HRSD SWIFT Research Center (SRC) Quarterly Report on SWIFT Water Quality Targets

This report documents SWIFT Water Quality results for recharge operations from April 1 – June 30, 2020. The compliance requirements are documented in HRSD's SWIFT Underground Injection Control Inventory Information Package (UIC-IIP) submitted to EPA Region III in January 2018. These requirements are noted in Tables 1-4. While table 2-4 are identical to those originally submitted with the UIC-IIP, Table 1 is being revised effective with this quarterly report. The total coliform limit has been revised following discussion with Virginia Department of Health (VDH) and EPA Region III UIC staff. Total coliform monitoring and compliance is discussed in greater detail on page 2 of this report.

Figures 1 and 2 and Table 6 provide a summary of the data from the referenced quarter of operations relative to the SWIFT Water Quality Targets. Table 6 represents a summary of all analytes that were present above the laboratory reporting limit. A detailed table identifying the parameters monitored for the purpose of evaluating compliance with the SWIFT Water Quality Targets can be found as an Appendix to this report.

Parameter	Proposed Regulatory Limit	Non-Regulatory Action/Goal
EPA Drinking Water Primary Maximum Contaminant Levels (MCLs)	Meet all primary MCLs	N/A
Total Nitrogen	5 mg/L Monthly Average; 8 mg/L Max Daily	Secondary Effluent Critical Control Point (CCP) Action Limit for Total Inorganic Nitrogen (TIN) = 5 mg/L-N; CCP Action Limit for SWIFT Water Total Nitrogen (TN) = 5 mg/L-N
Turbidity	Individual Filter Effluent (IFE) < 0.15 NTU 95% of time and never >0.3 NTU in two consecutive 15 min measurements	CCP Action Limit IFE of 0.10 NTU to initiate backwash or place a filter in standby
Total Organic Carbon (TOC)[1]	4 mg/L Monthly Average 6 mg/L Maximum	Critical Operating Point (COP) Action Limit to Initiate GAC Regeneration
Total Coliform[2]	<2 CFU/100 mL for 95% of calendar month observations, applied as the 95th percentile	N/A
E.coli	Non-detect	N/A
TDS[3]	N/A	Monitor PAS Compatibility

Table 1: SRC Regulatory and Monitoring Limits for SWIFT Water

[1] Regulatory limit applies to the TOC laboratory analysis which is collected at a frequency of 3 times per week.

[2] The TC monitoring requirement for the SRC originally included compliance with a geometric mean of 3 CFU/100 mL for a running 20 daily samples. The Virginia Department of Health (VDH) determined that the requirement to meet TC < 2 CFU/100 mL 95% of the time within a given month was protective of this geometric mean requirement, and the application of both regulatory limits was not necessary. Following consultation with EPA Region III UIC staff, the geometric mean requirement has been removed as an additional TC compliance requirement.

[3] No limit for TDS proposed as the primary driver is aquifer compatibility. The concentration of SWIFT Water at the SRC generally ranges from 500-850 mg/L.

Total Coliform Investigation

As discussed in the previous quarterly report, HRSD conducted additional analyses in May to determine if the method of analysis for total coliform (Colilert) was potentially resulting in false positives. The data obtained from this follow-up comparison of membrane filtration vs Colilert indicated that the method was unlikely to be a contributory factor in the observed total coliform detections. The most likely source of the total coliform observed sporadically in SWIFT Water continues to be the accumulated sediment within the chlorine contact pipeline (CCPL) as observed by closed-circuit television (CCTV). Total coliform in the CCPL is well controlled when free chlorine is added post-UV disinfection to prevent biofouling in the recharge well. Conversely, total coliform detections are quite likely to result when free chlorination post-UV is not engaged.

On April 11, total coliform was detected at 9 MPN/100 mL. E. coli was absent. An investigation identified that at the time of sample collection the hypochlorite pump dosing free chlorine post-UV had failed due to a leak in the sample line. The pump failure was identified at the time of sample collection and free chlorine dosing was resumed within one hour. Review of chlorine residuals identified that the pump failure occurred at approximately 1 am on April 11. Chlorine residual when free chlorinating post-UV is correctly characterized as a Critical Operating Parameter (COP) since free chlorination is not being used to achieve disinfection credits. The low chlorine residual should have triggered the COP and sent an alert to the Operator. Further investigation identified that the Distributed Control System was erroneously in the control mode for chloramination which does not send alerts for low chlorine residual. HRSD implemented corrective action in the form of daily checks on the relevant DCS set points. These setpoints are also verified following power disruptions.

Total coliform and E. coli were both detected in samples collected on June 25 with concentrations of 1 MPN/100 mL each. This is the first time E. coli was observed in a SWIFT Water analysis. The duplicate analysis for E. coli from this date was non-detect and the sample result for June 26 was non-detect. Given the results of the duplicate analysis and of the June 26 sample, it is strongly believed that the E. coli detection of June 25 is attributable to sample contamination. The HRSD Central Environmental Laboratory has implemented new sample transport and handling procedures in the laboratory to minimize the potential for cross-contamination with wastewater samples.

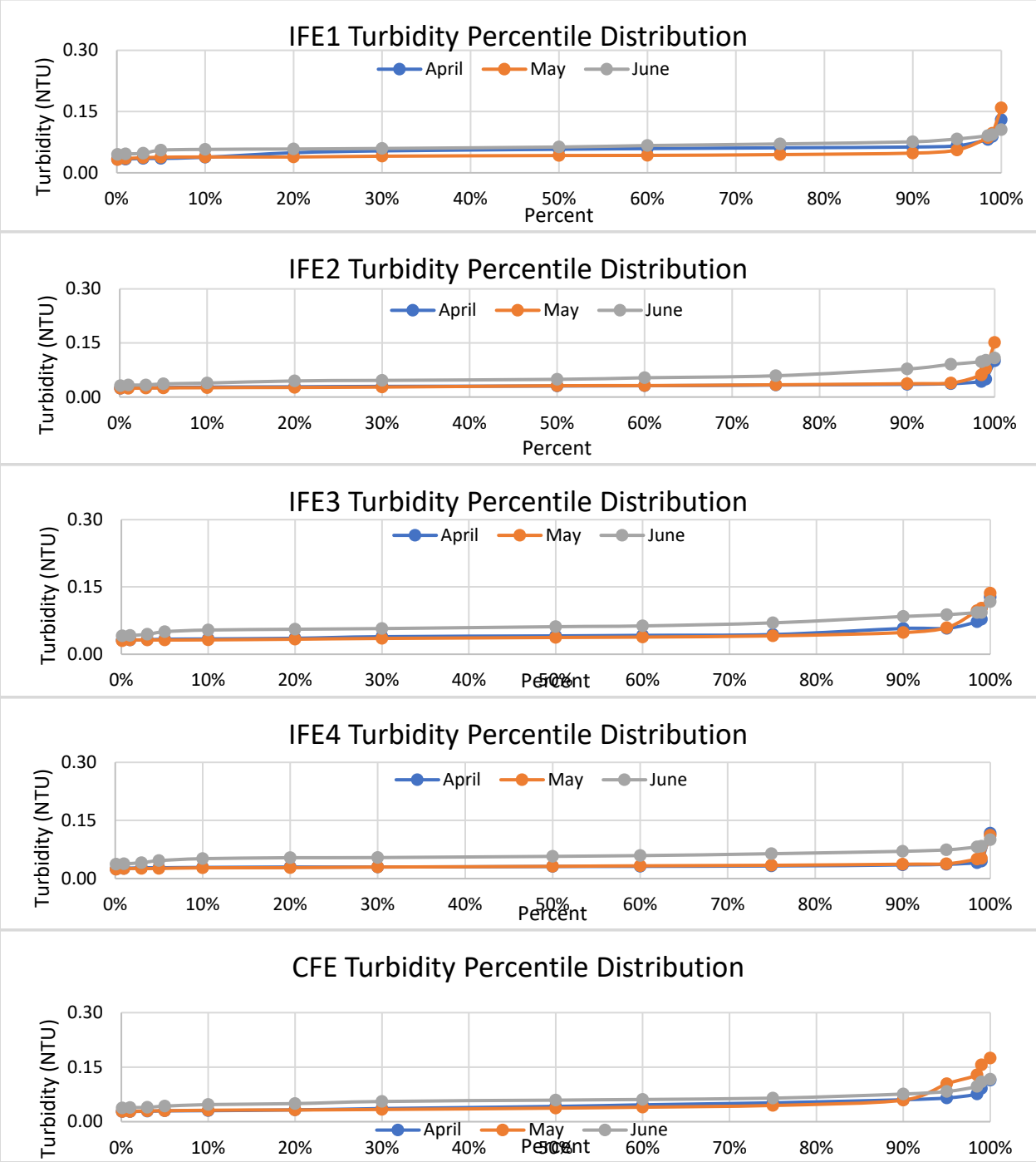

Figure 1: Percentile distribution of 15-minute average Individual Filter Effluent (IFE) Turbidities for Biofilters 1-4 (IFE1-4) and Biofilter Combined Filter Effluent (CFE). There were no 15-minute periods in this quarter with biofilter effluent turbidity values greater than 0.3 NTU. The 95% measured value for each biofilter IFE and the CFE was less than 0.15 NTU for each month in this quarter.

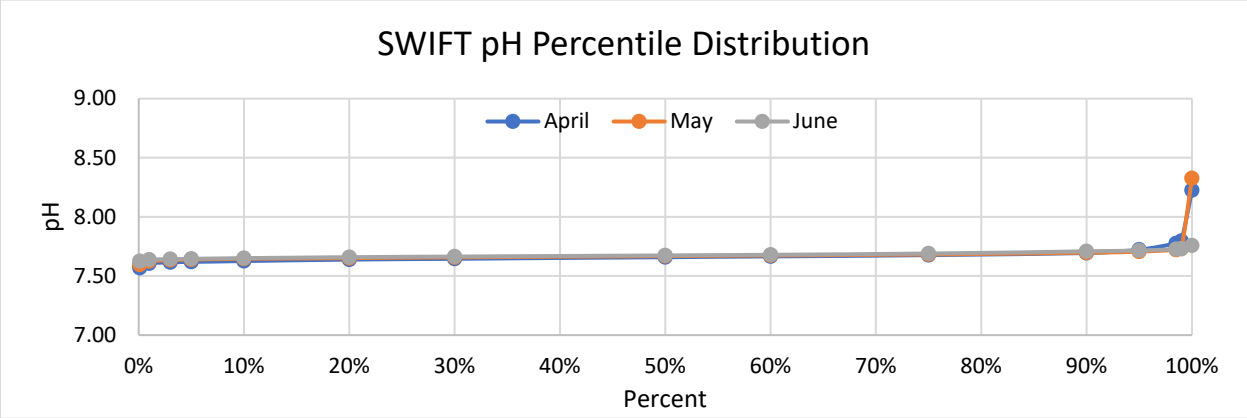

Figure 2: Distribution of Monthly SWIFT Water pH values.

Monitoring at the SRC also includes monitoring for performance indicators as documented in Table 2, extracted from Attachment B of the UIC-IIP.

Constituent	Category	Trigger Value	Unit	Notes
1,4-Dioxane	Public Health	1	µg/L	CCL4; CA Notification Limit
17-β-Estradiol	Public Health	TBD	ng/L range	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	TBD	ng/L range	CCL4
NDMA	Public Health	10	ng/L	CCL4; CA Notification Limit
Perchlorate	Public Health	6	µg/L	CA Notification Limit
PFOA+PFOS	Public Health	70	ng/L	CCL4; EPA Health Advisory
TCEP	Public Health	5	µg/L	MN Health Guidance Value
Cotinine	Treatment Effectiveness	1	µg/L	Surrogate for low molecular weight, partially charged cyclics
Primidone	Treatment Effectiveness	10	µg/L	
Phenytoin	Treatment Effectiveness	2	µg/L	
Meprobamate	Treatment Effectiveness	200	µg/L	High occurrence in wastewater treatment plant effluent
Atenolol	Treatment Effectiveness	4	µg/L	
Carbamazepine	Treatment Effectiveness	10	µg/L	Unique structure
Estrone	Treatment Effectiveness	320	ng/L	Surrogate for steroids
Sucralose	Treatment Effectiveness	150	mg/L	Surrogate for water soluble, uncharged chemicals with moderate molecular weight
Triclosan	Treatment Effectiveness	2,100	µg/L	Chemical of interest

TBD = to be determined

Table 2: SRC Non-Regulatory Performance Indicators

Pathogen Log Removal Value (LRV) is not strictly regulated but the SRC has been designed and is operated to achieve at least 12 LRV for viruses and 10 LRV for *Cryptosporidium* and *Giardia* through a combination of advanced treatment processes and soil aquifer treatment. Table 3 provides a treatment process pathogen LRV summary for recharge conditions. Table 4 provides additional monitoring that is being completed to document compliance with the LRVs for ozone and UV.

Parameter	Floc/Sed (+BAC)	Ozone	BAC+GAC	UV	Cl2	SAT	Total
Enteric Viruses	2	0-3 (TBD)	0	4	0-4	6	12-19
Cryptosporidium	4	0	0	6	0	6	16
Giardia	2.5	0-1.5 (TBD)	0	6	0	6	14.5-16

Table 3: SRC Pathogen LRV for Potomac Aquifer System (PAS) Recharge.

Ozone LRV
Ozone Influent Temperature
Ozone Influent Flow
Liquid Phase Ozone Concentration[1]
Contact Time
CT
UV LRV
UV Intensity, each reactor
UVT, GAC Combined Effluent
Reactor Flow, each
Calculated Dose, each Lamp
Status, each

[1] The ozone liquid phase probe is verified with lab grab samples performed at least once per week.

Table 4: Additional Monitoring to Support Ozone and UV LRV. All data are collected as continuous measurements. The 15-minute LRV data is submitted in Table 6.

Critical Control Points

The SRC incorporates Critical Control Points (CCP) throughout the treatment process, per Attachment G of UIC-IIP to verify that treatment goals are being met at each of the individual processes. A violation of any CCP means that the SRC may not be producing water that meets the treatment goals and will trigger a diversion of the SWIFT Water so that it is not directed to the recharge well. In most instances, the SRC will continue to operate through the CCP violation, but the SWIFT Water will be diverted back to the Nansemond Plant chlorine contact tanks (CCT).

CCPs have alert values at which point the operator is expected to take action to correct the performance as well as the alarm values at which point an automated response will trigger action and prevent flow from going to the recharge well. Both

the alert and alarm values will be measured consistently for a specified duration before action is taken so that blips in online analyzers do not trigger action. The specific values for the alert and alarm levels will be configured as adjustable set points in the Distributed Control System (DCS) and optimized as needed to meet the water quality requirements.

Table 5 shows the current CCPs in effect at the SRC. Modifications have been made to the CCPs since startup as compared to the original design documents in order to optimize their performance. Each of the modifications from previous quarters was discussed in the relevant quarterly report for the period. Only one modification was made for this quarter. Since free chlorination post-UV at this time is for the purpose of preventing biofouling and not utilized for the purpose of achieving disinfection credit, the free chlorine CT CCP identified in Table 5 was reclassified as a critical operating parameter (COP) with the same triggers and responses. If SRC operations are modified in the future to claim disinfection credit for free chlorination post-UV, the COP will be reclassified as a CCP.

Parameter	Alert Value	Alarm Value	Unit	Action
Critical Control Points (CCPs)				
Influent Pump Station Conductivity	1,400	1,600	microSiemens per centimeter	Place Biofilters in Filter To Waste
Influent Pump Station Total Inorganic Nitrogen	4.0	5.0	mg/L-N	Place Biofilters in Filter To Waste
Influent Pump Station Turbidity	3.5	5.0	NTU	Place Biofilters in Filter To Waste
Preformed Chloramine Failure on Injection	N/A	Failure	mg/L	Divert SWIFT Water
Total Chlorine Post Injection upstream of ozone	2.0	1.0	mg/L	Divert SWIFT Water
Chloramine injection upstream of ozone	2.0	1.0	mg/L	Divert SWIFT Water
Ozone Feed	N/A	Failure	N/A	Open Biofilter Backwash Waste Valve
Ozone Contactor Calculated LRV – Virus	<120% LRV Goal	≤110% LRV Goal	%	Open Biofilter Backwash Waste Valve
Biofilter Individual Effluent Turbidity	0.1	0.15	NTU	Place That Biofilter in Filter To Waste
Biofilter Combined Filter Effluent Turbidity	0.1	0.15	NTU	Place Biofilters in Filter To Waste
GAC Combined Effluent TOC, instantaneous online analyzer	4.0	5.0	mg/L	Divert SWIFT Water
UV Reactor Dose	<120% of Dose Setpoint	<105% of Dose Setpoint	%	Divert SWIFT Water
~~Free Chlorine CT ***(This CCP is not being used since free chlorination of the SWIFT Water is not currently being practiced)***~~	~~<120% of CT Target~~	~~<105% of CT Target~~	~~%~~	~~Divert SWIFT Water~~
GAC Combined Effluent Nitrite	0.25	0.50	mg/L-N	Divert SWIFT Water
SWIFT Water TN	4.5	5.0	mg/L-N	Divert SWIFT Water
Ozone dose	70	80	lbs/day	Place Biofilters in Filter To Waste

Parameter	Alert Value	Alarm Value	Unit	Action
Tasting System Free Chlorine CT	<110% of Required CT	<100% of Required CT	mg-min/L	Shut Down Tasting System
Tasting System Total Ammonia	0.1	0.3	mg/L-N	Shut Down Tasting System

Table 5. Critical Control Points for the SRC

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	April 2020			May 2020			June 2020		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	**3.74**	**4.45**	**25**	**3.14**	**4.66**	**20**	**3.01**	**4.13**	**17**
NO_3	mg/L	10	0.01	Daily[3]	**3.14**	**3.89**	**25**	**2.67**	**4.19**	**20**	**2.38**	**3.52**	**17**
NO_2	mg/L	1	0.01	Daily[3]	**<0.01**	**<0.01**	**25**	**<0.01**	**0.01**	**20**	**0.01**	**0.07**	**17**
Turbidity	NTU	NA	0.01	Continuous	**Figure 1**								
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	**3.40**	**3.67**	**18**	**3.49**	**3.89**	**14**	**3.71**	**4.07**	**14**
pH		NA	NA	Continuous	**Figure 2**								
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		**709**	**1**		**729**	**1**		**654**	**1**
Microorganisms													
Total Coliform[5]	MPN/100 mL	MCLG = 0	1	Daily[3]	**<1**	**9**	**25**	**<1**	**<1**	**20**	**<1**	**1**	**16**
E. coli[6]	MPN/100 mL	NA	1	Weekly	**<1**	**<1**	**25**	**<1**	**<1**	**20**	**<1**	**1**	**16**
Disinfection Byproducts													
Bromate	µg/L	10	0.15	Monthly		**3.77**	**1**		**1.58**	**1**		**4.07**	**1**
Trihalomethanes[7]													
Bromodichloromethane	µg/L		1.00	Monthly		**<1.00**	**1**		**1.13**	**1**		**1.00**	**1**
Bromoform	µg/L		1.00	Monthly		**4.22**	**1**		**4.52**	**1**		**6.37**	**1**
Chloroform	µg/L		1.00	Monthly		**<1.00**	**1**		**<1.00**	**1**		**<1.00**	**1**
Dibromochloromethane	µg/L		1.00	Monthly		**2.28**	**1**		**3.12**	**1**		**3.00**	**1**
Total Trihalomethanes	µg/L	80				**6.50**			**8.77**			**10.4**	
HAAs[7]													
Dichloroacetic acid	µg/L		0.60	Monthly		**1.03**	**1**		**1.23**	**1**		**1.32**	**1**
Trichloroacetic acid	µg/L		0.20	Monthly		**0.44**	**1**		**0.52**	**1**		**0.60**	**1**
Monochloroacetic acid	µg/L		0.60	Monthly		**<0.60**	**1**		**<0.60**	**1**		**<0.60**	**1**
Bromoacetic acid	µg/L		0.40	Monthly		**0.88**	**1**		**0.62**	**1**		**0.84**	**1**
Dibromoacetic acid	µg/L		0.20	Monthly		**8.54**	**1**		**6.22**	**1**		**7.97**	**1**
Total Haloacetic Acids	µg/L	60				**10.9**			**8.59**			**10.7**	
Disinfectants[7,8]													
Monochloramine (as Cl_2)	mg/L	4		Continuous	**0.03**	**1.58**		**0.02**	**0.63**		**0.01**	**0.32**	
Chlorine (as Cl_2)	mg/L	4		Continuous	**0.60**	**0.84**		**0.68**	**1.70**		**0.99**	**2.71**	
Inorganic Chemical													
Antimony	µg/L	6	0.5	Monthly		**<0.5**	**1**		**0.6**	**1**		**0.6**	**1**
Arsenic	µg/L	10	1	Monthly		**<1**	**1**		**0.9**	**1**		**0.8**	**1**
Barium	mg/L	2	0.005	Monthly		**0.007**	**1**		**0.007**	**1**		**0.008**	**1**
Fluoride	mg/L	4.0	0.100	Monthly	**0.819**	**0.896**	**25**	**0.826**	**0.941**	**20**	**0.820**	**0.935**	**17**

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	April 2020			May 2020			June 2020		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Organic Chemicals													
Acrylamide[9]	µg/L	Treatment Technique, MCLG = 0	0.1	Monthly		**0.29**	**1**		**<0.1**	**1**		**0.18**	**1**
Radionuclides													
Beta particles and photon emitters	pCi/L	4 mrem/yr[10]	3	Monthly		**18**	**1**		**16**	**1**		**16**	**1**
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	**0.37**	**0.40**	**5**	**0.31**	**0.35**	**4**	**0.31**	**0.33**	**4**
Perfluorooctanoic Acid (PFOA)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly					**5.7**	**1**			
Treatment Efficacy Indicators		**Trigger Limits**											
Cotinine	ng/L	1,000	10	Quarterly		**26**	**1**						
Primidone	ng/L	10,000	5	Quarterly		**11**	**1**						
Sucralose	ng/L	150,000,000	1000	Quarterly		**11000**	**1**						
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV				Continuous	**4.57**	**3.82**		**4.51**	**3.89**		**4.50**	**4.13**	
Ozone Giardia LRV				Continuous	**2.36**	**1.95**		**2.29**	**1.97**		**2.13**	**1.94**	
UV Dose Reactor 1	mJ/cm^2			Continuous	**>186**	**>186**		**>186**	**>186**		**>186**	**>186**	
UV Virus LRV Reactor 1				Continuous	**>4**	**>4**		**>4**	**>4**		**>4**	**>4**	
UV Dose Reactor 2	mJ/cm^2			Continuous	**>186**	**>186**		**>186**	**>186**		**>186**	**>186**	
UV Virus LRV Reactor 2				Continuous	**>4**	**>4**		**>4**	**>4**		**>4**	**>4**	

[1] When minimum reporting limits varied during the quarter, the highest minumum reporting limit used is identified.

[2] Analytical results less than the reporting limit were treated as zero for the purposes of the averaging calculation.

[3] Daily samples are typically not collected on days in which there is no or limited recharge. TOC sample collection occurs routinely on Monday through Friday when recharging. Limited or inconsistent recharge impacts the collection of daily samples, particularly for the microbiological samples collected for total coliform and e coli which have limited holding time requirements. In April, recharge did not occur on 3 days and limited time periods of recharge impeded sampling on 2 additional days. In May, recharge did not occur on 8 days and limited time periods of recharge impeded sampling on 3 additional days. In June, recharge did not occur on 10 days and limited time periods of recharge impeded sampling on 3 additional days.

[4] TDS of the Potomac Aquifer System is based on the averages within the upper, middle and lower Potomac Aquifer as determined during baseline montioring.

[5] The total coliform sample analysis for June 2 failed QC requirements. Please refer to total coliform narrative in report for further information on total coliform detections in April and June.

[6] E coli was detected in the June 25 sample. The duplicate analysis was non-detect and the June 26 sample was non-detect. Sample contamination is suspected. Please see the narrative on total coliform for additional information.

[7] Free chlorine was used as an alternative to monochloramine to prevent biofouling of the well post-UV disinfection during this operational period.

[8] The maximum residual disinfectant level (or MRDL) MCL for monochloramine and chlorine are based on annual averages.

[9] Acrylamide was detected in SWIFT Water in April and June. HRSD polymer dosing in both the wastewater and advanced water treatment trains meets the treatment technique requirement for NSF-certified polymer. HRSD is using NSF-certified Clarifloc C-6260 for dewatering and thickening in the Nansemond wastewater treatment system and NSF certified Clarifloc C-6220 for flocculation and sedimentation in the SWIFT advanced water treatment system. HRSD is also continuing to apply controls on the discharge of acrylamide from industry.

[10] The measurement unit for beta particles and photon emitters is pCi/L while the MCL is expressed as mrem/yr. Per EPA's Implementation Guidance for Radionuclides (EPA 816-F-00-002, March 2002), the screening threshold for beta particles and photon emitters is 50 pCi/L. If sample concentrations exceed 50 pCi/L, each individual beta particle and photon emitter is converted from pCi/L to mrem using the EPA designated conversion tables, currently available in the referenced document.

Recharge Statistics

The total volume recharged during this operational period was 42.0 million gallons. The backflushed volume was 6.3 million gallons for a net recharge of 35.7 million gallons (Figure 3). Brief backflushing periods occur as part of routine well maintenance on an approximate daily basis. During its entire period of operation, the SRC has recharged a total volume of 330.5 million gallons.

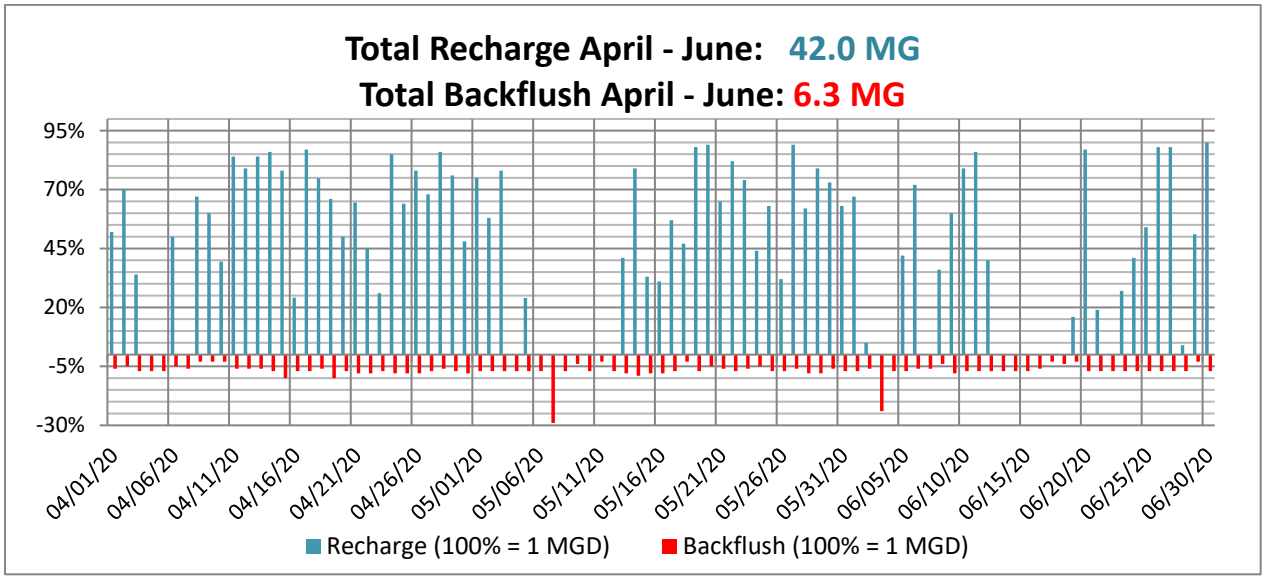

Figure 3: Recharge and Backflush Volumes, April 1 – June 30, 2020

HRSD has developed an internal target to recharge 75% of a SWIFT facility's operational capacity. This is a particularly relevant planning target for full-scale operations and HRSD is striving to meet this target at the SRC. Operational redundancies will exist at full-scale facilities (e.g., multiple recharge wells) which will likely result in a higher rate of recharge at full-scale. For this operational period, the recharge capture was 46%. Figure 4 depicts the operational activity for this monitoring period identifying the percentage of operational time spent in recharge as well as the general factors precluding recharge.

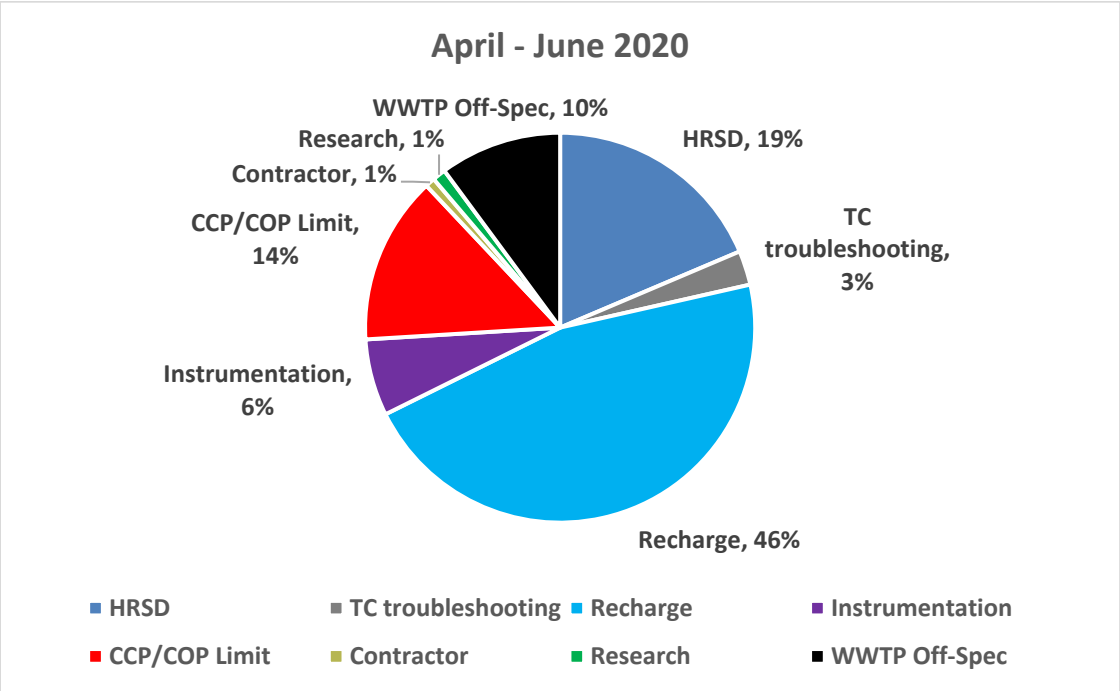

Figure 4: Operational activity for monitoring period. Notes: *Recharge*: Recharge of SWIFT Water; *TC Troubleshooting*: Period of special investigation to determine cause of TC detections (discussed elsewhere in document); *CCP/COP*: Critical Control Point/Critical Operating Parameter threshold triggered, diverting SWIFT Water from recharge well (e.g. elevated conductivity on SRC influent, elevated TOC/TN in SWIFT Water, low LRV, etc.); *WWTP Off-Spec*: Influent to the SWIFT facility (wastewater facility secondary clarifier effluent) does not meet influent quality requirements (e.g. elevated TOC or TN, or WWTP repairs; *HRSD*: Broad category covering activity within SWIFT facility that may lead to shut-down (e.g. maintenance and repairs, operational problems); *Instrumentation*: On-line analyzer and/or instrumentation maintenance and repair; *Contractor*: Recharge suspended to accommodate contractor activity at the AWT and/or recharge well; *Research*: Recharge suspended due to research-driven operational adjustments.

Conventional Monitoring Wells

The conventional monitoring well for the upper zone of the Potomac Aquifer (MW-UPA), located approximately 400 ft from the recharge well, has been routinely monitored to detect the arrival of the recharge front. As discussed in previous reports, fluoride was intended to serve as a tracer in MW-UPA but did not provide the consistent response necessary to serve as a tracer. Routine monitoring for total organic carbon (TOC) (Figure 5) alerted HRSD to the presence of recharge water in MW-UPA and routine regulatory and indicator monitoring was initiated in November 2019. Similar increases in TOC have not been observed in the monitoring wells located in the middle and lower zones of the Potomac Aquifer (MW-MPA, MW-LPA). Results for all regulatory parameters are less than the PMCL and all regulated organics were non-detect. Nitrite and arsenic observations are described in further detail in the sections below.

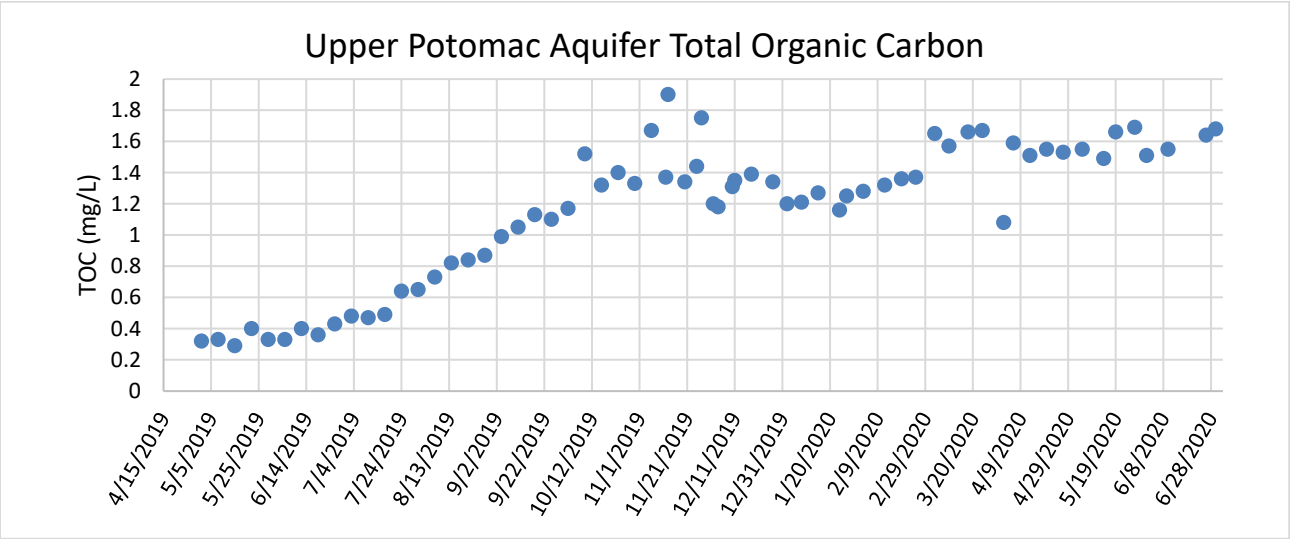

Figure 5: TOC concentration in the Upper Potomac conventional monitoring well, MW-UPA. TOC concentration in the January - June 2020 monitoring period in MW-UPA averaged 1.5 mg/L. The monthly average of SWIFT Water TOC since the start of operations is 2.5 mg/L. The monthly average for the 2018 and 2019 operational periods was 1.5 and 2.6 mg/L, respectively.

Initial monitoring identified quantifiable concentrations of the indicator compounds, 1,4 dioxane, NDMA, and sucralose in MW-UPA (Table 7). All reported values were less than the action thresholds ("trigger values") identified in Table 2 of this report. 1,4 dioxane and sucralose continue to be quantified above the reporting limit in this operational period. However, NDMA is no longer being detected above 2.00 ng/L in MW-UPA.

A bromide tracer study designed to resolve some of the existing uncertainty associated with travel time estimations is still planned for late summer-early fall of this year provided there are no further travel restrictions for Virginia Tech students as a result of the COVID-19 pandemic.

Table 7: Indicator compounds quantified in MW-UPA. Average values are not calculated when the maximum value reported represents a single sample.

	MW-UPA						SWIFT Water	
	April 2020		May 2020		June 2020		2018-2019 Operations	
Indicator	**Max**	**Avg**	**Max**	**Avg**	**Max**	**Avg**	**Max**	**Avg**
1,4 Dioxane, µg/L	0.53	0.48	0.42	0.38	0.47	0.42	0.61	0.40
NDMA, ng/L	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	8.34	1.07
Sucralose, ng/L	310	-	140	-	<100	-	780	175

Nitrite in MW-SAT Update

HRSD continues to monitor nitrite levels within the monitoring well located 50 ft from the recharge well, MW-SAT, and the conventional wells to better understand the occurrence of in situ partial denitrification and the potential for nitrite migration with the recharge front. The maximum nitrite concentration was quantified in screen interval 9 in April at 0.29 mg/L. Nitrite concentration in the remaining screen intervals for this monitoring period was < 0.1 mg/L. Nitrite concentration in SWIFT Water during this operational period was < 0.1 mg/L (Table 6).

As described above, recharge water is being detected in the upper zone of the Potomac in the conventional monitoring well, MW-UPA. Nitrite concentrations in MW-UPA during this monitoring period remain <0.01 mg/L.

Arsenic in MW-SAT Update

HRSD continues to closely track arsenic concentrations in MW-SAT following an observed increase in arsenic in screen interval 9 in May 2019. In this monitoring period, screen interval 8 had the highest observable arsenic concentration at 4.30 µg/L in the month of April. All other samples collected during this quarterly monitoring period for screen interval 8 were < 3 µg/L. Sample results for screen intervals with an observed a maximum monthly concentration > 1.50 µg/L are documented in Table 8.

As described above, recharge water is being detected in the upper zone of the Potomac in the conventional monitoring well, MW-UPA. The concentration of arsenic in MW-UPA during this monitoring period remained <1.00 µg/L.

Table 8: Total arsenic concentration in selected screen intervals of MW-SAT. Total arsenic concentration in the remaining screen intervals was ≤ 1.50 µg/L in each month of the monitoring period. Total arsenic concentration in the conventional monitoring wells, MW-UPA, MW-MPA and MW-LPA as well as SWIFT Water remained <1.00 µg/L during the monitoring period.

MW-Sat Screen	Total Arsenic, µg/L					
	April		May		June	
	Max	Avg	Max	Avg	Max	Avg
2	1.25	0.89	1.99	1.24	1.88	1.21
3	1.86	1.52	2.63	2.18	2.25	1.96
8	4.30	2.35	2.63	1.90	2.76	2.17
9	1.71	1.39	2.55	2.48	3.25	2.66

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	April 2020			May 2020			June 2020		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	**3.74**	**4.45**	**25**	**3.14**	**4.66**	**20**	**3.01**	**4.13**	**17**
NO_3	mg/L	10	0.01	Daily[3]	**3.14**	**3.89**	**25**	**2.67**	**4.19**	**20**	**2.38**	**3.52**	**17**
NO_2	mg/L	1	0.01	Daily[3]	**<0.01**	**<0.01**	**25**	**<0.01**	**0.01**	**20**	**0.01**	**0.07**	**17**
Turbidity	NTU	NA	0.01	Continuous	**Figure 1**								
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	**3.40**	**3.67**	**18**	**3.49**	**3.89**	**14**	**3.71**	**4.07**	**14**
pH		NA	NA	Continuous	**Figure 2**								
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		**709**	**1**		**729**	**1**		**654**	**1**
Microorganisms													
Total Coliform[5]	MPN/100 mL	MCLG = 0	1	Daily[3]	**<1**	**9**	**25**	**<1**	**<1**	**20**	**<1**	**1**	**16**
E. coli[6]	MPN/100 mL	NA	1	Weekly	**<1**	**<1**	**25**	**<1**	**<1**	**20**	**<1**	**1**	**16**
Cryptosporidium	oocysts/L	Treatment Technique, MCLG = 0	0.093	Quarterly		**<0.093**	**1**						
Giardia lamblia	oocysts/L	Treatment Technique, MCLG = 0	0.093	Quarterly		**<0.093**	**1**						
Legionella	MPN/100 mL	Treatment Technique, MCLG = 0	10	Quarterly		**<10**	**1**						
Disinfection Byproducts													
Bromate	µg/L	10	0.15	Monthly		**3.77**	**1**		**1.58**	**1**		**4.07**	**1**
Chlorite	mg/L	1.0	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Trihalomethanes[7]													
Bromodichloromethane	µg/L		1.00	Monthly		**<1.00**	**1**		**1.13**	**1**		**1.00**	**1**
Bromoform	µg/L		1.00	Monthly		**4.22**	**1**		**4.52**	**1**		**6.37**	**1**
Chloroform	µg/L		1.00	Monthly		**<1.00**	**1**		**<1.00**	**1**		**<1.00**	**1**
Dibromochloromethane	µg/L		1.00	Monthly		**2.28**	**1**		**3.12**	**1**		**3.00**	**1**
Total Trihalomethanes	µg/L	80				**6.50**			**8.77**			**10.4**	
HAAs[7]													
Dichloroacetic acid	µg/L		0.60	Monthly		**1.03**	**1**		**1.23**	**1**		**1.32**	**1**
Trichloroacetic acid	µg/L		0.20	Monthly		**0.44**	**1**		**0.52**	**1**		**0.60**	**1**
Monochloroacetic acid	µg/L		0.60	Monthly		**<0.60**	**1**		**<0.60**	**1**		**<0.60**	**1**
Bromoacetic acid	µg/L		0.40	Monthly		**0.88**	**1**		**0.62**	**1**		**0.84**	**1**
Dibromoacetic acid	µg/L		0.20	Monthly		**8.54**	**1**		**6.22**	**1**		**7.97**	**1**
Total Haloacetic Acids	µg/L	60				**10.9**			**8.59**			**10.7**	
Disinfectants[7,8]													
Monochloramine (as Cl_2)	mg/L	4		Continuous	**0.03**	**1.58**		**0.02**	**0.63**		**0.01**	**0.32**	
Chlorine (as Cl_2)	mg/L	4		Continuous	**0.60**	**0.84**		**0.68**	**1.70**		**0.99**	**2.71**	
Inorganic Chemical													
Antimony	µg/L	6	0.5	Monthly		**<0.5**	**1**		**0.6**	**1**		**0.6**	**1**
Arsenic	µg/L	10	1	Monthly		**<1**	**1**		**0.9**	**1**		**0.8**	**1**

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	April 2020			May 2020			June 2020		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Asbestos	MFL	7	0.2	Monthly		<0.2	1		<0.2	1		<0.2	1
Barium	mg/L	2	0.005	Monthly		0.007	1		0.007	1		0.008	1
Beryllium	µg/L	4	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Cadmium	µg/L	5	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Chromium (total)	µg/L	100	5*	Monthly		<5	1		<2.5	1		<2.5	1
Copper	mg/L	1.3 (action level)	0.005	Monthly		<0.005	1		<0.005	1		<0.005	1
Cyanide (total)	µg/L	200	10	Monthly		<10	1		<10	1		<10	1
Fluoride	mg/L	4.0	0.100	Monthly	0.819	0.896	25	0.826	0.941	20	0.820	0.935	17
Lead	µg/L	15 (action level)	0.5*	Monthly		<0.1	1		<0.5	1		<0.1	1
Mercury	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Selenium	µg/L	50	5	Monthly		<5	1		<5	1		<5	1
Thallium	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Organic Chemicals													
Acrylamide[9]	µg/L	Treatment Technique, MCLG = 0	0.1	Monthly		0.29	1		<0.1	1		0.18	1
Alachlor	µg/L	2	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Atrazine	µg/L	3	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Benzo(a)pyrene (PAHs)	µg/L	0.2	0.02	Monthly		<0.02	1		<0.02	1		<0.02 (S6)	1
Di(2-ethylhexyl) adipate	µg/L	400	0.6	Monthly		<0.6	1		<0.6	1		<0.6	1
Di(2-ethylhexyl) phthalate	µg/L	6	0.6	Monthly		<0.6	1		<0.6	1		<0.6 (S6)	1
Hexachlorocyclopentadiene	µg/L	50	0.05	Monthly		<0.05	1		<0.05 (LE)	1		<0.05	1
Hexachlorobenzene	µg/L	1	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Simazine	µg/L	4	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Carbofuran	µg/L	40	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
Oxamyl (Vydate)	µg/L	200	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
Chlordane	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Endrin	µg/L	2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Heptachlor	µg/L	0.4	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Heptachlor Epoxide	µg/L	0.2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Lindane	µg/L	0.2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Methoxychlor	µg/L	40	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Toxaphene	µg/L	3	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
PCB Arochlor1016	µg/L		0.08	Monthly		<0.08	1		<0.08	1		<0.08	1
PCB Arochlor1221	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1232	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1242	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1248	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1254	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1260	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Total Polychlorinated Biphenyls (PCBs)	µg/L	0.5											
2,4-D	µg/L	70	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Dalapon	µg/L	200	1	Monthly		<1	1		<1	1		<1	1

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	April 2020			May 2020			June 2020		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Picloram	µg/L	500	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
2,4,5-TP (Silvex)	µg/L	50	0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**<0.2**	**1**
Dinoseb	µg/L	7	0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**<0.2**	**1**
Pentachlorophenol	µg/L	1	0.04	Monthly		**<0.04**	**1**		**<0.04**	**1**		**<0.04**	**1**
Dioxin (2,3,7,8-TCDD)	pg/L	30	5	Monthly		**<5**	**1**		**<5**	**1**		**<5**	**1**
Diquat	µg/L	20	0.4	Monthly		**<0.4**	**1**		**<0.4**	**1**		**<0.4**	**1**
Endothall	µg/L	100	5	Monthly		**<5**	**1**		**<5**	**1**		**<5**	**1**
Epichlorohydrin	µg/L	Treatment Technique, MCLG = 0	4	Monthly		**<4**	**1**		**<4**	**1**		**<0.4**	**1**
Glycophosphate	µg/L	700	6	Monthly		**<6**	**1**		**<6**	**1**		**<6**	**1**
Benzene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Carbon Tetrachloride	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Chlorobenzene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
2-dibromo-3-chloropropane (DBCP)	µg/L	0.2	0.02	Monthly		**<0.02**	**1**		**<0.02**	**1**		**<0.02**	**1**
o-Dichlororbenzene	µg/L	600	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
p-Dichlorobenzene	µg/L	75	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2-Dichloroethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1-Dichlororethylene	µg/L	7	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
cis-1,2-Dichloroethylene	µg/L	70	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
trans-1,2-Dichloroethylene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Dichloromethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2-Dichloropropane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Ethylbenzene	µg/L	700	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Ethylene Dibromide (EDB)	µg/L	0.05	0.02	Monthly		**<0.02**	**1**		**<0.02**	**1**		**<0.02**	**1**
Styrene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Tetrachloroethylene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Toluene	µg/L	1,000	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2,4-Trichlorobenzene	µg/L	70	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1,1-Trichloroethane	µg/L	200	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1,2-Trichloroethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Trichloroethylene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Vinyl Chloride	µg/L	2	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
p/m-Xylene	µg/L			Monthly									
o-Xylene	µg/L			Monthly									
Total Xylene	µg/L	10,000	3	Monthly		**<3**	**1**		**<3**	**1**		**<3**	**1**

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	April 2020			May 2020			June 2020		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Radionuclides													
Alpha particles	pCi/L	15	3	Monthly		**<3**	**1**		**<3**	**1**		**<3**	**1**
Beta particles and photon emitters	pCi/L	4 mrem/yr[10]	3	Monthly		**18**	**1**		**16**	**1**		**16**	**1**
Radium 226	pCi/L	5 (226+228)	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Radium 228	pCi/L	5 (226+228)	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Uranium	µg/L	30	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Strontium-90	pCi/L	NA	1.06	Monthly		**<1.06**	**1**		**<0.521**	**1**		**<0.951**	**1**
Tritium	pCi/L	NA	376	Monthly		**<376**	**1**		**<348**	**1**		**<355**	**1**
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	**0.37**	**0.40**	**5**	**0.31**	**0.35**	**4**	**0.31**	**0.33**	**4**
17-β-estradiol	ng/L	TBD	0.42	Quarterly		**<0.42**	**1**						
DEET	ng/L	200,000	10	Quarterly		**<10**	**1**						
Ethinyl estradiol	ng/L	TBD	0.95	Quarterly		**<0.95 (S6)**	**1**						
s(2-carboxyethyl)phosphine (TCEP)	ng/L	5,000	10	Quarterly		**<10**	**1**						
NDMA	ng/L	10	2	Quarterly	**<2**	**<2**	**5**	**<2**	**<2**	**4**	**<2**	**<2**	**4**
Perchlorate	µg/L	6	0.5	Quarterly		**<0.5**	**1**						
Perfluorooctanoic Acid (PFOA)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly					**5.7**	**1**			
erfluorooctanesulfonic Acid (PFOS)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly					**<2**	**1**			
Treatment Efficacy Indicators		**Trigger Limits**											
Cotinine	ng/L	1,000	10	Quarterly		**26**	**1**						
Primidone	ng/L	10,000	5	Quarterly		**11**	**1**						
Phenytoin (Dilantin)	ng/L	2,000	20	Quarterly		**<20**	**1**						
Meprobamate	ng/L	200,000	5	Quarterly		**<5 (R7)**	**1**						
Atenolol	ng/L	4,000	5	Quarterly		**<5**	**1**						
Carbamazepine	ng/L	10,000	5	Quarterly		**<5**	**1**						
Estrone	ng/L	320,000	2.1	Quarterly		**<2.1**	**1**						
Sucralose	ng/L	150,000,000	1000	Quarterly		**11000**	**1**						
Triclosan	ng/L	210,000	200	Quarterly		**<200**	**1**						

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	April 2020			May 2020			June 2020		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV				Continuous	**4.57**	**3.82**		**4.51**	**3.89**		**4.50**	**4.13**	
Ozone Giardia LRV				Continuous	**2.36**	**1.95**		**2.29**	**1.97**		**2.13**	**1.94**	
UV Dose Reactor 1	mJ/cm^2			Continuous	**>186**	**>186**		**>186**	**>186**		**>186**	**>186**	
UV Virus LRV Reactor 1				Continuous	**>4**	**>4**		**>4**	**>4**		**>4**	**>4**	
UV Dose Reactor 2	mJ/cm^2			Continuous	**>186**	**>186**		**>186**	**>186**		**>186**	**>186**	
UV Virus LRV Reactor 2				Continuous	**>4**	**>4**		**>4**	**>4**		**>4**	**>4**	

[1] When minimum reporting limits varied during the quarter, the highest minumum reporting limit used is identified.

[2] Analytical results less than the reporting limit were treated as zero for the purposes of the averaging calculation.

[3] Daily samples are typically not collected on days in which there is no or limited recharge. TOC sample collection occurs routinely on Monday through Friday when recharging. Limited or inconsistent recharge impacts the collection of daily samples, particularly for the microbiological samples collected for total coliform and e coli which have limited holding time requirements. In April, recharge did not occur on 3 days and limited time periods of recharge impeded sampling on 2 additional days. In May, recharge did not occur on 8 days and limited time periods of recharge impeded sampling on 3 additional days. In June, recharge did not occur on 10 days and limited time periods of recharge impeded sampling on 3 additional days.

[4] TDS of the Potomac Aquifer System is based on the averages within the upper, middle and lower Potomac Aquifer as determined during baseline montioring.

[5] The total coliform sample analysis for June 2 failed QC requirements. Please refer to total coliform narrative in report for further information on total coliform detections in April and June.

[6] E coli was detected in the June 25 sample. The duplicate analysis was non-detect and the June 26 sample was non-detect. Sample contamination is suspected. Please see the narrative on total coliform for additional information.

[7] Free chlorine was used as an alternative to monochloramine to prevent biofouling of the well post-UV disinfection during this operational period.

[8] The maximum residual disinfectant level (or MRDL) MCL for monochloramine and chlorine are based on annual averages.

[9] Acrylamide was detected in SWIFT Water in April and June. HRSD polymer dosing in both the wastewater and advanced water treatment trains meets the treatment technique requirement for NSF-certified polymer. HRSD is using NSF-certified Clarifloc C-6260 for dewatering and thickening in the Nansemond wastewater treatment system and NSF certified Clarifloc C-6220 for flocculation and sedimentation in the SWIFT advanced water treatment system. HRSD is also continuing to apply controls on the discharge of acrylamide from industry.

[10] The measurement unit for beta particles and photon emitters is pCi/L while the MCL is expressed as mrem/yr. Per EPA's Implementation Guidance for Radionuclides (EPA 816-F-00-002, March 2002), the screening threshold for beta particles and photon emitters is 50 pCi/L. If sample concentrations exceed 50 pCi/L, each individual beta particle and photon emitter is converted from pCi/L to mrem using the EPA designated conversion tables, currently available in the referenced document.

Contract Laboratory Flags
(S6) - Surrogate recovery was below laboratory and method acceptance limits. Re-extraction and/or reanalysis confirms low recovery caused by matrix effect.
(LE) - MRL Check recovery was above laboratory acceptance limits.
(R7) - LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.