

HOLTWOOD REDEVELOPMENT PROJECT

**DESKTOP REVIEW OF DOWNSTREAM PASSAGE AND TURBINE
SURVIVAL OF DIADROMOUS FISHES PASSING THROUGH THE
REDEVELOPED HOLTWOOD STATION**

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1.0 INTRODUCTION

PPL Holtwood, LLC. (PPL) owns and operates the Holtwood hydroelectric project (Project) located on the Susquehanna River in Lancaster and York Counties in south-central Pennsylvania. PPL is evaluating the potential for redevelopment of the Project to add a new 125 MW powerhouse that will add economic renewable power in PA while also helping to resolve fish passage issues at the Project. The current project operates under Federal Energy Regulatory Commission License No. 1888 and is set to expire on September 1, 2014. PPL expects to seek an amendment and extension to the existing license (to 2030, the maximum term allowable under the Federal Power Act) in order to proceed with the redevelopment as quickly as possible. PPL is currently working with resource agencies to determine project issues and environmental concerns prior to submitting the amendment application to FERC. One of the issues that has been identified is downstream passage and turbine survival of diadromous fishes passing through the redeveloped Holtwood station. This study is designed to better understand and address this issue.

2.0 ISSUE

One of the potential issues associated with the Holtwood Redevelopment is the effect that the proposed minimum-gap Kaplan units will have on the downstream passage survival of diadromous fishes. This includes the survival of juvenile and post-spawned adult Alosids and adult American eel (collectively referred to as the target species). The review shall include pertinent data and conclusions from other studies and estimates of downstream passage survival of the target species at projects that have turbines that are similar to the proposed Kaplan Units. The assessment will also include a comparison of passage survival between the proposed Kaplan units and the existing Francis units.

3.0 OBJECTIVE

This review is being conducted to understand the effect that downstream turbine passage is expected to have on diadromous fish as they pass through the Holtwood project. This includes a characterization of the mortality associated with passage through the proposed Kaplan turbine units, the existing Francis turbine units, and the downstream bypass.

4.0 PROJECT SCOPE

PPL is proposing to conduct a literature-based downstream passage and turbine passage survival study using existing published and unpublished data related to the survival of the target species. To the extent possible, the review shall focus on results of downstream passage studies conducted at hydroelectric stations with physical characteristics (e.g., flow, intake location, turbine type) that are similar to those in the proposed redevelopment. The review will also include estimates of downstream passage survival using equations that predict blade strike probability based on fish size and turbine characteristics. The review will be accomplished through the following tasks:

1. Conduct a literature review on passage survival for the target species from studies conducted at hydropower stations. This will include turbine passage at facilities with similar turbine characteristics and also available data on the survival of the target species using spillways and downstream bypass structures.
2. Estimate turbine passage survival using predictive equations based on the size of the target species and the proposed turbine characteristics.
3. Develop survival estimates for the target species for both the existing and proposed turbines at the Holtwood Project. The range of estimates will be based on tasks 1&2 above.
4. Prepare both a draft and final report that summarizes pertinent data and conclusions from other studies and from model estimates of downstream passage survival of the target species at the redeveloped Holtwood project.

Detailed Task Description

Task 1. Review existing downstream passage data and studies for adult and juvenile Alosids and American eels.

A review of relevant downstream passage studies for adult and juvenile Alosids and American eels at hydropower projects that have similar turbines to the Holtwood station will be conducted. Information will be obtained from an extensive in-house library of published and gray literature on this subject, as well as study data from staff's recent work in this field. Additional information will also be obtained from colleagues and other industry contacts. Although there is an abundance of turbine mortality data for juvenile Alosids, the data sets and the available survival studies for post-spawned adult Alosids and American eels will be more limited.

Additionally, survival data for downstream passage through spillways, bypasses, and other mechanisms will be reviewed. It is anticipated that the amount of information available for the target species may be limited. Therefore, information for other species will also be considered in order to provide a characterization of anticipated survival rates.

The findings and data from the individual studies will be summarized and used to support an estimated range of survival rates for the target species passing the redeveloped Holtwood station.

Task 2. Estimate turbine passage survival using predictive equations.

Estimates of turbine passage survival for the target species will be predicted using published turbine survival equations that factor in the fish's body size and specific turbine characteristics based upon Von Raben's equation, the equation developed by Franke, *et al.* (1997), the Headrick Equation.

The fish survival prediction methods used for our calculations will be developed based upon the work of Von Raben, 1957. Von Raben's formula has recently been updated by Franke et al (1997). This updated fish survival prediction equation is termed the Advanced Hydro Turbine formula and it specifically accounts for leading edge strikes. It does not account for abrasion, which could indirectly cause mortality through infection, disorientation, etc or gap grinding. The Advanced Hydro Turbine formula was obtained from "Development of Environmentally Advanced hydropower Turbine System Design Concepts."

The survival assessment will also utilize an equation by Michael R. Headrick (Headrick Equation) that provides a simplified estimate of turbine survival for fish based on the fish length, the number of blades in the turbine, and the rpm of the turbine. This equation is most effective for turbines operating close to peak efficiency.

Task 3 Develop Survival Estimates.

Use the information obtained in Tasks 1 and 2 to develop survival estimates. These efforts will result in a range of survival estimates rather than a single-point estimate.

The range of estimates will consider the validity of the available empirical data and its applicability to Holtwood. The results of the predictive equations will also be compared to the available empirical data for ground-truthing.

Task 4 Reporting.

A draft report will be prepared that includes the following sections: an executive summary, introduction, project description, methods, results, discussion and literature cited. The project description will include information on project facilities and the operation of the existing Francis Units and proposed Kaplan Units.

The methods and results sections of the report will include information on the size of juvenile and adult Alosids passed, site characterization relative to turbine passage survival including a summary of existing site-specific survival studies, and a turbine survival assessment for each turbine type. Specifically, the turbine survival assessment will include information pertaining to database development

and acceptability criteria, information extracted from acceptable studies, and survival estimates using predictive models for turbine survival by size classes. The report will also provide a characterization of downstream passage survival through spillways bypasses, and other mechanisms and how the results may apply to the target species at Holtwood. The discussion will consider the survival probability for individual size groups of Alosids and American eels. The information derived from this study is intended to allow resource managers to assess the anticipated affects on the restoration of diadromous fish to the Susquehanna River and potential alternatives that could be investigated to avoid or lessen impacts, if warranted.

5.0 DELIVERABLES

The deliverables for this work scope will include:

- A copy of all data gathered and survival computations.
- Presentation of monthly status reports to PPL and the Agency consultation team.
- A copy of the Draft Final Report for review and comment.
- One electronic copy of the final report. The text shall be in MS Word format (MS 9 or higher). All tables and figures shall be in MS Word format or Microsoft Excel.
- A copy of the revised final report that incorporates comments of the Agency Consultation Team.

6.0 SCHEDULE

The desktop review will be conducted in spring/summer 2005 with a Draft Final Report due by September 1, 2005. Monthly status reports will be provided to PPL and members of the Cooperative Consultation team.

<i>Milestones</i>	<i>Dates</i>
Task 1. Review and summarize existing turbine survival information	August 1, 2005
Task 2. Develop survival estimates	September 1, 2005
Task 3. Develop draft final report	October 1, 2005
Final report	November 1, 2005