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# Appendix L – Source Water Protection Case Study

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# Source Water Protection Case Study

The Catawba–Wateree Water Management Group (CWWMG) coordinates watershed planning and management activities across the Catawba–Wateree River Basin. Within this group, the Source Water Protection Committee (SWPC) focuses on advancing land-based strategies that protect both water quantity and water quality. The SWPC is composed primarily of land conservancies, along with representatives from utilities, agencies, and other CWWMG members.

Each year, the CWWMG allocates a dedicated funding amount to the SWPC to support conservation and restoration projects that provide source water protection benefits. Members bring forward proposed projects and request funding through an application process. Because available funding is limited, the SWPC had emphasized the need for a transparent and objective approach to prioritizing projects with the greatest water-resource benefits.

Beginning in 2021, the SWPC adopted a structured project evaluation worksheet to support funding decisions. This framework partially relied on watershed modeling developed by RTI International, which quantified the benefits of conserving natural lands under projected future development scenarios. This approach provided a consistent, quantitative basis for comparing projects and identifying areas where land conservation could mitigate increases in runoff, nutrient loading, and sediment delivery.

However, because the original modeling framework focused on avoiding impacts from future development, it inherently favored projects located in areas with significant projected land use change. As a result, several limitations emerged:

- The value of protecting high-quality natural lands not immediately threatened by development was underrepresented.
- Restoration-focused projects, such as stream restoration or land rehabilitation, could not be evaluated consistently.
- Agricultural conservation practices and other land management actions fell outside the scope of the evaluation framework.

In 2025, advancements through the Integrated Water Resources Plan (IWRP) analyses and expanded capabilities within RTI's Watershed Flow and ALLocation model (WaterFALL®) enabled the development of an updated evaluation framework. This new approach supports consistent, objective assessment across a broader range of project types, including conservation, restoration, and management actions with differing objectives.

The case studies presented in this section demonstrate how the updated framework can be applied to projects with varying goals, locations, and conservation strategies, while maintaining a consistent basis for comparing water quantity and water quality benefits.

### General Methods for Project Evaluation

The SWPC project evaluation framework follows a standardized six-step process designed to ensure consistency, transparency, and objective comparison across projects. While early steps rely on project information provided by applicants and SWPC members, later steps use watershed modeling and standardized post-processing to quantify benefits.




### Step 1. Project Summary

Each project begins with a standardized project summary that describes what is being proposed and why. The project summary establishes the context needed to evaluate expected water quantity and water quality benefits and includes:

- Project location and watershed context, including the site, local catchment, and downstream drainage area
- Lead organization (e.g., land conservancy or project sponsor)
- Proposed conservation, restoration, or management actions
- The primary project objective, such as reducing sedimentation, addressing nutrient impairment, preserving high-quality land or waters, or mitigating flooding

To promote consistency across applications, project objectives and actions are selected from standardized lists. Objectives include categories such as reduction of sediment loading, preservation of high-quality waters, restoration of aquatic ecosystem health, and mitigation of flooding. Actions include land conservation, land restoration, stream restoration, wetland restoration, and implementation of agricultural conservation practices. Using standardized objective and action categories ensures that projects with similar goals are evaluated using comparable criteria.

### Step 2. Evaluation Method

Projects are evaluated using either a specific or relative comparison approach:

- Specific evaluations compare modeled results to defined numeric targets or thresholds, such as water quality criteria or volume-reduction targets, when such benchmarks are available and appropriate.
- Relative evaluations compare the percent change in modeled hydrologic and water quality metrics to the proportion of the watershed or catchment affected by the project.

Relative evaluation is commonly used when numeric regulatory targets are not available or when project benefits are best interpreted in relation to project scale. In these cases, changes that exceed the proportion of the drainage area influenced by the project are considered significant.

**Step 3. Metric and Weight Assignment**

Based on the selected project objective, a tailored set of hydrology and water-quality metrics is selected for evaluation. Metric selection is objective-driven, ensuring that each project is assessed using measures that directly reflect the condition it is intended to address.

Metric Categories:

Metrics are drawn from standardized categories that may include:

- Land-surface runoff metrics, such as total runoff volume, runoff frequency, peak runoff depth, and nutrient or sediment loads generated from the land surface
- Streamflow metrics, including average and maximum daily streamflow, flow duration, and indicators of flood magnitude or frequency
- Instream water quality metrics, such as sediment, nitrogen, and phosphorus loads or concentrations transported through the stream network and include streambank erosion loads
- Supporting hydrologic indicators, including infiltration and baseflow stability metrics that reflect improvements to watershed function and aquatic habitat

Primary and Secondary Metrics:

For each objective, metrics are designated as either primary or secondary:

- Primary metrics directly measure the main condition the project is intended to address and carry the greatest influence in scoring.
- Secondary metrics capture related or supporting benefits that are important but not the central focus of the project.

For example:

- Projects focused on reducing sedimentation from land prioritize sediment loads generated from the land surface, with secondary consideration given to instream sediment loads, particularly during high-flow conditions.
- Projects addressing nutrient loading emphasize nitrogen and phosphorus loads from the land surface, with secondary consideration of downstream instream loads.

- Projects focused on aquatic ecosystem restoration prioritize hydrologic stability metrics, such as baseflow and flow flashiness, with secondary consideration of instream nutrient conditions.
- Projects addressing flooding emphasize peak flow magnitude, flow duration, or runoff metrics, depending on whether riverine or surface flooding is the primary concern.

Analysis Type Considerations:

Metric interpretation depends on the analysis type associated with the objective:

- Improved vs. Current Condition evaluations compare modeled outcomes under project implementation to existing conditions, quantifying the magnitude of improvement achieved.
- Current Condition Relative to Catchment or Subbasin evaluations are used for preservation objectives, where benefits are defined by maintaining areas that already perform better than surrounding lands or waters.

For preservation projects, some metrics are scored based on relative performance (for example, whether runoff or pollutant loading rates from the project area are lower than the surrounding catchment), rather than absolute reductions.

Weighting Framework:

Each metric is assigned a weight based on:

1. Whether it is classified as primary or secondary
2. The number of metrics used to represent the project objective
3. Whether hydrology or water quality is the dominant component for the objective

Primary metrics receive a larger share of the total objective weight, while secondary metrics receive proportionally smaller weights. This approach ensures that scoring reflects both project intent and measurable outcomes, while still recognizing ancillary benefits.

**Step 4. Scenario Simulation**

For each project, baseline conditions and one or more comparison scenarios are simulated using WaterFALL. Scenarios are configured to represent:

- Conservation or preservation of existing land cover
- Restoration actions that alter land cover, stream condition, or management practices
- Alternative future conditions, such as development scenarios avoided through conservation

Model inputs reflect changes in land use, land cover, and streambank condition appropriate to the selected project actions.

**Step 5. Hydrology and Water Quality Evaluation**

Model outputs are post-processed using standardized scripts to calculate site-level, catchment-level, and instream metrics for hydrology and water quality. This step produces consistent tables and figures summarizing:

- Changes in runoff and streamflow
- Changes in nutrient and sediment loading
- Differences between baseline and project scenarios across spatial scales

Standardization of post-processing ensures that all projects are evaluated using the same analytical approach and quality-controlled procedures.

**Step 6. Evaluation Scoring**

Finally, metric results and assigned weights are combined to calculate an overall evaluation score for each project. Scores reflect the extent to which a project meets its stated objectives and delivers meaningful water quantity or water quality benefits.

Scoring thresholds are used to distinguish projects that:

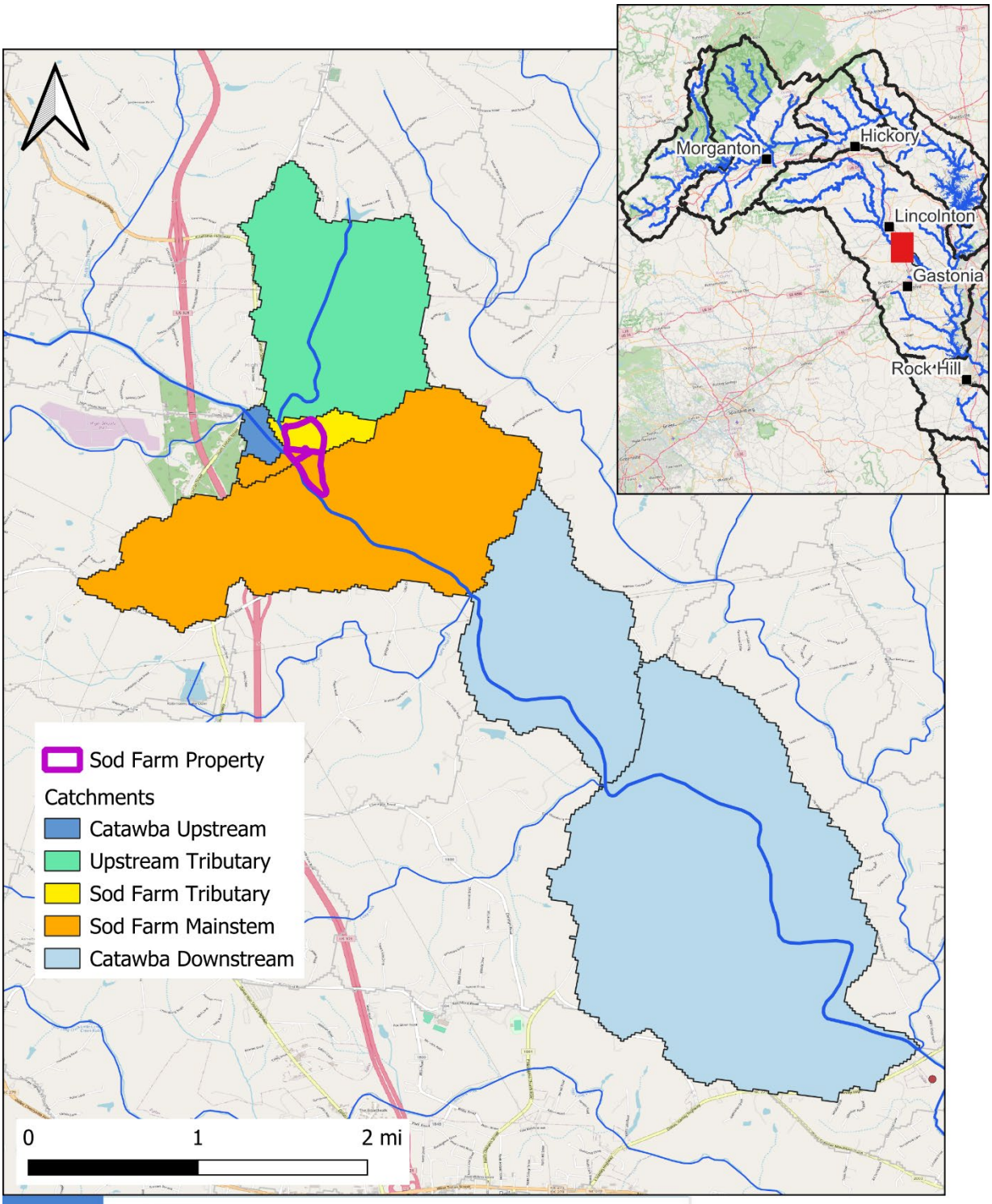
- Strongly satisfy objectives and demonstrate high value
- Provide moderate benefits warranting consideration
- Do not demonstrate sufficient hydrologic or water-quality justification relative to other projects

This scoring framework provides a transparent and consistent basis for prioritizing projects for funding across a wide range of conservation, restoration, and management actions.

## Sod Farm Land Restoration Case Study

#### PROJECT OVERVIEW

The Sod Farm Land Restoration Project, proposed by the Catawba Lands Conservancy (CLC), focuses on restoring approximately 50 acres of former sod production land along the South Fork Catawba River in Gaston County, North Carolina, near High Shoals. Historically, sod cultivation extended to the river's edge, creating a direct pathway for runoff, nutrients, and sediment to enter the river system.




Catawba-Wateree Water Management Group
INTEGRATED WATER RESOURCES PLAN

SOD FARM CASE STUDY

The project area spans approximately 0.0784 mi² (50.18 acres) across three NHDPlus catchments (9747244, 9747420, and 9747424), which together drain 2.6 mi². While the site represents a very small fraction of the overall watershed (~0.015% of the 512.5 mi² drainage area), it is located within a sensitive river corridor where land surface conditions directly influence water quality.

The proposed action is land restoration, converting cultivated sod fields to deciduous forest. This project is evaluated under the SWPC framework as a General Land Restoration project, with the objective of improving degraded land conditions to reduce runoff, erosion, and nutrient mobilization while restoring more natural hydrologic function.

Three conditions were evaluated:

- Baseline (current conditions)
- Intermediate restoration (early vegetative recovery)
- Final nature-based solution (full forest restoration)

| | |
|---|---|
| **Site Name:** | Sod Farm |
| **Organization:** | Catawba Lands Conservancy (lead); Corporate partner (funding) |
| **Identified Issue:** | Existing sod farming with irrigation as well as aggregate mining along streambank |
| **Action:** | Land Restoration - converting crop land to deciduous forest |
| **Objective:** | General Land Restoration |
| **Watershed Position:** | South Fork Catawba River, downstream of Indian Creek and upstream of the USGS stream gage at Lowell, NC |
| **Drainage Area:** | 512.5 mi^2 |
| **Site Area:** | 0.0784 mi^2 (50.18 acres) |
| **Catchment(s):** | 9747244, 9747420, 9747424 |
| **Catchment Area:** | 2.614 mi^2 |
| **Subbasin:** | South Fork Catawba River |
| **Baseline:** | Current Conditions |
| **Comparison State(s):** | Improved baseline conditions (i.e., Convert agricultural lands to deciduous forest) |
| | Comparison between 3 scenarios: baseline, intermediate growth state, and NBS Final |

#### EVALUATION FRAMEWORK APPLICATION

Consistent with the methodology described in Section 7.5.2, this project was evaluated using a relative evaluation approach, as no specific regulatory thresholds were applicable. Under this approach, modeled changes in hydrology and water quality metrics are interpreted relative to the proportion of the drainage area influenced by the project:

- Instream threshold: ~0.015% of total drainage area
- Catchment threshold: ~3% of local catchment area

**Evaluation Method (either Specific OR Relative must be selected)**

| **Specific Evaluation** | **No** |
|---|---|
| **Flow Metrics & thresholds/targets:** | N/A |
| **WQ Metrics & thresholds/targets:** | N/A |
| **Relative Evaluation** | **Yes** |
| **Drainage Area Threshold for Instream Metrics** | $\frac{0.0784\ \text{mi}^2}{512.5\ \text{mi}^2} = 0.000153 \text{ or } 0.015\%$ |
| **Local Area Threshold for Catchment Metrics** | $\frac{0.0784\ \text{mi}^2}{2.614\ \text{mi}^2} = 0.03 \text{ or } 3\%\%$ |

The selected objective (General Land Restoration) prioritizes water quality metrics, with hydrology treated as a secondary component. Metrics used in scoring include:

- Water Quality (primary focus):
  sediment, nitrogen, and phosphorus loads generated from the land surface
- Hydrology (secondary focus):
  mean annual total catchment runoff and average annual maximum daily streamflow

Metric weights reflect this prioritization, with 70% of the total score assigned to water quality and 30% to hydrology.

**Selected Metrics & Framework Assigned Objective Weight**

| **Target Metric (Primary metrics in bold)** | **Met Objective** | **Objective Weight** |
|---|---|---|
| Hydrology | | 0.3 |
| | Mean annual total catchment runoff | 0.7 |
| | Average annual maximum daily streamflow | 0.3 |
| **Water Quality** | | 0.7 |
| | Sediment load from the land surface | 0.4 |
| | Nitrogen load from the land surface | 0.3 |
| | Phosphorus load from the land surface | 0.3 |

#### MODELING APPROACH

To quantify project benefits, RTI International conducted a 20-year daily simulation (2001–2020) using the WaterFALL model. Simulations compared baseline conditions with intermediate and

final restoration scenarios. Consistent with SWPC evaluation practices, results from the final restoration condition were used for scoring to reflect long-term project outcomes.

### WATER QUANTITY AND QUALITY BENEFITS

Restoration primarily influences site-scale hydrology by reducing the volume and frequency of surface runoff. Under baseline conditions, the project area generates approximately 5.01 million gallons of runoff annually across about 44 runoff-producing days. Intermediate restoration reduces runoff by approximately 0.36 million gallons per year, while full forest restoration results in a total reduction of about 0.86 million gallons annually and approximately 15 fewer runoff days.

At the catchment scale, however, hydrologic changes are modest. Reductions in mean annual runoff (~2.3%) and average annual maximum daily streamflow (0.0%) fall below the relative significance thresholds established by the SWPC framework. As a result, hydrology metrics did not contribute to the project's Priority Score. This reflects the project's small footprint relative to the overall drainage area rather than a lack of localized hydrologic benefit.

Water quality improvements form the primary basis of the project's evaluation. Under the final forested condition:

- Sediment loads from the land surface decrease by approximately 10.3%
- Nitrogen loads decrease by approximately 8.7%
- Phosphorus loads decrease by approximately 13.6%

All reductions exceed the relative significance threshold for catchment-scale metrics and align directly with the project's objective. Because these metrics are designated as primary (sediment) and secondary (nutrients) under the SWPC framework, all received full credit in scoring.

These site-scale improvements translate into substantial downstream benefits. At the outlet of the downstream-most catchment containing the project area, long-term restoration results in reductions of up to approximately 450 lbs/year of total nitrogen, 40 lbs/year of total phosphorus, and more than 20,000 lbs/year of total suspended sediment. Further downstream, average annual instream load reductions reach approximately 1,700 lbs of nitrogen, 220 lbs of phosphorus, and 35 tons of sediment, with even greater reductions during wetter years.

### PROJECT SCORING AND INTERPRETATION

Using the SWPC evaluation framework, the Sod Farm project received a Priority Score of 0.7. This score reflects:

- Minimal contribution from hydrologic metrics due to project scale relative to the watershed
- Strong and consistent reductions in sediment and nutrient loading, which directly support the project objective

A score of 0.7 indicates that the project meets the majority of its stated objectives and provides meaningful water quality benefits, supporting its prioritization for funding.

**PRIORITY SCORE EVALUATION**

| | |
|---|---|
| **Evaluation Type:** | Relative Evaluation |
| **Drainage Area Threshold for Instream Metrics** | 0.015% |
| **Local Area Threshold for Catchment Metrics** | 3.0% |

**Using results from final NBS implementation with full forest restoration**

| **Selected Metrics:** | | **Weights:** | **% Reduction Value** | **Metric Score*** | **Weighted Value** | **Final Score** |
|---|---|---|---|---|---|---|
| Hydrology | | 0.3 | | | | 0.0 |
| | Mean annual total catchment runoff | 0.7 | 2.3% | 0 | 0.0 | |
| | Average annual maximum daily streamflow* | 0.3 | 0.0% | 0 | 0.0 | |
| Water Quality | | 0.7 | | | | 0.7 |
| | Sediment load from the land surface | 0.4 | 10.3% | 1 | 0.4 | |
| | Nitrogen load from the land surface | 0.3 | 8.7% | 1 | 0.3 | |
| | Phosphorus load from the land surface | 0.3 | 13.6% | 1 | 0.3 | |
| | | | | | | |
| | | | | | **Evaluation Score:** | 0.7 |

*Using daily 90th percentile of streamflow at outlet of lower Sod Farm mainstem catchment

## SUMMARY

This case study demonstrates how targeted upland and riparian restoration can produce substantial water quality benefits even at relatively small spatial scales. Although catchment-scale hydrologic changes are limited, the consistent reduction in sediment and nutrient export, particularly during runoff-driven events, supports improved channel stability, downstream water quality, and overall watershed resilience.