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Hampton Roads Sanitation District's Sustainable Water Initiative for Tomorrow Proposal

Patrick Harner

Alexa Pecht

Emily Tucker

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Patrick Harner, J.D. Candidate 2018
Alexa Pecht, J.D. Candidate 2017
Emily Tucker, J.D. Candidate 2018
Virginia Coastal Policy Center at William & Mary Law School

WILLIAM & MARY LAW SCHOOL
VIRGINIA COASTAL POLICY CENTER

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About the Authors

Patrick Harner has a B.A. in History from William & Mary, an M.A. in Earth and Environmental Science from Wesleyan University, and a M.S. in Planetary Science from University of Arizona. Patrick is a 2L at William & Mary Law School.

Alexa Pecht has undergraduate degrees in Environmental Science and Environmental Technology and Management from North Carolina State University. Alexa is a 3L at William & Mary Law School and will begin practicing as an Associate at Keller & Heckman in Washington, DC in Fall 2017.

Emily Tucker has an undergraduate degree in Chemical and Biomolecular Engineering from Georgia Tech. Emily is a 2L at William & Mary Law School and intends to practice in the areas of patent prosecution and litigation. During Summer 2017, Emily will be splitting her time as a Summer Associate between Crowell & Moring and Wilson, Sonsini, Goodrich & Rosati in Washington, DC.

CONTACT US

Please contact Elizabeth Andrews (eaandrews@wm.edu) if you have comments, questions, or suggestions.

About the Virginia Coastal Policy Center

The Virginia Coastal Policy Center (VCPC) at the College of William & Mary Law School provides science-based legal and policy analysis of ecological issues affecting the state's coastal resources, providing education and advice to a host of Virginia's decision-makers, from government officials and legal scholars to non-profit and business leaders.

With two nationally prominent science partners – the Virginia Institute of Marine Science, one of the largest marine research and education centers in the United States, and Virginia Sea Grant, a nationally recognized broker of scientific information – VCPC works with scientists, local and state political figures, community leaders, the military, and others to integrate the latest science with legal and policy analysis to solve coastal resource management issues. VCPC activities are inherently interdisciplinary, drawing on scientific, economic, public policy, sociological, and other expertise from within the University and across the country. With access to internationally recognized scientists at VIMS, to Sea Grant's national network of legal and science scholars, and to elected and appointed officials across the nation, VCPC engages in a host of information exchanges and collaborative partnerships.

VCPC grounds its pedagogical goals in the law school's philosophy of the citizen lawyer. VCPC students' highly diverse interactions beyond the borders of the legal community provide the framework for their efforts in solving the complex coastal resource management issues that currently face Virginia and the nation. Whether it is working to understand the underlying realities of local zoning policies or attempting to identify and reconcile the concerns of multiple stakeholders, VCPC students experience the breadth of environmental lawyering while gaining skills that will serve them well regardless of the legal career they pursue upon graduation.

I. PROJECT INTRODUCTION

The Hampton Roads Sanitation District (HRSD) is a political subdivision of the Commonwealth of Virginia that serves approximately 1.7 million individuals throughout Hampton Roads and the Middle Peninsula.[1] The HRSD operates thirteen water treatment plants with approximately 460,000 service connections,[2] with its stated mission "to protect public health and the waters of Hampton Roads by treating wastewater effectively."[3]

To this end, HRSD is offering a unique solution, called the Sustainable Water Initiative for Tomorrow (SWIFT). The proposal is aimed at addressing several issues currently facing Eastern Virginia, particularly the overuse of groundwater in the Potomac Aquifer. HRSD proposes upgrading six or seven of its current wastewater treatment plants such that they are able to clean wastewater to standards that exceed current drinking water quality requirements.[4] This ultra-cleaned wastewater would then be reinjected into the Potomac Aquifer, potentially at a rate as high as 120 million gallons of water per day,[5] storing the cleaned water and effectively replenishing the aquifer.

II. PROJECT BENEFITS

In addition to reversing the depletion of the aquifer, the HRSD groundwater injection project has the potential to bring multiple benefits to the Virginia Coastal Plain, including abating land subsidence, preventing saltwater intrusion into the aquifer near coastal zones, and reducing nutrient discharges to tributaries of the Chesapeake Bay. However, these benefits must be balanced with the risks of pumping treated wastewater into the aquifer that may not match the chemistry of the existing groundwater. This section highlights the major scientific implications of the proposed groundwater injection, and indicates areas of the project that will require further scientific monitoring.

A. Replenishing the Potomac Aquifer

i. Current State of the Aquifer

a. Hydrologically

The Potomac Aquifer, extending from the Atlantic coast to the inland Fall Line, is the largest groundwater source in the Virginia Coastal Plain.[6] The aquifer consists of porous sections

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[1] HAMPTON ROADS SANITATION DISTRICT, FAST FACTS, http://www.hrsd.com/fastfacts.shtml (last visited Nov. 23, 2016).
[2] Hampton Roads Sanitation District, *Capital Improvement Program – Fiscal Year 2017*, http://www.hrsd.com/pdf/CIP/FY2017/01_Introduction.pdf.
[3] *Id.*
[4] Hampton Roads Sanitation District, *Sustainable Water Recycling Initiative Summary* (2016), http://www.hrsd.com/pdf/SWR/SWR_BrochureForWeb.pdf.
[5] *Id.*
[6] USGS, *The Virginia Coastal Plain Hydrogeologic Framework*, 31 (2006), http://pubs.usgs.gov/pp/2006/1731/PP1731.pdf. [hereinafter USGS, *Virginia Coastal Plain*]; VIRGINIA'S COASTAL PLAIN (TIDEWATER) REGION, http://web.scott.k12.va.us/martha2/Tidewater.htm.

of saturated sand and gravel in between layers of dense clays.[7] The aquifer is hydrologically contiguous throughout the Virginia Coastal Plain, but on a more localized scale, the clay layers can create impediments to the free movement of water.[8] The Potomac Aquifer is a confined aquifer, meaning that the portion of the aquifer that is saturated with water is contained in between impermeable layers.[9] This confinement creates a pressurized system; thus, when wells are drilled down into the confined aquifer and withdraw water, the overall pressure in the aquifer below is reduced.[10]

The aggregate effect of these well withdrawals, from both industrial and residential users, is the gradual subsidence of the land above the aquifer, as the pressure from the water beneath decreases.[11] The United States Geological Survey (USGS) has determined that groundwater pumping has contributed to more than half of the land subsidence in the area, which occurs at rates between 1.1 and 4.8 mm per year.[12] This subsidence, in combination with sea level rise, contributes to the threat of flooding, especially in the low-lying waterfront regions of the Virginia Coastal Plain.[13]

b. Current Groundwater Allocation

Virginia's Department of Environmental Quality (DEQ) monitors groundwater throughout the state,[14] and within two designated Groundwater Management Areas – Eastern Virginia and the Eastern Shore – the DEQ is able to limit groundwater withdrawal under the Groundwater Management Act.[15] Within the Eastern Virginia Groundwater Management Area, any user wishing to withdraw 300,000 gallons/month or more of groundwater must obtain a permit, and during the permitting process the state assigns a maximum allowed withdrawal amount.[16] Several criteria are incorporated in assigning a maximum allowed withdrawal, including reasonable anticipated use, but the DEQ also employs an 80% drawdown criterion, which requires that a

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[7] USGS, *The Virginia Coastal Plain*, *supra* note 6, at 31.
[8] *Id.*
[9] *Id.* at 35; *Groundwater and Aquifers FAQs*, USGS (2016), https://www2.usgs.gov/faq/categories/9812/2776.
[10] USGS, *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region*, 11 (2013), http://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf [hereinafter USGS, *Land Subsidence*].
[11] *Id*. at 1.
[12] *Id.*
[13] *Id.* at 6.
[14] There has been some criticism that the Commonwealth's current level of monitoring is insufficient to precisely monitor groundwater withdrawal, and that the resources available for groundwater and surface water monitoring have declined steadily over the past two decades. *See, e.g.*, Jefferson D. Reynolds, *Virginia's Water Resource Law: A System of Exemptions and Preferences Challenging the Future of Public Health, The Environment, and Economic Development*, 50 U. RICH. L. REV. 365 (2015); *see also* JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION, REPORT TO THE GOVERNOR AND THE GENERAL ASSEMBLY OF VIRGINIA, Rep. No. 486, Effectiveness of Virginia's Water Resource Planning and Management, 13-14 (Oct. 2016) (addressing the strengths and weaknesses of Virginia's monitoring system for the Potomac Aquifer).
[15] VA. CODE ANN. §§ 62.1-254, -263 (1992).
[16] VA. CODE ANN. §§ 62.1-259, -261, -263; COMMONWEALTH OF VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY, Application for a Groundwater Withdrawal Permit (revised 2012), http://leg5.state.va.us/reg_agent/frmView.aspx?Viewid=7f2e6001781~13&typ=40&actno=001781&mime=application/pdf [hereinafter VDEQ, Applicataion].

permitted withdrawal not reduce aquifer water levels below a point that represents "80% of the distance between historical prepumping water levels in the aquifer and the top of the aquifer."[17]

Because natural recharge is not keeping up with the Potomac Aquifer groundwater withdrawal rate (which is currently over 100 million gallons daily), DEQ is in the process of substantially reducing the maximum permitted groundwater withdrawal for several of the largest permitted users within the Eastern Virginia Groundwater Management Area. Permits are issued on a ten year basis, and DEQ has proposed substantial cuts to the permitted use of fourteen of the largest users upon renewal, each of which have a permit to withdraw more than one million gallons daily.[18] For some users, these proposed reductions have decreased the permitted allowed groundwater withdrawal rate below that which the user could feasibly accomplish through conservation efforts, and have raised significant concerns about the availability of alternate sources of water, as well as the long term sustainability of the Potomac Aquifer.[19] As an extreme example, James City County is anticipating incurring a cost of nearly $130 million to either purchase water from Newport News Waterworks or invest in infrastructure to capture and treat surface water, as DEQ is discussing reducing their permitted groundwater withdrawal below their minimum usage.[20]

DEQ has currently issued just under two hundred permits allowing for a maximum groundwater withdrawal of approximately 150 mgd,[21] but an additional estimated 40 mgd is still withdrawn by 200,000 unpermitted users.[22] Although these permitting reductions are aimed at balancing groundwater withdrawal with natural recharge, the recent reductions have highlighted many of the inconsistencies in Virginia's current regulatory framework. The Groundwater Management Act prioritizes human consumption in the case of conflicting water rights or insufficient water supply,[23] yet 60% of permitted groundwater withdrawal is for industrial uses.[24] It appears to run counter to the statute to reduce groundwater permitting for public water supplies, thus forcing them to invest heavily in finding alternative sources of water, while many industrial permittees go unreduced.[25] Moreover, the majority of withdrawers (including individual households, residential communities, businesses, and agriculture) remain unpermitted, and either

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[17] VDEQ, Application, *supra* note 16.

[18] Hampton Roads Sanitation District, *HRPDC Annual Commission Meeting, Agenda Note, Item # 6: Groundwater Withdrawal Permits* (2014), http://www.hrpdcva.gov/uploads/docs/10162014-PDC-AN6.pdf.

[19] *See, e.g.*, Dave Ress & Austin Bogues, *Groundwater drain a big-dollar dilemma*, DAILY PRESS, Oct. 10, 2015.

[20] James City County currently withdraws approximately 5mgd and is permitted to withdraw 8mgd, but the DEQ is expected to reduce their permit to 4mgd when renewed this year. Austin Bogues, *HRSD pitches plan to replenish groundwater aquifer*, VIRGINIA GAZETTE, Mar. 25, 2016; *see also* Dave Ress & Austin Bogues, *supra* note 19.

[21] Tiffany Smith, *HRPDC Releases 2014 Summary of Permitted Groundwater Withdrawals in the Eastern Virginia Groundwater Management Area*, HAMPTON ROADS PLANNING DISTRICT COMMISSION – WATER RESOURCE NEWS (Dec. 8, 2014) (listing permitted users and approximate total allocation as of Oct. 29, 2014); Virginia Department of Environmental Quality, *Current Issued Groundwater Permits*, http://www.deq.virginia.gov/Programs/Water/WaterSupplyWaterQuantity/WaterWithdrawalPermittingandCompliance/CurrentIssuedGroundwaterWithdrawalPermits.aspx (listing permits issued within the last two years by DEQ).

[22] HRSD, *supra* note 4; JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION, *supra* note 14, at 11.

[23] VA. CODE ANN. § 62.1-263 (1992).

[24] JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION, *supra* note 14.

[25] This is not a novel observation. *See* PAUL M. BARLOW, GROUND WATER IN FRESHWATER-SALTWATER ENVIRONMENTS OF THE ATLANTIC COAST, 36 (2003), http://pubs.usgs.gov/circ/2003/circ1262/pdf/circ1262.pdf (noting the inconsistencies in Virginia groundwater permitting with regard to human consumption).

withdraw an amount below the permit threshold or are subdivided in such a way that discrete parcels remain below the threshold.[26]

ii. Potential Improvement by SWIFT

The SWIFT project promises to substantially increase the recharge rate of the aquifer, and could allow the Commonwealth to dramatically increase permitted groundwater withdrawal in the future – potentially easing the growing conflict inherent in allocating a limited groundwater supply and allowing for water-dependent growth, either in population or industry. However, the benefits from injection will not be seen in DEQ's current regulatory framework for several decades. SWIFT is not expected to be fully operational until 2030,[27] and substantial change in the aquifer could take decades to observe. Because DEQ currently issues groundwater withdrawal permits on a ten year basis,[28] any recovery observed would not be reflected in a maximum permitted water withdrawal limit until that permit came up for renewal. Communities like James City County would still have to find alterative sources of water for at least the next several decades before any aquifer replenishment is reflected in their permit.

B. Abatement of Land Subsidence

The HRSD groundwater injection proposal should increase the pressure within the aquifer through pumping water back into the aquifer, and also allow for recovery of a portion of the land subsidence. However, the extent of recovery will be limited due to non-recoverable compaction of the aquifer that has already occurred.[29] Most of the compaction occurs in the impermeable clay layers, which are inelastic and cannot be recovered.[30] By contrast, the porous sandy/gravelly regions of the aquifer can expand with groundwater recharge.[31] Thus, while some of the compaction will not be recoverable, groundwater recharge can abate further subsidence and allow recovery of a portion of the aquifer's original volume.[32] Due to the confined and hydrologically continuous nature of the Potomac Aquifer, the beneficial effects of pressure build-up should radiate well beyond the 6 or 7 injection site areas, abating land subsidence throughout the aquifer.[33]

C. Barrier to Saltwater Intrusion

Groundwater injection increases pressure within the aquifer system, effectively serving as a barrier to saltwater intrusion. While land subsidence can be targeted with the aggregate effect of groundwater recharge at various injection sites, saltwater intrusion is more effectively targeted with localized wells on the boundaries of saltwater regions.[34]

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[26] *See generally id.* at 9-11, 19.
[27] HRSD, *supra* note 4. It should be noted that 2030 is a target for full operation in all 6-7 facilities. Several injection wells could begin operation several years prior to that date, but the effects on groundwater pressure will not generate substantial change in regional groundwater models for several years.
[28] COMMONWEALTH OF VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY, *supra* note 17.
[29] USGS, *Virginia Coastal Plain*, *supra* note 6, at 11.
[30] USGS, *Land Subsidence, supra* note 10.
[31] *Id.*
[32] *Id.*
[33] USGS, *Virginia Coastal Plain*, *supra* note 6, at 31, 35.
[34] BARLOW, *supra* note 25.

Saltwater intrusion in the Potomac Aquifer has resulted from a decrease in pressure within the aquifer, particularly near the border of the aquifer and the sea.[35] Generally, pressure within coastal aquifers causes freshwater to push outward against the saltwater area.[36] When this pressure is reduced, saltwater is drawn into the freshwater zone of the aquifer, contaminating the freshwater supply.[37] Groundwater recharge reverses this trend, and causes the freshwater to apply seaward pressure.[38] Injection well sites along the coast can effectively abate intrusion by providing increased pressure locally at the site of the saltwater barrier.[39]

This practice has been effectively implemented along the East Coast, including Chesapeake, Virginia,[40] to prevent saltwater intrusion, and thus seems to be a promising solution for maintaining the purity of the Potomac Aquifer.[41] Generally, this is achieved through the use of aquifer storage and recovery (ASR) wells, which allow pumping and withdrawal at the same site. This allows water to be stored in times of excess and withdrawn in times of need.[42]

D. Unused Wasteload Allocations and Generated Nutrient Credits

Amongst the many benefits presented by HRSD's SWIFT project is the promise of achieving sizeable reductions in the discharge of nutrients to the Chesapeake Bay. Currently, HRSD discharges nutrients into surface waters pursuant to discharge permits issued by DEQ. These permits include wasteload allocations (WLAs) that limit how much nutrients HRSD can legally discharge. The HRSD projects that the SWIFT project will eliminate over 90% of HRSD's discharge into the James, York, and Elizabeth rivers - all tributaries of the Chesapeake Bay - by taking the wastewater that would otherwise be discharged and treating it to a level suitable for injection into the Potomac Aquifer.[43] Consequently, HRSD's discharges to surface waters would be limited to periods of extraordinarily high flows, such as those that occur during significant periods of precipitation.[44] While this vast reduction in nitrogen and phosphorous discharges into the James, York, and Elizabeth rivers can positively impact the local water quality, the Chesapeake Bay, and the surrounding region, there are still questions that arise with this reduction. Namely, what should be done with the nutrient credits generated by this reduced discharge, and the unused portion of HRSD's WLAs? However, this question presupposes an answer to the question of who controls or possesses the decision-making power regarding the generated credits, which is at the heart of the discussion.

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[35] USGS, *Saltwater Intrusion* (2013), http://water.usgs.gov/ogw/gwrp/saltwater/salt.html.
[36] *Id.*
[37] *Id.*
[38] BARLOW, *supra* note 25, at 12.
[39] *Id.* at 36.
[40] *Id.*
[41] *Id.*
[42] *Id.*
[43] HAMPTON ROADS SANITATION DISTRICT, Helping the Chesapeake Bay, http://swiftva.com (last visited Nov. 5, 2016); *HRSD Launches Sustainable Water Initiative for Tomorrow (SWIFT): Pilot Phase produces purified water*, HAMPTON ROADS SANITATION DISTRICT (Sept. 15, 2016), http://swiftva.com/swift-press-release.
[44] Ted Henifen, *Summary: Sustainable Water Recycling Initiative*, HAMPTON ROADS SANITATION DISTRICT 1, 3 (2016), http://www.hrsd.com/pdf/SWR/SWR_BrochureForWeb.pdf.

The Chesapeake Bay Watershed Nutrient Credit Exchange[45] was established in Virginia in 2005 as a water quality trading program for nutrient allocations. While this is not a new institution in the state, the implementation and management of the program still raises questions concerning the program's provision of long-term certainty. The Virginia General Assembly enacted the Chesapeake Bay Watershed Nutrient Credit Exchange Program to aid in meeting the state's obligations under the Chesapeake Bay Agreement[46] and to accommodate growth and development in the watershed.[47] The legislation establishing the program included the issuance of a watershed-based nutrient general permit that incorporates trading and the creation of the Virginia Nutrient Credit Exchange Association to coordinate said trading.[48] Recognizing the existence of lingering questions, Virginia Governor Terry McAuliffe issued Executive Order 52 in January 2016, which called for the formation of a Work Group to investigate the development of "methods to facilitate the acquisition of nutrient allocations and/or credits through the Virginia Nutrient Credit Exchange Program to offset discharges of nutrients by point-source dischargers in the Chesapeake Bay watershed on a long-term (20+ year) basis."[49]

Some of the matters the Work Group must consider include "the protection of established nutrient allocations . . . establishment of a merit-based qualification process for nutrient credit acquisition . . . and [promoting] credit generation," among others.[50] To adequately address the charge of Executive Order 52 and provide recommendations regarding the continuance and longevity of the Nutrient Credit Exchange program, the Work Group also was faced with the question of what should be done with "freed up" allocations and generated credits, such as those in the case of the SWIFT project. To that end, the Secretaries' recommendations in the final report addressed the issue of "freed up" or unused allocations by suggesting a structured review process that would periodically reassess and, if necessary, adjust allocations so that allocations may be used more efficiently by new or expanding sources or be held by the state for future growth.[51] An analysis of the legal framework giving rise to and supporting the effectuation of states' water quality trading programs is required to answer such questions and weigh any policy implications.

[45] *See* VA. CODE ANN. § 62.1-44.19:12 to :19 (1992).
[46] The Chesapeake Bay Watershed Agreement was signed in June 2014 by the Bay's headwater states as a commitment to their partnership and collaboration in the Chesapeake Bay Program, which focuses on the restoration and protection of the Chesapeake Bay. Virginia is among those signatories and is thus committed to the goals of the Bay Agreement, including the reduction of pollutants for improved water quality. *Chesapeake Bay Watershed Agreement*, CHESAPEAKE BAY PROGRAM, http://www.chesapeakebay.net/chesapeakebaywatershedagreement/page (last visited Nov. 29, 2016).
[47] *See* VA. CODE ANN. § 62.1-44.19:12 to :19 (1992).
[48] *Water Quality Trading Toolkit for Permit Writers*, EPA 1, 7 (2009), https://www3.epa.gov/npdes/pubs/wqtradingtoolkit_fundamentals.pdf [hereinafter *Water Quality Trading Toolkit*].
[49] VA. Exec. Order No. 52 (Jan. 28, 2016), https://governor.virginia.gov/media/5278/eo-52-development-of-long-term-offsetting-methods-within-the-virginia-nutrient-credit-exchange-program.pdf. The Executive Order required the Work Group to make its recommendations to the Secretaries of Commerce and Trade, Natural Resources and Agriculture and Forestry by November 1, 2016, and for the Secretaries to make their recommendations to the Governor by December 1, 2016. The report to the Governor is available at: http://naturalresources.virginia.gov/media/8113/report-final-12-01-2016.pdf.
[50] VA. Exec. Order No. 52, *supra* note 49, at 2.
[51] *Development of Long-Term, Offsetting Methods Within the Virginia Nutrient Credit Exchange Program* (2016), available at http://naturalresources.virginia.gov/media/8113/report-final-12-01-2016.pdf.

i. Legal Framework for Trading Under the CWA

The Clean Water Act (CWA or "the Act")[52] and its regulations provide the legal framework for water quality trading programs, despite the absence of an express authorization or a federal program concerning trading. The United States Environmental Protection Agency (EPA) simply oversees the trading systems, leaving it to the states to create, administer, and manage their own unique trading schemes.[53] EPA did, however, issue a Water Quality Trading Policy in 2003 and subsequent guidance documents that provide direction to states in creating and managing their water quality trading programs in line with the requirements of the CWA.[54] The goal of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters," and to eventually eliminate the discharge of pollutants into navigable waters.[55] To achieve this goal, the Act instituted two types of standards, including technology-based controls, the chief concentration of the National Pollutant Discharge Elimination System (NPDES) permit program, and water quality-based standards, which are the basis of the Total Maximum Daily Load (TMDL) program and serve as an important reference for the more stringent standards under the NPDES program.[56]

Water quality standards (WQS), or the water quality goals for all the water bodies or segments of water within the state, are defined by the state and approved by the EPA.[57] Each state is required to review the imposed WQS every three years and for each water body that does not or is not expected to meet the WQS, a TMDL must be established.[58] A TMDL is a "calculation of the maximum amount of a single pollutant that a waterbody can receive and still meet water quality standards."[59] The maximum amount of pollution receivable at levels necessary to achieve and maintain WQS, or the 'loading capacity,' is then allocated amongst dischargers.[60] These allocations are distributed by means of waste load allocations (WLAs) for point source dischargers and load allocations (LAs) for nonpoint and natural background dischargers that are assigned via regulation.[61]

Since stringent water-quality based effluent limitations (WQBELs) are imposed in NPDES permits, a TMDL, or a similar pollutant cap, establishes the motivation and foundation for a trading

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[52] 33 U.S.C. §1251 et seq. (1972).

[53] Environmental Law Practice Guide § 18B.02 (11) (Michael B. Gerrard ed., Matthew Bender).

[54] *Water Quality Trading Policy*, EPA (Jan. 13, 2003), https://archive.epa.gov/ncer/events/calendar/archive/web/pdf/finalpolicy2003.pdf. EPA provides more information and guidance regarding water quality trading on its website. *Water Quality Trading Basics and Policy*, EPA (July 21, 2016), https://www.epa.gov/npdes/water-quality-trading-basics-and-policy.

[55] Clean Water Act § 101(a), 33 U.S.C. § 1251(a).

[56] Clean Water Act § 304(b)(1)(B), 33 U.S.C. § 1314(b)(1)(B); Clean Water Act § 402, 33 U.S.C. § 1342; Clean Water Act § 303, 33 U.S.C. § 1313; Environmental Law Practice Guide § 18.11(1) (Michael B. Gerrard ed., Matthew Bender). The WQS approach has become a critical aspect of the CWA in order to further ratchet down on the limitations imposed by technology-based controls alone. *Id*.

[57] Clean Water Act § 303(c)(1), 33 U.S.C. § 3113(c)(1); *NPDES Permit Writers' Manual*, EPA 6-2 (Sept. 2010), https://www.epa.gov/sites/production/files/2015-09/documents/pwm_2010.pdf.

[58] Clean Water Act § 303(c)(1), 33 U.S.C. § 3113(c)(1); Environmental Law Practice Guide § 18.11(3)(a) (Michael B. Gerrard ed., Matthew Bender).

[59] *NPDES Permit Writers' Manual*, *supra* note 57, at 6-14; *see* 40 C.F.R. 130.2(i).

[60] 40 C.F.R. 130.2(i); *NPDES Permit Writers' Manual*, *supra* note 57, at 6-14.

[61] Environmental Law Practice Guide § 18.11 (3) (Michael B. Gerrard ed., Matthew Bender). *See, e.g.*, 9 VA. ADMIN. CODE § 25-720.

scheme.[62] The EPA notes that the TMDL program, which focuses on the overall pollutant loadings of a water body and seeks to allocate responsibility for pollution control, lends itself naturally to a trading scheme where responsibility may be shifted among dischargers via an exchange market.[63] The baseline water quality requirement for a particular point source is specified by a waste load allocation (WLA) in the TMDL and incorporated in the point source's NPDES permit, expressed as a WQBEL that is reflective of the WLA.[64] The pollutant reduction that is required of the point source is the difference between its current pollutant load and the load required to meet the WQBEL.[65] Among other means, point sources may achieve this reduction by purchasing the reduction needed from a point or nonpoint source that is selling generated credits.[66] Dischargers generate credits by achieving pollutant reductions greater than those reductions required by the WQBEL in their NPDES permit, which is calculated using "the difference between the discharger's WQBEL in its permit implementing the WLA and the pollutant load actually discharged after installing treatment processes or other pollutant reduction measures."[67] The result of credit generation and trading is, thus, that the post-trading loadings from each source (generator and purchaser) would be equal to or less than the loadings that would have been discharged by both sources if the trade had not occurred.[68]

ii. Control and Distribution of Generated Credits

As discussed above, the WLA for a particular discharging entity is assigned via regulatory action in Virginia. There is no dispute that, performed within the confines of reasonable discretion, it is an authority left to a state to distribute WLAs under a TMDL as it sees fit.[69] However, once an entity is apportioned a WLA, which is assigned on an effectively permanent basis until the discharger ceases operations, the line of control becomes obscured, especially when it comes to the generation of credits or a drastic reduction in pollutant discharges. This obscurity is created by the juxtaposition between the assignment of WLAs by the state versus the strictly voluntary process of credit generation and trading, which is not required of permittees. As such, there are distinctly different views that arise regarding who, at the point of generation and trading, controls those freed up allocations that were generated on a voluntary basis.

The argument that is advanced for "state control" of available WLAs or credits is based upon two supporting pillars. First, the VPDES General Permit expressly notes that it does not include conveyance of a property right interest "in either real or personal property or any exclusive privileges."[70] Thus, while the permit provides permitted entities with the ability to discharge legally in compliance within the limitations of the permit and the ability to obtain or trade credits, this is all a fiat of regulation.[71] As an offshoot of an authorization given by the state, unused WLAs

[62] *Water Quality Trading Toolkit*, *supra* note 48, at 20.
[63] *NPDES Permit Writers' Manual*, *supra* note 57, at 6-14.
[64] *Water Quality Trading Toolkit*, *supra* note 48, at 20.
[65] *Id*.
[66] *Id*.
[67] *Id*.
[68] *Id*. at 4.
[69] Environmental Law Practice Guide § 18.11 (3) (Michael B. Gerrard ed., Matthew Bender).
[70] VPDES Permit Manual, VA DEPT. OF ENVT'L QUALITY 1, 23 (2014), http://www.deq.virginia.gov/Portals/0/DEQ/Water/PollutionDischargeElimination/VPDESPermitManual.pdf.
[71] VA. CODE ANN. § 62.1-44.19:12 to :23 (1992).

or generated credits are, thus, not within the control of the permitted entity. Instead, under this line of reasoning, the generating entity is merely receiving remuneration, via state-guided exchanges, for its pollutant reduction investments that are part of participation in the larger regulatory scheme.

On the other hand, the argument advanced on the "entity-controlled" side of the spectrum focuses on the voluntariness of reductions that result in tradable allocations or credits. As a voluntary undertaking by the entity, this act could be interpreted as occurring outside of the permitting realm and the control of the credits should therefore belong to the generating entity. This point is bolstered by the fact that the generation of credits is a voluntary action done by taking steps to reduce discharges below the permit specifications.[72] Further, projects, such as SWIFT, that are initiated by entities on their own accord often require the dedication of a sizeable amount of resources up front. Consequently, entities argue that they should retain control of this self-generated reduction to maintain some guarantee on their investment and any potential resulting benefit.[73] In other words, the benefit generated by an entity should not automatically pass to the control of the state purely because of the regulatory scheme governing the entities' permitted discharges.

These two opinions, each at the opposite side of the spectrum, offer differing policy implications for permitting entities and the facilitation and encouragement of large-scale, community-benefiting projects in the future. First, the "state-controlled" argument requires entities to place their faith in the state to not direct the use of their reductions in a manner unfavorable to them or to adjust their permits to new, more stringent discharge levels, creating a new obligation and removing the benefit of trading. To that end, this "state-control" argument seems to lend itself more to the arguments in opposition of trading that advocate for states to step in and ratchet down on permit limitations based on entities' achieved reductions.[74] These arguments seem to align on the basis of their emphasis on more state involvement and control and overall reductions in pollutant discharges.

At any rate, the lack of confidence in the benefit to be gained by investing in reduction projects, especially sizeable projects, may serve as a discouragement as permitted entities may be seeking more assurance than merely policy or good business practice incentives when making such a large investment on a voluntary basis. Arguably, there is stability and reliability in the case of Virginia's system. However, there is an argument to be made that it is important to provide more certainty in the benefits to be reaped from voluntary reductions in order to encourage the continued

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[72] *Credit Exchange Policy for the Purchase and Sale of Chesapeake Bay Nutrient Credits*, VA DEP'T OF ENVT'L QUALITY § 3.1(b) (June 2012), http://www.deq.virginia.gov/Portals/0/DEQ/Water/PollutionDischargeElimination/ExchangeCompliancePlan-2015AnnualUpdate.pdf; albeit, there are some regulatory influences that would still apply to this 'outside' activity such as the imposition of any applicable trade ratios between trading entities pursuant to 9 VA. ADMIN. CODE 25-820-70.

[73] Conversations with regulated community, Oct. 2016. While permitted entities' WLAs are largely a permanent, consistent allocation, the nitrogen and phosphorous credits they may generate under that WLA are only good for the year in which they are generated, in terms of applicable use for compliance by the purchaser. Thus, the turnover on the usefulness of credits makes this a yearly source of funding that is relied on by generating entities. VA. CODE ANN. § 62.1-44.19:18(A)(1).

[74] Food & Water Watch, *Water Quality Trading: Polluting Public Waterways for Private Gain*, 1, 12 (2015), http://www.foodandwaterwatch.org/insight/water-quality-trading-polluting-public-waterways-private-gain.

undertaking of projects that create large-scale community benefits and economic opportunity by allowing permittees to control credits generated by their investments in projects such as SWIFT. The certainty provided by the entity-controlled stance provides that encouragement to support such projects in the future.

III. INJECTION INTO AN AQUIFER – CHEMISTRY CONCERNS

A. Treatment Steps and Potential Impacts on the Water Supply

HRSD's current plan is to have a fully operational groundwater injection system by 2030, with the capacity to replenish the Potomac Aquifer at a rate of 120 million gallons per day.[75] The system will involve six or seven wastewater treatment plants, accompanied by dispersed injection wells at each treatment site.[76]

The HRSD groundwater injection project involves treating wastewater to drinking water quality standards, and injecting it into the aquifer for recharge.[77] This requires a balance between making the water sufficiently clean to remove microorganisms, microplastics (from personal care products), and pharmaceuticals, without making the water incompatible with the chemistry of the native water within the aquifer.[78] Injecting treated wastewater that is of a different alkalinity or pH may result in mineral precipitation.[79] Mineral precipitation can clog the injection well, preventing the efficient recharge of the aquifer.[80] Further, the presence of minerals leached into the groundwater results in poorer water quality for well withdrawers.[81] To protect the injection equipment and well withdrawers, the HRSD will likely need to take steps to monitor the quality of the water in the aquifer as injection takes place.[82] The HRSD has guidance on matching the chemistry of the Potomac Aquifer from the Chesapeake Aquifer Storage and Recovery facility, which has successfully used groundwater injection for the purpose of abating saltwater intrusion.[83]

The HRSD is evaluating three potential wastewater treatment trains to determine an option that treats wastewater to a level above drinking water standards, while maintaining compatibility with native groundwater.[84] The first treatment train consists of reverse osmosis followed by an ultraviolet advanced oxidation process.[85] The second train begins with nanofiltration, and is also

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[75] Bogues, *HRSD pitches plan to replenish groundwater aquifer*, *supra* note 20, at 2.
[76] *Id*.
[77] Henifin, *supra* note 44, at 1 (2016).
[78] TED HENIFIN, JAY BERNAS, DANIEL HOLLOWAY, & ED SNYDER, *Sustainable Water Recycling: Aquifer Replenishment System (ARS)*, 2, 10 (2015).
[79] City of Malibu, *Conceptual Groundwater Injection Plan*, 30-33 (2012), http://www.waterboards.ca.gov/rwqcb4/water_issues/programs/basin_plan/Malibu/july2012/Malibu%20Conceptual%20Injection%20Plan%20-%20Final062912.pdf.
[80] *Id.*
[81] *See* B. Willis Jones & I. Brandes de Roos, *Clogging Associated with Well Injection*, 159, http://recharge.iah.org/recharge/documents/clogging-MAR-injection.pdf.
[82] CITY OF MALIBU, Conceptual Groundwater Injection Plan, 33 (2012), http://www.waterboards.ca.gov/rwqcb4/water_issues/programs/basin_plan/Malibu/july2012/Malibu%20Conceptual%20Injection%20Plan%20-%20Final062912.pdf.
[83] Henifin, *supra* note 44, at 2; BARLOW, *supra* note 25, at 36.
[84] *Id.* at 11.
[85] *Id.*

followed by an ultraviolet advanced oxidation process.[86] The third train consists of a biological activated carbon treatment followed by a granular activated carbon treatment.[87]

All of the treatment trains use state-of-the-art wastewater treatment technologies capable of filtering out harmful pharmaceuticals and microplastics.[88] Preliminary testing on wastewater treatment with the three different trains has revealed that the biological activated carbon/granular activated carbon treatment train, as well as the nanofiltration based train, produced clean water that is compatible with the chemistry of the native groundwater.[89] However, the reverse osmosis based treatment produced clean water that did not match the pH and alkalinity of the native groundwater.[90] As a result, salts had to be added to make the treated water compatible.[91] Thus, it appears from a preliminary standpoint that the carbon-based and nanofiltration-based trains may be more efficient methods of wastewater treatment for this project.

B. Regulation

i. EPA Underground Injection Control (UIC) Permit

In order to inject into a groundwater source used for human consumption, HRSD must demonstrate that the injection will not jeopardize human health. The Safe Drinking Water Act (SDWA), passed in 1974, established the Underground Injection Control (UIC) permitting program as one of the primary means to ensure groundwater safety.[92] Functionally similar to the Clean Water Act's National Pollutant Discharge Elimination System permit program, the UIC program prohibits underground injection unless the injector receives a permit to do so, and requires that all injections into a groundwater source used for human consumption meet minimum Federal safety requirements.[93] The UIC program is relatively broad, regulating groundwater injections from aquifer recharge to mining fluids. It thus defines six classes of wells, based on the characteristics of the injection well and the fluid being injected, and each class has distinct minimum requirements that regulate monitoring, well operational parameters, and minimum safety requirements.[94] Class V, which is somewhat of a catch-all category, includes the injection of potable water for artificial storage and recovery or aquifer recharge.[95]

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[86] *Id.*
[87] *Id.*
[88] Carson Lee, Keery Howe, & Bruce Thompson, *State of Knowledge of Pharmaceutical, Personal Care Product, and Endocrine Disrupting Compound Removal during Municipal Wastewater Treatment*, 1-2 (2009), http://www.unm.edu/~howe/UNM%20Howe%20PPCP%20Final%20Report.pdf.
[89] HENIFIN, BERNAS, HOLLOWAY, & SNYDER, *supra* note 78, at 11.
[90] *Id.*
[91] *Id.*
[92] 42 U.S.C. § 300h (2006); ENVIRONMENTAL PROTECTION AGENCY, Underground Injection Control, Aquifer Recharge and Aquifer Storage and Recovery, https://www.epa.gov/uic/aquifer-recharge-and-aquifer-storage-and-recovery.
[93] ENVIRONMENTAL PROTECTION AGENCY, Underground Injection Control, Aquifer Exemptions, https://www.epa.gov/uic/aquifer-exemptions-underground-injection-control-program.
[94] ENVIRONMENTAL PROTECTION AGENCY, Underground Injection Control, General Information About Injection Wells, https://www.epa.gov/uic/general-information-about-injection-wells.
[95] *Id.*

In states like Virginia, which does not administer its own UIC permitting program, the SDWA authorizes the EPA to administer the federal UIC permitting program; however, the SDWA also allows for states to apply for primacy over the UIC permitting program, allowing them to regulate injection directly.[96] State-specific injection standards vary and can be as stringent as the state chooses, but state regulations must be at least as strict as the federal standards, and cannot violate any other federal laws.[97] In addition to applying at least the federal minimum requirements for what can be injected underground, a primacy state must also ensure that it has an adequate inspection, monitoring, record-keeping, and reporting program in place.[98] In fact, if a state with primacy is found not to be in compliance with federal requirements, the EPA is authorized to issue fines or even withdraw primacy from the state entirely.[99] To obtain primacy, an applicant state must obtain approval from the state Governor and regional EPA director, and must demonstrate not only a complete plan for carrying out its UIC program, but also that state laws are in place that provide an adequate means of enforcing the program.[100] Federal contributions to state UIC programs, which were initially authorized to cover 75% of program costs, have not kept up in recent decades and so many of the financial incentives for states to obtain primacy no longer exist.[101] Despite this and the relatively arduous requirements for obtaining primacy, the majority of states do administer their own UIC permitting programs, and several more have shared-primacy, which gives them primacy over Class II wells only. Virginia remains one of the few states that has not yet sought primacy, so HRSD will have to seek its permit from the EPA directly.

ii. Water Quality – EPA Standards for Injection

In order to obtain its UIC permit, HRSD's cleaning process must meet the EPA's drinking water standards for over 90 potential contaminants.[102] For a regulated contaminant the EPA will specify a maximum contaminant level goal (MCLG), which is the maximum level of the contaminant at which there is no known or anticipated risk for adverse health effects.[103] Although not an enforceable standard, the MCLG is a goal for regulators, and from it the EPA then sets a maximum contaminant level (MCL) which is the enforceable, maximum-level of the contaminant allowed in a public water system.[104] Ideally, the EPA will set the MCL as close to the MCLG as

[96] *Id.*
[97] *Id.*
[98] 42 USC 300h(b)(1); *see also* Bruce M. Kramer, Federal Legislative and Administrative Regulation of Hydraulic Fracturing Operations, 44 TEX. TECH L. REV. 837, 840 (2012).
[99] 45 Tex. Prac., Environmental Law § 9:3 (2d ed.). Even though the EPA has the ability to withdraw the approval of a state's primacy program, there are several incentives in place that discourage the EPA from choosing this route. For a full discussion *see* Markus G. Puder & Michel J. Paque, Tremors in the Cooperative Environmental Federalism Arena: What Happens when a State Wants to Assume Only Portions of a Primacy Program or Return A Primacy Program? – The Underground Injection Control Program Under the Safe Drinking Water Act as a Case Study, 24 TEMP. J. SCI. TECH. & ENVTL. L. 71 (2005).
[100] 45 Tex. Prac., Environmental Law § 9:3 (2d ed.).
[101] Puder & Paque, *supra* note 99, at 76-77.
[102] ENVIRONMENTAL PROTECTION AGENCY, How EPA Regulates Drinking Water Contaminants, https://www.epa.gov/dwregdev/how-epa-regulates-drinking-water-contaminants#decide. Once adopted, contaminant regulations are published in the Federal Register. *See* 40 C.F.R. § 141.
[103] ENVIRONMENTAL PROTECTION AGENCY, How EPA Regulates Drinking Water Contaminants, https://www.epa.gov/dwregdev/how-epa-regulates-drinking-water-contaminants#decide.
[104] *Id.*

possible, but will deviate if excessive costs or technology makes meeting the MCLG infeasible.[105] Additionally, the SDWA requires that the EPA identify and list unregulated contaminants, which could eventually be included in future iterations of regulated contaminants.[106] Finally, the EPA provides some guidance for regulators and injection projects, including potential health risks not specifically regulated, such as the necessity of matching injection fluid and aquifer chemistry to prevent the leaching of potentially harmful materials.[107]

IV. FISCAL COST OF THE PROJECT

A. Initial Cost

The total cost to construct the new facilities, which would include both the pilot project and the necessary upgrades to 6-7 of the HRSD's facilities, is projected to be around $1 billion, with an additional $21-43 million in annual operational costs.[108] The HRSD's current fiscal plan requires that the project begin soon. In 2010 HRSD entered into a Consent Decree with the EPA that, among other things, requires the HRSD to develop a Regional Wet Weather Management Plan (RWWMP) aimed at minimizing the occurrence of sanitary sewer overflows (SSOs).[109] Included in the requirements are substantial upgrades to sewer systems, and HRSD has estimated that total compliance with the decree will cost nearly $2 billion over the next several decades – the implementation of which would begin in 2017.[110] The HRSD planned to formally request that the EPA allow them to postpone the required upgrades under the RWWMP until after the injection project upgrades have been completed.[111] HRSD has argued that the benefits of the injection project to long-term aquifer stability, abatement of land subsidence, and the health of the Chesapeake Bay in reducing discharges of nutrients would provide the Commonwealth with a more cost-efficient and meaningful benefit to water quality and the health of the Bay than storm water upgrades could provide.[112] It is possible that the EPA could require certain critical SSO upgrades while still permitting non-critical RWWMP upgrades to be delayed until after the injection project upgrades have been completed.

Creating an additional incentive to begin the project soon, the Commonwealth must issue Phase III of its Chesapeake Bay TMDL Watershed Implementation Plan in 2017, which will

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[105] *Id.*
[106] These lists are published in the Contaminant Candidate List (CCL) and are published periodically. The most recent list was published on November 17, 2016 and can be found on EPA's website at https://www.epa.gov/ccl/chemical-contaminants-ccl-4.
[107] This can include radionuclides, arsenic, or other harmful ions easily leached from the surrounding aquifer. For instance, an EPA study of ASR operations in the US noted manganese and iron concentrations exceeding drinking water regulations, as well as the presence of disinfection by-products. https://www.epa.gov/uic/aquifer-recharge-and-aquifer-storage-and-recovery.
[108] Henifin, *supra* note 44, at 1.
[109] *See generally* Third Amended Consent Decree, United States v. Hampton Roads Sanitation District, Civil Action No. 2:09-cv-481 (2014).
[110] Ted Henifin, Jay Bernas, & Daniel Holloway, Sustainable Water Recycling, EVGWAC – Workgroup 1, 46 (Sep. 17, 2015).
[111] Dave Mayfield, *Waste not the wastewater: Hampton Roads sanitation agency fast-tracks plan to turn wastewater into drinking water*, THE VIRGINIAN-PILOT, Jul. 21, 2016. The request had to be made prior to October 2017, when the RWWMP was due.
[112] *Id.*

require additional reductions to comply with the Bay TMDL.[113] This too has a substantial financial impact on the HRSD, estimated at nearly $1 billion,[114] but the facility upgrades associated with the SWIFT project would reduce HRSD's nutrient discharges well below the likely TMDL requirements.

B. Maintenance Cost

i. Permitted Users Fee

In addition to the initial cost of building the facility, HRSD anticipates $21-43 million in annual operational cost, which could be recovered by a modest charge for permitted groundwater withdrawal.[115] In terms of equity, HRSD's service area is smaller than the extent of the Potomac Aquifer, and many users who are not HRSD customers will benefit from the SWIFT project. Rather than passing this cost on to HRSD customers exclusively, the annual operational cost could be at least partially offset by an aquifer recharge fee, administered by the DEQ, on permitted water users.[116] This type of fee would be unique in the Commonwealth as Virginia does not currently incorporate any volume-based charge for groundwater use; however, it has been suggested that incorporating a groundwater withdrawal fee, or perhaps an aquifer recharge fee, is one method by which the Commonwealth could encourage more efficient water use.[117] Under Virginia's current regulatory system only the largest groundwater users are required to obtain a permit, but this only accounts for around two-thirds of the groundwater withdrawal from the Potomac Aquifer – many users are not within the system, and older wells have not even been registered with the State.[118] Moreover once a permitted user has paid the required permit fee, there is no additional fee for the volume of water they use. Extending an aquifer recharge fee beyond the less than two hundred current permitted users would ease the burden further, but the process of registering and imposing an aquifer recharge fee on so much larger a pool of individuals poses its own legal and administrative challenges.

ii. Funding from Trading

In addition to the cost recovery provided by charging for permitted groundwater withdrawal there is the potential, and likely an expectation on the part of HRSD, to recover a portion of the project's cost via remuneration received for the nutrient credits generated for sale to other entities. Under Virginia's Chesapeake Bay Watershed Nutrient Credit Exchange Program, existing point sources exceeding their WLAs or new and expanding point sources that do not have adequate WLAs may purchase credits generated by non-point or, in this case, point sources.[119] These generated credits are defined as the difference between the generator's WLA and its total annual discharge.[120] Purchased credits currently expire on a yearly or five-year basis in the case of

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[113] *Id.*
[114] *Id.*
[115] Henifin, *supra* note 44.
[116] *Id.*
[117] JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION, *supra* note 14, at 44-45.
[118] *Id.* at 47-48 (discussing the potential challenges that grandfathered, unpermitted users could pose for Virginia).
[119] Kurt Stephenson, et al., *An Evaluation of Virginia's Nutrient Credit Trading Program* 1, 5 (2006).
[120] *Id.*

new or expanding point sources and, thus, may create a steady source of income for credit generating entities.[121]

V. OTHER JURISDICTIONS

When evaluating the HRSD groundwater injection proposal, it is instructive to look at other established projects across the United States to understand what types of wastewater treatment mechanisms and regulatory frameworks are effective. While there are many groundwater injection projects across the country, particularly in California,[122] this paper will focus on three of the major, well-established projects for comparison: the Orange County Water District Groundwater Replenishment System, the Hueco Bolson Recharge Project, and the City of Scottsdale Water Campus. Additionally, this section will mention the Upper Occoquan Service Authority Regional Water Reclamation Plant located in Fairfax, Virginia, which is an example of a successful advanced water treatment system in close proximity to the HRSD SWIFT project.

A. Orange County Water District Groundwater Replenishment System (Orange County, CA)

The motivation behind the Orange County Water District (OCWD) decision to explore groundwater injection resulted from increasing saltwater intrusion into the Orange County groundwater basin.[123] The system currently injects water into the groundwater aquifer at a rate of 100 million gallons per day.[124]

The OCWD Groundwater Replenishment System employs a combination of membrane filtration, reverse osmosis, and oxidation to clean water to drinking water standards and remove additional contaminants, such as pharmaceuticals, from the water.[125]

Orange County regulates water withdrawals through a well-permitting system and a replenishment assessment.[126] The Orange County Well Ordinance requires a permit to be obtained before construction of a new well and before deconstruction of existing wells.[127] Additionally, well permits must be renewed annually.[128] While Orange County provides no restrictions on water withdrawals, it does charge replenishment assessment fees to well-users, based on the volume of water withdrawn.[129] This fee system provides incentives against over-pumping.[130] Further, in times

[121] *Id.*; VA. CODE ANN. §§ 62.1-44.19:15(B)(2) & :18(A)(1) (1992).
[122] San Diego, *Potable Reuse Projects in the United States*, 3-4 (2011), https://www.sandiego.gov/sites/default/files/legacy/water/pdf/purewater/2011/2011potablereusepro.pdf.
[123] *80 Years of Successful Groundwater Management in Orange County*, GROUNDWATER ACT BLOG (Feb. 23, 2015), http://www.water.ca.gov/cagroundwater/blog-ocwd.cfm.
[124] *Rely on Us for High-Quality Groundwater*, OCWD, 1-2 (2016), http://www.ocwd.com/media/3849/ocwd_fact-sheet_v34-final.pdf.
[125] San Diego, *supra* note 122, at 3.
[126] OC HEALTHCARE AGENCY, http://www.ochealthinfo.com/eh/water/well; *80 Years of Successful Groundwater Management in Orange County*, *supra* note 123.
[127] OC HEALTHCARE AGENCY, *supra* note 127.
[128] *Id.*
[129] *80 Years of Successful Groundwater Management in Orange County*, *supra* note 123.
[130] *Id.*

of drought or water shortage, the fees can be raised to encourage reduced withdrawals.[131] Revenue generated from the replenishment assessment fees has been used to pay for the construction of the recharge facilities of the Groundwater Replenishment System, and to purchase imported water in times of need.[132] The groundwater injection project, initiated in 1976, has succeeded in keeping saltwater intrusion at bay, and also has aided in the replenishment of the local water supply through aquifer recharge.[133]

B. Hueco Bolson Recharge Project (El Paso, TX)

The Heuco Bolson Recharge Project was necessitated by severe groundwater depletion in the Hueco Bolson Aquifer.[134] The project began in 1986, and now recharges groundwater at a rate of up to 7.5 million gallons per day.[135] The water is treated at the Fred Hervey Plant, which has a 10 million gallon per day capacity.[136] Two parallel streams of wastewater undergo an extensive, 20-step process to treat the water to drinking water standards, including lime treatment, two-stage recarbination, ozonation, granular activated carbon filtration, and chlorination.[137]

The El Paso Water Utilities (EPWU), which pumps water from the Hueco Bolson Aquifer, has created a Conservation Program to stop the rapid depletion of the water supply.[138] This program includes a fee structure that penalizes high water consumption with high rates, withdrawal restrictions on residential areas, and a rebate system for the replacement of inefficient water fixtures.[139] Certain wells are exempted from pumping requirements by the Texas legislature (for example, wells for domestic use on plots over 10 acres and that pump less than 25,000 gallons per day).[140] This program has led to substantial progress in water conservation, and in combination with efficient use of surface waters, has provided a sustainable water supply for the EPWU.[141]

C. City of Scottsdale Water Campus (Scottsdale, AZ)

The Scottsdale Water Campus was created to achieve the goals set out in Arizona's Groundwater Management Act,[142] which is an initiative to reduce groundwater overdraft throughout the state.[143] The Campus became operational in 1998, and now treats up to 70 million

131 *Id.*
132 *Id.*
133 *80 Years of Successful Groundwater Management in Orange County*, *supra* note 123.
134 Daniel Knorr, *City of El Paso Ground Water Recharge Project*, 87 (1987), http://www.wrri.nmsu.edu/publish/watcon/proc32/Knorr.pdf.
135 *Id.*; San Diego, *supra* note 122, at 4.
136 KNORR, CITY OF EL PASO GROUND WATER RECHARGE PROJECT, *supra* note 134, at 88 (1987), http://www.wrri.nmsu.edu/publish/watcon/proc32/Knorr.pdf.
137 *Id.*
138 EL PASO WATER, Water, http://www.epwu.org/water/water_resources.html.
139 *Id.*
140 *Id.*
141 *Id.*
142 ARIZ. REV. STAT. ANN. §§ 45-453 (2016); CITY OF SCOTTSDALE, Water Supply, http://www.scottsdaleaz.gov/water/water-supply.
143 *Id.*

gallons of wastewater per day.[144] The facilities treat water to ultrapure, above drinking-water standards through a combination of ozonation, microfiltration, reverse osmosis, and ultraviolet disinfection.[145] The water is injected in a recharge well field consisting of 63 injection wells.[146]

Well pumping is regulated throughout the state of Arizona through the Groundwater Management Code (pursuant to the Groundwater Management Act),[147] which requires a permit to pump groundwater, unless the particular well is exempt.[148] Through this permit system, Arizona has the authority to regulate the withdrawal of water, and restrict certain uses.[149] Wells are considered exempt from the permitting requirements if the pumping capacity is less than thirty-five gallons per minute.[150] Owners of non-exempt wells must report their annual pumpage to the Arizona Department of Water Resources (ADWR).[151] These owners must also pay an annual, volume-based groundwater withdrawal fee.[152] Additionally, notice of intent to drill a new well or make well modifications must be filed with the ADWR.[153] The City of Scottsdale, specifically, requires registration of all wells.[154]

During the summer months, when demand is high, almost all of the treated water is directly consumed or used for golf course irrigation.[155] When this demand is reduced in winter, a portion of the treated water is reinjected into the groundwater aquifer.[156] This groundwater injection, combined with greater exploitation of surface water resources, has enabled Scottsdale to ensure a sustainable water supply for its entire service area.[157]

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[144] *Id.*; Nicole Sherbert, *Scottsdale Water recognized as global leader in recycled water use*, CITY OF SCOTTSDALE (Nov. 2015), http://www.scottsdaleaz.gov/water/news/scottsdale-water-recognized-as-global-leader-in-recycled-water-use_s1_p21798. *But see* San Diego, *supra* note 122, at 4 (lists capacity of Scottsdale plant at 12 million gallons per day).
[145] Sherbert, *supra* note 144.
[146] *Id.*
[147] Arizona Department of Water Resources, *ADWR History* (2014), http://www.azwater.gov/AzDWR/PublicInformationOfficer/history.htm.
[148] *Overview of the Arizona Groundwater Management Code*, ARIZONA DEPARTMENT OF WATER RESOURCES, http://www.azwater.gov/AzDWR/WaterManagement/documents/Groundwater_Code.pdf.
[149] *Id.*; Arizona, *Water Rights Fact Sheet* (2001), http://www.uafwp.org/html/WL1%20Arizona%20Water%20Law%20Fact%20Sheet.pdf.
[150] *Overview of the Arizona Groundwater Management Code*, *supra* note 149.
[151] *Id.*
[152] *Id.*; Arizona Municipal Water Users Association, *Board of Directors: Information Summary – Groundwater Withdrawal Fee*, 1 (2016), http://www.amwua.org/pdfs/202__4_Grdwtr%20Withdrawal%20Fee%20Info%20Summary.pdf.
[153] Arizona Department of Water Resources, *Wells* (2016), http://www.azwater.gov/azdwr/WaterManagement/Wells/.
[154] City of Scottsdale, *Environmental Regulations Guide: Section 2 Clean Water*, http://www.scottsdaleaz.gov/Asset6749.aspx.
[155] El Paso Water, *Water* (2007), http://www.epwu.org/water/water_resources.html.
[156] *Id.*
[157] City of Scottsdale, *Water Supply* (2016), http://www.scottsdaleaz.gov/water/water-supply.

D. Upper Occoquan Service Authority Regional Water Reclamation Plant (Fairfax County, VA)

The Upper Occoquan Service Authority Regional Water Reclamation Plant, located in Fairfax County, Virginia, does not inject treated wastewater into the groundwater supply, but instead treats wastewater to high purity standards before discharging it into local tributaries that feed into the Occoquan Reservoir.[158] Poor water quality in the Occoquan Reservoir, a regional water supply source, led to a mandate by the Virginia Department of Health and the State Water Control Board to create the Upper Occoquan Service Authority in 1971.[159] The plant was constructed in 1978, and after several expansions, now has the capacity to treat 54 million gallons per day.[160] The plant treats water to drinking water standards through a five-step treatment process of screen filtration, microorganism treatment, lime treatment, sand/activated carbon filtration, and bleach disinfection.[161] Overall, this project represents a Virginia-based, advanced wastewater treatment system that has successfully produced drinking quality water for decades and that can serve as a model for the HRSD advanced treatment facilities.

E. Summary of Effective Groundwater Injection Implementation in Other Jurisdictions

Each of the injection projects discussed above—the Orange County Water District Groundwater Replenishment System, the Hueco Bolson Recharge Project, and the City of Scottsdale Water Campus—demonstrate that groundwater injection is a well-established and effective method of safely recharging groundwater supply. Commonalities between the projects suggest that there are key components of a successful groundwater management system: all three projects have implemented a rigorous well-permitting system (albeit subject to exemptions) and regulate water withdrawals through adjustable, consumption-based fees. This adjustable-rate system allows the localities to increase or decrease fees depending on current conditions, such as periods of drought or excessive rainfall. To model these successful projects, Virginia should consider expanding its well-permitting requirements, and instituting adjustable, consumption-based withdrawal fees.

VI. POLICY RECOMMENDATIONS

1. To provide maximum benefit for a groundwater injection project of this scale, the Virginia legislature should seek to reduce groundwater withdrawal permit duration, and, if necessary, provide funds to improve the groundwater monitoring system and increase the number of physical groundwater monitoring wells. A more responsive permitting system based more on actual monitoring and less on modeling would allow the benefits of aquifer recharge to be more readily reflected in users' groundwater allocations. Reducing permit durations would reduce the likelihood that permit allocations would have to be dramatically

[158] San Diego, *supra* note 122, at 3.
[159] PRINCE WILLIAM COUNTY SERVICE AUTHORITY, WASETWATER TREATMENT PLANTS, https://www.pwcsa.org/what-we-do/treatment-plants.
[160] *Id.*
[161] PRINCE WILLIAM COUNTY SERVICE AUTHORITY, WASTEWATER TREATMENT PROCESS, https://www.pwcsa.org/what-we-do/treatment-process.

altered from one permit to the next, increasing predictability for businesses and municipalities, and allowing them to more reliably create long-term water management plans.

2. The Commonwealth should administer an aquifer recharge fee to assist with the HRSD's annual operational cost, and the fee should be based on volume withdrawn. Not only would adding a volume-based fee encourage conservation, but using these fees to cover the annual operational cost of the aquifer recharge would allow the Commonwealth to pilot a reduced-burden version of a charge-by-volume system, with a substantially lower cost per gallon than that associated with most other states that incorporate water usage fees.

3. In regards to the questions surrounding the control and use of the WLAs and nutrient credits made newly available by the SWIFT project, the Commonwealth should take the opportunity presented by this project and the Executive Order 52 Work Group to formally address the question of authority to distribute available WLAs and nutrient credits. The uncertainty surrounding the control of generated credits could, conceivably, serve as a deterrent for entities like HRSD to invest large amounts of capital into research, innovation, and, ultimately, voluntary undertakings to create the reductions necessary to generate credits and create headspace under their particular WLAs and TMDLs. Encouraging participation via credit generation is paramount to the continued success of the trading program as well as the availability of new economic opportunities.

4. HRSD should continue steps to monitor the quality of the water in the aquifer as injection takes place. Monitoring for precipitation of minerals is essential to protect the water quality and injection equipment. If detected early, adjustments in pH and alkalinity can be made before detriment to the aquifer and before the injection well is clogged.

5. The Commonwealth should reexamine the benefits of obtaining primacy for the UIC permitting program. This process requires support from regulators and state legislators, but with so many residents reliant on groundwater within the Commonwealth, primacy is the best means by which to ensure that groundwater injection regulations are tailored to Virginia's long term environmental and health interests.