



RIVER E

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BUSINESS PLAN

2022



R I V E R E

Research ● Education ● Technology ● EcoCulture

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Company Description and Logo

The Rappahannock River Ecological Park LLC is operating as RIVERESM, a 501(c)(3) not for profit corporation, aiming to help mitigate effects of human population growth and global climate variability on freshwater systems by supporting water research, education, technology and ecoculture for the Rappahannock region. RIVERESM, with a location on the Rappahannock River in Stafford, VA, will serve as an ideal living laboratory for water researchers, management agencies and environmental educators. RIVERESM will be a game changing future forward Center with multi-faceted and far-reaching benefits for Stafford County and the surrounding region.



The RIVERESM logo is the artistic version of leaves derived from Liquidambar, a genus of trees, commonly referred to as Sweetgum. This native tree is an ancient source of beneficial compounds that offer modern benefits. The logo stands for 'river reverence', and all that it connects. It depicts the connection of a flowing river, interaction of plants with the water way, and four dots that stand for research, education, technology and ecoculture. The logo colors show an ombre effect of how blues and greens are ever present in ecosystem services from the air we breathe, the water we drink, and abundant plant life.

Executive Summary

The RIVERESM Ecological Center is a next generation research and education facility that will embrace the capabilities of Artificial Intelligence to help researchers accomplish goals thought to be unachievable in the past. The RIVERESM Center will be a hub of collaborative effort focused on making the Rappahannock River Virginia's first complete SmartRiver from its headwaters to the Chesapeake Bay with smart sensors that monitor the tributaries and river real-time for pollutants. Big data from this effort can be used to identify pollution sources, enable rapid mitigation responses, and support predictive modeling to inform regional, national, and global freshwater challenges.

Coming decades will present unprecedented challenges in managing competing demands for freshwater. These challenges will be exacerbated by projections of more frequent and severe droughts and flooding. In 2018, the National Academies of Sciences, Engineering and Medicine identified the top strategic opportunities for water science research to address the highest priority national water challenges over the next 25 years. The need to enhance and make emerging technologies more accessible is at the top of this priority list. Scientific research using automated sensors, machine learning, and big data integration will play a key role in helping government agencies make intelligent water management decisions. The Commonwealth of Virginia is well-positioned to contribute to these efforts through its proactive approach to projecting future water availability and needs through state-wide conservation planning and prioritization models. Of particular interest is Virginia's Rappahannock River Watershed, which is big enough to provide realistic challenges to test watershed Best Management Practices (BMP), but also small enough to demonstrate success of BMP concepts. These conditions make the Rappahannock a model system for conducting impactful watershed research that can scale to larger river systems. Unprecedented environmental pressure exists on the Rappahannock River region, however. While declines in Chesapeake water quality and associated habitat have resulted from centuries of land use change, more recent intensification in both agriculture and urban/suburban development throughout the watershed have accelerated nutrient and sediment loading and habitat decline. This region containing Stafford, Spotsylvania, King George and Caroline counties, and the City of Fredericksburg is projected to increase 60% from 350,380 in 2025, to 562,598 in 2045, making it the fastest growing area within Virginia. There is an urgent need to preemptively protect the Rappahannock.

RIVERESM is a 501(c)(3), not for profit corporation that will take a lead role in supporting this effort. RIVERESM aims to promote and enhance the ecological and economic umbrella for the region by building a world-class ecological center on the banks of the Rappahannock. The RIVERESM Ecological Center will be a facilitator of water conservation efforts by offering flexible coworking, laboratory, and outdoor space for organizations helping to mitigate environmental pressures on the Rappahannock and the Chesapeake Bay watershed. The Center's outdoor landscape design will enhance natural habitat by incorporating a native botanical garden with trails that draw visitors to experience research, education, technology and ecoculture. Due to its unique location and associated pressing environmental concerns, RIVERESM is in an excellent position to serve as a regional and global magnet for watershed research and conservation, by providing an innovative center that makes it convenient to integrate research, education, conservation, and outreach.

Vision

RIVERESM will serve as a regional and global magnet for watershed research, conservation, education and ecoculture.

Mission

Create a world-class ecological center designed in form and function to attract, support, and integrate scientific research into conservation, education, and public outreach.

Objectives

RIVERESM will:

1. Provide an **innovative center** that brings together and supports partners involved in research, conservation, education, and ecotourism by offering flexible memberships with access to co-working, laboratory, education, auditorium, and event space
2. Support the use of **emerging technologies** for research aligned with high priority national water challenges
3. Recruit and support researchers to establish **Virginia's first complete SmartRiver** using smart sensor technology throughout the Rappahannock.
4. Offer **indoor and outdoor venues** that promote, showcase, and communicate the work of those involved in restoring, protecting, and enhancing watersheds
5. Provide outreach, ecotourism, and ecoculture opportunities with **native botanical gardens** that weave watershed research, sustainable agriculture, creative exhibits, and indigenous ecological knowledge into the surrounding landscape

Location and approach

In May 2022, the founder of RIVERESM purchased a 12-acre riverfront property in Stafford County with the intent of donating the property to RIVERESM upon successful fundraising efforts. The current target facility size is 25,000 sq. ft. Final square footage will be determined by financial analysis of economic sustainability based on stakeholder interest and projected membership income. This property is adjacent to a 60-acre parcel, owned by Stafford County in association with the Duff McDuff Green Memorial Park. RIVERESM is working with Stafford County to explore ways in which the 60-acre property can be used to expand the RIVERESM Center's operations through the creation of a native botanical garden that supports and integrates scientific research, sustainable agriculture, and indigenous relationships with the land in collaboration with the [Patawomeck Native American Tribe](#).

Supporting Research with Emerging Technologies to Create Virginia's First SmartRiver

RIVERESM will support research involving automated sensors, machine learning, predictive modeling, and big data through key partnerships. First, RIVERESM will help water researchers pilot and test new wireless sensor network initiatives through a collaboration with the [Virginia Innovation Partnership Corporation](#) and its [Virginia Smart Community Testbed](#) initiative in Stafford County. Smart Stafford is Virginia's first Smart City Testbed involving a fully integrated IoT-5G platform and emerging technologies. RIVERESM will complement Smart Stafford initiatives by working with researchers to develop the SmartRiver concept to the Rappahannock River. Second, RIVERESM will partner with [RIoT](#), a non-profit organization that accelerates the impact of start-up businesses involved in IoT technology. RIoT will assist

RIVERESM with co-writing grant proposals and offering workshops for researchers to learn IoT-5G technology. Third, RIVERESM will form a science advisory board to define the SmartRiver concept, phases and timeline, identify necessary technologies, recruit investigators to develop research proposals to establish the SmartRiver concept, and seek support from initiatives such as [Microsoft's AI for Earth](#), [Amazon's Imagine Grant Program](#), and [IBM Cloud](#). RIVERESM will also offer researchers and likeminded organizations flexible coworking space, wet and dry laboratories, an auditorium, a greenhouse, high-bandwidth technology, audio/visual resources, copy/print resources, and a kitchen. Surrounding the Center, RIVERESM will offer deep-water river access, as well as on-site BMP landscaping and testing grounds, a canoe livery, 24/7 secure access and parking, and affordable bunkhouse accommodations. Finally, RIVERESM will provide scientists space to conduct research with easy access to collaborators with regional and global watershed expertise.

Supporting Environmental Education

RIVERESM will support environmental education through a collaboration with [Friends of the Rappahannock](#), a non-profit organization that provides nationally recognized environmental education programs to over 15,000 students annually. The RIVERESM Center will be designed to support teaching, learning, and connecting with nature. The building interior will have flexible education space with movable walls and furniture. The surrounding landscape will serve as a “living laboratory” where students and visitors can learn about the natural world and have direct access to the river. Creative outdoor landscaping will provide a venue where educators can offer environmental education programs that parallel and complement research being conducted at the Center. Visitors can experience artistic displays, educational exhibits, and interactive learning experiences, all of which will communicate fundamental scientific knowledge and evoke new forms of scientific understanding.

Supporting Outreach, Ecotourism, and Ecoculture

As a world class ecological center that showcases research, education and sustainability, RIVERESM can serve as an ecotourism destination and botanical garden. RIVERESM is well positioned geographically to attract national and international visitors. The greater Stafford area is equidistant from the state and nation's capitals along Interstate 95's corridor, making it equally accessible to locals and tourists. RIVERESM will involve researchers in landscape design, providing visitors with demonstrations of how landscaping can support research in biological systems engineering, horticulture, permaculture, biology, wildlife ecology, forestry, crop, and soil science. RIVERESM will also partner with Virginia Tech and the Patawomeck Tribal Center to use intentional design principles that weave BMP watershed research, sustainable agriculture, and Traditional Ecological Knowledge throughout the surrounding landscape. Displays from regional artists will also enhance the visitor experience.

Showcasing Sustainability

RIVERESM will integrate principles of economic, environmental, social, and cultural sustainability into the Center design and operations. RIVERESM is working with the renowned SmithGroup architectural firm to develop and accomplish these goals. Economic sustainability will be ensured through income from flexible coworking, lab, and gathering space. Environmental sustainability will include green certification and living building design principles

and BMP landscaping that provide visitors and staff with a rich connection to nature. Design features, exhibits, and small, intimate gathering ecospace will include living flora and fauna and features that mimic natural patterns of biomorphic forms. Social and cultural sustainability efforts will balance Traditional and Scientific Ecological Knowledge in collaboration with the Patawomeck Tribal Center.

Introduction

“The provision of adequate fresh-water resources for people and ecosystems will be one of the most critical and potentially contentious issues facing society and governments at all levels during the 21st century.”

-- American Meteorological Society

According to the world’s leading climate experts, unequivocal evidence shows that anthropogenic influenced climate change is responsible for unprecedented increases in extreme weather noted in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, In Press). Extreme variability in climate, resulting in increased droughts and floods, is projected to rise as the global temperature moves closer to the critical threshold established by the Paris Accord. The global temperature is currently 0.4 degrees Celsius shy of this critical threshold (IPCC, In Press). Rapid growth in human population and associated increases in land use will further exacerbate impacts on natural systems that support human life. Of particular concern is the dwindling global availability of clean water due to increased human consumption and contamination. By 2050, the projected total human population will reach ten billion with 65% of humans living in the global urban areas of the world (World Health Organization, 2019). By 2025, half of the world’s population will be living in water-stressed areas (World Health Organization, 2019). Over the next three decades, projected food production needs and increasing water effluents associated with increasing populations, suggest a 10-15% increase in river input by nitrogen loads into coastal ecosystems (United Nations, 2020). Finally, global water demand in water withdrawals is projected to increase by 55% by 2050, due to growing demands from a 400% increase in manufacturing (Organization for Economic Co-operation and Development, 2012). Current and projected impacts on environmental systems point to an unavoidable conclusion -- *the future of human existence is inextricably embedded in the health of Earth’s natural systems, particularly water.*

Adequate safe water provides the foundation of a nation’s health, economy, security, and ecology. Coming decades will present unprecedented challenges in managing competing demands for freshwater (drinking water, energy, agricultural and industrial demands, and ecosystem requirements), given projections of more frequent and severe droughts and flooding (National Research Council, 2004). In 2018, the National Academies of Sciences, Engineering and Medicine identified the top strategic opportunities for water science and research to address the highest priority national water challenges over the next 25 years. The need to enhance and make emerging technologies more accessible is at the top of this list. Current barriers to water research include limitations in data collection, monitoring, sharing, and processing, and coordination of research between government and research institutions. These barriers make it difficult to support efficient water resource planning (Brown et al., 2015).

To address emerging water resource problems, government decision makers need to make intelligent choices informed by scientific research and analysis. Emerging and innovative technologies such as automated sensors, machine learning and big data integration will play a key role in water research. The Commonwealth of Virginia is well-positioned to contribute to these efforts. Virginia currently takes a proactive approach to projecting future water availability and needs through state-wide conservation planning and prioritization models (Hazler et al., 2018). Virginia’s river network model incorporates all water withdrawals & releases (e.g., energy, industry, agriculture, water supply) including projected population growth and changing climate to develop simulations that help management agencies make

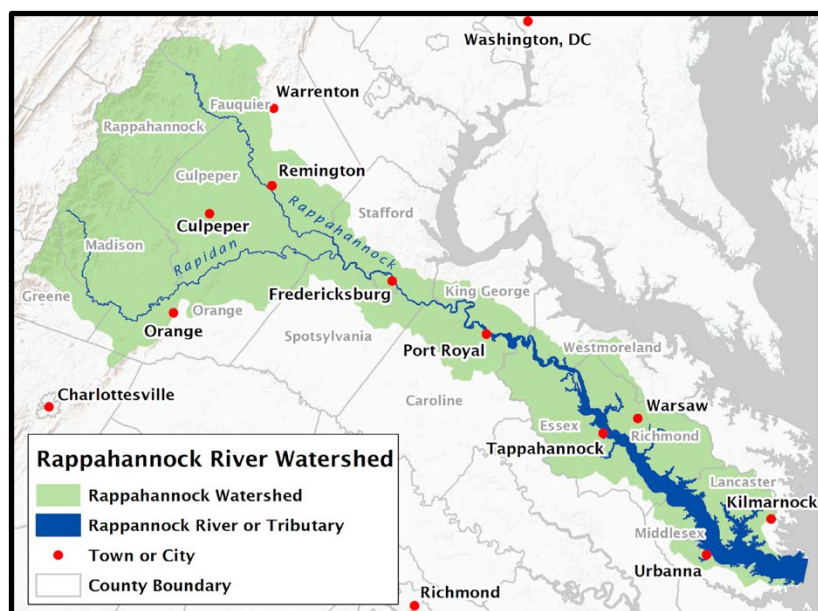
intelligent decisions for future water management needs (Hazler et al., 2018; Virginia Department of Environmental Quality, 2021). Virginia's forward-looking approach is uncommon for the eastern United States, which is generally considered to be water rich. Of particular interest in Virginia is the Rappahannock River Watershed.

The Rappahannock as a Model System for Watershed Research

The Rappahannock River is an especially promising focal point for water resources conservation, restoration, and proactive management solutions that meet competing demands. With headwaters that originate in Chester Gap in the Blue Ridge Mountains, the Rappahannock carves a 185-mile free flowing path through Virginia's three distinct geographical regions, ultimately joining more than 100,000 interconnected streams and rivers flowing into the Chesapeake Bay (Figure 1).

Figure 1

The Rappahannock River Watershed



Note. The Rappahannock is the longest free-flowing river in Virginia, encompassing 7000 km² with headwaters in the Shenandoah National Park. Image Credit: Friends of the Rappahannock.

The Rappahannock River is representative of many other rivers on the East Coast of the United States. It flows through low-intensity agricultural lands (e.g., hay) and forests in its upper reaches, flanked by sprawling suburbia and high-intensity agricultural lands at and below the fall line. Like most rivers, the Rappahannock is experiencing significant environmental pressures from intense population growth, increased climate variability, and lingering effects of deforestation during America's early history. At the same time, the Rappahannock River Watershed is free from an over-abundance of complex industry and municipal effluent discharges. In 2006, 4,232 forested acres along 32 miles of the Rappahannock and Rapidan Rivers above Fredericksburg, were placed into conservation easement, to be managed by The Nature Conservancy (City of Fredericksburg, 2011). An additional 30 plus miles of tributaries and streams flow in the river along the easement. Ten water quality monitoring stations exist

within this easement. The river also has a relatively low degree of runoff associated with impervious surfaces because of the relatively small number of large cities located within the watershed. In addition, its percentage of agricultural runoff is lower than other watersheds, given the dominance of low-intensity agriculture in upper reaches of the watershed. The Rappahannock flows, unimpeded from its source in the Blue Ridge Mountains, to the fall line at Fredericksburg where it becomes tidal and increasingly brackish as it continues to the Chesapeake Bay.

As a high-quality resource with a wide spectrum of activities occurring within its watershed, the Rappahannock River is virtually tailor-made for a broad-based approach to identifying the challenges and developing and implementing solutions. First, the Rappahannock watershed is small and compact relative to other river systems, which makes the full watershed more accessible to researchers than other larger river systems. The entire river's stretch offers significant research opportunities all within a day's travel from beginning to end. The compact size of this watershed also makes it possible to demonstrate success with Best Management Practices (BMP) to control runoff pollutants and sediments. At the same time, the Rappahannock is still large enough that it can significantly impact the Chesapeake Bay and provide realistic challenges for testing the ability of BMP concepts to mitigate sediment and nutrient loads. Combined, these features position the Rappahannock to serve in proactive watershed solutions and management well-beyond the mid-Atlantic region -- a potential model study system for water research and management questions that can be scaled up to larger river systems. Given its just-right set of conditions, the Rappahannock is colloquially referred to as the 'Goldilocks River'. The Goldilocks principle, inspired by the children's story 'Goldilocks and the Three Bears', states that something must fall somewhere within the middle of extremes to be 'just right'. With its Goldilocks just-right qualities, RIVERESM aims to position the Rappahannock River as Virginia's first SmartRiver from its headwaters to the Chesapeake Bay, utilizing smart sensor technology that is ideally suited for the development of globally relevant research, demonstrable modeling, and mitigation strategies.

The Rappahannock as an Economic Engine

In addition to providing habitat for wild mammals, birds, freshwater mussels and fish, the Rappahannock River is a quiet economic engine for the entire watershed. The river provides potable drinking water and recreational value, and supports economically valuable species such as Oysters, Blue Crabs, Menhaden, Herring, Shad, Striped Bass and Atlantic Sturgeon. The river's collective 'natural capital' is significant to local and regional economies. The Rappahannock also has great potential for EcoTourism. The Rappahannock provides fishing, canoeing, kayaking, tubing, swimming, camping, hiking, and biking opportunities for visitors. Combined, these key features of the Rappahannock offer great potential to bolster the regional economy through EcoTourism. Virginia had a revenue stream of \$25 billion in the tourism industry in 2019, and according to the local Tourism Advisory Council, Fredericksburg and surrounding Stafford and Spotsylvania counties may reach an economic impact of a billion dollars by 2028. Local governments continue to seek novel ways to increase tourism opportunities in recreation, culture, and art.

The Rappahannock River offers an excellent opportunity for EcoTourism development, particularly within the greater Stafford/Fredericksburg area where the river passes through 32 miles of environmentally protected acreage owned by the City of Fredericksburg. This entire

protected expanse of the river above the fall line is minimally affected by environmental stresses associated with human encroachment. This is a rare attribute shared by only a few remaining rivers across the U.S.

Current and Projected Threats to the Rappahannock River

As of 2021, well-documented and compelling data places the Rappahannock River at the precipice of extreme environmental pressure that will degrade water quality and jeopardize river health and economic stability. While declines in Chesapeake water quality and associated habitat have resulted from centuries of land use change, more recent intensification in both agriculture and urban/suburban development throughout the watershed have accelerated nutrient and sediment loading and habitat decline (National Fish and Wildlife Foundation, 2018). Projected population growth rates upstream, for Stafford and Spotsylvania County, show some of the fastest rates of population growth in the country. For example, the Fredericksburg population was 27,982 in 2020, and is projected to rise to 38,094 by 2040, an astounding 36% increase (Weldon Cooper Center for Public Service, 2019). Stafford County's current population of 256,927 is projected to increase to 183,161 by 2030, and 209,250 by 2040, a 33.4% increase (Weldon Cooper Center for Public Service, 2019). The region containing Stafford, Spotsylvania, King George and Caroline counties and the City of Fredericksburg is projected to increase 60% from 350,380 in 2025, to 562,598 in 2045, with the largest concentrations of employment per square mile occurring in Fredericksburg and the Dahlgren area of King George County (George Washington Regional Commission, 2018). This rapid growth will bring an unprecedented surge in potential pollutants and sediments entering the river over a short period of time.

Currently, the Rappahannock River and Chesapeake Bay watersheds are considered impaired due to excess levels of nitrogen, phosphorus, and sediments. These pollutants largely come from non-point source pollution from stormwater runoff. Approximately 291,000 metric tons per year of the non-point source runoff of nitrogen and phosphorus combined enter the Rappahannock River (Dauer et al., 2005). The current Rappahannock reports on nitrogen, phosphorus, and sediment loads (Figure 2) indicate a degrading situation for nutrient and sediment loading (Mason et al., 2021). A significant percentage of land in the area is in low-intensity agricultural use, which historically may have provided a source of bioaccumulative pesticides to the land and the river. Those pesticides no longer are registered for use (Dauer et al., 2005). In addition, the City of Fredericksburg has the lowest percentage of wetlands and shoreline with a riparian buffer of all the Virginia river tributaries of the Chesapeake Bay (Berman et al., 2017). Segments of the Rush, Thornton, Hughes, Hazel, and Rappahannock Rivers in Rappahannock County have been designated "303(d) Impaired" for fecal coliform or E. coli bacteria (RappFLOW, 2005). More recently, Friends of the Rappahannock assessed 11 river tributaries to obtain a representative sample of streams in the middle river section of the Rappahannock River. Streams were graded on human health, land use, stream ecology and community engagement. In the resulting 'Report Card', the middle Rappahannock was graded a "C" (FOR, 2018).

Figure 2

Reports on Nitrogen, Phosphorus and Sediment Loads in the Chesapeake Bay.

RIVER INPUT MONITORING STATION	TOTAL NITROGEN LOAD		TOTAL PHOSPHORUS LOAD		SUSPENDED- SEDIMENT LOAD	
	Long- term	Short- term	Long- term	Short- term	Long- term	Short- term
SUSQUEHANNA RIVER AT CONOWINGO, MD	Improving	Improving	Improving	Improving	Degrading	Improving
POTOMAC RIVER AT CHAIN BRIDGE, MD	Improving	Improving	Improving	No Trend	Improving	No Trend
JAMES RIVER AT CARTERSVILLE, VA	Improving	Improving	Improving	Improving	Degrading	Improving
RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA	Improving	Degrading	Degrading	No Trend	Degrading	Degrading

Note. Rappahannock River near Fredericksburg, degrading in all areas (Mason et al., 2021).

There is an urgent need to take preemptive steps to protect the Rappahannock River. RIVERESM is a 501(c)(3), not for profit corporation that will take a lead role in supporting this effort. RIVERESM aims to promote and enhance the ecological and economic umbrella for the region by building a world-class ecological center on the banks of the Rappahannock. The RIVERESM Ecological Center will be a facilitator of water conservation efforts by offering flexible office, laboratory, and outdoor rental space for organizations helping to mitigate environmental pressures on the Rappahannock and the Chesapeake Bay watershed. The Center's outdoor landscape design will further enhance natural habitat by incorporating a native botanical garden with meandering trails that draw visitors to experience an adventure in research, education, technology and ecoculture.

What We Do: Facilitate, Promote, Support

RIVERESM aims to join and complement the great environmental centers of the world that share a similar mission to mitigate the impacts of human population growth and global climate change on freshwater systems. Due to its unique location and associated pressing environmental concerns, RIVERESM is in an excellent position to serve as a regional and global magnet for watershed research and conservation. The RIVERESM Ecological Center will support, promote and facilitate collaboration among water researchers, conservationists, environmental educators, and management agencies by bringing them into a shared space. RIVERESM will accomplish this goal by providing a state-of-the-art facility that offers flexible memberships with access to coworking, laboratory, education, auditorium, and event space. RIVERESM will support the use of emerging technologies by partnering with the Virginia Innovation Partnership Corporation and water researchers to create the Rappahannock SmartRiver. Finally, RIVERESM will support ecoculture and ecotourism through the creation of a native botanical garden that integrates Best Management Practice watershed research, sustainable agriculture, and indigenous knowledge into the surrounding landscape, which will provide visitors with meaningful learning opportunities. The Center will follow a phased approach for construction of the building and grounds that will continue to develop over time (see Phases of Development section). Each phase of research, education, technology and ecoculture will be developed incrementally for the interior and exterior of RIVERESM to ensure economic sustainability.

Supporting Watershed Research

RIVERESM will support water research and conservation in several ways. First, the high-tech design of the Center will help researchers align with national water research priorities involving emerging technologies such as automated sensors, machine learning, predictive modeling, and big data. These national research priorities include (1) enhancing data collection, citizen science, and development of Web-based analytical tools, and (2) coordinating with agencies and organizations on data delivery (National Academies of Sciences, Engineering and Medicine, 2018). To accomplish this first goal, RIVERESM will form a science and conservation advisory board to identify research areas to prioritize and inform the integration of emerging technologies into the Center. Second, the physical location and structure will provide researchers with ample indoor and outdoor resources to support research. The RIVERESM Center interior will include a flexible office, coworking and collaboration space, wet and dry laboratories, a greenhouse, flexible educational, auditorium and event space. The Center will integrate high-bandwidth technology and audio/visual resources, copy/print resources, and a kitchen. Surrounding the Center, RIVERESM will offer direct access to the Rappahannock River, as well as on-site Best Management Practice landscaping and testing grounds, walking trails, a canoe livery, 24/7 secure access and parking, and affordable bunkhouse accommodations for researchers and students. Finally, RIVERESM will provide scientists a venue in which to conduct imperative environmental research with concentrated access to a network of potential partners and collaborators who share local, regional, and global-level watershed expertise. Combined, these features will support scientists' efforts to develop novel and replicable mitigation strategies for dissemination to watersheds around the globe. RIVERESM has already taken initial steps to kickstart research efforts and academic engagement with the Rappahannock by funding programs at the University of Mary Washington, Virginia Tech, and Virginia Cooperative Extension (see Important and Potential Stakeholders, section for more details).

Supporting Use of Emerging Technologies to Create Virginia's First SmartRiver

Emerging technologies will play a critical role in addressing water research challenges over the next 25 years (National Academies of Sciences, Engineering, and Medicine, 2018). The wide adoption of new technologies will require development of systems (e.g., hardware, software, management frameworks, protocols) that can rapidly collect data from disparate sources, assess, store and process, and share data in formats that are informative and accessible in near real time. Consequently, developments in managing big data and integrating data from multiple sources and of different types will be critical to supporting scientific research involving predictive modeling and decision-making under uncertainty.

RIVERESM will support water research involving emerging sensor technologies, applied machine learning and predictive modeling by bringing the Smart River concept to the Rappahannock River in Virginia. Recent advances in wireless sensors and communication technologies have led to the emergence of next generation water quality monitoring systems that are changing the ways in which bodies of water can be monitored and managed (Adu-Manu et al., 2017; Burke & Allenby, 2013; Chen et al., 2018; Dong et al., 2015). The Rappahannock SmartRiver concept is a smart water quality monitoring system in which a network of wireless sensors collects real-time data on chemical, biological and physical aspects of the river, and transmit those data through a centralized server to be processed, stored, and made available online. Resulting data can be used for monitoring water quality, detecting

changes over time, sending notifications on existing or emerging water quality issues, and contributing to a long-term 'big dataset' to support predictive modeling. Over the past fifteen years, many examples of wireless sensor networks used for water quality monitoring have been developed throughout the world and are reviewed in Dong et al. (2015) and Adu-Manu et al. (2017). The Intelligent River© system on the Savannah River in South Carolina (White et al., 2010) is of particular relevance to the mid-Atlantic region of the U.S.

Making the Rappahannock Virginia's first complete SmartRiver through the strategic placement of wireless sensors from its headwaters to the Chesapeake Bay will enable real-time monitoring of the river and its tributaries for pollutants that damage the ecological health of the river. The river will include an automated wireless sensor network that relays real time data on water quality and quantity parameters such as temperature, pH, flow rate, turbidity, and web clouds used to predict water availability and the effects of weather or climate-based events on the watershed. In addition to standard water quality and quantity, experimental sensors for emerging contaminants such as microplastics, pharmaceuticals, and perfluorinated compounds may be developed and tested as part of the installed sensor networks. Big data from this effort can be used to identify pollution sources, enable rapid mitigation responses, and support predictive modeling to inform regional, national and global freshwater challenges. The development of a smart wireless sensor network through the full length of the Rappahannock will enable much-needed proactive monitoring, mitigation and planning measures as projected population growth and development upstream place increased pressure on the river. The Rappahannock SmartRiver system can also support and complement the growing network of technology-based, precision conservation initiatives within the Chesapeake Bay watershed (Burke & Allenby, 2013).

RIVERESM will support research efforts to acquire and apply emerging technologies associated with Smart Cities to the Rappahannock SmartRiver concept (Trindade et al., 2017), and will accomplish this goal through several key partnerships. First, RIVERESM will help water researchers pilot and test new wireless sensor network initiatives through a collaboration with the Virginia Innovation Partnership Corporation (VIPC) and its Virginia Smart Community Testbed initiative in Stafford County (Virginia Innovation Partnership Corporation, 2022). VIPC created the Testbed in Stafford to test new technologies in a real-world setting to drive faster innovation. Smart Stafford is the first Smart City Testbed in Virginia involving an IoT platform, fully integrated with 5G and other new and emerging technologies for Smart Cities in the state. RIVERESM will complement Smart Stafford's Integrated Water Management initiative by connecting water researchers with the Smart Community Testbed. Through its partnership with VIPC, RIVERESM can help water researchers pilot and test design ideas prior to implementation of the full SmartRiver concept by (a) determining if there are available sensors or sensors that can be developed to collect desired data, (b) deploying sensors, (c) bringing data from sensors into the cloud, and (d) making those data available in an online dashboard. RIVERESM will also partner with VIPC to write joint grant applications to seek federal funding in support of the SmartRiver concept. Ultimately, the Rappahannock SmartRiver will enable researchers and government agencies to identify correlations between the built and natural environment within the Rappahannock Watershed. Resulting data will improve the capacity of rapid mitigation responses as well as predictive modeling of water availability and use in relation to increases in frequency and severity of flooding and droughts.

Second, RIVERESM will partner with RIoT, a non-profit organization that aims to accelerate and increase the impact of start-up businesses involved in IoT technology (RIoT, 2022). RIoT has played a central role in helping Stafford County develop the Smart Community Testbed and will serve as a critical liaison to ensure that the RIVERESM Center's research technology objectives align with, and complement, the Testbed in efficient and synergistic ways. RIoT will also assist RIVERESM during its development stages by co-writing grant proposals, connecting RIVERESM with its IoT business consortium network, and training RIVERESM staff via the 12-week RIoT Accelerator Program. After the RIVERESM Center is established, RIoT can offer workshops that help inform researchers with IoT-5G technology training.

Finally, RIVERESM will seek support from initiatives such as Microsoft's AI for Earth (Microsoft, 2022a), Amazon's Imagine Grant Program (Amazon, 2022), and IBM Cloud (IBM, 2022). These initiatives support environmental research by providing funding and cloud-based resources to store and analyze big data. Examples of support requested include Microsoft Azure credits for big data storage space, getting a Microsoft data scientist assigned to RIVERESM, and obtaining funding for emerging technologies such as microsensors that advance measuring, monitoring, and analysis of water quality.

Supporting Environmental Education

Of equal importance to the RIVERESM Center's mission is supporting the Friends of the Rappahannock (FOR) non-profit organization. FOR works throughout the watershed to provide high quality environmental education programs, address nutrient, sediment, and bacteria pollution, enhance terrestrial and aquatic habitat for fish and wildlife, and increase public access to outdoor spaces. Through its partnership with FOR, RIVERESM is well-positioned to support regional education and outreach efforts. The Center will provide flexible classroom space, access to the river and creative outdoor landscaping where educators can develop and implement environmental education outreach programs that parallel and complement research being conducted at the Center. RIVERESM will also support FOR's coordination of the Rappahannock River Roundtable by offering highly flexible coworking and educational space that can be adapted to the needs of educational and community groups, as well as government agencies involved in watershed conservation.

Supporting Outreach, Ecotourism, and Ecoculture

As a world class ecological center, RIVERESM will also serve as an attractive and novel ecotourism destination for both visitors and residents. The Center's goal is to be recognized as a botanical garden and be known for showcasing water research, education, and cultural programs for the community, with an opportunity to become a trend setting tourist attraction. The RIVERESM Center is well positioned geographically to attract national and international visitors. The greater Stafford/Fredericksburg area is equidistant from the state and nation's capitals, along Interstate 95's corridor, making it equally accessible to Virginians, as well as national and international tourists.

The RIVERESM site is adjacent to a 60-acre parcel, owned by Stafford County in association with the Duff McDuff Green Memorial Park. RIVERESM is working with Stafford County and the Patowomeck Native American Tribe to explore ways in which the 60-acre parcel can be used to expand the RIVERESM Center's operations through the creation of native botanical gardens that support and integrate scientific research, sustainable agriculture, and

indigenous relationships with the land. As a culture of people dependent on water ecosystems, the location of the Patawomeck Native American Tribal Center is positioned as an important sentinel on the banks of the Rappahannock River. The RIVERESM Center will respectfully embrace boundaries between both properties. The Center will partner with Virginia Tech and Native American Tribal members throughout Virginia, using intentional design principles that weave Best Management Practice watershed research, sustainable agriculture, and indigenous knowledge into the surrounding landscape. The integration of Scientific Ecological Knowledge and Traditional Ecological Knowledge will provide visitors with meaningful educational opportunities, inspire sustainable design principles, and serve as an example for home landscapes.

Showcasing Sustainability

RIVERESM will integrate principles of economic, environmental, social, and cultural sustainability into the design and operations of the Center. Economic sustainability will be ensured through membership income for flexible coworking, research lab, and auditorium space. Environmental sustainability will include LEED® Platinum and Living Building design criteria and best management landscape practices. Social and cultural sustainability efforts will balance Traditional and Scientific Ecological Knowledge in collaboration with the Patawomeck Tribal Center and other cultures.

Environmental Sustainability

With environmental sustainability in mind, the Center design will consider surrounding landscape, working to restore diverse habitats disturbed by monoculture farming practices. RIVERESM will consider the real-life cycle impact of design, construction, and operation at the Center. The design team will strive to meet Leadership in Energy and Environmental Design (LEED®) and Living Building Challenge (LBC) stringent requirements and meet the most ambitious performance standards with environmental sustainability in mind. Transparency of the building design and operation will provide a deep learning experience for optimizing energy use, engaging member occupants and short-term visitors. The building design will challenge the broader community's view of business-as-usual building design concepts in construction and operation. The RIVERESM Center will also entice the public with educational opportunities and create development platforms for students to use available space and the surrounding landscape as living learning laboratories. From monitoring the renewable energy systems of the building to maintaining outdoor living laboratory gardens, and overseeing the water systems in the building, the Center will provide many opportunities to learn. Students will interact with the Center in unique ways and help position the RIVERESM Center as a Landmark Living Building. The Center will showcase solutions to global environmental building problems through BMPs for water quality improvement. Firsthand regenerative approaches will be showcased to students, administrators, and researchers with local integrated river sensor technology that can be appreciated globally.

Economic Sustainability

The 2020 global pandemic provided a dose of reality for all businesses, highlighting the fact that overhead costs for building occupancy can be reduced through leasing/rental shared spaces. From small availability to large conference spaces, having flexibility in office space and associated costs reduces overall overhead expenses. All levels of successful organizations have shifted away from the ‘business as usual’ norm to discovering innovative ways to work. In this spirit, the RIVERESM Center will use a flexible coworking and membership financial model for economizing space as conceptualized and proven successful by Gather.[®], a registered trademark of Gather Workspaces, LLC. In addition, RIVERESM has consulted with Wipfli LLP, to conduct a financial analysis to determine how much square footage must be leased at the Center to cover annual operating costs. The analysis will be used to determine size of the Center and rates for leasing space, hereinafter referred to as ‘membership’. See the ‘Projections of Facility Cost and Endowment Needs’ section below for more details.

Social and Cultural Sustainability

The Center will also explore social systems and how human interaction, with natural environments, can be improved and sustained through a balance of Traditional and Scientific Ecological Knowledge. Located adjacent to the Native American Patawomeck Tribal Center, the RIVERESM Ecological Center will work in conjunction with the Tribe, offering a unique balance of sustainability that is in keeping with the balance of both forms of Ecological Knowledge. The RIVERESM laboratories will be committed to science-based decision-making and long-term strategic planning. Considering long-term goals while addressing short term gains, the Center will provide a clearing house and focal point for mission critical research, environmental ecosystems exploration, as well as cultural awareness.

Location Analysis

RIVERESM has considered several sites on the Rappahannock River, including a 4-acre property in Fredericksburg and two properties in Stafford County (a 60-acre parcel and a 12-acre parcel). In May 2022, the 12-acre riverfront property in Stafford County was purchased by the founder of RIVERESM, with the intent of donating the property to RIVERESM upon a successful fundraising campaign. This site offers deep water access and has no issues with flooding. The RIVERESM site is also adjacent to a 60-acre property owned by Stafford County in association with the Duff McDuff Green Memorial Park and the Patawomeck Native American Tribal Center. These adjacent properties provide exciting opportunities for collaboration (see above section ‘Supporting Outreach, Ecotourism and Ecoculture’). The RIVERESM site is located on Route 3 (aka King’s Highway) approximately one mile east of the George Washington Boyhood home, a major tourist attraction, and numerous historical sites within the greater Fredericksburg area. The RIVERESM site is easily accessible via rail to Fredericksburg or by vehicle to dense population centers including Washington D.C., Richmond, the Virginia State Capitol.

Justification

The RIVERESM Center will align with and enhance both national and regional priorities by supporting environmental research, technology, educational programming, and ecoculture. First, the high-tech design of the RIVERESM Center will support scientists aligned with national water research priorities (see above sections ‘Supporting Watershed Research’ and ‘Supporting Use of Emerging Technologies to Create the Rappahannock SmartRiver’). Second, RIVERESM will partner with and support already established regional stakeholders to address environmental pressures on the Rappahannock River in association with projected regional growth (see ‘Partners and Stakeholders’ section below). Finally, RIVERESM will align with Stafford County’s long-term strategic plans and provide regional financial benefits across a diverse range of sectors, including economic development, natural goods, services, and resources, ecotourism & outdoor recreation, county level fiscal health, public health, and wellbeing (below).

Alignment with Regional Strategic Plans

As Stafford County faces rapid population growth, there will be increasing pressure on the county’s natural and cultural resources. To proactively mitigate impacts of this projected growth, Stafford County produced several long-term planning documents that highlight, analyze, and expand strategic initiatives, goals, and objectives. RIVERESM will support and align with these strategic plans in multiple ways, particularly in Stafford’s objectives to protect and restore the ecological integrity of county waterways, while also helping promote rural economic development through ecotourism.

RIVERESM will provide direct support to goals outlined in the Stafford County Virginia Comprehensive Plan 2016-2036 (Stafford County Planning Commission, 2021). Through its BMP landscaping and support of BMP watershed research, RIVERESM affiliates will help protect and restore streams through reduction of surface and groundwater pollution, helping Stafford County identify, adopt, and implement programs that protect the Chesapeake Bay watershed. RIVERESM will enhance public education in Stafford County by supporting environmental education programs provided by Friends of the Rappahannock at the RIVERESM Center. These green programs will increase public awareness in many federal and state mandated topic areas, such as protecting drinking water resources, effective and proper use of fertilizers and pesticides, and habitat restoration. RIVERESM will support Stafford’s promotion of alternative rural development to increase tourism by promoting the Center as an ecotourism destination. The unique location in Stafford, adjacent to the Patowomeck Tribal Center, with deep water access, will create a draw for ecotourists as well as a regional and global research magnet for many disciplines. Finally, the site of the RIVERESM Center can be used as acreage for the beginning of an environmental quality corridor.

As indicated in the Stafford County 2040 Vision - Board of Supervisors Strategic Plan (Stafford County Board of Supervisors, 2021), residents using the county’s park, recreation, and community facilities were surveyed and indicated that their highest rated choices for recreational programs included interest in trails, outdoor/nature, and fishing. RIVERESM will showcase at least three of these recreational choices at the Center.

According to the Stafford County Department of Economic Development Strategic Plan, underutilization of natural amenities was listed as a weakness in the County’s SWOT analysis report (Stafford County Department of Economic Development, 2015). Riverfront placement of RIVERESM in Stafford County will directly address this concern. A priority focus area outlined

how the county has not effectively tapped waterfront amenities for appropriate commercial development on both the Rappahannock and Potomac Rivers. RIVERESM is positioned to help Stafford County by establishing itself as one of the first effective environmental quality corridors, filled with attractive destinations.

In alignment with Stafford County's Bicycle & Pedestrian Facilities Plan (Stafford County Planning Commission/Board of Supervisors, 2019), RIVERESM supports the concept of an eco-friendly waterfront trail, accessible across land and waterfront acreage as part of the Center design. The RIVERESM Center will also align with recommendations from the 2013 Virginia Outdoors Plan, to include developing a comprehensive trail system linking communities with destinations and providing more access to recreational waters. In addition, Stafford County's facility recommendations for the George Washington Region Bicycle and Pedestrian Plan, shows that shoulder improvements are needed along King's Highway at the RIVERESM site.

In alignment with the Stafford County (2018) Groundwater Resources Evaluation, RIVERESM can help promote water quality health for Stafford's supply of water through water sensing technology. Stafford County does not currently utilize public supply wells as a water source. All of the county's water is currently sourced from surface water features, such as Smith Lake, Lake Mooney, and the Rappahannock River.

Financial Benefits to Stafford County

The RIVERESM Center will provide direct and indirect financial benefits to Stafford County with measurable impacts across a diverse range of sectors, including economic development, natural goods, services, and resources, ecotourism & outdoor recreation, county level fiscal health, public health, and wellbeing.

The Center will contribute to regional *economic development* by promoting investments in land conservation, proactive approaches to natural hazard mitigation, and by serving as a venue for professional conferencing, seminars, and industry workshops. Investments in land conservation in the state of Virginia has had significant direct and measurable financial returns, with up to an estimated 400% return on investment as documented in a 2016 study, *Virginia's Return on Investment for Land Conservation* (Trust for Public Land, 2016). This study found that for every \$1 dollar invested in conserving natural land in Virginia, an estimated \$4 is gained through services such as improved water quality, carbon sequestration, and increased quality of habitats for flora and fauna (Trust for Public Land, 2016). In addition, being proactive in natural hazard mitigation has been shown to generate significant and noticeable return on investment. FEMA's 2018 *Natural Hazard Mitigation Saves Interim Report* shows that for every \$1 spent on natural hazard mitigation, \$6 is saved (FEMA, 2018). The analysis was completed by the National Institute of Building Sciences and the 6:1 ratio is also cited in Virginia's December 2021 *Coastal Resilience Master Plan* in reference to the need for proactively developing cost effective resilience strategies (Department of Conservation and Recreation, 2021). The largest gains can be realized the sooner local governments begin addressing the increasing natural hazards caused by climate change. Finally, RIVERESM will serve as a location for professional conferencing, seminars, and industry workshops which will regularly bring industry leaders as guests to the Stafford region. With increased business-related travel to Stafford County, associates traveling to RIVERESM will help support Stafford with both increased tax revenue and spending for local businesses. In 2019, the average travel party spending, for business trips in

Virginia, was \$932 per trip with each trip lasting, on average, 2.8 nights with a majority (68%) of visitors originating from somewhere outside of the state (Virginia Tourism Corporation, 2019).

RIVERESM will contribute to the protection and enhancement of *natural goods, services, and resources* in Stafford County by partnering with Stafford County in floodplain management. RIVERESM will assist the Stafford region in floodplain management efforts through the development, testing, and implementation of state-of-the-art monitoring equipment. Floods are the most common and most expensive natural disaster, and according to FEMA's Historical Flood Impact data, Stafford County has seen 67 flooding events since 1996 (FEMA, 2018). In the state of Virginia, flooding and associated costs are expected to increase dramatically over the next sixty years. Notable findings from the *2021 Virginia Coastal Resilience Master Plan* technical study's impact assessment shows that between 2020 and 2080, "the number of miles of roadways exposed to chronic coastal flooding is projected to increase from approximately 500 to nearly 2,800 miles, an increase of 460%", and "the number of residential, public, and commercial buildings exposed to an extreme coastal flood is projected to increase by almost 150%, from 140,000 to 340,000, while annualized flood damages increase by 1,300% from \$0.4 to \$5.1 billion" (Department of Conservation and Recreation, 2021). As increased flooding occurs in the coming decades, RIVERESM research will contribute to the region's efforts to manage flood related events, helping to save lives, structures, and other important resources. RIVERESM will contribute to offsetting Stafford County's flood-associated costs, that are expected to increase dramatically over the next 60 years (Department of Conservation and Recreation, 2021).

RIVERESM will also position itself as a developed open space with the financial return, felt through various environmental impacts, including air pollution removal, carbon sequestration, and stormwater management. Open space near developed areas is typically park land or characteristically similar to parks. An analysis of the value of air pollution removal, carbon sequestration, and stormwater management provided by parks in Virginia, found that the annual per-acre value of these services is \$1,800 (Trust for Public Land, 2016). The impact of RIVERESM as a developed open space will provide a vital service to those living in the area by providing enhanced environmental services.

RIVERESM will support *regional ecotourism and outdoor recreation* both directly and indirectly. The Rappahannock River represents a means of enjoyment for both tourists seeking paddling activities and as an economic engine for the businesses catering to outdoor recreation. In 2012, economic impacts and benefits of recreational paddlers along the Northern Forest Canoe Trail in Vermont were quantified, including individual and group spending while on the trail. The study found that, "approximately 90,000 visitors paddled the waterways in the six study regions. Their spending in local communities created \$12 million in total economic impacts and supported about 280 jobs. The median paddler group spent \$215 per trip, primarily at lodging establishments, restaurants, grocery stores, and service stations. Nonlocals spent an average of \$414-498, or \$46 per person per day" (Pollock et al., 2012). Similarly, the Rappahannock River serves the Stafford community as a means of outdoor recreation. Through its support of partners that work to protect and maintain the health of the Rappahannock River, RIVERESM will help improve the experience of recreational paddlers and preserve the pastime of freshwater fishing for local and regional residents. Over 800,000 Virginia residents and non-residents participate in fishing each year, with the economic impact from fishing, more than \$1.3 billion to the State of Virginia (Department of Wildlife Resources, 2022). In Stafford

County, the Department of Wildlife Resources issued a total of 8,575 fishing licenses in FY 2021, with 4,959 Resident State Freshwater Fishing licenses. Since fishing is important to many living in the Stafford region, protecting the water quality of the Rappahannock River to promote the health of fish, is a concern for thousands in the Stafford region alone. Combined, these efforts will help bring adventure-seekers to the area and promote new and existing businesses. The overall health of the river will also have a significant economic impact on the shellfish industry for the Chesapeake Bay watershed. Finally, RIVERESM will support regional ecotourism through its educational outreach (in coordination with Friends of the Rappahannock), botanical gardens, BMP demonstration projects, and natural gathering spaces for events.

As a greenspace for the region, RIVERESM can contribute to *fiscal health* in Stafford County by attracting new home buyers who are looking for more desirable places to live, work, and raise a family. The increase in new residents will provide increased revenues from personal property as well as sales tax. According to the National Association of Realtors (2020), in the *2020 Profile of Homebuyers and Sellers*, 26% of buyers who purchased a home in a suburb or subdivision listed ‘convenient to parks/recreational facilities’, as a factor influencing neighborhood choice, that is 2% higher than ‘convenient to schools’ at 24%. Having RIVERESM as an additional greenspace for the region could influence home buying decisions for those seeking to relocate to or near Northern Virginia. Property values will increase in Stafford County with the addition of offerings at RIVERESM. The price of homes facing a park have been found to command an eight to ten percent premium on property values. A comprehensive literature review on 33 studies measuring how much of an impact that parks have on property value, shows the range of impact extends over 2,000 feet for parks over 40 acres in size (Crompton, 2020). The current targeted location for RIVERESM in Stafford County will help increase the surrounding area’s appeal even further for those looking to relocate to this area, with the potential to increase home prices for current residents.

The RIVERESM Center will also contribute to improving *public health and wellbeing* of the regional community by promoting key values associated with nature centers including environmental connection, leisure provision, community resilience, and civic engagement (Browning et al., 2018). Through nature trails and a botanical garden, RIVERESM can provide residents with access to an outdoor botanical area where visitors can be physically active while increasing their connection with the natural world. Having a community that is more physically active can help reduce health related expenses and increase quality of life (Kahn et al., 2002).

Partners and Stakeholders

The RIVERESM concept is based on collaboration of partners and stakeholders who work together as a community of professionals striving toward ecological solutions through science, education, technology and ecoculture. It is important to note that the primary role of RIVERESM is to serve as a conduit of connection, support, and promotion of the work conducted by these partners and stakeholders. A vast community of stakeholders and partners has already been established and will continue to develop with interest toward a more responsible view of watershed and ecosystem services.

Friends of the Rappahannock (FOR)

Friends of the Rappahannock is an impactful organization that focuses on the well-being of the river and educating citizens. They are our most cherished non-profit partner. Their successes are long and distinguished. Since 1985, FOR has worked throughout the basin to be the voice and active force for a healthy and scenic Rappahannock River watershed. FOR works throughout the entire 18 county region of the watershed to offer a broad spectrum of programs to address nutrient and sediment pollution outlined in the Chesapeake Bay TMDL, local bacteria pollution, enhance terrestrial and aquatic habitat for fish and wildlife, increase public access to outdoor spaces, and provide high quality environmental education programs.

In 2016, FOR began administering the Rappahannock River Roundtable (Roundtable) in partnership with the Virginia Department of Environmental Quality (DEQ). The Roundtable is a strategic partnership of stakeholders working to accelerate the pace of land and water conservation through increased community engagement, education, and capacity building throughout the entire Rappahannock River Watershed. The Roundtable works to implement the Rappahannock River watershed's portion of Phase III watershed implementation plan (WIP) which outlines priority BMPs for the agricultural, urban, and natural sectors. In 2019, the Roundtable was awarded a \$810,000 grant to accelerate collaboration and implementation of non-point source pollution BMPs. The initiatives underway range from riparian buffers, tree plantings, nutrient management planning, and livestock exclusion in the upper portions of the watershed to oyster reef restoration and living shorelines in the lower watershed. Virginia Tech, Virginia Cooperative Extension, soil and water conservation districts, natural resource conservation service, and many other agencies and organizations participate in projects and programs with the Roundtable. This collaborative approach to regional water quality improvement is an innovative way to share resources, expertise, and maximize economies of scale and pollution reduction.

Virginia Cooperative Extension (VCE)

RIVERESM teamed with VCE in 2018 to explore the possibilities of sighting an Ecological Center (EC) on the Rappahannock River. Funding was raised through three different sources to fund two different efforts. First, VCE and RIVERESM agreed to fund an Extension Agent position to facilitate the RIVERESM concept with area stakeholders to include FOR, Stafford County and the City of Fredericksburg. This position helped solidify relationships with area stakeholders and nonprofits with existing facilities to include the Chesapeake Bay Foundation, the Stroud Lab, Ohio State Universities Stone Lab and the Cary Institute in New York. RIVERESM and VCE are in discussions to extend Virginia Tech's role in the Ecological Center to include additional employees to further the cause. The second effort involved funding from RIVERESM and the Wetland Studies and Solutions Trust Fund to support several projects on the Rappahannock. The first study is being conducted to verify assumptions made within the EPA's Chesapeake Bay Model by documenting the concentration of nutrients and sediments within run-off water during storm events for 5 different land uses in the Fredericksburg area. VCE researchers are working with the University of Mary Washington and Friends of the Rappahannock to collect this information. VCE and Biological Systems Engineering at Virginia Tech are currently assessing the potential for a long-term physical presence on the Rappahannock and position the Rappahannock as a Model Study System for watershed research. This would be a significant alliance and potentially fulfill the need for an anchor tenant.

Stafford County

Partnering with Stafford County offers RIVERESM an opportunity to work directly with the Patawomeck Tribal members. The RIVERESM site is adjacent to a 60-acre property owned by Stafford County in association with the Duff McDuff Green Memorial Park and the Patawomeck Native American Tribal Center. These adjacent properties provide exciting opportunities for collaboration (see above section 'Supporting Outreach, Ecotourism and Ecoculture'). RIVERESM envisions using Stafford's 60-acre property to create native botanical gardens and associated walking trails that serve as a natural corridor, fostering connections between the ecological center and the Patawomeck Tribal Center. These botanical gardens and associated environmental educational opportunities can be a big tourism draw if done well. It will be the goal of RIVERESM to make the gardens a major tourism attraction to the area with significant potential to increase tourism attendance for all three destinations in the immediate area - the George Washington Boyhood Home, the Patawomeck Tribal Center and the RIVERESM Center. The location for the proposed Center will advance economic development for Stafford in the environmental sector with an Environmental Quality Corridor and provide deep water access needed for valuable big data research.

Virginia Innovation Partnership Corporation

The Virginia Innovation Partnership Corporation (VIPC) is a non-profit corporation that creates technology-based economic development strategies to accelerate innovation, imagination, and the next generation of technology and technology companies in Virginia. VIPC has worked closely with Stafford County to create the Virginia Smart Community Testbed initiative in Stafford to test new technologies in a real-world setting to drive faster innovation. Through its partnership with VIPC, RIVERESM will help water researchers pilot and test design ideas prior to implementation of the full SmartRiver concept. RIVERESM will also partner with VIPC to write joint grant applications to seek federal funding in support of the SmartRiver concept.

RIoT

RIoT is a non-profit organization that aims to accelerate and increase the impact of start-up businesses involved in Internet of Things (IoT) technology. RIoT played a central role in helping VIPC and Stafford County develop the Smart Community Testbed and has been instrumental in supporting economic development by working with emerging markets and accelerating startups. RIoT Labs provide hardware, wireless and software prototyping with all the tools startup companies need. RIVERESM has joined forces with the RIoT team in the development of its SmartRiver concept and supporting research involving emerging technologies. RIoT will serve as a critical liaison to ensure that the RIVERESM Center's research technology objectives complement the Testbed in efficient and synergistic ways. RIoT will assist RIVERESM by co-writing grant proposals, connecting RIVERESM with its IoT business consortium network, and training RIVERESM staff via the RIoT Accelerator Program. After the RIVERESM Center is established, RIoT can offer workshops to provide researchers with IoT-5G technology training.

Virginia Tech (VT)

Dr. Julien Cadot from Virginia Tech (VT) leads a group of researchers at VT (including the Biological Systems Engineering department) that are looking for funding opportunities to conduct research on the Rappahannock River. The Rappahannock River Roundtable effort, coordinated by Friends of the Rappahannock, is working to provide research opportunities and assistance to facilitate funding for the group to consider.

Virginia State University (VSU)

As a historically black land grant university, established in 1882, Virginia State University is the first fully, state supported four-year university of higher education for Black Americans. The RIVERESM Center supports all cultures and will work to establish a culturally diverse stakeholder community that works together for improvements in water quality and river research. With a robust aquaculture program, Virginia State University will be an integral partner for research and education in this region. As an already established stakeholder with Virginia Tech and Virginia Cooperative Extension, Virginia State University is an important partner to promote diversity and cultural awareness for the community.

Rappahannock River Roundtable (RRR)

Collectively, the RRR is partnership coordinated by Friends of the Rappahannock that works to accelerate the pace of implementation for priority best management practices (bmps) and associated conservation programs outlined in the Virginia Phase III Watershed Implementation Plan (WIP) through innovation, resource sharing, capacity building, and technical assistance. The Roundtable provides assistance with grant writing, project development, outreach and education programs and campaigns, social media and digital content development and management, GIS and mapping support, and a variety of other support services to members and partners serving the Rappahannock River Region. The RIVERESM Ecological Center will be a home for the RRR members.

University of Mary Washington (UMW) and UMW Foundation

RIVERESM has helped fund projects involving environmental projects for UMW scientists and students. RIVERESM helped coordinate an alliance with VCE and Biological Systems Engineering Department in the College of Agriculture and Life Sciences at Virginia Tech to assess runoff water within the City of Fredericksburg. Similar studies can be initiated with Stafford County. The UMW business school was an integral partner in researching key elements for the RIVERESM business plan.

American Canoe Association (ACA)

The American Canoe Association with an Olympic Gold Medalist in a past summer's Olympics has voiced interest in locating their offices within the RIVERESM Ecological Center and would take advantage of the easy access to the Rappahannock River.

The Nature Conservancy

The Nature Conservancy (TNC) are the overseers of the City of Fredericksburg's impressive 31-mile long conservation easement along the river upstream of the City and is a logical partner to advance their role for this beautiful section of the Rappahannock River.

Patawomeck Tribal Office

As a State recognized Native American Tribe, the Patawomeck Tribal Center has a membership of approximately 2,500 strong, the largest in Virginia. The RIVERESM Center will work in conjunction with the Patawomeck Tribe, offering a unique balance of sustainability that is in keeping with the balance of Scientific Ecological Knowledge and Traditional Ecological Knowledge. The RIVERESM laboratories will be committed to science-based decision making and long-term strategic planning. Considering long-term goals while addressing short term gains, the Center will provide a clearing house and focal point for mission critical research with reverence to Indigenous knowledge.

Rappahannock Tribe

As a Federally recognized Native American Tribe, the Rappahannock's were founded prior to 1570. The Rappahannock mission is to preserve tribal culture, social, and political structures, while educating the public on rich contributions to Virginia and the Nation. The RIVERESM Center will work with all Native American tribes, but especially those that have direct connections with the Rappahannock River.

Additional stakeholders that may have interest in the RIVERESM facility (listed alphabetically):

- American Battlefield Trust (ABT)
- George Washington Regional Commission (GWRC)
- National Parks Conservation Association
- National Park Service
- Virginia Department of Conservation and Recreation
- Virginia Department of Conservation Resources (DCR)
- Virginia Department of Environmental Quality (DEQ)
- Virginia Department of Health (VDH)
- Virginia Department of Historic Resources
- Virginia Department of Wildlife Resources (DWR)
- Virginia Marine Resources Commission
- Virginia Outdoors Foundation (VOF)
- Tri-County/City Soil & Water Conservation District (TCCSWCD)
- US Army Corps of Engineers (ACOE)
- US Department of Agriculture: Farm Service Agency (FSA)
- US Department of Agriculture: Natural Resources Conservation Service (NRCS)
- US Geological Services (USGS)

Comparative Analysis of Commensurate Facilities

A comparative analysis was conducted to enhance sustainability through a collection of empirical data and research-supported solutions from twelve commensurate organizations. This data will be valuable to address planning outcomes, programs and general operating procedures during the design and building phases for construction. The early and continuous access of this information will challenge the concept of risk and provide opportunities to make adjustments, providing a forward and sustainable trajectory in building design, program and initiative development, and research. A rubric was developed to guide data collection, form

data sets, and provide comparable information for analysis in site location, organizational concept and structure, programs and initiatives, rentable space, annual reports, accountability, funding sources, building design and construction, and overall costs. Rubric and data set information results are available in Appendix A.

Upon completion of data set analyses, notable similarities and differences were highlighted as areas of interest and consideration. Organizational initiatives, interdisciplinary collaboration, educational programs, community inclusion, and outreach were common with similarities in fundraising approaches. Differences existed in the delivery method and degree of success of each organization's initiatives. The strengths and strategies identified by this comparative analysis will inform the design and development of the RIVERESM Center.

Center Design Concept

The creation of the RIVERESM Center on the Rappahannock River will provide a much-needed centralized location for a wide range of stakeholder involvement including environmentally focused researchers, non-profit organizations, governmental organizations, K-12 students, special interest community groups, and tourists. The Center will be a physical conduit for conservation-related entity collaboration in research, to deliver and participate in meaningful educational opportunities, host symposiums, and educational conferences. The Center will also serve as a centralized community space for environmentally relevant gatherings and special events. RIVERESM will be an architecturally organic structure on the banks of the Rappahannock, using green living, biophilic, and LEED® design principles.

Architectural Design

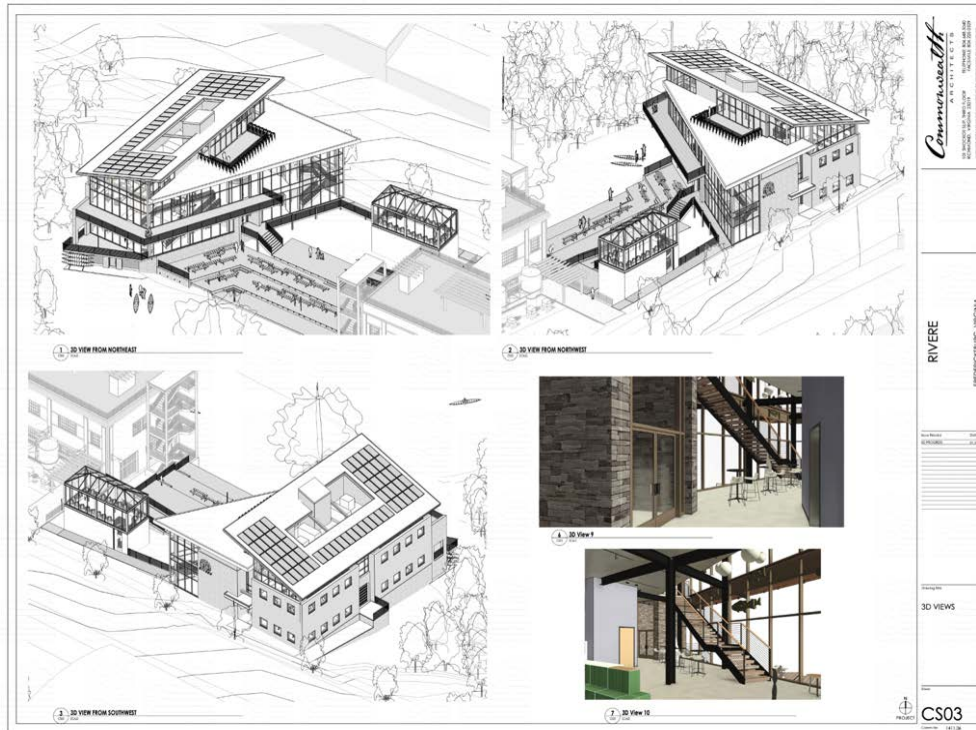
Early in the planning process, RIVERESM was considering a 4-acre property in the City of Fredericksburg and worked with Commonwealth Architects to develop conceptual design renderings of a 10,000 sq. ft. Center, the maximum suitable size for that site. Later in the planning process, a 60-acre property in Stafford County came available as a second potential site option for the RIVERESM Center. In May 2022, the RIVERESM founder purchased a 12-acre parcel adjacent to the 60-acre site, with plans to partner with Stafford County in the use of the 60-acre parcel for outdoor exhibits and themed gardens that support and integrate scientific research, sustainable agriculture, and indigenous relationships with land. The 12-acre site also opened up the possibility of a 25,000 sq. ft. Center with an expanded concept. The final square footage of the Center will be determined by financial analysis of economic sustainability based on stakeholder interest and projected coworking membership income.

The RIVERESM Ecological Center will be a structure with three scientific laboratories (a wet lab, a dry lab, and a flex lab), flexible auditorium space to accommodate 250 people, flexible office and coworking space, collaboration space, flexible education space, dedicated space for education exhibits, interactive learning stations and artistic displays, a greenhouse, state of the art audio-visual and internet capability, office support, a kitchen, a small retail shop, and a canoe livery. The surrounding landscape will be designed and managed to support learning opportunities to feature native plants and modern methods for utilizing plants and biological systems to treat runoff pollutants. RIVERESM will also offer affordable bunkhouse accommodations, walking trails, 24/7 secure access and parking and direct deep-water access to the Rappahannock River. RIVERESM will strive for LEED® Platinum or Living Building Challenge

certification and serve as a smart facility with integrated technology. The facility will use the latest technology building management system to (a) promote energy efficiency through features like motion detectors and individualized room controls to automatically adjust lighting and ventilation, and (b) provide high-speed wireless capacity to partners and guests. With its current partnership with the Virginia Tech School of Architecture, RIVERESM will explore the possibility of bringing the international award winning 'FutureHAUS' design to its onsite housing accommodations (Virginia Tech, 2022). Figures 3-6 depict architectural renderings for a 10,000 sq. ft. center suitable for the originally considered 4-acre site in Fredericksburg, reflecting design principles that can be scaled to a larger building in Stafford County. More detailed information on these architectural renderings can be found in Appendix B. A video of the RIVERESM Center concept can be found here: <https://tinyurl.com/RIVERE-Center-Concept>.

Given its emphasis on showcasing sustainability and green building design principles, RIVERESM is consulting with the Vice President, Corporate Director of Sustainability at SmithGroup architecture firm in Washington, DC. SmithGroup architects have expertise in campus planning, energy & environmental modeling, LEED, strategy, and sustainable design, and are known for green building design work on the [Brock Environmental Center in Virginia Beach, VA](#), the [Philip Merrill Environmental Center in Annapolis, MD](#), and the [Virginia Tech Innovation Campus and Academic 1 Building in Alexandria, VA](#). RIVERESM is excited to bring SmithGroup's extensive experience with LEED® certification and Living Building Challenge certification standards to the design of the Center. Given the significant evolution of the RIVERESM vision since its inception, including site considerations and associated opportunities, architectural design concepts in Figures 3 and 4 (and the above video link) are also likely to evolve. Consequently, these figures and videos should be viewed as conceptual renderings only.

Figure 3
Conceptual Digital Rendering of the RIVERESM Center



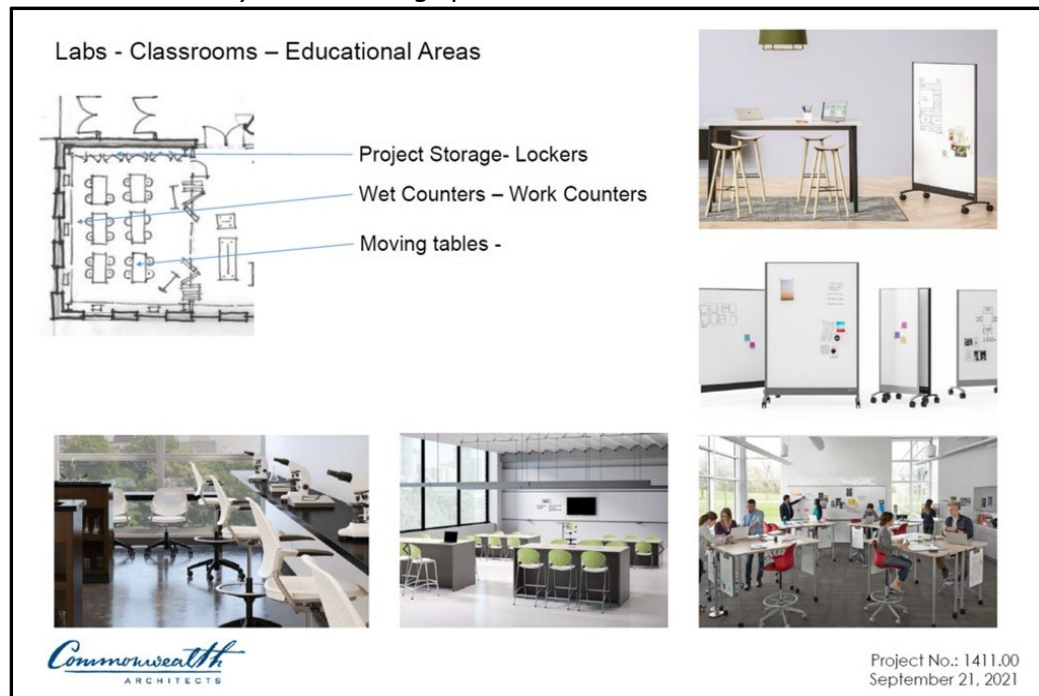
Note. Views of the RIVERESM Center from different angles. Developed by Commonwealth Architects for the originally considered location in Fredericksburg.

Figure 4
Conceptual Digital Rendering of the RIVERESM Center Exterior



Note. Riverfront view of the RIVERESM Center. Developed by Commonwealth Architects for the originally considered location in Fredericksburg. Features shown include an open design with ample natural lighting, a greenhouse propagation lab, a green roof terrace and a canoe/kayak storage area.

Figure 5
Flexible Laboratory and Learning Spaces



Note. Examples of how laboratories and learning spaces can be designed with flexibility. Open designs with moveable tables and chairs enable adjustment to accommodate different needs.

Figure 6
Flexible Office and Coworking Space



Note. Examples of how office space can be designed with flexibility in mind. An open design with moveable walls, tables and chairs enables flexible adjustment of the same workspace to provide different formats that accommodate differing tenant needs over time.

Green Building Design and Management

As a Center that focuses on environmental sustainability, the RIVERESM Center construction will model energy and environmental design principles in conjunction with the LEED® certification and the Living Building Challenge certification standards. Members (occupying rentable space) and visitors will be exposed to unique innovative design solutions, utilizing smart technology, environmentally friendly design concepts, and recycled building materials.

Living laboratories will be provided to demonstrate and disseminate real time data, generated from research within the building. To prioritize building efficiency, LEED® building certification will decrease operational costs, increase asset value and ensure productivity, comfort, health and well-being for occupants, as well as aid in implementing ecologically ethical management practices for investors (Williams, 2021). LEED® certification will position RIVERESM as a globally recognized symbol of sustainability and leadership, utilizing sustainable construction as part of the effort to address climate change and resource depletion (Pham, et al., 2020).

The Living Building Challenge performance standard provides a framework of regenerative design to create spaces that are empathetic to nature, a system beneficial for human interaction with light, air, food, and nature, and designs that offer positive impact for the community (Williams, 2021). The Living Building Challenge is a design concept for regenerative buildings connecting collaborators to a holistic approach to construction with site location self-sufficiency. This Challenge is the world's most rigorous proven performance standard for buildings and people from around the world using regenerative design framework to create spaces that give more than they take.

The RIVERESM Center's building management will utilize resources similar to Microsoft's Cloud for Sustainability platform that will be helpful to record, report and reduce emissions while gaining efficiencies (Microsoft, 2022b). This system of carbon accounting and insight technology will help generate data to track the Center's carbon footprint and meet goals of sustainability (i.e., attain carbon neutrality). Tracking of data reporting and decision making will drive sustainability objectives.

Accessibility

The RIVERESM design plan will allow for unrestricted access to the entire building and surrounding landscape areas. The building design will focus on the American Disabilities Act (ADA) compliance for ease of entrance for all, with prominent ramps to ensure effortless access, including educational exhibits, and safe, deep water access. The ADA sets building standards for handicap access. In dock layouts, specifications are used to govern width, turning radius, degree of incline, and side rail protection. Everyone deserves the chance to enjoy boating and water sport activities and our ADA compliant dock options will provide a world of possibilities!

Design of Natural Environments

The building site provides an opportunity to showcase natural based solutions for best management practices in both restorative and regenerative model study systems that benefit water quality. As an example of transformational landscape change, innovative management practices for sustainable land and building management will be implemented. The 12-acre

RIVERESM site location in Stafford County provides the ‘model botanical study system’, to showcase the before and after version of restoring habitats. Transformational landscape change will be available through a documented photo montage that visually depicts what the area would have looked like prior to agricultural farming, while the land was farmed, and after the installation of sustainable native plant communities. The property is currently under farm use and cyclically plowed with a leveled grade. This would be the ideal location to showcase native plant communities that restore natural habitats.

Landscape Design Concept

A Living Laboratory for Research, Education, and Cultural Knowledge

The RIVERESM site location will have significant potential for visual and tangible exhibits as well as themed gardens. As watermen, the Patawomeck Tribal Center is positioned as an important sentinel on the banks of the Rappahannock River and the RIVERESM Center will respectfully embrace the boundaries between both properties. The Center envisions partnering with Virginia Tech and Native American Tribal members to use intentional design principles that weave Best Management Practice watershed research, sustainable agriculture, and indigenous knowledge throughout the landscape. This integration of Scientific Ecological Knowledge and Traditional Ecological Knowledge will provide visitors with meaningful educational opportunities and inspire the use of sustainable design principles in home landscapes. The goal of the RIVERESM Center is to be recognized as a botanical garden and be known for showcasing water research, education, and cultural programs for the community, with an opportunity to become a trend setting tourist attraction.

Deep water access on the Rappahannock River will be the focus of the exterior grounds for research and education opportunities. A dock and boat launch will allow direct access to deep water research, educational tours and monitoring stations at this location, accessorized with plants that secure the riparian zone (the interface between land and river). These plants will prevent direct runoff of storm water and silt deposits through erosion mitigation strategies including a sloping riparian bench, riparian plantings and existing trees (Appendix C, Figure 1). The boat launch will also be available to partners, including Friends of the Rappahannock and The American Canoe Association for education as well as recreation tours (Appendix C, Figure 2). This deep-water access will be the source for community involvement, research, and education that will focus on improving the health of this environmental asset.

RIVERESM will also showcase sustainable design principles both within and around the facility that connect people with the importance of plants in promoting watershed health. Landscape design will use watershed-specific plant choices included with Virginia stormwater Best Management Practices (BMP's) and demonstrate how native plant gardens serve as natural filters that prevent polluted runoff from entering the watershed. The erosion prevention exhibits at RIVERESM will show tangible natural filtration planning schemes that use an understanding of root morphology and layers (structural, seasonal, ground cover) and can be replicated throughout the region to reduce sediment run-off into the river (Appendix D, Figure 3). Central to the Center's landscape design research strategy, will be access to native plant landscape design schemes and long-term monitoring of soil inputs. Involving researchers in the design of the surrounding landscape has the potential to provide visitors with demonstrations of how native landscaping can support research in biological systems engineering, horticulture, permaculture, biology, wildlife ecology, forestry, crop, and soil science. The Center will also

offer researchers a variety of BMP designs at one location, for better monitoring and data collection. There are 15 practices listed in subsection [9VAC25-870-148](#) of the Virginia Stormwater Management Program VSMP regulation (LIS Virginia State Law, 2022) (Appendix C). From a Vegetated Roof to permeable pavements and even rain gardens, there are many options. Project settings will be available at the Center for year-long senior design projects that identify and analyze water resource problems and develop practical solutions based on the BMP's identified. A phased approach for installation of BMPs will be utilized with location and size of the building determining scope and scale of those practices.

Finally, the RIVERESM facility's interior and exterior will serve as inviting spaces for the community to dwell in an ecologically friendly landscape and learn how sustainable landscaping can simultaneously contribute to both ecological and human well-being. Using an intimate knowledge of plant growth habits and ecology, native plant selections will be arranged in the surrounding landscape in aesthetically pleasing drifts of color (Figure 7). Because plants benefit human health by providing cleaner air, increased well-being, reduced stress and increased productivity (Lohr, 2010), RIVERESM will integrate living wall accents into the design of the building interior (Figure 8). By demonstrating how aesthetically pleasing landscape designs can be incorporated into work and living spaces (Figure 9), we hope to inspire home and business owners to consider using sustainable design principles.

Figure 7
Drifts of Color



Note. A visual of the diversity of plants and color drifts that can be created with proper plant placement. Photo Credit: Piet Oudolf and Noel Kingsbury Plant Design.

Figure 8
Interior Living Wall



Note. Interior living wall in work and gathering spaces. Photo Credit: Greenroofs

Figure 9
Natural Outdoor Workspaces



Note. Outdoor workspaces by Alberto Mattiello and Davide Anzalone. Photo Credit: Global Design News.

Exhibit Design Concepts

The Creative Director of RIVERESM will be responsible for the artistic design of interior exhibit space, collaborating with staff and administrative boards on the development of exterior features. The interior will provide dedicated partitioned space to support independent researchers, instructors, and environmental organizations who operate beyond the public boundary. The remaining public space will be dedicated to the inclusion of various educational learning components needed to endorse and justify RIVERESM as an ecotourist location. Exhibits will be inviting, inclusive and sensitive to all social and cultural aspects. Exhibits will seek to educate individuals on topics related to the Rappahannock River watershed in scientific and traditional ecological knowledge, kinship ecology, emerging technologies in science, restorative and regenerative landscaping, and environmental ecology. Exhibits will be designed to incorporate current RIVERESM research on water quality and support in-house educational programming already established by Friends of the Rappahannock. Whether static, dynamic, or interactive, exhibits will offer independent opportunities for visitors of all ages to experience an in-depth exploration into geography of the river, various historical cultures, and chemical and biological systems affecting a wide range of native flora and fauna.

During the development phase of the optimal visitor experience, RIVERESM cross-referenced data from a strategic resource for cultural organizations. According To Colleen Dilenschneider (2022), the Chief Market Engagement Officer at IMPACTS Research & Development, research data determined that 10 metrics can be utilized to identify attractiveness for consumers to enjoy an optimal visitor's experience. This is an on-going long-term study of perceptions and behaviors related to visitor-serving organizations in the United States. Following the metrics, the RIVERESM Center scored very high in the top five most desirable areas, especially in proximity to waterfront, historical value, hiking and park locations, and the offering of scientific experiences. Using high-confidence data, these metrics offer developing businesses with audience engagement strategies that benefit visitors with an enjoyable cultural experience, while optimizing mission execution and financial sustainability (Dilenschneider, 2022). Ms. Dilenschneider has a long record of success, working on the following projects: Monterey Bay Aquarium, California Academy of Sciences, Carnegie Museums, Stanford University, Exploratorium, John G. Shedd Aquarium, Tennessee Aquarium, United Nations Educational, Scientific and Cultural Organization, San Diego Zoo, and Wildlife Conservation Society. Colleen currently serves on the Board of Directors at the National Aquarium. Utilizing these metrics will offer strategies to optimize experiences for visitors at the RIVERESM Center.

While the Communications Director will navigate the effort to encourage visitors to choose our destination, the Creative Director will collaborate with staff to develop an inviting venue, complete with intuitive floor plans sensitive to inclusivity for ALL visitors. Suggested flow patterns with clear and concise signage will alert and guide visitors to important interior and exterior exhibits and current program offerings. Curiosity will draw visitors to inspect and investigate artistic displays, educational exhibits, and interactive learning experiences designed to communicate scientific and traditional ecological knowledge, and environmental kinship.

The plan for flexibility of design exhibits will be utilized to produce permanent structural and interactive exhibits as well as dynamic exhibits that alternate with spatial and temporal patterns in nature. Topics will be derived from relevant core as well as emerging scientific knowledge, drawing specifics from the broad sciences of chemistry, biology, geography,

geology, archeology, and physics. Advisory boards will offer suggestions for exhibits supporting areas of Research, Education, Technology, and Ecoculture. Relevant ideas for displays and interactive experiences will focus on in-depth sciences such as stream ecology, conservation biology, and human health. The Creative Director will meet frequently with Friends of the Rappahannock (FOR) educational staff, to review upcoming curricular themes and education objectives needed to support and promote FOR programming, for seamless integration of Center exhibits.

RIVERESM staff will consider code of ethics strategies in preparation for designs and exhibit implementation in alignment with the American Alliance of Museums, as well as through support from professional agencies. Strengths and weaknesses will be identified in order to develop and initiate a positive visitor experience. An implementation of a structured exhibit design plan proposal will outline the process for exhibit creation, from concept to construction.

Artistic displays coordinating the inclusion of environmentally themed art from local and regional artisans will serve as design enhancing features for the interior of RIVERESM. Meaningful permanent and semi-permanent artwork displays will serve as vibrant components conveying environmental activism, generating stimulating conversations, and inviting participation. Local and regional artists will provide a positive impact on numerous topics of environmental justice to inspire and support transdisciplinary learning. The local Stafford/Fredericksburg area has already been established as a mecca for numerous artists whose expertise will be showcased and provide items available for purchase at the Center.

Biophilic design elements will be incorporated to enhance visitor experiences, in keeping with environmental principles and practices of LEED[®] Design strategies. The integration of emergent technology is included within the design and operations of the Center and will be utilized in research programs. Augmented Reality, IoT, and 5G technologies will be useful tools for enhancing educational programs, interactive exhibits, and artistic displays. An example of emergent technology, involving an augmented reality sandbox, is shown in Figure 10.

To enhance the visitor experience for all, RIVERESM will experiment with reserve times and locations for visitors requiring special accommodations, providing these special guests with more autonomy and support within the least restrictive environment. Visitors with special needs may choose reserved times as an option, providing additional support in mobility, sensory perception, and autonomy. An example of augmented reality that would be helpful for engaging visitors with disabilities shown in Figure 11. Reserved times will provide modified features and be helpful with exhibit engagement and navigation. This strategy will remain dynamic with room for modifications. Reserved times and locations are being considered for families with small children, providing easy access to diaper changing stations, and a quiet room for nursing. Visitors who require support in mobility, the need for sensory interpretation, and reduction in cognitive load can also benefit from reservations, as well as senior citizens needing assistance with exhibit engagement and navigation throughout the building. Additional examples of novel and interactive exhibits are available in Appendix D.

Figure 10
Shaping Watersheds Augmented Reality Sandbox



Note. Sand is overlaid with top-down projection so visitors can physically manipulate various characteristics of water flow within watersheds Image Credit: Silverman

Figure 11
Augmented Reality User Application



Note: Useful for exhibition interactions during Covid-19 restrictions. Augmented reality is very attractive, especially to younger visitors. Image Credit: Prafulla

A Retail Venue Within the RIVERESM Center

As an integral part of public outreach, RIVERESM will design and operate a retail store, the River's Edge, within the building. All inventory will reflect environmental themes relevant to conservation and river ecology, including both gift-oriented and functional items. All products will have a limited impact on the environment and positive influence on the consumer. Retail offerings will include items that continue to inspire and engage visitors in conservation appreciation and activism, without competing with the Patawomeck Tribal Center gift shop located adjacent to the RIVERESM site. Merchandise will be diverse, with emphasis on locally sourced items, including RIVERESM branded gifts, handcrafted items, clothing, and accessories. Inventory items for consideration will comply with all retail product sales guidelines and may include packaged food products such as honey, jams and jellies, handmade candles and soaps, instructional toys, and 'green' products. Available literature will focus on environmental topics, instructional kits, and guides for implementing environmentally conscious projects.

A Green Retail Management Plan will also be developed by the RIVERESM team, in keeping with the sustainability concept for the building to improve retail value of products, eliminate waste, increase efficiency, and reduce costs. Items will be sourced that provide repurposed items and materials for in-shop design features, promote fair trade organizations and local producers. The Center will employ energy efficient lighting strategies throughout, and utilize eco-friendly/recycled packaging, tags, and bags demonstrating zero-waste and recycled or repurposed materials.

Organizational Structure

The focus of the RIVERESM organization structure is to create a model of cultural acceptance and community within the center. As a phased approach that will expand over time, the center will be based on diversity and inclusion, and promote a multicultural community, with a sense of belonging for all, that attracts top talent and drives innovative results. Hybrid work modes and transitional office spaces will provide a more comfortable place to attract like-minded members of the community working to improve sustainability for this river environment. Since the majority of waking hours are spent in a work status, it is important for the culture of RIVERESM to promote and support cultural acceptance through employee recruitment and practice, creating an overall positive and aesthetically pleasing work environment. The concept is purposely designed to leverage the synergy of like-minded environmental concerns by locating them in a single location to enhance the abilities of those organizations to collaborate for the greater good of all participants. RIVERESM will be the facilitator for positive environmental progress in the region by fostering research concepts applicable to watersheds across the globe.

Nondiscrimination Policy

This policy states the RIVERESM position on discrimination and applies to all RIVERESM employees, volunteers, members, clients, and contractors. RIVERESM does not discriminate on the basis of race, creed, color, ethnicity, national origin, religion, sex, sexual orientation, gender expression, age, height, weight, physical or mental ability, veteran status, military obligations, and marital status. This policy also applies to internal promotions, training opportunities for advancement, terminations, outside vendors, organizational members and customers, service

clients, use of contractors and consultants, and dealings with the general public. The research component of this organization is critical and will draw strength from collective data obtained by research associates who utilize the center. Attracting professionals to the center with laboratory space to perform meaningful research, the ecological collaborative will accomplish multi- disciplinary projects with the opportunity to accommodate on-site global researchers and promote diversity from all walks of life.

Executive Team

The RIVERESM executive team will epitomize gender and cultural diversity, serving as an example for all who work and visit the center. The Center will acknowledge and honor multiple religions and cultural practices, by integrating communication channels onto one platform where all voices are heard, recognized, and diverse viewpoints are welcome. The executive team will embrace a multilingual and multigenerational workforce and have an open-door policy, with technology accessible to everyone. Internship opportunities will be an integral part of the structure with possibilities for future employment. Many volunteers will continue to be involved from the beginning of this concept and continue to devote time, amassing hours of work along with the Executive staff. Three Advisory Boards will offer expert advice throughout the planning, design, construction, and operational phases, guiding the executive team in all aspects of research, education, technology and ecoculture. The RIVERESM Executive team will be comprised of four levels:

1. The first level will be held by the Executive Director of Operations
2. The second level will comprise of department directors
3. The third level is for jobs held under those department directors
4. The fourth level is for intern positions held under those departments

The organizational structure will be composed of levels, and staff hiring will be accomplished through a phased approach noted in Figures 12, 13, 14, 15, and 16, based on the organization phases of planning, building design, building construction and building completion. The present plan for day-to-day management of the rentable space and common space will be contracted with the professional management company, Gather.[®]. Information on Staff duty details can be found in Appendix E.

RIVERESM Board of Directors

Henry “Buck” Cox, PhD
Mikel Ann Manchester

The RIVERESM Board of Directors will represent a diversity of organizations and establish a governance system for the Center. An additional four board members have expressed interest from Virginia Tech, University of Mary Washington, Stafford County, and Friends of the Rappahannock, and will be identified upon confirmation.

Advisory Boards

A **Research and Conservation Advisory Board** is being established. The purpose of this advisory board is to bring together a well-rounded team of local and regional experts to guide the development and direction of the RIVERESM Center design in ways that effectively support research and conservation involving emerging technologies and big data. This advisory board will also define the SmartRiver concept, phases, and timeline, and identify emerging technologies needed for the SmartRiver and RIVERESM Center. The Board will develop 5-6 project ideas that lay the foundation for establishing and using the SmartRiver to address cutting edge watershed research and conservation needs. After preparing outlines of these ideas, including research questions, technology and resources needed, the Board will identify and recruit 'power teams' with relevant expertise, who can write the research aspect of proposals for their assigned project. RIVERE and RIoT will assist in grant proposal writing, particularly for sections involving emerging technologies, facility resources (lab space, greenhouse, BMP testbeds, accommodations, etc.) and broader impacts (education, outreach and ecoculture). Proposals will be used to seek support from a variety of funding sources.

An **Education and Outreach Advisory Board** has been established with RIVERESM staff and Friends of the Rappahannock education staff to inform and guide education and outreach efforts, ensuring that indoor and outdoor interactive exhibits serve the needs of partners and the community at large. The board will provide expert educational advice and seek interactive exhibits that will complement standards of learning established by regional school systems based on their already successful curriculum. The RIVERESM Center will showcase interior and exterior exhibits, serving as an anchor, and promoting positive educational outcomes. This advisory board will not interfere with already successful education programs offered by Friends of the Rappahannock; it will support their efforts.

The **Ecoculture Advisory Board** will be established as a collaboration of ecological fellowship to help encourage and support ecoculture with compassion and empathic responses to current issues. This advisory board will work to promote, develop, and critically assess cultural engagement needed for momentum toward socio-ecological change. It will be established with experts in education, communications, ecology, Native American and other diverse cultures. The Ecoculture advisory board will work to embrace ecological aspects, while recognizing the necessity for negotiation of diverse inhabitants of many places, both locally and globally. RIVERESM will offer a series of speakers and research associates to promote cultural understanding and educate the public on socio-ecological topics.

Internships and Independent Study

RIVERESM has a strong tradition of attracting collaboration and partnership with other institutions. The majority of our Science, Education, Technology and Ecoculture grounded staff routinely collaborate with colleagues at other institutions, through government channels, and other non-profit organizations. It is with this center-wide networking, that we have the ability to extend internship opportunities to students through university affiliations. RIVERESM has offered paid internships through collaborative efforts with University of Mary Washington, Virginia Wesleyan University and Virginia Tech. Internships fall under the direction of the executive team in departments that have a need when appropriate. It is our hope that these short-term relationships will provide long-term employment opportunities for the surrounding community.

Phases of Development

Phases of development for RIVERESM will be determined by incremental growth based on: Initial planning, fundraising, building design, building construction, membership recruitment, move-in and training, as well as a fully operational Center. As the team moves forward utilizing the phased approach of implementation, time will allow for better planning, control, and testing of all systems prior to a fully functioning ecological Center. Hiring and recruitment of employees will follow phases of development and provide staff as required in those phases (Appendix F).

Phase I - Planning and Fundraising

The Center began this planning operation phase with four staff members, two interim positions, and three interns. During this phase, a site location will be determined, a lease agreement for the building site location will be initiated with Stafford County, and the business plan will be complete. A financial consultant, hired to determine economic sustainability for the center, will provide direction and guidance. Website construction will be near completion for a soft opening. The organization will continue to develop with advisory boards, collaboration with partners and stakeholders, and building and landscape design for the site. Planning will continue with an aggressive marketing and fundraising strategy, design of building spaces and exterior exhibits.

Staff

- Executive Director of Operations - Mikel Ann Manchester
mmanchester@RIVERECenter.org
- Creative Director - Michele Phillips
mphilips@RIVERECenter.org
- Communications Director - Taylor Johnson
tjohnson@RIVERECenter.org
- Tribal Liaison - Barry Sullivan
- Financial Director – Pending (currently a consulting accounting firm)

Interim

- Founder and Interim Director - Henry “Buck” Cox, PhD
- Environmental Consultant - Lori Blanc, PhD

Interns

- Ava DiVita - Virginia Polytechnic Institute and State University
- Kyle Close - University of Mary Washington
- Matthew Amato - Virginia Wesleyan University
- Patawomeck Tribe of Virginia Intern - Pending

Volunteers

- A large number of volunteers will be committed to the success of the Center throughout all phases of development and fall under the direction of associated departments

In Phase I, employees and interns are included in the organizational chart as noted in Figures 12 and 13. Information on Staff duty details can be found in Appendix E.

Figure 12
Phase I Organizational Chart



Note. Planning and Fundraising Phase I, organizational chart with positions identified.

Figure 13
Intern Organizational Chart



Note. Phase I, Interns identified in this phase.

Phase II - Building Design

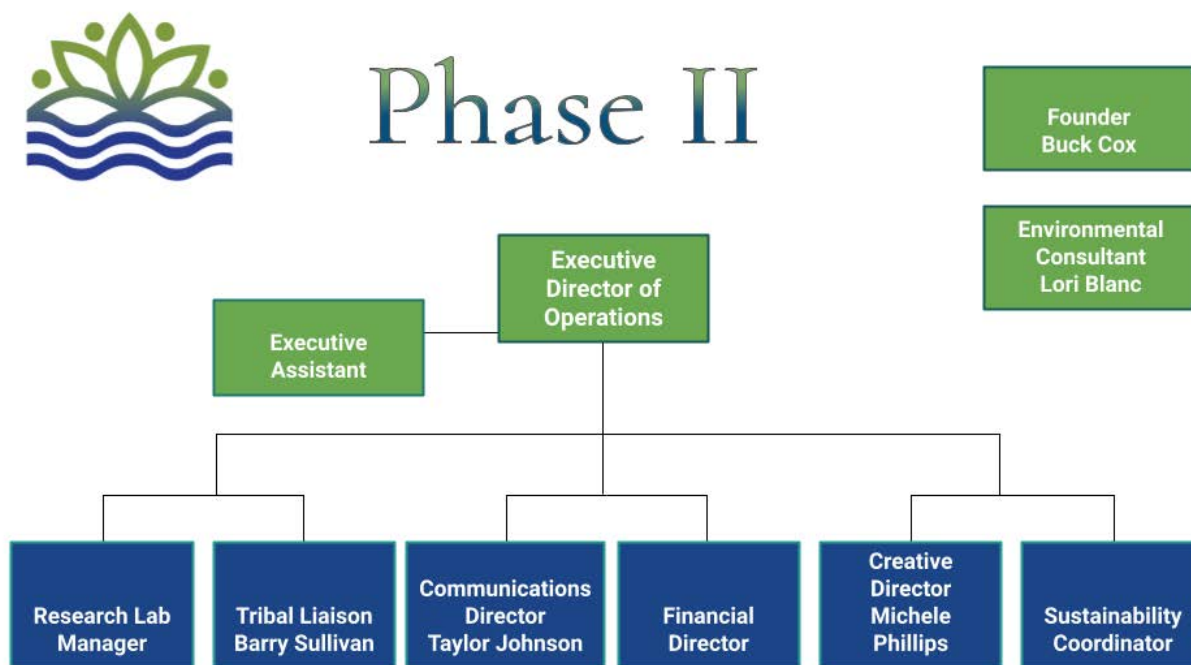
As RIVERESM moves forward into Phase II, acquiring a building location, securing a lease agreement, working with architects and commissioning agents on green building design and construction plans, and recruiting more employees to support the diversity of the organization. Data will be analyzed from financial consultants to determine size and sustainability requirements of the building. Advisory boards will be instrumental in organization of proper lab

facilities and structure of other departments for Research, Education, Technology and Ecoculture. The Tribal Liaison will be needed for center connections with Native American aspects incorporated into the overall vision. The Patowomeck Tribal Center, adjacent to the site, will provide initial input. As one aspect of the Center, RIVERESM is ideally situated to accommodate representatives from all Indigenous Tribes in the Commonwealth of Virginia. A large group of volunteers will be required to assemble for installation and maintenance of the BMP landscape exhibits as well as the green roof garden. Additional employees in this phase:

- Executive Assistant
- Communications Intern
- Financial Director
- Sustainability Coordinator
- Research and Laboratory Manager
- IT Consultant

In Phase II, employees are identified in the organizational chart as noted in Figure 14. Information on Staff duty details can be found in Appendix E.

Figure 14
Phase II Organizational Chart



Note. Building Design Phase II, organizational chart with positions identified.

Phase III - Building Construction and Membership Recruitment

With the foundation of consultant input, during this phase of the building design completion, RIVERESM will be prepared to break ground in this construction phase. Parallel to building construction, RIVERESM will engage partners and facilitate lease agreements for available space. The present plan for day-to-day management of the rentable space and common space will be contracted with the professional management company, Gather.[®]. Research for the Center will focus on water quality data for the Rappahannock River and stress the development of robust sensing technology components to benefit the region. Educational programs will take center stage with Friends of the Rappahannock implementing their already successful program lineup with meaningful watershed experiences. Collaboration with Stafford County's Smart Community Testbed will provide access to emergent technology, supporting members leasing space at the Center. A commissioning agent will be consulted and be instrumental in addressing proper design of building systems, especially non-traditional building systems, to ensure alignment with green building certification. Interior and exterior exhibits will begin construction for displays in educational spaces and areas throughout the site. The *River's Edge* discovery shop will provide visitors with educational and ecological retail items, with artistically, locally sourced, as well as free-trade options from abroad. The overall goal is to provide opportunities to make impactful connections between research, education, emerging technologies and ecoculture that reach the community, especially the underserved.

In Phase III, additional employees will be needed in the organizational chart as noted in Figure 15. Information on Staff duty details can be found in Appendix E.

Additional employees in this phase:

- Research and Lab Manager
- Data Science Management Consultant (interim position)
- Event Manager
- Acquisitions Specialist (Grant Funds)
- Gift Shop Manager
- Maintenance and Security Manager
- Membership Manager

Figure 15
Phase III Organizational Chart



Note. Building Construction and Membership Recruitment Phase III, organizational chart with positions identified.

Phase IV - Move-In and Training

During this transitional period, nearing the end of building construction completion, staff and recruited members will be moving into the building under the direction of the Maintenance and Security Manager. A commissioning agent will be consulted to test the design of the building systems, especially non-traditional building systems, to ensure alignment with green building certification. New technology will be incorporated into all aspects of the building design and available for use upon completion of training. Safety training will be required for staff and members. Laboratory space safety training will be required for all members occupying the laboratory space. Water safety training, as well as first aid certification and automated external defibrillator training will be required for all staff. This phase will address any logistical problems, allowing staff to take corrective action to resolve issues prior to a fully functional Center.

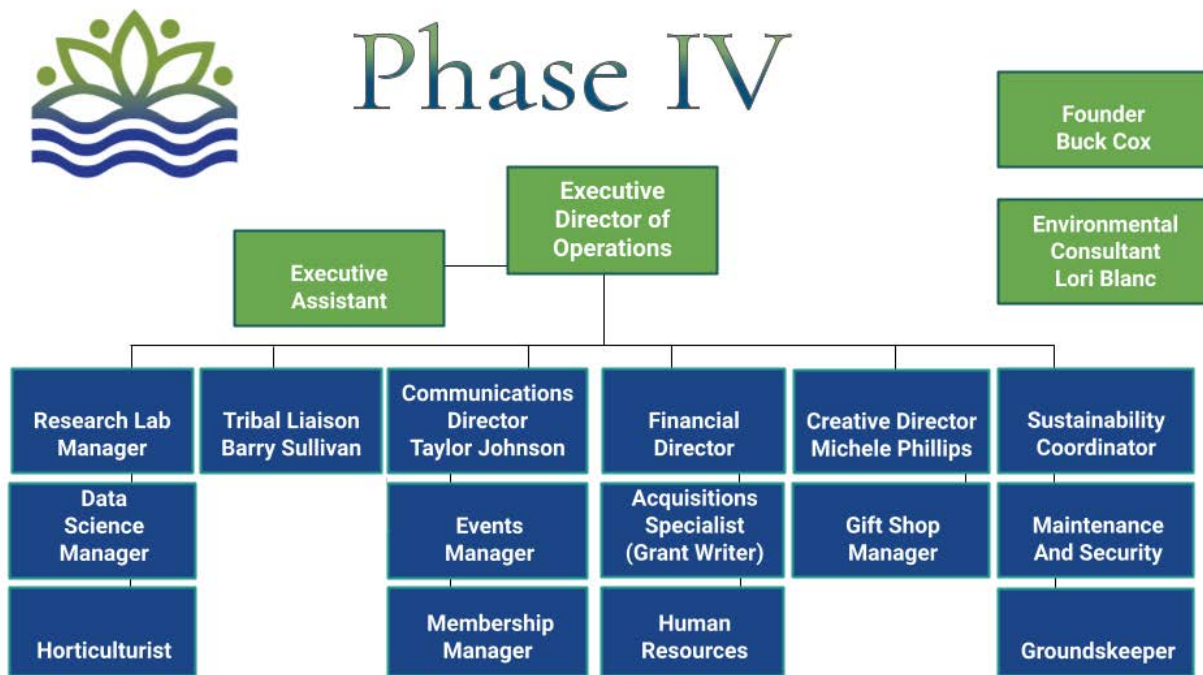
In Phase IV, additional employees will be needed in the organizational chart as noted in Figure 16, that will carry over into Phase V, as a fully operational Center. Information on Staff duty details can be found in Appendix E.

Additional employees in this phase:

- Data Science Manager (permanent position)
- Horticulturist
- Membership Manager
- Human Resources Manager

Figure 16

Phase IV Organizational Chart



Note. Move In and Training Phase IV, organizational chart with positions identified.

Phase V - Operational Center

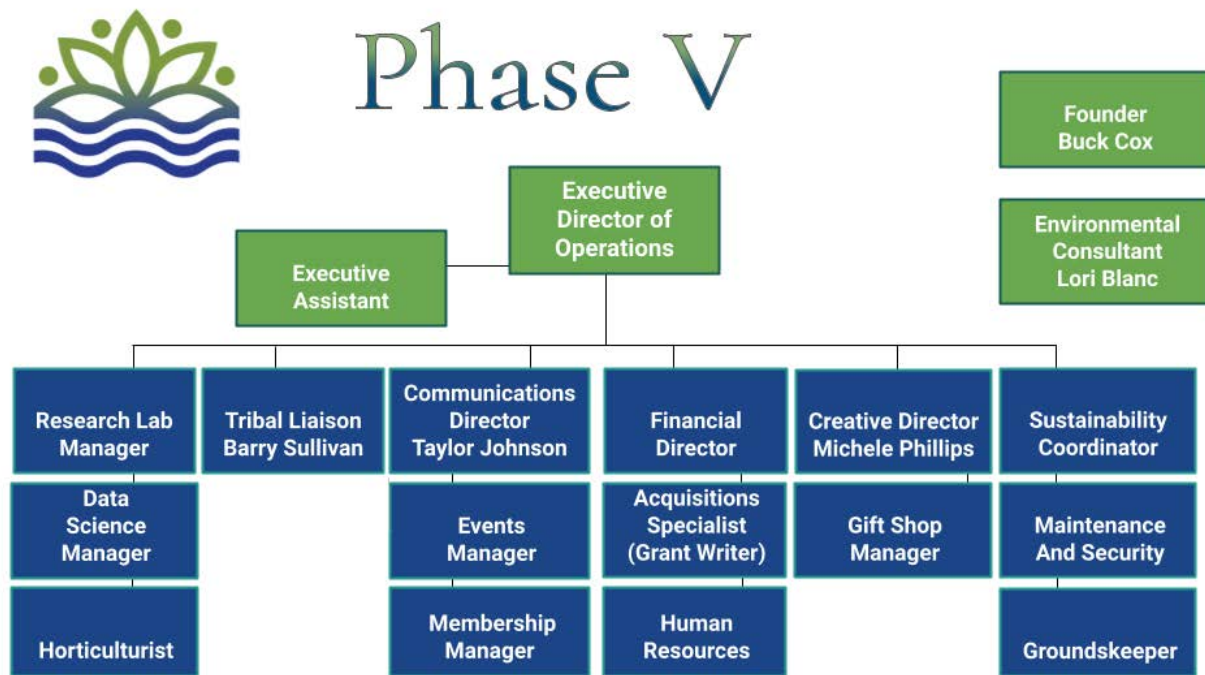
As a fully operational center, RIVERESM will serve as a conduit for ongoing research, program education extension, technology integration, as well as ecoculture aspects. Accommodations for environmental collaborators will be available for onsite, long-term research. Staff will be required in this operational phase with attention turned to the Center's daily activities in interior spaces, as well as the exterior grounds. The inspiration for a native plant botanical garden was initiated in appreciation for an honored donor, Weber Taylor. The *Taylor Made Native Gardens*, will include a conservatory and laboratory space, needed for educational programming. Throughout the interior of the building, exhibits will be available, bringing the outdoors inside, enhancing the overall experience. With living walls, innovative waterwise systems, and educational design elements, RIVERESM will be a draw for all ages. An investment in this facility will be an investment in community economic development. With all available space utilized, the Center will be an attraction for the region.

In Phase V, additional employees will be included in the organizational chart as noted in Figure 17, carried over from the Move-in and Training Phase IV. Information on Staff duty details can be found in Appendix E. Additional employees in this phase:

- Data Science Manager (permanent position)
- Horticulturist
- Membership Manager
- Human Resources Manager

Figure 17

Phase V Organizational Chart



Note. Operational Phase V, organizational chart with positions identified.

Communications, Marketing, and Advertising

RIVERESM will focus on establishing and using an online presence to communicate the mission of the organization and provide information on resources that support and promote collaborative partnerships for our target audience. A modern, user-friendly website will comply with Americans with Disabilities Act (ADA). The RIVERESM website will provide an overview of support for partners involved with research, education, technology and ecoculture at the Center with links to more detailed information from partner websites, such as Friends of the Rappahannock. Spaces offered for lease at the Center will be identified on the website when conceptual rendering of building spaces are available. The RIVERESM website will also highlight the importance of watersheds scales from local to global, and how critical research completed at RIVERESM will support other communities. Email marketing and philanthropic initiatives will also be employed through the website, offering a range of platforms for more community involvement.

Partnerships will be established with a network of ecological organizations, agencies and institutions with shared visions. Our website will draw from and showcase their work, connecting the public with a broader online presence. Following the launch of the website, a social media presence through Facebook, Instagram, Twitter and LinkedIn, will be established to initiate marketing the Center through clever, inspiring posts, photos, and videos instilling passion for the community. Digital (including online, TV and streaming services), print and social media advertising will be utilized to promote brand awareness for the Center, publicize

programs, special events and space rentals, encouraging customers and community members to engage with and visit RIVERESM. There are two main categories for target markets in which stakeholders play a role for RIVERESM. Stakeholders are either those who will impact the successful establishment of the Center or those who will be impacted by what is provided. The target markets are derived from three main categories of stakeholders: enablers, influencers and users (Figure 18). Additional details on communications and marketing and advertising plans can be found in Appendix F, including a SWOT analysis, primary marketing goals, metrics, strategies and tactics, and marketing budget.

Figure 18
Target Markets for RIVERESM



Note. Categories of stakeholders from which target markets are derived.

Financial Model for Economizing Space in the RIVERESM Ecological Center

The financial success of RIVERESM will rely on four major forms of revenue as follows:

1. Revenue from rentable space as offered by modern office concepts similar to Gather Workspaces, LLC.
2. Grants from governmental and private sources
3. Fundraising with a significant focus on large companies that prioritize Artificial Intelligence and Big Data in their business plans.
4. Events and programming income

Forming an alliance with a major entity in the AI/Big Data market is a major goal for the concept of RIVERESM. The key players in this market include, but are not limited to Microsoft, Amazon, and IBM. The SmartRiver concept is a unique approach for large corporations to make an impactful environmental statement and showcase distinctive, state of the art research technology. RIVERESM will consider a partnership with any large business in this market to offer high level funding and associate their brand with the Center. Virginia will benefit from establishing its first SmartRiver from the headwaters of the Rappahannock River to the final discharge into the Chesapeake Bay watershed.

Projections for filling membership space in the RIVERESM Center clearly indicate that the concept could stand on its own financially by filling the building with organizations that focus on clean water and river conservation, particularly those organizations utilizing AI/Big Data research. Survey results, conducted by Wipfli, LLP financial consultants for RIVERESM, indicated strong interest in the overall concept. The list of favorable stakeholders interviewed involved many impactful organizations including the Chesapeake Bay Foundation, Virginia's Division of Environmental Quality, Virginia Tech, University of Mary Washington, Friends of the Rappahannock, and more. Numerous grant opportunities have been identified to pursue developmental funding. With the completion of the full business plan, effort to negotiate with decision makers at large funding organizations and companies will commence with special focus on key players in the AI/Big Data sector. As the 2021 Microsoft Nonprofit Partner of the Year, Wipfli has offered to guide RIVERESM in developing a competitive proposal for Microsoft.

The Ecological Center's Projected Co-Working Model for Membership Space

Space within the RIVERESM Ecological Center will be designed to establish professional coworking space as conceptualized and proven successful by Gather Workspaces, LLC (Gather.[®]). RIVERESM intends to utilize the talents of Gather.[®] to manage the physical facilities of the Ecological Center along the lines of the services they provide at their seven existing facilities in Richmond and Hampton Roads. Gather.[®] is basically in the hospitality business. They take care of all of the details associated with running an office so that RIVERESM members can focus on what they do best – running their organizations. The core values of Gather.[®] align closely with RIVERESM and include:

- Maintaining a policy that member's interest always come first
- Intensely focusing on building a caring community of like-minded organizations and companies within the RIVERESM Center
- Caring for the most important assets at the location - employees
- Treating everyone within the space with respect, courtesy, civility, and dignity

Configuring the Space to Maximize Profit and Collaboration

Models for similar facilities in the U.S. indicate that economic success can be most efficiently realized by targeting 20,000 to 25,000 square feet of usable coworking office space with a maximum of 30,000 square feet. It can be demonstrated that larger facilities begin to lose the close-knit networking community that RIVERESM intends to foster. It will be important for the RIVERESM concept to promote collaborative efforts through the like-minded organizations and companies that populate the member space in the facility. Architects will be tasked with the following requirements for interior space allocation:

- A work café including kitchen, coworking area, reception and event space for a 150 – 200-person cocktail party - it is ideal to be able to see all of the work café from the reception desk
- Items to include in the kitchen area of the work café include a variety of equipment needed to support large social events and amenities for day-to-day use by members
- Men's and women's showers
- A wellness room for nursing mothers with a small sink, refrigerator, and microwave
- A sound studio (to hold a minimum of three people with a table)
- A place to store bicycles inside (if feasible/necessary)
- Two 2-person Gather.® and RIVERESM offices for managers - near reception, if possible
- "Neighborhoods" of different size offices
- A secure IT/Server room - not accessible to the general population
- A secure mailroom - accessible to the general population via Proxy
- Banquet seating and booths in the work café
- "Coworking tables" for coworking areas
- A space for a mini market in the kitchen area
- Soft seating areas in the work café and throughout the space
- The mix of office seats to dedicated desk seats to coworking seats. The following mix is being considered, but flexibility will be necessary, particularly for the number of dedicated desks and coworking seats:
 - 70 - 85% of seats for offices
 - 10 - 15% of seats for coworking
 - 5 - 10% of seats for dedicated desks
- The following mix of offices by size is being considered but can be flexible depending on demand and building design considerations. A large open office area with dedicated office sections can also be considered.
 - One-person offices - 30 - 40%
 - Two-person offices - 30 - 40%
 - Four-person offices - 10 - 15%
 - Six-person offices - 3 - 6%
 - Eight-person offices - 2 - 4%
 - Ten-person offices - 1 - 3%
 - Fifteen-person offices - 1 - 2%
- Please note that the number of each office size are guidelines for architects. It is understood that flexibility to alter spacing will be built into the concept. In addition, the designs consider the maximum number of desks (seats) into each office that can fit comfortably.

- The following number of conference rooms by size is being considered but can be flexible depending on demand and building design considerations. Conference rooms will also serve as educational spaces. For a 25,000 sq. ft. space would typically specify:
 - One fifty-person conference room that can be divided into two 25-person rooms. A larger meeting room may be a preferred regional amenity. If design considerations allow, this conference room should be designed in a way that can combine with event space for use as an auditorium.
 - Two eight-person conference rooms
 - Two six-person conference rooms
 - Five four-person conference rooms
- Phone booths. A reasonable number of phone booths can be attained by dividing the number of potential phone booth users by 25. The number of phone booth users is defined as the total number of coworking and dedicated seats in the facility minus people in one-person offices that do not use phone booths.
- Number and general location of copy/print stations
- Offices are to offer windows as much as possible with a bias for locating smaller offices near windows (i.e., one-person offices, two-person offices rather than six or eight-person offices). Reasoning for this strategy is to offer a premium, charging more per sq. ft. for smaller offices.
- Conference rooms and phone booths are to be designed for areas with less light (no windows) if possible.
- A “coworking seat” is any seat that is not an office seat, a dedicated desk, a conference room or a phone booth
- The office area should be secure and separated from the work café with a locked door accessing a digital identity in a physical space (with a Proxy App)
- The large conference room, one or two smaller conference rooms and three or four phone booths should be accessible from the work café, offering guest access without navigation through secured doors.
- The economics of a coworking space are predicated on density (the sq. ft. per seat)
- Laboratories - RIVERESM will differ substantially from basic office space membership fees. Each of the three labs projected will cost substantially more to build and equip than common office space. Laboratory space pricing will vary depending on client needs, but will be competitive with similar regional laboratory space
- Density - The RIVERESM Center will be designed around a range of 25-40 usable sq. ft. per seat (25 sq. ft. per seat in conference rooms; 40 sq. ft. per seat for office and coworking space; adjustable as design considerations allow). A seat is defined by individual seats in offices, dedicated desks and coworking seats.

Pricing Per Seat

Average pricing has proved to be acceptable in the marketplace based on the following cost structure:

- Coworking Seats - \$375 per seat per month
- Dedicated Seats - \$450 per seat per month
- Overall average - \$400 per seat per month

Systems

- **HubSpot** - RIVERESM will use HubSpot for Customer Relationship Management (CRM). This system allows for tracking potential members and has a high rate of success if properly utilized. Every contact RIVERESM receives from a prospective member or networking source will be entered. RIVERESM will use this information to track a number of metrics. For example:
 - Close rates
 - Number of tours given for potential members each week
 - The robustness of the pipeline (i.e., the number of opportunities being actively worked)
 - Periodic contact tracking with prospective members
 - Data related to the contacts future needs and timing for those needs
- **Office RND** – This is software for the coworking industry. This invoicing software keeps records of all members, type of membership, the specific office or dedicated desk the member has (if applicable), and their payments. Specific information available includes:
 - For Offices, the number of offices and seats
 - Available
 - Occupied
 - Available Soon (the member has given notice and are leaving)
 - Reserved (a membership agreement has been signed, but the member will not move in until a future date)
 - For dedicated desks
 - Available
 - Occupied
 - Available Soon
 - Reserved
 - For coworking memberships
 - Available
 - Occupied
 - Pay-as-you-go memberships
 - Available
 - Occupied
 - Available Soon
 - Virtual Offices (Mailbox)
 - Available
 - Occupied
 - Revenue and projected revenue
- **QuickBooks** - All financial statements for RIVERESM will be held in QuickBooks. QuickBooks is integrated with Office RND. Office RND generates the invoices and they are exported to QuickBooks.
- **Bill.com** - This system will be used to pay bills. Invoices are scanned into the system. They then are coded for the following:
 - Expensed or Capitalized

- The line item on the Income Statement or Balance Sheet that is to be charged
- The person approving the bill for payment (Executive Operations Director or her designee)

Projections of Center Cost and Endowment Needs

The expected demand for space within the RIVERESM Center will financially support a fully staffed 25,000 sq. ft. building, as demonstrated by operation projections. These projections assume that a large donor or combination of large donors will fund all or a substantial portion of the capital cost to build the Center and provide a reasonable endowment to fund the effort until revenues from operations exceed the cost of running the Center. RIVERE'sSM primary fundraising goal will be to enlist the support of big donors, particularly companies that are dedicated to the RIVERESM Center research focus as outlined in this business plan. The team is confident that a high level of financial support can be secured within a year of focused effort to identify big donors. RIVERESM is asking that Stafford County guarantee an option to lease adequate property for developing the native botanical garden and other RIVERESM programming concepts for Stafford's 60-acre site adjacent to the 12-acre RIVERESM site. This will give RIVERESM time to identify the substantial funding sources needed to capitalize construction of the Center and botanical/ecological gardens and establish an adequate endowment to sustain the effort. Associated with this site development will be to involve the Patawomeck Native American Tribe in plans for development of their concepts for establishing their Native American village concept that should align well with the RIVERESM botanical garden concept. The goal is for RIVERESM to work with the Patawomeck tribe, blending a tapestry of botanical, traditional, and scientific ecological knowledge design concepts that incorporate a Native American village with native botanical gardens.

The RIVERESM Ecological Center should represent the best possible example of minimizing its ecological footprint. The Center should give back more energy than it requires for day-to-day sustainability, and recycle all water used, while utilizing building construction that minimizes its carbon footprint. The building will demonstrate green building practices with an artistic design that inspires and educates the community with a vision of the future. In addition to the talented design team at Commonwealth Architects in Richmond, Virginia, RIVERESM received an offer from one of the leading architecture firms in the world that can make this a reality. The Smith Group in Washington, D.C., designed the Innovation Campus for Virginia Tech with support from Amazon in Northern Virginia, and the Brock Environmental Center for the Chesapeake Bay Foundation in Virginia Beach. The Smith Group is very interested in designing the RIVERESM Center. Construction costs for this building will be high, but the value to the community, the region, and beyond will be great as this building becomes a tourist destination to complement its status as a world class research and environmental education Center. The Rappahannock will be the go-to destination for environmental education, with Friends of the Rappahannock leading educational opportunities at RIVERESM, enhancing their nationally recognized education efforts in the watershed.

An in-depth analysis for design of the 25,000 sq. ft. Center (operating costs and projected revenues from memberships) was conducted by Wipfli LLP, prominent financial consultants. The Wipfli analysis estimated the basic capital cost, operating costs, and expectations for member income for the Center. Estimated capital cost per square foot to build

the facility was \$600 (low) to \$750 (high). These estimates assume LEED® Platinum designation costs, included in cost per sq. ft., and do not include leasehold conditions or improvements related to lab specifications and related equipment. A wider range of costs per sq. ft. reflects pandemic market pricing shifts and potential inflation surge pressures. Table 1 represents summary projections for construction of a 25,000 sq. ft. RIVERESM Center with a healthy contingency estimate.

Architects for the project are being tasked to design a building that represents the best in construction methods and materials currently available to minimize the ecological footprint of the RIVERESM Center. Once complete the Center will recycle most of its water, produce more electricity than needed for day-to-day usage, with excess power sent back to the grid, and recycle most waste for beneficial reuse (compost). Finally, the RIVERESM Center architects will be tasked with a design that is visually unique and aesthetically pleasing that complements the surrounding natural setting, capturing the imagination for a vision of a sustainable world.

The RIVERESM concept is solid and there is little reason to doubt the basic assumptions made within this business plan regarding the need for the development of advanced technology to help mitigate effects of projected rapid population growth in the watershed. This is a winning concept for Stafford County, for the region and, most importantly, for the Rappahannock River.

Table 1

Total Cost Estimates for Construction of the 25,000 sq. ft. RIVERESM Center

<i>Total construction cost (low)</i>	<i>Total construction cost (high)</i>	<i>Contingency fund</i>	<i>Total project factor cost (low)</i>	<i>Total project factor cost (high)</i>	<i>Estimated project cost (low)</i>	<i>Estimated project cost (high)</i>
\$15,000,000	\$18,750,000	30%	\$4,500,000	\$5,625,000	\$19,500,000	\$24,375,000

Note: These estimates assume LEED® Platinum designation costs are included in cost per sq. ft., and do not include leasehold conditions or improvements related to lab specifications and related equipment. A wider range of costs per sq. ft. reflects pandemic market pricing shifts and potential inflation surge pressures. Projected costs were provided by Wipfli LLP.

First Full Year Profit/Loss Projections

Financial projections for the RIVERESM Center are centered around the concept of a 25,000 sq. ft. LEED® Platinum certified, next generation, world class research and education center that provides coworking space for conservation-oriented public and private organizations. The coworking model is intentionally designed to promote collaboration among like-minded organizations to mitigate impacts of human population growth and global climate change on freshwater systems. In short, the RIVERESM Center aims to be a recognized global hub for networking and collaboration to find solutions for rivers locally and globally.

The RIVERESM Center will be modeled after successful companies that provide co-working office space for public and private businesses to locate their operations. WeWork and Gather.® are two notable examples of the co-working model. In a changing world brought on by

digital networking and telecommuting, traditional office space becomes a far more expensive venture for many businesses that now see the value in ‘work from home’ and mobile office concepts, particularly in light of the advent of online meeting technologies. The recent global pandemic has clearly demonstrated the feasibility of this concept.

RIVERESM has partnered with Gather.[®] to help manage the coworking model. Gather.[®] offers a variety of flexible options to become a member. A company can opt to purchase a fixed number of seats in an office or, if they have employees that come and go on a frequent basis, they may choose to purchase a few coworking seats to save money. In short, Gather.[®] is flexible in many ways to accommodate the needs of clients. The Gather.[®] model is used to project the financial future at RIVERESM as it relates to economizing the space. Gather.[®], operates a new 25,000 square foot facility at one of their operations in Richmond, which has enabled RIVERESM to project monthly operating expenses and revenue based on the number of rentable member seats at RIVERESM using an average rate of \$400 per seat per month (Table 2). These projections reflect operational costs of coworking space only, without RIVERE staffing, programming, and events (see Scenario 1, Table 3).

RIVERESM is considering three scenarios for projecting financial break-even points based on monthly revenue generated from the percentage of seats occupied at the Center (Table 3). Scenario one assumes coworking space operations and facility management only without any RIVERESM staffing in place. Scenario two assumes that RIVERESM staff is in place and adds in a 10% contingency factor for unexpected costs. Scenario three factors in additional revenue sources. We identified additional revenue sources by using an in-depth analysis of the IRS tax reports of commensurate facilities. We selected three facilities that most closely align with the RIVERESM model (Cary Institute in New York, Stroud Environmental Center in Pennsylvania, Brock Center in Virginia). Based on this analysis, RIVERESM identified two key areas of revenue to target, including grants/donations and events/programming. Examples of event and programming revenue include hosting small conferences, and renting space for meetings, weddings, and “gala” events. To project estimates of income, we averaged these revenue sources from relevant commensurate facilities and assumed ten percent of those revenues as a conservative estimate for RIVERESM for year one. Table 3 represents the impact of these assumptions for the final profit/loss projection.

Summary of Operating Projections

The Gather.[®] model for facility operations can work well to support the concept in a profitable manner with low occupancy rates. RIVERESM fully expects to fill or nearly fill the facility. We believe that this concept can grow beyond the limits of a 25,000 square foot facility. The research area in which RIVERESM is focusing is expected to grow rapidly in the near future. Furthermore, revenue from grants, donations, events, and programming have been projected at very conservative rates for the RIVERESM concept resulting in a break-even point with only 30-50% occupancy. The financial operating model appears to be solid. Our primary challenge will be to identify big donor partners that can assure success for this business plan.

Table 2.

Projected Monthly Operating Costs for a 25,000 sq. ft. Center (Coworking Operations and Facility Management Only)

Revenue: 25,000 Sq Ft Co-working Space

Number of Seats Filled	275	248	220	193	165	138	110	83	55	28
Occupancy	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
Monthly Revenue @ \$400/seat average	110,000	99,200	88,000	77,200	66,000	55,200	44,000	33,200	22,000	11,200

Costs per Square Foot

	Factor									
Common Area Maintenance, Insurance, Tax	0.500	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042
Janitorial	0.108	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700
General Repairs and Maintenance	0.109	2,725	2,725	2,725	2,725	2,725	2,725	2,725	2,725	2,725
Utilities	0.150	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750

Costs per Person

Coffee/Tea/Water per Person	5.00	1,375	1,240	1,100	965	825	690	550	415	275	140
Facility Supplies	8.00	2,200	1,984	1,760	1,544	1,320	1,104	880	664	440	224
Office Supplies	1.25	344	310	275	241	206	173	138	104	69	35
Bank Service Charge	4.00	1,100	992	880	772	660	552	440	332	220	112

Costs per Location

Printing	107	107	107	107	107	107	107	107	107	107	107
Dues and Subscriptions	225	225	225	225	225	225	225	225	225	225	225
Digital Apps	327	327	327	327	327	327	327	327	327	327	327
Telephone Expense	180	180	180	180	180	180	180	180	180	180	180
Copier Lease	581	581	581	581	581	581	581	581	581	581	581
Computer Expense	1,983	1,983	1,983	1,983	1,983	1,983	1,983	1,983	1,983	1,983	1,983
Postal	18	18	18	18	18	18	18	18	18	18	18
Postage	18	18	18	18	18	18	18	18	18	18	18
Business License	337	337	337	337	337	337	337	337	337	337	337
Accounting	579	579	579	579	579	579	579	579	579	579	579
Attorney	181	181	181	181	181	181	181	181	181	181	181
Marketing	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000

Gather Facility Management

Regional Manager (split across 3 locations)	2,222	2,222	2,222	2,222	2,222	2,222	2,222	2,222	2,222	2,222	2,222
2 X Community Manager @ \$41,000/Yr Ea	6,833	6,833	6,833	6,833	6,833	6,833	6,833	6,833	6,833	6,833	6,833
Employee Healthcare	1,103	1,103	1,103	1,103	1,103	1,103	1,103	1,103	1,103	1,103	1,103
Payroll Tax	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016
Gather Subtotal	11,174	11,174	11,174	11,174	11,174	11,174	11,174	11,174	11,174	11,174	11,174

Total Expenses

	Monthly Cash Flow Subtotal	76,056	65,749	55,060	44,753	34,064	23,756	13,067	2,760	-7,929	-18,236
	Rate										
	0.10	7,606	6,575	5,506	4,475	3,406	2,376	1,307	276	0	0
	Total Gather Fee (cost + commission)	18,779	17,749	16,680	15,649	14,580	13,549	12,481	11,450	11,174	11,174
	Final Monthly Cash Flow	68,450	59,174	49,554	40,277	30,657	21,381	11,761	2,484	-7,929	-18,236

Table 3.*Projected Annual Profitability Scenarios for 25,000 sq. ft. RIVERESM Center*

Scenario 1: Coworking Operations & Facility Management Only										
Occupancy Rate	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
Annual Revenue (Occupancy Income)	1,320,000	1,190,400	1,056,000	926,400	792,000	662,400	528,000	398,400	264,000	134,400
Annual Expenses (Operations & Facility Mgt)	498,594	480,312	461,354	443,072	424,113	405,831	386,873	368,591	359,147	353,234
Annual Cash Flow	821,406	710,088	594,646	483,328	367,887	256,569	141,127	29,809	-95,147	-218,834
Scenario 2: CoWorking Operations with RIVERE Salaries & Contingencies										
Occupancy Rate	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
Annual Revenue (Occupancy Income)	1,320,000	1,190,400	1,056,000	926,400	792,000	662,400	528,000	398,400	264,000	134,400
Annual Expenses										
Building Management	474,284	456,002	437,044	418,762	399,803	381,521	371,192	365,279	359,147	353,234
RIVERE Salary and Wage expenses	243,100	243,100	243,100	243,100	243,100	243,100	243,100	243,100	243,100	243,100
Total Annual Expenses	717,384	699,102	680,144	661,862	642,903	624,621	614,292	608,379	602,247	596,334
Annual Cash Flow (Subtotal)	602,616	491,298	375,856	264,538	149,097	37,779	-86,292	-209,979	-338,247	-461,934
Contingency costs (10%)	60,262	49,130	37,586	26,454	14,910	3,778	0	0	0	0
Annual Cash Flow	542,354	442,168	338,271	238,084	134,187	34,001	-86,292	-209,979	-338,247	-461,934
Scenario 3: Full Scale Operation with Additional Revenue Categories										
Occupancy Rate	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
Revenue Source										
Occupancy Income	1,320,000	1,190,400	1,056,000	926,400	792,000	662,400	528,000	398,400	264,000	134,400
Grants and Donations*	700,000	700,000	700,000	700,000	700,000	700,000	700,000	700,000	700,000	700,000
Events & Programming Income**	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
Total Annual Revenue	2,085,000	1,955,400	1,821,000	1,691,400	1,557,000	1,427,400	1,293,000	1,163,400	1,029,000	899,400
Annual Expenses										
Building Management	474,284	456,002	437,044	418,762	399,803	381,521	371,192	365,279	359,147	353,234
RIVERE Salary and Wage expenses	243,100	243,100	243,100	243,100	243,100	243,100	243,100	243,100	243,100	243,100
Total Annual Expenses	717,384	699,102	680,144	661,862	642,903	624,621	614,292	608,379	602,247	596,334
Annual Cash Flow (Subtotal)	1,367,616	1,256,298	1,140,856	1,029,538	914,097	802,779	678,708	555,021	426,753	303,066
Contingency (10% cash flow sans grants/events)	60,262	49,130	37,586	26,454	14,910	3,778	0	0	0	0
Annual Cash Flow	1,307,354	1,207,168	1,103,271	1,003,084	899,187	799,001	678,708	555,021	426,753	303,066

* Assumes 10% of grant/donation income obtained by commensurate facilities (Stroud & Cary)

** Assumes 10% of programming income obtained by commensurate facilities (Brock & Cary)

Note. Green highlight indicates percent of occupancy at which financial break-even point occurs.

Fundraising

To build a fully self-sufficient center, RIVERESM will need to raise funds and have continuous income to support Center operations. To cover the projected building costs of the Center, RIVERESM will need to raise between \$19,500,000 (low end estimate) and \$24,375,000 (high end estimate) (Table 1), plus an additional \$2 million endowment to support operating costs during the start-up period of the Center. Funds will come from various outlets including donors, grants, events, space membership, community partners and more. The bulk of fundraising will be obtained from partnering companies, private donations, and grants. A legacy program will be employed for estate planning provisions for the Center. RIVERESM will also accept onsite donations. Social media and multiple digital media avenues will be utilized, with an established website presence and Facebook following. Hard copy information will be distributed at all educational and promotional events.

The fundraising strategy for the RIVERESM Center will focus on three sequential phases. The first phase will receive the complete focus of RIVERESM staff for a 2 to 3-month period and will commence when RIVERESM finalizes the establishment of the site location for the Center. During this phase, RIVERESM will use its network of contacts to arrange in-person meetings with high-tech companies that align with RIVERE's objective of creating Virginia's first SmartRiver on the Rappahannock River from the headwaters to the Chesapeake Bay. Because the SmartRiver initiative will support real-time water quality monitoring and predictive modeling on the Rappahannock through smart sensor technology, an integrated IoT/5G platform, cloud-based computing, Artificial Intelligence, and applied machine learning, RIVERESM will seek to engage high profile, high-tech companies such as Microsoft Azure, Amazon Web Services, IBM Cloud, and Google Cloud Services. Success in attracting the interest of one or more of these companies as partners in this effort will contribute significantly to assuring the viability of the RIVERESM concept. Without meaningful success in attracting one of these companies as a partner, projections for the RIVERESM Center will likely need to be re-evaluated. Because the Rappahannock River is uniquely qualified for a project of this nature, RIVERESM can be positioned as a center to showcase applied AI and machine learning. Thus, this marketing potential alone should attract the attention of one or more of these companies. In addition to targeting these key technology companies, RIVERE has keen interest from a network of impactful stakeholders, including the Chesapeake Bay Foundation, the Virginia Department of Environmental Quality, Virginia Tech, University of Mary Washington, Virginia Cooperative Extension and Friends of the Rappahannock. A vibrant effort to meet with these key stakeholders and people within the targeted technology companies has already begun but will ramp up significantly when phase 1 of the fundraising plan formally commences.

The second and third fundraising phases will be led by professional marketers and a fundraising consultant. The second phase will focus on engaging with additional large companies that are seeking to enhance their reputation for environmental stewardship. The third phase will be dedicated to a significant regional fundraising and awareness campaign, in ways that are not competitive with our partners at Friends of the Rappahannock.

In addition to these three fundraising phases, RIVERESM has identified numerous grant opportunities related to AI, big data, emerging technologies and water research as well as funding opportunities for building infrastructure. RIVERESM will aggressively pursue these

funding opportunities by collaborating with university researchers and aligning with a private grant writing company that has a high degree of success. RIVERESM has formed a science and conservation advisory board comprised of respected researchers involved in water research using predictive modeling and emerging technologies. This advisory board will help identify teams of scientists to recruit for collaboration to produce six professionally written research grant proposals to develop the SmartRiver concept. Three of these topics are already in preparation as pre-proposals designed to utilize the Rappahannock River as a testbed for sensors to monitor for pollutants and important water chemistry. Virginia Tech's Biological Systems Engineering and the College of Science have taken lead roles in writing these proposals, which includes an interesting concept to use sensors to monitor groundwater intrusion into the Rappahannock. In addition, the University of Mary Washington has an active program to study endocrine disruptors and microplastics. RIVERESM will be seeking alliances with other organizations working in this area to include the Smithsonian, University of Maryland, VCU, VIMS and the Stroud Center.

Risk Assessment

Risk management planning is important to identify and assess risks before they occur. Using data from the Comparable Analysis of Commensurate Organizations, the RIVERESM risk management plan will seek best management practices from Cary Institute of Ecological Studies, Brock Environmental Center, Stroud Water Research Center, Chesapeake Bay Foundation and several botanical gardens in the planning of a well-rounded risk management plan. The focus of these best practices will be on the operation and sustainability aspect of development, that will include the day-to-day operation of the shared lab and research space. The Executive Director of Operations, Mikel Manchester, is the current risk manager and will supervise the risk management and analysis process for RIVERESM in the immediate future. Risk analysis can be engaged through a multiple step process as outlined in an initial Risk Management Plan created by the University of Mary Washington's College of Business for RIVERESM during a three-semester directed study course. Risks that have been identified will be monitored through a risk register. The risk register will act as a single location where identified risks will be documented, monitored, and tracked.

In addition to benchmarking risk management plans from similar research institutions, RIVERESM consulted with non-profit industry expert, Wipfli LLP to identify and assess risks. As part of the risk assessment process, RIVERESM used a Logical Framework Approach to clearly articulate the Center's Goals, Outcomes, Outputs and Activities. The indicators of success were identified for, what metrics used to measure those indicators, and what risks and assumptions hold for each of the categories (Appendix H). A full risk analysis completed by Wipfli is provided in Table 4. RIVERESM will do follow-up consulting with Wipfli to develop strategic plans to address and minimize these projected risks.

Table 4*Identification and Assessment of Risks for the RIVERESM Center.*

RISK CLASS	RISK RATE	RISK DESCRIPTION	MITIGATING STRATEGIES
Funding	High	Overall interest in renting office space is lacking	RIVERE SM is working with rapidly growing Gather® LLC to manage rentable space. The Gather® model offers maximum flexibility for renting space that meets the needs of companies and organizations in the rapidly changing office leasing market. See WorkAtGather.com.
Operational	High	Construction difficulties and costs increase as a result of the pandemic – i.e. inflation and supply chain issues	RIVERE SM will remain open to rapidly changing conditions for building the facility. Back up planning will include strategies to mitigate challenges due to changes in market conditions. What won't change is RIVERE's dedication to helping facilitate SmartRiver research on the Rappahannock
Strategic	High	University of Mary Washington Jepson Center may be competition	The University of Mary Washington (UMW) is an important stakeholder and partner in the RIVERE SM concept. RIVERE SM has donated money to researchers at UMW and facilitated collaboration for projects with Virginia Tech. RIVERE SM will continue to push UMW as a key player for research projects identified by collaboration partners.
Strategic	High	Cost of leasing space is a draw back for many	The Gather® LLC model offers maximum flexibility for office space at significant savings as compared to the traditional leasing model. See WorkAtGather.com.
Funding	High	Difficulties in funding a large project	RIVERE SM is engaging a professional fundraiser to develop a successful funding plan. The first phase of RIVERE's fundraising campaign will seek to identify key corporate partners that have a vested interest in water technology using artificial intelligence and big data expertise to showcase the possibilities of a fully functional Smart River. RIVERE SM is interested in approaching Microsoft, Amazon Web Services and IBM among others.
Strategic	Medium	Stakeholders questioned, if technology is the actual strategy; what is the need for the building?	RIVERE SM will showcase innovative technology developed by partners and stakeholders through exhibits, social media and seminars.

Funding	Medium	Work from home is devaluing office space	Gather® LLC is thriving in the declining traditional office space market through innovative concepts designed to reduce cost while maximizing opportunities to collaborate. See WorkAtGather.com
Funding	Medium	Ability to raise enough capital	Philanthropy increased by 19% from 2019 to 2020 primarily driven by big donors. The message here is to target big donors.
Strategic	Medium	Potential misalignment of cause with underlying objectives – are we really addressing what we set out to accomplish? Mission creep	The build will serve as a nexus, supporting collaborative efforts, working toward a healthy watershed. RIVERE SM will support and promote members without competition.
Funding	Medium	Direct competition for fund-raising	RIVERE's fundraising strategy will focus on larger donors that are not likely to compete with local stakeholder funds.
Funding	Low	Several stakeholders indicated they would not want to pay for office space Lack of consistent, ongoing funding	RIVERE SM has identified several interested organizations to include governmental organizations that will consider taking a hard look at the Gather model for renting space. Many organizations realize that flexible rental options could mitigate issues with traditional long-term leasing agreements.
Operational	Low	Sustainable buildings are hard to build and maintain – cost per square foot	The Chesapeake Bay Foundation's Brock Environmental Center is a shining example of innovative building concepts that has resulted in numerous positive benefits for the community. The architects responsible for that building (SmithGroup) are the architects for RIVERE SM . The facility will be more expensive to build but the benefits will outrun the costs.
Strategic	Low	Part of the plan is lab space, but users may only be interested in labs tailored to their specific needs	Flexible strategies will support the needs of members.
Operational	Low	Sustainable buildings require appropriate occupancy behaviors – i.e., they need the right type of client	Strategies to rent space to ecologically minded entities may limit risk.

Note. Risk assessment conducted by Wipfli LLP

Acknowledgments

With an allegiance to gratitude, RIVERESM accepts the responsibility of environmental stewardship and will support those who leave the earth a little better than it was found. We acknowledge and thank the many people who contributed to creating the RIVERESM concept and bringing it to reality - our founder, professional team, partners, and stakeholders.

The vision for creating an ecological center on the Rappahannock started with Dr. Henry “Buck” Cox, who grew up in Fredericksburg and spent countless hours fishing, canoeing, and swimming on the Rappahannock. In the 1970s, after graduating from Virginia Tech, Buck worked for the State Water Control Board (now the DEQ). His job was to sample the Rappahannock and its tributaries from the headwaters to Port Royal. Over the past 60 years, Buck has witnessed slow but insidious sediment on the Rappahannock due largely to runoff from agriculture and development. It has been Buck’s dream to give back to the Rappahannock and region that means so much to him, by creating an ecological center that will help us better understand and mitigate projected impacts to the river and, importantly, provide significant economic benefits to the area through ecotourism.

We are grateful for the dedicated RIVERESM team who contributed significantly to developing the RIVERESM concept, writing the business plan, and converting this vision into action. The founding RIVERESM team includes Dr. Henry “Buck” Cox (Founder), Mikel Manchester (Executive Director), Dr. Lori Blanc (Environmental / Business Consultant), Michele Phillips (Creative Director), and Taylor Johnson (Communications Director). Significant contributions were also made by our student interns, Kyle Close (University of Mary Washington), Ava DiVita (Virginia Tech), and Matthew Amato (Virginia Wesleyan University).

It is with sincere gratitude that the RIVERESM team recognizes Mrs. Weber Taylor for her legacy of supporting environmental causes, including RIVERESM. In her honor, the RIVERESM Center grounds will be named ‘Taylor Made Native Gardens’.

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