Chester River **A**ction, **R**estoration, and **E**nforcement **S**chematic (CARES): Watershed Management Report

Team 7

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UAPP 411/611: Regional Watershed Management

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1.0 Mission Statement:

The goal of the Chester River Action, Restoration, and Enforcement Scheme (CARES) initiative is to analyze the environmental and anthropogenic stressors affecting the Chester River and its tributaries to promote a healthy and resilient ecosystem within the broader Chesapeake Bay. By addressing specific impairments to water quality and biological integrity, CARES seeks to achieve environmental sustainability and the restoration of vital aquatic habitats by 2035 through targeted mitigation and strategic multi-jurisdictional cooperation.

2.0 Background

2.1 Geographical Context

The Chester River is a critical brackish tributary of the Chesapeake Bay, located on Maryland's Eastern Shore within Kent and Queen Anne's Counties (ShoreRivers, 2025). The total drainage area of the watershed is approximately 368 square miles. The Upper Chester River sub-watershed encompasses 178 square miles, of which 137 square miles are located in Maryland, and approximately 41 square miles extend into Delaware (MDE, 2019). This cross-border context is a vital management factor, as upstream sediment and nutrient loads from Delaware discharge directly into Maryland's non-tidal 8-digit watershed. Consequently, Delaware is prescribed specific sediment reductions at the state boundary to ensure Maryland's water quality standards are met (MDE, 2019).

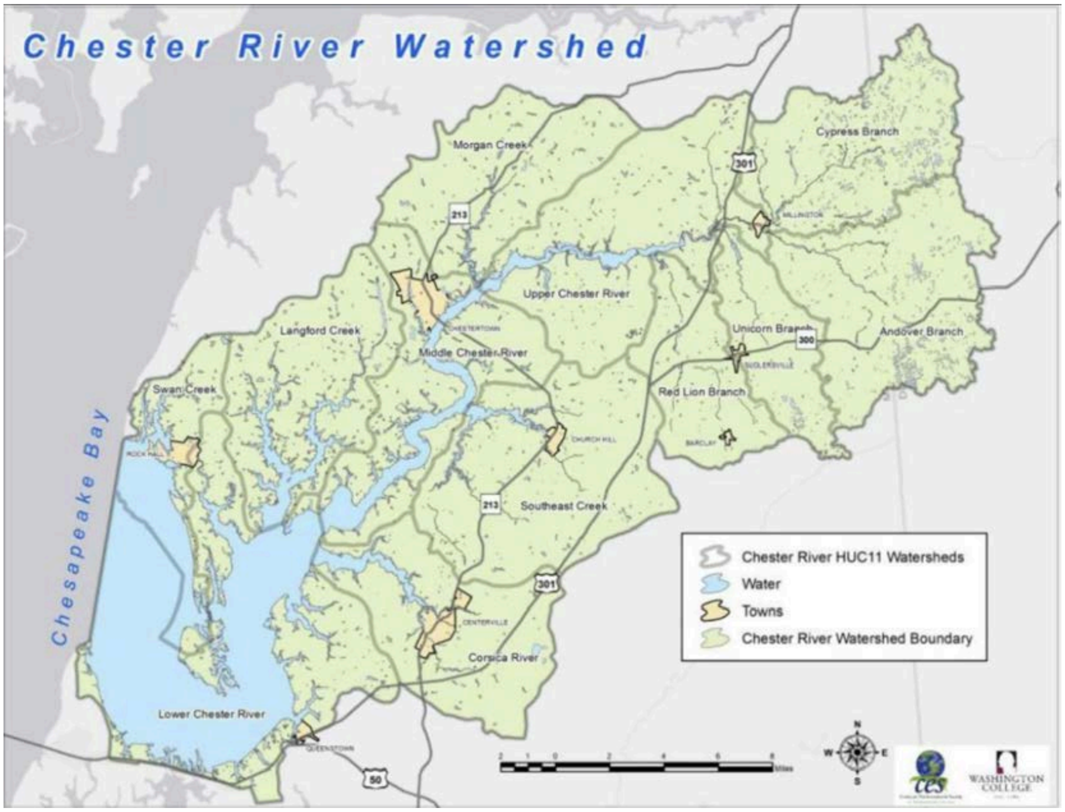

Figure 1: GIS mapping of the Chester River Watershed

This ArcGIS map highlights the major land-use types within the Chester River watershed. The watershed contains relatively few urbanized areas and is instead dominated by farmland and other agricultural land.

2.2 Physical Characteristics of the River

The watershed is situated within the Coastal Plain Province, characterized by low topographical relief and a geological landscape of unconsolidated sediments, including sand, gravel, silt, and clay (MDE, 2019). The Upper Chester River extends approximately 16.9 kilometers from its headwaters in Delaware to its confluence with Foreman Branch. The region is dominated by Sassafras and Ingleside soil associations; these are categorized as prime farmland due to their high productivity for both agriculture and forestry (MDE, 2019).

2.3 Water Quality and Composition

The biological health of the Chester River is currently impaired by high concentrations of Total Suspended Solids (TSS) and nutrient runoff (Nitrogen and Phosphorus). Watershed health is measured through the Benthic Index of Biotic Integrity (BIBI) and the Fish Index of Biotic Integrity (FIBI). These indices have historically indicated significant negative deviations from reference conditions, reflecting a degraded aquatic environment (MDE, 2019; UAPP411, 2025).

2.4 Biological Diversity

Despite ecological stressors, the watershed remains a vital habitat for various species, including oysters, catfish, striped bass, diamondback terrapins, blue herons, yellow perch, and blue crabs (ShoreRivers, 2025). Submerged Aquatic Vegetation (SAV) serves as a critical habitat-creating element, providing nursery and spawning areas. While turbidity and sedimentation have historically suppressed SAV populations, recent restoration efforts have facilitated its return to specific reaches of the river.

2.5 Human Activities and Ecological Factors

Land use in the Upper Chester River is predominantly agricultural. While agriculture is a primary economic driver, it represents the largest source of nutrient and sediment pollution within the watershed.

Table 1: Land-Use Distribution in the Upper Chester River Watershed

Land-Use Category	**Percentage Distribution**
Agriculture (Crop, Pasture, AFO/CAFO, Nursery)	52%
Forest	39%

Urban/Developed	5%
Water/Wetlands/Other	4%

(Source: MDE, 2019)

Ecological degradation is further driven by poorly managed agricultural operations, failing septic systems, and increased suburbanization, which contribute to untreated stormwater discharge (ShoreRivers, 2025).

3.0 Policies

The regulatory framework for the watershed is anchored by the EPA's 2010 Chesapeake Bay Total Maximum Daily Load (TMDL), which establishes rigorous loading caps for nitrogen, phosphorus, and sediment (EPA, 2010). Implementation is managed through state-level Watershed Implementation Plans (WIPs) in both Maryland and Delaware.

In Maryland, the 1998 Nutrient Management Law is a primary enforcement mechanism, with the Maryland Department of Agriculture (MDA) overseeing fertilizer and manure application rates and mandatory setback distances (UAPP411, 2025). Because the Upper Chester receives significant upstream inputs, the MDE coordinates with the Delaware Department of Natural Resources and Environmental Control (DNREC) to manage sediment reductions at the state boundary (MDE, 2019). Non-governmental advocacy provided by ShoreRivers and the Chester Riverkeeper serves an essential role in independent water quality monitoring and policy enforcement.

4.0 Problems

The CARES scheme identifies three primary environmental stressors impacting the river's biological and physical integrity.

Table 2: Primary Environmental Stressors and Causes

Problem	Description	Primary Causes
Low Dissolved Oxygen (DO)	Hypoxic "dead zones" in deeper waters during summer months, leading to aquatic distress and fish kills.	Decomposing algal blooms; water stillness (thermal stratification prevents mixing); slow tidal flushing in certain tributaries.
Eutrophication	Excessive nutrient enrichment fueling rapid algal growth that blocks sunlight and depletes oxygen levels.	Excess nitrogen and phosphorus from fertilizers, animal waste (poultry and livestock), and septic system leakage.
Sedimentation & Habitat Loss	Elevated turbidity (cloudy water) that smothers benthic habitats and prevents the growth of SAV.	Agricultural and shoreline erosion; loss of natural riparian buffers; stormwater runoff from impervious urban surfaces.

These problems are separate issues that each need to be addressed, but are also very complex problems that often can become overlapped with one another. For example, eutrophication of a body of water can cause low dissolved oxygen content, which in turn can affect habitats that may be sensitive to changes in the amount of sunlight or drastic increases and decreases in certain macronutrients like nitrogen and phosphate. It is important when facing problems such as these to have direct, quantifiable goals in order to be able to measure some sort of impact of any changes made either in regulations or physically.

4.1 Problem 1: Low Dissolved Oxygen

Low dissolved oxygen is one of the most important water quality problems affecting the Chester River because oxygen availability directly controls whether fish, crabs, oysters, and benthic organisms can survive. Dissolved oxygen levels are especially vulnerable during the summer months when warmer water holds less oxygen and biological activity increases. In deeper or slower-moving sections of the river, thermal stratification can prevent mixing between oxygen-rich surface water and oxygen-poor bottom water. This can create hypoxic conditions, often called "dead zones," where aquatic organisms experience stress, displacement, or mortality.

In the Chester River, low dissolved oxygen is closely connected to nutrient pollution and algal blooms. When excess nitrogen and phosphorus enter the river, they fuel rapid algal growth. As algae die and decompose, bacteria consume oxygen from the water column. This process can significantly reduce dissolved oxygen levels, especially in areas with slow tidal flushing. Since the Chester River is a brackish tributary of the Chesapeake Bay, these local oxygen problems also contribute to broader Chesapeake Bay water quality concerns.

Low dissolved oxygen also affects the biological indicators used to evaluate watershed health. The Chester River's biological condition is measured using the Benthic Index of Biotic Integrity (BIBI) and Fish Index of Biotic Integrity (FIBI), which have shown negative deviations from reference conditions. These impaired scores suggest that poor water quality is affecting both bottom-dwelling organisms and fish communities. For CARES, improving dissolved oxygen is therefore a central goal because it supports habitat stability, aquatic biodiversity, and the long-term resilience of the river.

4.2 Problem 2: Eutrophication

Eutrophication is another major issue in the Chester River watershed and is primarily caused by excess nutrients entering the river system. Nitrogen and phosphorus from fertilizers, animal waste, poultry and livestock operations, septic system leakage, and stormwater runoff can enter tributaries and eventually reach the main river. Since the Upper Chester River watershed is heavily agricultural, nutrient pollution is strongly tied to land-use practices. Agriculture makes up 52% of land use in the Upper Chester River watershed, making it the dominant land use and a major contributor to nutrient and sediment pollution.

When too many nutrients enter the river, they stimulate excessive algal growth. These algal blooms can block sunlight from reaching submerged aquatic vegetation, reducing the growth of important underwater habitats. When the algae die, decomposition consumes oxygen and contributes to low dissolved oxygen conditions. This creates a cycle where nutrient pollution causes algal blooms, algal blooms reduce water clarity and oxygen, and lower oxygen harms aquatic life.

Eutrophication is especially concerning because it affects both the Chester River and the broader Chesapeake Bay. The Chesapeake Bay TMDL was created to establish loading caps for nitrogen, phosphorus, and sediment, and the Chester River watershed is part of that larger restoration framework. Reducing nutrient loading is therefore not only important for local water quality but also necessary for meeting regional Chesapeake Bay restoration goals.

4.3 Problem 3: Sedimentation and Habitat Loss

Sedimentation and habitat loss are major physical stressors in the Chester River watershed. Sedimentation occurs when soil particles are carried into waterways through erosion and runoff. In the Chester River, this problem is linked to agricultural fields, shoreline erosion, stormwater runoff, and the loss of natural riparian buffers. When sediment enters the river, it increases turbidity, making the water cloudy and reducing the amount of sunlight that can reach underwater plants.

This is especially harmful to submerged aquatic vegetation, or SAV, which provides nursery habitat, spawning areas, and shelter for aquatic species. SAV is a critical habitat-forming feature in the Chester River, but turbidity and sedimentation have historically suppressed its growth. Without healthy SAV beds, fish, crabs, oysters, and other organisms lose important habitat. Sediment can also smother habitats, which affects bottom-dwelling organisms and reduces overall biological integrity.

Habitat loss is also connected to land-use patterns in the watershed. The Upper Chester River watershed is mostly agricultural and forested, with only a small percentage of urban/developed land. This means that restoration should focus heavily on agricultural runoff control, streambank stabilization, and riparian buffer restoration. Reestablishing vegetation along waterways can reduce erosion, filter pollutants, stabilize banks, and improve habitat quality.

5.0 Goals for 2035

To restore the ecological resilience of the Chester River, the CARES initiative has established the following strategic goals:

1. **Dissolved Oxygen Improvement:** Raise summer dissolved oxygen levels above 5.0 mg/L in all major tributary segments to support fish respiration and habitat stability.
2. **Nutrient Loading Reduction:** Target a 30% reduction in total Nitrogen and Phosphorus loading to the Chester River from identified baseline levels.
3. **Habitat Restoration:** Restore 25 square kilometers of riparian buffers and wetlands to increase natural filtration zones and stabilize eroding streambanks.

The intent of these goals is specific to ensure that the needs of the river are being met without causing too much of a change to the laws and regulations of the surrounding area, through simple physical changes. To raise dissolved oxygen levels, a natural spillway can be constructed to increase the velocity of the water, which would cause more mixing of the hot and cold portions of water and keep dissolved oxygen levels higher. In addition to this, a reduction in eutrophication would decrease the biological oxygen demand, working in tandem to raise levels above 5.0 mg/L. Reducing nitrogen and phosphorus loading comes down to more tightly regulating industry in the surrounding area to decrease runoff of nutrients and pollution of the river, but can also be achieved by establishing riparian buffers that can absorb some of these nutrients and reduce the levels even after industry and agriculture has polluted the runoff, like native switchgrasses or cypress trees. This overlaps with the goal to solve the sedimentation issue, wherein riparian buffers will be restored to assist in stabilizing the area around the river to reduce the amount of sediment getting trapped in parts of the river.

6. Recommendations

To achieve the 2035 targets, the following actions are prioritized based on their efficacy and contribution to watershed health:

- **Implement Agricultural Best Management Practices (BMPs):** Prioritize nutrient management plans that optimize fertilizer application, improve manure storage/handling, and expand the use of stream fencing to exclude livestock from waterways.
- **Restore Riparian Buffers and Wetlands:** Focus on the restoration of shoreline vegetation as the most cost-effective short-term action for reducing sediment loads and increasing nutrient uptake (UAPP411, 2025).
- **Improve Urban Stormwater Treatment:** Adopt Environmental Site Design (ESD) principles in developing areas to mitigate runoff and upgrade aging infrastructure to treat stormwater before it enters tributaries.
- **Enhance State Policy Enforcement and Cooperation:** Strengthen the partnership between MDE (Maryland) and DNREC (Delaware) to ensure Delaware meets the prescribed sediment reductions at the state boundary.
- **Expand Public Education and Stakeholder Engagement:** Increase local awareness regarding watershed health, septic maintenance, and individual conservation practices to support long-term restoration goals.

7. Conclusion

The Chester River is an important brackish tributary of the Chesapeake Bay that supports ecological, recreational, and economic value for surrounding communities. However, the watershed faces several major environmental stressors, including low dissolved oxygen, eutrophication, sedimentation, and habitat loss. These issues are closely connected to nutrient runoff, agricultural land use, shoreline erosion, failing septic systems, and untreated stormwater discharge.

The CARES initiative provides a framework for restoring the Chester River by 2035 through targeted water quality improvements, habitat restoration, and multi-jurisdictional cooperation. The most important goals are to raise summer dissolved oxygen levels above 5.0 mg/L, reduce nitrogen and phosphorus loading by 30%, and restore 25 square kilometers of riparian buffers and wetlands. These goals directly address the main causes of ecological degradation in the watershed.

To achieve these goals, CARES recommends implementing agricultural Best Management Practices, restoring riparian buffers and wetlands, improving urban stormwater treatment, strengthening Maryland-Delaware cooperation, and expanding public education. These actions work together to reduce nutrient and sediment pollution while improving habitat quality and long-term watershed resilience. With continued monitoring, enforcement, and community involvement, the Chester River can become a healthier and more sustainable watershed within the broader Chesapeake Bay system.

7.0 References

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