Evaluating the Benefits of Land Conservation on Water Quality in the Falls Lake Watershed

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Executive summary

Falls Lake – a reservoir completed in 1981 by the US Army Corps of Engineers – provides potable drinking water to over half a million people in North Carolina's piedmont, serving residents of Raleigh, Garner, Knightdale, Roseville, Wake Forest, Wendell, and Zebulon. Shortly after the lake was impounded, algal levels from excess nitrogen and phosphorus exceeded the state water quality standard. In 2008, Falls Lake was officially listed under Section 303(d) of the Federal Clean Water Act because the reservoir supported chlorophyll-a levels beyond those deemed permissible by the state.

To target excess nutrient inputs, the Falls Lake Nutrient Management Strategy was adopted under the Falls Lake Rules. The Rules address nutrient loading from point and nonpoint sources under three main guiding principles: to return the current nutrient levels back to the 2006 baseline, to protect the lake's use as a drinking water source, and to maintain and enhance current practices by local governments that ensure water quality (15A NCAC 2B .0275). In 2016, the NC General Assembly tasked UNC-Chapel Hill and the NC Collaboratory with analyzing water quality and nutrient management strategies for Falls Lake.

Land conservation and its contribution to nutrient load reductions is one facet of watershed management that the NC Collaboratory is investigating. Research shows that when forest cover drops below 70%, there are measurable negative impacts on a watershed's water quality. Recognizing that approximately 60% of land in Falls Lake is forested, promoting land conservation and maintaining forested areas near waterways can provide numerous benefits to the watershed. Forests store, cycle, and slowly release nutrients like nitrogen and phosphorus to sustain aquatic and terrestrial life. The presence of conserved land near water bodies reduces flooding, improves animal migration routes, sequesters carbon, reduces streambank erosion, and minimizes algal growth by shading streams. Most relevantly to Falls Lake, land conservation can be instrumental in reducing nutrient loading and eutrophication in watersheds through direct and indirect means. Forested land surrounding watersheds act as a filter for runoff, protects land that would otherwise be developed, serves as a risk management strategy, and ensures that ecosystem services are maintained.

Land conservation is a critical component of the Interim Alternative Implementation Approach (IAIA), an optional, investment-based approach for jurisdictions to comply with the Stage I Existing Development Rule. The IAIA follows in the footsteps of the successful Upper Neuse Clean Water Initiative (UNCWI). The Initiative is a program voluntarily funded by a variety of jurisdictions and organizations under the guiding philosophy that protecting this land is the most proactive, holistic, and cost effective way to ensure water quality. Outside of North Carolina, other watersheds such as the Chesapeake Bay have incorporated land conservation into their management practices, which provide meaningful lessons and potentially new opportunities for land conservation efforts in Falls Lake.

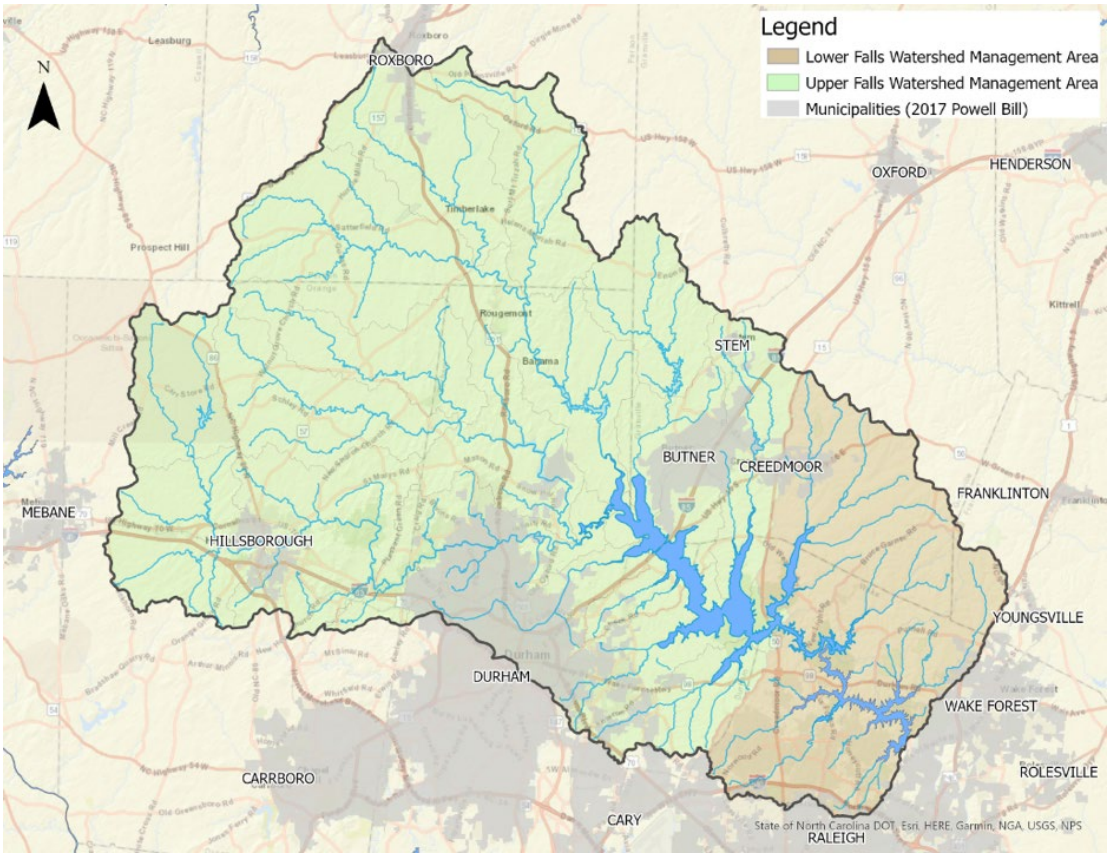
This paper will discuss the benefits of land conservation for watersheds, describe the current activities supporting land conservation in Falls Lake, and analyze conservation efforts in a

case study of the Chesapeake Bay. This paper is intended to inform ongoing discussions at the State level on land conservation as a nutrient management strategy.

1) Background on Falls Lake

Falls Lake, a 12,410-acre reservoir along the Neuse River in North Carolina's piedmont, was impounded in 1981 by the US Army Corps of Engineers. The City of Raleigh contracted with the US Army Corps of Engineers to purchase the drinking water supply, which was included under Congressional authorization. Today, the City of Raleigh uses the lake to provide drinking water for over 500,000 residents of Raleigh, Garner, Knightdale, Roseville, Wake Forest, Wendell, and Zebulon. The Congressional authorization for the reservoir also included the control of flooding, protection against the effects of droughts, and enhancement of water quality for fish and wildlife.

The watershed draining into Falls Lake is located in the Upper Neuse River Basin and is composed of forests, grasslands, wetlands, and open water (75%), agricultural (9%), and urbanized lands (16%). Agriculture in this watershed is mostly small family farms; the acreage of agriculture has declined by almost half since the mid 2000s. Urban areas are predominantly developed open space or low intensity existing development. Only 1.5% of the watershed is classified as medium or high intensity development.



Falls Lake Watershed (courtesy of DEQ)

North Carolina is the ninth fastest growing state in the United States, with a population growth rate of approximately 1.1% per year. Raleigh is among the top ten fastest growing metropolitan areas in the country, with an annual population growth rate of 2.0%. Between 2001

and 2016, the area's rapid growth has increased developed land by 13%, and decreased forested, agricultural, and wetland land cover by 2%, 5%, and 7%, respectively. Considering Falls Lake is the primary source of drinking water for six counties, including the city of Raleigh, it is imperative that the reservoir meet its designated uses.

When Falls Lake was being considered for construction in the 1970s, officials predicted that algal blooms would occur promptly and the lake would not meet water quality standards; however, the anticipated benefits of the reservoir outweighed the risks associated with algal blooms. In 1983, two years after construction finished, Falls Lake was classified as nutrient sensitive waters, with elevated levels of chlorophyll-a. Chlorophyll-a is a photosynthetic pigment in algae, high levels of which can indicate eutrophication and nutrient imbalances in lakes. Algae growth is accelerated by high nitrogen and phosphorus inputs. Their widespread use and aggregation in agricultural runoff, wastewater treatment plants, sewers and septic systems, urban runoff, erosion, and atmospheric deposition has led to high nutrient concentrations in water bodies around the world. Excessive nutrient loading can lead to toxic algal blooms, aquatic community die-offs, and other negative environmental and human health outcomes. While Falls Lake is currently listed as a 303(d) impaired water body under the Federal Clean Water Act, fortunately these more extreme adverse events have not been reported.

2) Falls Lake Rules

To redress excess nutrient inputs and improve water quality as per the Clean Water Act, the North Carolina legislature and Department of Water Quality implemented the Falls Lake Nutrient Management Strategy in 2011. The Rules reassert North Carolina's commitment and responsibility to the conservation, preservation, and development of the state's water resources and ensure the continued enjoyment of the area's natural attractions. The three main purposes of the Strategy set forth in the Falls Lake Rules are described in 15A NCAC 2B .0275:

- Firstly, "to attain the classified uses...from current impaired conditions related to excess nutrient inputs" by returning nutrient loading to the 2006 baseline;
- Next, to "protect its classified uses...including use as a source of water supply for drinking water;"
- And finally, to "maintain and enhance protections currently implemented by local governments in existing water supply watersheds encompassed by the watershed..."

To achieve these goals, the Nutrient Management Strategy targets discharge into the lake from various point and nonpoint sources, including stormwater runoff from existing development, wastewater treatment plants, and agriculture. These sources are required to reduce their nitrogen and phosphorus loads from a 2006 baseline load by 40 and 77 percent, respectively. Compliance with the Falls Lake Rules has been implemented in two stages. The primary goal of Stage I is to control nutrient impacts in the lower lake at the intake point of the Raleigh water supply and requires approximately half of the full reduction targets to be reached. Stage II aims to meet full reductions and chlorophyll-a standards in both the upper and lower sections of the lake by 2041.

In Stage I, the Falls Lake Rules require nutrient reductions for both existing and new development. Lands developed after the implementation of the New Development Rule in 2012 must use pre-approved nutrient control practices to avoid excess nutrient loading. For existing development prior to 2012, the Stage I goal is to offset the increased loading from development which occurred between the baseline year 2006 and 2012. This effort is aimed at reducing the nutrient impact from this period back to baseline levels.

The Existing Development Rule relies on the "toolbox" of approved nutrient reduction practices to demonstrate that load reductions are adequate. Verifying the available nutrient reduction practices and building this "toolbox" has required intensive research and time; thus, to allow the toolbox time to grow while not limiting local governments, the Upper Neuse River Basin Association (UNRBA) and Department of Water Resources (DWR), in collaboration with local governments, developed a compliance option known as the Stage I Existing Development Interim Alternative Implementation Approach (IAIA).

The IAIA is an investment-based approach that relies on minimum annual funding commitment levels by jurisdictions toward a broader array of beneficial, eligible nutrient reduction practices. Jurisdictions who opt to participate in the Program and who meet their minimum investment requirement are in full compliance with Stage I requirements for reductions on an annual basis. Participants can always provide additional investment efforts beyond the minimum requirement. The suite of investment options include both approved nutrient practices and practices that provide broader water quality benefits and nutrient value. The investment-based approach is in contrast to the original Stage I requirements, which purely track nutrient load reductions.

The IAIA program is classified as an interim approach because it is designed to only apply until the Falls Lake Rules are readopted in 2025 or later. As submitted and approved, the IAIA is for a five-year period of implementation in accordance with the revised model local program developed by DWR and approved by the Environmental Management Commission. However, it is anticipated that the successes and failures of the IAIA will inform and be integrated into the revised nutrient management strategies in the readopted rules.

3) Benefits of land conservation for watersheds

Land conservation is one aspect of holistic watershed management, and its integration in management plans play a vital role in protecting watersheds and the ecosystem services they provide. Healthy watersheds ensure clean drinking water, innumerable public health benefits, recreational opportunities, and habitat for wildlife. Conserved land near waterways provides these benefits through reducing flooding, improving animal migration routes, sequestering carbon, reducing streambank erosion, and minimizing algal growth by shading streams. Most relevantly, land conservation strategies can be instrumental in reducing nutrient loading and eutrophication in watersheds. The ways in which land conservation reduces excess nutrients in watersheds are two-fold. One, conserved land may directly minimize nutrient loading through filtration and preventing erosion. Two, conservation may indirectly reduce nutrient loading by displacing development to less sensitive areas and avoiding excessive stormwater runoff from additional impervious surfaces.

Firstly, conserved land surrounding waterways – including forests, wetlands, and unmanaged grassland – can act as a filter for runoff. When water flows through the land gradually, sediment and pollutants are reduced before entering bodies of water. Both emergent and submerged plants purify runoff by absorbing nutrients and chemicals through their roots and providing substrate for bacterial growth. The resulting microbe populations provide a medium for filtration and absorption as well as decompose organic substances. Additionally, undeveloped forest land near streambanks prevents erosion, which contributes a significant amount of nutrients. High intensity runoff during storms exacerbate the effects of erosion. When forests are maintained, root systems hold the soil in place and less erosion occurs.

These biological and ecological processes are highly effective in minimizing nutrients and other pollutants in waterways. Studies have found 30 to 98% reductions in nitrogen, phosphorus,

sediments, pesticides, and pollutants in surface and groundwater after passing through forested land along streams and other water bodies. Additionally, a survey of 27 water suppliers conducted by Ernst et al. in 2004 found that more forest cover was correlated with lower water treatment cost. The researchers found that water treatment and chemical costs decreased by 20% for every 10% increase in forest cover, up to approximately 60% forest cover.

Secondly, conservation prevents the development of high priority areas around waterways. Sprawling urban areas necessitate roads, highways, parking lots, sidewalks, and buildings, all of which compact the soil and increase impervious surface cover. Impervious surfaces are areas that water is unable to penetrate like paved areas and other hard-packed surfaces. This prevents the natural water filtration services provided by undeveloped forests, wetlands, and grasslands. Further, impervious surfaces increase the speed and quantity of runoff during rainfall and snow-melts, which collects pollutants and sediments before flowing into water bodies. Collectively, nutrient loading associated with development – originating from agricultural and urban runoff, wastewater treatment plants, sewers, and septic systems – plays a significant role in eutrophication. Thus, conserving land near waterways shifts ever-expanding development away from high priority areas that could serve as a buffer to filter out pollutant-laden runoff.

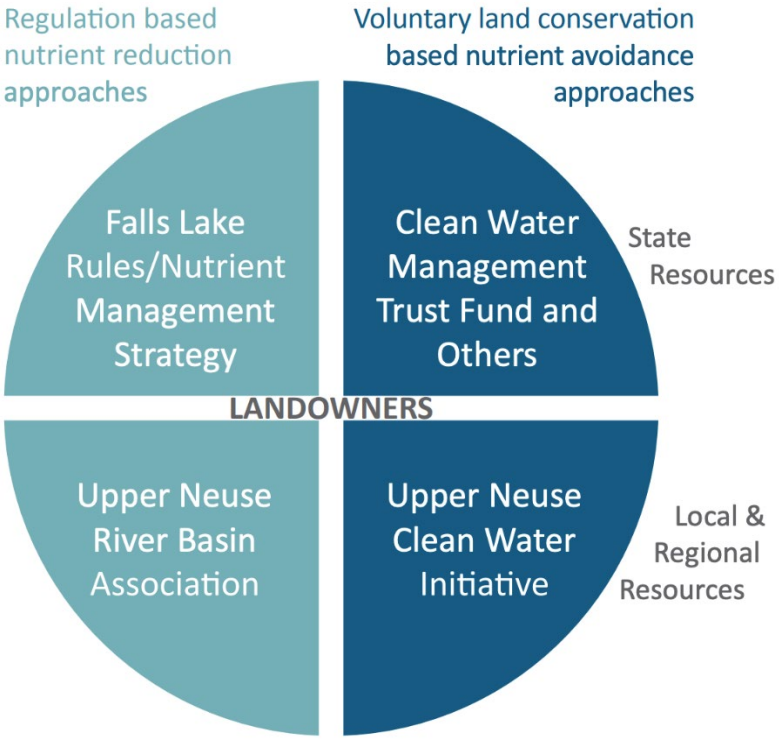
One argument against land conservation is the claim that this practice will limit viable land for development and ultimately hurt industry, growth, and the taxpayers. However, a literature review conducted by researchers at NC State University found evidence to the contrary. While land conservation does reduce the quantity of land available for development, the fraction of land conserved does not impact the amount of land required for the pace of development. Zipp et al. (2017) found that the conservation of open spaces caused land development to redistribute instead of reducing the rate of development. Furthermore, McDonald et al. (2007) found no correlation between development rate and proximity to conserved lands. In select cases, development rates were higher near conserved areas, supporting economic modeling results described by Armsworth et al. (2006).

Finally, land conservation is a method of risk management, making it essential to watershed management plans. Other ways to reduce nutrient loading from runoff, such as wet ponds and stormwater control measures, are more prone to failure if not properly maintained, leading them to overflow and discharge untreated runoff into adjacent water bodies. Even when these systems are properly maintained, their hydraulic capacity is standardly designed for one inch of rainfall. When larger storms hit, or when rainfall is constant over multiple days, constructed stormwater control systems bypass a portion of the water and discharge it into streams or stormwater systems. In contrast, forests do not require routine maintenance and can infiltrate higher depths of rain. While nutrient loading from forested lands does still occur during storms and baseflow conditions, the per acre rates of loading are much lower than developed land without stormwater controls.

4) Current land conservation activities in the Upper Neuse watershed

Land conservation has long been a priority to protect drinking water in the Falls Lake watershed and the broader Upper Neuse River Basin. Research shows that when forest cover drops below 70%, there are measurable negative impacts on a watershed's water quality. Recognizing that approximately 60% of land in the Falls Lake watershed is forested, multiple organizations took immediate action to protect remaining forestland. In 2006, the Upper Neuse Clean Water Initiative (UNCWI) was founded. The Initiative is a partnership between conservation organizations, local and state governments, and landowners within the Upper Neuse River Basin to protect Falls Lake and other vulnerable waterbodies through conservation. The Conservation

Trust for North Carolina oversees this partnership of local governments and nonprofit organizations - including Ellerbe Creek Watershed Association, Eno River Association, Tar River Land Conservancy, Triangle Greenways Council, Triangle Land Conservancy, and The Conservation Fund.



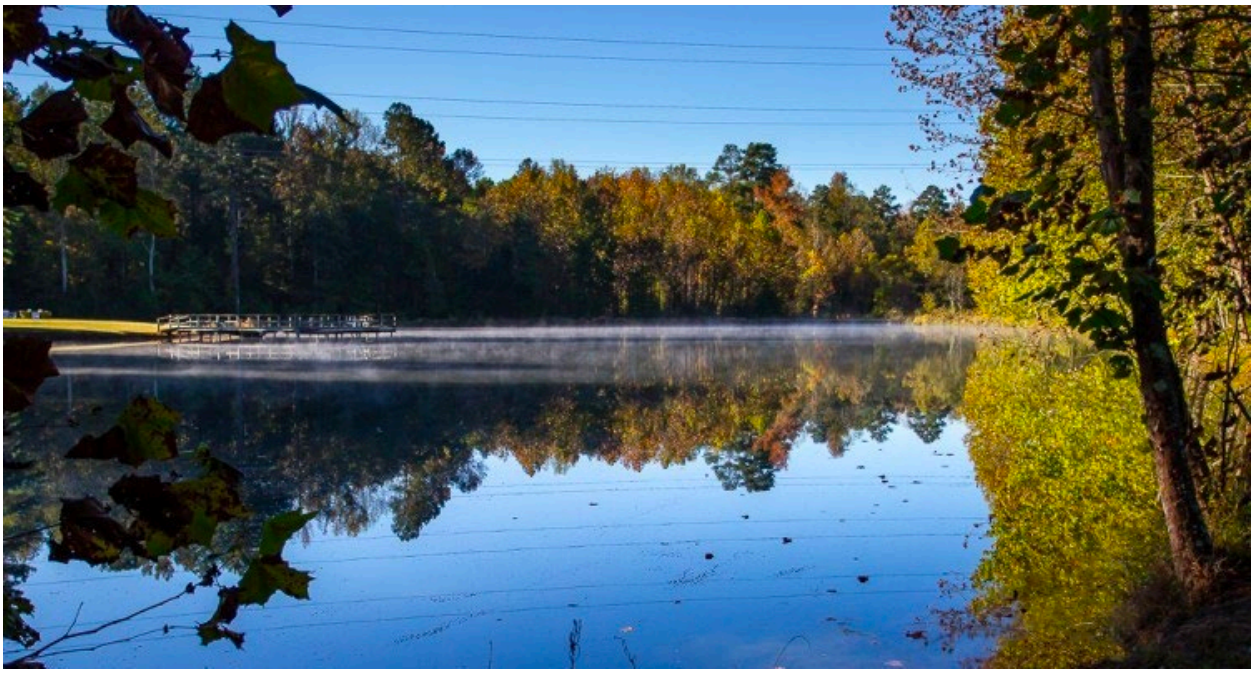
Land conservation programs within the Upper Neuse watershed (photo courtesy of UNCWI)

With 36% of the Triangle projected to be covered in impervious surfaces by 2040, the philosophy behind UNCWI is based on the principle that protecting land around water bodies is the most proactive, holistic, and cost effective way to ensure water quality. The Conservation Fund spearheaded the creation of a GIS-based Watershed Protection Model to map and prioritize potential land acquisitions in the area. The Model is aligned with the four main goals of UNCWI: protecting water sources, preserving upland forests and farms, protecting wetlands and floodplains, and protecting vulnerable areas with steep slopes and wet soils. More than 17,000 parcels of land totaling over 260,000 acres have been identified as eligible for funding through Raleigh's Watershed Protection Program.

To fund conservation easements and land purchases, the Cities of Raleigh and Durham have dedicated revenue sources for UNCWI. Raleigh residents are charged $0.15 per 1,000 gallons of water used, averaging to 60 cents a month per household. Similarly, the City of Durham has a tiered rate system, generating approximately $200,000 per year solely for watershed protection. Orange County, Wake County, Granville County, Durham County, City of Creedmoor, Town of Butner, Town of Hillsborough, and Durham Soil and Water Conservation District have also generated funds to protect high priority lands.

UNCWI has been successful in its mission -- between its inception in 2006 and 2015, the Initiative protected 88 properties stretching along 84 miles of stream banks across 7,658 acres. UNCWI researchers conducted a study and estimated that their efforts avoid at least 7,926 lbs of

nitrogen and 1,408 lbs of phosphorus from entering nearby waterways every year. In their 2015-2045 Conservation Strategy, the Initiative established a goal of protecting an additional 30,000 acres over the 30 year period. This translates to approximately 11% of eligible acreage within the watershed.



George and Julia Brumley Family Nature Preserve, protecting 673 acres of land adjacent to rivers flowing into Falls Lake (photo courtesy of Triangle Land Conservancy)

When the IAIA was established in 2022, land conservation quickly became a critical component of the Falls Lake nutrient management strategy for complying with Stage I Existing Development Rules, largely due to the collaboration between environmental advocacy and land conservation groups, local governments in the watershed, and staff at DWR. As mentioned previously, the IAIA is an optional, investment-based approach that allows jurisdictions to be in compliance with Stage I requirements by investing a minimum amount in a broad host of projects that reduce nutrient loads. In the 2021-2022 fiscal year, the 13 cities and counties participating in the IAIA committed $5.5 million dollars to nutrient reduction projects. The total funds allocated were more than three times higher than the minimum requirements to demonstrate compliance. Land conservation projects were the most heavily funded, with $3.95 million dollars dedicated to preserve high priority forested lands.

One land conservation project in 2021-2022 was undertaken in Person County, NC. The county had been facing pressure to timber and develop nearly 300 acres of land adjacent to an Army Corps of Engineers buffer around Falls Lake. However, because of the compliance benefits encouraged by the IAIA, Person County decided to allocate its minimum investment requirement towards preserving that land in perpetuity.

Prior to developing the IAIA, UNRBA had proposed that land conservation qualify as a nutrient credit for the purpose of compliance with the Existing Development Rule. Nutrient credits are a quantifiable unit of improvement to the environment (measured in pounds of nutrients reduced per acre per year) that has been approved by the NC Department of Environmental

Quality. They are a core aspect of watershed management under the original Falls Lake Rules because they provide a clear metric that quantitatively describes reductions in nutrient loading for some practices. After years of discussion and negotiations, in 2016 UNRBA submitted to DWR proposed nutrient credit assignments for land conservation. Nitrogen credits for this practice ranged from 0.4 to 1.2 lb-N/ac/yr, and phosphorus credits ranged from 0.16 to 0.19 lb-P/ac/yr. While small, amplified over thousands of acres, this nutrient credit could be substantial.

After much debate, the position of DWR was that land conservation could not serve as a nutrient credit because conservation does not actively reduce nutrient loads below the 2006-2012 baseline. The benefits associated with the parcels of land theoretically protected by conservation credits were pre-existing, and thus would not be an additional decrease to nutrient loading. This position limited the ability of local governments to expend certain types of funds on land conservation that had been collected specifically to improve water quality. The IAIA included land conservation as an eligible practice for complying with the Stage I Existing Development Rule, and this allowed local governments to fund land conservation projects using a broader array of funding.

Despite larger scale land conservation projects not qualifying as nutrient credits, the restoration of existing riparian buffers is currently an accredited nutrient management practice under the Neuse Nutrient Strategy (not the Falls Lake Rules). Restoring or enhancing riparian buffers can provide dischargers full or partial nutrient credits, depending on the distance the buffer is to the waterway. While this is not land conservation in its entirety, managing riparian buffers contributes many of the same benefits to watersheds.

5) Chesapeake Bay Case Study

Other watersheds around the United States, such as the Chesapeake Bay, emphasize land conservation as an important nutrient management strategy. The Chesapeake Bay is the largest estuary in the world, spanning several states along the east coast. Despite significant differences between Falls Lake and the Chesapeake, such as size and governmental jurisdiction, looking at case studies such as the Chesapeake can provide valuable insight into ways in which land conservation can be promoted in Falls Lake in the future.

In 1983, the Chesapeake Bay Program was formed as a partnership of federal agencies, state agencies, local governments, academic institutions, and non-governmental organizations to conserve land in the Chesapeake watershed. More recently, in 2014, the Program signed the Chesapeake Bay Watershed Agreement, which aims to “conserve treasured landscapes in order to maintain water quality and habitat; sustain working forests, farms and maritime communities, and conserve lands of cultural, indigenous and community value.” A target outcome of the Agreement is to protect an additional two million acres of lands throughout the watershed by 2025, including 225,000 acres of wetlands and 695,000 acres of forest land of highest value for maintaining water quality. Since the original Agreement was signed, the Program has added the additional target of protecting 30% of the total watershed by 2030.

The Program is currently on track in achieving its conservation goals. Based on data from 2019, 1.36 million acres have been protected since 2010, increasing watershed-wide protected lands by 17%. In total, 9.2 million acres of land in the watershed is protected. The Program’s success can be attributed to incentivizing private conservation efforts, significant public funding through a wide variety of financing mechanisms, developing and improving integrated watershed-wide conservation data, and creating predictive land use models and maps.

Currently, state governments within the watershed—Pennsylvania, Virginia, Delaware, Maryland, New York, and West Virginia—are the largest contributors to land conservation, owning 44% of conserved land, while the federal government is the second contributor, at 26%. Over the past few years, however, land conservation by private organizations has increased. Transferable tax credits that reward land preservation, acquisition, and certification have encouraged private investment. Wetland and stream mitigation banking, where a degraded water resource is restored, protected, and later sold to companies or agencies that need to offset negative impacts, is another significant source of private investment. Pay-for-success contracts have also been popularized, wherein governments of the Chesapeake pay private companies for achieving specific environmental outcomes such as nutrient load reductions. Land trusts also play a significant role in Chesapeake Bay land conservation; currently 100 regional, state, and local land trusts operate in the Chesapeake Bay region and are collectively responsible for protecting 1.8 million acres of land. Several land trusts are members of the Program, helping to foster a close relationship between the non-profit, private, and public sectors.

States within the Chesapeake watershed contribute significantly to conservation funding through various financing mechanisms, collectively generating over $300 million for land conservation projects in the 2019 fiscal year. Funding is drawn from realty transfer credits in several states, as well as income taxes in Virginia, cigarette taxes, landfill tipping, and oil and gas leases in Pennsylvania. In 2022, Maryland enacted the Comprehensive Conservation Finance Act, marking a significant development in conservation funding by expanding eligible initiatives. For instance, blue infrastructure is incentivised in the Act. As defined for the first time in this policy, blue infrastructure extends beyond the more common 'green infrastructure' by including water-based natural areas to improve the health and resilience of communities. The Act also made conservation easements on forests more eligible for state funds and loans and allowed for pay-for-success contracts with private investors.

The Chesapeake Bay is continually improving its watershed-wide methodology and local-level metrics for assessing changes in land use and its effects on water quality. In 2012, LandScope Chesapeake, now the Chesapeake Conservation Atlas, was launched as a publicly accessible platform for gathering data layers representing various conservation values and priorities. Serving as a watershed-wide clearinghouse for mapping data, the Chesapeake Conservation Atlas helps to ensure strategic, long-term coordination between organizations and agencies working to conserve lands in the watershed and demonstrates a commitment to adaptive management strategies.

Similar to nutrient credit policy in Falls Lake, no states within the Chesapeake watershed have included land conservation among creditable practices. In 2013, the Chesapeake Bay Commission (CBC), the legislative voice of the Program, composed a report on the viability of integrating land conservation nutrient credits in the Chesapeake Bay watershed management plan. They determined that conservation could contribute to nutrient load reduction, and consequently, the CBC proposed four key policy changes for the smooth implementation of nutrient credits for conserved land:

- The first policy proposal argued for the addition of a credit multiplier. This would vary the credits allotted to land based on the permanency of its conservation easement, as more long-lasting conservation efforts are considered to have a relatively greater role in reducing pollution.
- The second proposed policy was to grant premium nutrient credits for lands that provide greater water quality benefits than others.

- The third policy would grant greater credits for land included in a nutrient loading reduction or offset plan, similar to the wetlands mitigation component of the Clean Water Act.
- The Commission's final policy proposal involved the development of a predictive land use map to calculate necessary nutrient load reductions and review the effectiveness of current Best Management Practices (BMPs).

In 2018, this final policy was implemented and is now integral to the Program's success in reaching its conservation goals outlined within the 2014 Chesapeake Bay Watershed Agreement. The series of "what if" land use scenarios developed using the Chesapeake Bay Land Change Model have forecasted future urbanization scenarios in the watershed and been instrumental in incentivizing land conservation. Although proposed by the Commission in the context of crediting conservation, the policy has been primarily valuable in assessing and developing BMPs. Although this fourth policy suggestion was the only one implemented into the Chesapeake Bay Watershed Plan, each offers a noteworthy solution to the issues surrounding the integration of land conservation into holistic watershed management plans as managers look towards the future.

While the size and funding base of Falls Lake are significantly smaller than the Chesapeake, innovative policy in watersheds such as the Chesapeake Bay can be a helpful point of reference as new strategies to improve water quality in the Falls Lake watershed are developed. In promoting conservation, the Chesapeake Bay watershed demonstrates the importance of partnership across public and private agencies and the use of adaptive strategies to promote conservation, including conservation-incentivizing policies, funding from a variety of sources, and the development of integrated watershed data and predictive models.

6) Conclusion

Land conservation is an indispensable aspect of watershed and water quality management. Conserved land acts as a risk management strategy, continuously filtering nutrients from runoff and providing a development buffer near waterways without limiting growth. Presently, the Falls Lake watershed is making great strides to protect thousands of acres of land in order to maintain water quality for generations to come through initiatives such as UNCWI and the IAIA. As a revised nutrient management strategy is developed for the new Falls Lake Rules, land conservation can be a critical component based on the investment levels and success of the IAIA and the Chesapeake Bay Program.

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