Case Study: Sustainable Water Initiative for Tomorrow (SWIFT)

Incentivizing Groundwater Recharge
Case Study #10

Working Draft
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Center for Law, Energy, and the Environment
UC Berkeley School of Law

This case study is part of a series focusing on incentives for Managed Aquifer Recharge, and the institutional context in which MAR projects are conducted. The series is being produced as part of a larger project examining this topic. A symposium on September 10, 2019 will highlight these and other projects. More information is available at law.berkeley.edu/recharge2019.

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Sustainable Water Initiative for Tomorrow (SWIFT)
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Nell Green Nylen

Overview

Location: Hampton Roads Sanitation District, Virginia
Motivation for MAR: Meeting current and future wastewater effluent limitations for nutrients; insulation from uncertainty surrounding future surface water quality standards; regional groundwater overdraft
Groundwater Challenges: Declining aquifer pressure; hydraulic gradient reversal; land subsidence; saltwater intrusion
MAR Challenges: Compatibility of recharge water with native groundwater and aquifer materials; lack of state authority over underground injection
Project Goals: Recharge approximately 100 MGD (million gallons per day)
Key Actor(s): Hampton Roads Sanitation District (HRSD); United States Environmental Protection Agency (EPA); Virginia Department of Environmental Quality (VDEQ); Virginia Department of Health (VDH); Potomac Aquifer Recharge Oversight Committee
Water Source: SWIFT Water (municipal wastewater receiving advanced treatment to meet drinking water standards)
Start Date: 2014 for analysis and pre-planning; 2016 for room-scale treatment process pilots; 2018 for recharge at 1 MGD demonstration facility
Current Status: Demonstration and planning for full-scale implementation
Average Yield: Up to 1 MGD at demonstration facility; ~100 MGD expected at full scale
Cost: $1.1 billion estimated for full-scale construction; $21 to $43 million estimated for full-scale annual operating costs

1. Motivation and Goals

Hampton Roads Sanitation District (HRSD) is pursuing the Sustainable Water Initiative for Tomorrow (SWIFT), an innovative, multi-benefit program designed to address both nutrient pollution in the Chesapeake Bay watershed and groundwater overdraft in Virginia’s Coastal
Plain. At full-scale implementation, HRSD intends to recharge approximately 100 million gallons per day (MGD) of municipal wastewater that has been treated to meet drinking water standards) at five of its wastewater treatment plants in the Chesapeake Bay watershed. This recharged will increase regional aquifer pressures and combat hydraulic gradient reversal, aquifer compaction and related land subsidence, and saltwater intrusion. HRSD expects the SWIFT program to reduce the nutrient loads discharged from the five plants by approximately 90%, enabling it to meet its own mandated nutrient limits while also generating nutrient credits it can trade to other dischargers.

2. Geographic, Historical, and Regulatory Context

2.1. Creation of HRSD

In 1940, Hampton Roads area voters approved a referendum establishing HRSD to address regional water pollution caused by the routine discharge of untreated sewage in area waters. Today, HRSD provides regional sanitary sewer conveyance (primarily interceptor mains) and wastewater treatment for approximately 1.7 million people in 18 counties and cities, spanning much of Virginia’s Coastal Plain (see Figures 1 and 2). It operates nine major wastewater treatment plants and seven smaller plants with a combined capacity of 249 MGD that collectively treat an average of 150 MGD. HRSD is governed by an eight-member governor-appointed commission that independently sets its rates.

2.2. HRSD and Surface Water Regulation Under the Federal Clean Water Act

Discharges by wastewater treatment plants to waters of the United States require a permit under the federal Clean Water Act. EPA has delegated primary permitting responsibilities to many states, including Virginia.6

2.2.1. Chesapeake Bay Nutrient Regulation

Much of HRSD’s service area is located within the Chesapeake Bay watershed, a 64,000 square-mile area that includes parts of Virginia, West Virginia, Maryland, Delaware, Pennsylvania, and New York and the entire District of Columbia.

Nutrient pollution from agricultural and urban sources has degraded the Chesapeake Bay’s ecosystems, negatively impacting fisheries and human health and leading state and federal regulators to require significant dischargers to reduce their nutrient discharges over time. Virginia’s State Water Control Board first assigned nutrient allocations in 2005. In 2010, the

Figure 2. Physiographic provinces in Eastern Virginia, showing the location of the cross section in Figure 3. Red outline indicates the outer edge of the Chesapeake Bay Impact Crater. Modified from McFarland (2015).
United States Environmental Protection Agency (EPA) established the Chesapeake Bay Total Maximum Daily Load (TMDL), which established more restrictive watershed-wide and finer scale limits on discharges of nitrogen, phosphorus, and sediment. The Virginia Department of Environmental Quality (VDEQ) is implementing the TMDL in part through a watershed-based Virginia Pollutant Discharge Elimination System General Permit that includes waste load allocations for HRSD’s wastewater treatment plants and for other significant Virginia dischargers. Permittees can generate nutrient credits if they discharge an annual mass load that is less than their assigned waste load allocation and may trade these credits to other permittees. Dischargers were required to meet interim loads by 2017 and must meet final loads by 2025.

Since 2007, HRSD has been phasing in nutrient removal technologies at its treatment plants that discharge into the James and York Rivers, and is currently able to meet its aggregate load allocations in both basins. Although HRSD’s current nutrient load allocations are based on the design flows of its wastewater treatment plants, which were intended to support future wastewater needs with projected population growth, current average annual flows are far lower. In the future, HRSD’s nutrient waste load allocations are likely to be ratcheted down again, although it is not clear when, or by how much.

2.2.2. EPA Consent Decree

HRSD is under an EPA consent decree to reduce its wet weather sanitary sewer overflows. The decree requires significant financial investments in the coming years in order to reduce the incidence of overflows and the pollutants they introduce into Virginia’s surface waters. To prepare for those expenses, HRSD developed a financial plan that includes a new rate structure to support about $2.5 billion in capital improvements over the next 10 years. According to HRSD, more than 80% of this planned investment is directly tied to meeting its responsibilities under the consent decree or to meeting nutrient reductions required under the Chesapeake Bay TMDL.

2.3. Regional Groundwater Overdraft

Virginia’s 13,000 square-mile Coastal Plain physiographic province (Figure 2) is part of the broader Northern Atlantic Coastal Plain. This gently sloping terrain is underlain by a wedge of sediments that dips and thickens toward the east. The wedge contains a series of more permeable units, including the primary source of groundwater in the region, the Potomac Aquifer System, punctuated by less permeable confining units (Figure 2). An ancient impact crater near the mouth of the Chesapeake Bay disrupts the Coastal Plain sediments, creating a major barrier to regional groundwater flow (see Figures 2 and 3).
The Coastal Plain region receives an average of more than 40 inches of precipitation per year and experiences warm, humid summers and moderate winters. Although surface water is abundant in Virginia and accounts for approximately 90% of reported water withdrawals statewide, groundwater is heavily used in the Coastal Plain region. Groundwater extraction increased steadily over the past century, outpacing natural recharge and causing more than 200 feet of drawdown in some parts of the Potomac Aquifer System by 2003. With net groundwater extraction exceeding sustainable levels, sediments in the coastal aquifer system are undergoing compaction, reducing the space available for groundwater storage and causing land subsidence that is compounding the effects of global sea-level rise. Pumping has changed groundwater flow patterns in the region in complex ways, increasing the likelihood that “upconing” and lateral intrusion of saltwater will affect production wells. Currently, water users extract groundwater from the Potomac Aquifer System at a rate of more than 100 MGD.

2.4. State Groundwater Regulation

In response to concerns about groundwater quality, access, and long-term sustainability in the Coastal Plain, the State Water Control Board has designated, and the VDEQ administers, two Groundwater Management Areas (see Figure 4). In these areas, water users must have a permit to extract 300,000 or more gallons of groundwater per month. As of June 11, 2019, there were 334 active groundwater withdrawal permits for these large water users. The vast majority of groundwater withdrawn by permittees is for industrial or public water supply use (~52% and
~40% by volume, respectively, in 2017). 37 While other groundwater users do not need withdrawal permits, those extracting more than 10,000 gallons per day in any single month must report their withdrawals annually. 38 This leaves large numbers of smaller users out, however, and VDEQ has highlighted the need to gain a better understanding of unreported groundwater withdrawals. 39 A 2015 requirement for submitting well completion reports when new private wells are constructed within Virginia’s Groundwater Management Areas 40 is providing a new source of information that can improve estimates 41 of unreported groundwater use. An estimated 275,000 to 300,000 households rely on private domestic wells in the Eastern Virginia Ground Water Management Area alone. 42 To begin to address groundwater overuse in the Area, VDEQ negotiated permit reductions for the 14 permittees that are collectively responsible for approximately 80% of permitted groundwater withdrawals. 43 Additionally, permit applications for new or increased withdrawals require an impact and sustainability analysis as well as impact mitigation. 44 However, additional groundwater demand management and concerted efforts to increase groundwater recharge will be integral to achieving sustainable groundwater use in the region. 45

2.5. Regulation of Underground Injection in Virginia

Recharge by underground injection is regulated under the federal Safe Drinking Water Act’s Underground Injection Control (UIC) program. Recharge wells are considered Class V wells. 46 Those wishing to use this type of well must submit certain information to the UIC program and comply with requirements designed to protect underground sources of drinking water. 47 A permit is necessary if the injection activity would “allow the movement of fluid containing any contaminant into” an underground source of drinking water, “if the presence of that contaminant may cause a violation of the primary drinking water standards under 40 CFR part 141, other health based standards, or may otherwise adversely affect the health of persons.” 48 While many states implement their own UIC programs, Virginia does not. Instead, EPA Region 3 directly implements the UIC program in Virginia. 49

3. Origin and Development of SWIFT

HRSD began exploring the possibility of preemptively treating its wastewater effluent to a very high level to insulate itself from uncertainty surrounding future water quality standards, including its nutrient waste load allocations under the Chesapeake Bay TMDL. 50 Because the Virginia Coastal Plain is already rich in surface water but struggles with unsustainable levels of groundwater use, HRSD recognized the potential of using the highly treated effluent to replenish the overtapped Potomac Aquifer System.
3.1. Regional groundwater modeling / feasibility studies

During late 2014 and early 2015, a consultant examined the potential introduction of highly treated effluent into the Potomac Aquifer System near HRSD’s wastewater treatment plants and to what extent this would improve groundwater conditions in Virginia’s Coastal Plain. Analysis using VDEQ’s groundwater model provided evidence that injecting approximately 120 MGD of highly treated effluent from seven of HRSD’s wastewater treatment plants would increase pressure across much of the Potomac Aquifer System (Figure 5), helping to stave off coastal saltwater intrusion, reduce future compaction, subsidence, and related relative sea level rise, and sustainably support existing and projected groundwater withdrawals in the region at an estimated cost of approximately $1 billion. With the feasibility study results in hand, HRSD reached out to the governor, the secretary of natural resources, the VDEQ, the Virginia Department of Health (VDH), the United States Geological Survey (USGS), the Hampton Roads Planning District Commission, and others with a potential stake in the multi-benefit project to gather input and seek support for moving forward. HRSD would eventually name the project SWIFT.

3.2. Small-scale piloting of advanced water treatment processes

After initial research to examine treatment options, HRSD ran side-by-side small-scale pilots at its York River Wastewater Treatment Plant in Seaford, Virginia, in 2016. The pilots subjected plant effluent to two different treatment processes (1) a membrane-based reverse osmosis process and (2) a carbon-based advanced treatment process. Testing demonstrated that both processes produce effluent that meets all primary (human health-based) drinking water standards. HRSD decided to use the carbon-based process because it has several advantages over reverse osmosis, including using less energy, generating less waste, and creating effluent that is projected to be more chemically compatible with native groundwater and aquifer materials.

3.3. Large-scale demonstration facility: The SWIFT Research Center

As a next step, HRSD is demonstrating “at a meaningful scale” that the advanced treatment process it has chosen produces water that both (1) meets primary drinking water standards and (2) is chemically compatible with the native groundwater and sediments of the Potomac Aquifer System. The SWIFT Research Center, constructed at HRSD’s Nansemond Wastewater
Treatment Plant in Suffolk, Virginia, is a $25 million design-build demonstration facility capable of treating and injecting approximately 1 MGD.\textsuperscript{59} The facility began replenishing the Potomac Aquifer System with SWIFT Water in May of 2018.\textsuperscript{60}

3.4. \textbf{Moving towards full implementation}

In parallel with continuing to learn from the SWIFT Research Center, HRSD is currently laying the groundwork for full-scale implementation of SWIFT at five of its wastewater treatment plants (Figure 6).

HRSD plans to construct SWIFT facilities at five of its wastewater treatment plants: James River, York River, Nansemond, Virginia Initiative, and Williamsburg.\textsuperscript{61} However, as Figure 1 shows, seven wastewater treatment plants will be involved. HRSD will construct a new pump station and transmission force main to convey untreated service flows from its Boat Harbor plant to a combined SWIFT facility located at the Nansemond plant.\textsuperscript{62} It will also construct a new pump station and force main to convey secondary-treated effluent from its Army Base plant to a combined SWIFT facility located at the Virginia Initiative plant.\textsuperscript{63} HRSD hopes to secure all required approvals for and begin construction on the first full-scale SWIFT facility by 2020 and to have all five facilities up and running by 2032.\textsuperscript{64} At full implementation, HRSD expects to recharge approximately 100 MGD into the Potomac Aquifer System via the five SWIFT facilities.\textsuperscript{65}
4. Managed Aquifer Recharge Through SWIFT

Designs for the five full-scale SWIFT facilities and their associated monitoring systems will be based on knowledge gained from operating the SWIFT Research Center as well as the site-specific conditions at each location. Therefore, this section draws heavily from HRSD’s experience to date at the SWIFT Research Center.

4.1. The Recharge Process

Before it gets to a SWIFT facility, wastewater will be collected in HRSD’s sanitary sewer system, conveyed to one of its wastewater treatment plants, and subjected to at least secondary treatment. Within the SWIFT facility, the treated effluent will receive further treatment. At the SWIFT Research Center, secondary effluent from HRSD’s Nansemond plant goes through a treatment train that includes coagulation, flocculation, sedimentation, ozonation, biological filtration, granular activated carbon, and ultraviolet disinfection (Figure 7). When advanced treatment is complete, the “SWIFT Water” is injected into a 1,410-foot-deep, 12-inch-diameter test recharge well with 11 separate screened intervals that intersect different parts of the Potomac Aquifer System.

The SWIFT Research Center is helping HRSD gain critical operational experience, build knowledge, and identify and address potential issues with the scaled-up treatment process, injection infrastructure and processes, and groundwater quality and flow monitoring. For example, in the Center’s first few months of operation, HRSD discovered that an estimated 4.8 million gallons of recharged water exceeded the maximum contaminant level for nitrite because the biological filters in the treatment system were not yet fully functional. Staff established new procedures for identifying and addressing contaminant exceedances and...
installed a continuous nitrite monitoring analyzer as a critical control point. To ensure that it “cleared” the high nitrite water, HRSD pumped about 20 million gallons of water out of the aquifer system before resuming normal recharge operations. Similarly, in late 2018, HRSD suspended Research Center operations to address corrosion on process equipment, including the Center’s stainless steel flocculation and sedimentation tanks. HRSD has noted that it plans to use concrete tanks for full-scale SWIFT facilities. Following warranty repairs, the Research Center was restarted in early April 2019, with injection beginning again later that month.

4.2. Accounting

HRSD is keeping close track of how much water it recharges (and, as described in the previous section, pumps out) at the SWIFT Research Center. It is also tracking the impacts of recharge. In late May 2019, HRSD announced that the SWIFT Research Center had successfully introduced a net total of 100 million gallons of SWIFT Water into the Potomac Aquifer System. Although this represents a tiny fraction of the amount of water HRSD plans to recharge at full-scale implementation, USGS researchers were able to see “a signal of expansion of the aquifer by a third of a millimeter over the course of two months” in an area that has been experiencing estimated compaction rates of 1.5 to 3.7 mm per year.

Four monitoring wells are helping HRSD track the progress and impacts of water recharged at the SWIFT Research Center. Three conventional monitoring wells—each screened in the upper, middle, and lower portions of the aquifer—are located 400 to 500 feet from the injection well. Additionally, a special monitoring well 50 feet from the injection well uses a Flexible Liner Underground Technology (FLUTe) sampling system to collect samples from each of the 11 injection well screens. The monitoring data collected so far suggest that the movement of recharged water varies significantly over time and across space—for example, the rate of recharge flow appears to be much higher from certain screened intervals.

To track any water quality changes that occur, HRSD will monitor the recharge front as it migrates outward from the SWIFT facility. Because water recharged at the SWIFT Research Center is not expected to reach the closest private well for about 50 years, if a contamination problem begins to develop, there should be ample time for HRSD to detect it and mount an appropriate response.

4.3. Recovery

HRSD does not plan to recover the water it recharges. Instead the goals of SWIFT recharge are to increase regional aquifer pressures and reduce aquifer compaction, land subsidence, and saltwater intrusion. Recharged water will be available to Potomac Aquifer users, subject to permitting or other regulation under state law.
5. Management

5.1. Institutional Structure: Creating a New State Oversight Body

The SWIFT Research Center is currently operating under EPA authorization by rule for underground injection. The full-scale SWIFT facilities will likely require UIC permits, and HRSD will need to demonstrate that its injection wells will not adversely impact sources of drinking water, including the Potomac Aquifer System.

Because the state has not accepted delegation of the UIC program from EPA Region 3, VDEQ and VDH lack direct regulatory authority over HRSD’s ability to pursue SWIFT. Nonetheless, recognizing the strong state interest in ensuring safe drinking water, HRSD has worked with these agencies, other entities, and outside experts to enable robust state oversight. HRSD has held workshops, performed outreach, and maintained lines of communication with VDH and VDEQ at both the executive and technical levels throughout the SWIFT planning process, and EPA has solicited input from both agencies regarding proposed regulatory limits for water quality parameters.

This state oversight role was memorialized in legislation passed in February 2019. Virginia Senate Bill 1414 was modeled after an oversight program developed for indirect potable reuse intermediated by Virginia’s Occoquan Reservoir. The legislation creates a ten-member advisory board—the Potomac Aquifer Recharge Oversight Committee—and a new monitoring laboratory, co-directed by two university faculty members, to independently monitor SWIFT’s effects. The Potomac Aquifer Recharge Oversight Committee will include eight voting members (the State Health Commissioner, the Director of VDEQ, the Executive Director of the Hampton Roads Planning District Commission, both laboratory Co-Directors, the Director of the Occoquan Watershed Monitoring Laboratory, and two Virginia citizens appointed by the Governor) and two nonvoting members (the EPA Region 3 Administrator and the Director of the USGS’s Virginia and West Virginia Water Science Center). The legislation also explicitly authorizes the state to direct HRSD to stop injection activities or make needed changes if HRSD fails to comply with EPA permits or authorizations.

5.2. Costs and Financing

User fees for wastewater services are HRSD’s primary source of revenue. It issues bonds and uses cash on hand to finance capital projects, as well as pursuing available grant opportunities.

HRSD expects that fully implementing SWIFT will involve approximately $1.1 billion in capital spending. Early estimates of SWIFT’s operating costs range from $21 to $43 million per year.
While the costs associated with SWIFT are significant, HRSD plans to meet the program’s capital costs without altering its ten-year financial forecast by reprioritizing planned capital improvements. Specifically, based on SWIFT’s projected water quality benefits (and numerous co-benefits), HRSD has proposed funding SWIFT construction by reprioritizing $1.1 billion of the capital improvements planned under its Wet Weather Consent Decree. In September 2017, HRSD submitted an Integrated Plan / Regional Wet Weather Management Plan to the EPA that proposes prioritizing full-scale SWIFT implementation and delaying some required overflow reduction work. HRSD believes this reprioritization will produce greater environmental and human health benefits. However, EPA has not yet approved the Integrated Plan.

5.3. Potential Revenue Generation

SWIFT will significantly reduce HRSD’s nutrient discharges to the Chesapeake Bay watershed, eliminating an estimated 90% of the nutrient load from each SWIFT-equipped wastewater treatment plant. HRSD expects SWIFT to not only meet HRSD’s nutrient reduction responsibilities, but also to generate nutrient credits it can trade to municipal stormwater dischargers to help achieve the Chesapeake Bay TMDL more quickly and cost effectively. Estimates suggest that SWIFT might generate enough credits to enable the eleven counties and cities in the area that have municipal separate storm sewer system (MS4) discharge permits to save up to $2 billion on improvements that would otherwise be needed to meet mandated nutrient reductions. HRSD has already made agreements with all eleven dischargers. These arrangements have the potential to further the surface-water-quality and public health goals of VDEQ, EPA, and VDH while helping to minimize the costs of complying with the Chesapeake Bay TMDL for these cities and counties and the people they serve. Because the primary beneficiaries of the proposed trades will be HRSD ratepayers, who are funding SWIFT (and, therefore, credit generation) through their user fees, HRSD will provide nutrient credits under these agreements at no charge. However, HRSD will also look for opportunities—that do not directly affect its ratepayers—to trade credits to other interested parties at market prices.

6. Analysis and Summary

SWIFT is an innovative program designed to address both nutrient pollution in the Chesapeake Bay watershed and groundwater overdraft in Virginia’s Coastal Plain region. When SWIFT is fully implemented, HRSD expects to substantially reduce its wastewater discharges and nutrient loads in the watershed, generating nutrient credits it can trade to other dischargers, and recharge a total of approximately 100 MGD of SWIFT Water into the Potomac Aquifer System at five of its wastewater treatment plants.

6.1. Key Elements

One of the key features of SWIFT is that surface water quality regulation is a central driver. Without it, HRSD would have little motivation to pursue recharge, and the broad public benefits it is likely to bring.
Additionally, although HRSD is the primary proponent of and manager for SWIFT, it is a truly multi-benefit program that takes advantage of a confluence of needs and opportunities, and also carries multiple risks. As a result, other public and private entities have significant stakes in SWIFT’s successful implementation. For example:

- The reduced nutrient loading enabled by SWIFT will further the surface water quality goals and public health missions of VDEQ, VDH, and EPA and improve conditions for public water systems that use surface water, surface water for recreation, and Chesapeake Bay fisheries.
- The nutrient credits SWIFT is expected to generate will help cities and counties meet required nutrient reductions more cost-effectively and reduce the financial burden on their ratepayers.
- Groundwater users of all types stand to benefit from more reliable and sustainable access to groundwater if SWIFT fulfills its promise. Relatedly, they have a strong interest in robust oversight, monitoring, contingency planning, performance evaluation, and adjustment to ensure SWIFT’s success and to identify and appropriately address any problems that arise.
- SWIFT has the potential to reduce future subsidence and related relative sea level rise across the Virginia Coastal Plain, benefitting everyone in the region but especially those living or working in low-lying coastal areas.

Perhaps the program’s most distinctive features is HRSD’s recognition of and approach to addressing a particular type of regulatory risk—specifically, a lack of direct state regulatory authority over underground injection coupled with a strong state interest in groundwater quality and the state’s responsibility and broad general authority to protect public health. Not only has HRSD ensured that key state agencies (VDEQ and VDH) and other important stakeholders and experts have seats at the table during SWIFT development and implementation, HRSD has gone a step further, pursuing state legislation to formalize robust state oversight of SWIFT going forward. HRSD has also identified contingencies for addressing low-probability but high-consequence drinking water contamination, should it arise.

6.2. Incentives and Benefits

Among the factors that have motivated SWIFT or contributed to its success to date are the following:

*Surface water quality regulation* — Although water scarcity is often the primary motivator for reusing treated wastewater in the western United States, SWIFT offers a good example of another key motivator that can come into play even in water-rich areas: surface water quality regulation. The prospect of increasingly stringent nutrient limitations for HRSD’s discharges in the Chesapeake Bay watershed led it to explore the idea of treating its wastewater to a very high degree to avoid a cycle of investment in long-term assets that could quickly become outdated if effluent limitations for nutrients (or other pollutants) are ratcheted down in coming years.
**Regional groundwater supply, groundwater quality, and sea-level rise mitigation benefits** — Rather than discharging SWIFT water into the already water-rich lower reaches of the Chesapeake Bay watershed, where it would have little water supply benefit, or attempting to create stable demand for direct reuse of SWIFT Water, HRSD realized it could instead use the water to address a critical regional need. It could replenish the over-tapped Potomac Aquifer System, increasing aquifer pressures across the region and slowing or preventing further subsidence, related relative sea-level rise, and saltwater intrusion for the short- and long-term benefit of groundwater users and communities across Eastern Virginia.

**HRSD’s size/geography and SWIFT’s scale** — HRSD’s large geographic footprint will enable it to treat and recharge large volumes of water each day at a number of different locations with high recharge potential. These features will enable SWIFT to significantly improve regional aquifer conditions when fully implemented. Additionally, although site-specific analysis and design will be necessary for each SWIFT facility, the economies of scale associated with planning and constructing multiple large SWIFT facilities are likely to be significant.

**HRSD’s independent rate-setting authority and large ratepayer base** — HRSD has the ability to set its rates for wastewater service and spread costs across its large ratepayer base to achieve its goals. Wastewater service providers that need approval for rate changes and smaller providers that aren’t able to spread costs as widely may have a harder time funding a project like SWIFT.

**The generation of nutrient credits** — The nutrient credits HRSD expects to generate as a result of implementing SWIFT could provide the district with an additional source of revenue to help offset the program’s costs. Even where HRSD provides credits at no cost, the expected availability of credits and the savings they represent for potential trading partners and the communities they serve provide economic incentives for increased regional support.

**Extensive outreach/engagement** — From the beginning, HRSD has made concerted, extensive efforts to engage with EPA, VDEQ, VDH, area municipalities, nonprofit organizations, and other stakeholders about their goals, ideas, and concerns. The SWIFT Research Center has expanded opportunities for direct public engagement and education through, for example, frequent tours by school and community groups. These efforts have helped to build broad support for SWIFT and enabled learning that has made the project better.

**6.3. Challenges and Future Considerations**

The same factors that have so far made SWIFT possible also pose potential implementation challenges. For example, despite SWIFT’s explicitly multi-benefit nature, HRSD has been its primary decision maker and proponent to date. HRSD’s decisions need to account for the benefits SWIFT might bring and the burdens SWIFT might impose on a range of other parties with sometimes divergent interests and needs. To gain and maintain their support, HRSD has needed to frame SWIFT in terms of these distinct potential benefits and to ensure that SWIFT is
technically constructed and validated to actually produce them. The newly formed Potomac Aquifer Recharge Oversight Committee is likely to change this dynamic by, in effect, distributing formal responsibility for SWIFT among more actors.

As another example, HRSD is proposing to pay for SWIFT largely by reprioritizing funding that was originally intended for capital improvement projects required under its Wet Weather Consent Decree. If EPA does not approve this proposal, HRSD will need to pursue other sources of funding. This would at least complicate and delay SWIFT implementation, but might not pose an insurmountable barrier if other stakeholders that stand to benefit from SWIFT are willing to contribute financially.

Acknowledgements

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Abbreviations

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<th>Abbreviation</th>
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<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
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Endnotes


25 See map at Prism Climate Group, 30-Year Normals (1981–2010), http://www.prism.oregonstate.edu/normals/ (showing average annual precipitation for the period from 1981 to 2010 for the contiguous United States when climate variable "precipitation" and temporal period "annual values" are selected).


31 See Eastern Virginia Groundwater Management Advisory Committee, Report to the Virginia Department of Environmental Quality and Virginia General Assembly 19 (2017), available at


36 This includes 161 for municipal or non-municipal public water supply use, 67 for commercial use, 60 for agricultural use, 37 for industrial use, 6 for irrigation use, 1 for fossil power, 1 for nuclear power, and 1 for an “unknown” use. See Virginia Department of Environmental Quality, Spreadsheet: Currently Active Groundwater Withdrawal Permits, https://www.deq.virginia.gov/Portals/0/DEQ/Water/OWS-WWPandC/GWwithdrawal_permit_list2019-06-11.xlsx?ver=2019-06-12-091153-630.


46 See 40 C.F.R. §§ 144.80(e), 144.81(6), (7), (10).

47 See 40 C.F.R. §§ 144.82, 144.83.

48 See 40 C.F.R. §§ 144.82(a), 144.84(b)(1).


53 Figure 5 is from: Charles B. Bott and Jamie Heisig-Mitchell, HRSD’s Vision for Managed Aquifer Recharge in Eastern Virginia, Slide 18 (May 17, 2017), available at https://www.chesapeakebay.net/channel_files/25148/trading_wg_presentation_051717_towg.pdf.


62 See Hampton Roads Sanitation District, Capital Improvement Program for the Fiscal Years 2020–2029: Boat Harbor Treatment Plant Service Area CIP Projects, at 29–30 (effective July 1, 2019), available at https://www.hrsd.com/sites/default/files/assets/Documents/pdfs/cip/FY2020/07_Boat%20Harbor.pdf (“The SWIFT master planning effort has determined that advanced water treatment and injection at Boat Harbor has significant physical limitations including site availability and resiliency to sea level rise. In addition, a financial analysis indicates there is significant long term cost savings associated with consolidating wastewater treatment and SWIFT facilities at Nansemond Treatment Plant. This project will allow HRSD to further reduce the amount of nutrients contributed to the James River basin. Upgrades to Nansemond Treatment Plant to accommodate the additional flow will be completed under a separate capital project.”).

19 of 23 WORKING DRAFT
See Hampton Roads Sanitation District, Capital Improvement Program for the Fiscal Years 2020–2029: Army Base Treatment Plant Service Area CIP Projects, at 7–8 (effective July 1, 2019), available at https://www.hrsg.com/sites/default/files/assets/Documents/pdfs/cip/FY2020/05_Army%20Base.pdf (“The SWIFT master planning effort has determined that advanced water treatment and aquifer recharge at Army Base has significant physical limitations including site availability. This project would support the capture and further advanced treatment of Army Base secondary clarifier effluent in a consolidated SWIFT treatment facility located adjacent to VIP”).


See Meredith G. Bullard, Mark Widdowson, Germano Salazar-Benites, Jamie Heisig-Mitchell, Andy Nelson, and Charles Bott, Managed Aquifer Recharge: Transport and Attenuation in a Coastal Plain Aquifer, World Environmental and Water Resources Congress 2019, at 110–111 (2019), available at https://ascelibrary.org/doi/abs/10.1061/9780784482346.011. The system has a flexible liner that matches the screen lengths and depths of the recharge well but allows flow only through sample tubes at each screened interval to keep water from different intervals from mixing in the borehole. See id. at 110.


For example, if monitoring detects a water quality problem, HRSD could reverse the direction of its recharge pumps to remove the affected water. In the unlikely event that a severe, delayed-onset water quality problem were to develop and could not be addressed in other ways, HRSD could pay to extend public water service to those with affected wells.


See Code of Virginia §§ 62.1-272 (added by Virginia Senate Bill 1414 (2019)).

See Code of Virginia §§ 62.1-275 (added by Virginia Senate Bill 1414 (2019)).


