



US Army Corps  
of Engineers®

# APPENDIX H: COWFORD SWAMP STREAM RESTORATION ANALYSIS

WACCAMAW RIVER,

HORRY COUNTY, SOUTH CAROLINA

FLOOD RISK MANAGEMENT STUDY INTEGRATED  
FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

MAY 2026

## MAIN REPORT SUMMARY

The Integrated Feasibility Report and Environmental Assessment (FR/EA), that this appendix addresses, details a collaborative study by the U.S. Army Corps of Engineers (USACE) and Horry County, South Carolina. It is aimed at reducing existing and future flood risks to communities and transportation infrastructure within the Waccamaw River Basin, with a focus on Horry County. The study identifies four key flood impact areas: Longs & Red Bluff, Conway, Bucksport, and Socastee.

The flood impacts in each of these areas were independent of each other, so solutions could be evaluated self-reliantly, making any proposed alternative plans separable. The study considered a range of structural, non-structural, and nature-based solutions while incorporating public feedback gathered during meetings. An environmental analysis was completed, and a Finding of No Significant Impact is included within the main report. The document completed a public review and comment period while also undergoing internal agency reviews and adapted to those concerns and suggestions. In addition to historical flooding, the report acknowledges the flooding event caused by Hurricane Debby in August 2024 during this study, and its impact was assessed to further inform the study's conclusions.

The Recommended Plan, based on an evaluation of alternatives, includes two separable elements that are incrementally justified: Relief Bridges (cross drains) in the Conway flood impact area and Barrier Removal in the Socastee flood impact area. The Recommended Plan is classified as the National Economic Development Plan and is also the plan that maximizes net comprehensive benefits. No alternatives were justified for Federal investment for the Longs & Red Bluff and Bucksport flood impact areas. This Appendix provides a detailed example of an action for local consideration to supplement the Recommended Plan.

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## Cowford Swamp Stream Restoration Analysis – Introduction

As part of the Waccamaw River Flood Risk Management (FRM) Study, the U.S. Army Corps of Engineers conducted a hydraulic analysis of Cowford Swamp within the Bucksport Flood Impact Area. Multiple stakeholders expressed interest in potential improvements in this area; however, traditional structural flood risk reduction measures did not demonstrate sufficient benefits to justify Federal investment under the study authorization. The Cowford Swamp stream restoration concept was therefore evaluated as an additional measure during the study, though it was not part of the original screening process.

While the restoration concept did not produce sufficient flood damage reduction benefits to meet Federal interest criteria under the FRM authority, the analysis indicated that ecological restoration of Cowford Swamp could provide localized benefits to the surrounding community and watershed. Measures such as stream restoration or streambank stabilization can function as nature-based solutions by improving channel stability, reconnecting portions of the floodplain, and reducing sedimentation. These improvements may contribute to localized flood risk reduction by improving conveyance and restoring natural floodplain processes, similar to the benefits associated with streambank restoration.

The primary purpose of the proposed restoration concept would be stream restoration and channel stabilization, rather than large-scale flood risk reduction. Restoration efforts would focus on reestablishing natural hydrology and hydroperiods, removing channel obstructions and invasive vegetation, and implementing long-term management to prevent the reestablishment of invasive species. These actions would promote the regeneration of native wetland communities, including cypress–tupelo swamps and bottomland hardwood forests, improving overall ecosystem health and biodiversity.

Although the restoration concept was not carried forward as part of the Federally recommended plan, the hydraulic analysis and evaluation of restoration alternatives are presented here to inform potential locally implemented projects. The concept could be considered by the non-Federal sponsor or other local partners, who are not constrained by the same Federal interest requirements, as a nature-based measure that supports ecological restoration while providing potential localized flood risk reduction benefits.

### A.1 Location

Cowford Swamp is in Horry County, South Carolina, within the coastal plain region west of Conway. The potential project area extends approximately four miles upstream from the Pee Dee River, encompassing a broad, low-gradient floodplain system characterized by dense bottomland vegetation, shallow ponding, and poorly defined channels.

The swamp lies within the Waccamaw River watershed and is part of the larger Pee Dee River Basin. It is bounded to the east by the Conway city limits and transitions westward toward more rural, forested landscapes. Access to Cowford Swamp is limited due to frequent inundation, thick vegetation, and beaver activity, which has further altered the hydrology and obscured natural flow paths.

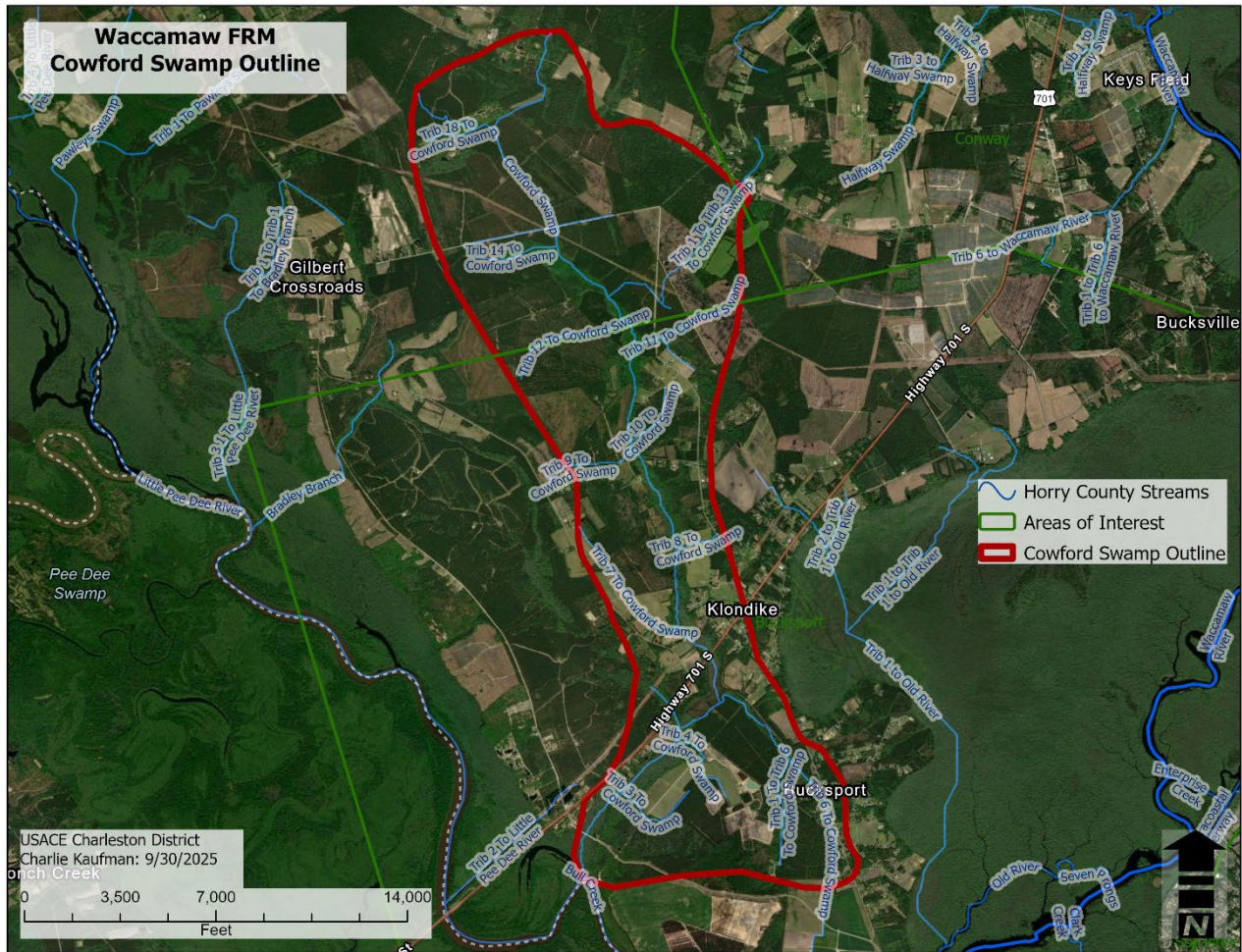


Figure A-4: Map of Cowford Swamp extents

**B HYDRAULIC MODELING – COWFORD SWAMP**

**B.1 Stream Restoration**

A 2D HEC-RAS model was developed specifically for Cowford Swamp to overcome limitations in the simplified FEMA Limited Detail Study (LDS) stream alignment. The FEMA dataset, derived from LiDAR, failed to capture true flow paths due to beaver activity, woody debris, ponding, and dense vegetation.

To refine the alignment, USACE’s Spatial Data Branch (SD) analyzed 1999 aerial imagery (pre-blockage accumulation), revealing a more complex network of bends and split channels. Using this as a base, SD delineated a revised alignment. Field survey data were then integrated, identifying confirmed obstructions and actual channel locations. The final alignment represents the flow path to be used in restoration, acknowledging that it may differ from the original channel but more accurately reflects current hydrologic conditions.

## B.2 Cross-Sections

Because field access was limited by flooding and vegetation, a hybrid approach combined historical data with targeted survey. The model geometry was updated to NAVD88. Many LDS cross-sections misrepresented floodplain topography, particularly downstream, where vertical “trenches” appeared due to LiDAR artifacts. Surveyed cross-sections were prioritized at major obstructions (58 identified), environmentally significant areas, and bridge crossings.

Wire Road was surveyed directly, while other bridge geometries were converted from the legacy HEC-RAS 2D dataset (NAVD88) and cross-checked with terrain data.

## B.3 Manning’s N Adjustments

Given the heavy vegetation, debris, and beaver dams, hydraulic roughness was carefully adjusted:

Upstream (heavily obstructed reaches): Channel  $n = 0.12$ ; Overbank  $n = 0.145$ .

Downstream (relatively unimpeded): Channel  $n$  reduced to 0.05; Overbank  $n$  remained at 0.145, consistent with FEMA LDS reference.

These adjustments allowed the model to better simulate true conveyance conditions and flow resistance.

## B.4 Bridges & Obstructions

Bridge geometry was refined using legacy data, field notes, and survey. Obstructions—including beaver dams and woody debris—were aligned to cross-sections to ensure hydraulic impacts were represented. Elevation differences between upstream and downstream sides of blockages confirmed their effect on flow restrictions.

## B.5 Restoration Alternatives

Alternative 1 – Full Restoration with Replanting

- Remove all woody debris, beaver dams, and impoundments.
- Remove invasive vegetation (herbicide, controlled burning).
- Replant with native species and provide long-term maintenance.

Alternative 2 – Full Restoration with Natural Regeneration

- Same as Alternative 1 but rely on natural regeneration without replanting.

Alternative 3 – Mechanical Clearance Only

- Excavate a 21-ft bottom channel path.
- Remove obstructions only within this corridor.
- Partial vegetation clearance.

#### Alternative 4 – No Action

- Maintain current degraded condition with continued decline.

### B.6 Model Implementation for Alternatives

In Feature Alt 1 and Alt 2, Manning's  $n$  for the channel is reduced to 0.05 throughout the entire area, while in Alt 3, it is reduced to 0.05 only within the 21-foot excavated path. Obstruction removal is fully implemented in Alt 1 and Alt 2, but in Alt 3, it is limited to the excavated corridor. The channel bottom width remains natural in Alt 1 and Alt 2, while it is modified to 21 feet in Alt 3. For vegetation management, Alt 1 involves full removal and replanting, Alt 2 includes partial removal with natural regeneration, and Alt 3 is limited to the excavator corridor.

### B.7 Results

The 2-year design storm was simulated using updated land use and reach-specific Manning's  $n$  values in HEC-RAS to reflect the proposed channel and floodplain restoration measures. Roughness coefficients were assigned spatially based on restored land cover, with Manning's  $n$  increased in reconnected floodplain and wetland areas to represent enhanced vegetative resistance, hydraulic storage, and overbank attenuation, and locally decreased within re-established channel segments to reflect improved conveyance associated with restored alignment, cross-sectional geometry, and removal of obstructions. Channel geometry was modified in the RAS geometry editor to reflect proposed realignment, cross-section reshaping, and reconnection of historic flow paths, while floodplain roughness was updated using land-use-based Manning's  $n$  polygons applied across the 2D flow area (or overbank regions in 1D).

Model results indicate that Alternatives 1 and 2 provide the greatest hydraulic benefit, reducing peak water surface elevations by approximately 4 percent and total inundated area by approximately 8 percent relative to existing conditions. These alternatives also decrease effective flow area and channel top width, resulting in shorter flood durations, enhanced floodplain connectivity, and hydraulic conditions that support long-term ecosystem recovery. Alternative 3 produces measurable but more localized improvements, whereas Alternative 4 yields minimal hydraulic benefit and allows continued degradation of channel form and floodplain function.

## C PROPOSED WORK TO BE PERFORMED

### C.1 Project Description:

This potential project for local consideration is the result of analyses conducted by USACE during the Waccamaw River Flood Risk Management Feasibility Study to understand if alternatives for restoring cypress-tupelo and bottomland hardwood forest in Cowford Swamp could benefit surrounding communities. Figures 2 and 3 show pictures of the Mineral Springs Road bridge crossing of Cowford Swamp. Site investigations show that forested wetland reach of Cowford Swamp showing shallow, tannin-stained water, dense vegetation, and a poorly defined channel indicative of low conveyance and dispersed overbank flow. The Cowford Swamp analysis was conducted to evaluate stream restoration opportunities that would restore natural hydrology, channel stability, and wetland function within the swamp system. While the primary objective is stream restoration, improvements to channel condition and floodplain connectivity could also provide localized reductions in water levels in surrounding areas. The Cowford Swamp stream

restoration concept was evaluated as an additional measure during the study but was not part of the original screening process. While it did not demonstrate sufficient flood damage reduction benefits to meet the Federal interest criteria under the study authority, it could still provide localized benefits.

Measures such as stream restoration or streambank stabilization can function as nature-based solutions that improve channel stability, reconnect portions of the floodplain, and reduce sedimentation, which can provide some localized flood risk reduction benefits similar to streambank restoration. However, the primary purpose of the measure would be ecosystem restoration and channel stabilization, rather than large-scale flood risk reduction.

As such, while it was not carried forward as part of the Federally recommended plan, it could still be considered by the non-Federal sponsor (NFS) as a locally implemented nature-based measure, since the NFS is not constrained by the same Federal interest requirements.

The aquatic ecosystem of Cowford Swamp has been severely degraded by a substantial loss of bottomland hardwood forest habitat. This degradation is characterized by declines in bottomland hardwood tree populations, loss of defined stream channels, loss of canopy cover (which provided shading and habitat diversity), and an increased presence of less desirable invasive species. This location makes Cowford Swamp an important ecological corridor, supporting migratory birds, native fish, and bottomland hardwood species, while also serving as a natural flood storage area for the surrounding region. Its proximity to Conway and the Pee Dee River increases the importance of restoring natural hydrology and ecological function, both for ecosystem resilience and for community benefits.

The primary restoration objectives are to:

- Restore and enhance the aquatic environment by reestablishing natural hydrology, flows, and connectivity;
- Restore and enhance the riparian corridor through the removal of invasive species; and
- Reforest the project area with keystone bottomland hardwood species to expand riparian corridors, reduce fragmentation, and increase both habitat and wildlife diversity.
- This study examined potential and practical alternatives for meeting these objectives.

The ecosystem restoration would increase habitat value over the life of the project by restoring approximately 150 acres of riparian bottomland hardwood with native vegetation and reestablishing historic hydrology. Habitats not subject to direct management would improve over time through increased species and structural diversity, offering more food and cover for wildlife. State and federal agencies have prioritized the protection and restoration of riparian and aquatic habitats nationwide. This potential project for local consideration and implementation supports those goals and serves as an example for future restoration efforts in South Carolina and across the country. The potential project provides important fish and wildlife benefits at a reasonable construction and O&M cost, along with other community benefits.



**Figure B-1: Upstream bridge location Cowford swamp**



**Figure B-2: Downstream bridge location Cowford swamp**

## **C.2 TASK 1: Removal of Blockages and Clearing of Channel**

Task 1 consists of the removal of blockages and the proper placement of cleared material both on- and off-site. This work involves the physical removal of blockages within the historic channel(s) throughout the Cowford Swamp project area. Blockages primarily include fallen timber, dense vegetation, debris choke points, and impoundments created by beavers. Their removal will restore natural hydrology by improving conveyance and reestablishing typical flood and low-water conditions.

Blockage removal will be accomplished through both mechanical and hand clearing. Mechanical removal will be performed using floating mechanized equipment (likely an amphibious track-hoe) to clear at least a 25-foot-wide path within the historic channel. Work will begin at the downstream end of the project reach and proceed upstream. If additional blockages are identified after the initial pass, crews will work back downstream to address them.

Because Cowford Swamp is a braided stream system, more than one channel alignment will require clearing. The design plan sheets will define project extents, including the minimum 25-foot clearing width along the primary channel and additional extents where two channels run parallel. It has been determined that approximately 5.25 miles of swamp channel clearing will be required, covering an estimated 16 acres.

Cleared organic material will be side-cast along the edges of the channel. Material near bridge crossings will be placed further away from openings to maintain hydraulic function. Inorganic material (e.g., tires, trash) will be removed, placed in dumpsters, and disposed of offsite.

This measure also includes an initial herbicide application across approximately 290 acres of Cowford Swamp that have been overtaken by cattails, alligator weed, and smartweed. Careful selection and application of herbicides will be critical to the successful removal of invasive and nuisance vegetation. All treatments will be designed to minimize impacts to adjacent croplands, wetlands, and forested areas.

After the initial application, the project area will be spot-treated for invasive species regrowth (from germination or outside introduction) for up to two years. If necessary, additional spot treatments may be conducted for up to two more years if triggers identified in the Adaptive Management Plan are met. Herbicide treatments will take place within the overall five-year Adaptive Management period (see Task 4).

### **C.2.1 TASK 2: Removal of Smaller Invasive Emergent Aquatic Vegetation**

Instead of the prescribed burning method, this proposed project will employ an aquatic bush hog to mechanically remove invasive emergent vegetation. While herbicide treatments are expected to be fatal to cattails (*Typha* sp.) and other nuisance species, cattail root systems are well embedded and their dead stalks would otherwise remain in the project area for years, clogging channels and reducing ecological function.

The aquatic bush hog will provide the most efficient means to physically remove dead cattails and other invasive vegetation. This process will also help recycle stored nutrients and carbon back into the system. All vegetation choking the channel within the defined removal path will be targeted, and cleared material will be side-cast outside of the main channel and away from bridge openings.

### **C.2.2 TASK 3: Replanting**

Task 3 includes replanting measures to supplement natural regeneration in the restored floodplain. A minimum mix of bald cypress, water tupelo, willow oak, and water oak will be used.

Post-planting maintenance will include targeted herbicide treatments (consistent with Alternative 3). Seedlings will be protected using biodegradable sleeves and regularly monitored to ensure establishment. Diseased or dead seedlings will be replaced to maintain survival rates and forest stand integrity.

**C.2.3 TASK 4: Adaptive Management**

The proposed project will incorporate an Adaptive Management Plan (AMP) to increase restoration success. Tasks will address both the cleared channel and the surrounding floodplain:

Cleared Channel: Responsibilities include maintaining the channel flow path free of new blockages and applying herbicides as needed to control nuisance vegetation.

Floodplain: Responsibilities include monitoring replanted vegetation for survival, removing diseased or failing seedlings, and applying herbicides to suppress invasive emergent vegetation that could outcompete native plantings.

Monitoring and maintenance will be most intensive in the years immediately following construction to ensure long-term success. As the bottomland hardwood swamp matures, maintenance demands will gradually decrease.

Monitoring indicators will include:

- Ensuring the channel reach remains free from blockages and excessive flooding,
- Verifying emergent vegetation does not obstruct the main channel and tributaries, and
- Confirming replanted trees remain viable and healthy.

The Monitoring and Adaptive Management period is recommended up to five years from project initiation, then full Operations and Maintenance for the life of the implemented project.