

Mission H₂O Groundwater Subgroup Water Reuse as a Solution in the Eastern Virginia Groundwater Management Area

Executive Summary

The Virginia Department of Environmental Quality is reviewing groundwater management options for the Eastern Virginia Groundwater Management Area. One of the options under consideration is greater use of water reclamation and reuse as a means of replacing or reducing groundwater withdrawals. Mission H₂O has developed this paper as an initial review of the benefits and opportunities for water reuse in the Eastern Virginia Groundwater Management Area. It specifically examines the idea of a “reuse pipeline” from wastewater treatment facilities owned and operated by the Hampton Roads Sanitation District (“HRSD”) and maps HRSD treatment plants and existing groundwater withdrawals to visualize the proximity of the potential reuse water sources to customers. The paper also proposes regulatory changes that could help promote water reuse.

The potential exists to expand water reclamation and reuse within the Eastern Virginia Groundwater Management Area, and the timing is right to do so. However, the incentives under the current economic and regulatory systems do not support water reclamation and reuse. For this reason, the Commonwealth must take the lead, either through statutory and regulatory changes, development and implementation of the State Water Resources Plan, or development of incentives. The initial step that is needed is a feasibility study to assess where and how the reuse projects with the greatest benefit to the Eastern Virginia Groundwater Management Area could be located and developed.

Mission H₂O is committed to helping the Commonwealth develop such a study, and stands ready to assist in removing the hurdles and moving forward with promotion of water reuse in the Eastern Virginia Groundwater Management Area.

Water Reuse as a Solution in the Eastern Virginia Groundwater Management Area

I. Introduction

The reuse of highly treated wastewater effluent could provide a sustainable water supply source to replace reductions in groundwater withdrawals. Water reuse is particularly suited to the Eastern Virginia Groundwater Management Area, where wastewater is often discharged to surface waters that are not used as water sources (unlike other areas of the state, where wastewater discharges are a significant source of instream flow). Reuse of wastewater effluent may also reduce the nutrient loads reaching the Chesapeake Bay.

This paper outlines the benefits and opportunities for water reuse in the Eastern Virginia Groundwater Management Area. It specifically examines the idea of a “reuse pipeline” from wastewater treatment facilities owned and operated by the Hampton Roads Sanitation District (“HRSD”) and maps HRSD treatment plants and existing groundwater withdrawals to visualize the proximity of the potential reuse water sources to customers. The paper also proposes regulatory changes that could help promote water reuse.

II. Changing Incentives for Water Reuse

While water reuse is currently being performed in Virginia on a small, local scale, there is very little motivation to incorporate the practice on a broader scale in the Eastern Virginia Groundwater Management Area. Existing treatment works are already permitted to discharge their effluent directly to receiving waters, and water reuse represents additional costs and regulatory hurdles to an already costly and highly regulated process. More recent data regarding the impacts of groundwater withdrawals in the Eastern Virginia Groundwater Management Area coupled with the need to reduce nutrient loadings to the Chesapeake Bay is causing more water users to consider reuse. Water reuse allows high-quality groundwater to be reserved for the most beneficial use (potable use), while allowing wastewater treatment works the opportunity to increase their influent volume without increasing the nutrient load discharged.

Modern wastewater treatment technologies produce a higher quality effluent than was generated just a few decades ago. Surface water withdrawal and/or reservoir projects are facing increasing environmental scrutiny, and waterworks owners are facing increased regulations with regards to drinking water quality. The costs associated with treatment and infrastructure to provide potable water for non-potable uses continues to drive up the costs to water consumers. For these reasons, water reclamation and reuse represents unrealized potential for the water and wastewater industry. Looking forward, Virginia’s ability to maintain its water supply and disposal avenues represents a limitation on future development and economic growth.

As a result of these factors, there are greater incentives to pursue water reuse in the Eastern Virginia Groundwater Management Area.

III. Opportunities For Water Reuse in the Eastern Virginia Groundwater Management Area

Eastern Virginia's population density, climate, and economy are favorable for beneficial application of reuse water. From a water supply management perspective, the area has an ample supply of treated effluent for disposal, a diverse economy dependent on a significant water demand for potable as well as non-potable uses, and is under the increasing regulatory constraints of being situated within the Eastern Virginia Groundwater Management Area and the Chesapeake Bay watershed. In recognition of the value of water resources, many industries already reuse water within their internal production processes. The question is how to expand the scale so that meaningful reductions in groundwater use are achieved. Examples of existing reuse activities in the Eastern Virginia Groundwater Management Area include:

- A typical paper mill reuses water 15 times before discharging it
- Several localities in the Eastern Virginia Groundwater Management area have engaged in wastewater reuse for golf course/racetrack irrigation
- An industrial facility in the Eastern Virginia Groundwater Management Area utilizes treated wastewater from a nearby wastewater treatment plant in portions of its air emissions control equipment

A. Reuse Pipeline from HRSD to Paper Mills

Within the Hampton Roads area there are opportunities for water reuse programs between wastewater treatment facilities and local industry. HRSD operates 13 wastewater treatment facilities within the Eastern Virginia Groundwater Management Area with an aggregate effluent discharge exceeding 150 million gallons per day (MGD) in 2013. There are also several industries within the Hampton Roads area that produce treated effluent and non-contact cooling water which have the potential for water reuse. These industries are permitted for their water withdrawals and discharges which individually may range between 2.5 MGD to 20 MGD.

Several times over the past 10 years the suggestion has been made that HRSD run a reuse pipeline to one or both of the paper mills located within the Eastern Virginia Groundwater Management Area. As new information becomes available about the potential need to reduce groundwater withdrawals, this concept becomes more viable. What is lacking is a feasibility study to fully address the technical, environmental and financial aspects of the concept. For a project of this magnitude to succeed, it cannot be

dependent on only one or two users. Rather, a feasibility study must address where and how other users could participate to sustain the project in the long-term. Finally, the pipeline must be viewed as a project for the aquifer, not “for the paper mills.” It would have long term benefits for all water users in the Eastern Virginia Groundwater Management Area, and thus should have a broader base of support and financial participation than just certain industrial users.

Attached to this paper is a map reflecting HRSD’s wastewater treatment facilities and significant water withdrawers. The map is a useful guide for lining up where reuse partnerships may be formed. Reuse projects have already been established on the peninsula between New Kent County and the Colonial Downs racetrack and, until recently, HRSD and the Yorktown Refinery (facility is no longer operating). The largest groundwater user, the West Point Mill, is located more than 35 miles from any large HRSD treatment plants. The map shows that several golf courses and industrial facilities are located within 10 miles of HRSD’s Williamsburg Treatment Plant. Almost all of the groundwater permits are located along Interstate 64 which could serve as a reuse corridor. The map of Southside Hampton Roads shows less density of groundwater users. Golf courses in Virginia Beach are relatively spread out. The industrial users in Norfolk, Portsmouth and Chesapeake are 5-15 miles from HRSD’s Virginia Initiative Treatment Plant and several water crossings would be required to create a reuse system to connect them. The map of Western Hampton Roads shows a cluster of large groundwater users around Franklin including the International Paper Mill and Hercules, Inc. These facilities are located more than 30 miles from HRSD’s Nansmond Treatment Plant. These maps illustrate both the potential for reuse partnerships and the significant distances between groundwater users and treatment plants.

B. Other Immediate Reuse Opportunities

Ample opportunities exist in Eastern Virginia for water reuse to be beneficially and economically applied in the following sectors:

- recreation/tourism – turf & landscape irrigation, commercial toilet flushing & cooling
- agriculture & aquaculture – crop irrigation, fish farms
- manufacturing – process & cooling water
- power generation & co-generation – steam & cooling water
- suburban development – landscape irrigation, construction site dust control, commercial cooling & toilet flushing, car washes
- water supply augmentation – recharging aquifers & replenishing reservoirs

Besides the potential reuse between HRSD and industrial facilities there may be opportunities to reuse water within the service districts of medium to large municipal

wastewater treatment facilities to support tourism, development and industrial needs. In areas or periods where reuse water supply may exceed demand, groundwater recharge may be employed to replenish aquifers within the Groundwater Management Area. In turn, this should mitigate some of DEQ's concerns associated with excessive groundwater pumping, such as saltwater intrusion, land subsidence and loss of aquifer storage. Surface water reservoirs may be replenished utilizing reuse water, particularly during periods of drought, and this practice may mitigate some water use restrictions during these periods. Indirect potable reuse has been successfully practiced in Virginia (e.g., the Occoquan Reservoir) and in other states.

C. Potential Future Reuse Opportunities

Although not discussed in detail in this paper, another reuse opportunity to be considered for the Eastern Virginia Groundwater Management Area is groundwater recharge. Highly treated effluent may be returned to the subsurface for disposal or temporary storage. This is accomplished through shallow infiltration basins (similar to a drainfield), or through direct injection into deep wells. Reuse water can be used to bolster potable aquifers when there are no suitable sites for surface water reservoirs due to space limitations or environmental considerations. Advantages of groundwater recharge include significantly lower design, permitting and construction costs than surface water reservoirs, less land use impact, no evaporative water loss, and none of the maintenance or liabilities associated with operating a reservoir and dam.

Additionally, stormwater management is a growing issue, and stormwater harvesting could be an additional option for the Eastern Virginia Groundwater Management Area, where runoff often flows into the ocean or other surface waters that are not used as a water supply source.

IV. Obstacles to Water Reuse in the Eastern Virginia Groundwater Management Area

The most easily addressed obstacle to water reuse in the Eastern Virginia Groundwater Management Area is a lack of readily available information about the feasibility of reuse opportunities. Reuse has been discussed in the abstract, without any real understanding of the technical and economic requirements needed to implement a project. The water supply planning process offers the ability to compare water supply to water demand, and develop concrete data about alternative sources. Funding feasibility studies for such options would be the best way to advance water reuse in the Eastern Virginia Groundwater Management Area. Such feasibility studies would need to address the following potential hurdles:

A. Regulatory

i. Reuse Regulations

Many of the obstacles with water reuse within the Commonwealth of Virginia are regulatory driven. Currently Virginia Department of Environmental Quality (VADEQ) regulations outline minimum reuse water quality standards for various applications (9VAC25-740-90). However, end user requirements only address wastewater reuse for turf irrigation and industrial use (i.e., cooling water), which narrows the available outlets for reuse water (9VAC25-740-140). In order to maximize reuse, VADEQ would need to incorporate broader regulations that address other outlets.

The existing reclaimed water regulations allow DEQ to require reuse systems to distribute reuse water under contract with the end user. For a municipal utility, this allows the cost to be negotiated by the user, rather than at a rate set by the controlling board. Connection fees, capital recovery fees or capacity fees are typically not charged. Therefore, reuse systems are operated as a part of the wastewater treatment system, and the cost of any capital water reuse projects are reflected in sewerage rates, rather than in the reuse water rates. As such, the application of reuse water is not viewed as financially self-sustaining.

ii. Groundwater Withdrawal Regulations

Currently there are few regulatory or financial incentives to water users to explore reuse water as a water source. Regulatory changes may be necessary to provide incentives for water users to look beyond groundwater for water supply.

Neither Virginia's Groundwater Withdrawal nor Water Reclamation and Reuse regulations address aquifer recharge with reclaimed water or other sources. Lacking appropriate regulations from the Commonwealth of Virginia, aquifer recharge is currently regulated by the EPA through the Underground Injection Control (UIC) program. EPA regulations provide that "no owner or operator shall construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 142 or may otherwise adversely affect the health of persons."

Virginia could submit an application to EPA to obtain primary enforcement responsibility or primacy for the UIC program. Some primacy states allow additional types of water to be used in ASR, including treated effluent, untreated surface and groundwater, reclaimed water subject to state recycled water criteria, or "any" injectate. However, state-specific ASR regulations do not supersede the prohibition of movement of fluid into underground sources of drinking water.

(<http://water.epa.gov/types/groundwater/uic/aquiferrecharge.cfm>).

State regulations addressing aquifer recharge could result in discharges utilizing the practice.

B. Financial

Funding the capital costs of reuse water infrastructure may be the largest obstacle to widespread water reuse within the Eastern Virginia Groundwater Management Area. Typically this would include pipelines, pumping/booster stations, storage tanks and additional treatment units (e.g. filtration, chlorination and UV treatment). Easements for infrastructure routing would also be needed. Retrofitting existing development areas and resolving conflicts with existing utilities will add additional costs.

Operating costs of reuse systems also represent an obstacle to water reuse in Eastern Virginia. Operating costs are similar to those associated with water distribution systems. Typical costs include energy for pumping, equipment maintenance, calibration and repair, chemicals for disinfection, extensive water quality testing, operator's salaries and benefits, etc. As with traditional utilities, regional service authorities could offer economies of scale which would not be realized with the current, small scale generator/user agreements. For water reuse to become accepted by the water and sewer industry, the provider needs the ability to set rates that reflect the true capital and operating costs of the utility.

In Hampton Roads, localities operate and finance the drinking water systems and HRSD operates the wastewater treatment system. If discharges from HRSD's treatment plants were used to supplement the public water system demands, the localities could lose revenue associated with the reduced drinking water sales. As discussed in the regional report, "Water and Wastewater Utilities, Designing the Rate Structure of the Future," most utility costs are fixed and do not decrease when water demands decrease. Therefore, development of a reuse system for irrigation and other non-potable uses within public water systems should involve drinking water utilities so they can anticipate and account for the potential loss in revenue.

C. Public Perception & Acceptance

Any reuse project must consider public perception. Where potable supplies may be augmented or replenished (directly or indirectly), absolute assurance that adverse health effects will not occur must be provided. As such, the Virginia Department of Health (VDH) also needs to become involved in revising existing regulations to allow use of reuse water for various applications outside of irrigation and industrial use. Although

introduction and promulgation of such regulatory requirements would be feasible, the acceptance by the public and regulatory communities, and the removal of the stigma associated with reuse water would be necessary. Such stigmas typically surround the use of “sewage” water for applications which are commonly associated with “clean” water.

An important component of public outreach is information about available supply, impacts from additional groundwater use, and the environmental benefits of reuse.

D. Technical Issues

i. Quality of Supply

Certain end uses require different levels of quality. Determining the quality needed can impact the cost of treatment and the viability of a reuse project. The provider and user must agree on which entity pays for additional treatment and liability associated with it. Ultimately, however, the provider must treat to the (typically) more restrictive standard of their surface water discharge, as most treatment facilities cannot make such adjustments “on the fly.”

ii. Quantity of Supply

Once implemented, maintaining adequate supply for the various applications may become an obstacle to moving water reuse forward. As with current water supplies, peak demand will occur during the summer months. While a short interruption in supply for an irrigation customer may not be problematic, it could be catastrophic for a manufacturing or industrial process. The need for on-site storage tanks or ponds and/or backup supply may be required, should for any reason, reuse water not be available in the desired quantities. A secondary connection to the potable water supply, or backup supply well (with appropriate separation and backflow prevention), may be needed in certain instances.

V. Conclusions

Reuse water is a greatly underutilized and undervalued resource in the Eastern Virginia Groundwater Management Area. Significant effort and expense is currently being expended to mitigate the effects of wastewater effluent discharges, as well as provide for adequate potable and non-potable water supply demand. The costs of these efforts must be passed along to end users in the municipal utilities and manufactured goods markets, or be absorbed by the providers. By integrating water reuse as part of the solution to some of Virginia’s vexing water quality and quantity issues, a great opportunity exists for the Commonwealth to create water sustainability and self-reliance in Eastern Virginia, while remaining competitive in the global and local economies. When viewed in this

light, a high economic and social value must be placed on potable, non-potable and re-useable water supplies.

The potential exists to implement water reuse projects within the Eastern Virginia Groundwater Management Area on a larger scale, and the timing is right to do so. New information provides greater understanding of the stress the system is under at current groundwater withdrawal levels. DEQ is evaluating different management approaches, including potential across-the-board reductions. Even if such reductions are not imposed, the ability of new users to obtain groundwater withdrawal permits is unlikely.

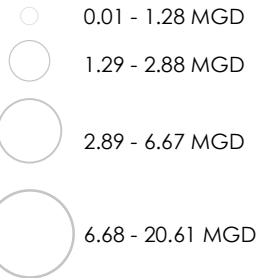
Individual utility providers are currently not incentivized to promote regional water reuse. For wastewater providers, reuse represents an additional layer of operation and regulation which is not financially self-sustaining. For water providers, reuse represents a low-cost competitor. For these reasons, the Commonwealth must take the lead in the reuse regulation and funding arenas to get these programs off the ground.

The immediate need is a feasibility study to assess where and how the reuse projects with the greatest benefit to the Eastern Virginia Groundwater Management Area could be located and developed. The Commonwealth can and should take the lead in this effort.

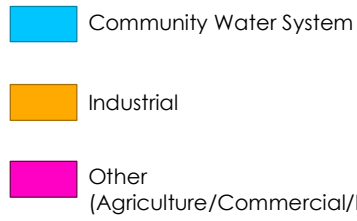
Mission H₂O is committed to helping the Commonwealth in developing such a study, stands ready to assist in removing the hurdles and moving forward with promotion of water reuse in the Eastern Virginia Groundwater Management Area.

HRSD Treatment Plant Discharge Rates & Active Groundwater Withdrawal Permits in Southside Hampton Roads

Permitted Withdrawal *



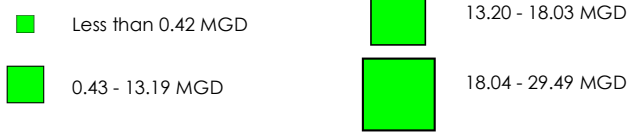
System Use



- Systems with Unrestricted Withdrawals (US Navy)
- Certificate of Groundwater Rights

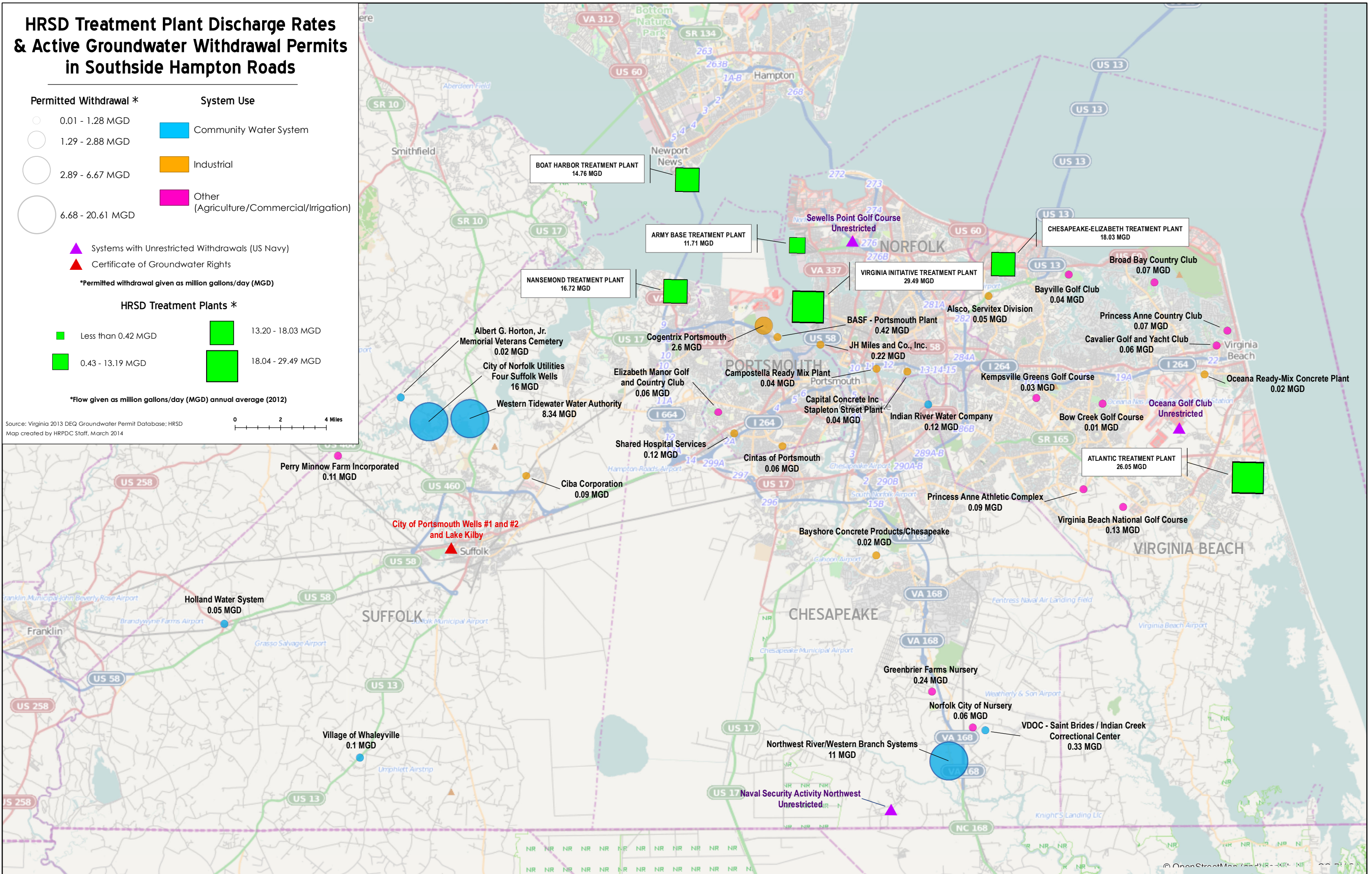
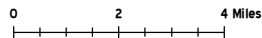
*Permitted withdrawal given as million gallons/day (MGD)

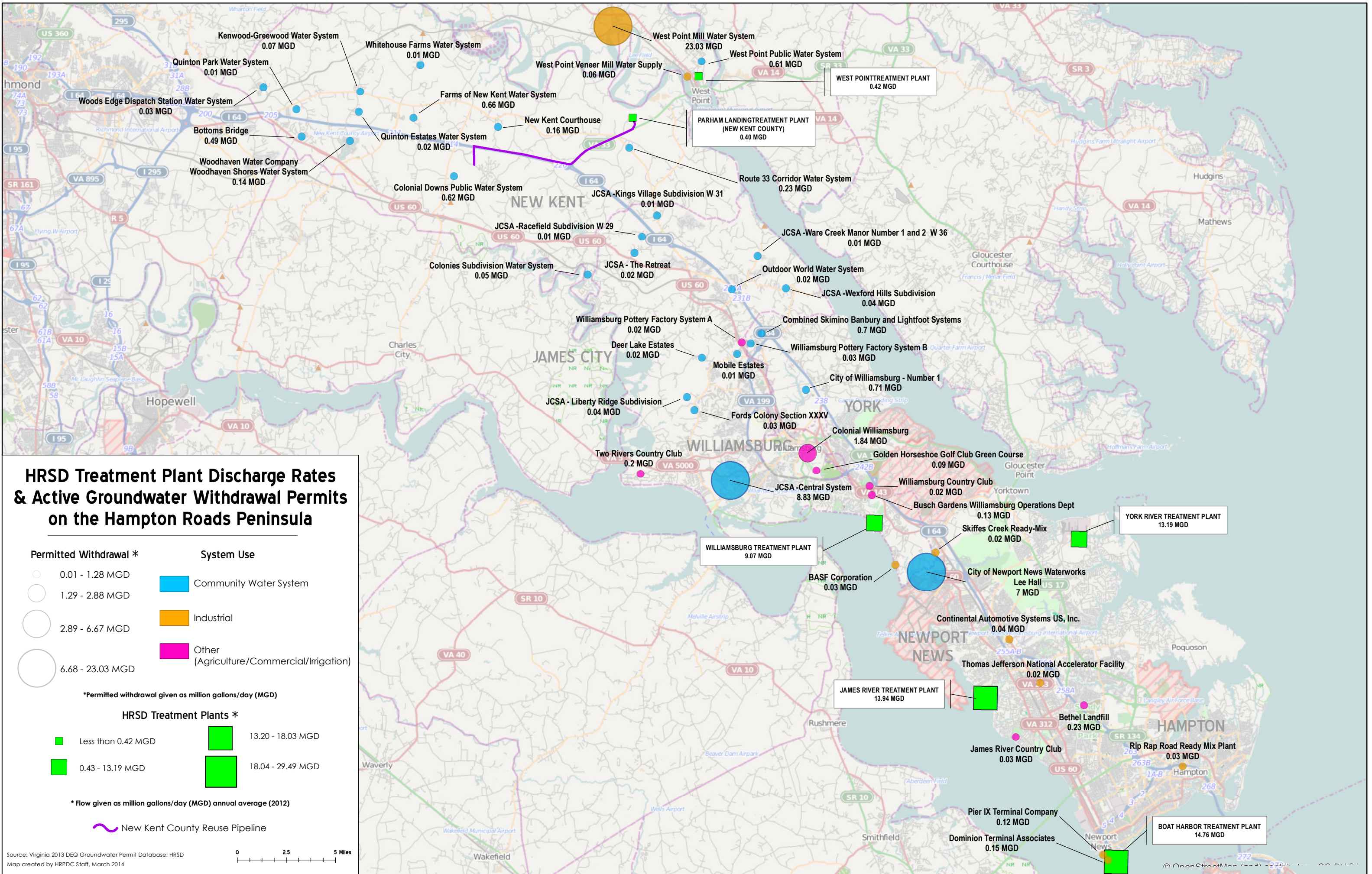
HRSD Treatment Plants *



*Flow given as million gallons/day (MGD) annual average (2012)

Source: Virginia 2013 DEQ Groundwater Permit Database; HRSD
Map created by HRPDC Staff, March 2014





HRSD Treatment Plant Discharge Rates & Active Groundwater Withdrawal Permits on the Hampton Roads Peninsula

Permitted Withdrawal *

- 0.01 - 1.28 MGD
- 1.29 - 2.88 MGD
- 2.89 - 6.67 MGD
- 6.68 - 23.03 MGD

System Use

- Community Water System
- Industrial
- Other (Agriculture/Commercial/Irrigation)

HRSD Treatment Plants *

- Less than 0.42 MGD
- 0.43 - 13.19 MGD
- 13.20 - 18.03 MGD
- 18.04 - 29.49 MGD

*** Permitted withdrawal given as million gallons/day (MGD)**

*** Flow given as million gallons/day (MGD) annual average (2012)**

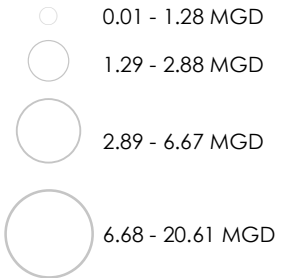
~ New Kent County Reuse Pipeline

Source: Virginia 2013 DEQ Groundwater Permit Database; HRSD
 Map created by HRPDC Staff, March 2014

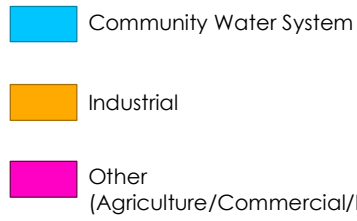
System Name	Rate (MGD)	System Use	Treatment Plant Name	Plant Rate (MGD)
Kenwood-Greewood Water System	0.07	Community Water System	WEST POINT TREATMENT PLANT	0.42
Whitehouse Farms Water System	0.01	Community Water System	PARHAM LANDING TREATMENT PLANT (NEW KENT COUNTY)	0.40
West Point Mill Water System	23.03	Industrial	WEST POINT TREATMENT PLANT	0.42
West Point Veneer Mill Water Supply	0.06	Community Water System	WEST POINT TREATMENT PLANT	0.42
West Point Public Water System	0.61	Community Water System	WEST POINT TREATMENT PLANT	0.42
Quinton Park Water System	0.01	Community Water System	WEST POINT TREATMENT PLANT	0.42
Woods Edge Dispatch Station Water System	0.03	Community Water System	WEST POINT TREATMENT PLANT	0.42
Bottoms Bridge	0.49	Community Water System	WEST POINT TREATMENT PLANT	0.42
Woodhaven Water Company	0.14	Community Water System	WEST POINT TREATMENT PLANT	0.42
Woodhaven Shores Water System	0.14	Community Water System	WEST POINT TREATMENT PLANT	0.42
Farms of New Kent Water System	0.66	Community Water System	WEST POINT TREATMENT PLANT	0.42
New Kent Courthouse	0.16	Community Water System	WEST POINT TREATMENT PLANT	0.42
Quinton Estates Water System	0.02	Community Water System	WEST POINT TREATMENT PLANT	0.42
Colonial Downs Public Water System	0.62	Community Water System	WEST POINT TREATMENT PLANT	0.42
JCSA - Kings Village Subdivision W 31	0.01	Community Water System	WEST POINT TREATMENT PLANT	0.42
JCSA - Racefield Subdivision W 29	0.01	Community Water System	WEST POINT TREATMENT PLANT	0.42
Colonies Subdivision Water System	0.05	Community Water System	WEST POINT TREATMENT PLANT	0.42
JCSA - The Retreat	0.02	Community Water System	WEST POINT TREATMENT PLANT	0.42
Route 33 Corridor Water System	0.23	Community Water System	WEST POINT TREATMENT PLANT	0.42
JCSA - Ware Creek Manor Number 1 and 2 W 36	0.01	Community Water System	WEST POINT TREATMENT PLANT	0.42
Outdoor World Water System	0.02	Community Water System	WEST POINT TREATMENT PLANT	0.42
JCSA - Wexford Hills Subdivision	0.04	Community Water System	WEST POINT TREATMENT PLANT	0.42
Combined Skimino Banbury and Lightfoot Systems	0.7	Community Water System	WEST POINT TREATMENT PLANT	0.42
Williamsburg Pottery Factory System A	0.02	Community Water System	WEST POINT TREATMENT PLANT	0.42
Deer Lake Estates	0.02	Community Water System	WEST POINT TREATMENT PLANT	0.42
Mobile Estates	0.01	Community Water System	WEST POINT TREATMENT PLANT	0.42
Williamsburg Pottery Factory System B	0.03	Community Water System	WEST POINT TREATMENT PLANT	0.42
City of Williamsburg - Number 1	0.71	Community Water System	WEST POINT TREATMENT PLANT	0.42
JCSA - Liberty Ridge Subdivision	0.04	Community Water System	WEST POINT TREATMENT PLANT	0.42
Fords Colony Section XXXV	0.03	Community Water System	WEST POINT TREATMENT PLANT	0.42
Colonial Williamsburg	1.84	Community Water System	WEST POINT TREATMENT PLANT	0.42
Two Rivers Country Club	0.2	Community Water System	WEST POINT TREATMENT PLANT	0.42
JCSA - Central System	8.83	Community Water System	WEST POINT TREATMENT PLANT	0.42
Golden Horseshoe Golf Club Green Course	0.09	Community Water System	WEST POINT TREATMENT PLANT	0.42
Williamsburg Country Club	0.02	Community Water System	WEST POINT TREATMENT PLANT	0.42
Busch Gardens Williamsburg Operations Dept	0.13	Community Water System	WEST POINT TREATMENT PLANT	0.42
Skiffes Creek Ready-Mix	0.02	Community Water System	WEST POINT TREATMENT PLANT	0.42
YORK RIVER TREATMENT PLANT	13.19	Community Water System	YORK RIVER TREATMENT PLANT	13.19
WILLIAMSBURG TREATMENT PLANT	9.07	Community Water System	WILLIAMSBURG TREATMENT PLANT	9.07
BASF Corporation	0.03	Industrial	WILLIAMSBURG TREATMENT PLANT	9.07
City of Newport News Waterworks	7	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
Continental Automotive Systems US, Inc.	0.04	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
Thomas Jefferson National Accelerator Facility	0.02	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
Bethel Landfill	0.23	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
James River Country Club	0.03	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
Rip Rap Road Ready Mix Plant	0.03	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
Pier IX Terminal Company	0.12	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
Dominion Terminal Associates	0.15	Community Water System	JAMES RIVER TREATMENT PLANT	13.94
BOAT HARBOR TREATMENT PLANT	14.76	Community Water System	BOAT HARBOR TREATMENT PLANT	14.76

HRSD Treatment Plant Discharge Rates & Active Groundwater Withdrawal Permits in Western Hampton Roads

Permitted Withdrawal *



System Use



- Systems with Unrestricted Withdrawals (US Navy)
- Certificate of Groundwater Rights

*Permitted withdrawal given as million gallons/day (MGD)

HRSD Treatment Plants *



* Flow given as million gallons/day (MGD) annual average (2012)

Source: Virginia 2013 DEQ Groundwater Permit Database; HRSD
Map created by HRPDC Staff, March 2014

