, Duluth, Georgia, filed on March 7, 2011.

[26] *See* letter from Thomas J. LoVullo, Chief, Aquatic Resources Branch, FERC, Division of Hydropower Administration and Compliance to Michael C. Summer, General Manager, Fossil/Hydo Technical Services, SCE&G, Cayce, South Carolina, issued on November 14, 2011.

[27] *See* letter from Michael C. Summer, General Manager, Fossil/Hydo Technical Services, SCE&G, Cayce, South Carolina, filed on August 8, 2013.

[28] Staff used GIS software to estimate the length of the impoundment shoreline. The individual lengths of the northern and southern impoundment shorelines are 1,234 feet and 1,160 feet, respectively.

3.3.2 Aquatic Resources

3.3.2.1 Affected Environment

Water Quantity

The project impoundment has a surface area of 6.6 acres at the normal pool elevation of 512 feet above msl and a gross storage capacity of 22 acre-feet. The impoundment extends 0.25 mile upstream of the dam to a bedrock ledge about 225 feet downstream from the Highway 221 Bridge. The impoundment is about 250 to 300 feet wide, shallow, and includes mid-channel sandbars and large woody debris. All flows currently pass over the dam and flow into the project's 1,400-foot-long bypassed reach.

The impoundment drainage area is 280.5 square miles. The estimated mean annual daily flow (MADF) at the project is 374 cfs.[29] The maximum peak flow for the period of record was approximately 52,200 cfs on August 27, 1995, as a result of Tropical Storm Jerry (table 3). As expected, the lowest flow periods occur during the summer and early fall (June–November).

TABLE 3—SYNTHESIZED MONTHLY FLOW DATA (CFS) FOR THE RIVERDALE PROJECT FROM USGS GAGE NO. 02160390 ENOREE RIVER AT WOODRUFF, SOUTH CAROLINA

[Source: Lockhart Power, 2010a; USGS, 2013, as modified by staff]

Month	Minimum	90 Percent exceedance	75 Percent exceedance	Mean	Maximum	25 Percent exceedance	10 Percent exceedance
January	153	180	252	475	6938	492	828
February	156	193	267	503	5853	521	803
March	191	247	298	590	8204	586	895
April	164	218	258	442	4656	498	709
May	127	160	188	343	463	359	557
June	62	107	140	300	2915	341	544
July	53	92	122	269	6893	263	489
August	38	68	90	307	22600	283	467
September	44	71	98	271	7255	276	414
October	59	87	115	256	5311	272	406
November	73	98	131	296	4497	301	512
December	101	149	188	439	5198	475	748

Note: Period of Record is January 1, 1994 through December 31, 2012. The Woodruff gage is located about 6.7 miles upstream of the project and has a drainage area of about 249 square miles. Flows were pro-rated to the project using the formula 280.5/249.

Water Use

Public water supply is the primary surface water use of the Enoree River. The Enoree River serves as the water supply for Lauren and Spartanburg counties. The town of Whitmire and city of Clinton withdraw water from the Enoree River downstream from the project. There are no current water withdrawals occurring at the project. However, the Woodruff-Roebuck Water District, South Carolina anticipates future withdrawals of 5 million gallons per day or 7.74 cfs from the Riverdale impoundment to support probable increases in area water demands.[30]

Water Quality

South Carolina DHEC designated the Enoree River waters at the project as freshwater, suitable for primary and secondary contact recreation, and as a source for drinking water supply after conventional treatment in accordance with the requirements of the South Carolina DHEC. State water quality standards that would be applicable for project discharge are described in table 4.

TABLE 4—SOUTH CAROLINA WATER QUALITY STANDARDS FOR FRESHWATERS

[Source: South Carolina Regulation 61–68—Water classifications and standards]

Quality standards for freshwaters	
Items	Standards
a. Garbage, cinders, ashes, oils, sludge, or other refuse	None allowed.
b. Dissolved oxygen	Daily average not less than 5.0 mg/l with a low of 4.0 mg/1.
c. *E. coli*	Not to exceed a geometric mean of 126/100 ml based on at least four samples collected from a given sampling site over a 30 day period, nor shall a single sample maximum exceed 349/100 ml.
d. Temperature	Temperature of all freshwaters which are free flowing shall not be increased more than 5°F (2.8°C) above natural temperature conditions and shall not exceed a maximum of 90°F (32.2°C) as a result of the discharge of heated liquids unless a different site-specific temperature standard has been established, a mixing zone has been established, or a Section 316(a) determination under the Federal Clean Water Act has been completed.
e. Turbidity (except for lakes)	Not to exceed 50 NTUs provided existing uses are maintained.

[29] This MADF is based on data collected during the following period of record: January 1, 1994 through December 31, 2012, as pro-rated from U.S. Geological Survey (USGS) gage No. 02160390, located on the Enoree River near Woodruff, SC.

[30] *See* letter from Curtis M. Dillard, PE, General Manager, Woodruff-Roebuck Water District, Woodruff, South Carolina, filed on February 9, 2012.

In general, water quality of the Enoree River upstream of, and downstream from, the project fully supports aquatic life, but recreational uses are only partially supported because of high fecal coliform levels (South Carolina DHEC, 2007). South Carolina DHEC's 2007 Water Quality Assessment identified 23 locations that are impaired in the Enoree River for fecal coliform bacteria. Sources of these water quality impairments include pastureland, cropland, and active point sources discharging fecal coliform bacteria (2007). South Carolina DHEC (2007, 2012) notes that aquatic life uses in Beaverdam Creek, a tributary immediately upstream of the Riverdale Project, are not supported based on macroinvertebrate community data due to excess copper. However, South Carolina DHEC (2007) documents some stream reaches in the Enoree River watershed with significant decreasing trends in turbidity, total phosphorus, total nitrogen, five-day biological oxygen demand, and fecal coliform, as well as increasing trends in DO concentrations which suggest that the water quality conditions are improving in portions of the Enoree River.

Lockhart Power intended to collect temperature, DO, pH, conductivity, and turbidity data throughout the 2010 and 2011 sampling season. However, limited access to the project area permitted Lockhart Power to collect water quality data in the morning and evening of June 18 and 30, and August 2, 2010 in the following areas: One location upstream of the impoundment, two locations within the impoundment at a depth of 1.5- and 3-feet, one location each in the bypass reach, tailrace, and at the confluence of the Broad and Enoree Rivers. Lockhart Power also used USGS data collected at the Whitmire gage.[31] Impoundment samples taken during the evening on June 18, 2010, at both depths, fell below the minimum instantaneous standard for DO (4.0 mg/L). All other samples collected by Lockhart Power met South Carolina's state standards for DO, temperature, conductivity, and pH.

Fishery Resources

The 6.6-acre impoundment is mostly riverine in nature with substrates of silt, clay, sand, and/or detritus. Upstream of the dam, just below the HWY 221 Bridge, a small shelf composed of boulder and bedrock provides shoal habitat. Littoral habitat in the impoundment includes shallow banks composed of sand, mud and submerged aquatic vegetation. The riparian forest at the edge of the impoundment provides overhanging vegetation with occasional snags and roots.

The tailrace is approximately 5 to 6 feet wide and 8 inches to 1 foot deep. The most prevalent substrate is sand, which covers bedrock, boulders and cobble. Root mats, aquatic vegetation, and a few logs are also present (Carnagey Biological Services, 2010).

The Enoree River bypassed reach extends for approximately 1,400 feet downstream from the toe of the dam to the confluence with the project's powerhouse tailrace. The bypassed reach is largely composed of habitat consistent with shoals in Piedmont streams of the Southeastern U.S. (Mulholland and Lenat, 1992). Shoals only comprise 2 percent of all habitats in the Enoree River (Lockhart Power, 2011b). The project bypassed reach, which contains 10 percent of the available shoals habitat in the Enoree River, includes a natural ledge, a braided portion, and a main channel.

The natural ledge or fall stretches across the entire width of the river, approximately 15 to 20 feet below the dam. Downstream from the natural ledge, the main channel runs on the south side of the river, and flows over small and large boulders with aquatic vegetation dispersed throughout. The main channel provides a series of riffle, run and pool habitat types. The substrate in the main channel consists mostly of bedrock and sand, interspersed with some boulders, cobble and gravel. Logs, root mats, and aquatic vegetation are also present (Carnagey Biological Services, 2010).

The north side of the bypassed reach is more complex and splits into three braided channels. The braided channels are approximately 6.5 to 19.5 feet wide and from 4 inches to greater than 2 feet deep, with a canopy cover of 45 percent. Substrate in this area is composed of boulders, cobble, gravel, sand, and some bedrock. Snags, root mats, leaf packs, and some aquatic vegetation provide other habitat (Carnagey Biological Services, 2010).

To characterize the fish resources within the Riverdale Project area, Lockhart Power conducted a baseline fisheries survey on June 10–11 and July 6–7, 2010 (Lockhart Power, 2010a). Sampling was conducted at six stations: One station was in the impoundment, three stations were in the bypassed reach, and one station each was in the tailrace and the confluence of the tailrace with the Enoree River. During the baseline fisheries survey, 29 freshwater fish species were collected in the vicinity of the Riverdale Project (table 5). The highest number of species (20) occurred in the bypassed reach upstream of the braiding. Fewer species were collected in the main channel along the southern shoreline of the bypassed reach (13), the braided reach along the northern shoreline (11), and the Riverdale impoundment (12). The lowest number of species (6) was collected at the confluence of the Enoree River and the powerhouse tailrace, which is a relatively homogenous habitat composed mostly of woody debris and undercut banks.

[31] The USGS Whitmire gage (USGS 02160700 Enoree River at Whitmire, SC) collects water quality parameters and was sampled as a point of reference.

Table 5. Fish species and number collected in the vicinity of the Riverdale Project during baseline sampling on June 10-11 and July 6-7, 2010. Species highlighted in gray are listed as Conservation Species (South Carolina DNR, 2005).

Family/Common name	Conservation Species Priority Listing	Sampling location						
		Impoundment	Tailrace	Bypass upstream of braiding	Braided bypass reach along north shoreline	Bypass reach main channel along south shoreline	Confluence	Species totals
Centrarchidae								
Redbreast Sunfish	none	7	6	19	9	21		**62**
Redeye Bass/Unknown	Highest	2		1	3		2	**8**
Redear Sunfish	none	1	1					**2**
Bluegill	none	1		3				**4**
Largemouth Bass	none						1	**1**
Cyprinidae								
Swallowtail Shiner	none		2	1			6	**9**
Sandbar Shiner	none	3	6	11	4	13	3	**40**
Bluehead Chub	none	2	1	12	13	4		**32**
Creek Chub	none		15	18		8		**41**
Santee Chub	High		6		1	2	1	**10**
Eastern Silvery Minnow	none		9	24				**33**
Creek Chubsucker	none			2				**2**
Whitefin Shiner	none	3		49	15	49	5	**121**
Thicklip Chub	Moderate			2				**2**
Greenfin Shiner	Moderate	2		2				**4**

Family/Common name	Conservation Species Priority Listing	Sampling location: Impoundment	Tailrace	Bypass upstream of braiding	Braided bypass reach along north shoreline	Bypass reach main channel along south shoreline	Confluence	Species totals
Highback Chub	none	44						**44**
Ictaluridae								
Yellow Bullhead	none	2	2	14	10	4	2	**34**
Brown Bullhead	none			4		2		**6**
Margined Madtom	none			1	2		1	**4**
Flat Bullhead	Moderate	11						**11**
Snail Bullhead	Moderate			2		5		**7**
Percidae								
Tesselated Darter	none		2	1	5	1	3	**12**
Swamp Darter	none		2					**2**
Piedmont Darter	High			1	4	1		**6**
Catostomidae								
Brassy Jumprock	none			6	2	1		**9**
Notchlip Redhorse	Moderate			2		1		**3**
Lepisosteidae								
Longnose Gar	none						1	**1**
Poeciliidae								
Gambusia	none	1						**1**
Total		79	52	175	68	112	25	511

Macroinvertebrates

Carnagey Biological Services (2010) conducted benthic macroinvertebrate surveys in the Riverdale Project vicinity on June 30, 2010. Collections of aquatic macroinvertebrates were made at six sampling stations. Stations were located above the Riverdale Project impoundment (i.e. reference location, station 1), in the tailrace (station 2), upstream of the braided area in the bypassed reach (station 3), in the main channel of the bypassed reach (station 4), in the braided flow channel of the bypassed reach (station 5), and at the confluence of the tailrace and the Enoree River (station 6). A total of 1,807 organisms, comprising 81 distinct taxa,

were collected. Station 4 had the most taxa and specimens collected, while station 6 had the fewest taxa and station 3 had the fewest specimens collected. The number of EPT taxa (i.e. insect orders Ephemeroptera, Plecoptera, and Trichoptera) was highest (17 taxa) at the reference station, lowest at stations 3 (11 taxa) and 6 (12 taxa), while stations 2, 4, and 5 had 15 to 16 EPT taxa.

Two indices were used to evaluate the quality of the environment for benthic macroinvertebrates. The North Carolina biotic index (NCBI) utilizes a pollution tolerance value developed over a wide range of conditions and pollution types to assess the amount of impact. The South Carolina DHEC bioclassification is determined by averaging scores for the NCBI and EPT index at each station. Based on NCBI, the environment at station 2 was ''excellent'' and all other stations were ''good.'' Based on the South Carolina DHEC bioclassification, the environment at station 2 was ''good'' and all others stations were ''good-fair.''

Freshwater Mussels

Alderman Environmental Services conducted freshwater mussel and snail surveys July 6–8, 2010 (Lockhart Power, 2010a). Visual and tactile sampling occurred in five reaches. Reach 1 was upriver of the dam, reach 2 was in the tailrace, reach 3 was at the confluence of the tailrace and the Enoree River, reach 4 was in the vicinity of SC 49 crossing (~ 4.75 miles downstream from project), and reach 5 was in the bypassed reach. Although there was no evidence of any mussels, six snail species were observed, including the panhandle pebblesnail, which was found in reaches 4 and 5.

Special Status Aquatic Species

Fish

None of the species identified during the survey are state or federally listed as threatened or endangered. However, eight fish species collected in the survey are listed as Conservation Species: redeye bass, Santee chub, thicklip chub, greenfin shiner, flat bullhead, snail bullhead, Piedmont darter, and notchlip redhorse (table 5).

Redeye bass is a Conservation Species of Highest Priority due to its restricted range, as well as competitive displacement and hybridization when found together with the introduced, non-native spotted bass (SCDNR, 2005). The species typically inhabits small to medium sized headwater streams within the Appalachian foothills of Gulf and Atlantic Slope drainages (Boschung and Mayden, 1999). It spawns in the spring (April–June; table 6) in headwater streams in gravel nests built in eddy waters at the heads of pools (Wallus and Simon, 2008). Outside of the spawning season, adult and juvenile redeye bass appear to prefer areas close to shorelines with heavy canopy cover (Knight, 2011). Redeye bass were observed in the impoundment, bypassed reach, and at the confluence of the tailrace and the Enoree River (table 5).

The Santee chub is a Conservation Species of High Priority due to its limited distribution (South Carolina DNR, 2005). Within its distribution, the Santee chub is found in small- to medium-sized streams over gravel, sand, and rubble; however, it is most abundant in sand-bottomed runs of larger streams. The life-history of the Santee chub is not well understood (including spawning season), but is probably similar to the thicklip chub (table 6; Rohde *et al.,* 2009). Santee chub were found in the bypassed reach, tailrace, and confluence during 2010 fish surveys (table 5).

The piedmont darter is a Conservation Species of High Priority, largely because one-third of its global distribution is in South Carolina and many of its preferred habitats are at risk (South Carolina DNR, 2005). Piedmont darter occupy cool to warm moderate-sized streams and rivers, but are usually found in riffles with gravel and rock substrate (Rohde *et al.,* 2009). Little else is known about the life-history of this species, but it likely spawns in mid- to late-spring (table 6; Jenkins and Burkhead, 1993). Piedmont darter was found in all sections of the bypassed reach during 2010 fish surveys (table 5).

The thicklip chub is a Conservation Species of Moderate Priority because it occurs only in the Carolinas and Georgia and only within a few drainages. About one-half of the global distribution of the species is in South Carolina (South Carolina DNR, 2005). It is primarily found in warmer, clear to turbid streams and rivers of the Piedmont. Adults occupy runs and riffles over sand and gravel, as well as sites characterized by rubble, boulder and bedrock (Jenkins and Burkhead, 1993). Thicklip chub spawning biology is not well understood, but likely occurs from mid-May to late August (table 6; Jenkins and Burkhead, 1993). Thicklip chub was found in the bypassed reach, upstream of channel braiding during 2010 fish surveys (table 5).

TABLE 6—SPAWNING DATES AND HABITAT REQUIREMENTS FOR EIGHT CONSERVATION SPECIES OBSERVED IN THE RIVERDALE BYPASSED REACH

[South Carolina DNR, 2005]

Species	Common name		Spawning dates		Habitat Use
	Range	Literature source	Range	Literature source	Category
Micropterus coosae.	Redeye Bass ..	April–June	Mettee *et al.* (1996) Wallus and Simon (2008).	fluvial [1] specialist.	Freeman and Marcinek (2006) Rohde *et al.* (2009)
Cyprinella zanema.	Santee Chub ..	information not available	none	fluvial specialist.	Rohde *et al.* (2009)
Cyprinella labrosa.	Thicklip Chub	possibly mid-May—late August.	Jenkins and Burkhead (1993)	fluvial specialist.	Freeman and Marcinek (2006) Rohde *et al.* (2009)
Cyprinella chloristia.	Greenfin Shiner.	information not available	none	fluvial specialist.	Freeman and Marcinek (2006) Rohde *et al.* (2009)
Ameiurus platycephalus.	Flat Bullhead ..	June-July (impoundment population).	Olmsted and Cloutman (1979)	generalist[2]	Rohde *et al.* (2009)
Ameriurus brunneus.	Snail Bullhead	May—early June	Jenkins and Burkhead (1993)	fluvial specialist.	Freeman and Marcinek (2006) Rohde *et al.* (2009)
Percina crassa	Piedmont Darter.	mid- to late-spring	Jenkins and Burkhead (1993)	fluvial specialist.	Rohde *et al.* (2009)

TABLE 6—SPAWNING DATES AND HABITAT REQUIREMENTS FOR EIGHT CONSERVATION SPECIES OBSERVED IN THE RIVERDALE BYPASSED REACH—Continued

[South Carolina DNR, 2005]

Species	Common name		Spawning dates		Habitat Use
	Range	Literature source	Range	Literature source	Category
Moxostoma collapsum.	Notchlip Redhorse.	March—early June	Jenkins and Burkhead (1993) Grabowski and Isely (2007) Coughlan *et al.* (2007).	fluvial specialist.	Freeman and Marcinek (2006) Rohde *et al.* (2009)

[1] Fluvial specialists are species that require flowing water for most or all of their life cycle (Galat *et al.,* 2005).
[2] Habitat generalists are species that are capable of successfully utilizing a variety of habitats to complete their life-cycle.

The greenfin shiner is a Conservation Species of Moderate Priority because they only occur in the Carolinas and Georgia, and only within a few drainages. About two-thirds of the global distribution is in South Carolina (South Carolina DNR, 2005). The species is found over sandy and rocky pools and in the runs of larger creeks and small to medium-sized rivers (Rohde *et al.,* 2009). The spawning biology of greenfin shiner is not well understood; however, it likely exhibits behavior similar to other species in its genera, which deposit eggs in crevices of submerged logs and rocks (Rohde *et al.,* 2009). The greenfin shiner was found in the impoundment and bypassed reach during 2010 fish surveys (table 5).

The notchlip redhorse is a Conservation Species of Moderate Priority due to habitat degradation such as deforestation and siltation (South Carolina DNR, 2005). The species occurs in large creeks to large rivers on the inner Coastal Plain and Piedmont of South Carolina (Rohde *et al.,* 2009). Its temporal spawning range may occur from March to early June (table 6), and it is thought to gather near shoals and flats to spawn over coarse gravel (Jenkins and Burkhead, 1993; Jennings *et al.,* 1996). The notchlip redhorse was found in the braided and main channel of the bypassed reach during 2010 fish surveys (table 5).

The flat bullhead is a Conservation Species of Moderate Priority due to sedimentation, hydrologic modification, impoundments, nonpoint source pollution, and development, as well as competition with and predation by non-native catfish species like the flathead and blue catfish (South Carolina DNR, 2005). The species occupies a variety of habitats, including impoundments (Olmstead and Cloutman, 1979). Spawning biology is not well understood in stream or riverine environments, though spawning in Lake Norman, North Carolina occurs during June and July (table 6; Olmstead and Cloutman, 1979). The flat bullhead was found in the impoundment during 2010 fish surveys (table 5).

The snail bullhead is a Conservation Species of Moderate Priority for the same reasons as flat bullhead. The species is frequently found in warm and medium-sized rivers, often in rocky runs and riffles, and appears to prefer shoals compared to pools (Kennon, 2007; Rohde *et al.,* 2009). Little is known about snail bullhead biology, but it likely spawns from May to early June (table 6). The snail bullhead was found in the main channel and upstream of braided sections of the bypassed reach during 2010 fish surveys (table 5).

All Conservation Priority Fish Species, with the possible exception of the flat bullhead, are fluvial specialists.[32] In contrast, habitat generalists,[33] such as flat bullhead, can be found in both lentic and lotic systems (Galat *et al.,* 2005).

Benthic macroinvertebrates

The panhandle pebblesnail is a Conservation Species of Highest Priority. Siltation of streams and rivers from agricultural runoff and erosion of unstable stream banks are the main factors affecting the distribution of the species (South Carolina DNR, 2005). The species is generally found in rivers and streams throughout the Piedmont—typically in rocky riffles with good flow and often with the hornleaf riverweed. Solid substrate seems to be a key habitat requirement. Its biology is not well understood; however, like all snails in the mud snail family it likely requires solid substrate to attach eggs (Dillon *et al.,* 2006). The panhandle pebblesnail was found in the bypassed reach and about 4.75 miles downstream from the project during freshwater mussel and snail surveys (Lockhart Power, 2010a).

[32] Fluvial specialists are species that require flowing water for most or all of their life cycle (Galat *et al.,* 2005).

[33] Habitat generalists are species that are capable of successfully utilizing a variety of habitats to complete their life-cycle.

3.3.2.2 Environmental Effects

Effects of Project Refurbishment and Operation on Water Quality

As discussed in section 3.3.1, *Geologic and Soil Resources,* if erosion control measures do not adequately mitigate soil erosion and sedimentation, there may be temporary increases in turbidity above the current state standard of 50 NTU in the Enoree River. Similarly, drawing down the impoundment to repair the sand gates and initial operations may result in the discharge of a large amount of sediment from the project impoundment. Peaking operation may also affect DO and temperature within the impoundment, particularly during low flows. Releasing poorly oxygenated, warm water from the impoundment could affect fish, mussels, and other aquatic species in the bypassed reach.

Lockhart Power is willing to monitor water quality in the project vicinity, as required by South Carolina DHEC, but did not specifically propose any water quality monitoring.

Interior recommends that Lockhart Power: (1) Conduct water quality monitoring in the impoundment at all proposed operational drawdowns for a minimum of 1 year; and (2) submit water quality monitoring results to South Carolina DHEC, South Carolina DNR, NMFS, Interior, and the Commission.

Our Analysis

Our understanding of water quality in the project vicinity under existing conditions is limited because it is based on three water quality samples collected by Lockhart Power, as described above. Low DO concentrations for the June 18, 2010 sample may have been due to high levels of decomposed organic matter in the impoundment, water temperature, or water quality of the impoundment's inflows.

Because of the limited storage capacity of the project impoundment, ROR operation would likely predominate. Water quality conditions

within the impoundment are not expected to differ greatly from existing conditions during ROR operation because all inflow would continually pass through the project as it currently does. However, during peaking operation, which would occur during lower flow periods, DO levels could decrease and water temperatures could increase as water retention times increase. The extent to which these water quality parameters would be affected is unknown, and would depend on inflow rates and ambient conditions.

Because all flows currently spill over the dam into the bypassed reach, some degree of aeration occurs. Given the presence of several species of fish and macroinvertebrates, sufficient aeration is likely occurring. Once operation begins, flows in the bypassed reach would be limited to minimum flows provided through the low-level sand gates, except when inflow exceeds the project's hydraulic capacity. Although the flows would be less than that which occurs currently, flows would be constant and aeration over the shoals is likely to be sufficient to protect aquatic biota. Thermal stratification of the impoundment, which could affect DO levels in the bypassed minimum flow to the bypassed reach, is unlikely because of its shallow depth (Dodds *et al.,* 2010).

Turbidity monitoring prior to the start of construction as well as during project rehabilitation would ensure that the erosion control and sediment management plan is meeting its objectives and that discharges are consistent with the current state water quality standards (table 4) and other permitting requirements throughout the project rehabilitation phase.

Monitoring water quality in the impoundment and in the bypassed reach prior to construction, during construction, and during the first year of project operation under the various operational levels, as recommended by Interior, would determine if operations are adversely affecting water quality parameters and if potential corrective actions are warranted. Depending on the results, monitoring may need to be extended beyond the first year.

Effects of Project Refurbishment and Operation on Fishery Resources

Instream Flow Releases

The proposed Riverdale Project would divert existing river flows away from the bypassed reach and toward the turbines for hydropower generation. Flow diversions would ultimately reduce the volume of flow in the bypassed reach, resulting in dewatering of habitat and modifying aquatic habitat parameters in the 1,400 feet of complex shoals habitat in the bypassed reach. Peaking operations would result in flow fluctuations within the impoundment, and in the Enoree River below the tailrace confluence. Such fluctuations could strand and isolate fish in back channels and on gravel bars, causing increased risk of predation and natural mortality, or dewater fish nests in the impoundment and downstream from the tailrace, leaving eggs vulnerable to predation and desiccation.

Lockhart Power proposes to provide a continuous minimum flow of 50 cfs through the bypassed reach and a downstream continuous minimum flow of 60 cfs, or inflow, whichever is less. Lockhart Power plans to release at least 10 cfs into the tailrace when the project is not generating via leakage, or through gate operations if necessary. In the event of a plant outage, Lockhart Power would release flows into the bypassed reach via the dam's sand gates or over the spillway.

South Carolina DNR recommends Lockhart Power release flows in the bypassed reach that are consistent with the Water Plan. Based on an estimated MADF of 393 cfs for a period of record from 1994–2009, the minimum flows should meet or exceed the following: July-November, 20 percent of MADF (79 cfs); January-April, 40 percent of MADF (157 cfs); and May, June, and December, 30 percent of MADF (118 cfs). Interior,[34] NMFS, and American Rivers support the recommendations provided by South Carolina DNR.

Although NMFS supports South Carolina DNR's proposed minimum flows, it also recommends Lockhart Power conduct an instream flow study after a license is issued, and when the project's sand gates are operational. NMFS states that this is because Lockhart Power could not provide an instream flow study to support flows needed to protect aquatic resources in the bypassed reach. NMFS recommends that Lockhart Power develop the study plan within 6 months of license issuance.

Our Analysis

The current licensee has not operated the project since 2001, and no river flow has been diverted for hydropower purposes since that time. Rather, all river flow has and continues to run over the dam/spillway and into the shoals of the 1,400-foot-long bypassed river channel. These conditions represent the no-action alternative.

[34] *See* email correspondence dated May 31, 2013 from Thomas McCoy, Deputy Field Supervisor, FWS, Charleston, South Carolina, to Sarah Salazar, FERC, Washington, DC, filed on June 6, 2013.

Piedmont streams like the Enoree River naturally exhibit large seasonal variations in stream flow with varying amounts of habitat. High rates of evapotranspiration during the growing season deplete soil moisture content and reduce groundwater input to streams, resulting in average stream flows that are generally much lower during the summer compared with winter and early spring. During winter and early spring, evapotranspiration is very low and groundwater discharge is usually considerably higher, resulting in higher baseflows (Mulholland and Lenat, 1992).

Many fish species have evolved life history strategies in the context of natural flow regimes. Consequently, fishes are generally adapted to the monthly, seasonal, annual, and interannual variations in flow, and are capable of surviving flows from drought to flood conditions (Bunn and Arthington, 2002; Thompson and Larsen, 2004). Some fishes also benefit from particular magnitudes of flow during specific periods of the year. For example, higher flow during spring can provide access to spawning grounds for migratory species, or access to the floodplain, where nursery value and foraging opportunities are optimal for some fish species (Bunn and Arthington, 2002). Thus, certain seasonal components of an annual flow regime can be important for some fishes.

A diversity of species currently exist in the bypassed reach, which is composed of complex shoals habitat. Shoals represent only 2 percent of all habitat in the Enoree River, and the bypassed reach contains 10 percent of shoals habitat in the Enoree River (Lockhart Power, 2011b). Wharton (1978) describes a Piedmont shoal as ''shallow, oxygenated water,'' and shoals as ''swift, rocky areas'' that are abundant with life. Despite their rarity, they are structurally complex habitats that support a higher number of species than more homogenous habitats in Piedmont rivers (Kennon, 2007).

The bypassed reach had the highest number of species collected, compared to all other habitats sampled during the 2010 fish surveys (table 5). A total of 21 species was observed in the bypassed reach, and seven of those species are listed by South Carolina as Conservation Species (table 5). Each of these species is a fluvial specialist, requiring flowing water for most or all of their life cycle (Galat *et al.,* 2005).

Redeye bass is one of the more unique species present in the bypassed reach, and is listed as Conservation Species of Highest Priority. This species is restricted to watersheds in northwest

South Carolina, and is currently in decline in the state due to hybridization with the introduced Alabama spotted bass (South Carolina DNR, 2008). Continued hybridization could eventually restrict redeye bass populations to isolated tributaries (Barwick *et al.,* 2006).

The panhandle pebblesnail is another unique and rare species present in the bypassed reach, and also is listed as a Conservation Species of Highest Priority. In 1994, this species was under candidate review for listing under the Endangered Species Act; however, it was determined that persuasive data on biological vulnerability and threat were not available to support listing at the time (DOI, 1994). This species is only documented at seven locations in South Carolina (Dillon *et al.,* 2006). Siltation of streams and rivers from agricultural runoff and erosion of unstable streambanks are the main factors affecting the distribution of the species (South Carolina DNR, 2005).

Because Lockhart Power could not conduct a controlled-flow study of the instream flows needed to support aquatic resources in the bypassed reach or downstream from the tailrace, it proposed to provide a minimum continuous flow of 60 cfs downstream from the tailrace and 50 cfs through the bypassed reach when operating. Lockhart Power asserts that such flows would meet 7Q10 [35] requirements (56 cfs) in the Enoree River established by South Carolina DHEC.[36]

The proposed 50 cfs is 13 percent of the MADF, or 393 cfs. Lockhart Power states that this flow is within the range of minimum bypass flows for five other Commission-licensed projects located within South Carolina's Broad River Basin (table 7), each of which were built at a shoal site, have similar fish species as found at the Riverdale Project, and were based on flow studies. Lockhart Power asserts that if a field study could have been conducted at the Riverdale Project it would have yielded similar results, supporting a similar percent of MADF for minimum flows in the project bypassed reach. Consequently, Lockhart Power states that its proposed flow would adequately protect aquatic habitat in the bypassed reach and the Enoree River. However, for each of the projects cited by Lockhart Power (i.e. table 7), site-specific instream flow studies were conducted to support the minimum flows . No instream flow studies have been conducted in the Riverdale bypassed reach or downstream from the tailrace to support Lockhart Power's proposed minimum flows.

TABLE 7—FLOWS THROUGH THE BYPASSED REACH AT FERC LICENSED PROJECTS IN THE BROAD RIVER BASIN, SOUTH CAROLINA

[Source: Lockhart Power]

Project Name	MADF (cfs)	Range of flow through bypassed reach (cfs)	Percent range of MADF
Gaston Shoals	2,170	150–350	7 to 16.
Lockhart	3,600	200–385	5 to 11.
Catawba	4,878	550–950	11 to 19.
Columbia	6,923	500–900	7 to 13.
Pacolet	505	22–49	4 to 9.
Riverdale Proposed	393	50	13.

Without a site-specific flow study, desktop standard-setting methods, such as 7Q10, the Water Plan, and Tennant (1976) can be used to provide minimum flow recommendations.

The 7Q10 flow is a hydrologically-based design flow that represents the lowest 7-day average flow that occurs, on average, once every 10 years. The 7Q10 flow does not necessarily take into account biological needs of aquatic resources. Nonetheless, Lockhart Power's proposed minimum flow of 50 cfs is not equivalent to the 7Q10 flow (56 cfs) in the bypassed reach; however, it is equivalent to the 7Q10 flow below the tailrace when combined with leakage through the turbine.

Where site-specific flow studies are not available, South Carolina DNR uses the state Water Plan [37] to recommend flows that will protect fishery resources in all waters of the state when natural streamflow regimes cannot be maintained. The Water Plan minimum flow requirements are based on instream flow studies conducted at six regulated reaches in the South Carolina Piedmont. These minimum flow requirements were designed to provide a useable width for migratory fish [38] passing through shoals during high flows, provide ''generally adequate'' flows to protect fisheries during low flows, provide ''adequate'' flows during periods when flows are increasing or decreasing, and provide flows that conform to seasonal variation in flow. These objectives resulted in three distinct minimum flow periods that capture high (January–April; 40 percent of MADF), low (July–November; 20 percent of MADF), and increasing (December; 30 percent of MADF) or decreasing (May, June; 30 percent of MADF) flow periods (Bulak and Jobsis, 1989).

Based on the stipulations of the Water Plan and the flow record at the time, which established a MADF of 393 cfs for the bypassed reach, South Carolina DNR, Interior, and NMFS concluded that the minimum flows should meet or exceed the following: 79 cfs from July–November (20 percent of MADF); 157 cfs from January–April (40 percent of MADF); and 118 cfs in May, June, and December (30 percent of MADF). Using the most current flow data available, staff calculated the MADF to be 374 cfs, which results in the following slightly lower flows: July–November, 75 cfs (20 percent of MADF); January–April, 150 cfs (40 percent of MADF); and May, June, and December, 112 cfs (30 percent of MADF). In contrast, Lockhart Power's proposed flows of 60 cfs (16 percent of MADF) downstream from the tailrace

[35] The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years.

[36] The 50-cfs minimum flow in the bypassed reach represents an increase from the 30-cfs minimum flow requirement of the existing license.

[37] The Water Plan states that the current policy for determining instream flow requirements for fishery resources can be found in *South Carolina Instream Flow Studies: A Status Report* (Bulak and Jobsis, 1989).

[38] Striped bass were considered a migratory species of prime importance in the instream flow studies, and habitat suitability (i.e. stream width and depth requirements) was based on passage of this species.

and 50 cfs (13 percent of MADF) in the bypassed reach would fall below all of the Water Plan's minimum flows and would not be adequate to protect the existing fishery in the bypassed reach. In addition, unlike the Water Plan's seasonally variable minimum flows, Lockhart Power's proposed year-round flows would not maintain or mimic the natural flow regime, which according to the Water Plan, can be important because fish have evolved to spawn in synchrony with the seasonal hydrologic cycle.

One of the criteria used to establish minimum flow requirements of the Water Plan is to provide sufficient depth for passage of striped bass. Bulak and Jobsis (1989) concluded that in Piedmont streams, where striped bass are generally of prime importance, a minimum depth of 1.5 feet and passage width of 10 feet is necessary for unimpeded passage for the spawning migration. During high flow periods, study results from the six Piedmont reaches indicated that establishing a 1.5-foot-deep by 10-foot-wide passage route required flows at shoals to range from 39–70 percent of MADF (Bulak and Jobsis, 1989). Therefore, the 40 percent of MADF flow recommended by South Carolina DNR, Interior, and NMFS for the period between January and April represents the lower end of flows deemed necessary for maintaining a zone-of-passage for striped bass.

Striped bass are not present in the bypassed reach and a spawning migration does not occur up to the Riverdale Project due to the lack of passage at Parr dam, located 65 miles downstream from the Riverdale Project. Therefore, the passage requirements outlined in the Water Plan are not relevant for the Riverdale bypassed reach. While a 1.5-foot-deep by 10-foot-wide passage was determined to be suitable for striped bass, which at maturity can range in length from 18 inches to greater than 40 inches, the species with the largest adult size range that presently inhabits the Riverdale bypassed reach is redeye bass, which in South Carolina, can range from 6–17 inches in length (Rohde *et al.,* 2009). Based on size, redeye bass do not require the same depths as striped bass for movement within the bypassed reach, nor is there evidence that other species require depths of 1.5 feet. Therefore, flows of 40 percent MADF from January to April are not necessary for maintenance of suitable habitat for the current fish community in the bypassed reach.

Based on the study conducted by Bulak and Jobsis (1989), flows ranging from 15 to 32 percent of MADF are acceptable from January to April if a channel 1.0-foot-deep by 10-feet-wide is adequate for the species present. Given the absence of striped bass and other anadromous species at the Riverdale Project, a minimum flow of 20 percent of MADF (75-cfs) between January and April should provide suitable passage conditions in the bypassed reach for the existing aquatic community. Bulak and Jobsis (1989) also concluded that a minimum flow of 20 percent MADF is generally adequate during the low flow period. Although a year-round minimum flow of 75 cfs would not mimic the seasonal variation in hydrology sought by the Water Plan, there is currently no evidence that the fishes or invertebrates in the bypassed reach, or downstream from the tailrace require such annual variation in flow to complete their life-cycle.

In addition to using the parameters of the Water Plan, we analyzed flows in the bypassed reach using the Tennant method. The Tennant method is based on the assumption that a proportion of MADF would maintain suitable depths and water velocities for fish. Although Tennant's method is derived from rivers in Montana, Wyoming, and Nebraska, analyses in the southeast exhibit general agreement with his recommendations (Wood and Whelan, 1962). Bulak and Jobsis (1989) also used Tennant as one of the factors to establish South Carolina's policy on minimum flows. Tennant concluded that 10 percent of MADF is the minimum instantaneous flow needed to sustain short-term survival and is considered the lower limits for aquatic life. Tennant also concluded that at 20 percent of MADF, the widths, depths, and velocities of most streams would be ''good'' during the dry season and close to ''fair or degrading'' during the wet season.

Table 8 shows the percentages of mean annual flows and corresponding narrative descriptions of the habitat created by these flows in the Enoree River using the Tennant method. According to this method, and using the most current flow data available (i.e. 1994–2012; MADF = 374 cfs), a flow of 60 cfs (15 percent of MADF) downstream of the tailrace and 50 cfs (13 percent of MADF) in the bypassed reach would provide fair or degrading conditions, and close to poor or minimum conditions during the dry and wet seasons, respectively. In contrast, the South Carolina DNR's recommended minimum flows of 20 percent of MADF during the dry season and 40 percent of MADF during the wet season, would provide good conditions year round at the project. A year-round minimum flow of 75 cfs (20 percent of MADF), would result in good, and close to fair or degrading conditions during the dry season and wet season, respectively.

TABLE 8—MINIMUM FLOW REQUIRED FOR FISH IN STREAMS IDENTIFIED BY TENNANT

[1976]

Description of flow	% of MADF	
	Dry season	Wet season
Outstanding	40	60
Excellent	30	50
Good	20	40
Fair or degrading	10	30
Poor or minimum	10	10
Severe degradation	0–10	0–10

NMFS recommended that an instream flow study be conducted after the license is issued, and when the sand gates have been renovated to allow management of flows into the bypassed reach. However, as discussed above, we already have sufficient information to evaluate bypassed reach minimum flow alternatives. For this reason, an instream flow study is not needed for this project.

Fluctuating Water Levels

Lockhart Power's peaking operation would result in periods of daily discharge fluctuations downstream from the tailrace. Lockhart Power's proposed

peaking operations would also involve a 4-foot impoundment drawdown during peaking events.

Beyond the minimum flow alternatives described above, no one recommended changing proposed project operations.

Our Analysis

Lockhart Power states that peaking operation would occur when inflows to the project are greater than 170 cfs (i.e. 50 cfs minimum bypass flow and about 120 cfs minimum hydraulic capacity of the turbine). Lockhart Power also indicates that flow would be spilled over the dam when inflow is greater than 500 cfs (i.e. 50 cfs minimum bypass flow and about 450 cfs maximum hydraulic capacity of the turbine) (Lockhart Power, 2011b). Based on this proposed operation, peaking could occur when inflow to the project is greater than 170 cfs and less than or equal to 500 cfs. Accordingly, peaking could occur as little as 38.6 percent of the time in August, to as much as 75.2 percent of the time in April (figure 2). Peaking would occur greater than 50 percent of the time during January, February, March, April, May, June, and December (figure 2).

Downstream from the tailrace, the highest fluctuations would occur from December through June, when monthly mean flows range from 300–590 cfs (see table 3). During this period, daily flows downstream from the tailrace could range from 60 cfs when the project is not operating and the pond is refilling, to pulses of 500 cfs during operation.

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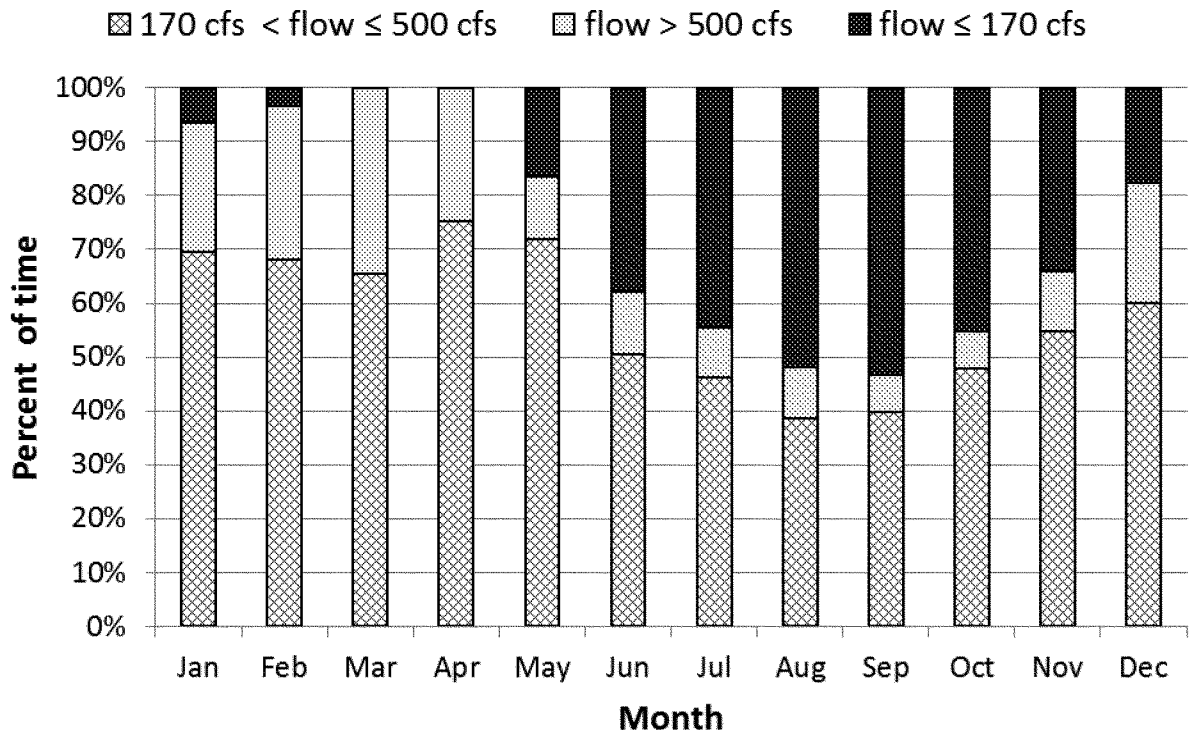

Figure 2. Percent of time during each month that inflows to the Riverdale Project are greater than 170 cfs and less than or equal to 500 cfs (i.e. when peaking with drawdown operation can occur under Lockhart Power's proposed operations), less than or equal to 170 cfs (i.e. flow below turbine minimum turbine capacity plus 50 cfs minimum flow), and > 500 cfs (i.e. flows greater than maximum turbine capacity plus 50 cfs minimum flow). (Source: Staff).

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Downstream Effects

Flow fluctuations associated with peaking may have negative consequences for fish occurring downstream from the tailrace. When flows are high, large areas of habitat can be used by fish for foraging, cover, or reproduction. However, when water levels recede, the connection between side channels and the main channel can be lost (Bradford, 1997). As a result, fish stranding can occur on gravel bars, back channels, or pot-holes that become isolated from the main flow (Cushman, 1985). These isolated off-channel habitats often expose fish to greater predation risk, lower DO, and higher water temperature, which can lead to stranding mortality (Nagrodski *et al.,* 2012). Early-life stages (i.e. larvae, juveniles), which have a reduced swimming capacity compared to older fish, are particularly vulnerable to stranding and associated mortality, because they are unable to reach the main channel as flows decrease (Dabrowski *et al.,* 1986). Furthermore, many riverine fishes, spawn on stony

substrate in off-channel locations that are susceptible to dewatering, which can leave eggs vulnerable to predation and desiccation (Nagrodski *et al.,* 2012).

Alterations in discharge during the spawning season can particularly affect reproduction of species with short spawning seasons (Craven *et al.,* 2010). Freeman *et al.* (2001) demonstrated that fish assemblages below projects with peaking operations in Piedmont rivers are dominated numerically by species that display prolonged spawning seasons (i.e. extending into July or later; Freeman *et al.,* 2001). In contrast, species that spawn exclusively during the spring are less abundant below peaking projects compared to unregulated sites, due to unstable and sometimes unavailable spawning habitat (Freeman *et al.,* 2001). Redeye bass, snail bullhead, Piedmont darter and notchlip redhorse are fluvial specialists that spawn exclusively during the spring. These species are currently present in the bypassed reach, but their populations could decline due to flow variability associated with peaking operation.

As discussed above, under Lockhart Power's proposed operation, daily flows downstream from the tailrace could range from 60 cfs when the project is not operating and the impoundment is refilling, to pulses of 500 cfs during operation. The magnitude of this flow fluctuation would be 440 cfs. Higher minimum instream flows recommended by South Carolina DNR would reduce the magnitude of the flow fluctuation proportionally and would result in less exposed shoreline downstream from the tailrace when the project is not generating.

Impoundment Effects

Fluctuating water levels may produce unfavorable spawning conditions and recruitment for resident fish species that occupy the Riverdale impoundment. Effects may be particularly pronounced for centrarchids, which build nests and spawn at shallow depths in the littoral zone during spring and summer. When water levels decrease during drawdowns, nests become exposed and egg desiccation can occur (Maraldo and MacCrimmon, 1981). Lower water levels can also result in reduced shoreline cover and increased predation on juvenile fish (Willis, 1986).

Inflows are greater than 170 cfs and less than 500 cfs, between 50.6 and 75.2 percent of the time during April through June, when most centrarchids build nests and spawn (figure 2). Thus, peaking operation, with up to a 4-foot drawdown, could occur daily about 50 to 75 percent of the time during April through June when centrarchids are building nests and spawning (figure 2).

Proposed peaking operation, with up to a 4-foot drawdown, would change the littoral zone fish habitat in the project impoundment, compared to the natural flow conditions that have been present at the project for the last 12 years. Frequent drawdowns from April through June have the potential to dewater fish nests, disturb spawning, and reduce reproductive success of the four centrarchid species occupying the impoundment (see table 5). Peaking operation at the project could affect each of these species. However, three centrarchids are multiple spawners (e.g., bluegill, red breast sunfish, and redear sunfish) and could spawn again if project operation disrupts initial spawning activities.

With regard to redeye bass, the impoundment likely does not possess significant amounts of spawning or juvenile habitat. The impoundment's littoral zone includes shallow banks composed of sand, mud, and submerged aquatic vegetation (Carnegey Biological Services, 2010). Redeye bass, however, spawn in gravel nests built in eddy waters at the heads of pools (Wallus and Simon, 2008) and juveniles appear to prefer areas close to shorelines with heavy canopy cover (Knight, 2011). These types of habitats are not present in the project impoundment, but are present in the bypassed reach, where Lockhart Power captured the most redeye bass during 2010 baseline fisheries survey (table 5).

Low Inflow/Drought Conditions

The project is located in the Southeast U.S., which is susceptible to severe drought events that can reduce water supplies for several years at a time. Recently, severe droughts occurred from 1998–2002, 2005–2007, and 2012. During these events, incoming flow can fall below minimum continuous flows, stressing aquatic resources and creating conflicts among competing uses, including generation, water supply, and recreation.

To address drought conditions, Lockhart Power developed what it terms a low inflow protocol (LIP), which states that ''when average daily project inflow is less than approximately 80 cfs (+/− 10 percent), the following would be in effect: Continuous project outflow shall approximately (+/− 10 percent) equal project inflow.'' [39] South Carolina DNR recommends Lockhart Power develop and implement a LIP for the project, consistent with the Water Plan. They also recommend that Lockhart Power implement the LIP during periods of extended drought and design it to provide instream flows to protect fish and wildlife and other water uses associated with the Enoree River in the Project vicinity.[40] Interior concurs with South Carolina DNR's recommended LIP.

Our Analysis

The overall objective of a LIP is to provide sufficient instream flows to protect fish, wildlife and other water uses in the project vicinity during droughts. Lockhart Power and stakeholders have agreed that the project needs a LIP to adequately protect fishery resources. The recent high frequency of severe drought events in the Southeast U.S. reinforces this need.

Severe drought events can affect fishes in a number of ways. Low streamflows during a drought reduce stream width and depth, limiting habitat availability and the ability of fish to move freely among habitats (Lohr and Fausch, 1997). Droughts also affect water temperature and DO concentrations, which can negatively affect reproduction and juvenile recruitment (Schlosser *et al.,* 2001). This can reduce stream fish populations and change fish assemblage structure by favoring hypoxia-tolerant species and reducing intolerant species (Smale and Rabeni, 1995). Moreover, drought can simply kill fish directly (Lohr and Fausch, 1997).

Ideally, a LIP would be designed to provide flexibility to adjust minimum flows during drought periods so that the effects of low flows are balanced among competing uses, while still protecting fish and wildlife. As written, Lockhart Power's proposed LIP does not provide a mechanism to adjust minimum flows during drought periods; rather it proposes to ensure project outflow is equal to inflow when average daily inflow is less than 80 cfs. This would ensure no interruption of flow (i.e. storage of water) through the project to downstream resources when flows are 80 cfs or less. However, Lockhart Power's LIP is not clear as to how that flow would be passed through the project. In other words, would all flow be provided through the sand gates into the bypassed reach, or as a combination

[39] Based on pro-rated inflow data from the USGS gage near Woodruff, SC (#02160390).

[40] The Water Plan does not prescribe specific flows, recommends that a Water-shortage Contingency Plan (i.e., drought contingency plan) be developed and coordinated with appropriate federal and state agencies, local governments, and other stakeholders. The Water Plan also recommends that the Water-shortage Contingency Plan include water-shortage severity levels and water releases associated with each severity level.

of bypassed reach minimum flows and generation? The project's minimum operating hydraulic capacity of 120 cfs suggests that all inflow would be released into the bypassed reach when average daily inflow to the project is 80 cfs or lower.

Eighty cfs represents 20 to 21 percent of MADF, depending on whether the flow record includes 1994–2009 (MADF = 393 cfs) or the most complete record from 1994–2012 (MADF = 374 cfs), respectively. Bulak and Jobsis (1989) determined that during the low flow period (July–November) in South Carolina Piedmont streams, 20 percent of MADF was ''generally adequate'' for aquatic resources. If drought conditions were to extend into the high flow period (January–April), 20 percent of MADF was within the range (15–32 percent of MADF) of flow that provides a 1-foot-deep by 10-feet-wide stream of water. Thus, 80 cfs would provide good habitat in the bypassed reach and downstream from the tailrace. Any inflows that are lower would represent natural flow conditions that Lockhart Power could not control, and would result in the best aquatic habitat conditions possible given drought conditions. However it would also limit the project's ability to generate until drought conditions subside.

Lockhart Power also does not explain the basis for selecting an average daily inflow of 80 cfs to represent low flow/drought conditions, only noting that this was being discussed with resource agencies during its application development. Developing and implementing an LIP, as recommended by South Carolina DNR and Interior, would allow Lockhart Power and the resource agencies to cooperatively define water-shortage severity levels (i.e. drought conditions) and potentially adjust minimum flows, depending on the severity of the drought so that the effects of low flows are balanced among competing uses.

The LIPs recommended by South Carolina DNR inherently allow flows to drop below the minimum flow releases determined to be suitable for fish and benthic invertebrates in the bypassed reach. Although further reductions of minimum flow requirements are likely to have additional effects on aquatic habitat and fish populations, fishes have developed physiological and behavioral adaptations for coping with drought conditions. For example, some fishes move to pools that contain water (Gelwick, 1990) or larger downstream reaches (Magoulick and Kobza, 2003), and darters may survive in the hyporheic zone[41] (Tramer, 1977). Also, fishes tend to move back into an affected area as soon as a drought disturbance has subsided (Larimore *et al.,* 1959; Peterson and Bayley, 1993), and fish assemblages can return to pre-disturbance levels within one year (Larimore *et al.,* 1959; and Meffe and Sheldon 1990). Thus, a reduction in minimum flow requirements during drought periods may affect fishery resources in the bypassed reach and downstream from the tailrace temporarily; however, stream fish communities are resilient and can recover quickly from these temporary disturbances.

Releasing and Distributing Minimum Instream Flows Across the Bypassed Channel

As discussed above, Lockhart Power proposes to use one or more of the existing sand gates in the dam to provide its proposed minimum flows to the bypassed reach. Currently, the sand gates on the middle and right side of the dam are closed and inoperable, while the gate on the left side remains open.[42] Lockhart Power proposes to repair the sand gates, and work with the resource agencies to determine which gate(s) to use to provide the bypassed reach minimum flow. Lockhart Power also would develop a rating curve following the repairs and verify the rating curve once every 6 years.

South Carolina DNR and Interior recommend Lockhart Power evaluate the feasibility and effectiveness of using the sand gates to provide flows on a permanent, continuous basis to the bypassed reach. South Carolina DNR also recommends that Lockhart Power evaluate flow distribution through the sand gates, and the gates be operated to optimize downstream aquatic habitat in the bypassed reach. In addition, American Rivers recommends the new license require: (1) A study of flow delivery alternatives to determine how to release flows from the dam to fully wet the shoals of the bypassed reach; and (2) the best method for delivering flows to the bypassed reach under all flow conditions. NMFS recommends conducting an instream flow study once the gates are operational.

[41] The hyporheic zone is a portion of the groundwater interface in streams where a mixture of surface water and groundwater can be found. Hyporheic zone waters can be found both beneath the active channel and within the riparian zone of most streams and rivers.

[42] The sand gate on the right side does not have any gate mechanism installed, and is permanently sealed. The operating mechanism for the middle sand gate is tilted relative to its foundation and appears to be damaged (FERC, 2013).

Our Analysis

Under existing conditions, flows in the Enoree River are capable of covering the entire breadth of bypassed reach, creating complex shoal habitat that supports a diverse assemblage of 21 fish species. There is a natural ledge or fall immediately downstream from the dam that stretches across the entire width of the river for about 15 to 20 feet. Downstream from the natural ledge, the main channel runs on the south side of the river, and flows over small and large boulders with aquatic vegetation dispersed throughout (Carnagey Biological Services, 2010). The north side of bypassed reach is more complex and splits into three braided sections, each approximately 6.5 to 19.5-foot-wide and 4 inches to greater than 2-foot-deep, with 45 percent canopy cover (Carnagey Biological Services, 2010).

The distinct physical features between the north and south side of the bypassed reach enables a unique assemblage of fish to occupy each habitat. Lockhart Power's 2010 fish survey of the bypassed reach, demonstrated that fish species observed on the south side were often absent, or less common on the north side, and vice versa (table 5). For example, redeye bass and Piedmont darter, Highest Priority and High Priority Conservation Species, respectively, were collected most frequently on the north side, and absent on the south side (table 5). Whereas, the snail bullhead, a Moderate Priority Conservation Species, was collected most frequently on the south side, but absent on the north side (table 5).

Because Lockhart Power did not have control of the dam, it was unable to determine if the sand gates could be made operable, or how best to use them to release minimum flows on a continuous and permanent basis. If the gates cannot be made operational, or used in a manner to provide the required flows, alternative mechanisms would need to be identified. These alternatives would need to be functional prior to operating the project to ensure that the aquatic resources in the bypassed reach are protected.

Assuming that the bypassed flows can be provided through the sand gates, distributing the flows across the shoals to optimize benthic invertebrate and fish habitat may require delivering flows from one or more sand gates. While fully wetting the shoals would likely provide benthic invertebrate and fish habitat, it may not provide the best habitat for targeted channels supporting rare species. To determine which combination of gates to use would require a post-licensing flow study as

recommended by NMFS and American Rivers that examines depth, velocity, and wetted width across the shoals using various combinations of the sand gates to deliver the required flows. Targeted species and habitat conditions would need to be selected in consultation with the South Carolina DNR, FWS, NMFS, and American Rivers to define habitat suitability criteria.

Benthic Invertebrate and Fish Surveys

The shoals within the bypassed reach represents a unique habitat that is relatively rare and currently supports seven fish species and a snail (panhandle pebblesnail) recognized in the South Carolina Wildlife Action Plan as in need of conservation because of their restricted ranges and specialized habitat needs (table 5). Sediment discharges and minimum instream flows could lead to physical, chemical, and biological changes in the bypassed reach affecting the distribution and occurrence of these species in the bypassed reach.

Interior recommends that Lockhart Power conduct fish surveys before and after construction at the project, and again 1 year later, to provide information on the presence of the eight Conservation Species. Interior also recommends that Lockhart Power conduct invertebrate surveys before and after construction at the project, and again 1 year later, to provide information on the panhandle pebblesnail within the bypassed reach. Interior requests that Lockhart Power design the surveys in consultation with South Carolina DNR, South Carolina DHEC, NMFS, and FWS, and that sampling efforts be concentrated in the multiple habitat types in the bypassed reach. Interior states that additional surveys may be necessary depending on the results.

Our Analysis

Interior does not explain why surveys for the conservation species are needed before and after construction and again one year later, or the level of effort it anticipates would be required for such surveys.

Pre- and post-construction surveys of fish and benthic invertebrates in the bypassed reach would identify current locations of these species in the bypassed reach and their locations following initial operations. However, sufficient information already exists to document their occurrence in the bypassed reach and to evaluate how best to distribute flows to optimize aquatic habitat. Therefore, there is no need for this information.

Monitoring Compliance With Impoundment Levels and Minimum Flows

Lockhart Power proposes to limit impoundment fluctuations to 4 feet and to establish a rating curve of minimum flow releases through the sand gates and very the rating curves every six years.

No agency recommended measures to monitor compliance with these operations.

Our Analysis

Developing and implementing an operation compliance monitoring plan would provide additional detail about project operations. Such a plan would provide the Commission a means to monitor compliance with the minimum flow releases and the limits on impoundment fluctuations. To be effective, the plan would need to: (1) Define the criteria by which compliance with impoundment fluctuations and minimum flows would be measured; (2) specify the type and location of all equipment used to monitor impoundment levels and minimum flows; and (3) identify the data collection intervals and reporting procedures.

Fish Impingement and Entrainment

Water intake structures at hydropower projects can injure or kill fish that are either impinged on intake screens/trash racks, or entrained through turbines. Larger aquatic organisms (typically fish and larger invertebrates) can be trapped against the intake screens or trash racks by the water flowing into a penstock. This process is known as impingement, and can cause physical stresses and/or suffocation that lead to death of some organisms (EPRI, 2003).

If fish are able to pass through screens or trash racks (i.e. entrained), fish injury or mortality can result from collisions with turbine blades, or exposure to pressure changes, sheer forces in turbulent flows, and water velocity accelerations created by turbines (Knapp *et al.,* 1982). The number of fish entrained and at risk of turbine mortality at a hydroelectric project is dependent upon site-specific factors, including physical characteristics of the project, as well as the size, age, and seasonal movement patterns of fish present within the impoundment (EPRI, 1992). Fish that are entrained and killed are removed from the river population and no longer available for recruitment to the fishery.

The project includes two sets of trash racks: One with 2.25-inch bar rack spacing that is located at the intake to the project headrace and a second located at the downstream end of the headrace (at the entrance to the turbine penstock) that has bar rack spacing of approximately 10 inches. Lockhart Power proposes to decrease the spacing on the trashrack at the penstock intake from 10 inches to 5 inches.[43] Lockhart Power is not proposing any changes to the 2.25-inch bar spacing on the trashracks at the headrace intake (hereafter, headrace trashracks).

Interior is concerned with the existing 2.25-inch bar rack spacing on the headrace trashracks, and with approach velocities during proposed project operation, especially during peaking when the head pond is lowered by 4 feet. Interior requests that a 1-inch bar rack spacing be installed at the headrace trashrack to minimize fish entrainment and mortality at the project.

Our Analysis

Fisheries surveys conducted by Lockhart Power indicate that the project impoundment contains 11 species of fish, including redeye bass and flat bullhead, which are Conservation Species of Highest and Moderate Priority, respectively (table 5). Overall, two redeye bass and 11 flat bullhead were captured within the impoundment, which represented 2.5 and 13.9 percent of the total number of fish captured, respectively. Highback chub was the most common fish captured in the impoundment, representing 55.7 percent of the total number of fish captured.

Fish Impingement

Fish can become impinged on the bars of a trash rack if they are unable to overcome the approach velocity[44] and are unable to pass between the trashrack bars due to their larger body size. Fish that are wider than the trashrack bar spacing and have burst swim speeds[45] lower than approach velocities would be susceptible to impingement. Thus, determining the risk of impingement for fish in the project impoundment requires an understanding of approach velocities at the headrace trashracks, as well as the widths and burst swim speeds of fish in the impoundment.

Lockhart Power was not able to provide approach velocities at the headrace trashrack because it does not currently own or have access to the

[43] This trash rack is isolated from the project impoundment and, thus, its modification would result in little to no effect on aquatic fauna.

[44] Approach velocity is the calculated water flow velocity component perpendicular to the trashrack face.

[45] Burst swimming speed is the maximum swimming speed that can only be sustained for a few seconds. It is usually used to escape danger (Murray, 1974).

project. However, we estimated approach velocities for the existing 2.25-inch and Interior's recommended 1-inch clear bar spacing, as described below.

To estimate approach velocities at the project we used existing information on the dimensions of the headrace trashracks,[46] as well as certain assumptions regarding the composition of the trashracks.[47] Each unit with the 2.25-inch bar spacing was 67.75 inches (or 5.65 feet) wide (i.e. two 31.875-inch panels,[48] plus one 4-inch timber in between). Each unit with 1-inch bar spacing was 68 inches (or about 5.67 feet) wide (i.e. two 32 inch panels,[49] plus one 4 inch timber in between. The larger panel width for the trashracks with 1-inch bar spacing was necessary to accommodate 1-inch bar spacing and still maintain similar sized units. All trashrack units were 13.4 feet high. With all five units combined, the total number of open spaces between bars in the 2.25-inch and 1-inch trashracks is 120 and 230, respectively (figures 3 and 4).

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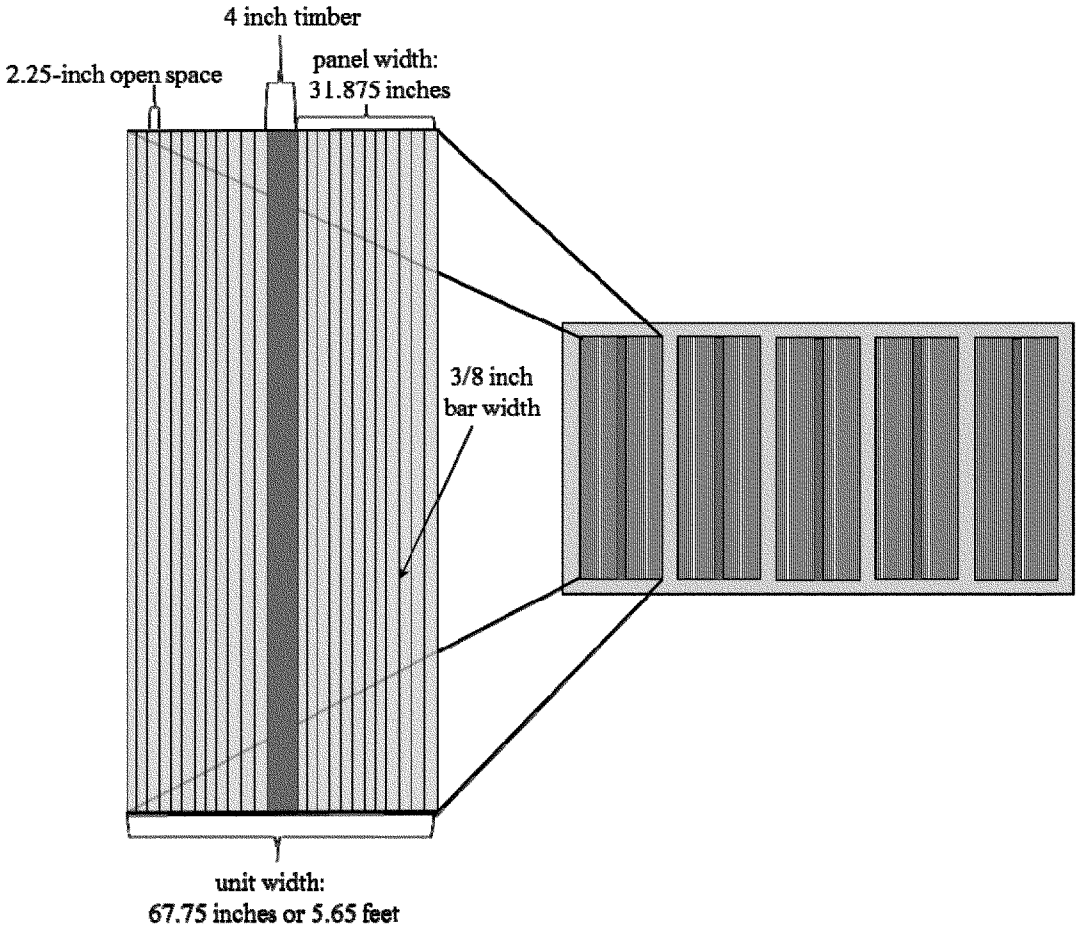

Figure 3. Illustration of the front of the 2.25-inch headrace trashrack, which is composed of five individual trashrack units. A zoomed image of one trashrack unit is shown to the left of the trashrack. The illustration is not to scale (Source: Staff).

[46] Drawings in Exhibit F of the license application show that the headrace trashracks are composed of five steel units, with 4-inch timbers in the middle of each unit and 3/8-inch vertical bars (figures 3 and 4). The total width of each unit was estimated to be about 5.5 feet wide and 13.4 feet high.

[47] We assumed the 4-inch timbers represented closed space in each unit, and that each unit was composed of two panels. We also assumed each bar was 3/8-inch wide.

[48] The 31.875-inch-wide panels are composed of 13 vertical bars totaling 4.875 inches (3/8-inch bar width × 13 = 4.875), and 12 open spaces (2.25 inches each) totaling 27 inches (figure 3).

[49] The 32-inch-wide panels are composed of 24 vertical bars totaling 9 inches (3/8 inch bar width × 24 = 9), and 23 open spaces (1 inch each) totaling 23 inches (figure 4).

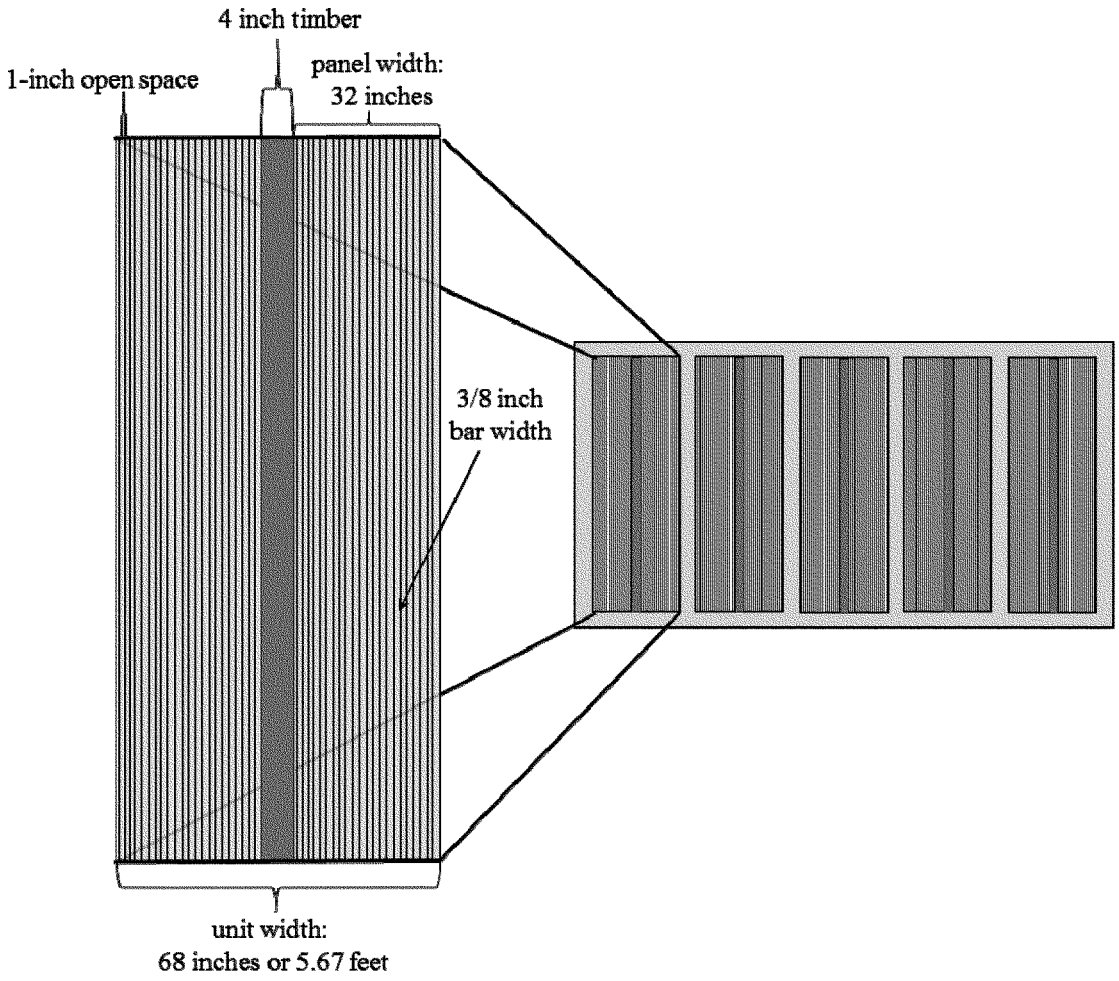

Figure 4. Illustration of the front of the 1-inch headrace trash rack, which is composed of five individual trashrack units. A zoomed image of one trashrack unit is shown to the left of the trashrack. The illustration is not to scale (Source: Staff).

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To estimate approach velocity (V_0, feet per second [fps]), we used the following equation (EPRI, 2000):

$$V_0 = \frac{intake\ flow}{intake\ cross\text{-}sectional\ area}$$

where intake flow is in cfs and cross-sectional area is in square-feet. We used intake flows of 120 cfs and 450 cfs, which represent the minimum and maximum turbine hydraulic capacities, respectively. Total intake cross-sectional area is shown in table 9, and was estimated using the information shown in figures 3 and 4.

TABLE 9—CALCULATION OF INTAKE CROSS-SECTIONAL AREA FOR THE 2.25-INCH AND 1-INCH TRASHRACKS

[Source: Staff]

Spacing between bars (inches)	Spacing between bars (W; feet)	Height of space between bars (H; feet)	Open area between two bars (a; feet^2)	Number of open spaces between bars (n)	Total intake cross-sectional area (A; feet^2)
2.25	0.1875	13.4	W × H = 2.51	120	a × n = 301.2
1	0.08333333	13.4	W × H = 1.12	230	a × n = 257.6

Approach velocities did not differ substantially between the 2.25-inch and 1-inch trashracks, though they are slightly lower with the 2.25-inch trashrack. At the minimum hydraulic capacity, estimated approach velocities are 0.40 and 0.47 fps with 2.25-inch and 1-inch trashracks, respectively. At the maximum hydraulic capacity, estimated approach velocities are 1.49 and 1.75 fps with the 2.25-inch and 1-inch trashracks, respectively.

To evaluate the potential for impingement at the existing trashrack with 2.25-inch and with 1-inch bar spacings, we focused our analysis on redeye bass, flat bullhead, redbreast sunfish and highback chub—which represented a combination of both Conservation Species and the most common species occurring in the impoundment. The burst swimming speeds of these species and the minimum total lengths that are susceptible to impingement (based on estimated fish width alone and exclusive of burst swim speeds) are shown in tables 10 and 11, respectively.

Table 10. Burst swim speeds of four species found in the Riverdale impoundment.

Species	Surrogate Species[1]	Total length (inches)	Burst swim speed (fps, feet per second)
Redeye bass	Largemouth bass[2]	2-4	3.2
		5.9-10.6	4.3
Flat bullhead	Channel catfish[3]	6.3-8.3	1.3
Redbreast sunfish	Bluegill[2]	2	1.8
		4-6	2.4
		6	4.3
Highback chub	not applicable[4]	2	1.67
		3	2.5

[1] Burst swim speeds were not available for the species included in our analysis. Surrogate species used were fish in the same family and with similar body morphometry to the species included in our analysis.
[2] Source: Appalachian Power Company (2009)
[3] Source: Venn Beecham et al. (2007)
[4] Highback chub burst swim speeds are assumed to be equivalent to 10 lengths per second. Beamish (1978) considered 10 lengths per second to be a conservative measure of burst swim speed for fish.

TABLE 11—MINIMUM FISH TOTAL LENGTHS SUSCEPTIBLE TO IMPINGEMENT AT 1-INCH AND 2.25-INCH TRASHRACKS, BASED ON TRASHRACK BAR SPACING AND FISH WIDTH-AT-ENGTH RELATIONSHIP (I.E. WIDTH = $\alpha \times$ TOTAL LENGTH β) ALONE AND EXCLUSIVE OF BURST SWIM SPEEDS

Species	Surrogate species used in calculation[1]	Alpha (α)[2]	Beta (β)[3]	Maximum total length (inches)	Minimum fish total length (inches) susceptible to impingement:	
					1-inch trash rack spacing	2.25-inch trash rack spacing
Redeye bass	Smallmouth bass	0.10095	1.0394	17	9.1	none.[4]
Flat bullhead	Brown bullhead	0.19905	0.9919	11	5.1	none.[4]
Redbreast sunfish	Bluegill	0.1317	0.997	9	7.6	none.[4]
Highback chub	Fathead minnow	0.00077	2.1795	3	[4] none	none.[4]

[1] Length-width equations were not available for species included in our analysis. Surrogate species were fish in the same family and with similar body morphometry to the species included in our analysis.
[2 3] The alpha and beta parameters for equations are from Lawler, Matucky, and Skelly Engineers (1991).
[4] The calculated minimum total length susceptible to impingement is greater than the maximum total length of the species; therefore, no length of this species is susceptible to impingement at this trackrack spacing.

Fish are at risk of impingement if their burst swim speed (see table 9) is less than the approach velocity at the trashrack, and if their size prevents them from passing through the bar spacing on the trashrack (see table 10). The results of our analysis show that none of the species analyzed would be susceptible to impingement with a trashrack having 2.25-inch bar spacing (see figures in appendix A), because of their swimming abilities. However, larger flat bullhead (i.e. greater than 5.1 inches) would be susceptible to impingement with a trashrack having 1-inch bar spacing when intake flows approach the maximum turbine capacity of 450 cfs.

The risk of impingement would be greater for adult flat bullhead if Lockhart Power replaces the existing 2.25-inch bar spacing with Interior's recommended 1-inch bar spacing. The reduced porosity of the 1-inch bar spacing design would also lead to greater accumulation of debris compared to the 2.25-inch bar spacing design, which could lead to a greater risk of impingement than would occur with a design having 2.25-inch bar spacing. Routine maintenance of either trashrack would be required to ensure approach velocities do not increase. Greater maintenance would be required for the 1-inch bar spacing versus the 2.25-inch bar spacing.

Fish Entrainment and Turbine Mortality

Entrainment can occur if fish can pass between trashrack bars, and do not behaviorally avoid entrainment. Consequently, smaller (i.e. fish smaller than those susceptible to impingement [table 10]) redeye bass, flat bullhead, redbreast sunfish, and highback chub could each be entrained through both trashrack designs. Larger and older fish of each species would be protected by both trashrack designs; but, the 1-inch bar spacing would be more protective than the 2.25-inch bar spacing.

Even if fish are small enough to fit through trashrack bar spacing, generally they will behaviorally avoid entrainment if their burst swim speeds exceed approach velocities at trashracks. Based on our analysis, only highback chub and flat bullhead lack the burst swim speeds needed to overcome approach velocities and avoid entrainment through trashrack designs that have 1-inch and 2.25-inch bar spacing, respectively (see figures in appendix A). Small (i.e. 2-inch) highback chub are susceptible to entrainment with a trashrack that has 1-inch bar spacing when intake flows approach the maximum turbine capacity of 450 cfs. However, all sizes of flat bullhead are susceptible to entrainment with the existing trashrack that has 2.25-inch bar spacing when intake flows approach the maximum turbine capacity. As these results indicate, and as other studies have shown, the majority of fish entrained consists of small fish (EPRI, 1997). The survival of smaller individuals of both species is likely to be relatively high because they are less prone to mechanical injury from turbine passage than larger fish. Smaller fish are also less prone to injury resulting from shear stresses and rapid pressure changes associated with turbine passage. Combined, these results indicate that each trashrack design has the potential to entrain one species; however, turbine mortality is expected to be similarly low for both designs.

Lockhart Power's desktop fish entrainment and turbine mortality analysis considered information from published literature [50] to estimate fish entrainment rates and turbine mortality rates, and to characterize the anticipated composition of fish entrained and killed at the project. Results of the analysis indicate that on average, about 48,271 fish could potentially pass through the turbines on an annual basis, and of those, 5,412 fish could potentially be killed by the turbine. Sunfish had the highest estimated entrainment and turbine mortality, which represented 38 percent (18,346) and nearly 36 percent (1,941) of all fish entrained and killed, respectively.

Lockhart Power's analysis did not include Conservation Species due to the absence of data on redeye bass and flat bullhead. However, the analysis did include species in the redeye bass genus (i.e. *Micropterus;* black bass) and the flat bullhead family (i.e. *Ictaluridae;* catfish). Annual entrainment estimates for black bass represented only 1.6 percent (804) and 3.4 percent (182) of the total fish entrained and killed, respectively. Estimates for catfish were higher, and represented 22.1 percent (10,645) and 11.0 percent (593) of the total fish entrained and killed, respectively.

Although Lockhart Power's analysis did not provide details on the size or age-class of redeye bass or flat bullhead entrained, based on other studies, it is likely that most entrained fish would consist of smaller fish—primarily young-of-the-year (EPRI, 1997). These younger individuals in the population generally have high rates of mortality, even in the absence of hydropower operations. Fish populations have generally evolved to withstand losses of these smaller and younger individuals with little or no impact to long-term population sustainability. Thus, any turbine mortality of redeye bass and flat bullhead is likely to have minimal effect on their respective populations.

3.3.3 Terrestrial Resources

3.3.3.1 Affected Environment Vegetation

The Riverdale Project is situated at the northern edge of what is considered the Piedmont ecoregion. This region is characterized by gently rolling hills and stream-cut valleys with elevations that range from 375 feet to 1,000 feet msl. Historically, plant communities in the region consisted of oak and hickory-dominated forests, with associated species varying by slope and soil moisture. The landscape in the Piedmont ecoregion has a long history of forest clearing, intensive agriculture, and other economic uses that date back to the earliest European settlements. Today, the Piedmont landscape is predominantly a mosaic of agricultural land and managed pine and mixed pine-hardwood woodlands, with hardwood-dominated forests limited primarily to narrow floodplains and scattered upland sites.

The project area and immediate project vicinity include a mix of managed areas and natural communities. The rural community of Enoree surrounds the project, with its lawns, hedgerows and limited commercial development representing the primary managed areas. Extensive agricultural lands, including managed hay fields, pastures, row croplands and pine plantations, occur in the uplands surrounding the community of Enoree and the project. The majority of farmland in the Enoree River Basin is dedicated to pasture and hay fields. This cover type commonly includes early successional species such as daisy fleabane, horse nettle, sunflower, pokeweed, and spiny amaranth.

Forested uplands in the project vicinity are characterized primarily by managed pine plantation and mixed hardwood-pine stands. Mature stands tend to consist of a diverse assemblage of hardwoods, primarily oaks and hickories, as co-dominants in combination with pines. Common pine species of the piedmont include shortleaf and loblolly, with the former better adapted to dry, fine textured upland soils and loblolly achieving maximum growth on deep soils with good moisture and drainage. The understory in pure pine stands is often open, but in mixed or older stands, it is dominated by the hardwoods characteristic of the site.

The areas immediately adjacent to the project impoundment and along the Enoree River downstream from the dam are characterized by heavily vegetated, primarily forested shorelines. Forested shorelines of the impoundment and downstream from the dam are typical of hardwood-dominated streamside forests that characterize the Piedmont. The typical canopy species in these forests is a mixture of bottomland and mesophytic trees including river birch, sycamore, sweetgum, tulip tree, American elm, hackberry, green ash, and red maple. Sites farther upslope on

[50] The database is based on specific entrainment studies conducted at FERC licensed projects that are similar to the Riverdale Project in geographic location, hydraulic capacity, operation, fish species, and water quality (Lockhart Power, 2010c).

protected bluffs and ravines are more characteristic of the cove forests typical of the region. The canopy and understory on such sites is typically composed of hardwoods including beech, tulip tree, black gum, sourwood, white oak, northern red oak, black oak, sweetgum, red maple, southern sugar maple, basswood, ironwood, flowering dogwood, American holly, witch-hazel, and hop-hornbeam. Because this habitat has a closed canopy, the likely substory consists of the more shade tolerant species including young beech and maples. Poison ivy, Virginia creeper, and wood sage are typical of the remaining shrubby stratum. Along the riverbank, shade intolerant species such as sumac, tree-of-heaven, daisy fleabane, and blackberry are likely common.

Wetlands

Wetlands are common in the Piedmont ecoregion as a whole, although they are much less abundant than in the low lying Coastal Plain region. Wetlands coverage in the Piedmont is overwhelmingly dominated by palustrine forests, otherwise known as floodplain or bottomland hardwoods, which are estimated to account for approximately 80 percent (i.e. 1 million acres) of wetlands in the region. Bottomland/floodplain forests generally occur as narrow corridors along the region's rivers and streams due to the prevailing moderate topography. Bottomland/floodplain forests are also the dominant wetlands type in the immediate vicinity of the Riverdale Project. They are characterized by moist alluvial soils and are dominated by hardwood species such as sweetgum, loblolly pine, water oak, willow oak, laurel oak, cherrybark oak, and American holly.

National Wetlands Inventory (NWI) data for the project area indicate a lack of wetlands in the area immediately surrounding the impoundment and adjacent to the Enoree River immediately downstream from the dam. However, a number of bottomland/floodplain (palustrine forested) wetlands are located along the river's floodplain upstream of the dam. These are located well upstream of the influence of the project impoundment, adjacent to a free flowing reach of the river, and thus would not be affected by the project.

Riparian areas surrounding the project impoundment and the river downstream from the dam are relatively narrow due to the moderately sloped banks. The well vegetated banks are characterized by abundant willows and alders in areas directly abutting and overhanging the water, with upslope areas containing a mix of bottomland and mesophytic trees typical of the Piedmont including river birch, sycamore, sweetgum, tulip tree, American elm, hackberry, green ash, and red maple.

Non-Native Invasive Vegetation

In the Piedmont ecoregion, invasive plant populations are often present within the forested communities. Data from the Forest Inventory Analysis, collected by the U.S. Forest Service, indicates that almost three quarters of sampled plots within the Piedmont ecoregion contain at least one exotic (non-native) plant. The South Carolina Exotic Pest Plant Council (South Carolina EPPC) identifies the following terrestrial exotic invasive plants as severe threats to the composition, structure, or function of natural areas in the state of South Carolina: tree-of-heaven, chinaberry, princess tree/royal paulownia, Chinese tallow, scotch broom, thorny-olive, autumn-olive, shrub lespedeza, Japanese privet, Chinese privet, kudzu, English ivy, Japanese climbing fern, Japanese honeysuckle, Cherokee rose, Chinese wisteria, bigleaf periwinkle, tall fescue, cogongrass, Japanese stilt grass, bahia grass, common reed/phragmites, Chinese bush clover, marsh dewflower, and tropical soda apple.

As noted above, tree-of-heaven is among the species that are likely common in the riparian area in the vicinity of the project. Tree-of-heaven is a non-native invasive deciduous tree native to central China that has spread throughout the United States in natural, agricultural, and developed areas. Tree-of-heaven is a severe ecological threat because it is fast-growing, reproduces prolifically from both seeds [51] and vegetatively from suckers and sprouts from cut stumps, and releases chemicals into the soil that inhibit growth of other plants. In addition, the root system of this species can cause structural damage to concrete structures such as sewers and foundations (Swearingen and Pannill, 2009).

Kudzu is a terrestrial non-native invasive species known to occur within Spartanburg County at troublesome levels. The county has concerns regarding the effect of over 1,000 acres of kudzu infestation on beautification efforts in the urban areas of Spartanburg. Kudzu is a climbing, semi-woody, perennial vine native to Asia that was introduced to the United States for erosion control and is now found throughout most of the Southeast. Although kudzu grows best in disturbed areas such as forest edges, abandoned fields, and along roads and trails, this species thrives in a wide range of conditions. Kudzu is a severe ecological threat because it grows rapidly—at a rate of approximately one foot daily—and it can envelope and eventually kill other plants by shading them out, breaking limbs, and even uprooting trees under the weight of its blanket of tangled vines (Bergmann and Swearingen, 2005).

Aquatic non-native plant species also occur throughout South Carolina. South Carolina DNR's Aquatic Nuisance Species Program maintains a list of aquatic plant species currently listed as illegal to possess, import, or distribute in South Carolina. Examples of invasive exotic aquatic plants on this list include alligatorweed, common reed/phragmites, Eurasian watermilfoil, hydrilla, and water hyacinth (South Carolina DNR, 2010). Where these plants occur, they can obstruct navigable waterways, restrict water flow, degrade water quality, interfere with recreation, and alter fish populations. South Carolina DNR has identified water bodies throughout the state, including two within Spartanburg or Laurens counties, as 'problem areas,' or areas where aquatic plants interfere with water uses. These areas and associated aquatic plants include hydrilla, slender naiad, and water primrose at Lake Greenwood; and water primrose and hydrilla at Lake Edwin Johnson (South Carolina DNR, 2012), both of which are located within about 30 miles from the project area.

The extensive beds of aquatic vegetation observed in the project impoundment are a mixture of a native smartweed species and alligatorweed, an invasive non-native species. Alligatorweed, an emergent perennial plant, is native to South America (USDA, 2013) and it is listed as a noxious weed in South Carolina. This species can grow in upland sites, but it prefers saturated soils along shorelines of lakes, ponds, streams, ditches, and wetlands. It spreads vegetatively from fragments and by seeds that can be dispersed by water, wildlife, and people. Alligatorweed forms dense mats that grow into open water habitats, shading out native plant species and reducing DO in the water under the mat which, in turn, decreases the quality of the habitat for fish and wildlife. Mats of alligatorweed can also inhibit navigation and recreational use (Madsen).

Wildlife

Wildlife habitats within the Lockhart Power's proposed 25.9-acre project area

[51] While only the female trees produce seeds, a single tree can produce 325,000 seeds annually.

are typical of the Piedmont region of South Carolina. Of the 25.9 acres, there are 11.3 acres of terrestrial habitat. The shoreline area is predominately undeveloped riparian and upland forests. Mixed hardwood forest is the dominant terrestrial habitat type along the edge of the project boundary. This habitat type is characterized by a high degree of structure, including both vertical complexity (height class diversity of vegetation) and microhabitat features such as snags, dead-and-down wood, and forest floors consisting of leaves and woody debris. The mixed hardwood forest cover type typically contains a high density of small mammals. This may be attributable to the fact that these areas produce substantial amounts of mast (seeds and nuts) that provide valuable forage habitat for a variety of wildlife species. Other wildlife species potentially using these areas include white-tailed deer, raccoon, fox, wild turkey, grouse, blue jay, ovenbird, red-bellied woodpecker, hairy woodpecker, eastern king snake, black racer, black rat snake, copperhead, and timber rattlesnake.

The aquatic and semi-aquatic habitats of the 6.6-acre project headpond and upstream and downstream river reaches also provide wildlife habitat in the project area. Wildlife species that potentially use open water and semi-aquatic areas of the impoundments and the lower tailrace and bypassed reach include beaver, muskrat, otter, mink, belted kingfisher, wood duck, great blue heron, green heron, great egret, redbellied water snake, bullfrog, leopard frog, yellowbelly slider turtle, and common snapping turtle. Species typical of river margins include raccoon, woodcock, red-winged blackbird, various thrushes, green treefrog and American toad.

Special Status Terrestrial Species

There is one terrestrial species documented as occurring in Laurens County that is a candidate for federal listing under the ESA. Georgia aster (*Symphyotrichum georgianum*) is a perennial herbaceous plant that forms clonal clumps and can spread through modified stems called rhizomes (NatureServe, 2013a). Adequate sunlight appears to be one of the most important factors in the success of this species. Historically this species was found in post oak savanna and prairie communities in the Southeast. This habitat type has dwindled since wildfires have been suppressed and large native grazers are no longer present to maintain it. While there are small isolated populations surviving in areas of Alabama, Georgia, North Carolina, and South Carolina that are maintained in an open, early successional stage such as roadway, railroad, and transmission line rights-of-way (ROW), the species is still threatened by residential development, highway expansion/improvement projects, encroachment of non-native invasive plants, deer browsing, herbicide use, and by woody succession due to wildfire suppression that historically maintained its open grassland habitat (FWS, 2012).[52]

3.3.3.2 Environmental Effects

Currently the project is inoperable and all available flows pass through the impoundment, over the Riverdale dam, and into the shoals and braided channels within the bypassed reach. The plants and wildlife in the riparian corridor along the impoundment and downstream from the dam have adapted to the natural variation in stream flows.

Effects of Project Refurbishment and Vegetation Maintenance

Refurbishing the project facilities, developing the canoe portage facilities, and maintaining these areas would require clearing or trimming of some vegetation. Heavy equipment and activities associated with the replacement of the 193-foot-long above ground section of the penstock and repairs to the powerhouse, dam, and other project facilities would disturb wildlife near the construction areas. Disturbance to plants and wildlife would also occur during periodic vegetation maintenance, including mowing and/or trimming, around the perimeter of the existing powerhouse and along the transmission line ROW which follows the access road, as well as the area within the proposed portage trail, canoe take-out and put-in, and parking area for recreation.

In order to preserve the vegetative communities within the project boundary, Lockhart Power proposes to consult with state and federal resource agencies on the implementation of BMPs during project refurbishment and maintenance activities. Lockhart Power would minimize effects to terrestrial resources by limiting ground-disturbing activities and disturbance of riparian vegetation whenever possible on lands acquired for project purposes.

South Carolina DNR supports the applicant's proposal to consult with state and federal agencies on the implementation of BMPs during all construction and maintenance activities to preserve the vegetative communities within the project boundary. FWS recommends that the applicant avoid and minimize any adverse impacts to fish, wildlife, shoreline vegetation, and other natural resources while conducting construction and maintenance activities.

Our Analysis

The majority of disturbances to vegetation and wildlife related to Lockhart Power's project refurbishment activities and installation of the proposed recreation area would be temporary, minor, and confined to approximately 2 acres of previously disturbed habitats within the footprint of the former textile mill and associated parking lots and roadways. The noise and movement of equipment and materials associated with replacing the 193-foot-long portion of the penstock could disturb wildlife, especially small species with confined home ranges or limited mobility. However, this portion of the penstock is above ground so the disturbances would be temporary and would not change the character of the surrounding habitat. Most wildlife would likely leave the immediate project area and return when construction and repairs are complete.

Periodic mowing along the existing paved access road and trimming of tree limbs and underbrush along the proposed canoe portage trail are necessary to maintain access to the proposed project facilities. Given that the existing project transmission line is adjacent to the access road, periodic mowing would be limited and would not affect any unique terrestrial habitat or change the character of the vegetation within the ROW corridor. The proposed canoe portage is within an existing (non-project) transmission line ROW. Consequently, trimming trees and underbrush to maintain recreation access would cause little incremental disturbance to plants or wildlife.

Implementing BMPs during project refurbishment, recreation area installation, and periodic vegetation maintenance activities would minimize potential disturbances to vegetation and wildlife. BMPs to preserve terrestrial habitats could include, but not be limited to, minimizing disturbances to existing vegetation, maintaining a riparian buffer on project shorelines, and cleaning construction and maintenance equipment before and after use to prevent the transport of seeds and fragments of invasive non-native vegetation to new (uninfested) areas.

Effects of Invasive Non-Native Plants

Alligatorweed is a prolific non-native plant and a South Carolina noxious weed that has become established in the

[52] 77 FR 69,994, 70,047 (Nov. 21, 2012).

project impoundment. Alligatorweed competes with native riparian and aquatic species, reducing the quality of fish and wildlife habitat where it becomes established. Large mats of alligatorweed can impede boating and access to the shore. These mats could become fragmented and spread during in-water construction activities, such as during the canoe take-out and mechanical removal of sediment from the impoundment. Fluctuations in the impoundment levels and periodic sediment management activities may also create conditions facilitating its spread.

Lockhart Power does not propose any specific measures to control existing mats of alligatorweed and does not anticipate that project refurbishment would affect the distribution of this species within the project boundary (Lockhart Power, 2011b).

Lockhart Power also states that alligatorweed was not observed growing on the southern shore of the impoundment at the proposed canoe take-out (Lockhart Power, 2012). Similarly, Lockhart Power does not propose any specific measures to control alligatorweed in the impoundment during operation, mainly because it does not anticipate that this species would interfere with project operations. Rather, Lockhart Power states that proposed project operation could aid in controlling this species through periodic dewatering (i.e. drawdowns) and potential exposure to freezing temperatures during the winter months.

No one recommended measures to control alligatorweed.

Our Analysis

Extensive mats of alligatorweed have become established in the project impoundment. Although alligatorweed was not present in areas that would be disturbed during project refurbishment or at the canoe put-in and take-outs in 2010 when Lockhart Power examined the impoundment, it may have spread into these areas. Construction activities could facilitate their spread in the impoundment and downstream from the project. A survey of the impoundment prior to beginning construction repairs and developing the canoe portages would determine if specific BMPs should be taken to prevent its spread. Any such BMPs could be developed in consultation with FWS and South Carolina DNR based on the survey results.

Once operational, flow fluctuations from peaking operations may help control the spread of alligatorweed as Lockhart Power suggests. However, daily impoundment fluctuations of 1 to 4 feet can also stress existing riparian communities, causing some of the existing riparian vegetation to die and exposing shorelines to erosion and colonization of non-native invasive plants. Periodic monitoring of invasive species in the impoundment would facilitate early detection of new invasive plant introductions, as well as the spread of invasive species, including the existing mats of alligatorweed. Monitoring would also allow Lockhart Power, the resource agencies, and the Commission to determine when, and if, correction measures may be needed to protect native plant communities and the wildlife that depend on them.

To be effective, the monitoring program should define the monitoring schedule, include a means to document changes in invasive species composition and distribution between monitoring events, and include criteria that would determine when corrective actions may be required.

Avian Electrocution Hazards

Birds in the project area may have become accustomed to using the transmission lines and poles for perching or nesting. Transmission lines can represent an electrocution hazard to roosting and perching birds if the spacing between the conductors and ground wires is narrower than the bird's wingspan, or when they use poles for nesting.

Lockhart Power proposes to use the existing transmission line which extends from the powerhouse along the project access road to an existing Duke Energy distribution line to deliver power to the grid. However, the current condition of the project transmission line is unknown. Lockhart Power also did not provide any description of the design of the transmission lines to determine if the line could represent an electrocution hazard.

Lockhart Power did not propose and no one recommended any measures to address these potential hazards.

Our Analysis

APLIC, a consortium of utilities, and FWS developed guidelines for design of electrical lines to minimize potential for electrocutions (APLIC, 2006). The APLIC guidelines define applicable separation distances for energized conductors and groundwires. The guidelines also describe measures to deter perching and/or nesting depending on transmission line pole designs.

As part of project refurbishment, Lockhart Power would need to determine the condition of the existing line as well as any repairs that may be necessary to transmit power. While conducting this initial inspection of the transmission line, Lockhart Power could concurrently evaluate whether the transmission line was built in accordance with the APLIC guidelines and look for evidence of bird nesting on the poles. Depending on the design, corrective measures may be needed to minimize electrocution hazards, which could include monitoring or the installation of insulation, line marking devices, and structures to discourage perching and/or nesting (i.e. for poles where other protection measures cannot be used). However the extent or need for such measures cannot be determined until the evaluation is complete.

Effects of Flow Fluctuations on Plants and Wildlife

Lockhart Power's proposal to resume hydroelectric operations with 1 to 4-foot fluctuations in the impoundment would affect some of the terrestrial, riparian, and littoral habitats. Impoundment fluctuations can affect the distribution, species composition, and productivity of riparian and littoral habitat. In general, hydroelectric impoundments with extreme long or short-term fluctuation in water surface elevations exhibit reduced plant species diversity, reduced plant productivity, and a proliferation of exotic species (Stanford *et al.,* 1996), and provide less value for wildlife, especially for breeding waterfowl and hibernating reptiles and amphibians (Nilsson and Berggren, 2000).

To address the potential effects of project operation and maintenance on terrestrial resources, Lockhart Power proposes to maintain a 25-foot-wide forested riparian buffer around the project impoundment, as well as the tailrace and bypassed reach downstream from the dam, as long as this does not interfere with Lockhart Power's ability to perform project-related activities. In order to preserve natural conditions, Lockhart Power would also minimize ground-disturbing activities and disturbance of riparian vegetation whenever possible on acquired lands. Lockhart Power would consult with the South Carolina DNR in the event that it needed to make exceptions to these environmental protection measures.

South Carolina DNR and Interior support Lockhart Power's proposal to establish and maintain a 25-foot riparian buffer on all shorelines within the project boundary and to avoid and/or minimize disturbances and adverse impacts to soils, vegetation, wildlife, and other natural resources. Interior also recommended measures to address

existing and potential project-induced erosion on project shorelines, as discussed in section 3.3.1, *Geologic and Soil Resources.*

Our Analysis

Lockhart Power states that its proposed project operation would only affect those areas within the natural banks of the Enoree River, and, thus, would have no effect on terrestrial resources (Lockhart Power, 2011b). However the 2-foot-tall flashboards were washed out during a storm event in late 2009. The flashboards were subsequently replaced, but were damaged again in 2012 and 2013 by floodwaters, floating logs, and tree stumps (FERC, 2013). Therefore the existing full pool condition is two feet lower than Lockhart Power's proposed full pool condition and vegetation has had over 3 years to colonize the exposed shoreline. The results of Lockhart Power's Headpond Fluctuation Study conducted in 2010, indicate that the width of the littoral zone and the associated riparian vegetation along the impoundment has increased since the flashboards were washed out. Once Lockhart Power reinstalls/repairs the flashboards and resumes project operation, a portion of the riparian zone would be inundated again potentially submerging existing vegetation. Riparian plant communities are made up of species adapted to varying degrees of water level fluctuations. Water level fluctuations associated with project operation could lead to changes in species composition and distribution in the riparian zone.

Lockhart Power's proposal to minimize ground-disturbing activities and disturbance of riparian vegetation whenever possible on acquired lands would ensure that effects to terrestrial resources during project operations and maintenance would be minor and temporary. Maintaining a 25-foot-wide forested buffer around the impoundment, the tailrace, and bypassed reach downstream from the dam would minimize the effects of flow fluctuations during project operation by minimizing soil erosion, filtering pollutants and slowing runoff from impermeable surfaces in the project area. The buffer would also preserve a movement corridor for wildlife. Lockhart Power's proposal to consult with South Carolina DNR regarding any exceptions on its proposed terrestrial resource protection measures would provide a mechanism to address future unforeseen actions that could adversely affect riparian vegetation and the wildlife it supports. Limiting disturbances to soils and vegetation, maintaining a 25-foot riparian buffer, and using the shoreline stabilization methods described in section 3.3.1, *Geologic and Soil Resources,* would further reduce the potential for invasive plant establishment and protect native plants and wildlife.

Effects of Project Repairs, Construction, Operation, and Maintenance on Special Status Terrestrial Species

Georgia aster is not known to occur within the project boundary and there is limited potential habitat for this species in the project area. No measures were proposed or recommended to protect this species.

Our Analysis

Because the majority of the project area is dominated by mature riparian hardwood forest and Lockhart Power proposes to minimize disturbances to existing vegetation wherever possible, it is unlikely that Georgia aster would become established in the project area. Therefore the proposed project repairs, operation, and maintenance are not expected to affect Georgia aster.

3.3.4 Threatened and Endangered Species

3.3.4.1 Affected Environment

Three federally listed terrestrial species and one aquatic species are known to or potentially occur in Spartanburg or Laurens Counties, South Carolina and could potentially occur within the project area.

Aquatic Species

FWS lists the federally endangered Carolina heelsplitter mussel (*Lasmigona decorate*) as potentially occurring in Laurens County. Endemic to South Carolina and North Carolina, the historic range of this species is not known, although current data suggest it was relatively widespread in the Pee Dee and Catawba river systems in North Carolina and the Pee Dee, Savannah and Saluda systems in South Carolina. Current distribution in South Carolina is limited to generally small populations in the Lynches River (Pee Dee River system), tributaries to the Savannah River, a tributary to the Saluda River, and one location in the Catawba River Basin. Carolina heelsplitter is usually found on mud, muddy sand, or muddy gravel substrates in cool, slow-moving, small to medium-sized streams or rivers along well-shaded streambanks. Stable streambanks and channels, with pool, riffle and run sequences, little or no fine sediment, and periodic natural flooding, appear to be required for the Carolina heelsplitter. The stability of the stream banks appears to be a very important factor in the habitat.

South Carolina DNR spatial distribution data for threatened and endangered species indicate no known occurrences of Carolina heelsplitter in Laurens or Spartanburg Counties. Further, freshwater gastropods surveys conducted in the project area in support of relicensing found no live, dead, or shell fragments of Carolina heelsplitter; this species was one of the primary target species of the survey effort.

Terrestrial Species

One federally listed plant species, the dwarf-flowered heartleaf (*Hexastylis naniflora*), is known to occur in Spartanburg County. Dwarf-flowered heartleaf is a terrestrial plant species that typically occurs on bluffs and in ravines in deciduous forests with acidic sandy loam soils, often in association with mountain laurel. A search of the South Carolina Heritage Trust Geographic Database of Rare and Endangered Species revealed no occurrences of dwarf-flowered heartleaf in the Enoree Quad, where the project would be located. Further, field surveys of sites containing the Pacolet, Madison, or Musella soil types required by this species, conducted in support of licensing as part of the Rare, Threatened and Endangered Species Assessment, found no occurrences of the species within the project area.

The red-cockaded woodpecker (*Picoides borealis*) is listed as endangered at both the state and federal level and is known to occur in Laurens County. The red-cockaded woodpecker is endemic to open, mature, and old growth pine ecosystems in the southeastern United States. Over 97 percent of the pre-colonial era red-cockaded woodpecker population has been eradicated, leaving only roughly 14,000 red-cockaded woodpeckers living in about 5,600 colonies scattered across eleven states, including South Carolina. Red-cockaded woodpecker decline is generally attributed to a loss of suitable nesting and foraging habitats, including longleaf pine systems, due to logging, agriculture, fire suppression, and other factors. Suitable nesting habitat generally consists of open pine forests and savannahs with large, older pines and minimal hardwood midstory or overstory. Living trees, especially older trees that are susceptible to red-heart disease making them more easily excavated, provide red-cockaded woodpecker's preferred nesting cavities. Suitable foraging habitat consists of open-canopy, mature pine forests with low densities of small pines, little midstory vegetation, limited hardwood

overstory, and abundant bunchgrass and forb groundcover.

The expansive old-growth pine forests required by this species do not occur in the areas surrounding the project. Further, South Carolina DNR spatial distribution data indicate no documented occurrences of red-cockaded woodpecker in Laurens and Spartanburg Counties, suggesting that the ''known'' status listed by FWS for Laurens County may potentially be related to historical records of this species. Terrestrial areas within the project area were examined for presence of the mature longleaf pine forest required by red-cockaded woodpeckers as part of the Rare, Threatened and Endangered Species Assessment. No such habitat was documented.

3.3.4.2 Environmental Effects

Our Analysis

No federally listed species are known to occur within the project area. Suitable habitat for the red-cockaded woodpecker does not occur in the area. Therefore, refurbishment, operation, and maintenance of the proposed project would have no effect on the endangered Carolina heelsplitter mussel, the threatened dwarf-flowered heartleaf, or the endangered red-cockaded woodpecker.

3.3.5 Recreation and Land Use

3.3.5.1 Affected Environment

Recreation

Statewide Recreation Plan

The 2008 South Carolina State Comprehensive Outdoor Recreation Plan (SCORP) guides recreation planning and development in the state. The plan has no specific recommendations for the project area; however, it does identify major goals for recreation within the state. These goals include: Providing a balanced and comprehensive system of public and private recreation opportunities; conserving and interpreting significant historic, cultural, and natural areas; and encouraging cooperation between various agencies, levels of government, private enterprise, and volunteers to meet the state's recreation needs. The SCORP also identifies issues associated with recreation supply and demand in the state. The plan indicates there is a demand for additional trail development for walking, boating, and equestrian use; additional education and outreach relating to outdoor recreation opportunities; and development of, or improvements to, recreation access for various user groups including the elderly and disabled (South Carolina DPRT, 2008).

Regional Recreation Resources

Spartanburg and Laurens counties are regionally-important destinations for outdoor recreation activities such as fishing, hiking and sightseeing. The region is home to several state parks, recreation areas and historic sites. Recreation lands account for over 28,000 acres in the region and provide opportunities for hiking, camping, fishing, motorized- and non-motorized boating, horseback riding, picnicking, and wildlife viewing.

The South Carolina Rivers Assessment (1988) identifies several high-value recreation areas on the Enoree River. A four-mile reach of the Enoree, upstream of the project, from State Route 14 in Pelham to State Route 296 is identified as regionally significant for whitewater boating, which American Whitewater (2009) identifies as having Class II and III rapids under normal flow conditions. Downstream from the project, from RM 42 to the confluence with the Broad River, the Enoree River is designated as both a regionally-significant flatwater boating river and as a back-country boating river of statewide significance. The entire Enoree River from its headwaters to the confluence with the Broad River is categorized as a recreational fishing river of regional or local significance (South Carolina WRC and NPS, 1988).

Formal recreational boating opportunities are provided on the Enoree River Canoe Trail, which begins approximately 16 miles downstream from the project, at the western border of the Sumter National Forest's Enoree Ranger district (RM 36). The trail continues through the National Forest to the Enoree River's confluence with the Broad River. Six hand-carry boat ramps provide access to the canoe trail for non-motorized boaters. The canoe trail is characterized by steep hardwood bluffs, bottomland forests, and small marshy areas. In the early spring, high flows make the river unsafe for flatwater recreational boating. In the late spring and fall, fast-moving flatwater conditions are best for experienced paddlers. Summer flows, particularly during drought conditions, are generally too low for recreational boating (U.S. Forest Service, 2010). The South Carolina Trails Plan (2002) identifies 45 miles of Enoree River in Spartanburg County and 5 miles of the river in Union County for future development as a canoe trail.

Recreation in the Project Vicinity

In the vicinity of the project, boating on the Enoree River is limited by a lack of developed boating access and boat ramps. The shallow nature of some sections of the river, which typically ranges in depth from 2 to 6 feet, limits boating access to canoes and flat-bottomed boats of less than 14 feet in length (U.S. Forest Service, 2010). Non-motorized boaters typically access the river at informal locations like bridge crossings or dams. There are no formal portage facilities on the stretch of river near the proposed project, and small dams, such as the Riverdale dam, impede navigation.

Angling activities near the proposed project occur primarily from shore and are concentrated in tributaries and below the Pelham and Riverdale dams. Largemouth bass, crappie, channel catfish, yellow perch, bluegill, gizzard shad, redear sunfish, and redbreast sunfish are the primary game fish expected in the Enoree River (see section 3.3.2, *Aquatic Resources*). There is no fish consumption advisory for the Enoree River in the vicinity of the project.

Recreation at the Proposed Project

There are no formal recreation facilities located at the project. Under Inman Mill's license, the project was exempt from filing the Licensed Hydropower Development Recreation Report (FERC Form 80) because of the lack of recreation facilities and potential for recreation use.[53] However, members of the public periodically use the impoundment for fishing, as evidenced by the presence of discarded bait containers, fishing line, and other debris.

Land Use

The project is located on the Enoree River, which comprises the border between Laurens and Spartanburg counties, South Carolina. The project is located within the Enoree River subwatershed, which extends from the confluence of Beaverdam Creek, immediately upstream of the project impoundment at RM 52, to Duncan Creek south of the town of Whitmire at RM 20. Lands in the subwatershed are typically undeveloped, with forest lands comprising 61.6 percent of the watershed and agricultural lands comprising an additional 26.7 percent. Major agricultural uses include hay pastures and crops such as peaches, soybeans, and grain corn. Other land uses within the watershed are urban/

[53] *See* FERC issuance of March 16, 1998 for the Riverdale Project No. 4362.

developed lands (5.8 percent), wetlands (4.5 percent), and barren lands (1.8 percent).

The most intensive land uses in the project vicinity occur in the town of Enoree, located north of the project in Spartanburg County, and the town of Lanford, to the south of the project in Laurens County. These areas are characterized primarily by residential, commercial, and industrial development. Both counties regulate private land development through planning and zoning measures.

The project boundary encloses approximately 25.9 acres, of which 11.3 acres are land. The remainder is occupied by the waters of the impoundment, bypassed reach, and tailrace. Aerial photos indicate that within the project boundary, the predominant land cover is forest. The bypassed reach of the Enoree River is characterized by bedrock, granite dome, and cobble overlaid with sand bars, which create a series of riffles and pools. Limited industrial use, including the project's powerhouse and disturbed areas formerly occupied by Inman Mills, is also present along the northern shoreline of the project. For more information about ground cover and wildlife habitat within the project boundary, see sections 3.3.1, *Geologic and Soil Resources* and 3.3.3, *Terrestrial Resources.*

There are no lands in the immediate vicinity of the project that are included in the national trails system or designated as wilderness lands. No portion of the Enoree River is included on the list of wild and scenic rivers; however, the reach of the Enoree River from RM 0 to RM 98 is listed on the Nationwide Rivers Inventory (NRI) for its outstanding values in scenery, recreation, geology, fish, wildlife, history, and cultural significance. The NRI, which was created in 1982 and amended in 1993, identifies river segments in the United States that are believed to possess one or more ''outstandingly remarkable'' natural or cultural values judged to be of more than local or regional significance (NPS, 2011).

3.3.5.2 Environmental Effects

Recreation Enhancements and Public Access

Lockhart Power proposes to construct and maintain a 1,650 foot-long portage trail around the dam, a parking area adjacent to the portage trail, a canoe take-out located approximately 220 feet upstream of the dam, and a canoe put-in located approximately 1,075 feet downstream from the dam. Signage would be posted at both the canoe take-out and put-in denoting their purpose. Directional signage would be used along the portage trail to indicate the locations of the take-out and put-in. Lockhart Power also proposes to provide informal public access for fishing at the project, including at the impoundment, tailrace, and bypass reach.

All proposed recreation facilities would be located within the project boundary. The proposed portage trail and parking area would be located entirely on lands owned by the Woodruff Roebuck Water District. The trail would follow two separate transmission line ROW, owned and maintained by Duke Energy, that cross the Water District's property. Lockhart Power has proposed to operate and maintain the recreation facilities through an agreement with the Water District. FWS, South Carolina DNR, and American Rivers concur with the proposed recreation measures.

Our Analysis

Lockhart Power's proposed recreation enhancement measures, including the canoe take-out, put-in, and portage trail would address the need for canoe trail development in the region, as identified by the South Carolina State Trails Plan (2002) and South Carolina SCORP (2008). The addition of a formal portage trail along with signs identifying the canoe take-out and put-in would improve access to the outdoors and enhance the quality of the recreation experience on the Enoree River. Signage and parking would improve accessibility and provide information about recreation opportunities at the site.

Increased recreation use induced by the proposed recreation features may negatively affect wildlife and aquatic habitat at the project. However, by formalizing recreation access, Lockhart Power would have more opportunities to manage the effects of recreation on sensitive areas. For example, although the portage trail may bring additional recreation use to the area, it would also protect terrestrial resources from the effects of informal portaging that may already be occurring. The shoals in the bypassed reach, a unique habitat on the Enoree River, would be protected by guiding users to a developed put-in, rather than dispersing access along the reach. The spread of non-native invasive terrestrial plant species, such as Japanese stilt grass, would be minimized by restricting foot traffic to the maintained transmission line ROW.

Lockhart Power expects that the public would continue informal use of the impoundment and areas downstream from the dam for fishing or sightseeing. Signage indicating standard safety measures, as required as part of any Commission-issued license, would ensure that public access would not compromise project operations, safety, or security. Additional signage referring to ''pack-it-in, pack-it-out'' garbage disposal at the parking area, as well as the canoe take-out and put-in, could limit negative effects of public use on the surrounding environment. The Licensed Hydropower Development Recreation Report (Form 80—filed every 6 years) would allow Lockhart Power to assess recreation use at the project and determine if additional measures would be needed to address future recreation use.

Effects of Project Operation and Flows on Recreation

Project operation has the potential to affect recreational boating at the project. Lockhart Power proposes to operate the project in ROR mode with daily peaking, as well as maintain continuous minimum flows of 50 cfs in the bypassed reach during project operations. See section 2.2.1, *Proposed Project Operation,* for a more detailed description of Lockhart Power's proposal. Interior and South Carolina DNR recommend Lockhart Power provide minimum flows to the bypassed reach that are consistent with the Water Plan. American Rivers recommends seasonally-adjusted, continuous instream flows for the bypassed reach. The minimum flows recommended by Interior, South Carolina DNR, and American Rivers are higher than those recommended by Lockhart Power.

Our Analysis

The proposed canoe put-in, which would be located downstream from the dam on the shore of the bypassed reach, may be unusable under low-flow conditions. In situations where the canoe launch is unusable, boaters would be required to portage to an area farther downstream past the confluence of the Enoree River and the project tailrace. Informal portaging could affect wildlife habitat or increase the spread of invasive plant species.

Higher minimum flows in the bypassed reach, as recommended by Interior, South Carolina DNR, and American Rivers would provide greater latitude for boat launching in the bypassed reach. However, the effect of diverting flows from the bypassed reach is unlikely to be significant because during summer months or in drought conditions, much of the Enoree River is too shallow for recreational boating, independent of project operations.

Spring and fall are the primary boating seasons on the Enoree, and during those periods flows through the project would be sufficient for use of the proposed portage trail and canoe put-in.

Flow fluctuations associated with peaking also have the potential to affect recreational flows downstream from the project in the Enoree River. As discussed in section 3.3.2, Aquatic Resources, peaking operations would ultimately alter the existing natural flow regime to one of increased daily fluctuation downstream from the tailrace and in the bypassed reach. Lower flow through the project when the project's impoundment recharges would negatively affect recreation downstream from the project by increasing the likelihood that boaters would need to portage shallow areas of the river. However, pulses of higher flows when peaking operation begins may provide recreational benefits by providing additional boating depth downstream from the project. Because Lockhart Power anticipates operating in ROR mode for much of the time, the effects of peaking operations are expected to be minimal.

Drawdowns of the project impoundment associated with peaking operations, may also affect use and maintenance of the proposed canoe take-out and recreational boating upstream of the dam. However, standard canoe launch designs can accommodate a wide range of river levels, with proper siting and maintenance. Lockhart Power's proposed canoe take-out would be a positive amenity on a section of the river that currently is undeveloped for recreation. Additionally, conditions for recreational boating immediately upstream of the project may improve with repair to the project's flashboards and maintenance of the project impoundment.

Land Use

Lockhart Power proposes to restore the project to operating status and construct recreation enhancements within the project boundary. In addition, Lockhart Power proposes to maintain all lands within 25 feet of the project shorelines as a forested riparian buffer, unless those lands are required for other project purposes. Lockhart Power also proposes to negotiate with the Water District regarding maintenance of forested riparian buffers on any lands that the applicant cannot obtain through purchase. FWS and South Carolina DNR concur with the proposed land management measures to stabilize erosion of project shorelines, reduce runoff into the Enoree River, and provide wildlife habitat.

Our Analysis

Refurbishing, operating, and maintaining the proposed project would have no effect on land use within the project boundary. The addition of a portage trail would add additional recreation lands to the project boundary; however, that use would be consistent with existing land use. Additionally, the portage trail would follow two existing transmission line ROW, limiting ground disturbance and reducing the potential for effects on terrestrial habitat within the project boundary.

The applicant's proposal to maintain a 25-foot forested buffer along project shorelines would be consistent with the recommendations by FWS and South Carolina DNR to protect shoreline and riparian habitats. Additional analysis of measures to reduce erosion, prevent runoff, and protect wildlife habitat are discussed in sections 3.3.1., *Geologic and Soil Resources,* and 3.3.3., *Terrestrial Resources.*

The Enoree River's designation on the NRI would not be affected by the proposed project. The reach of the Enoree River from RM 0 to RM 98 was listed on the NRI in 1982, when the project was operational. Returning the project to operating status would be unlikely to significantly affect or alter the character of the river. Further, the addition of a portage trail would improve recreation access to a reach of the Enoree River that has been identified for its outstanding recreation value.

3.3.6 Cultural Resources

3.3.6.1 Affected Environment

Area of Potential Effects

Section 106 of the NHPA of 1966, as amended, requires that the Commission evaluate the potential effects of continued operation of the project on properties listed or eligible for listing on the National Register. Such properties listed, or eligible for listing, in the National Register are called historic properties. In this case, the Commission must take into account whether any historic property could be affected within the project's area of potential effects (APE). The APE is defined as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. We define the APE for the proposed Riverdale Project as: (1) Lands enclosed by the proposed project boundary; and (2) lands or properties adjoining the proposed project boundary, where the authorized project uses may cause changes in the character or use of historic properties, if historic properties exist.

Cultural History Overview

The archaeological record dates Native American presence in central South Carolina to at least the late Paleo-Indian period (11,000 B.C.-8,000 B.C.). The earliest Native Americans in the area used the region to forage and hunt on a seasonal basis. Over the Archaic (8,000 B.C.-1,000 B.C.) and Woodland (1,000 B.C.-1000 A.D.) periods, Native populations grew larger and more sedentary. These populations developed trade networks and became more dependent on agriculture for subsistence (FERC, 2010). Prior to European settlement, the primary Native American groups in the region were the Catawba and Cherokee. The Cherokee maintained territory in the area of Spartanburg County until 1777 (Benson, 2006).

Permanent European settlement in South Carolina began in 1670 on the Ashley River near present-day Charleston. By 1700, settlers had moved inland and up the Congaree River to the fall line (south of present-day Columbia, South Carolina), which marked the upper limit of navigation. Modern industrial development of upstate South Carolina began in 1815 with the construction of series of water-powered textile mills in Greenville and Spartanburg counties. Many early mills failed due to lack of capital, shortage of workers, limited distribution, and competition from more established textile mills in New England and New York. Following the Civil War, local investors began to renew their interest in the region's textile mills.

In 1888, a group of Charleston investors purchased property for the Riverdale Mill, which was constructed between two hills with Two Mile Creek running under the factory. The project's original hydroelectric facilities, including the dam, forebay, headrace, penstock, and turbine were installed between 1910 and 1913 and were used to power the manufacturing operations at the mill. The mill changed owners several times during the twentieth century, being last owned by Inman Mills, which refurbished the project's turbine and penstock in the 1980s. The project has been inoperable since 2001, when the adjacent textile mill was closed. The original mill buildings and powerhouse were removed by the current owner and the original concrete and brick masonry powerhouse was replaced with a wood frame building with a wood truss roof system and asphalt shingles.

Archeological Resources and Historic Properties

There are no known archeological sites or historic properties that would be affected by the proposed Riverdale Project. As discussed previously, while the project dates from the early 20th century, many of the mill's original facilities were removed in recent years.

3.3.6.2 Environmental Effects

On November 23, 2009, the Commission designated Lockhart Power as a non-federal section 106 representative, which enabled it to conduct the day-to-day section 106 consultation responsibilities pursuant to 36 CFR § 800.2(c)(4) of the Preservation Act regarding their proposal to repair or upgrade the existing turbine unit and return the project to operation. By letter dated December 7, 2009 and filed as part of the license application on August 31, 2010, the South Carolina SHPO determined that no historic properties listed in, or eligible for listing in, the National Register would be affected by the project.

By letter filed September 30, 2010, the Catawba Indian Nation stated that they have no immediate concerns with regard to traditional cultural properties, sacred sites, or Native American archeological sites at the project. The Catawba Indian Nation also commented that the tribe should be notified if Native American artifacts and/or human remains are located during ground disturbing activities. In comments e-filed January 18, 2012, the Catawba Indian Nation requested that the applicant consult with the tribe prior to any ground disturbing activities and indicated that a cultural resource survey involving shovel testing would likely be required.

Our Analysis

Based on the assessment of the South Carolina SHPO and the information in the record for this proceeding, operation of the proposed project would not alter the historic character of existing structures. In addition, there would be no historic properties affected by the construction and operation of the proposed project.

At this time, there is also no evidence indicating the presence of archeological properties within the project's APE that would warrant a cultural resource survey and shovel testing as recommended by the Catawba Indian Nation. However, it is possible that unknown archaeological or historic resources may be discovered in the future as a result of project construction, operation, or other project related activities. If such resources are discovered, immediately stopping work and consulting with the Commission, the South Carolina SHPO and the Catawba Indian Nation to define appropriate treatment would prevent any further harm to previously unidentified archaeological or cultural artifacts.

3.4 No-Action Alternative

Under the no-action alternative, the Riverdale Project would not be refurbished, operated, and maintained by Lockhart Power. There would be no changes to the physical, biological, or cultural resources of the area, and electrical generation from the project would not occur. The power that would have been developed from a renewable resource would have to be replaced from nonrenewable fuels. The proposed public recreation amenities and access points would not be built and public access to the Enoree River in this area would not be available.

4.0 Developmental Analysis

In this section, we look at the Riverdale Project's use of the Enoree River for hydropower purposes to see what effect various environmental measures would have on the project's costs and power benefits. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp.*,[54] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of alternative power). In keeping with Commission policy as described in Mead, our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) The cost of individual measures considered in the EA for the protection, mitigation, and enhancement of environmental resources affected by the project; (2) the cost of alternative power; (3) the total project cost (i.e. for construction, operation, maintenance, and environmental measures); and (4) the difference between the cost of alternative power and the total project cost. If the difference between the cost of alternative power and the total project cost is positive, the project would produce power for less than the cost of alternative power. If the difference between the cost of alternative power and the total project cost is negative, the project would produce power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 Power and Developmental Benefits of the Project

Table 12 summarizes the assumptions and economic information we use in our analysis. This information was provided by Lockhart Power in its license application and its responses to staff's additional information requests. We find that the values provided by Lockhart Power are reasonable for the purposes of our analysis. Cost items common to all alternatives include: Taxes and insurance costs; net investment (the total investment in power plant facilities to be depreciated); estimated future capital investment required to maintain and extend the life of plant equipment and facilities; licensing costs; normal operation and maintenance cost; and Commission fees. Throughout this section all dollars are 2013, unless otherwise specified.

TABLE 12—PARAMETERS FOR THE ECONOMIC ANALYSIS OF THE PROPOSED RIVERDALE PROJECT

[Source: Staff and Lockhart Power]

Economic parameter	Value
Average annual generation (MWh).	4,895.[a]
Composite power value	$72.31/MWh.[b]
Period of analysis	30 years.
Term of financing	20 years.
Capital investment	$5,225,000.[c]
License application cost	$200,000.[a]
Interest/discount rate	7.0 percent.[d]
Federal tax rate	34 percent.[d]
State tax	3.0 percent.[d]
Insurance (percent)	0.25.
Annual Operation and Maintenance.	$81,000.[d]

[a] Value from license application dated August 31, 2010, as clarified in Lockhart Power's responses to staff's additional information request, filed on August 5, 2011.

[54] See *Mead Corporation, Publishing Paper Division,* 72 FERC ¶ 61,027 (July 13, 1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

[b] The composite power value was provided by Lockhart Power and incorporates peak and off-peak energy and capacity rates and a value for Renewable Energy Credits offered by North Carolina. The basis of these values is a power purchase contract currently offered by Duke Energy Carolinas, LLC.

[c] This value includes staff's estimate of cost to purchase the project site and Lockhart Power's estimate to rehabilitate the project features.

[d] Assumed by staff.

4.2 Comparison of Alternatives

Table 13 summarizes the installed capacity, annual generation, cost of alternative power, estimated total project cost, and the difference between the cost of alternative power and total project cost for the three alternatives considered in this EA: No-action, Lockhart Power's proposal, and the staff alternative.

TABLE 13—SUMMARY OF ANNUAL COST, POWER BENEFITS, AND ANNUAL NET BENEFITS OF THE ALTERNATIVES FOR THE RIVERDALE PROJECT

[Source: Staff]

Parameter	No-action	Lockhart Power's proposal	Staff alternative
Annual generation (MWh)	0.0	4,895	4,370
Annual cost of alternative power	$0	$353,957	$315,995
($/MWh)	0.00	72.31	72.31
Annual project cost	$0.00	$619,336	$613,481
($/MWh)	0.00	126.52	140.38
Difference between the cost of alternative power and project cost	$0.0	($265,378)	($297,487)
($/MWh)	0.00	(54.21)	(68.07)

Note: A number in parentheses denotes that the difference between the cost of alternative power and project cost is negative, thus the total project cost is greater than the cost of alternative power.

4.2.1 No-Action Alternative

Under the no-action alternative, Lockhart Power would not rehabilitate the Riverdale Project; the project would not generate electricity; and no environmental protection, mitigation, or enhancement measures would be implemented.

4.2.2 Lockhart Power's Proposal

The Riverdale Project has been inoperable since 2001. After repairing the hydroelectric facilities, Lockhart Power proposes to operate the project in a ROR mode, with daily peaking under certain flow conditions. Upon completion of the proposed repairs, the project's installed capacity would be 1.24 MW and would generate an average of 4,895 MWh of electricity annually. The average annual cost of alternative power under Lockhart Power's proposal would be about $353,957 ($72.31/MWh). The average annual project cost would be about $619,336 ($126.52/MWh). Overall, the project would produce power at a cost that is about $265,378 ($54.21/MWh) more than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative includes most of the measures proposed by Lockhart Power, with some modifications and additional recommended measures. The additional staff-recommended measures that would increase the annual cost of the project include: (a) A soil erosion and sediment control plan; (b) a sediment management plan; (c) a shoreline stabilization plan; (d) a water quality monitoring plan; (e) higher continuous minimum flows in the bypassed reach; (f) an operation compliance monitoring plan; (g) an invasive vegetation monitoring and control plan; and (h) an evaluation of the project transmission line consistency with APLIC guidelines.

Under the staff alternative, the project would generate an average of 4,370 MWh of electricity annually. The average annual cost of alternative power under the staff alternative would be about $315,995 ($72.31/MWh). The average annual project cost would be about $613,481 ($140.38/MWh). Overall, the project would produce power at a cost that is about $297,487 ($68.07/MWh) more than the cost of alternative power. The staff alternative would increase the annual project cost about $32,109, or about $13.86/MWh, compared to the project as proposed by Lockhart Power.

4.3 Cost of Environmental Measures

Table 14 gives the cost of each of the environmental enhancement measures considered in our analysis.[55] We convert all costs to equal annual (levelized) values over a 30-year period of analysis to give a uniform basis for comparing the benefits of a measure to its cost.

TABLE 14—COST OF ENVIRONMENTAL MITIGATION AND ENHANCEMENT MEASURES CONSIDERED IN ASSESSING THE ENVIRONMENTAL EFFECTS OF REFURBISHING, OPERATING, AND MAINTAINING THE RIVERDALE PROJECT

[Source: Staff and Lockhart Power]

Enhancement/mitigation measure	Entities	Capital cost (2013$)	Annual cost (2013$)	Levelized cost (2013$)
Geology and Soils Resources				
1. Develop and implement a soil erosion and sediment control plan, which includes the BMPs described in the South Carolina DHEC's Stormwater BMP Handbook.	South Carolina DNR, Staff.	5,000	0	390

[55] Lockhart Power provided costs for specific protection, mitigation, and enhancement measures in its license application dated August 31, 2010, and in its responses to the Commission's additional information request (Lockhart Power, 2011a; 2011b; 2012).

TABLE 14—COST OF ENVIRONMENTAL MITIGATION AND ENHANCEMENT MEASURES CONSIDERED IN ASSESSING THE ENVIRONMENTAL EFFECTS OF REFURBISHING, OPERATING, AND MAINTAINING THE RIVERDALE PROJECT—Continued

[Source: Staff and Lockhart Power]

Enhancement/mitigation measure	Entities	Capital cost (2013$)	Annual cost (2013$)	Levelized cost (2013$)
2. Implement a sediment management plan that consists of using the sand gates for periodic inspections and maintenance drawdowns and, if possible, avoiding drawdowns from March 15 through June 1.	Lockhart Power	0	[a] 0	0
3. Develop and implement a sediment management plan that includes provisions to: (a) Test impoundment sediments for heavy metals and other contaminants prior to beginning in-water construction activities; (b) prepare a contingency plan for proper disposal [b] of any contaminated sediments found in the impoundment; (c) monitor sediment accumulation in the impoundment annually; (d) develop criteria that would trigger, sediment removal and proper disposal, if necessary; (e) conduct maintenance drawdowns in late fall and winter (November through January); (f) avoid drawdowns from March 15 through June 1, if possible; and (g) file an annual report.	Interior, South Carolina DNR, Staff.	[c] 12,000	[d] 1,000	1,597
4. Develop and implement a shoreline stabilization plan with provisions to: (a) Identify eroding or potential project-induced erosion sites on project shorelines prior to operation; (b) stabilize areas of shoreline erosion; (c) monitor shorelines after resuming operation and implement stabilization techniques as necessary; (d) conduct shoreline stabilization activities from September through February if possible; and (e) file an annual report.	Interior, Staff	5,000	1,000	1,050
Aquatic Resources				
5. Develop and implement a water quality monitoring plan with provisions to: (a) Monitor DO, temperature, and turbidity prior to the start of construction, during construction, and for 1 year after project operation begins; (b) define sampling methods, timing, and locations for monitoring these parameters in consultation with South Carolina DHEC, FWS, and NMFS; and (c) file a report that presents the monitoring data, describes any project-related effects and identifies corrective actions if necessary.	Interior, NMFS, Staff.	20,000	0	1,561
6. Maintain a minimum flow of 50 cfs in the bypassed reach and a total minimum continuous flow of 60 cfs downstream from the project.	Lockhart Power	0	30,567	[e] 20,174
7. Provide the following seasonal minimum instream flows into the bypassed reach (based on the South Carolina Water Plan and a MADF of 393 cfs): 79 cfs (July–November), 118 cfs (May, June, and December), and 157 cfs (January–April).	Interior,[f] South Carolina DNR, NMFS, American Rivers.	0	122,501	[e] 80,851
8. Provide a continuous minimum instream flow of 75 cfs into the bypassed reach.	Staff	0	69,000	[e] 45,540
9. Develop and implement a plan to release required minimum flows into the bypassed reach that includes: (a) A feasibility assessment for using the sand gates as a flow-release mechanism; (b) if found to be feasible, a study to determine how the sand gates would be used to distribute flow into the bypassed reach; (c) if the sand gates are not feasible, a description of how the minimum instream flows would be provided to the bypassed reach; (d) a report documenting the outcome of the feasibility assessment, flow study, and consultation with the agencies; and (e) an implementation schedule.	Interior, South Carolina DNR, NMFS, Staff.	7,000	0	546
10. Develop and implement a low inflow protocol/drought contingency plan.	South Carolina DNR, Interior, staff.	5,000	0	390
11. Develop and implement an operation compliance monitoring plan that includes: (a) A rating curve to provide the seasonally defined flows; (b) protocols to monitor and document compliance with required flows; (c) protocols to monitor and document impoundment fluctuations; and (d) an implementation schedule.	Lockhart Power, Staff.	15,000	1,500	2,161
12. Modify trash rack bar spacing at the headrace intake by decreasing the spacing from 2.25 inches to 1 inch.	Interior	15,000	0	1,171

TABLE 14—COST OF ENVIRONMENTAL MITIGATION AND ENHANCEMENT MEASURES CONSIDERED IN ASSESSING THE ENVIRONMENTAL EFFECTS OF REFURBISHING, OPERATING, AND MAINTAINING THE RIVERDALE PROJECT—Continued

[Source: Staff and Lockhart Power]

Enhancement/mitigation measure	Entities	Capital cost (2013$)	Annual cost (2013$)	Levelized cost (2013$)
13. Conduct fish surveys before and after construction, and 1 year after construction is complete.	Interior	30,000	0	2,341
14. Conduct comprehensive invertebrate surveys before and after construction, and 1 year after construction is complete.	Interior	9,000	0	702
Terrestrial Resources				
15. Implement BMPs to protect vegetation within the project boundary, such as limiting vegetation and ground-disturbing activities and maintaining a minimum 25-foot-wide forested riparian buffer on project shorelines, as long as this does not interfere with Lockhart Power's ability to perform project-related activities.	Lockhart Power, Interior, South Carolina DNR, and Staff.	[g] 0	[g] 0	0
16. Develop and implement an invasive vegetation monitoring and control plan that includes: (a) Survey methods to determine the extent of alligatorweed in the impoundment and riparian area prior to beginning refurbishment activities; (b) BMPs, as well as monitoring and control methods to prevent the spread of alligatorweed in the impoundment to areas downstream from the dam during project refurbishment; (c) monitoring protocols to detect the introduction or spread of other invasive plants within the project boundary during operation and maintenance; (d) criteria that would determine when corrective actions would be required; and (e) a schedule for filing monitoring reports and any recommended control measures.	Staff	[h] 6,000	[h] 1,000	1,128
17. Determine if the project transmission line is consistent with APLIC guidelines, consult with FWS, and file a report with the Commission describing the results of the evaluation and any measures recommended by FWS.	Staff	[h] 5,000	0	390
Recreational and Land Use				
18. Construct and maintain a canoe take-out located approximately 220 feet upstream of the dam; a canoe put-in located approximately 1,075 feet downstream from the dam; a 1,650-foot-long portage trail connecting the proposed canoe take-out and put-in; and a parking area located adjacent to the proposed portage trail.	Lockhart Power, Interior, South Carolina DNR, and Staff.	15,000	4,000	[e] 3,811
19. Provide informal public access for fishing at the project impoundment, tailrace, and bypassed reach.	Lockhart Power, Interior, South Carolina DNR, and Staff.	0	0	0
20. Install informational signage that includes: (1) Identification of the canoe take-out and put in; (2) directions from the parking area to river access points; and (3) information regarding garbage disposal.	Lockhart Power, Staff.	[i] 0	1,000	[e] 660
Cultural Resources				
21. Stop work and notify the South Carolina SHPO and the Catawba Indian Nation, and follow the South Carolina SHPO's guidance if any unknown archaeological resources are discovered as a result of project construction, operation, or project-related activities.	Staff	0	0	0
22. Consult with the Catawba Indian Nation prior to any ground disturbing activities, and conduct a cultural resource survey involving shovel tests, if necessary.	Catawba Indian Nation.	[h] 10,000	0	780

[a] Sediment management would occur in conjunction with periodic inspections and maintenance activities. There are no additional costs associated with this measure.

[b] We assume that the cost of initial sediment disposal, if necessary, is included in Lockhart Power's estimates for project refurbishment.

[c] This cost includes the initial/capital cost of monitoring sediment accumulation in the impoundment.

[d] The precise frequency of monitoring sediment accumulation would likely be determined after consultation with the South Carolina DHEC, the Corps, South Carolina DNR, and Interior.

[e] In many cases in this table, the 30-year levelized cost is lower than the annual cost (i.e. operation and maintenance cost). The reason for this is the levelized cost includes an estimate of tax savings that the applicant would realize due to the combined high capital (including interest and depreciation) and operation and maintenance costs of the measure.

[f] Interior's recommendation actually called for a seasonal flow of 80 cfs from July through November instead of 79 cfs.

[g] We estimate that the implementation of the measure would not result in any appreciable additional cost.
[h] Cost estimated by staff.
[i] This cost is included in the $15K for constructing and maintaining the portage trail. The additional staff measures are not expected to increase the overall cost.

5.0 Conclusions and Recommendations

5.1 Comparison of Alternatives

In this section we compare the development and non-developmental effects of Lockhart Power's proposal, Lockhart Power's proposal as modified by staff, and the no-action alternative. We estimate the annual generation of the project under those three alternatives. Our analysis shows that the annual generation would be 4,895 MWh for the proposed action and 4,370 MWh for the staff alternative. Under the no-action alternative, no power would be generated. We summarize the environmental effects of the different alternatives below in table 15.

TABLE 15—COMPARISON OF ALTERNATIVES FOR THE RIVERDALE PROJECT

[Source: staff]

Resource	No action alternative	Proposed action	Staff recommended alternative
Generation	0 MWh	4,895 MWh	4,370 MWh.
Geology and Soils	Impoundment sediments would continue to accumulate and be flushed downstream from the dam during high flows.	Project refurbishment would disturb about 2 acres of vegetation. Implementing BMPs would minimize soil disturbance and erosion. Avoiding drawing down the impoundment between March 15 and June 1 would prevent the release of large quantities of sediment into the bypassed reach in the Enoree River during fish spawning season.	Same as proposed action, but implementing a site-specific soil erosion and sediment control plan and a more clearly defined sediment management plan would more effectively minimize erosion and impoundment sediment loads, helping to prevent an accidental release of large quantities of sediment downstream. Implementing a shoreline stabilization plan would further reduce potential erosion and sedimentation during operations and also benefit fish and wildlife in the riparian and littoral areas of the project.
Water Quality (*during construction*).	No change in existing water quality conditions.	Short-term increases in turbidity and sedimentation during rehabilitation; BMPs would minimize erosion and sedimentation.	Same proposed action, but implementing a water quality monitoring plan during pre- and post- construction activities would provide a mechanism to identify and address water quality effects.
Water Quality (*post-construction*).	No change in existing water quality conditions.	Project flow diversions could reduce DO levels and raise water temperatures in bypassed reach.	Same as proposed action, except higher minimum flows would reduce the potential for elevated temperatures and low DO levels. Implementing a water quality monitoring plan would detect any effects to water quality caused by project operations and maintenance.
Fishery Resources (*during construction*).	No change to the fishery resources.	Short-term increases in turbidity and sedimentation during construction could adversely affect fish habitat in the Enoree River downstream from the dam.	Same as proposed action, except that implementation of a water quality monitoring plan and a soil erosion and sediment control plan during construction activities may minimize adverse effects of turbidity and sedimentation on fish habitat downstream from the dam.
Fishery Resources (*post-construction*).	No change to the fishery resources.	Reduction of flow to 50 cfs in the bypassed reach and 60 cfs downstream from the project would likely result in poor to low quality fishery and benthic habitat conditions in the bypassed reach; Impoundment surface elevation fluctuations of up to 4 feet below full pool with associated adverse effects on impoundment fish habitats; Entrainment of fish through the development's 2.25-inch trashrack.	Same as the proposed action except that minimum flows in the bypassed reach would be reduced to 75 cfs year-round. Minimum flows would maintain adequate conditions for fish and benthic macroinvertebrates.
Terrestrial Resources	No change in existing conditions.	Project refurbishment, operation, and maintenance would result in minor, temporary disturbances to upland vegetation and wildlife. However, in-water repair work, peaking operation, and sediment management activities could fragment and spread alligatorweed from the impoundment to areas downstream or facilitate introduction of other invasive plants. In addition, project transmission lines may represent an electrocution hazard to birds.	Same as proposed action, except developing and implementing an invasive vegetation monitoring and control plan, would minimize spread and introductions of non-native invasive plants and benefit native plant communities and the fish and wildlife in the project area. In addition, evaluating the transmission line for consistency with APLIC guidelines and consulting with FWS to identify mitigative measures, if needed, would minimize the risk of avian electrocution.
Wetlands	No effect	No effect	No effect.

TABLE 15—COMPARISON OF ALTERNATIVES FOR THE RIVERDALE PROJECT—Continued

[Source: staff]

Resource	No action alternative	Proposed action	Staff recommended alternative
Threatened and Endangered Species.	No effect	No effect	No effect.
Recreational Access	No effect	The addition of a portage trail, parking, and directional signage would improve canoe portaging around the project.	Same as the proposed action. Additional signage requesting visitors to pack out their garbage would reduce the likelihood that any increase in recreation use at the project would negatively affect the surrounding environment.
Land Use	No effect	Slight increase in recreation land use within the project boundary. This use would be consistent with existing land uses, and, therefore, would have no adverse effect.	Same as proposed action.
Cultural Resources	No effect	No effect	No effect. However, if any unknown archaeological resources were found, Lockhart Power would stop work and notify the South Carolina SHPO and the Catawba Indian Nation.

5.2 Comprehensive Development and Recommended Alternative

Sections 4(e) and 10(a)(1) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality. Any license issued shall be such, as in the Commission's judgment, will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. This section contains the basis for, and a summary of, our recommendations for licensing the Riverdale Project. We weigh the costs and benefits of our recommended alternative against other proposed measures.

Based on our independent review of agency and public comments filed on this project and our review of the environmental and economic effects of the proposed project and its alternatives, we selected the staff alternative, as the preferred option. We recommend this option because: (1) Issuance of a hydropower license for the project would allow Lockhart Power to develop and operate the project and provide a dependable source of electrical energy for the region (4,370 MWh annually); (2) the 1.24 MW of electric energy generated from a renewable resource may offset the use of fossil-fueled, steam-electric generating plants, thereby conserving non-reviewable resources and reducing atmospheric pollution; (3) the public benefits of this alternative would exceed those of the no-action alternative; and (4) the recommended environmental measures would protect and enhance environmental resources affected by the project.

In the following section, we make recommendations as to which environmental measures proposed by Lockhart Power or recommended by agencies and other entities should be included in any license issued for the project. In addition to Lockhart Power's proposed environmental measures, we recommend additional staff-recommended environmental measures to be included in any license issued for the project. We also discuss which measures we do not recommend including in the license.

Measures Proposed by Lockhart Power

Based on our environmental analysis of Lockhart Power's proposal discussed in section 3.0, *Environmental Analysis,* and the costs discussed in section 4.0, *Developmental Analysis,* we conclude that the following measures proposed by Lockhart Power would protect and enhance environmental resources in the project area, and would be worth the cost. Therefore, we recommend including these measures in any license issued for the project.

- Implement BMPs to protect vegetation within the project boundary, such as limiting vegetation and ground-disturbing activities and maintaining a minimum 25-foot-wide forested riparian buffer on project shorelines, as long as this does not interfere with Lockhart Power's ability to perform project-related activities.
- Construct and maintain: (1) A canoe take-out located approximately 220 feet upstream of the dam; (2) a canoe put-in located approximately 1,075 feet downstream from the dam; (3) a 1,650-foot-long portage trail connecting the proposed canoe take-out and put-in; (4) a parking area located adjacent to the proposed portage trail; and (5) signage to improve public access at the project and to the Enoree River.
- Provide informal public access for fishing at the project impoundment, tailrace, and bypassed reach.

Additional Measures Recommended by Staff

We recommend the measures described above, as well as 12 additional staff-recommended measures and modifications to Lockhart Power's proposed measure(s). These additional and modified measures include the following:

- Develop and implement a site-specific soil erosion and sediment control plan, which includes the BMPs described in the South Carolina DHEC's Stormwater BMP Handbook, to minimize erosion and sedimentation during soil-disturbing activities associated with project construction and repairs.
- Develop and implement a sediment management plan that includes provisions to: (a) Test impoundment sediments for heavy metals and other contaminants prior to beginning in-water project construction activities and initial operation; (b) prepare a contingency plan for proper disposal of any contaminated sediments that may be found in the impoundment; (c) monitor sediment accumulation in the impoundment annually to facilitate planning of sediment management activities; (d) develop criteria that would trigger sediment removal from the impoundment (i.e. by opening the sand gates, if appropriate, during high flow events, or via mechanical

methods); (e) conduct sediment management activities during the months of November through January except during high rain events (e.g. tropical storms or hurricanes); (f) avoid maintenance activities that would draw down the impoundment below normal operating levels and potentially pass sediment into the bypassed reach from March 15 through June 1, if possible, to minimize adverse impacts to spawning fish; and (g) prepare annual reports with sediment monitoring results, sediment management activities, and an evaluation of the effectiveness of the plan in minimizing sediment accumulation in the impoundment.

- Develop and implement a shoreline stabilization plan that includes provisions to: (a) Identify eroding or potential project-induced erosion sites on the project shorelines prior to beginning operation; (b) stabilize areas of shoreline erosion using native vegetation, bio-engineering, slope flattening, toe armoring with anchored logs, and/or riprap that incorporates native vegetation plantings; (c) monitor shorelines after resuming operation, and implement stabilization measures if project-induced erosion is identified; (d) conduct shoreline stabilization activities from September through February to protect aquatic species and wildlife; and (e) file annual reports describing monitoring results and any implemented shoreline stabilization measures.
- Develop and implement a water quality monitoring plan that includes provisions to: (a) Monitor DO, temperature, and turbidity prior to the start of project construction, during construction, and for 1 year after project operation begins to ensure the levels specified by the current state water quality standards are met and aquatic resources are protected; (b) define sampling methods, timing, and locations for these parameters in consultation with South Carolina DHEC, FWS, and NMFS; and (c) file a report that presents the monitoring data, describes any project-related effects and identifies corrective actions if necessary.
- Release a continuous minimum flow of 75 cfs in the bypassed reach to protect aquatic habitat.
- Develop and implement a plan to release required minimum flows into the bypassed reach that includes: (a) A feasibility assessment for using the sand gates as a flow-release mechanism; (b) if found to be feasible, a flow study to determine how the sand gates would be used to distribute flow into the bypassed reach to protect aquatic habitats; (c) if the sand gates are not feasible, a description of how the minimum instream flows would be provided to the bypassed reach; (d) a report documenting the outcome of the feasibility assessment, flow study, and consultation with the agencies; and (e) an implementation schedule.
- Develop and implement a low inflow protocol/drought contingency plan to define periods of extended drought and the low inflow protocols to minimize adverse effects on generation, and on fish and wildlife, water quality, water supply, and generation.
- Develop and implement an operation compliance monitoring plan that includes: (a) A rating curve to provide the seasonally defined flows; (b) protocols to monitor and document compliance with required flows; (c) protocols to monitor and document impoundment fluctuations; and (d) an implementation schedule.
- Develop and implement an invasive vegetation monitoring and control plan that includes: (a) Survey methods to determine the extent of alligatorweed in the impoundment and riparian area prior to beginning refurbishment activities; (b) BMPs, as well as monitoring and control methods to prevent the spread of alligatorweed in the impoundment to areas downstream from the dam during project refurbishment; (c) monitoring protocols to detect the introduction or spread of other invasive plants within the project boundary during project operation and maintenance; (d) criteria that would determine when control measures would be required; and (e) a schedule for filing monitoring reports and any recommended control measures with the Commission.
- Determine whether the existing project transmission line is consistent with APLIC guidelines. Identify, in consultation with FWS, measures to minimize potential electrocution hazards to birds and file a report with the Commission describing the results of the evaluation and any measures recommended by FWS.
- Install informational signage that includes: (a) Identification of the canoe take-out and put in; (b) directions from the parking area to river access points; and (c) information regarding garbage disposal in order to improve public information available at the project and protect environmental resources.
- Stop work and notify the South Carolina SHPO and the Catawba Indian Nation if any unknown archaeological resources are discovered as a result of project construction, operation, or project-related activities to avoid, lessen, or mitigate potential adverse effects.

We discuss the basis for our recommended measures below.

Soil Erosion and Sediment Control Plan

Project refurbishment, tailrace dredging, and construction of the proposed canoe take-out, put-in, and portage trail would result in soil-disturbing activities that could increase turbidity and sedimentation in the Enoree River. Lockhart Power's proposal would limit ground-disturbing activities to previously disturbed areas within the footprint of the former textile mill and associated parking lots and roadways, minimizing adverse effects on vegetated areas. Developing a site-specific soil erosion and sediment control plan that includes standard industry BMPs (such as those found in South Carolina DHEC's Stormwater BMP Handbook) would further reduce potential soil erosion and sedimentation effects. Applicable erosion and sediment control BMPs may include the use of silt fences, sediment traps, stabilized construction entrances, and alternative techniques that may be developed in consultation with the South Carolina DHEC. We do not expect that development of the soil erosion and sediment control plan would incur any additional costs not already included in the costs for project refurbishment. Based on our review and analysis contained in section 3.3.1, *Geologic and Soil Resources,* we find that the benefits of implementing a soil erosion and sediment control plan as described above are worth these costs.

Initial Testing of Impoundment Sediments

There currently is no information on the volume of sediment deposits and potentially embedded contaminants in the Riverdale impoundment. However, the Enoree River carries a high sediment load and visual observations indicate a significant buildup of sediment in the impoundment. Project refurbishment activities and operation could disturb the bottom sediments and release a large amount of sediment downstream, causing any heavy metals or other contaminants present within the sediments to re-suspend with clays, silt, sand, and other sediments in the water column. Depending on the toxicity, contaminants suspended and transported in the water column could then harm fish and wildlife and adversely affect other stream uses.

Testing for heavy metals and other contaminants in the sediment in the impoundment prior to beginning operation, as recommended by Interior, would prevent the accidental release of any toxic substances and allow for their

proper disposal. The test results would help Lockhart Power, the resource agencies, and South Carolina DHEC design appropriate methods for short- and long-term sediment management at the project, discussed next. Preparing a contingency plan for handling any contaminated sediments would ensure that sediments are disposed of properly and would minimize potential adverse effects to aquatic resources. Based on our review and analysis contained in section 3.3.1, *Geologic and Soil Resources,* we find that the benefits of initial testing of impoundment sediments and preparing a plan for proper disposal of any identified contaminated sediments as elements of a sediment management plan are worth the estimated annual levelized cost provided below.

Sediment Management Plan

Project rehabilitation and periodic dam maintenance (e.g., repair the sand gates) would likely require drawing down the impoundment below the normal operating levels of four feet, resulting in the re-suspension and discharge of sediment from the impoundment. Heavy sediment loads can adversely affect fish and wildlife, recreation opportunities, and other stream uses.

Lockhart Power's proposal to avoid periodic inspection and maintenance drawdowns from March 15 to June 1 would prevent the release of large sediment loads during fish spawning periods, but would do little to actively manage sediment deposited behind the dam. Actively managing sediment within the impoundment, as recommended by Interior, and South Carolina DNR, would help prevent the buildup of sediment in the impoundment and minimize the risk of potentially releasing excessive sediment loads through the sand gates during planned and un-planned maintenance activities. Conducting maintenance drawdowns and sediment management activities between November and January, as recommended by the agencies, would ensure that sediment management is occurring when flows are most likely to be high enough to carry the sediment downstream from the sensitive shoals habitat and avoid fish spawning periods.

To be effective, sediment management would need to include provisions to: (a) Test impoundment sediments for heavy metals and other contaminants prior to beginning project repairs; (b) prepare a contingency plan for proper disposal of any contaminated sediments that may be found; (c) monitor sediment accumulation in the impoundment annually; (d) develop criteria triggering sediment removal from the impoundment (i.e. by opening the sand gates, if appropriate, during high flow events, or via mechanical methods); (e) conduct sediment management activities from November through January except during high rain events (e.g., tropical storms or hurricanes); and (f) avoid maintenance activities that would draw down the impoundment below normal operating levels and potentially pass sediment into the bypassed reach from March 15 through June 1 unless required for emergency purposes. Annual monitoring reports would assist the Commission and resource agencies in documenting compliance with the requirements of any license issued and evaluating the overall effectiveness of the sediment management plan.

Based on our review and analysis contained in section 3.3.1, *Geologic and Soil Resources,* we find that the benefits of implementing a sediment management plan with the measures outlined above are worth the estimated annual levelized cost of $1,597.

Shoreline Stabilization Plan

Resuming project operation as Lockhart Power proposes would result in impoundment fluctuations between 1 and 4 feet. As Interior notes, such fluctuations may cause shoreline erosion and lead to instability in the riparian zone, channel aggradation, increased turbidity, and associated adverse effects to fish and invertebrates. Developing and implementing a shoreline stabilization plan, as recommended by Interior, would identify and stabilize any existing areas of active erosion, minimizing the potential for erosion due to project operation. It would also allow Lockhart Power to effectively and efficiently focus any monitoring efforts on specific areas prone to erosion in the project boundary and address those areas before they become a significant problem. Using native vegetation and techniques such as bio-engineering, slope flattening, toe armoring with anchored logs, and/or riprap that incorporates native vegetation plantings would stabilize eroding shorelines while providing habitat for wildlife and aquatic species. Implementing shoreline stabilization measures during the fall and winter (i.e. September through February), except under emergency situations, as recommended by Interior, would help minimize potential disturbances to aquatic species and wildlife. As with the sediment management plan discussed above, annual reports would assist the Commission and resource agencies in documenting compliance with the requirements of any license and evaluating the overall effectiveness of the shoreline stabilization plan. Based on our review and analysis contained in section 3.3.1, *Geologic and Soil Resources,* we find that the benefits of implementing a shoreline stabilization plan with the measures outlined above are worth the estimated annual levelized cost of $1,050.

Water Quality Monitoring Plan

Refurbishing and operating the project could increase turbidity levels, raise water temperatures, and lower DO levels in the impoundment and bypassed reach. Lockhart Power intends to monitor water quality as may be required by South Carolina DHEC, but did not propose any specific monitoring measures.

Interior recommends that Lockhart Power: (1) Conduct water quality monitoring in the impoundment at all proposed operational drawdowns for a minimum of 1 year and (2) submit water quality monitoring results to South Carolina DHEC, South Carolina DNR, NMFS, Interior, and the Commission.

Our understanding of water quality in the project vicinity under existing conditions is limited. Monitoring turbidity, DO, and temperature in the impoundment and bypassed reach prior to the start of construction, during construction, and for 1 year after project operation begins would provide a means to ensure that the current state water quality standards (table 4) are met and that erosion control measures and minimum flows are adequately protecting aquatic resources. Therefore, we recommend that Lockhart Power develop a water quality monitoring plan that defines sampling methods, timing, and locations for monitoring these parameters in consultation with South Carolina DHEC, FWS, and NMFS. Based on our review and analysis contained in section 3.3.2, *Aquatic Resources,* we find that the benefits of developing and implementing the water quality monitoring plan with the measures outlined above would be worth the estimated annual levelized cost of $1,561.

Minimum Instream Flows

Since 2001, flows at the project have passed over the dam rather than the through the powerhouse to generate electricity. These flows provide habitat conditions in the bypassed reach that support a diversity of fish and invertebrate species in the complex shoals habitat, including eight species identified by the State of South Carolina

as ''Conservation Species.'' Two of the species, redeye bass and panhandle pebblesnail, are either declining or rare, and both are limited in their distribution within the state.

Lockhart Power proposes to provide a minimum continuous flow of 60 cfs downstream from the tailrace and 50 cfs in the bypassed reach to maintain and protect aquatic resources in the bypassed reach and in the Enoree River. South Carolina DNR, Interior, NMFS, and American Rivers recommend the following minimum flows in the bypassed reach based on the state's Water Plan: 79 cfs in July–November (20 percent of MADF); 157 cfs in January–April (40 percent of MADF); and 118 cfs in May, June, and December (30 percent of MADF). Using flow data for the period 1994 through 2009, South Carolina DNR, Interior, NMFS, and American Rivers calculated the flows based on a prorated MADF of 393 cfs. Using the most current flow data available (1994–2012), we calculated a MADF of 374 cfs and base our recommendations on this flow calculation.

The Water Plan's minimum flow regime is based on flow studies conducted at six regulated reaches in the South Carolina Piedmont, and three distinct periods that capture high (January–April), low (July–November), and increasing (December) or decreasing (May, June) flow periods (Bulak and Jobsis, 1989). The Water Plan states that seasonal variation in flow is important because fish have evolved to spawn in synchrony with the hydrologic cycle. While beneficial to a certain extent, there is currently no evidence that the fishes or invertebrates in the bypassed reach, or downstream from the tailrace require such annual variation in the flow regime to complete their life-cycle.

The state's Water Plan concludes that the 20 and 30 percent flows represent ''generally adequate'' and ''adequate'' flows, respectively, to protect aquatic habitat and fish during low flow periods, while 40 percent flows would protect fishery resources during high flow periods. As discussed in section 3.3.2.2, *Environmental Effects,* a flow of 60 cfs (16 percent of MADF) downstream of the tailrace and 50 cfs (13 percent of MADF) into the bypassed reach falls considerably short of the Water Plan's recommended flows in most months, thus would not likely maintain adequate aquatic habitat conditions. However, the Water Plan recommended flows for January through April (150 cfs, 40 percent MADF) were based on flows needed to provide a 1.5-foot-deep by 10-foot-wide passage route at shoals for striped bass. There are no striped bass, or other anadromous species present at the project.[56] In contrast, a flow of 75 cfs (20 percent MADF [57]) from January to April is expected to provide a channel 1.0-foot-deep by 10-foot-wide, which would be sufficient to maintain habitat and passage requirements for fish currently inhabiting the bypassed reach. A flow of 75 cfs also provides generally adequate flows during low flow periods based the study conducted by Bulak and Jobsis (1989).

Based on the Tennant (1976) method, a flow of 60 cfs (16 percent of MADF) downstream of the tailrace and of 50 cfs (13 percent of MADF) into the bypassed reach would represent fair or degrading conditions during the dry season, and close to poor or minimum conditions during the wet season. South Carolina DNR's variable flows based on the state Water Plan would result in good conditions year-round. However, a continuous minimum flow of 75 cfs (20 percent of MADF) year round would represent good conditions during the dry season and close to fair or degrading conditions during the wet season.

The annual levelized cost of Lockhart Power's minimum flow for the bypassed reach would be $20,174. Providing a continuous 75-cfs minimum flow to the bypassed reach would have an annual levelized cost of $45,540, which is $25,366 more than the annual levelized cost of Lockhart Power's proposed flow regime. Providing the agency-recommended minimum flows would have an annual levelized cost of $80,851, which would be $60,677 more than the annual levelized cost of Lockhart Power's proposed flow regime.

In consideration of the benefits and costs of the proposed and recommended minimum flows as well as the relative uniqueness of the bypassed reach fishery within the state of South Carolina, we conclude that the appropriate balance of the benefits and costs of the various flows is best met through a bypassed reach flow of 75 cfs. For this reason, we recommend a license condition requiring Lockhart Power to provide a continuous minimum flow of 75 cfs within the bypassed reach, or inflow if less. We see no need for a separate minimum flow requirement for the reach downstream of the powerhouse as proposed by Lockhart Power given that a continuous 75-cfs minimum flow in the bypassed reach would flow downstream to the reach below the powerhouse and provide the same benefits to aquatic resources.

Flow Release Plan for Minimum Flows Into the Bypassed Reach

Lockhart Power proposes to repair the sand gates and work with the resource agencies to determine which combination of gates to use to provide the required bypassed reach minimum flows. South Carolina DNR and Interior recommend Lockhart Power evaluate the feasibility of using the sand gates to reliably provide minimum instream flows on a continuous basis, and the flow distribution through the gate(s) to optimize aquatic habitat in the bypassed reach. American Rivers recommends Lockhart Power study alternatives to releasing minimum instream flows to select the best method to deliver flows that ensure that the bypassed reach is fully wetted. NMFS recommends conducting an instream flow study.

The shoals below the dam are complex and its distinct physical features create different habitats on the north and south side of the bypassed reach that support different fish and benthic macroinvertebrate assemblages, including some rare species. Because the lack of access prevented Lockhart Power from determining if it could make the sand gates operable, a feasibility assessment would be necessary as proposed by Lockhart Power and recommended by the agencies. If the gates cannot be made operational or used in a manner to provide the required flows, alternative mechanisms would need to be identified and made operational prior to operating the project to ensure that the aquatic resources in the bypassed reach are protected.

Assuming that the bypassed flows can be provided through the sand gates, distributing the flows across the shoals to optimize benthic invertebrate and fish habitat may require delivering flows from one or more sand gates. While fully wetting the shoals as recommended by American Rivers would likely provide some benthic invertebrate and fish habitat, it may not provide the best habitat for targeted channels supporting rare species. To determine which combination of gates to use would require a post-licensing flow study as recommended by NMFS. Such a study would not be used to establish required minimum flows because the minimum flow requirements have been determined as described above. Rather, it would be used to determine how to distribute the

[56] Anadromous fish are also unable to pass upstream of Parr dam, which is located 65 miles downstream on the Broad River.

[57] The study (i.e. Bulak and Jobsis, 1989) used to identify Water Plan minimum flows indicated that if a 1.0-foot-deep by 10-foot-wide was acceptable, required flows in shoals habitat ranged from 15 to 32 percent of MADF (mean = 24 percent of MADF).

required flows to optimize habitat. The study would need to examine depth, velocity, and wetted width across the shoals using various combinations of the sand gates. We recommend Lockhart Power select the targeted species and habitat suitability criteria to evaluate the flows in consultation with the South Carolina DNR, FWS, NMFS, and American Rivers. Developing a flow release plan that includes the feasibility assessment and the above flow study would have an estimated annualized cost of $546. The benefits of determining which combination of gates best optimize aquatic habitats would be worth the cost.

Low Inflow Protocol/Drought Management Plan

As discussed above, the staff recommended minimum flow releases would adequately maintain aquatic habitat in the bypassed reach during most years. However, during moderate and extreme drought years, such as those experienced in the Southeast U.S. from 1998–2002, 2005–2007, and 2012, inflows to the project may be insufficient to continually release the required flow.

During such low inflow periods, Lockhart Power would implement the following low inflow protocol: When average daily project inflow is less than approximately 80 cfs (+/− 10 percent), continuous project outflow shall approximately (+/− 10 percent) equal project inflow. However, Lockhart Power does not explain how or where such flows would be released, or its basis for selecting 80 cfs as defining low inflow/drought conditions. A flow of 80 cfs represents about 20 percent of the MADF which would be ''generally adequate'' to maintain aquatic resources during typical low inflow periods (July through November), but would be inadequate if drought conditions extended into the typically high flow periods.

The South Carolina DNR and Interior recommend that Lockhart Power develop low inflow protocol (i.e. a drought contingency plan) in consultation with appropriate federal and state agencies, local governments, and other stakeholders that continues to protect fish and wildlife and other water uses in the Enoree River.

Ideally, a low inflow protocol would provide some flexibility to adjust minimum flows during drought periods so that the effects of low inflows are balanced among competing uses. We recommend Lockhart Power develop a low inflow protocol in consultation with South Carolina DNR, Interior, and NMFS. The protocol should define water shortage severity levels (i.e. drought conditions), and how project operation would be adjusted depending on drought conditions to balance competing needs.

Developing the low inflow protocol would have an annual levelized cost of $390. There could be additional costs in some years during droughts that depend on the operational changes needed and the frequency and severity of drought over the term of the license. We find that the benefits of these measures are worth the cost.

Operation Compliance Monitoring Plan

Lockhart Power proposes to operate the Riverdale Project using a combination of ROR and peaking modes, resulting in fluctuations between 1 and 4 feet from the top of the flashboards. Lockhart Power would ensure minimum flow releases are being provided through one or more of the sand gates by establishing a rating curve and verifying the rating curve every 6 years.

To assist the Commission in monitoring compliance with operation limitations, we recommend Lockhart Power develop and implement an operation compliance monitoring plan. Such a plan would need to explain how Lockhart Power would monitor impoundment fluctuations to ensure that the impoundment is not drawn down below 4 feet unless required for maintenance or emergencies beyond the control of the applicant. The plan would also need to define how Lockhart Power would document flows through the sand gates into the bypassed reach as required based on the flow release plan. In addition, the plan should include a schedule for implementing the provisions of the plan, maintaining monitoring equipment, and filing annual reports with the resource agencies and the Commission. Based on our review and analysis contained in section 3.3.2, *Aquatic Resources,* we find that the benefits of implementing an operation compliance monitoring plan, with the measures outlined above, would be worth the estimated levelized annual cost of $2,161.

Invasive Vegetation Monitoring and Control Plan

Alligatorweed is a prolific state noxious weed and that has become established in the project impoundment. Alligatorweed competes with native aquatic species, reducing the quality of fish and wildlife habitat where it becomes established. In mats covering extensive areas, it can impede boating and access to the shore.

Existing mats of alligatorweed can become fragmented and spread during in-water construction activities, such as during the installation of the canoe portage facilities and repairs to the sand gates, as well as during sediment management activities. Fluctuations in the impoundment levels may also create conditions facilitating its spread. Lockhart Power does not propose any measures to monitor or control the spread of alligatorweed or other invasive plants that may become established in the project area.

Developing and implementing an invasive vegetation monitoring and control plan would minimize the potential spread and adverse effects of alligatorweed during project refurbishment, and project-related recreation activities as well as other invasive plants that may be detected during project operation and maintenance. We recommend that Lockhart Power develop an invasive vegetation monitoring and control plan that includes surveying the impoundment to determine the distribution of alligatorweed prior to beginning construction repairs or installing the canoe portage facilities and identifying specific BMPs that should be taken to prevent spreading this species. We also recommend periodic monitoring for invasive species in the impoundment to facilitate early detection of new invasive plant introductions, as well as the spread of the existing mats of alligatorweed. Such monitoring would allow Lockhart Power, the resource agencies, and the Commission to determine when, and if, correction measures may be needed to protect native plant communities and the wildlife that depend on them.

To be effective, the monitoring program should define the monitoring schedule, document changes in invasive species composition and distribution between monitoring events, and include criteria that would determine when corrective actions may be required. Based on our review and analysis contained in section 3.3.3, *Terrestrial Resources,* we find that the benefits of implementing an invasive vegetation management plan with the measures outlined above are worth the estimated levelized annual cost of $1,128.

Avian Protection

Lockhart Power proposes to use the existing transmission line which extends from the powerhouse along the project access road to an existing Duke Energy distribution line. Transmission lines with inadequate spacing between the conductors can represent an electrocution hazards for birds with

broad wingspans, such as raptors. However, Lockhart Power's limited access to the project prevented it from determining and whether the line could represent an electrocution hazard.

Evaluating the consistency of the transmission line with APLIC guidelines would allow Lockhart Power to determine if a potential hazard exists and if protective measures may be needed. If the transmission lines do not meet APLIC guidelines, potential mitigation measures could include changing the relative position of conductors, or installing insulators, or structures to discourage perching and/or nesting (APLIC, 2006). A small cost would be incurred in evaluating the consistency of the transmission line design with APLIC guidelines, preparing a report, and consulting with the FWS to determine if potential measures are needed. Based on our review and analysis contained in section 3.3.3, *Terrestrial Resources,* we find that the benefits of evaluating the transmission line against APLIC guidelines would be worth the estimated levelized annual cost of $390.

Recreation Signage

Lockhart Power proposes to install a canoe put-in and take-out, a portage trail, a parking area, and to use informational and directional signage to indicate recreation access at the project. However, development of more formal recreation facilities is likely to induce greater amounts of garbage and debris. Although recreation use at the project is expected to remain relatively low, adding signage reminding users to ''pack-it-in, pack-it-out'' or a similar ''leave no trace'' message would help minimize the accumulation of garbage at project recreation facilities and reduce the maintenance responsibility for the applicant.

Because Lockhart Power has proposed developing directional and informational signage for the project, the additional signage relating to garbage disposal would not result in a significant change to the applicant's levelized annual cost of $660.

Cultural Resources

There are no known archeological sites or historic properties within the proposed project's APE; however, there is a possibility that unknown archaeological resources may be discovered due to project construction, operation, or other project-related activities. To ensure proper treatment of any unknown archaeological resources that may be discovered at the project, we recommend in the case of any such discovery that Lockhart Power notify and consult with the South Carolina SHPO and the Catawba Indian Nation to: (1) Stop work and determine if the discovered archaeological resource is eligible for the National Register; (2) determine if the proposed project would adversely affect the resource; and (3) if the resource would be adversely affected, obtain guidance from the South Carolina SHPO on how to avoid, lessen, or mitigate for any adverse effects. Also we recommend that Lockhart Power inform the Commission of its discovery of any unknown archaeological resource, and any measures proposed if the archaeological resource is eligible for the National Register and is adversely affected by project construction or operation. There is no estimated cost associated with this measure.

Measures Not Recommended by Staff

Fish Impingement and Entrainment

Water intake structures at hydropower projects can injure or kill fish through impingement at intake screens/trash-racks, or entrainment through intakes and into turbines. The Riverdale Project currently includes two sets of trash racks, one of which is located at the intake to the project headrace and has 2.25-inch bar spacing. Interior recommends that Lockhart Power install 1-inch bar spacing at the headrace trash-rack to avoid and minimize fish entrainment and mortality.

Our analysis in section 3.3.2.2, *Environmental Effects,* indicates that entrainment and turbine mortality impacts of a trash-rack design with 1-inch bar spacing are potentially greater than the impacts of a design with the existing 2.25-inch bar spacing. Further, based on the intake velocities and the size of the bar spacing, most fish residing in the impoundment would be able to avoid impingement on the trashrack, but could be susceptible to entrainment through the turbines if they fail to use behavioral avoidance (i.e. burst swimming). The fish involved would likely consist of younger and smaller fish, which generally have high rates of mortality, even in the absence of hydropower operations. Fish populations have generally evolved to withstand losses of these smaller and younger individuals with little or no impact to long-term population sustainability. Consequently, replacing the existing trash-rack with a design having 1-inch bar spacing would not likely provide any benefits to fishery resources at the Riverdale Project. Therefore, we conclude that installation of 1-inch bar spacing at the headrace trashrack would not be worth the estimated levelized annual cost of $1,171.

Fish and Macroinvertebrate Surveys

The bypassed reach supports seven species of fish and one macroinvertebrate that are considered of conservation concern by the state. Interior recommends that Lockhart Power conduct surveys for fish and invertebrates before and after construction at the project, and again 1 year later, to provide information on the presence of the eight Conservation Species. Interior requests that Lockhart Power design the surveys in consultation with South Carolina DNR, South Carolina DHEC, NMFS, and FWS, and that sampling efforts be concentrated in the multiple habitat types in the bypassed reach. Interior states that additional surveys may be necessary depending on the results.

As explained in section 3.3.2.2, *Environmental Effects,* sufficient information already exists to document their occurrence in the bypassed reach and to evaluate how best to distribute flows to optimize aquatic habitat to support these species. Therefore, there is no need for this information. Consequently, we conclude that the information obtained from such surveys is not worth the estimated levelized annual costs of $2,341 and $702, for fish surveys and invertebrate surveys respectively.

Cultural Resource Survey

The Catawba Indian Nation recommends that Lockhart Power consult with the tribe prior to any ground-disturbing activity and states that Lockhart Power would most likely need to conduct a cultural resources survey involving shovel testing. Our analysis in section 3.3.6, *Cultural Resources,* indicates that there is no evidence archeological properties are present within the project's APE that would warrant a cultural resource survey and shovel testing prior to project construction. Rather, we recommend that should unknown archeological or historic resources be discovered in the future, as a result of project construction, operation, or other project related activities, Lockhart Power cease ground disturbing activities and consult with the Commission, the South Carolina SHPO, and the Catawba Indian Nation to establish the proper treatment of any potential archaeological or cultural resources. Therefore, we conclude that a cultural resources survey and shovel testing prior to ground-disturbing activity would not be worth the estimated levelized annual cost of $780.

5.3 Unavoidable Adverse Effects

Project refurbishment and the addition of canoe portage facilities would result in some land-disturbing activities that would affect approximately 2 acres of land. Implementing the erosion and sediment control plan would minimize these effects. Repairs to the sand gates on the Riverdale dam spillway would cause minor amounts of sediment to enter the Enoree River; however, the sediment management plan and sediment testing would ensure that the timing of sediment releases would occur when they would have the least adverse effect to aquatic resources. Repairs to the dam, penstock, powerhouse and other project facilities would also cause temporary and minor disturbances to wildlife near the construction activities.

Project operation would reduce flows to the bypassed reach and may release water that has a lower DO concentration than existing flows. Recommended minimum flows would be adequate to protect existing aquatic resources. Water quality monitoring would allow identification of any needed measures to maintain state water quality standards. Project operation would result in some fish impingement and entrainment mortality of resident fish in the Enoree River, but these would represent young fish and be comprised of highly prolific species that have the ability to compensate for losses.

5.4 Fish and Wildlife Agency Recommendations

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, and enhancement of fish and wildlife resources affected by the project.

Section 10(j) of the FPA states that whenever the Commission believes that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency will attempt to resolve any such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

In response to our REA notice, the following fish and wildlife agencies submitted recommendations for the project: Interior (letter filed September 10, 2012), South Carolina DNR (letter filed September 10, 2012), and NMFS (letter filed September 11, 2012). Table 16 lists the federal and state recommendations filed pursuant to section 10(j), and indicate whether the recommendations are included as part of the Staff Alternative. Environmental recommendations that we consider outside the scope of section 10(j) have been considered under section 10(a) of the FPA, and are addressed in the specific resource sections of this document.

Of the 9 recommendations that we consider to be within the scope of section 10(j), we include 7, and do not include 2 in the staff alternative. We discuss the reasons for not including those recommendations in section 5.2, *Comprehensive Development and Recommended Alternative.* Table 16 indicates the basis for our preliminary determinations concerning measures that we consider inconsistent with section 10(j).

TABLE 16—FISH AND WILDLIFE AGENCY RECOMMENDATIONS FOR THE RIVERDALE PROJECT

[Source: staff]

Recommendation	Agency	Within the scope of section 10(j)	Annualized cost ($)	Adopted?
Erosion and Sediment Control				
Implement South Carolina DHEC's stormwater BMP's during construction and maintenance activities to prevent or minimize erosion and sedimentation.	South Carolina DNR ...	Yes	390	Yes.[a]
Sediment Management Plan				
Develop and implement a sediment management plan with provisions to: (a) Consult with South Carolina DHEC to address the potential presence of contaminated sediments in the impoundment and additional monitoring and sediment management needs; (b) test impoundment sediment for heavy metals and other contaminants; (c) monitor sediment accumulation in the impoundment annually; (d) develop criteria that would trigger sediment removal from the impoundment, by opening sand gates, if appropriate, during high flow events, or mechanical methods; (e) conduct sediment management activities from November–January; and (f) file an annual report describing sediment monitoring and management activities, and an evaluation of the effectiveness of the plan.	South Carolina DNR, Interior.	Yes	1,597	Yes.[b c]

TABLE 16—FISH AND WILDLIFE AGENCY RECOMMENDATIONS FOR THE RIVERDALE PROJECT—Continued

[Source: staff]

Recommendation	Agency	Within the scope of section 10(j)	Annualized cost ($)	Adopted?
Management of Shoreline Erosion				
Implement the following measures to minimize the effects of project operations and associated shoreline erosion: (a) Identify eroding or potential project-induced erosion sites on project shorelines prior to beginning operation; (b) stabilize areas of shoreline erosion with native plants, bioengineering, slope flattening, toe armoring, and/or rip-rap which incorporates native vegetation plantings; (c) monitor shorelines after operation and implement stabilization techniques as necessary; and (d) conduct shoreline stabilization activities September–February to protect aquatic species and wildlife.	Interior	Yes, because it could not be done prior to licensing.	1,050	Yes.[d]
Water Quality Monitoring				
Conduct Water quality monitoring for 1-year at the impoundment during all proposed project operational drawdowns.	Interior	No[e]	1,561	Yes.
Instream Flows				
Provide minimum seasonal instream flows into the bypassed reach based on a MADF of 393 cfs. Seasonal flows to include: ○ 79 cfs—July–November ○ 118 cfs—May, June, and December ○ 157 cfs—January–April	Interior, South Carolina DNR, NMFS.	Yes	80,851	Not Adopted[f] (see section 5.2).
Develop an instream flow study plan within 6-months of license issuance and implement the plan after spillway gate renovations are complete, in consultation with NMFS, Interior, South Carolina DNR.	NMFS	Yes	6,244	Yes.[g]
Develop and implement a low inflow protocol/drought contingency plan, consistent with the South Carolina Water Plan including provisions for minimum flow requirements during drought periods.	South Carolina DNR, Interior.	Yes	390	Yes.
Evaluate the feasibility and effectiveness of using sand gates to provide minimum flows into the bypassed reach. Evaluation should include optimizing downstream habitat.	Interior, South Carolina DNR.	Yes	546	Yes.[h]
Aquatic Species Measures				
Modify trash rack bar spacing at headrace intake from 2.25 inches to 1 inch to avoid and minimize fish entrainment and mortality.	Interior	Yes	1,171	Not Adopted[f] (see section 5.2).
South Carolina Conservation Species study: Conduct comprehensive fish surveys of redeye bass, santee chub, piedmont darter, thicklip chub, greenfin shiner, notchlip redhorse, flat bullhead, snail bullhead. Conduct surveys before and after construction activities as well as 1 year after construction is complete to provide status of above mentioned priority species. Survey areas are to include multiple habitats within bypassed reach.	Interior	No[e]	2,341	No.[i]
Enhance and protect the panhandle pebblesnail to include provisions of appropriate minimum flows in bypassed reach.	Interior	No[e]	[j]0	No (staff-recommended minimum flows would maintain habitat).

TABLE 16—FISH AND WILDLIFE AGENCY RECOMMENDATIONS FOR THE RIVERDALE PROJECT—Continued

[Source: staff]

Recommendation	Agency	Within the scope of section 10(j)	Annualized cost ($)	Adopted?
Conduct comprehensive invertebrate surveys within the bypassed reach before and after construction, and one year after construction is complete. Surveys should be designed in consultation with South Carolina DNR, NMFS, South Carolina DHEC, and Interior.	Interior	No[e]	702	No.[i]
Riparian Buffer Zone				
Implement BMPs to protect vegetation within the project boundary, such as limiting vegetation and ground-disturbing activities and maintaining a minimum of 25-foot-wide vegetated buffer zone on all shorelines within the project boundary.	South Carolina DNR, Interior.	Yes	0	Yes.

[a] The measure was adopted under the staff-recommended soil erosion control plan.
[b] The measures were adopted under the staff-recommended sediment management plan.
[c] The measures were adopted under the staff-recommended measure to conduct testing for contaminants in the impoundment sediments prior to beginning project refurbishment activities.
[d] The measures were adopted under the staff-recommended shoreline stabilization plan.
[e] Not specific measures to protect, mitigate, or enhance fish and wildlife resources.
[f] Preliminary findings that recommendations found to be within the scope of section 10(j) are inconsistent with the comprehensive planning standard of section 10(a) of the FPA, including the equal consideration provision of section 4(e) of the FPA, are based on staff's determination that the cost of the measures outweigh the expected benefits.
[g] This measure is accommodated as part of the flow distribution study to determine how best to distribute flows in the bypassed reach to protect aquatic resources, but not to determine appropriate flows.
[h] This measure was adopted under the staff-recommendation flow release plan.
[i] Preliminary findings that recommendations found to be within the scope of section 10(j) are inconsistent with the substantial evidence standards of section 313(b) of the FPA based on a lack of evidence to support the reasonableness of the recommendation or a lack of justification for the measure.
[j] The measure is too vaguely defined to assign a cost and instream flow costs are included in the minimum instream flow recommendations.

5.5 Consistency With Comprehensive Plans

Section 10(a)(2)(A) of the FPA,[58] requires the Commission to consider the extent to which a project is consistent with the federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. We reviewed 22 state and federal comprehensive plans that are applicable to the Riverdale Project, located in South Carolina. The project would be consistent with their provisions with the exception of the state Water Plan. As discussed in section 5.2, *Comprehensive Development and Recommended Alternative,* the Water Plan's minimum flow regime is based on flow studies that capture high (January-April), low (July-November), and increasing (December) or decreasing (May, June) flow periods in the South Carolina Piedmont (Bulak and Jobsis, 1989). The Water Plan states that periods of seasonal variation in flow are important because fish have evolved to spawn in synchrony with the hydrologic cycle. While true, there is currently no evidence that the fishes or invertebrates in the bypassed reach, or downstream from the tailrace require such variation in the annual flow regime to complete their life-cycle.

Based on the Tennant (1976) method, Lockhart Power's proposed minimum flow of 60 cfs (16 percent of MADF) downstream of the tailrace and of 50 cfs (13 percent of MADF) into the bypassed reach would represent fair or degrading conditions during the dry season, and close to poor or minimum conditions during the wet season. However, a continuous minimum flow of 75 cfs (20 percent of MADF) year round would represent good conditions during the dry season and close to fair or degrading conditions during the wet season.

In section 5.2 of this EA, we find that our recommended continuous minimum flow of 75 cfs provides the best balance between providing flows for generation and providing flows for aquatic resource protection.

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6.0 Finding of No Significant Impact

Licensing the Riverdale Project would allow Lockhart Power to rehabilitate an existing, inoperable hydro facility and begin generating power. Project repairs and the addition of canoe portage facilities would result in some land-disturbing activities that would permanently affect a small amount of vegetation. Our recommended measures would ensure that erosion and sedimentation at the site is minimized. Providing minimum flows in the bypassed reach would ensure state water quality standards are met and aquatic habitat is maintained. Project operation and associated fish impingement and entrainment would result in some loss of resident fish in the Enoree River, but these would represent young fish and be comprised of highly prolific species that have the ability to compensate for losses. Native vegetation and wildlife within the project boundary would be preserved by limiting vegetation and ground-disturbing activities and maintaining a minimum 25-foot-wide forested riparian buffer on project shorelines. Public recreation opportunities would be improved in the project area and historic resources are protected for the life of the license.

On the basis of our independent analysis, we find that issuance of a license for the Riverdale Project, with our recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment.

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8.0 List of Preparers

Federal Energy Regulatory Commission

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Allan Creamer—Water and Fisheries Resources (Fisheries Biologist; B.S. and M.S., Fisheries Science)

Jeanne Edwards—Water Resources (Environmental Biologist; B.S., Biology/Biochemistry; MM, Public Administration)

Rachel McNamara—Recreation and Land Use, Cultural Resources (Outdoor Recreation Planner; B.A., Public Policy/Environmental Studies; M.C.P., Land Use and Environmental Planning)

Adam Peer—Fisheries Resources (Fish Biologist; B.S. Biology; M.S., Fisheries Science; Ph.D., Marine, Estuarine and Environmental Sciences)

Michael Spencer—Need for Power, Engineering and Developmental Analysis (Civil Engineer; B.S., Civil Engineering)

Appendix A

Fish lengths susceptible to impingement (shaded gray) and entrainment (shaded blue) as a function of burst swim speed. Horizontal dashed line is approach velocity and solid vertical line is minimum fish length susceptible to impingement. (Source: Staff).

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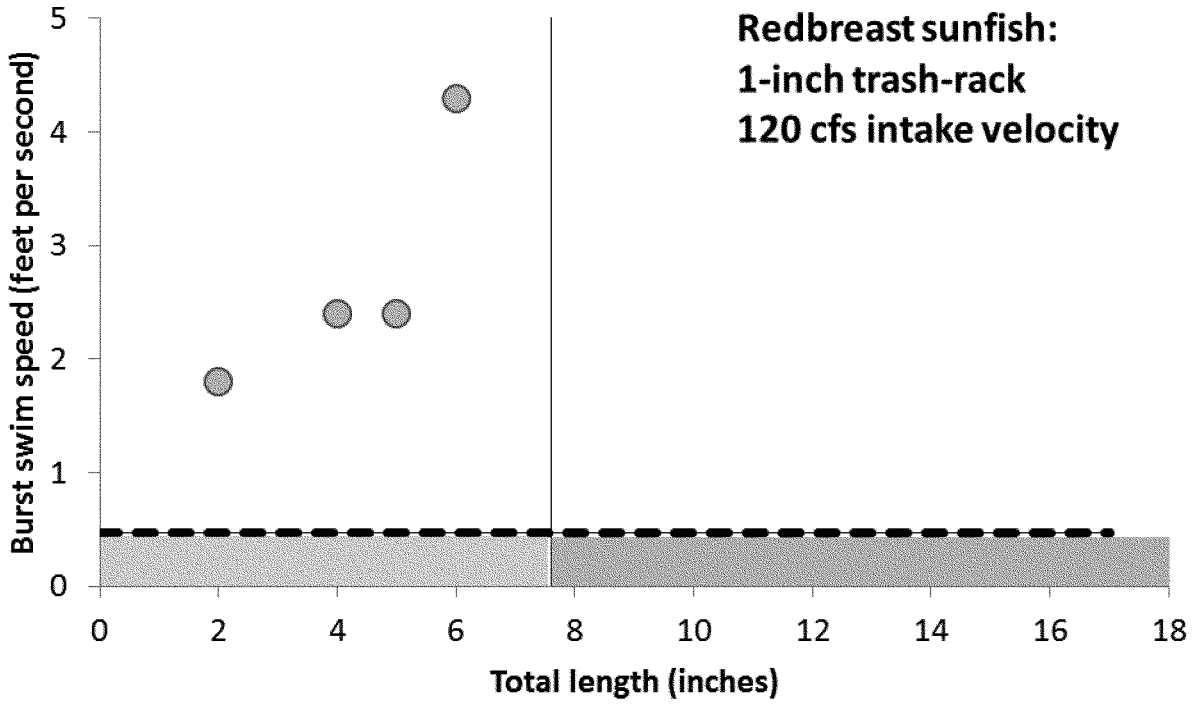
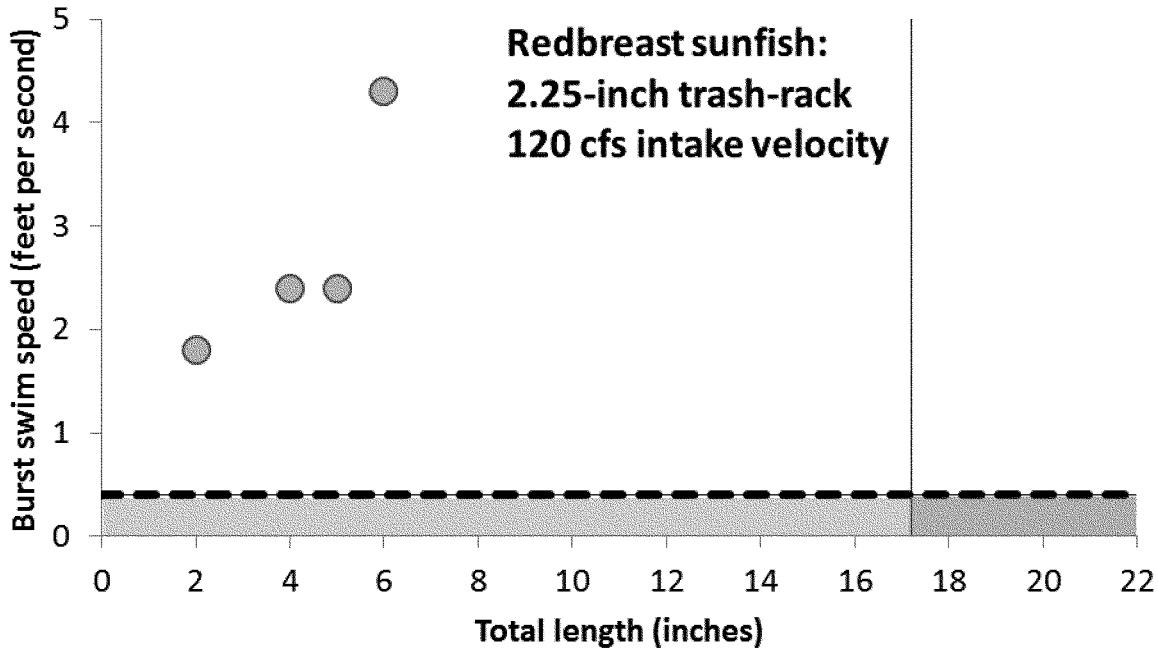
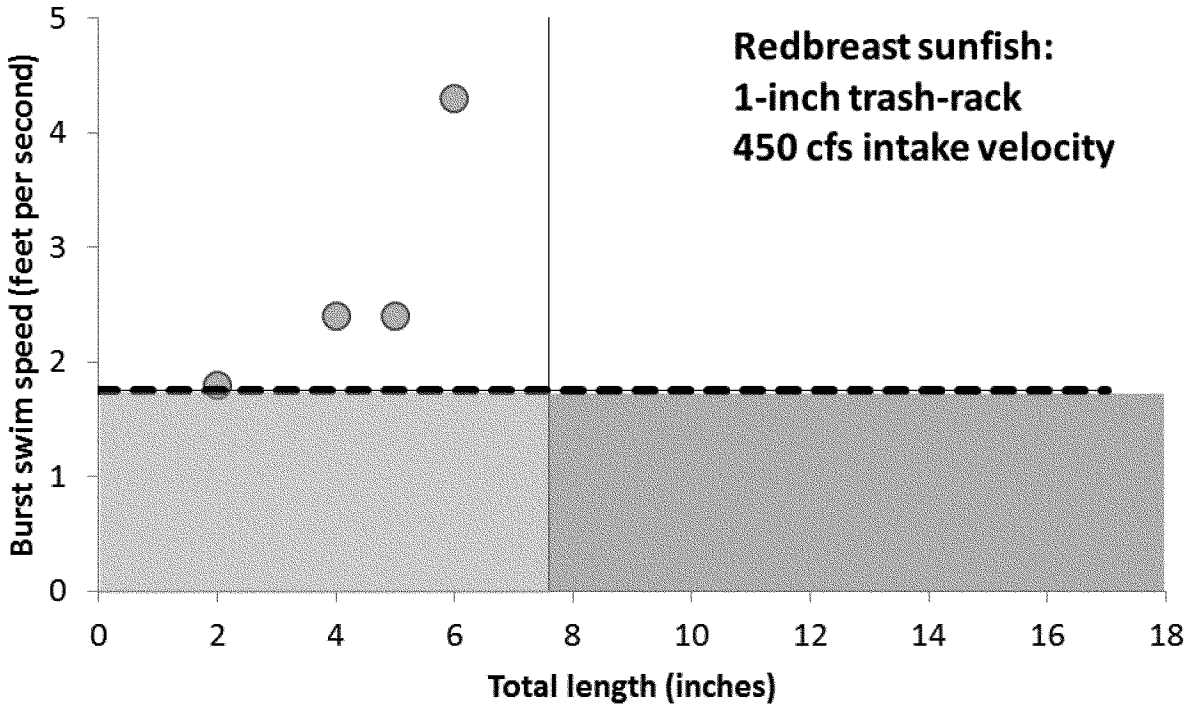


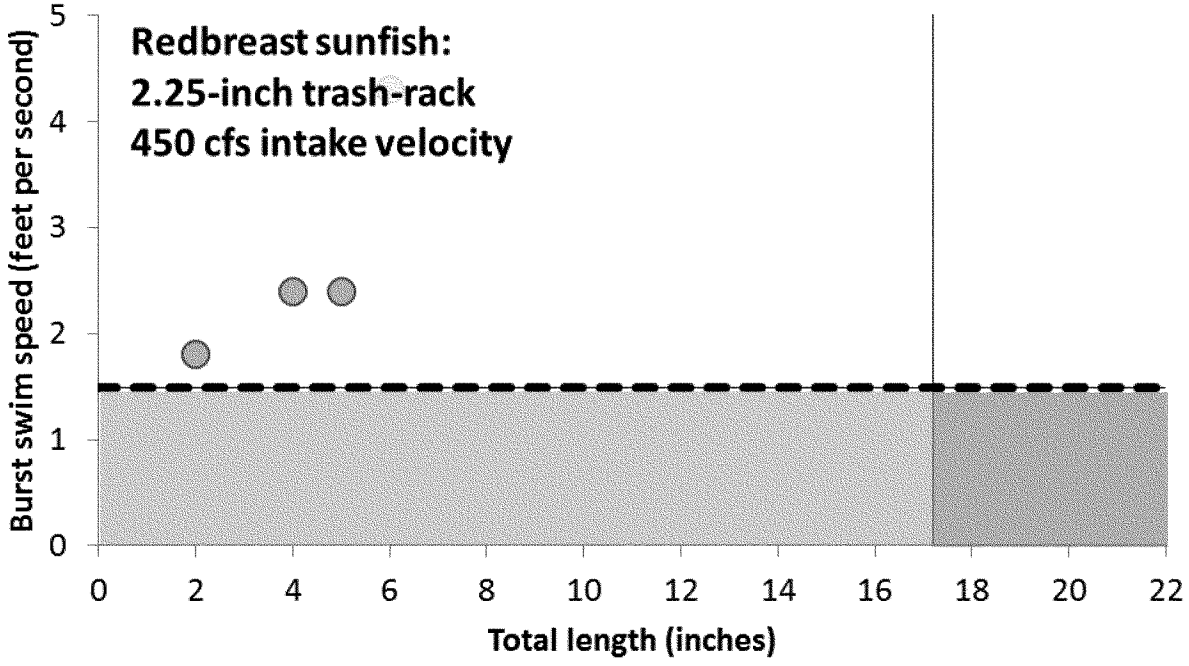
Redbreast sunfish exposed to 1-inch trashrack and 120 cfs intake velocity.



Redbreast sunfish exposed to 2.25-inch trashrack and 120 cfs intake velocity.



Redbreast sunfish exposed to 1-inch trashrack and 450 cfs intake velocity.



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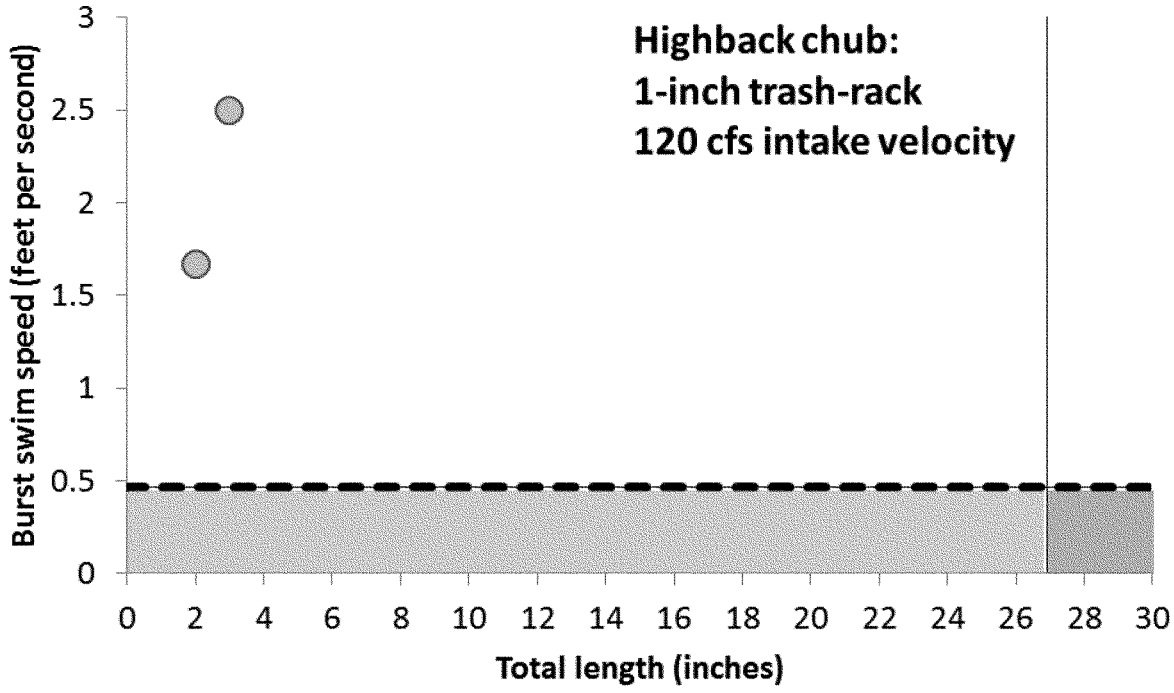
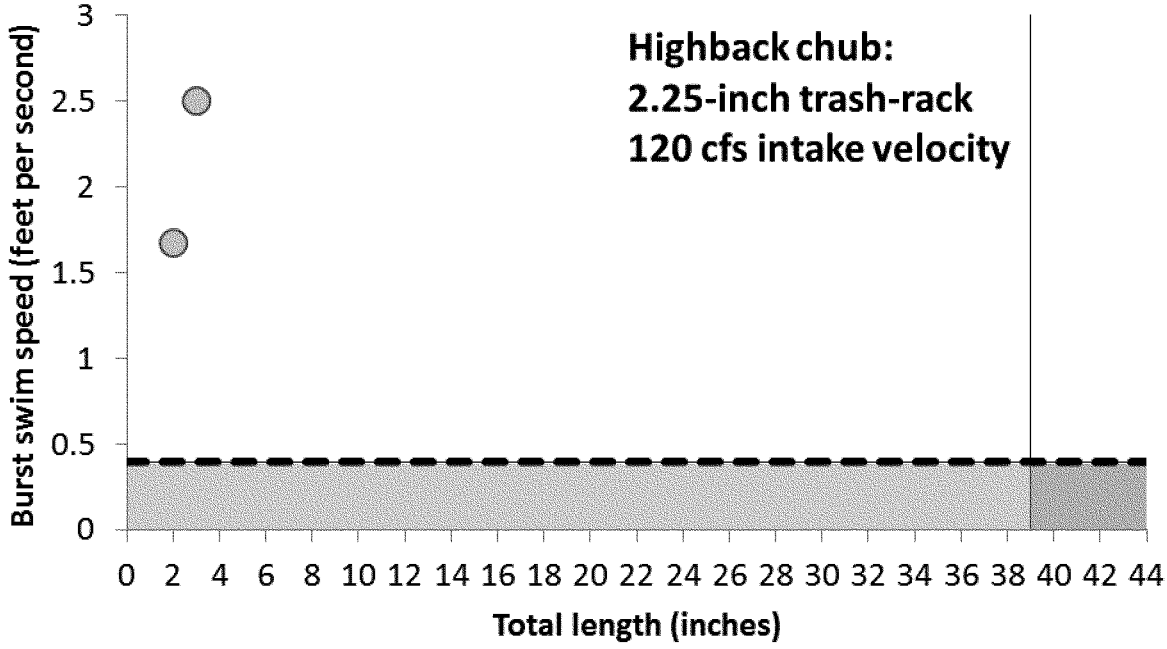
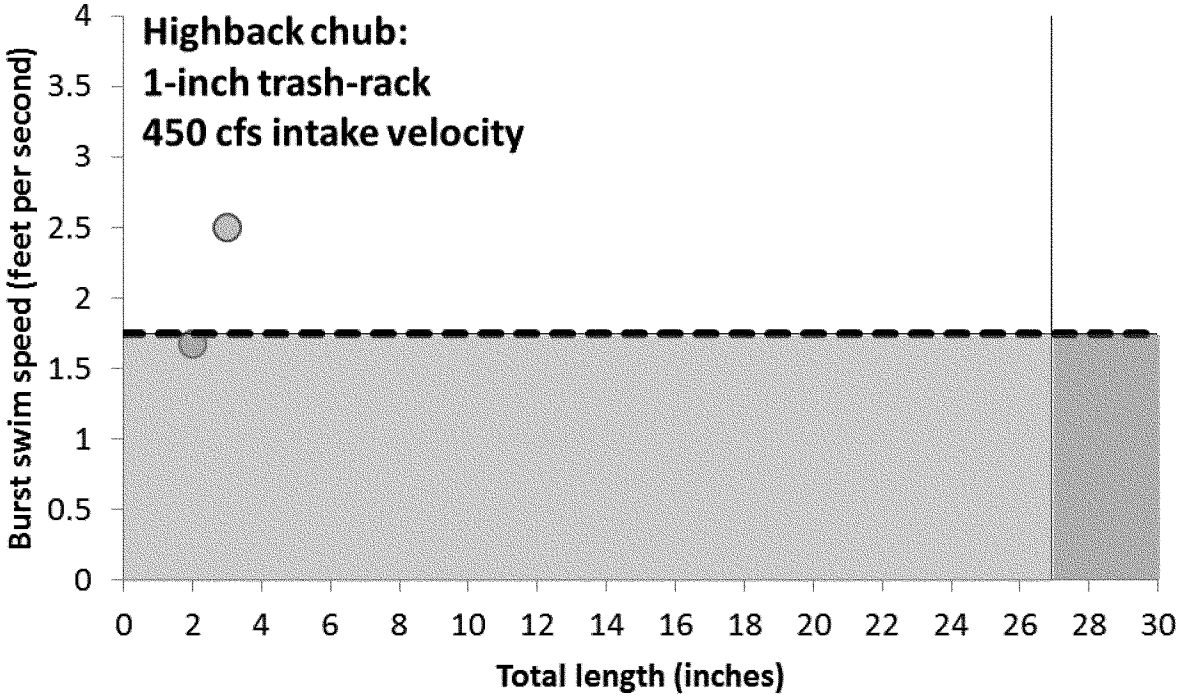


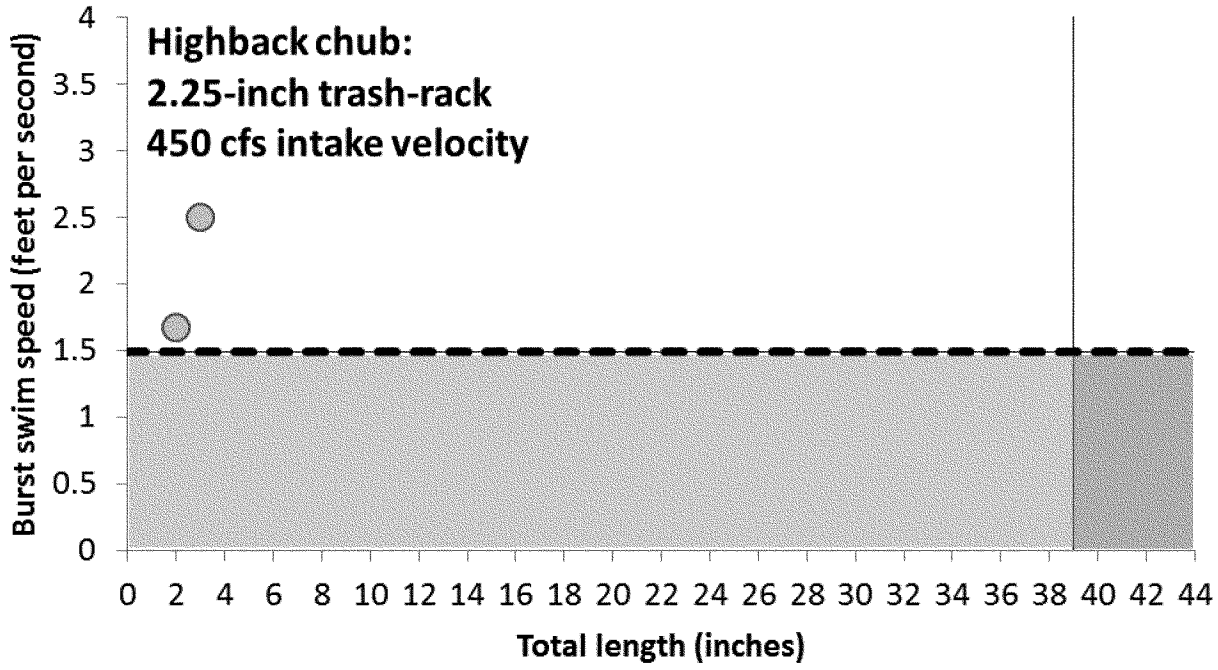
Highback chub exposed to 1-inch trashrack and 120 cfs intake velocity.



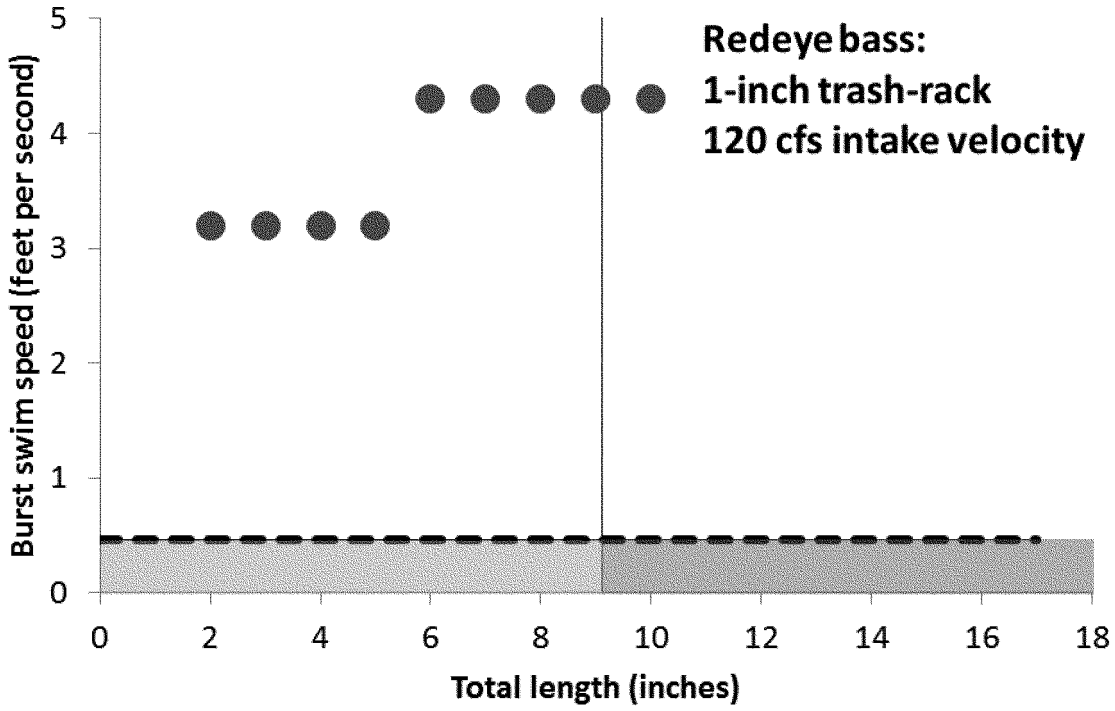
Highback chub exposed to 2.25-inch trashrack and 120 cfs intake velocity



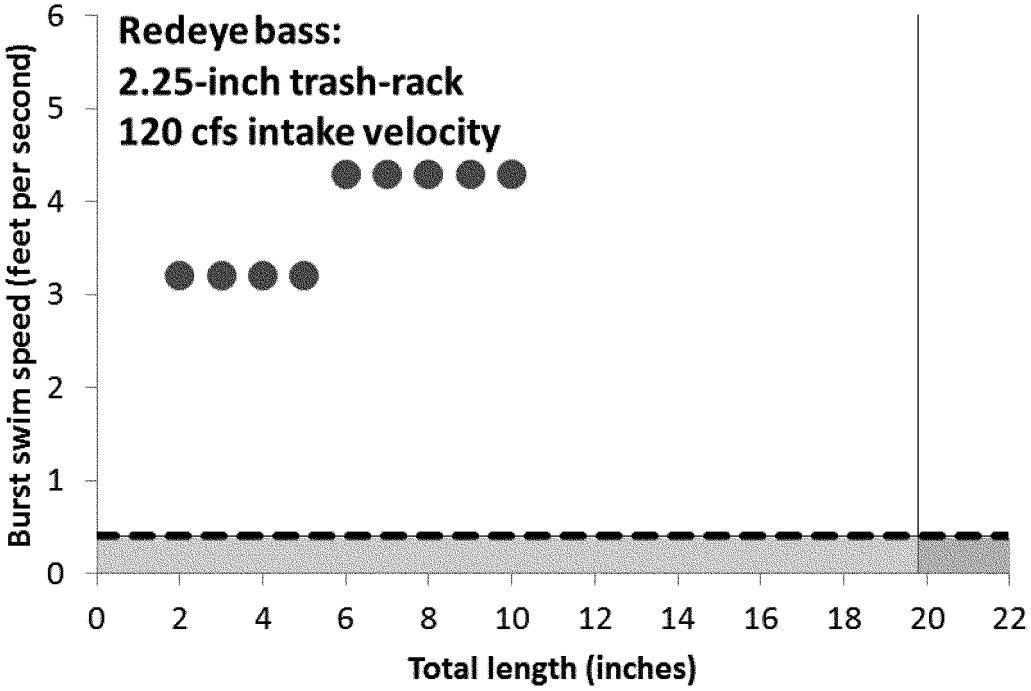
Highback chub exposed to 1-inch trashrack and 450 cfs intake velocity



Highback chub exposed to 2.25-inch trashrack and 450 cfs intake velocity



Redeye bass exposed to 1-inch trashrack and 120 cfs intake velocity



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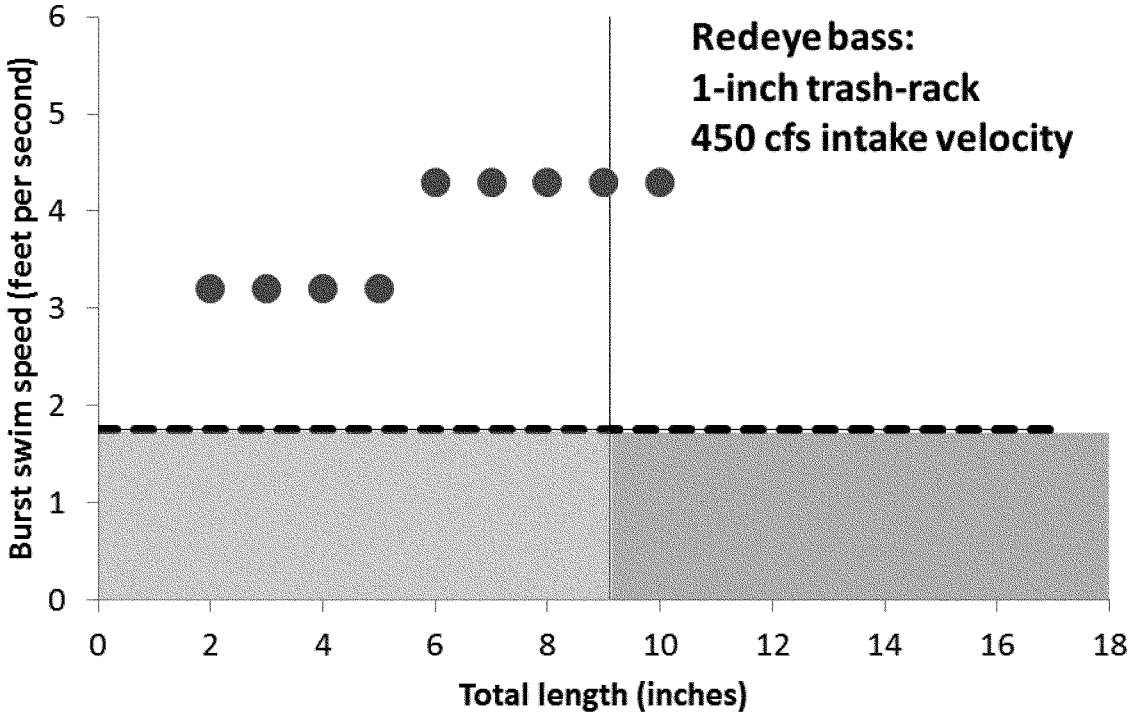

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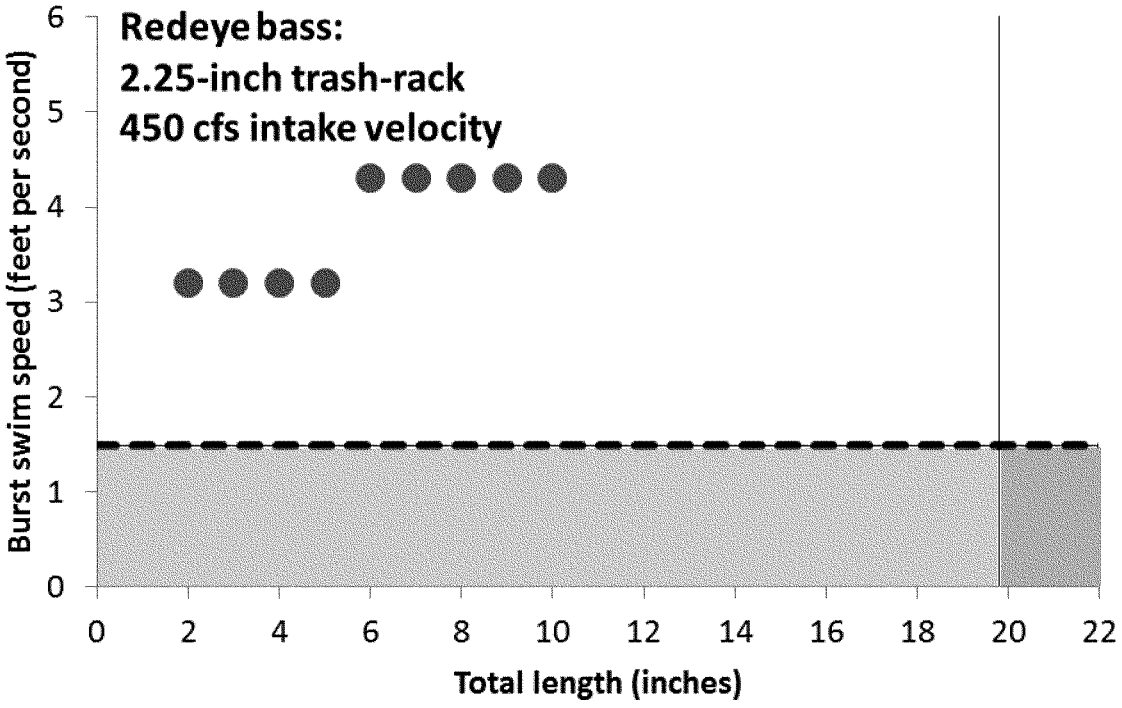
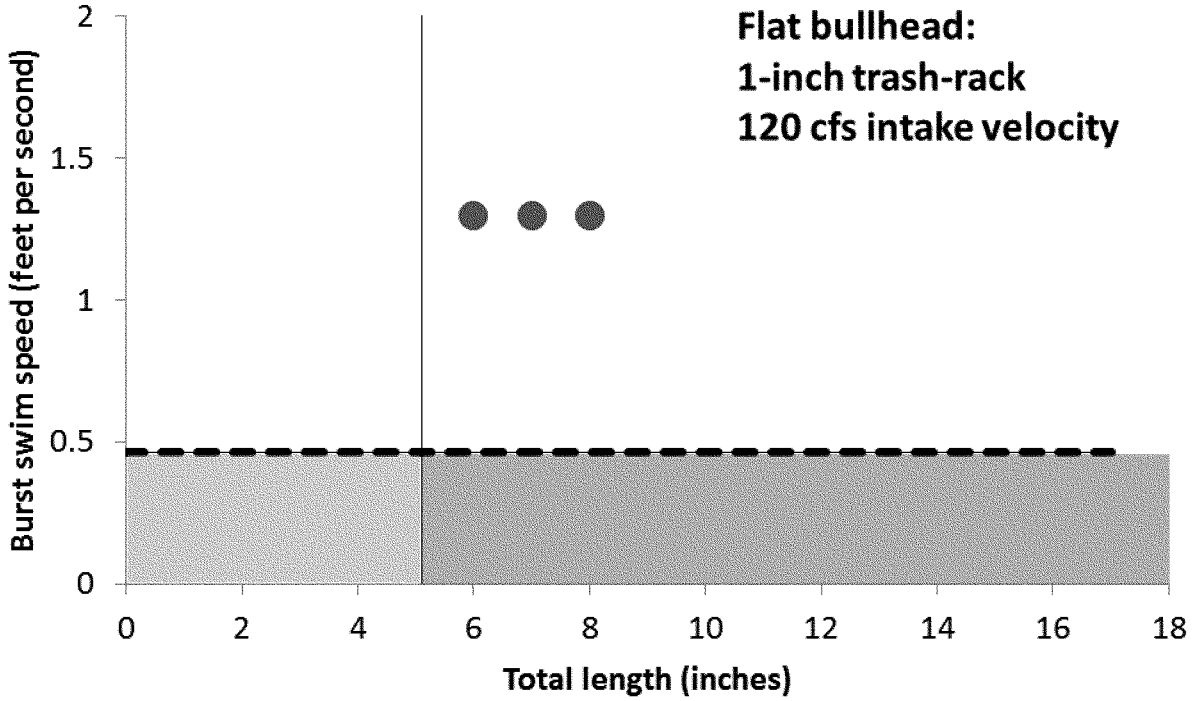
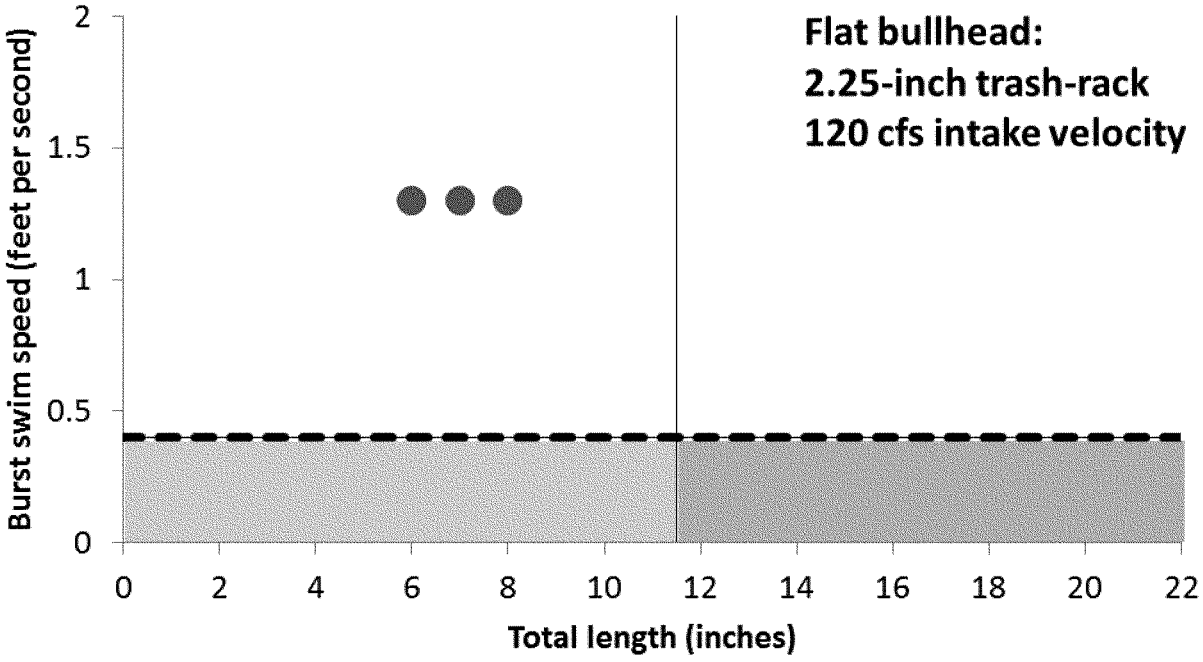


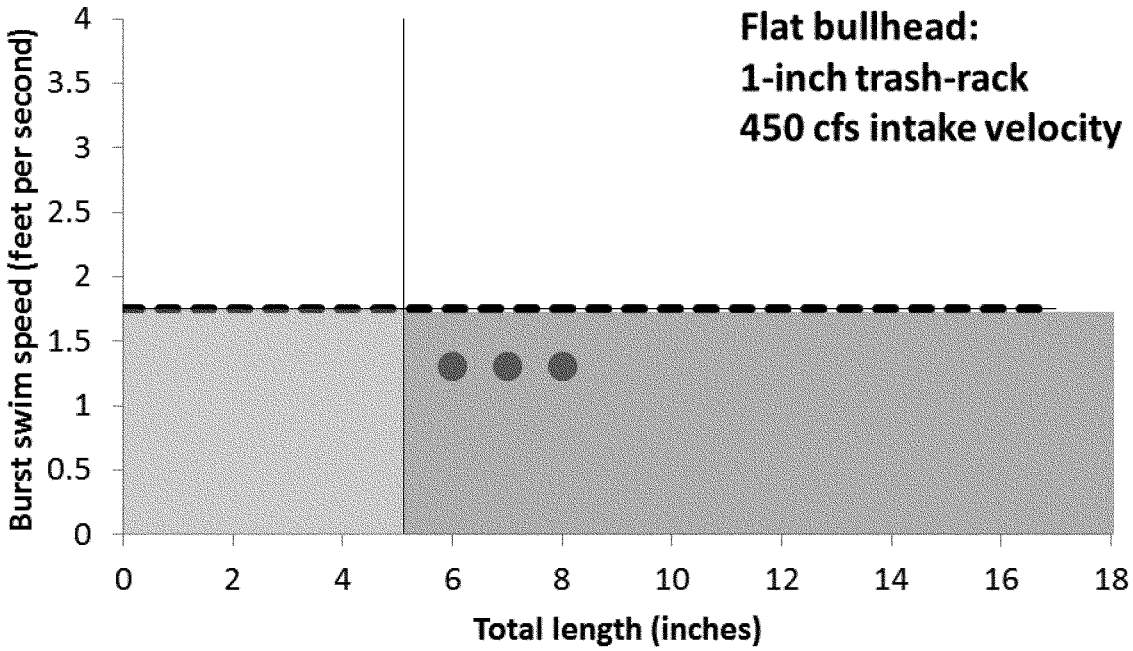
Redeye bass exposed to 2.25-inchtrash rack and 450 cfs intake velocity



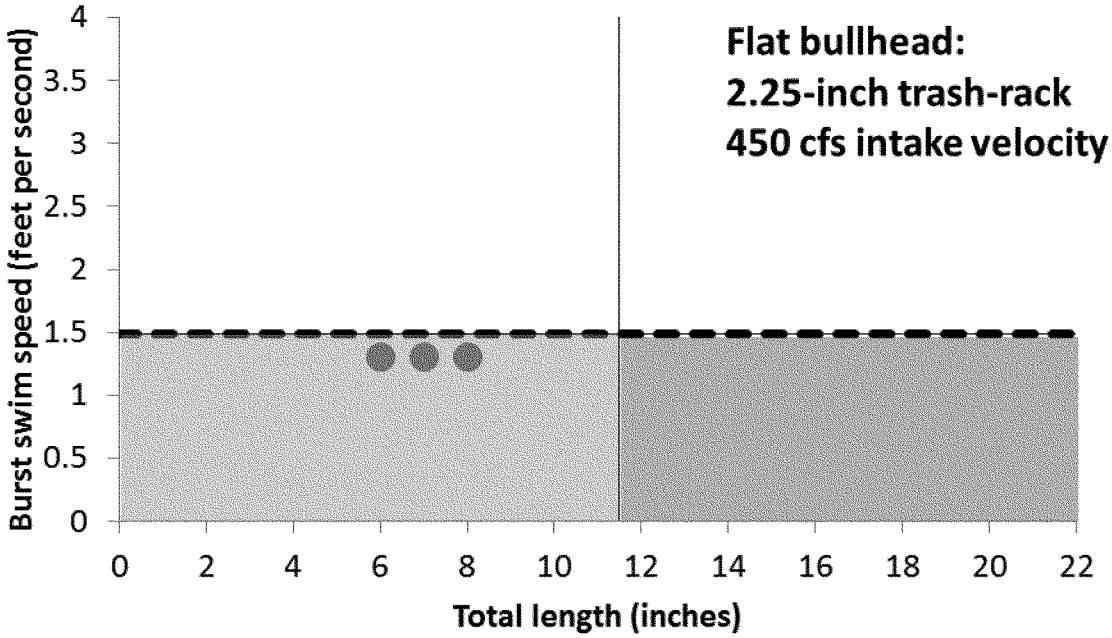
Flat bullhead exposed to 1-inch trashrack and 120 cfs intake velocity



Flat bullhead exposed to 2.25-inch trashrack and 120 cfs intake velocity



Flat bullhead exposed to 1-inch trashrack and 450 cfs intake velocity



Flat bullhead exposed to 2.25-inch trashrack and 450 cfs intake velocity

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