Attachment D: Injection Operation and Monitoring Program

D.1 Part I Facility Information

D.1.1 Flow Diagram of Fluid Flow through the Facility

A process flow diagram of the James River SWIFT treatment process is shown in Figure D.1. The full treatment process provides a multiple barrier approach to the control of contaminants and pathogens and produces a SWIFT Water which meets the Safe Drinking Water Act (SDWA) Primary Maximum Contaminant Levels (PMCLs). The SWIFT process consists of rapid mix with coagulant addition, flocculation and sedimentation, ozone oxidation, biologically active carbon filtration (BAF), GAC adsorption, and ultraviolet (UV) disinfection. This is the same treatment process that has been proven during pilot testing conducted in 2016-2017 and at the SWIFT Research Center (SRC) in 2018-2020. A more detailed description of the SWIFT process and the SWIFT Water regulatory requirements can be found in Appendix A, James River SWIFT Water Quality Targets.

A major upgrade to the existing JR Treatment Plant will be constructed concurrently with the SWIFT facilities. This will improve the quality and consistency of the secondary effluent that will in turn increase the quality and consistency of the SWIFT Water. Improvements include flow equalization in the interceptor system, new secondary clarifiers, and process upgrades for nitrogen treatment. The primary objectives of the improvements are to provide consistent flows and nutrient loads to SWIFT.

Following is a brief description of each treatment process with accompanying design criteria listed in Table D.1 for both JR SWIFT and the SRC:

- **Rapid Mix, Flocculation, Sedimentation:** Chemical coagulant and an organic polyelectrolyte will be added to the water to remove particles and dissolved organics through the formation and settling of chemical flocs and to prepare the water for effective filtration. The chemical coagulant is anticipated to be aluminum chlorohydrate (ACH) subject to change based on the results of bench-scale testing for this facility.
- **Ozone Oxidation:** Ozone will be added to oxidize high molecular weight organics for downstream removal in biofiltration and for direct oxidation of trace organics (e.g., contaminants of emerging concern such as pharmaceuticals and personal care products). Disinfection of pathogens will also be achieved with ozone addition though disinfection credit is not being claimed for this unit process. A hydrogen peroxide addition point will be added upstream of ozone injection such that ozone can be operated as an advanced oxidation process (AOP) for additional 1,4-dioxane removal.
- **Biofiltration (BAF):** Deep-bed granular media filters will provide biological removal of organic matter and particle and pathogen removal. Low filtered water turbidity (<0.15 nephelometric turbidity units [NTU]) will be targeted to ensure proper pathogen removal consistent with the design and operation of drinking water filters (see D.1.3.5 Critical Control Points below).
- **GAC Adsorption:** Granular activated carbon will provide removal of trace organics through biological and adsorption mechanisms. GAC media will be regenerated to meet the

proposed regulatory limit for total organic carbon (Table D.1) or per D.1.3.3 below, based on an assessment of the removal of non-regulatory performance indicators.

- **UV Disinfection:** UV irradiation will provide disinfection of the water before groundwater injection. A UV dose that is significantly higher than typically used for drinking water is being provided for JR SWIFT to allow for a minimum of 4-log virus removal (>186 mJ/cm2) and other treatment benefits, specifically NDMA photolysis during the startup and acclimation period prior to achieving necessary NDMA removal through BAF. Similar to ozone, a hydrogen peroxide addition point will be added upstream of UV and equipment will be selected to allow the UV system to be operated as an AOP for additional 1,4-dioxane removal.
- **pH & Alkalinity Adjustment for Aquifer Compatibility:** Sodium hydroxide will be used to adjust the final pH and alkalinity of the SWIFT Water prior to recharge at JR SWIFT, similar to the SRC. The pH target at the SRC is 7.6, and sodium hydroxide is added to raise the pH from nominally 7.0 (after UV). Raising the pH achieves two objectives: increasing the Langelier Saturation Index (LSI) to reduce the potential for corrosion in the recharge well and promoting the formation of hydrous ferric oxide (HFO) surfaces in the aquifer to limit metals mobilization. Many variables affect the pH target, including SWIFT Water alkalinity and dissolved oxygen and the aquifer oxidation-reduction potential (ORP), among otherss. HRSD is currently working on improving the understanding of both of these pH objectives at the SRC and will propose new pH and alkalinity targets prior to startup of JR SWIFT. It is likely that the pH target will be a function of the aquifer ORP and SWIFT Water alkalinity, and that it will decline over the course of operation.
- **Recharge Well Biofouling Control:** JR SWIFT will allow for the controlled addition of either free chlorine, preformed monochloramine, or hydrogen peroxide prior to the recharge well to prevent biological fouling of the well. Free chlorine will be utilized as needed to control nitrite during initial biofilter acclimation (i.e., prior to colonization of nitrite oxidizing bacteria during biofilter start-up). Free chlorine may also be used for an extended period of time to better manage biofouling in the well and coliform bacteria control. Hydrogen peroxide residual will only be used for biofouling control if UV advanced oxidation (UV + H_2O_2) is being performed for other water quality benefits, as this will likely result in an acceptable residual.

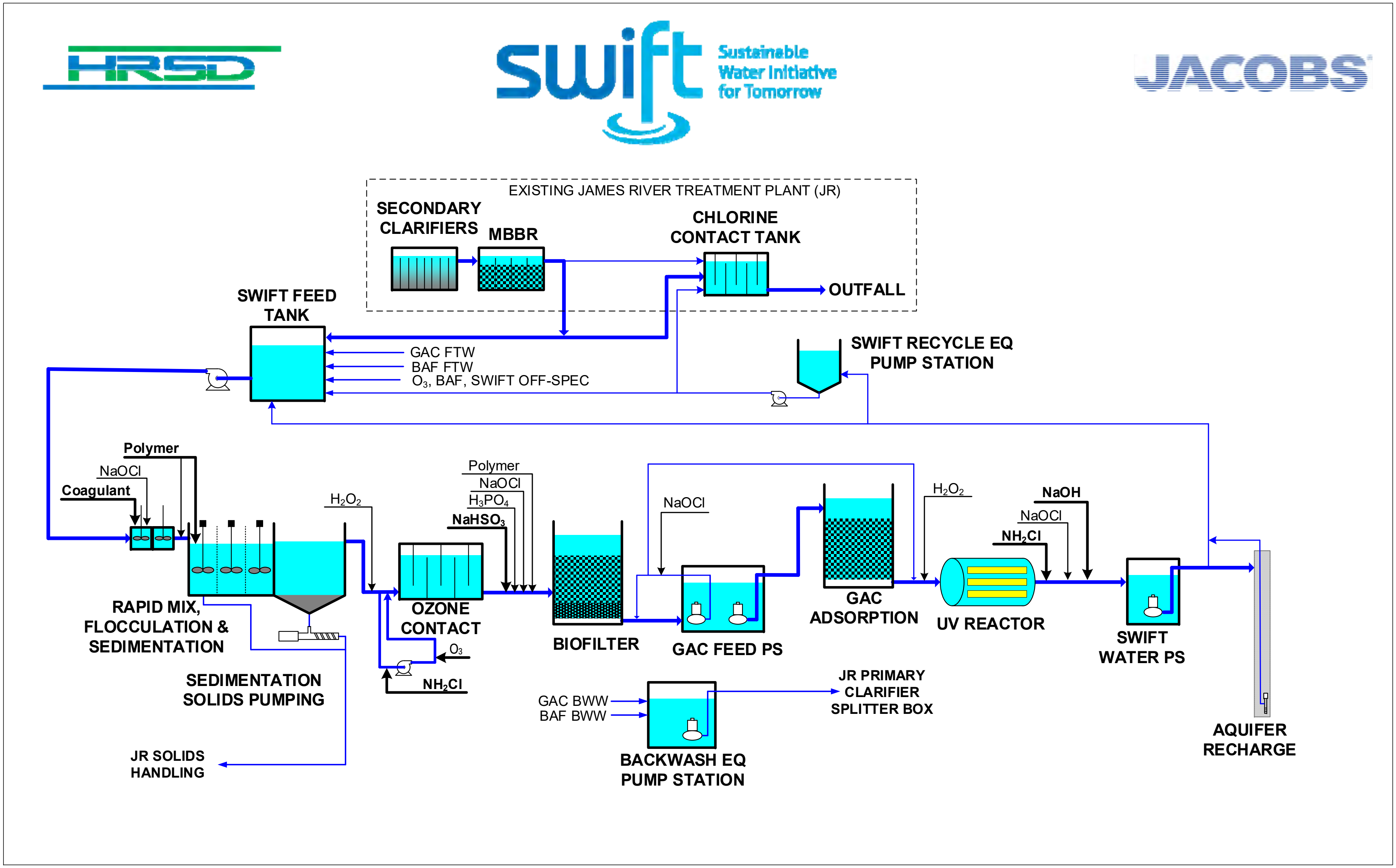

Figure D.1: JR SWIFT Process Flow Diagram

D.1.2 Contingency Plan

JR SWIFT Water will meet drinking water standards and will recharge the Potomac Aquifer System (PAS), identified as a potable water supply in Virginia. There is no contingency plan(s) to cope specifically with well failure as HRSD will maintain its Virginia Pollutant Discharge Elimination System (VPDES) permit which allows for discharge to surface waters. Automated Critical Control Points (CCPs) in the SWIFT Advanced Water Treatment facility (AWT) will prevent discharging effluent into the PAS that fails to meet PMCL's. HRSD has tied feedback from the CCP's into the AWT's Distributed Control System (DCS, HRSD's supervisory control automated data acquisition [SCADA] system. The DCS system automatically shuts down recharge flow to the MAR wells and diverts it to the outfall system should a water quality parameter or other index fall outside of programed limits. CCPs are described further in Section D.1.3.5 Monitoring Injection Fluids, below.

HRSD will monitor SWIFT Water recharge within the aquifer through the monitoring well nests. Appendix B, Aquifer Monitoring and Contingency Plan, describes the planned groundwater monitoring in detail. This document details a Contingency Plan should HRSD find that SWIFT Water that exceeded the PMCL was recharged to the aquifer or that an exceedance of the PMCL is observed in data collected from the monitoring wells. The plan includes notifying the agency, re-sampling, and providing additional information to the agency on measures taken to correct WQ issues.

JR SWIFT monitoring wells will be installed within the Area Boundary (shown in Attachment A, Figure A.1) at locations equidistant between two of the MAR wells; approximately 500 to 600 feet from a MAR well which equates to 1.5X total aquifer thickness is preferred for siting monitoring wells.

D.1.3 Drawing of the Surface Construction

Figures D.2 through D.7 show the surface construction of the MAR Facilities, including:

- wellhead assembly
- location of flow meter, flow totalizers
- location of injection pressure and annulus pressure gauges.

Figures D.2 and D.5 depict the two MAR well house configurations: On-Site at JR SWIFT property, and Off-Site proximal to the JR SWIFT property. Off-site areas surrounding JR SWIFT consist of a municipal parks and playground operated by the City of Newport News. The footprint of those facilities located Off-Site is reduced to minimize the impact to recreational activities near those sites. See Attachment A for approximate locations of the MAR wells.

Figures D.3 and D.4 show the wellhead piping assembly, valves, flow meters/totalizers and indicates the location of pressure monitoring at the On-Site MAR well facilities.

Figures D.6 and D.7 show the wellhead piping assembly, valves, flow meters/totalizers and indicate the location of pressure monitoring at the Off-Site MAR well facilities.

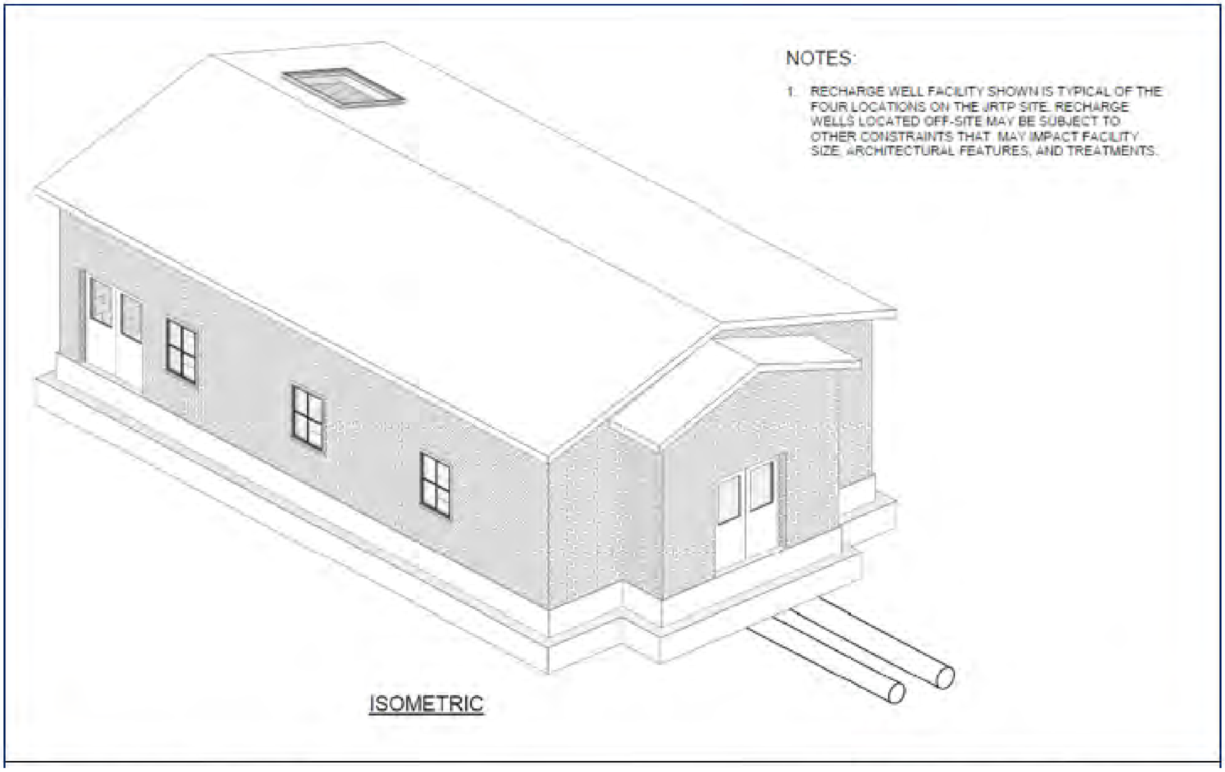

Figure D.2: Surface construction around MAR wells on-site at the James River SWIFT Facility. Figure taken from bridging documents prepared by Hazen and Sawyer for James River SWIFT and Nutrient Upgrade.

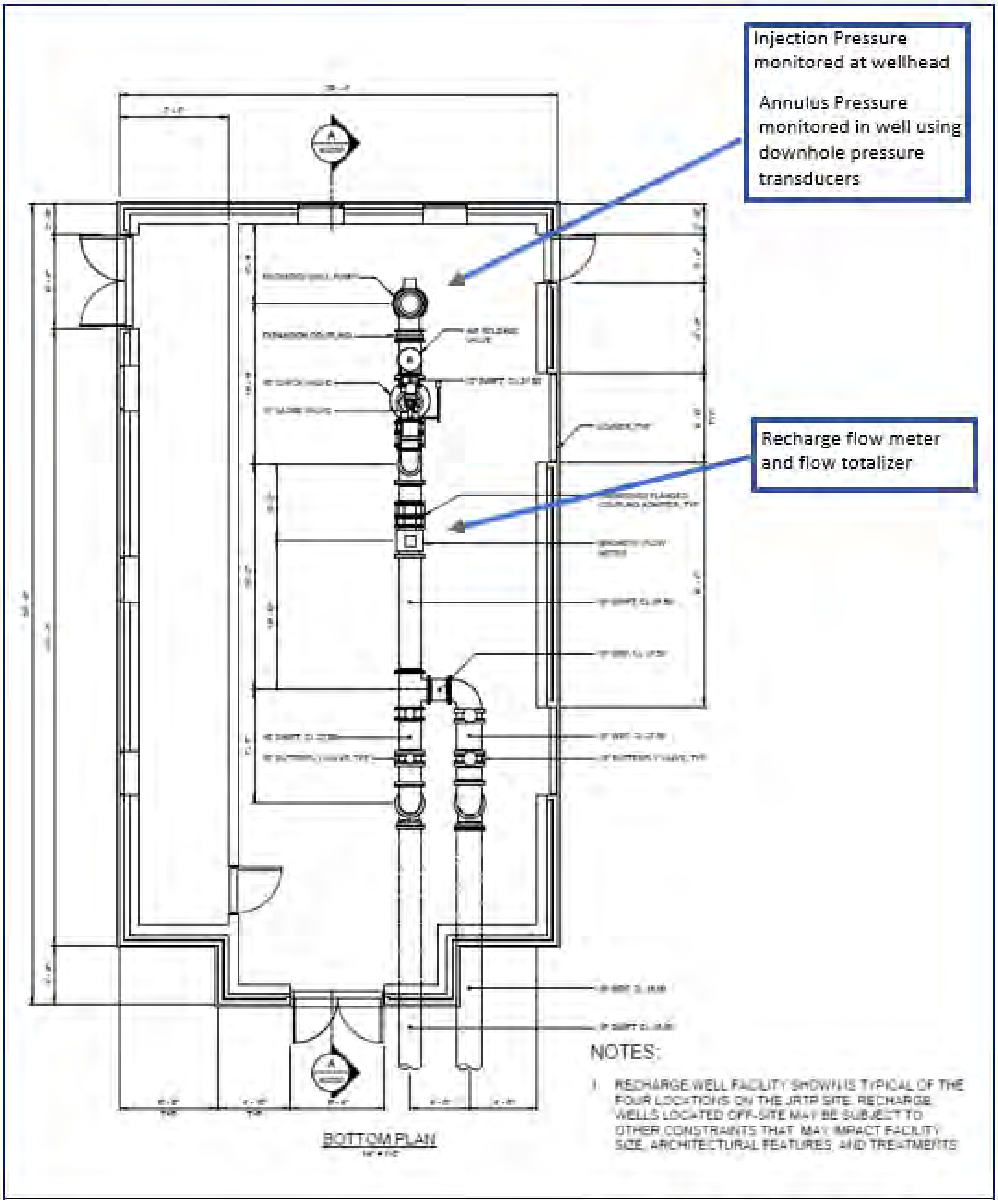

Figure D.3: Planview of surface construction around MAR wells on-site at the James River SWIFT Facility. Figure taken from bridging documents prepared by Hazen and Sawyer for James River SWIFT and Nutrient Upgrade.

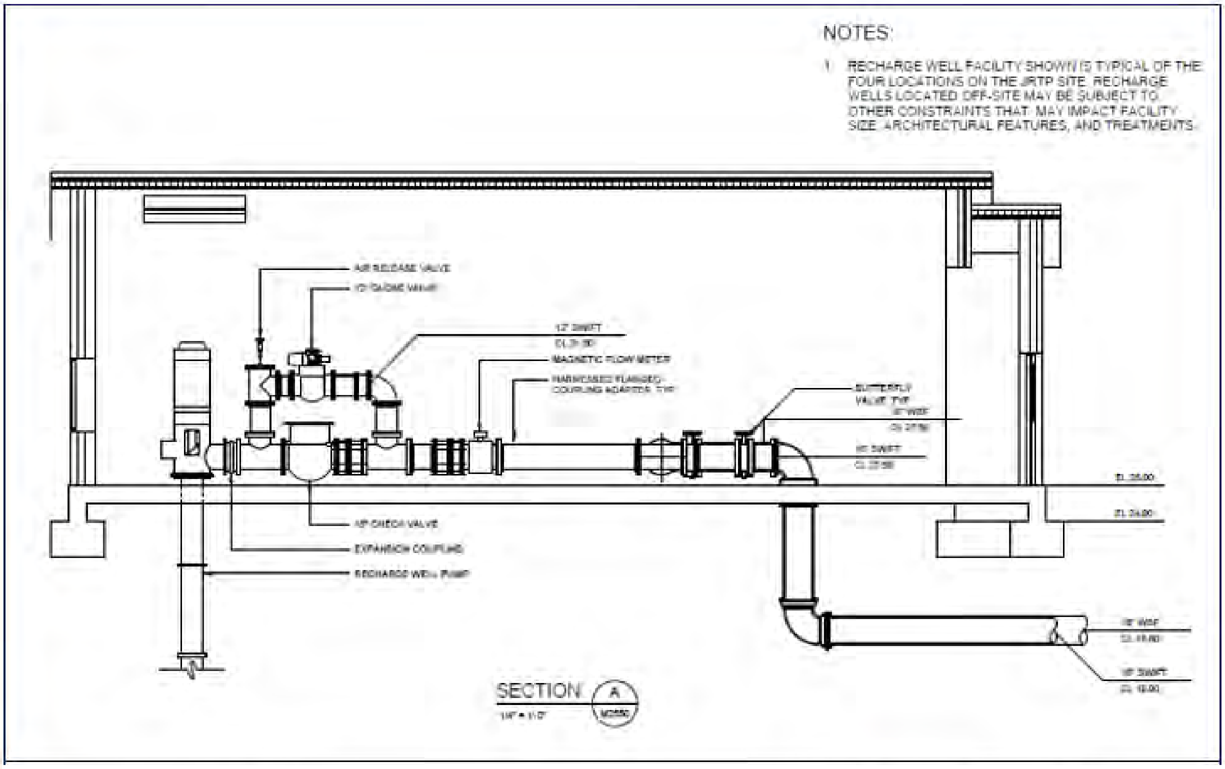

Figure D.4: Profile of surface construction around MAR wells on-site at the James River SWIFT Facility. Figure taken from bridging documents prepared by Hazen and Sawyer for James River SWIFT and Nutrient Upgrade.

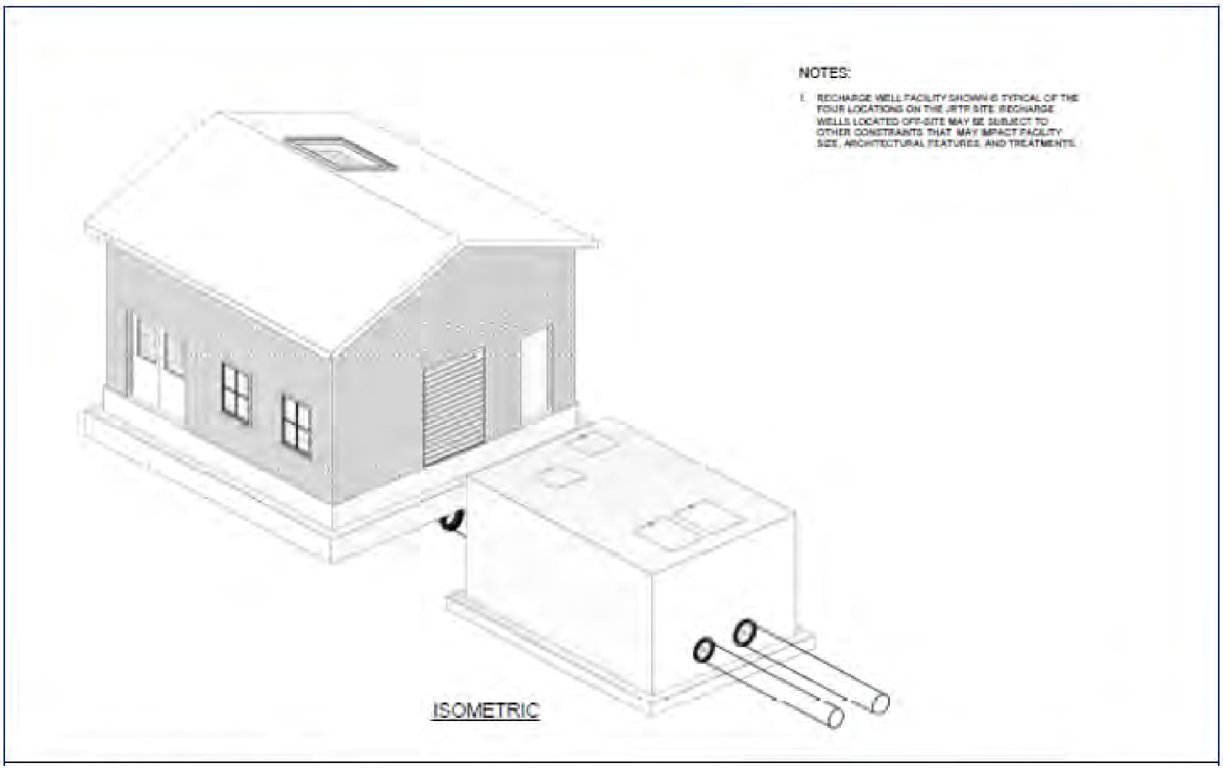

Figure D.5: Surface construction around MAR wells located off-site but proximal to the James River SWIFT Facility. Figure taken from bridging documents prepared by Hazen and Sawyer for James River SWIFT and Nutrient Upgrade.

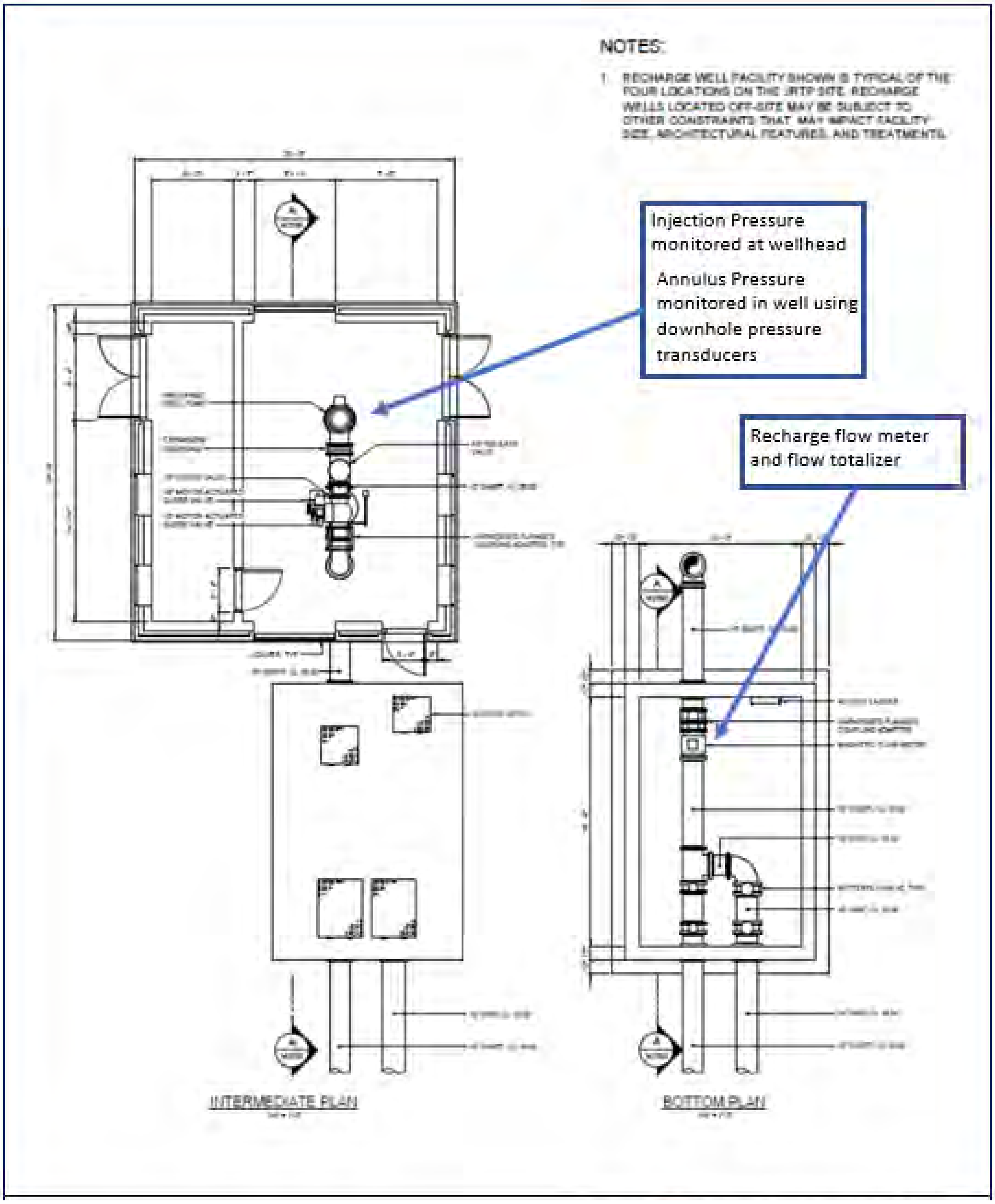

Figure D.6: Planview of surface construction around MAR wells located off-site but proximal to the James River SWIFT Facility. Figure taken from bridging documents prepared by Hazen and Sawyer for James River SWIFT and Nutrient Upgrade.

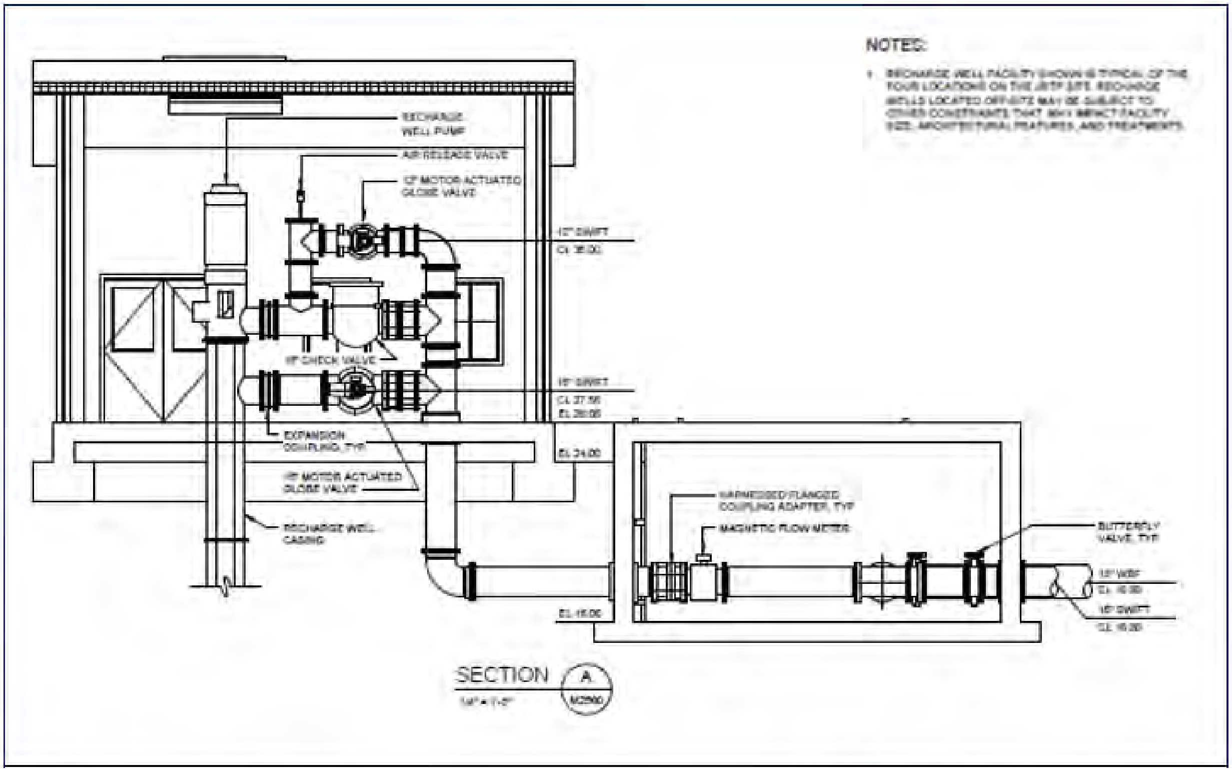

Figure D.7: Profile of surface construction around MAR wells located off-site but proximal to the James River SWIFT Facility. Figure taken from bridging documents prepared by Hazen and Sawyer for James River SWIFT and Nutrient Upgrade.

D.1.3 Monitoring of Injection Fluids

D.1.3.1. JR SWIFT Regulatory Limits

SWIFT Water regulatory requirements are outlined in detail in Appendix A, James River SWIFT Water Quality Targets. Briefly, Table D.1 provides a list of the regulatory limits for JR SWIFT. Most parameters have a treatment goal in addition to the regulatory limit. The treatment goals will be supported by Critical Control Points identified in Table D.5. Table D.1 presents the complete list of regulatory requirements for JR SWIFT Water to recharge to the PAS. Quarterly reports detailing compliance with the regulatory limits will be provided to the U.S. Environmental Protection Agency (EPA) and the PAROC.

Table D.1: Regulatory Limits for SWIFT Water

Parameter	Regulatory Limit
EPA Drinking Water Primary Maximum Contaminant Levels (PMCLs)	Meet all PMCLs[1]
Total Nitrogen (TN)	5 mg/L Monthly Average; 8 mg/L Max Daily
Turbidity	Individual Filter Effluent (IFE) <0.15 NTU 95% of time and never >0.3 NTU in two consecutive 15-minute measurements
Total Organic Carbon (TOC)[2]	4 mg/L Monthly Average, 5 mg/L Maximum Instantaneous
Total Coliform[3]	<2 CFU/100 mL 95% of collected samples within one calendar month, applied as the 95th percentile
E. Coli	Non-Detect
TDS[4]	No Limit

1 Refer to Table D.7 for proposed sampling frequency of PMCLs. Within 24 hours of notification from HRSD or contract laboratory of a potential PMCL exceedance as identified in Table D.2, SWIFT Water will be diverted to the wastewater treatment facility. A confirmation sample will be collected and submitted for analysis as soon as practical and no later than one week after receiving the initial sample results. If the confirmation sample does not confirm the result, recharge will resume. If the PMCL exceedance is confirmed, SWIFT Water will remain diverted until HRSD can complete an investigation as to the likely cause, take corrective action, and perform follow-up sampling to demonstrate that the corrective actions taken have been effective. HRSD will submit documentation describing the problem, the assessment, the corrective action taken, and the results of follow-up sampling within 14 days of resuming recharge.

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

3 The TC monitoring requirement at the SRC included compliance with a geomean of 3 CFU/100 mL for 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 geomean requirement and the application of both regulatory limits was not necessary.

4 No limit for TDS as the primary driver is aquifer compatibility. Expected range for SWIFT Water at JR SWIFT is 300-700 mg/L.

D.1.3.2. Compliance Determination

The methodology for determining PMCL compliance varies depending on the specific parameter of interest. Consistent with Virginia Waterworks Regulation, 12VAC5-590-410, the constituents are categorized into groups, and for each constituent group PMCL compliance is determined by either a running annual average (RAA) or as a single-instance limit. Constituents regulated on a RAA basis are in violation when the RAA exceeds the numerical PMCL. Constituents regulated on a single-instance limit are in violation when the results of any single sample exceed the numerical PMCL. In all cases, compliance shall be determined by rounding off results to the same number of significant figures as the PMCL. Further details on compliance evaluations and calculations can be found in Appendix A, James River SWIFT Water Quality Targets.

Table D.2: JR SWIFT Primary Maximum Contaminant Level Compliance Determination

Analytes	SWIFT Water Monitoring Frequency[1]	Compliance Determination
Total coliform	5x/week	TC < 2 CFU/100 mL 95% of collected samples within one calendar month[2]
E coli	5x/week	Non-detect
Antimony, arsenic, barium, beryllium, cadmium, cyanide, chromium, fluoride, mercury, nickel, selenium, thallium	Monthly	Compliance with the PMCL is determined by a Running Annual Average (RAA). If the average is greater than the PMCL, the PMCL has been exceeded.
Asbestos	Quarterly	Compliance with the PMCL is determined by a Running Annual Average (RAA). If the average is greater than the PMCL, the PMCL has been exceeded.
Nitrate, Nitrite	5x/week	Compliance for these constituent groups is to be determined based on individual sample results. If any single sample is greater than the PMCL, the PMCL has been exceeded.
Organic chemicals	Monthly	Compliance with the PMCL is determined by a Running Annual Average (RAA). If the average is greater than the PMCL, the PMCL has been exceeded.
Disinfection byproducts (TTHM and HAA5), Bromate, Chlorite	Monthly	Compliance with the PMCL is determined by a RAA of monthly data. If the average is greater than the PMCL, the PMCL has been exceeded.
Radionuclides	Monthly	Compliance for these constituent groups is to be determined based on individual sample results. If any single sample is greater than the PMCL, the PMCL has been exceeded.

[1] Minimum required monitoring frequency. All data collected during recharge operations and when the SWIFT facility is shut down due to a PMCL exceedance shall be reported and included in the compliance determination calculations. Data collected during a planned shutdown (such as a GAC contactor re-start) or during a pre-emptive shut down (such as when a CCP triggers a diversion of SWIFT water) are exempt from this requirement.

[2] If TC exceeds 2 CFU/100 mL > 95 % of samples (calculated by the 95th percentile) in one calendar month, HRSD will conduct an additional investigation (e.g., evaluating sample collection and training protocols, possible sample line contamination, etc.) A TC exceedance is not considered a PMCL exceedance unless E. coli is present. The results of the investigation will be included in the next quarterly report.

D.1.3.3. Performance Indicators

Table D.3 provides a list of performance indicators. These constituents are separated into those that are of public health interest and those that provide information on the effectiveness of treatment (*Final Report of an NWRI Independent Advisory Panel: Recommended DPR General Guidelines and Operational Requirements for New Mexico, 2016*). If the running annual average for any of the threshold values shown in Table D.3 is exceeded, an investigation will be conducted to determine the best action to address the issue. This could include sampling at the monitoring well to determine removal by soil aquifer treatment (SAT), source control, modifying wastewater treatment, modifying advanced treatment, no action, or an alternative approach.

HRSD is currently evaluating the occurrence of a broader suite of non-regulated parameters in order to develop an indicator list that reflects the characteristics of local wastewater sources. The collection and evaluation of this data is on-going, and an additional list of indicators will be developed prior to the start of JR SWIFT recharge operations and provided to the PAROC/PARML for review. The Hampton Roads-specific list of indicators will be evaluated in parallel with the indicators in Table D.3 to confirm the suitability of this new list for performance monitoring.

Table D.3: JR SWIFT Non-Regulatory Performance Indicators

Constituent	Category	Threshold Value	Unit	Notes
1,4-Dioxane	Public Health	1	µg/L	CCL4; CA Notification Limit
17-β-Estradiol	Public Health	0.9[1]	ng/L	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	280[1]	ng/L	CCL4
NDMA	Public Health	10	ng/L	CCL4; CA Notification Limit
Perchlorate	Public Health	6	µg/L	CA Notification Limit
PFOA+PFOS[2]	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

[1] Threshold value identified in *Monitoring Strategies for Constituents of Emerging Concern (CECs) in Recycled Water, Recommendations of a Science Advisory Panel, 2018; SCCWRP Technical Report 1032.*

[2] Though no thresholds have been established, monitoring and reporting will include PFBA, PFHpA, PFHxS and PFNA.

D.1.3.4. Design Pathogen Log Removal Value

JR SWIFT will be designed and operated (using CCPs) to achieve at least 12 log removal value (LRV) for viruses and 10 LRV for *Cryptosporidium* and *Giardia* through a combination of advanced treatment processes and soil aquifer treatment. Table D.4 provides a treatment process pathogen LRV summary for JR SWIFT. Monitoring at the SRC will be used to verify the claimed credits for each process unit. The following key design and operational considerations and regulatory references are provided for context for Table D.4:

- Two-log removal of viruses and 2.5-log *Giardia* removal is granted per the *Surface Water Treatment Rule Guidance Manual*, 1991 edition, section 5.5.2, for a well operated conventional filtration treatment plant.

- Three-log *Cryptosporidium* removal is granted per the *Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual* section 1.4.1 if the combined filter effluent (CFE) is less than 0.3 NTU 95% of the time and never greater than 1.0 NTU. An additional 0.5-log credit is granted in section 7.2.1 for achieving individual filter effluent (IFE) of 0.15 NTU 95% of the time and having no two consecutive measurements 15 minutes apart greater than 0.3 NTU. One more additional 0.5-log credit is granted in section 7.2.1 for achieving CFE of 0.15 NTU 95% of the time. CCPs will be enacted to ensure that these turbidity requirements are met.
- The ozone system will not be operated specifically to achieve pathogen removal credit. It is anticipated that ozone operation to achieve oxidation of organics will also achieve very high levels of pathogen removal, but this will not be a programmed CCP or operational goal at JR SWIFT. If ozone is operated in AOP mode, there will be no ozone residual and no way to demonstrate pathogen log removal under the current EPA guidance, although research is being and will be conducted in the future to demonstrate removal using other verification methods.
- The design Ultraviolet "UV" dose of 186 mJ/cm^2 provides 4 LRV for viruses according to Table 1.4 of the *Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*. Significantly greater inactivation of *Cryptosporidium* and *Giardia* would be achieved at this design dose, though only 4-log removal is claimed in Table D.4. If UV is operated in AOP mode, significantly more pathogen removal credit could be achieved, but that is not claimed in Table D.4.
- At least 6-log credit for viruses, *Cryptosporidium*, and *Giardia* is expected through SAT based on the modeled travel time of the recharge water in the PAS. Literature has demonstrated additional treatment of recharge water as it moves through an aquifer system; the California Department of Health Regulations Related to Recycled Water section 60320.108 states that 1-log virus reduction credit is granted for every month the water is in the ground up to 6-log reduction. A minimum 6-log removal of *Cryptosporidium* and *Giardia* is expected when achieving 6-log virus reduction. HRSD's soil column testing has confirmed this assumption.

Table D.4: JR SWIFT Design Pathogen LRV

Parameter	Floc/Sed (+BAF)	Ozone	BAF+GAC	UV	Cl2	SAT	Total
Enteric Viruses	2	0	0	4	0	6	12
Cryptosporidium	4	0	0	4	0	6	14
Giardia	2.5	0	0	4	0	6	12.5

D.1.3.5. Critical Control Points

JR SWIFT will incorporate CCPs and critical operating points (COPs) throughout the treatment process, similar to the SRC, to ensure public health protection and to verify that treatment goals are being met at each of the individual processes. A violation of any CCP means that JR SWIFT 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 wells. In most instances, JR SWIFT will continue to operate through the CCP violation, but the SWIFT Water will be diverted back to the JR chlorine contact tank and will not be recharged into the aquifer. CCPs specifically protect public health and ensure compliance with regulatory parameters while COPs can be adapted as needed to ensure proper treatment performance throughout the SWIFT process.

CCPs have alert values at which point the operator is expected to take action to correct the performance as well as alarm values at which point an automated response will trigger action and prevent flow from going to the recharge wells. Both the alert and alarm values will be measured for a specified duration or computed as a running average 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 and optimized as needed to meet the water quality requirements.

Table D.5 provides the current, preliminary list of CCPs for JR SWIFT, which is largely the same as the current list for the SRC. During the first year of SRC operation, several CCPs have been adjusted (and documented with EPA) based on lessons learned during operation. It is anticipated that there will be additional changes to Table D.5 as the SRC continues in operation.

Table D.5: Critical Control Points for JR SWIFT

Parameter	Alert Value	Alarm Value	Unit	Type[1]	Action
Critical Control Points (CCPs)					
SWIFT Feed Turbidity	3.5	5	NTU	Latched	Place Biofilters in Filter To Waste
SWIFT Feed Conductivity	1,500	2,000	microSiemens per centimeter	Latched	Place Biofilters in Filter To Waste
SWIFT Feed Total Inorganic Nitrogen	4.0	5.0	mg/L-N	Latched	Place Biofilters in Filter To Waste
Preformed Chloramine Failure (if used for bromate suppression)	N/A	Failure	mg/L	Latched	Divert SWIFT Water
Total Chlorine Upstream of Ozone (if used for bromate suppression)	2.0	1.0	mg/L	Latched	Divert SWIFT Water
Monochloramine Upstream of Ozone (if used for bromate suppression)	2.0	1.0	mg/L	Latched	Divert SWIFT Water
Ozone Feed Failure	N/A	Failure	N/A	Latched	Open Biofilter Backwash Waste Valve
High Ozone Dose	7.0	8.0	mg/L	Latched	Place Biofilters in Filter To Waste
Biofilter Individual Effluent Turbidity	0.1	0.15	NTU	Running Average	Place Biofilter in Filter To Waste
Biofilter Combined Filter Effluent Turbidity	0.1	0.15	NTU	Running Average	Place Biofilters in Filter To Waste
GAC Combined Effluent TOC, Instantaneous Online Analyzer	4.0	5.0	mg/L	Latched	Divert SWIFT Water
GAC Combined Effluent Nitrite	0.25	0.5	mg/L-N	Latched	Divert SWIFT Water
GAC Combined Effluent Ammonia[2]	0.1	0.3	mg/L-N	Latched	Divert SWIFT Water
UV Reactor Dose	<120% of Dose Setpoint	<105% of Dose Setpoint	%	Latched	Divert SWIFT Water
SWIFT Water Total Nitrogen	4.5	5.0	mg/L-N	Latched	Divert SWIFT Water

[1] A latched CCP requires the measured value to be above/below the limit for a specified duration before alerting or alarming. A running average will generate an alert or alarm if the running average over a specified duration is above/below the limit. Running averages were implemented for specific CCPs to more conservatively protect against water quality requirements.

[2] Ammonia control of GAC CE is applicable only when using free chlorine post-UV for well biofoulant control. Refer to table D.7, footnote 9 for additional information.

The following CCPs were removed or adjusted from the current CCPs in use at the SRC:

- Ozone Contactor Calculated LRV – Virus (CCP): As JR SWIFT will not operate ozone to achieve disinfection credit, the LRV has been removed from the CCP list.
- Free Chlorine CT (CCP): As JR SWIFT will not add free chlorine for disinfection of SWIFT Water, the required CT has been removed from the CCP list. SWIFT Water Chlorine Residual remains a COP to prevent biofouling in the recharge wells.
- CCPs associated with the tasting system at the SRC have been removed as JR SWIFT will not be designed for tastings.

D.1.3.6 JR SWIFT Regulatory Sampling Plan

Sampling will be performed throughout the treatment process to verify treatment performance, online analyzer accuracy, and compliance with regulatory limits. A detailed sampling plan has been generated that addresses these purposes. Sampling will consist of a combination of onsite analysis, lab analysis performed by HRSD, and specialized analysis performed by outside contract labs. Table 4.1 provides the additional monitoring required to document compliance with the targeted LRV for the UV system. Table D.6. provides the sampling plan specific to the proposed regulatory limits and performance indicators including the location and frequency of each sample.

Table D.6: Additional Monitoring to Support UV LRV [1]

UV LRV
UV Intensity, each reactor
UVT, GAC Combined Effluent
Reactor Flow, each
Calculated Dose (validated), each reactor
Status, each

[1]All continuous measurements. Calculated dose and LRV will be reported as part of the quarterly monitoring reports. Calculations will be based on 15 min data.

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Regulatory Parameters								
Total Nitrogen		Weekly				Monthly	Monthly	5x/week
Turbidity					Continuous[4]	Continuous[4]		
TOC		Weekly	3x/week			3x/week		3x/week
pH[5]								Continuous
TDS[5]								Monthly
Regulatory Parameters: EPA Primary MCLs								
Microorganisms								
Male-specific and somatic coliphages[5]		Quarterly						Quarterly
Cryptosporidium	Quarterly	Quarterly						Quarterly
Giardia lamblia	Quarterly	Quarterly						Quarterly
Legionella		Quarterly						Quarterly
Total Coliform		Weekly						5x/week
E. coli		Weekly						5x/week
Disinfection Byproducts								
Bromate				5x/week				Weekly
Chlorite	Quarterly	Monthly						Monthly
Haloacetic acids (HAA5)								Monthly
Total trihalomethanes								Monthly
Disinfectants[6]								
Chloramines (as Cl_2)								Continuous[7]
Chlorine (as Cl_2)								Continuous[7]

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Inorganic Chemicals								
Antimony, Total	Quarterly	Monthly						Monthly
Arsenic, Total	Quarterly	Monthly						Monthly
Asbestos		Quarterly						Quarterly
Barium, Total	Quarterly	Monthly						Monthly
Beryllium, Total	Quarterly	Monthly						Monthly
Cadmium, Total	Quarterly	Monthly						Monthly
Chromium, Total	Quarterly	Monthly						Monthly
Copper, Total	Quarterly	Monthly						Monthly
Cyanide, Total	Quarterly	Monthly						Monthly
Fluoride	Quarterly	Monthly						Monthly
Lead, Total	Quarterly	Monthly						Monthly
Mercury, Total	Quarterly	Monthly						Monthly
Nitrate -N		Weekly				Monthly	Monthly	5x/week
Nitrite-N		Weekly				Monthly	Monthly	5x/week
Selenium, Total	Quarterly	Monthly						Monthly
Thallium, Total	Quarterly	Monthly						Monthly
Organic Chemicals								
Acrylamide	Quarterly	Monthly						Monthly
Alachlor	Quarterly	Monthly						Monthly
Atrazine	Quarterly	Monthly						Monthly

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Benzene	Quarterly	Monthly						Monthly
Benzo(a)pyrene (PAHs)	Quarterly	Monthly						Monthly
Carbofuran	Quarterly	Monthly						Monthly
Carbon Tetrachloride	Quarterly	Monthly						Monthly
Chlordane	Quarterly	Monthly						Monthly
Chlorobenzene	Quarterly	Monthly						Monthly
2,4-D	Quarterly	Monthly						Monthly
Dalapon	Quarterly	Monthly						Monthly
1,2-dibromo-3-chloropropane (DBCP)	Quarterly	Monthly						Monthly
1,2-Dichlorobenzene (o-dichlorobenzene)	Quarterly	Monthly						Monthly
1,4-Dichlorobenzene (p-dichlorobenzene)	Quarterly	Monthly						Monthly
1,2-Dichloroethane	Quarterly	Monthly						Monthly
1,1-Dichloroethylene	Quarterly	Monthly						Monthly
cis-1,2-Dichloroethylene	Quarterly	Monthly						Monthly
trans-1,2-Dichloroethylene	Quarterly	Monthly						Monthly
Dichloromethane (Methylene chloride)	Quarterly	Monthly						Monthly
1,2-Dichloropropane	Quarterly	Monthly						Monthly
Di(2-ethylhexyl) adipate	Quarterly	Monthly						Monthly
Di(2-ethylhexyl) phthalate	Quarterly	Monthly						Monthly

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Dinoseb	Quarterly	Monthly						Monthly
Dioxin (2,3,7,8-TCDD)	Quarterly	Monthly						Monthly
Diquat	Quarterly	Monthly						Monthly
Endothall	Quarterly	Monthly						Monthly
Endrin	Quarterly	Monthly						Monthly
Epichlorohydrin	Quarterly	Monthly						Monthly
Ethylbenzene	Quarterly	Monthly						Monthly
Ethylene dibromide (EDB)	Quarterly	Monthly						Monthly
Glyphosate	Quarterly	Monthly						Monthly
Heptachlor	Quarterly	Monthly						Monthly
Heptachlor Epoxide	Quarterly	Monthly						Monthly
Hexachlorobenzene	Quarterly	Monthly						Monthly
Hexachlorocyclopentadiene	Quarterly	Monthly						Monthly
Lindane (Gamma-BHC)	Quarterly	Monthly						Monthly
Methoxychlor	Quarterly	Monthly						Monthly
Oxamyl (Vydate)	Quarterly	Monthly						Monthly
Polychlorinated biphenyls	Quarterly	Monthly						Monthly
Arochlor (AR)1016	Quarterly	Monthly						Monthly
AR1221	Quarterly	Monthly						Monthly
AR1232	Quarterly	Monthly						Monthly
AR1242	Quarterly	Monthly						Monthly

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
AR1248	Quarterly	Monthly						Monthly
AR1254	Quarterly	Monthly						Monthly
AR1260	Quarterly	Monthly						Monthly
Pentachlorophenol	Quarterly	Monthly						Monthly
Picloram	Quarterly	Monthly						Monthly
Simazine	Quarterly	Monthly						Monthly
Styrene	Quarterly	Monthly						Monthly
Tetrachloroethylene	Quarterly	Monthly						Monthly
Toluene	Quarterly	Monthly						Monthly
Toxaphene	Quarterly	Monthly						Monthly
2,4,5-TP (Silvex)	Quarterly	Monthly						Monthly
1,2,4-Trichlorobenzene	Quarterly	Monthly						Monthly
1,1,1-Trichloroethane	Quarterly	Monthly						Monthly
1,1,2-Trichloroethane	Quarterly	Monthly						Monthly
Trichloroethylene	Quarterly	Monthly						Monthly
Vinyl Chloride	Quarterly	Monthly						Monthly
Xylene, Total	Quarterly	Monthly						Monthly
Radionuclides								
Alpha particles		Monthly						Monthly
Beta particles and photon emitters		Monthly						Monthly
Radium 226		Monthly						Monthly

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Radium 228		Monthly						Monthly
Uranium		Monthly						Monthly
Regulatory Parameters: Virginia Groundwater Standards[8]								
Aldrin/Dieldrin	Quarterly	Monthly						Monthly
DDT	Quarterly	Monthly						Monthly
Kepone	Quarterly	Monthly						Monthly
Mirex	Quarterly	Monthly						Monthly
Phenols	Quarterly	Monthly						Monthly
Strontium-90		Monthly						Monthly
Tritium		Monthly						Monthly
Non-regulatory Parameters: Performance Indicators								
Public Health Indicators								
1,4-dioxane	Quarterly	Quarterly						Quarterly
17-β-estradiol	Quarterly	Quarterly						Quarterly
DEET	Quarterly	Quarterly						Quarterly
Ethinyl estradiol	Quarterly	Quarterly						Quarterly
NDMA	Quarterly	Quarterly		Weekly		Weekly		Weekly[9]
Perchlorate	Quarterly	Quarterly						Quarterly
PFOA + PFOS	Quarterly	Quarterly						Quarterly
PFBA	Quarterly	Quarterly						Quarterly
PFHpA	Quarterly	Quarterly						Quarterly

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
PFHxS	Quarterly	Quarterly						Quarterly
PFNA	Quarterly	Quarterly						Quarterly
tris(2-carboxyethyl)phosphine (TCEP)	Quarterly	Quarterly						Quarterly
Treatment Efficacy Indicators								
Cotinine	Quarterly	Quarterly						Quarterly
Primidone	Quarterly	Quarterly						Quarterly
Phenytoin	Quarterly	Quarterly						Quarterly
Meprobamate	Quarterly	Quarterly						Quarterly
Atenolol	Quarterly	Quarterly						Quarterly
Carbamazepine	Quarterly	Quarterly						Quarterly
Estrone	Quarterly	Quarterly						Quarterly
Sucralose	Quarterly	Quarterly						Quarterly
Triclosan	Quarterly	Quarterly						Quarterly
Non-regulatory Parameters: Aquifer Characteristics and/or Compatibility								
Unregulated Contaminant Monitoring Rule (UCMR)[10]								TBD[10]
Dissolved Oxygen								Monthly
Temperature								Monthly
Specific conductivity								Monthly
ORP								Monthly
Iron, Total								Continuous[11]

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	JR Influent	SWIFT Feed	Floc/Sed Effluent	Ozone Effluent	BAF IFE	BAF CFE	GAC CE	SWIFT Water
Aluminum, dissolved								Monthly
Aluminum, total								Monthly
Arsenic, dissolved								Monthly
Iron, dissolved								Monthly
Manganese, dissolved								Monthly
Manganese, total								Monthly
Magnesium, total								Monthly
Potassium, total								Monthly
Sodium, total								Monthly
Calcium, total								Monthly
Sulfate								Monthly
Chloride								Monthly
Bromide		Weekly						
Alkalinity								Monthly
Total Kjeldahl Nitrogen		Weekly				Monthly		Weekly
Ammonia as N								Weekly
Total Phosphorus			Weekly			Weekly		Weekly
Orthophosphate as P			Weekly			Weekly		Weekly
Silica as SiO_2								Monthly
Hardness, Total								Monthly

Table D.7: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	JR Influent	SWIFT Feed	Floc/Sed Effluent	Ozone Effluent	BAF IFE	BAF CFE	GAC CE	SWIFT Water

1 Compliance samples are collected during periods of recharge. Point of compliance for all regulatory parameters is SWIFT Water with the exception of turbidity. Compliance point for turbidity monitoring is BAF Individual and Combined Filter Effluents (BAF IFE, BAF CFE).

2 Non-compliance process monitoring may be modified based on operational needs.

3 All samples are collected as grabs unless denoted as “Continuous”. 15-minute data will be reported for each continuous measurement.

4 All in service turbidimeters will be verified with daily lab grabs. Only 15-min online turbidimeter data will be submitted for IFE and CFE. If a turbidimeter is out of service, unreliable or suspect, turbidity samples will be collected by grab for lab analysis every 4 hours, and those data will be submitted.

5 Monitoring requirement with no limit imposed.

6 ClO_2 not used for disinfection and therefore is not included in monitoring.

7 Continuous measurements of chlorine and chloramines will be confirmed with a daily grab sample.

8 Virginia Ground Water Standards (9VAC25-280-40) not included as a PMCL under the Safe Drinking Water Act (SDWA) and considered critical for inclusion by the Virginia Department of Health (VDH).

9 In addition to monitoring NDMA concentration, NDMA Formation Potential (FP) tests will be as follows:

- when monochloramine is being added following UV disinfection the frequency shall be monthly for one year. NDMA FP frequency will be reduced in years 2 – 3 to quarterly, followed by annual testing for the duration of the permit, provided the contingencies for phased reduction continue to be met. Phased reduction is contingent upon (i) NDMA concentrations under agreed-upon conditions in FP testing remaining < 10 ng/L, and (ii) NDMA concentrations in the monitoring wells remaining < 10 ng/L. Exceedance of either of these conditions will “reset” the phased reduction schedule.
- when free chlorine is being added following UV disinfection, NDMA FP testing will be conducted monthly for three months and will be ceased if (i) NDMA concentrations under agreed-upon conditions in FP testing remain < 10 ng/L, and (ii) NDMA concentrations in the monitoring wells remain < 10 ng/L. NDMA FP is expected to be minimal when using free chlorine post-UV and HRSD will further mitigate this risk by incorporating ammonia monitoring of the GAC combined effluent with a CCP for SWIFT Water diversion (Table D.5).
- All NDMA FP data will be evaluated by PARML and PAROC to ensure concurrence with phased reductions.

10 HRSD shall monitor currently effective UCMR parameters at the frequency required for large water systems.

11 Continuous measurements of total iron will be confirmed with a weekly grab sample.

D.2 Well Information

D.2.1 Recharge Flows

Average and maximum MAR recharge flows are estimated as follows:

- Average day flow per well: 1.65 million gallons per day (MGD)
- Maximum day flow per well: 2.0 MGD
- Average aggregate flow for wellfield: 12.375 MGD (75% of capacity)
- Maximum aggregate flow for wellfield: 16.5 MGD

D.2.2 Source of the Injection Fluid

The source of the injection fluid for recharge consists of treated secondary effluent from HRSD's wastewater treatment facilities that pass through the JR SWIFT AWT and meets EPA SDWA PMCLs.

D.2.2 Proposed Annular Fluid

Not applicable, no annular fluid will be used in the JR SWIFT MAR wells

D.2.3 Analysis of chemical and physical characteristics of the injection fluid

Table D.8 describes the predicted chemical and physical characteristics of the injection (recharge) fluid. Table D.8 also displays native groundwater quality from the receiving aquifers beneath JR SWIFT. Effluent/recharge emerging from the AWT at JR SWIFT will meet all PMCLs. Monitoring and regulatory thresholds for the injection fluid are noted in Table D.7.

Table D.8: Native groundwater chemistry, test well at James River

Test Intervals		72 HR CRT[1]	Packer Test 1 (398-524 fbg[2])	Packer Test 2 (570-636 fbg)	Packer Test 3 (735-790 fbg)	Packer Test 4 (960-1000 fbg)	Packer Test 5 (1048-1122 fbg)	Packer Test 6 (1240-1280 fbg)	Estimated Recharge Chemistry[3]	PMCL/ SMCL
Analyte	**Units**	**12/19/18**	**5/2/19**	**5/6/19**	**5/8/19**	**5/10/19**	**5/15/19**	**5/20/19**	**1/6/15**	
pH	standard units	6.32	6.76	7.71	6.14	7.20[6]	7.26	7.62	7.2 to 7.8	6.5 to 8.5
ORP[4]	mV	54.9	-133.8	-95	-70.3	-108	-103.2	-99.6	NA	
Eh (corrected)[5]	mV	254.9	66.2	105	129.7	92	96.8	100.4	NA	
Specific Conductivity	µs/cm	3113	4635	4088	5200[7]	6230	6690[7]	8700[7]	NA	
Temperature	ºC	20.27	25.97	23.57	26.77	25.87	25.8	26.59	15 to 26	
Turbidity	NTU	1.51	1.63	2.12	5.53	0.52	0.43	6.19		
Field Sulfide as S	mg/L	0	0	0	0.04	0	0	0.01	NA	
Field Sulfate as SO_4	mg/L	58	70	69	106	90	104	183	NA	
Field Iron (ferrous as Fe^{2+})	mg/L	0.22	2.35	2.31	1.35	1.34	2.07	2.22	NA	
Field Iron (total)	mg/L	0.91	2.04	2.01	1.7	1.79	2.22	3.14	NA	
Aluminum, dissolved	mg/L	<0.010	<0.010	0.014	<0.010	<0.010	<0.010	<0.010	<0.04	0.1
Aluminum, total	mg/L	0.063	<0.010	0.014	0.036	<0.010	<0.010	<0.010	<0.04	0.1
Arsenic, dissolved	µg/L	<1.00	0.25	<0.50	<0.50	<0.50	0.27	<0.50	0.7	10
Arsenic, total	µg/L	<1.00	0.24	<0.50	<0.50	<0.50	0.27	<0.50	0.7	10
Iron, dissolved	mg/L	0.203	2.49	2.74	1.39	1.46	2.07	2.28	0.07	0.3
Iron, total	mg/L	0.241	2.45	2.79	1.58	1.48	2.05	2.25	0.07	0.3
Manganese, dissolved	mg/L	0.0217	0.0518	0.0575	0.0527	0.0533	0.0829	0.142	0.01	0.05
Manganese, total	mg/L	0.0226	0.0504	0.0581	0.0539	0.0542	0.0852	0.142	0.01	0.05
Magnesium, total	mg/L	4.78	6.71	6.93	9.00	10.6	15.8	25.6	3.6	
Potassium, total	mg/L	15.4	19.6	19.6	20.4	24.6	29	36.9	13	
Sodium, total	mg/L	777	970	979	1060	1240	1500	1930	68	
Calcium, total	mg/L	13.2	19.8	20.7	25.4	29.6	42.1	63.8	34	
Sulfate	mg/L	70.3	90.6	91.6	119	126	175	275	53	250
Chloride	mg/L	825	1460	1490	1770	1830	2290	3070	106	250
Alkalinity	mg/L	326	273	265	258	240	222	217	38	
Nitrate/Nitrite-N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5.7	
Nitrate as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	3.1	10
Total Kjeldahl Nitrogen	mg/L	0.52	0.69	0.66	0.78	0.79	0.92	1.03	2.6	
Fluoride	mg/L	2.16	0.913	0.920	0.863	0.793	0.601	<0.500	0.65	4
Silica as SiO_2	mg/L	25.5	38.5	38.1	36.6	40.5	39.4	33.9	NE	
Silicon as Si	mg/L	11.9	18.0	17.8	17.1	18.9	18.4	15.8	NE	

Table D.8: Native groundwater chemistry, test well at James River

Test Intervals		72 HR CRT[1]	Packer Test 1 (398-524 fbg[2])	Packer Test 2 (570-636 fbg)	Packer Test 3 (735-790 fbg)	Packer Test 4 (960-1000 fbg)	Packer Test 5 (1048-1122 fbg)	Packer Test 6 (1240-1280 fbg)	Estimated Recharge Chemistry[3]	PMCL/ SMCL
Analyte	**Units**	**12/19/18**	**5/2/19**	**5/6/19**	**5/8/19**	**5/10/19**	**5/15/19**	**5/20/19**	**1/6/15**	
Dissolved organic carbon	mg/L	0.16	0.13	0.11	<0.10	0.21	0.14	0.13	4	
Total organic carbon	mg/L	0.14	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	4	
Total phosphorus	mg/L	0.20	0.14	0.17	0.17	0.13	0.08	0.04	0.02	
Orthophosphate as P	mg/L	0.19	0.04	0.03	0.05	0.02	0.02	0.01	0.01	
Total dissolved solids	mg/L	1880	2990	3060	3470	3590	4460	5800	420	
Total suspended solids	mg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.8	0.05	
Hardness, Total	mg eq	52.6	77.1	80.2	100	118	170	265	99	
Ammonia as N	mg/L	0.44	0.56	0.54	0.60	0.61	0.86	0.91	0.52	
BOD5	mg/L	<2	<2	<2	<2	<2	<2	<2	1	
COD	mg/L	<9.0	<12.0	<12.0	<12.0	<12.0	<15.0	<15.0	<10	
Gross Alpha	pCi/L	9.3	6.8	9.7	13	14	14	16	NE	15
Gross Beta	pCi/L	15	16	23	27	27	28	30	NE	
Ra 226 + Ra 228	pCi/L	1.1	ND	ND	1.4	1.6	4.8	8.8	NE	5
Uranium	µg/L	<0.200	<0.100	<0.100	<0.100	<0.100	<0.100	<0.500	NE	
Calculated species										
Ionic strength	mol/L	0.047	0.07475	0.0765	0.08675	0.08975	0.1115	0.145	0.0105	
Ionic balance (Stuyfzand, 1993)	%	4.3	5.5	5.7	9.3	2.8	2.3	3.6	6.6	
Ca + Mg/Na + K	meq/L ratio	0.028	0.025	0.027	0.031	0.029	0.052	0.063	0.597	
Organic phosphorous	mg/L	0.137	0.127	0.160	0.153	0.123	0.073	0.037	0.01	
Organic nitrogen	mg/L	0.08	0.13	0.12	0.18	0.18	0.06	0.12	2.08	

Notes:
[1] CRT - constant rate test
[2] fbg - feet below grade
[3] Estimated Recharge Chemistry based on JRTP effluent sampling in January 2015 and 2019 and mathematical modeling to estimate chemistry of JR SWIFT Water.
[4] ORP - oxidation/reduction potential
[5] Eh = ORP + 200 mV
[6] Instrument issue, pH estimated using PHREEQC
[7] Instrument issue, specific conductivity estimated by 1.5 x TDS
NA - Not applicable
ND – Non-detect
NM – Not measured
NE – Not estimated

Attachment E: Plugging and Abandonment Plan

No plugs will be used for abandonment. JR SWIFT Wells are constructed with casing, screens and gravel pack filter in unconsolidated clastic sediments of the Virginia Coastal Plain.

E.1 Plugging and Abandonment Procedures and Cost Estimate

Type of cement and method of abandonment is described below for both a typical SWIFT MAR well and typical monitoring well.

MAR Wells (Figure F.1)

Item #1 Includes all work associated with mobilization, demobilization of the drilling rig and supporting equipment for the work.

- Mobilize/demobilize drill rig, "kill" and remove wellhead **$16,000.**

Item #2 Remove pump and column from 250 to 350 feet below grade (fbg).

- Removal of injection and pump column: **$10,000.**

Item #3 Conduct a caliper log of the 18-inch, 20-inch and 30-inch diameter casings and screen from the base of the sump (1,175 fbg) to land surface.

- Caliper log **$3,000**.

Item #4 Place ASTM C150 Type I/II neat cement grout, via tremie pipe:

- 18-inch diameter from the base of the stainless-steel sump (1,175') to 370 fbg = 805 LF.
  - 805 LF = 1,425 ft3 of cement grout
- 20-inch diameter stainless steel casing from 310' to 370' fbg = 60 LF
  - 60 LF = 135 ft3 of cement grout
- 30-inch diameter stainless steel casing from ground surface to 310' fbg = 310 LF
  - 310 LF = 1,525 ft3 of cement grout
- Total estimated volume of cement grout = 3,085 ft3
- 3,085 ft3 @ $22/ft3 = **$67,870**.

MAR-1:	Estimated $96,870.00 per well x 10 wells:	$968,700
	Misc. & contingency (5%):	$48,435
	Total Estimated Cost to Abandon 10 wells:	**$1,017,135**

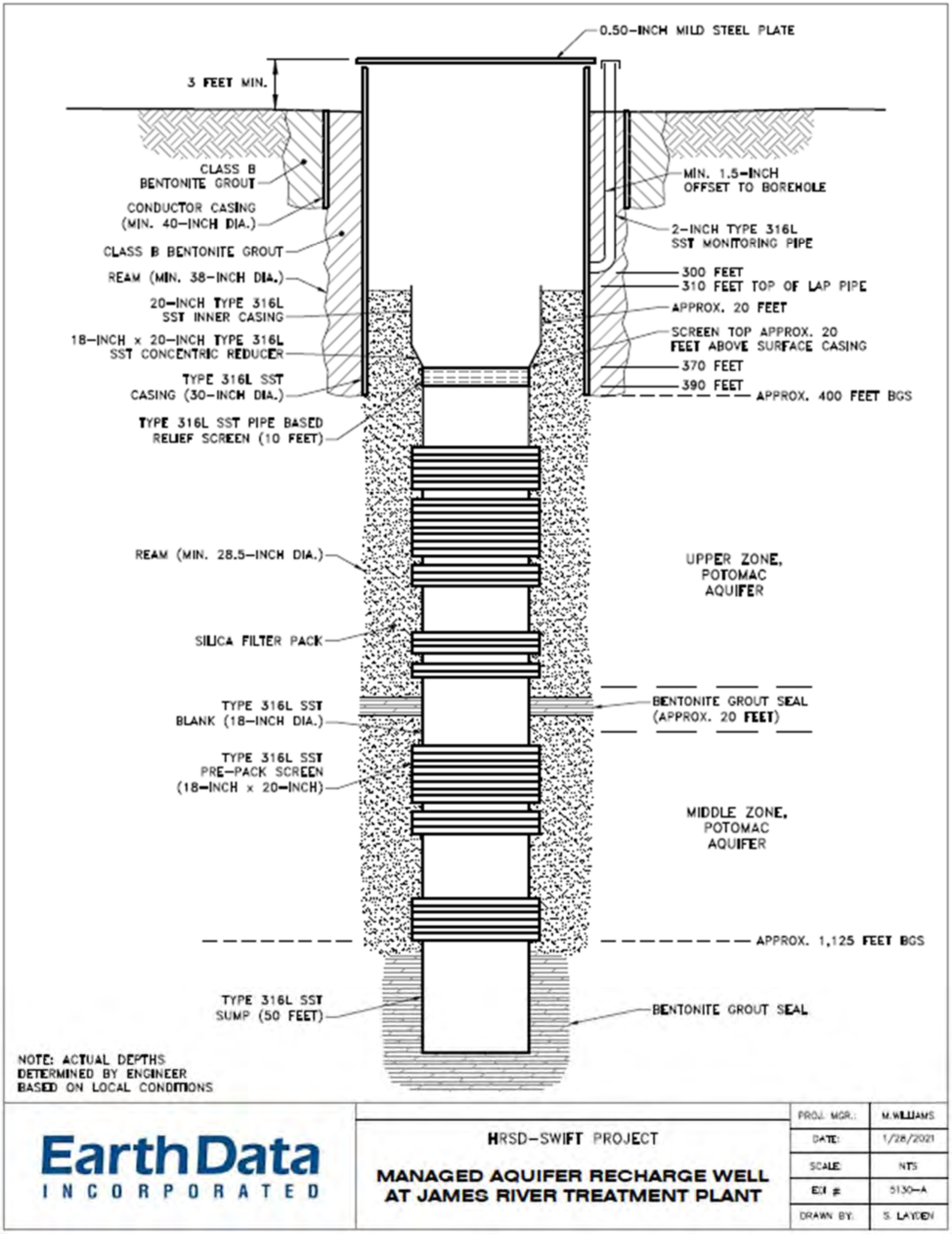

Figure F.1: Proposed Managed Aquifer Recharge Well at JR SWIFT. Elevations and materials of construction may change according to site specific conditions.

Monitoring Wells (Figures F.2, F.3, F.4)

- Six, upper zone of Potomac Aquifer System (UPA) = two at 450’, two at 640’ and two at 795’ to base of sump
- Two, middle zone of Potomac Aquifer System (MPA) = 1,125 to base of sump

Item #1 Includes all work associated with mobilization, demobilization of the drilling rig and supporting equipment for the work.

- Mobilize/demobilize drill rig, remove wellhead, and pull sampling pump **$5,000 per well or cluster (if all abandoned at once)**

Item #2 Remove pump and column from 250 to 350 feet below grade (fbg).

- Remove pump and piping **$6000 per well**

Item #3 Conduct a caliper log of the 4.5-inch diameter inner casing and well screen.

- MPA well x 1,125 fbg.
  - Caliper log 2 @ $2,500.00 **= $5,000**
- UPA well x 450, 640 and 795 fbg.
  - Caliper log, 6 @ $2,000 **= $12,000**
- Total estimated cost for caliper logging: **$17,000 (8 wells)**

Item #4 Place ASTM C150 Type I/II neat cement grout via tremie:

- MPA wells: 4.5” casing from base of sump (1,125 fbg) to ground surface = 1,125 LF
  - 1,125 LF = 200 ft^3 of cement grout per well x 2 wells = 400 ft^3 of cement grout
  - 400 ft^3 cement grout @ $22/$ft^3$ = **$8,800**
- UPA wells: 4.5” casing from base of sump (450, 640 and 795 fbg) to ground surface = 1,885 LF
  - 1,885 LF = 833 ft^3 of cement grout per cluster x 2 clusters = 1,666 ft^3 of cement grout
  - 1,666 ft^3 neat cement grout @ $22 = **$36,652**

UPA:	Estimated $47,326 per cluster x 2 clusters:	$94,652
MPA:	Estimated $17,400 per well x 2 wells:	$34,800
	Subtotal:	$129,452
	Misc. & Contingency (5%):	$3,497
	Total Estimated Cost to Abandon:	**$132,949**

<u>Abandonment Cost Summary:</u>

Estimated cost to abandon 10 MAR Wells:	**$1,017,135**
Estimated cost to abandon 8 monitoring wells:	**$132,949**
Total estimated cost to abandon:	**<u>$1,223,521</u>**

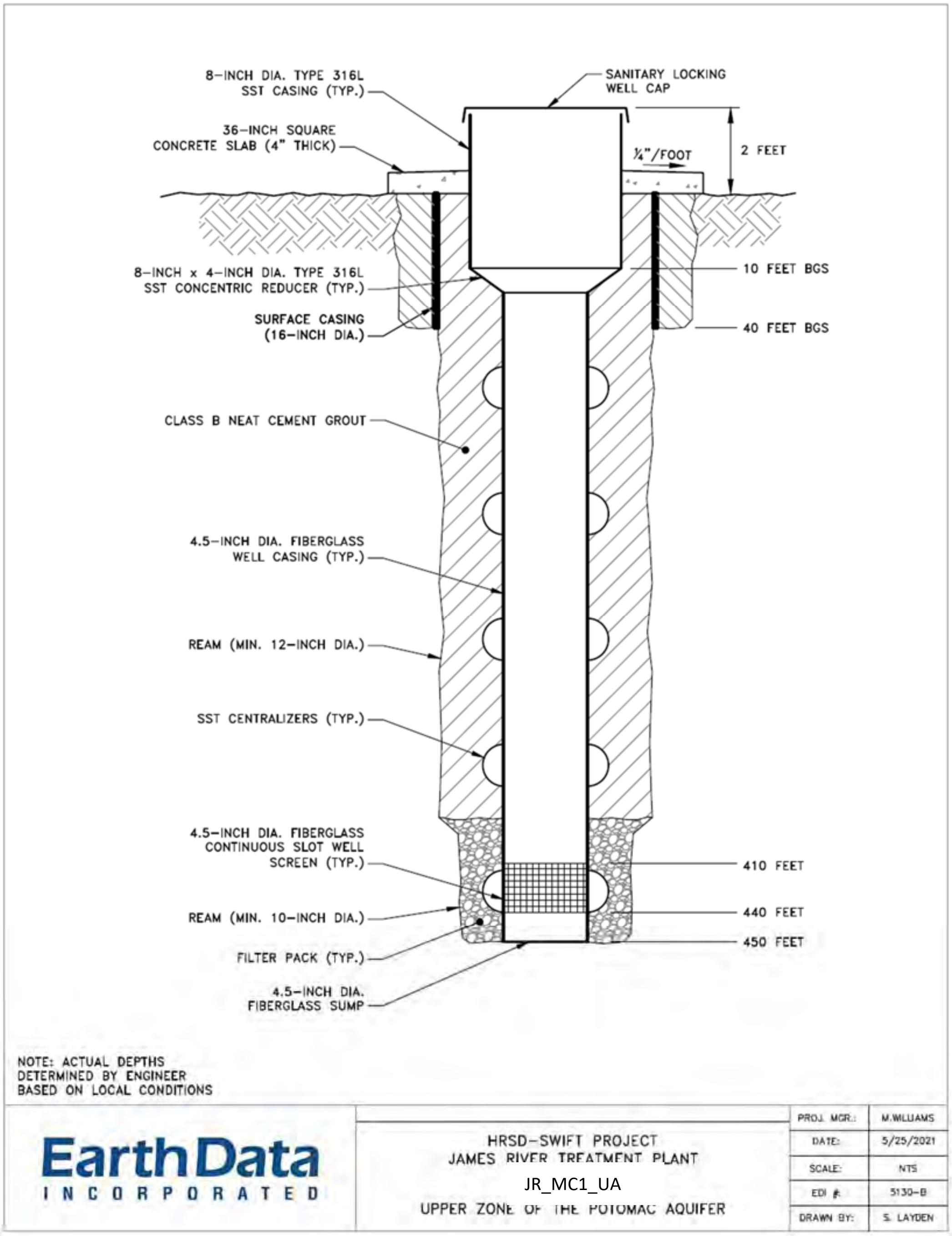

Figure F.2: Typical Shallowest Well Construction Diagram for James River SWIFT monitoring well clusters (JR_MC1 and JR_MC2). Elevations and materials of construction may change according to site specific conditions.

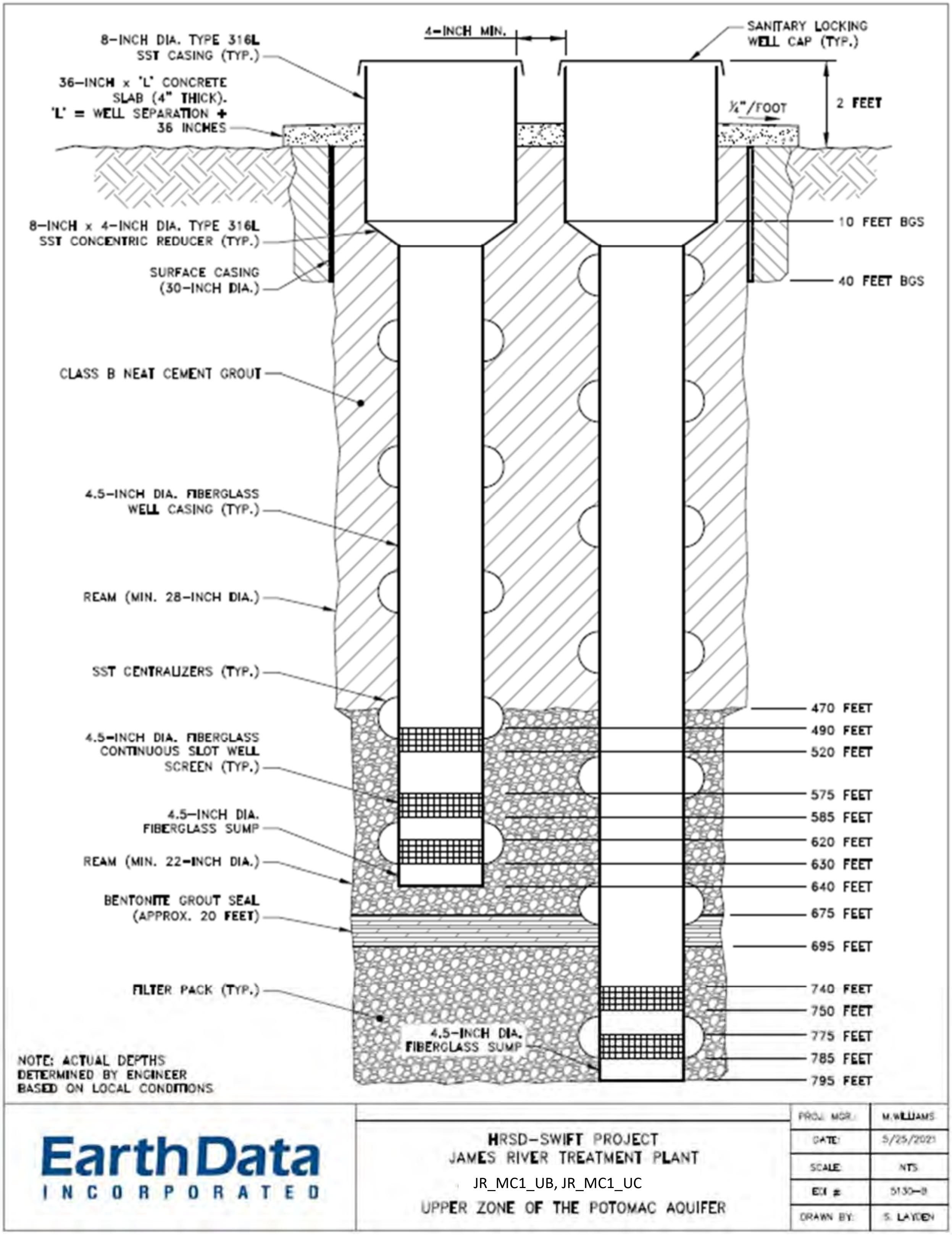

Figure E.3: Typical deeper Upper Zone Nest Well Construction Diagram for James River SWIFT monitoring well clusters (JR_MC1 and JR_MC2). Elevations may change according to site specific conditions.

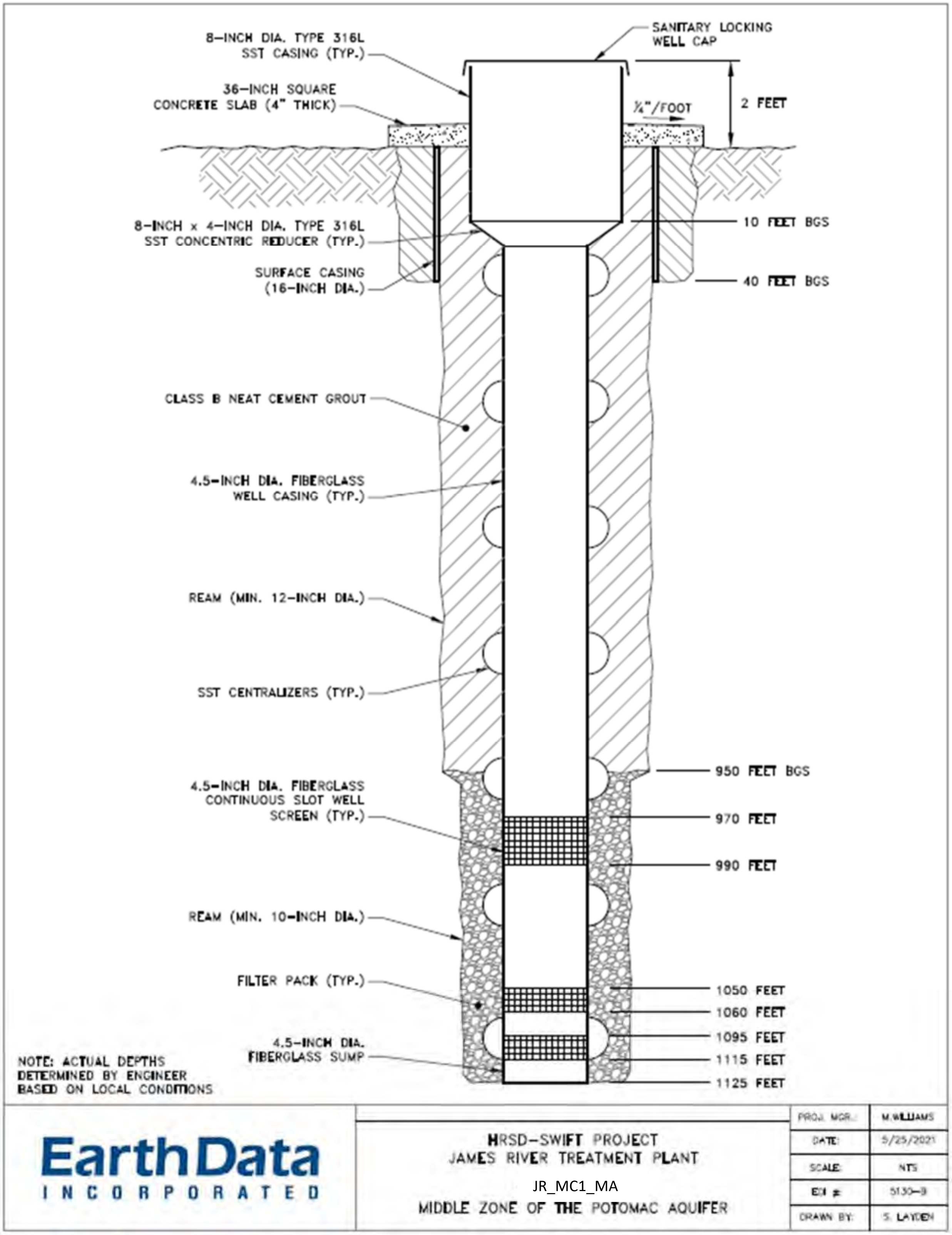

Figure E.4 Typical Middle Zone Well Construction Diagram for James River SWIFT monitoring well clusters (JR_MC1 and JR_MC2). Elevations may change according to site specific conditions.

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United States Environmental Protection Agency

EPA

WELL REWORK RECORD, PLUGGING AND ABANDONMENT PLAN, OR PLUGGING AND ABANDONMENT AFFIDAVIT

Name and Address, Phone Number and/or Email of Permittee

Hampton Roads Sanitation District
James River SWIFT Wastewater Treatment Plant
111 City Farm Road
Newport News, Virginia 23602

Permit or EPA ID Number	API Number	Full Well Name
VAS5B170028617	N/A	JR SWIFT Injection/Monitoring Wells

State	County
Virginia	City of Newport News

Locate well in two directions from nearest lines of quarter section and drilling unit

Latitude 37 05 04.8 N

Surface Location

1/4 of 1/4 of Section Township Range

Longitude 76 31 47.1 W

ft. from (N/S) Line of quarter section
ft. from (E/W) Line of quarter section.

Well Class	Timing of Action (pick one)	Type of Action (pick one)
Class I	Notice Prior to Work	Well Rework
Class II	Date Expected to Commence	✓ Plugging and Abandonment
Class III	Report After Work	Conversion to a Non-Injection Well
✓ Class V	Date Work Ended	

Provide a narrative description of the work planned to be performed, or that was performed. Use additional pages as necessary. See instructions.

SEE ATTACHED

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR § 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
EDWARD HENIFIN, GENERAL MANAGER	[signature]	11/3/2021

EPA Form 7520-19 (Rev. 4-19)

Cleaning wastewater every day for a better Bay.

June 14, 2021

RE: Financial Responsibility for Class V Well at the James River Treatment Plant

In conjunction with HRSD's application for a Class V Well at the James River Treatment Plant, HRSD is pleased to submit financial information demonstrating evidence of HRSD's financial resources available necessary for a third party to close, plug, or abandon the well in the event HRSD, the owner or operator, is unable to do so. The monetary amount is based on the P&A plan cost estimate of $1,224,000 provided in Attachment E.

Attachment F-1 provides summary information showing Current Assets in excess of Current Liabilities in the amount of $103.9 million and $33.7 million for the fiscal years ended June 30, 2019 and June 30, 2018, respectively; and Total Assets in excess of Total Liabilities in the amount of $769.7 million and $688.5 million for the fiscal years ended June 30, 2019 and June 30, 2018, respectively.

Attachment F-2 provides summary information showing Total Cash, Cash Equivalents, and Investments in the amount of $326.9 million and $285.2 million for the fiscal years ended June 30, 2019 and June 30, 2018, respectively, of which $284.0 million and $190.2 million are unrestricted.

The HRSD Comprehensive Annual Financial Report for the Fiscal Years Ended June 30, 2019 and 2018 (the CAFR) is available on the HRSD website at the link below. The Financial Statements have been audited by Cherry Bekaert, LLP, and has received an unqualified audit report, included on pages 9 and 10 in the CAFR. We believe the summary information provided on Attachments F-1 and F-2 and the audited CAFR provide sufficient support to show HRSD's ability to pay a third party to close, plug, or abandon the well in the event HRSD is unable to do so.

If you have additional questions regarding our submission, please feel free to contact me directly at 757-460-7215 or lacors@hrsd.com.

Sincerely,

Carroll L. (Lee) Acors
Chief of Accounting

https://www.hrsd.com/sites/default/files/assets/Documents/pdfs/finance/FY2019_CAFR.pdf

Water Quality Department • PO Box 5911, Virginia Beach, VA 23471-0911 • 757.460.7004

Attachment F-1

HAMPTON ROADS SANITATION DISTRICT
SUMMARY STATEMENTS OF NET POSITION
AS OF JUNE 30, 2019 AND 2018

ASSETS AND LIABILITIES (in thousands)

		2019	2018
A	**CURRENT ASSETS**	$ 244,423	$ 173,604
B	**NON-CURRENT ASSETS**	1,513,744	1,505,739
C=A+B	**TOTAL ASSETS**	1,758,167	1,679,343
	DEFERRED OUTFLOWS OF RESOURCES	21,442	20,762
		$ 1,779,609	$ 1,700,105
D	**CURRENT LIABILITIES**	$ 140,564	$ 139,914
E	**LONG-TERM LIABILITIES**	847,928	850,928
F=D+E	**TOTAL LIABILITIES**	988,492	990,842
	DEFERRED INFLOWS OF RESOURCES	9,412	11,634
	NET POSITION		
	Net investment in capital assets	494,779	512,398
	Restricted for debt service	28,553	27,799
	Unrestricted	258,373	157,432
	TOTAL NET POSITION	781,705	697,629
	TOTAL LIABILITIES, DEFERRED INFLOWS OF RESOURCES AND NET POSITION	$ 1,779,609	$ 1,700,105
G=A-D	**CURRENT ASSETS less CURRENT LIABILITIES**	$ 103,859	$ 33,690
H=B-E	**TOTAL ASSETS less TOTAL LIABILITIES**	$ 769,675	$ 688,501

SOURCE: **HRSD Comprehensive Annual Financial Report for the Fiscal Years Ended June 30, 2019 and 2018 pages 16 & 17**

Attachment F-2

HAMPTON ROADS SANITATION DISTRICT
SUMMARY OF CASH AND INVESTMENTS
AS OF JUNE 30, 2019 AND 2018

CASH AND INVESTMENTS (in thousands)

		2019	2018
	CURRENT ASSETS		
J	Cash and cash equivalents	$ 155,453	$ 66,078
K	Cash and cash equivalents - Restricted	42,888	44,718
L	Investments	-	17,871
		$ 198,341	$ 128,667
	NON-CURRENT ASSETS		
M	Cash and cash equivalents	$ 128,530	$ -
N	Cash and cash equivalents - Restricted	-	50,359
P	Investments	-	106,219
		$ 128,530	$ 156,578
	TOTAL		
Q=J+M	Cash and cash equivalents	$ 283,983	$ 66,078
R=K+N	Cash and cash equivalents - Restricted	42,888	95,077
S=L+P	Investments	-	124,090
	Cash, Cash Equivalents, and Investments	$ 326,871	$ 285,245
	Unrestricted Cash, Cash Equivalents, and Investments	$ 283,983	$ 190,168

SOURCE: **HRSD Comprehensive Annual Financial Report for the Fiscal Years Ended June 30, 2019 and 2018 pages 16 & 17**

Attachment G: Site Security (Commercial Wells Only)

G.1 Site Security

Though the James River SWIFT is not a commercial facility, note that the HRSD James River SWIFT Advanced Water Treatment (AWT) Facility will be co-located with the HRSD James River Treatment Plant. The site is surrounded by a perimeter fence and access to the site is controlled through a locked entrance gate. Managed Aquifer Recharge (MAR) and monitoring wells located off-site will be housed within locked buildings depicted in Attachment D, Figures D.2. and D.5.

Attachment H: Aquifer Exemptions

Not applicable. HRSD is not requesting an exemption.

Attachment I: Existing EPA Permits

Permitting Authority	Permit/Registration Number	Type
Virginia DEQ, State Water Control Board	VA0081272	VPDES Permit
VADEQ, State Water Control Board	VAN040090	Nutrient General Permit
VADEQ, State Air Pollution Control Board	#60996	State Operating Permit, Stationary Source
RCRA Registration	000800813	Hazardous Waste

Attachment J: Description of Business

HRSD is a regional wastewater entity serving 18 cities and counties located primarily in Hampton Roads in southeast Virginia. With a combined treatment capacity just under 250 MGD, HRSD provides wastewater treatment to approximately 1.7 million people. As a political subdivision of the Commonwealth of Virginia, HRSD is overseen by an 8-member board of Governor appointed Commissioners.

HRSD's Sustainable Water Initiative for Tomorrow (SWIFT) is a managed aquifer recharge program, adding multiple advanced water treatment processes to select HRSD wastewater treatment facilities to produce a highly treated water (SWIFT Water) that meets drinking water standards and is compatible with the receiving aquifer. Secondary effluent from up to seven of HRSD's existing treatment facilities will be treated at SWIFT facilities and SWIFT Water will be recharged into the Potomac Aquifer System (PAS) to counter depleting aquifer levels. At full-scale, HRSD will have the capacity to recharge approximately 100 million gallons per day of SWIFT Water that will significantly reduce the nutrient load to the sensitive Chesapeake Bay and provide significant benefit to the region by limiting saltwater intrusion, reducing land subsidence, and providing a sustainable source of groundwater, a necessity for continued economic expansion in the region.

This permit application is for HRSD's first full-scale facility to be located at HRSD's James River Treatment Plant (Newport News, VA). Since 2018, HRSD has been operating a demonstration scale 1 MGD advanced water treatment and recharge facility at the SWIFT Research Center located at its Nansemond Treatment Plant in Suffolk, Virginia. As of October 28, 2020, this SWIFT Research Center has successfully recharged 400 million gallons to the PAS.

Attachment K: Optional Additional Project Information

In conjunction with the application for a Water Infrastructure Finance and Information Act (WIFIA) loan, HRSD submitted the following information that may be relevant to the federal laws below.

K.1. The Wild and Scenic Rivers Act

There are no known wild and scenic rivers located within the Area of Review.

K.2. The National Historic Preservation Act of 1966

Table K.1. Potential project impacts to historical resources.

	IMPACT ANTICIPATED		
CULTURAL RESOURCES:	**NO IMPACT**	**LESS THAN SIGNIFICANT IMPACT**	**POTENTIALLY SIGNIFICANT IMPACT**
1. Changes to historical resources, including archaeological and cultural resources as defined in 36 CFR part 800.	☐	☒	☐
2. Modification of unique paleontological resources or site or unique geologic features.	☐	☒	☐
3. Disturbance of human remains, including those interred outside of formal cemeteries.	☒	☐	☐

A review of the Virginia Cultural Resources Information System (VCRIS) maintained by the Virginia Department of Historic Resources (VDHR), the Virginia Archaeological Site Survey Records, the Virginia Historic Inventory Property Forms, and the National Register of Historic Places (NRHP) was conducted as part of a cultural resources desktop survey of the project area. Immediately to the southeast of the James River Water Treatment Plant, along the bank of the Warwick River, is the location of the Colonial settlement of Warwicktowne, which served as the county seat of Warwick County (now the City of Newport News) (Gray and Pape 2020). The project area, therefore, is located in an area of high archaeological potential.

VCRIS shows three previously conducted cultural resource surveys in the project area, dating from 1976 to 1992, of both aboveground and belowground resources. There are three previously identified aboveground properties close to the Limit of Disturbance (LOD) – the Battle of Yorktown (VDHR ID #099-5283), Farmstead (VDHR ID #121-0103), and Newport News

City Prison Farm (VDHR ID #121-0104). There are nine previously identified archaeological sites close to the LOD, and two that fall within the LOD (Gray and Pape 2020).

AECOM conducted a Phase I archaeological survey in March 2020 of areas of proposed ground disturbance (i.e, area of potential effect, APE) in support of the proposed project and pursuant to Section 106 of the NHPA of 1966, as amended, the Advisory Council on Historic Preservation's (ACHP) "Protection of Historic and Cultural Properties" and the DHR Guidelines for Conducting Historic Resources Survey in Virginia (AECOM 2020b). A copy of the Phase I archaeological survey report was submitted with the WIFIA application and can be provided on request. AECOM conducted a second Phase I archaeological survey in October 2020 of the construction staging area and the proposed relocation of an access road (AECOM 2020c). AECOM conducted a third Phase I archaeological survey in May 2021 to incorporate additional areas of proposed ground disturbance associated with the recharge and monitoring wells (AECOM 2021). Copies of these two Phase I archaeological survey reports can be provided on request.

The three Phase I archaeological surveys of the JRTP APE resulted in the documentation of two new archaeological sites within the APE, 44NN0359 and 44NN0360, as well as the relocation within the APE of a portion of 44NN0281; no evidence of previously recorded sites 44NN0068, 44NN0069, 44NN0278, 44NN0281, and 44NN0282 was encountered.

While site 44NN0281 has been determined eligible for listing in the NRHP, it has been determined in consultation with VDHR, which serves as the Virginia State Historic Preservation Office (SHPO) that the archaeological deposits associated with 44NN0281 within the APE do not have the potential to yield significant information about the historic occupation of the APE and do not contribute to the NRHP eligibility of 44NN0281 as a whole. The archaeological deposits of two newly recorded sites, 44NN0359 and 44NN0360, likewise do not have the potential to yield significant information about the historic occupation of the APE, and the sites were determined not eligible for the NRHP by DHR. Therefore, the recommendation of the Phase I archaeological survey report is that the proposed project be allowed to proceed without concern for impacts to significant archaeological sites. Adherence with the Code of Virginia (e.g., §18.2-126, 127) is required should unanticipated graves or human remains be encountered during construction activities.

Effects to cultural resources could include encroachment, displacement or destroying or diminishing the historic integrity of NRHP listed or eligible properties; however, as described in the Phase I archeological survey report, no impacts to significant cultural resources are anticipated. Practicable mitigation measures include consultation with the SHPO and/ or Tribal Historic Preservation Office (THPO), minimization of adverse effects and development of an unanticipated discoveries plan. The location and extent of known cultural resources in the project vicinity would be considered during project design. If impacts to significant cultural resources cannot be fully avoided, HRSD would work with VDHR to determine appropriate measures to protect and reduce impacts to architectural and archaeological resources.

K.3. The Endangered Species Act

Table K.2. Potential project impacts to biological resources.

	IMPACT ANTICIPATED		
BIOLOGICAL RESOURCES:	**NO IMPACT**	**LESS THAN SIGNIFICANT IMPACT**	**POTENTIALLY SIGNIFICANT IMPACT**
1. Jeopardizing the continued existence of any threatened or endangered species identified in local or regional plans, policies, or regulations, or by the U.S. Fish and Wildlife Service or National Marines Fisheries Service.	☐	☒	☐
2. Modification, fragmentation, or degradation of critical habitat identified in local or regional plans, policies, or regulations, or by the U.S. Fish and Wildlife Service or National Marines Fisheries Service.	☐	☒	☐
3. Harm to fauna, including mammals, birds, reptiles, amphibians, fish, and invertebrates.	☐	☒	☐
4. Changes in vegetation type (native to the region), particularly if the vegetation type in the region is already highly fragmented because of human activity.	☐	☒	☐
5. Modification, fragmentation, or degradation of biological sensitive areas other than those mentioned above.	☐	☒	☐
6. Disturbances to marine mammals protected by the Marine Mammal Protection Act as defined under 16 U.S.C 1361-1407.	☒	☐	☐
7. Disturbances to Bald or Golden Eagles as defined under 16 U.S.C. 68 et seq.	☒	☐	☐
8. Disturbances to migratory birds as defined under 16 U.S.C. 703-712 as amended.	☐	☒	☐
9. Conflicts with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, state, or federal habitat conservation plan.	☒	☐	☐
10. Introduction or spread of invasive species as identified under Executive Order 13112.	☐	☒	☐

During construction, it would be expected that some vegetation cover would be lost due to direct impacts from clearing, trenching, excavation, soil compaction, and general activity on the site. Given the relatively small footprint of water and wastewater projects, this impact would be minimal and not likely cause disturbance to vegetation beyond site boundaries.

Likewise, minor, short-term effects on wildlife could occur as they would likely be deterred by construction activities, vehicles, and equipment. Minor, long-term effects on some wildlife are anticipated due to displacement. Less mobile wildlife species may not be able to relocate outside of the construction area. One federally-listed rare, threatened, or endangered species was identified by U.S. Fish and Wildlife Service (USFWS) during a review of the project vicinity via the Information for Planning and Consultation (IPaC) tool: the northern long-eared bat (NLEB) (*Myotis septentrionalis*) (threatened) (USFWS 2019a). Potentially suitable summer roosting habitat has been observed in the project area for the NLEB. According to the Virginia Department of Wildlife Resources (VDWR) NLEB Winter Habitat and Roost Tree Application, the nearest known maternity roost for the NLEB is approximately 35 miles southeast of the proposed project area (VDWR 2020). There are no documented maternity roosts or hibernacula within 150 feet and 0.25 miles of the project area, respectively; therefore, incidental take from tree removal is not prohibited. Voluntary conservation measures such as a time of year restriction (June 1 – July 31) and minimizing light pollution through adjusting light angles downward will be implemented where practical. Results of the IPaC database search and the NLEB Habitat and Roost Tree Map as well as a USFWS Self-Certification Letter, noting a “may affect, not likely to adversely affect” determination for the NLEB were submitted with the WIFIA application and can be provided on request. Prior to commencement of the project, coordination with USFWS would be conducted regarding the limits and timing of vegetation removal, in order to ensure compliance with the Endangered Species Act.

The Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act confer protection to the bald eagle (*Haliaeetus leucocephalus*) (USFWS 2019b). The southern portion of the peninsula separating the James and Warwick rivers near the mouth of the Warwick River has been documented as containing bald eagle nests that are historic, and nests that may currently be in use. The project area is located beyond the restricted radius of the documented bald eagle nests. No nests in use by a bald eagle has been observed within the project vicinity, and no bald eagles were observed flying over or in the vicinity of the project area during the onsite investigations. The Center for Conservation Biology (CCB) Mapping Portal identified the nearest documented bald eagle nest approximately 1,950 feet southeast of the project area boundary (CCB 2020). The USFWS Virginia Field Office’s Bald Eagle Map Tool identified one bald eagle concentration area intersecting the project area along the southwestern edge of the project boundary (USFWS 2020a). The CCB Map and the USFWS Virginia Field Office’s Bald Eagle Concentration Map are included in Appendix B. Due to the distance from the project construction activities (greater than 660 feet from the documented nest and inland from the shoreline), no impacts to the bald eagle concentration or nests are anticipated.

The Virginia Department of Game and Inland Fisheries maintains records of species known or likely to occur throughout the Commonwealth of Virginia in the Fish and Wildlife Information Service (FWIS) database. Review of the FWIS database identified eight federally endangered or threatened species with the potential to occur within a two-mile radius of the project area (FWIS 2020). The FWIS Project Report was submitted with the WIFIA application and can be provided on request. Of the eight species identified, there is one documented occurrence - the loggerhead sea turtle (*Caretta caretta*, federal listed threatened), which only occurs in open waters. Since there are no in-water activities associated with the project, no impacts to the loggerhead sea turtle are anticipated.

The FWIS habitat prediction model also identifies four species with the potential to occur within a two-mile radius of the project area: the federal proposed/state listed endangered eastern black rail (*Laterallus jamaicensis jamaicensis*); the state listed endangered canebrake rattlesnake (*Crotalus horridus*, southestern population); the state listed threatened Henslow's sparrow (*Centronyx henslowii*); and the state listed threatened Mabee's salamander (*Ambystoma mabeii*).

USFWS indicates that eastern black rail habitat consists of impounded and unimpounded salt and brackish marshes (USFWS 2020b). Wetlands within the project area are categorized as PFO and no positive observations have occurred within a two-mile radius of the project area; therefore, no effect is anticipated to the eastern black rail. Canebrake rattlesnake habitat consists of mature hardwood, mixed hardwood-pine forests, forested cane thickets, and ridges adjacent to swampy areas (VDWR 2011). A 100-foot RPA buffer is being placed on most wetlands within the project area which will not be disturbed by project activities. Swampy areas in the project area outside of the RPA appear to be heavily disturbed by past and current land use and no positive observations have been made within a two-mile radius of the project area. Therefore, no effect is anticipated to the canebrake rattlesnake. Henslow's sparrow habitat is described as hayfields, pastures, wet meadows, undisturbed protected grasslands, upland portions of salt marshes, and old fields (USFWS 2012). While some areas within the project area are upland grass fields, these areas are mowed turf grasses and are not allowed to grow as a hay field or meadow. Therefore, no effect is anticipated to the Henslow's sparrow. Habitat for Mabee's salamander is described as savannas on the edges of bogs or ponds, low wet woods and swamps, and adjacent to ditches and pools (VHS 2020). A 100-foot RPA buffer has been placed on all wetlands within the project area including low wet woods. The majority of uplands within 200 feet of wetlands in the project area, not covered by the RPA buffer, are heavily industrialized or managed turf grass. Therefore, no effect is anticipated to the Mabee's salamander.

Based on the land cover of the project area, mitigation measures, and proposed activities, the project is expected to have "no effect" on the federally listed threatened and/or endangered species.

No significant impacts to biological resources would be expected to result from the proposed SWIFT project. Potential effects could include reduced vegetative cover, soil compaction, erosion or sedimentation, habitat fragmentation, introduction of invasive species, changes in water availability, and disturbance from construction noise and dust. Practicable mitigation measures include implementation of avoidance and minimization measures and BMPs, implementation of recommendations from relevant governmental wildlife agencies, prevention of spills and leaks from vehicles and equipment, and implementation of measures to minimize soil compaction and the transportation of noxious, invasive and pest species. Protective measures would be identified in coordination with the U.S. Fish and Wildlife Service and state wildlife agencies, as applicable, to protect federally threatened or endangered species that may inhabit or otherwise utilize the project area. Protective measures may include time-of-year restrictions, lighting alterations, and/or design modifications, among others.

K.4. The Coastal Zone Management Act

Table K.3. Potential project impacts to water resources.

	IMPACT ANTICIPATED		
WATER RESOURCES:	**NO IMPACT**	**LESS THAN SIGNIFICANT IMPACT**	**POTENTIALLY SIGNIFICANT IMPACT**
1. Violations of any water quality standards or waste discharge requirements, including degradation of water quality.	☒	☐	☐
2. Depletion or contamination of groundwater supplies (including sole-source aquifers) or negatively interfere with groundwater recharge.	☒	☐	☐
3. Alteration of the drainage pattern of a water resource that would result in an increase in erosion or flooding on- or off-site.	☐	☒	☐
4. Soil erosion or stormwater runoff that increases sediment, pollutants, or contaminates into streams, rivers, or other water resources.	☐	☒	☐
5. Floodplain modification, development within, or redirection, as defined by executive order 11988.	☒	☐	☐

	IMPACT ANTICIPATED		
WATER RESOURCES:	**NO IMPACT**	**LESS THAN SIGNIFICANT IMPACT**	**POTENTIALLY SIGNIFICANT IMPACT**
6. Increase in flood risk affecting loss on human safety, health, and welfare.	☐	☒	☐
7. Loss, degradation, or destruction of wetlands and waterbodies through direct removal, filling, hydrological interruption, or other means.	☐	☒	☐
8. Alteration of wild and scenic rivers as defined by the Wild and Scenic River Act 16 U.S.C. 1271 et seq.	☒	☐	☐
9. Conflicts with the Rivers and Harbors Act, 33 U.S.C. 403.	☒	☐	☐
10. Conflicts with the Coastal Barrier Resources Act, 16 U.S.C. 3501 et seq.	☒	☐	☐
11. Conflicts with the Coastal Zone Management Act, 16 U.S.C. 1451 et seq.	☐	☒	☐

The project would have an overall long-term benefit on flood risk, aquifers, and the groundwater supply by reducing aquifer-related land subsidence in coastal Virginia and allowing additional time to adapt to sea level rise and protect valuable coastal wetlands for decades longer than currently projected.

A wetlands delineation was conducted in January 2020 to determine the extent of jurisdictional waters of the U.S. (WOUS) within and adjacent to the project area. In May 2020, AECOM conducted further wetlands investigations to confirm and expand upon the May 2020 findings (AECOM 2020a). A copy of the January 2020 Wetlands Delineation Report was submitted with the WIFIA application and can be provided on request.

The wetland field investigations identified five non-tidal wetlands and one non-tidal stream within the project area, identified as wetlands WA, WB, WD, WE, and WF, and stream SA. Wetlands WA and WF consist of both tidal and non-tidal wetlands, but only the non-tidal portions of these wetlands occur within the project boundary. The extent of wetland WD was expanded during the May 2020 field investigation by approximately 0.02 acres. The non-tidal portion of wetland WA, wetlands WB, WC, WD, WE, WF, and WG were field-verified by AECOM as palustrine forested (PFO) wetlands. The tidal portion of wetland WA, portions of wetlands WB, WD, WE, WF, and wetland WC and WG are located outside the project boundary.

Two of the wetlands (wetlands WB and WD) are located in previously disturbed areas within the fenced portion of the James River Treatment Plant property. Wetland WA is located in the forested area at the southern edge of the project area. The remaining wetland (WF) and stream SA are located in forested areas along the west and southwest project boundary adjacent to an unnamed tidal tributary to the Warwick River. The approximate location and extent of the jurisdictional features identified in the field are depicted on Figure K.1 and WOUS located within the project area are summarized in Table K.4. Appropriate federal, state, and local wetland permits would be secured prior to commencement of the project.

Table K.4. Summary of WOUS within Project Area

Wetland/Stream	Tidal	Cowardin Classification*	Area (Acres)
WA	Non-tidal	PFO	0.14
WB	Non-tidal	PFO	0.04
WD	Non-tidal	PFO	0.17
WE	Non-tidal	PFO	0.36
WF	Non-tidal	PFO	1.75
SA	Non-tidal	N/A	125 Linear Feet
Total			2.46
* Cowardin classification based on information from USFWS-NWI mapper (USFWS NWI 2020)			

The City of Newport News administers and enforces the Chesapeake Bay Preservation Act (CBPA) within the city limits via the City's Chesapeake Bay Preservation Act Ordinance (CBPO). Under the CBPO, Resource Protection Areas (RPAs) incorporate tidal wetlands, tidal shores, nontidal wetlands connected by surface flow and contiguous to tidal wetlands or waterbodies with perennial flow, and a 100-foot wide buffer surrounding the aforementioned features, as well as along waterbodies with perennial flow. Consistent with the CBPA and CBPO, a potential 100-foot RPA has been mapped along wetlands and streams that continue off-site where it is assumed that they are connected by surface water flow and contiguous to tidal wetlands or water bodies with perennial flow. The RPA includes portions of the parcel associated with the existing HRSD treatment plant; however, the proposed project and site layout largely avoids disturbance of the RPA. Should the selected contractor determine encroachment into the RPA may be necessary, a detailed field delineation of the RPA would be conducted, and proper approvals would be obtained from the City of Newport News and VDEQ, as appropriate.

According to the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), the proposed project improvements are located outside the 100-year and 500-year floodplains, as depicted on Figure K.2. Floodplains to the south and southwest do occur within the project boundary; however, the proposed site layout avoids encroachment into or disturbance of the floodplain. The nearby floodplains are associated with James River, Warwick River, and the unnamed tributary to the Warwick River located along the western parcel boundary of the treatment plant.

Effects could include ground and soil-disturbing activities, direct impacts to surface water or wetlands, new or expanded outfalls and discharges of effluent to water resources. Practicable mitigation measures include use of erosion and sediment control measures and BMPs, compliance with permit requirements, effective site selection and design, consistency with Executive Order 11990 and the Clean Water Act Section 404(b)(1) guidelines, water efficiency, coordination with Regional utilities, and planning for extreme weather. Minimization and avoidance of impacts to jurisdictional waters of the U.S. would occur during site design. Erosion and sediment control measures would be implemented during construction to protect surface waters from sediment and nutrient transport and deposition. Treatment processes would be identified to ensure protection of groundwater resources and water quality. Compensatory mitigation would be secured, if needed, to ensure no more than minimal impacts to jurisdictional waters of the U.S. result from the project.

Figure K.1: James River Treatment Plant Site Wetlands Map

Figure K.2: James River Treatment Plant FEMA Flood Map

The most significant change to water resources proposed by the project would be the pumping of large volumes of water into the deepwater Potomac Aquifer. However, the project's net impact would be beneficial, as the recharge water would be treated to drinking water standards prior to being returned to the aquifer.

It is anticipated that higher quality discharge waters would result in improvements in downstream waters and aquatic habitats. The project would utilize advanced water treatment (AWT) processes to treat secondary wastewater treatment plant effluent to drinking water standards. The SWIFT water would subsequently be used to recharge the Potomac Aquifer system to counter depleting aquifer levels and provide additional environment benefits (HRSD 2019). Analytical groundwater flow and geochemical modeling using various treatment and recharge techniques has been conducted to determine the optimal treatment and recharge methods (HRSD 2019). The modeling represented the VDEQ preferred metric for determining the beneficial impacts of proposed pumping/recharge on the Potomac Aquifer. The AWT is expected to improve drinking water sources, i.e., the Potomac Aquifer, by treating and reducing contamination and removing disease-causing agents (HRSD 2019). The project would provide a sustainable source of groundwater to the Potomac Aquifer, increase the hydrostatic pressure within the aquifer, prevent saltwater intrusion into the aquifer, and slow land subsidence related to aquifer withdrawals. The project is intended to have an overall beneficial effect on water resources; therefore, no significant adverse impact anticipated.

References

AECOM. 2020a. Wetlands and Waters Delineation Report. Prepared for the James River HRSD SWIFT Project. City of Newport News, Virginia. July 2020

AECOM. 2020b. Phase I Archaeological Survey of the Sustainable Water Initiative For Tomorrow Improvements to the James River Treatment Plant. Prepared for HRSD. May 2020.

AECOM. 2020c. Phase I Archaeological Survey of the Sustainable Water Initiative For Tomorrow Improvements to the James River Treatment Plant, Section 3 Addition. Prepared for HRSD. October 2020.

AECOM. 2021. Phase I Archaeological Survey of the Sustainable Water Initiative For Tomorrow James River Treatment Plant Recharge Wells. Prepared for HRSD. May 2021.

Center for Conservation Biology (CCB) 2020. CCB Mapping Portal. https://www.ccbbirds.org/maps.php. Accessed May 21, 2020.

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Appendix A: James River SWIFT Water Quality Targets

1.0 Introduction

The Hampton Roads Sanitation District (HRSD) Sustainable Water Initiative for Tomorrow (SWIFT) is a managed aquifer recharge program located in southeast Virginia. The SWIFT program will add multiple advanced water treatment processes to select HRSD wastewater treatment facilities to produce a highly treated water (SWIFT Water) that meets drinking water standards and is compatible with the receiving aquifer. Secondary effluent from up to seven of HRSD's existing treatment facilities will be treated at SWIFT facilities and SWIFT Water will be recharged into the Potomac Aquifer System (PAS) to counter depleting aquifer levels. At full-scale, HRSD will have the capacity to recharge approximately 100 million gallons per day of SWIFT Water that will significantly reduce the nutrient load to the sensitive Chesapeake Bay and provide significant benefit to the region by limiting saltwater intrusion, reducing land subsidence, and providing a sustainable source of groundwater, a necessity for continued economic expansion in the region.

HRSD's James River Treatment Plant (JR; Newport News, VA) will be the site of a full-scale SWIFT facility. The purpose of this document is to define the SWIFT water quality targets for JR SWIFT and demonstrate how the targets will be achieved. The intent is to build upon the targets established for the SWIFT Research Center (SRC) and leverage data and lessons learned from SRC operation to establish the JR SWIFT targets. As the SWIFT program evolves, the water quality targets are also expected to change so that appropriate targets are identified for each project. The SWIFT Water Quality Targets document is a detailed supplement to HRSD's Class V Underground Injection Control (UIC) permit application for James River SWIFT.

The SRC, located in Suffolk, VA, houses a demonstration-scale, 1 million gallon per day (MGD) Advanced Water Treatment (AWT) facility and recharge well. The facility and recharge well went on-line in the spring of 2018. More than 18 months of operational data has demonstrated at a meaningful scale that the SWIFT AWT can successfully meet the SWIFT Water Quality targets proposed below.

In addition to the 1 MGD demonstration-scale facility, the SRC houses a pilot ozone-biofiltration treatment train as well as soil columns used to evaluate the availability of soil aquifer treatment across multiple time scales (3-day, 1 month, and 6 month). As such, the SRC has proven invaluable in investigating a wide variety of questions common in the potable reuse arena. Much of this research focuses on the management of constituents of emerging concern (CECs) and optimizing treatment performance. Current research areas at pilot and/or demonstration scale include:

- The management of organic compounds (e.g., disinfection by-products and CECs) and understanding the potential for associated public health risk. This involves research in optimizing the performance of various unit processes in order to better control for compounds such as 1,4-dioxane, disinfection by-products (DBPs: e.g. bromate, NDMA, haloacetonitriles and haloacetaldehydes), per-and polyfluoroalkyl substances, and low molecular weight aldehydes. Acknowledging limitations in parameter-specific chemical analyses that cannot detect every known and unknown compound, HRSD is also working with researchers to conduct a variety of bioanalytical screening techniques (e.g., estrogen receptor assay, aryl hydrocarbon assay, and larval zebrafish assay) in an attempt to better understand the utility of these tools in providing an additional layer of public health protection in potable reuse frameworks.

- Microbiological studies which include understanding the occurrence of antibiotic resistance genes, antibiotic resistant bacteria, and a wide variety of pathogens and pathogen indicators in potable reuse scenarios. The pathogen monitoring has combined culture- and molecular-based methods for indicator and pathogen quantification. For early pilot work, HRSD analyzed male-specific and somatic coliphages by culture methods. Human polyomavirus, human adenovirus 40/41, enterovirus, norovirus, pepper mild mottle virus, enterococcus spp. Human specific Bacteroides spp., *E. coli* O157:H7, and Legionella pneumophila were enumerated by molecular methods. At the SRC, HRSD is analyzing male-specific and somatic coliphages by culture methods. *Campylobacter coli*, *Campylobacter jejuni*, human adenovirus 40/41, norovirus, rotavirus, enterovirus, and pepper mild mottle virus are being enumerated by molecular methods.
- Understanding the potential for additional soil aquifer treatment. This involves a series of columns containing soils obtained from test well drilling at the SRC. The columns are set up to simulate 3-day, 1 month, and 6 month travel times through the aquifer and have been used to evaluate the removal of total organic carbon, CECs, DBPs, and pathogen indicators.
- Aquifer studies to include modeling flow distribution and solute transport through the aquifer system.

Research and optimization studies regarding the control of chemical or microbial contaminants will evolve over the coming years as new questions arise or new technologies become available and will continue to inform design of other future full-scale SWIFT facilities.

1.1 General Description

The JR SWIFT facility will be designed to accept secondary effluent from the existing JR treatment plant. Average daily flows at JR are between 12 and 13 MGD and secondary effluent flow will be directed to the SWIFT Feed Tank, diverting flow away from the existing outfall. Planned interceptor system improvements will increase the average JR influent flow up to 16 MGD by diverting flow from other parts of the HRSD service area and will equalize the dry weather flows to JR. JR SWIFT is being designed to treat a nominal flow of 16 MGD through the Advanced Water Treatment (AWT) process. Ten recharge wells will be designed to receive the SWIFT Water for recharge into the Potomac Aquifer System (PAS). HRSD will maintain its Virginia Pollutant Discharge Elimination System (VPDES) permit and the use of its permitted outfall to allow for the discharge of flows as necessary (e.g., flows that exceed the capacity of the AWT, discharging SWIFT Water that doesn't meet the water quality specifications, or for other operational purposes).

The treatment process for JR SWIFT is described in this document and consists of the same advanced treatment technologies as the SRC. Where design criteria differ from the SRC, justification is provided. Performance data for the SRC is not provided in this document as it is assumed that the Quarterly Reports that have been submitted to EPA and available at https://www.hrsd.com/swift/quality sufficiently document the SRC performance to date.

JR SWIFT will differ from the SRC in that it will not be designed to offer tasting events to the public. The only end use for JR SWIFT water will be to recharge the PAS. As such, the primary compliance point for JR SWIFT will be after the SWIFT Water Pump Station, prior to recharge. Sampling will be conducted at this location to confirm compliance with all SWIFT Water quality targets. Online analyzers throughout the treatment process will confirm that the treatment performance is sufficient and critical control points (CCPs) will initiate action. CCP failures will result in action that prevents inadequately treated water from recharging the aquifer (see Table 3-1). The selection of these CCPs reflects thoughtful consideration of critical points in process control necessary for the protection of public health with regard to both microbial and chemical contamination.

A network of groundwater monitoring wells around the recharge wells will be used to monitor water quality as the recharge front migrates through the PAS. The purpose of these wells is detailed in the Aquifer Monitoring and Contingency Plan (Appendix B). Note that all of the proposed regulatory limits in this document are intended to be met at the SWIFT Water Pump Station.

An independent SWIFT oversight structure, similar to the Occoquan Watershed Monitoring Program formed to provide oversight of indirect potable reuse in northern Virginia, has been enabled through legislative action. The Potomac Aquifer Recharge Oversight Committee (PAROC) and the Potomac Aquifer Recharge Monitoring Laboratory (PARML) will serve to provide independent oversight and monitoring of the SWIFT treatment processes, observe the aquifer response to the recharge, and confirm compliance with SWIFT program performance targets.

1.2 Process Design Summary

A process flow diagram of the JR SWIFT treatment process is shown in Figure 1.1. The full treatment process consists of rapid mix with coagulant addition, flocculation and sedimentation, ozone oxidation, biologically active carbon filtration (BAF), GAC adsorption, and ultraviolet (UV) disinfection. This is the same treatment process that has been proven during pilot testing conducted in 2016-2017 and at the SRC in 2018-2020.

A major upgrade to the existing JR Treatment Plant will be constructed concurrently with the SWIFT facilities. This will improve the quality and consistency of the secondary effluent that will in turn increase the quality and consistency of the SWIFT Water. Improvements include flow equalization in the interceptor system, new secondary clarifiers, and process upgrades for nitrogen treatment. The primary objectives of the improvements are to provide consistent flows and nutrient loads to SWIFT.

Following is a brief description of each treatment process with accompanying design criteria listed in Table 1.1 for both JR SWIFT and the SRC:

- **Rapid Mix, Flocculation, Sedimentation:** Chemical coagulant and an organic polyelectrolyte will be added to the water to remove particles and dissolved organics through the formation and settling of chemical flocs and to prepare the water for effective filtration. The chemical coagulant is anticipated to be aluminum chlorohydrate (ACH) subject to change based on the results of bench-scale testing for this facility.
- **Ozone Oxidation:** Ozone will be added to oxidize high molecular weight organics for downstream removal in biofiltration and for direct oxidation of trace organics (e.g.,

contaminants of emerging concern such as pharmaceuticals and personal care products). Disinfection of pathogens will also be achieved with ozone addition though disinfection credit is not being claimed for this unit process. A hydrogen peroxide addition point will be added upstream of ozone injection such that ozone can be operated as an advanced oxidation process (AOP) for additional 1,4-dioxane removal.

- **Biofiltration (BAF):** Deep-bed granular media filters will provide biological removal of organic matter and particle and pathogen removal. Low filtered water turbidity (<0.15 nephelometric turbidity units [NTU]) will be targeted to ensure proper pathogen removal consistent with the design and operation of drinking water filters (see Critical Control Point section).
- **GAC Adsorption:** Granular activated carbon will provide removal of trace organics through biological and adsorption mechanisms. GAC media will be regenerated to meet the proposed regulatory limit for total organic carbon (see Regulatory Limits section) or per Section 2.1 below, based on an assessment of the removal of non-regulatory performance indicators.
- **UV Disinfection:** UV irradiation will provide disinfection of the water before groundwater injection. A UV dose that is significantly higher than typically used for drinking water is being provided for JR SWIFT to allow for a minimum of 4-log virus removal (>186 mJ/cm2) and other treatment benefits, specifically NDMA photolysis during the startup and acclimation period prior to achieving necessary NDMA removal through BAF. Similar to ozone, a hydrogen peroxide addition point will be added upstream of UV and equipment will be selected to allow the UV system to be operated as an AOP for additional 1,4-dioxane removal.
- **pH & Alkalinity Adjustment for Aquifer Compatibility:** Sodium hydroxide will be used to adjust the final pH and alkalinity of the SWIFT Water prior to recharge at JR SWIFT, similar to the SRC. The pH target at the SRC is 7.6, and sodium hydroxide is added to raise the pH from nominally 7.0 (after UV). Raising the pH achieves two objectives: increasing the Langelier Saturation Index (LSI) to reduce the potential for corrosion in the recharge well and promoting the formation of hydrous ferric oxide (HFO) surfaces in the aquifer to limit metals mobilization. Many variables affect the pH target, including SWIFT Water alkalinity and dissolved oxygen and the aquifer oxidation-reduction potential (ORP), among otherss. HRSD is currently working on improving the understanding of both of these pH objectives at the SRC and will propose new pH and alkalinity targets prior to startup of JR SWIFT. It is likely that the pH target will be a function of the aquifer ORP and SWIFT Water alkalinity, and that it will decline over the course of operation.
- **Recharge Well Biofouling Control:** JR SWIFT will allow for the controlled addition of either free chlorine, preformed monochloramine, or hydrogen peroxide prior to the recharge well to prevent biological fouling of the well. Free chlorine will be utilized as needed to control nitrite during initial biofilter acclimation (i.e., prior to colonization of nitrite oxidizing bacteria during biofilter start-up). Free chlorine may also be used for an extended period of time to better manage biofouling in the well and coliform bacteria control. Hydrogen peroxide residual will only be used for biofouling control if UV advanced oxidation (UV + H2O2) is being performed for other water quality benefits, as this will likely result in an acceptable residual.

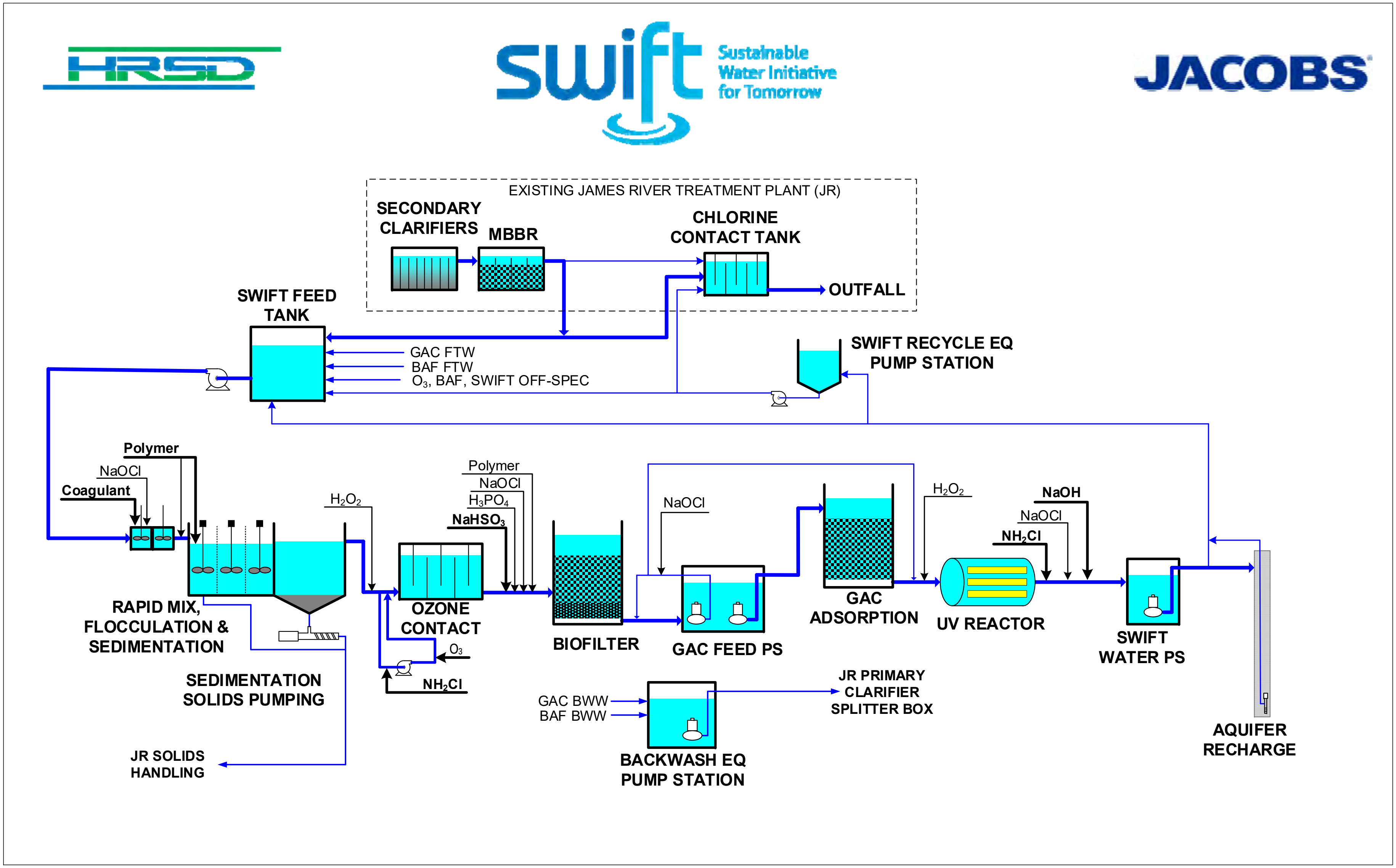

Figure 1.1: JR SWIFT Process Flow Diagram

Table 1.1: JR SWIFT and SRC Treatment Process Design Criteria

Process/Criteria	JR SWIFT Value	SWIFTRC Value	Units
Rapid Mix Velocity Gradient	1,000	1,000	s-1
Number of Flocculation Stages	3	3	#
Flocculation Stage Residence Time, each, all in service	10	15	Min
Design Sedimentation Projected Loading Rate, all in servic	0.28	0.20	gpm/sf
Maximum Ozone Dose	10	20	mg/L
Ozone Contactor Hydraulic Residence Time	5	8	Min
Number of Biofilters	7	4	#
BAF Loading Rate, each, one filter out of service	3.6	4	gpm/sf
BAF Empty Bed Contact Time, one filter out of service	10.4	9.3	Min
BAF Carbon Media Depth	5	5	Ft
BAF Sand Media Depth	1	1	Ft
Number of GAC Adsorbers	7	2	#
GAC Empty Bed Contact Time, one adsorber out of service	20.9	15	Min
Design UV Virus Log Removal Value	4	4	LRV
Design UV Dose	186	186	mJ/cm2
Minimum UVT	89	85	%
Minimum UV Lamp Age & Lamp Fouling Factor, each	90	90	%

LRV = Log Removal Value
mJ/cm2 = milijoules per square centimeter
UVT =ultraviolet transmittance
Gpm/sf=gallons per minute per square foot

The following design criteria have been adjusted from the SRC design:

- Flocculation Stage Residence Time: total flocculation residence time was reduced from 45 min at the SRC to 30 min at JR SWIFT. This is still within typical hydraulic residence times for flocculation.
- Maximum Ozone Dose: the design maximum ozone dose has been reduced from 20 mg/L at the SRC to 10 mg/L at JR SWIFT based on sampling at the SRC and pilot testing of the JR secondary effluent. The maximum ozone dose that can be applied is limited by bromate formation and testing has shown that ozone doses above 10 mg/L result in bromate concentrations that exceed the regulatory limit.
- Ozone Contactor Hydraulic Residence Time: a shorter residence time for ozone contact is included in the JR SWIFT design as the longer contact time is not necessary.

- Biofilter Loading Rate: the design biofilter loading rate has been decreased from 4 gpm/sf at the SRC to 3.6 gpm/sf in order to provide a longer empty bed contact time for improved treatment performance.
- GAC Empty Bed Contact Time (EBCT): The GAC EBCT with one adsorber out of service has been increased from 15 min at the SRC to 20.9 min.
- Minimum UVT: the design UVT for the UV reactors has been increased from 85% at the SRC to 89% as pilot testing and SRC operation have demonstrated that a UVT of 88-90% corresponds to a TOC around 4.0 mg/L. Operating at a lower UVT (~85%) would thus result in a violation of the 4.0 mg/L TOC regulatory target, so the design minimum has been increased to 89%.

It is important to acknowledge the role of the aquifer in providing additional treatment of the SWIFT Water. HRSD soil column testing and preliminary results from the SRC suggest there is significant removal of both pathogens and organics in the PAS. HRSD will continue to monitor the results of ongoing soil column testing and the SRC monitoring wells to determine if operational strategies or design criteria for future full-scale facilities should be adjusted.

2.0 Regulatory Limits and Performance Indicators

The proposed JR SWIFT water quality targets are similar to the water quality targets established for the SRC. Based on feedback from the Virginia Department of Health (VDH), the Total coliform regulatory limit was modified as described in Table 2-1. No other changes have been proposed as there has not yet been sufficient data collected from the SRC to justify or necessitate a change. As operation of the SRC progresses, HRSD intends to consider if the water quality targets can be adjusted based on the data collected.

The SWIFT Water quality targets have been separated into two groups: regulatory parameters and performance indicators. Regulatory parameters must be achieved in order to continue the recharge flow to the PAS and will be supported by the CCPs. Performance indicators provide additional input on the performance of the treatment process and can help inform treatment or process decisions.

2.1 JR SWIFT Regulatory Limits

Table 2.1 provides a list of the regulatory limits for JR SWIFT. Most parameters have a treatment goal in addition to the regulatory limit. The treatment goals will be supported by the CCPs. Table 2.1 presents the complete list of regulatory requirements for JR SWIFT Water to recharge to the PAS. Similar to the SRC, quarterly reports detailing compliance with the regulatory limits will be provided to the U.S. Environmental Protection Agency (EPA) and the PAROC.

Table 2.1: Regulatory Limits for SWIFT Water

Parameter	Regulatory Limit
EPA Drinking Water Primary Maximum Contaminant Levels (PMCLs)	Meet all PMCLs[1]
Total Nitrogen (TN)	5 mg/L Monthly Average; 8 mg/L Max Daily
Turbidity	Individual Filter Effluent (IFE) <0.15 NTU 95% of time and never >0.3 NTU in two consecutive 15-minute measurements
Total Organic Carbon (TOC)[2]	4 mg/L Monthly Average, 5 mg/L Maximum Instantaneous
Total Coliform[3]	<2 CFU/100 mL 95% of collected samples within one calendar month, applied as the 95th percentile
E. Coli	Non-Detect
TDS[4]	No Limit

1 Refer to Table 4.2 for proposed sampling frequency of PMCLs. Within 24 hours of notification from HRSD or contract laboratory of a potential PMCL exceedance as identified in Table 2.2, SWIFT Water will be diverted to the wastewater treatment facility. A confirmation sample will be collected and submitted for analysis as soon as practical and no later than one week after receiving the initial sample results. If the confirmation sample does not confirm the result, recharge will resume. If the PMCL exceedance is confirmed, SWIFT Water will remain diverted until HRSD can complete an investigation as to the likely cause, take corrective action, and perform follow-up sampling to demonstrate that the corrective actions taken have been effective. HRSD will submit documentation describing the problem, the assessment, the corrective action taken, and the results of follow-up sampling within 14 days of resuming recharge.

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

3 The TC monitoring requirement at the SRC included compliance with a geomean of 3 CFU/100 mL for 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 geomean requirement and the application of both regulatory limits was not necessary.

4 No limit for TDS as the primary driver is aquifer compatibility. Expected range for SWIFT Water at JR SWIFT is 300-700 mg/L.

2.1.1. Compliance Determination

The methodology for determining PMCL compliance varies depending on the specific parameter of interest. Consistent with Virginia Waterworks Regulation, 12VAC5-590-410, the constituents are categorized into groups, and for each constituent group PMCL compliance is determined by either a running annual average (RAA) or as a single-instance limit. Constituents regulated on a RAA basis are in violation when the RAA exceeds the numerical PMCL. Constituents regulated on a single-instance limit are in violation when the results of any single sample exceed the numerical PMCL. In all cases, compliance shall be determined by rounding off results to the same number of significant figures as the PMCL.

Table 2-2: JR SWIFT Primary Maximum Contaminant Level Compliance Determination

Analytes	SWIFT Water Monitoring Frequency[1]	Compliance Determination
Total coliform	5x/week	TC < 2 CFU/100 mL 95% of collected samples within one calendar month[2]
E coli	5x/week	Non-detect
Antimony, arsenic, barium, beryllium, cadmium, cyanide, chromium, fluoride, mercury, nickel, selenium, thallium	Monthly	Compliance with the PMCL is determined by a Running Annual Average (RAA). If the average is greater than the PMCL, the PMCL has been exceeded.
Asbestos	Quarterly	Compliance with the PMCL is determined by a Running Annual Average (RAA). If the average is greater than the PMCL, the PMCL has been exceeded.
Nitrate, Nitrite	5x/week	Compliance for these constituent groups is to be determined based on individual sample results. If any single sample is greater than the PMCL, the PMCL has been exceeded.
Organic chemicals	Monthly	Compliance with the PMCL is determined by a Running Annual Average (RAA). If the average is greater than the PMCL, the PMCL has been exceeded.
Disinfection byproducts (TTHM and HAA5), Bromate, Chlorite	Monthly	Compliance with the PMCL is determined by a RAA of monthly data. If the average is greater than the PMCL, the PMCL has been exceeded.
Radionuclides	Monthly	Compliance for these constituent groups is to be determined based on individual sample results. If any single sample is greater than the PMCL, the PMCL has been exceeded.

[1] Minimum required monitoring frequency. All data collected during recharge operations and when the SWIFT facility is shut down due to a PMCL exceedance shall be reported and included in the compliance determination calculations. Data collected during a planned shutdown (such as a GAC contactor re-start) or during a pre-emptive shut down (such as when a CCP triggers a diversion of SWIFT water) are exempt from this requirement.

[2] If TC exceeds 2 CFU/100 mL > 95 % of samples (calculated by the 95th percentile) in one calendar month, HRSD will conduct an additional investigation (e.g., evaluating sample collection and training protocols, possible sample line contamination, etc.) A TC exceedance is not considered a PMCL exceedance unless E. coli is present. The results of the investigation will be included in the next quarterly report.

2.1.1.1. Constituents Regulated on a RAA basis

This category includes the following constituent groups: inorganic chemicals (antimony, arsenic, barium, beryllium, cadmium, chromium, fluoride, mercury, nickel, selenium, and thallium), asbestos, organic chemicals, and disinfection byproducts. A RAA will be used to determine PMCL compliance for these constituent groups.

The RAA will be calculated as an average of single values that correspond to the minimum sampling frequency period defined in Table 2.2. When the average of multiple samples is calculated to evaluate compliance, any values less than the quantitation limit will be calculated as zero for the purposes of averaging.

- For constituent groups with a minimum sampling frequency period of “Monthly”, the RAA will consist of an average of 12 equally-weighted “single monthly values”, with each single monthly value representing the average of all data points collected during the corresponding calendar month.
- For constituent groups with a minimum sampling frequency period of “Quarterly”, the RAA will consist of an average of 4 equally-weighted “single quarterly values”, with each single quarterly value representing the average of all data points collected during the corresponding quarter. For the sake of brevity, this document will describe the method of calculating the RAA for “Monthly” groups only. RAAs for Quarterly constituent groups will be calculated in the same way, but with “quarter” substituted for “month”.

The RAA will be calculated as an average of the single monthly value of the current calendar month and the single monthly values of the last 11 calendar months.

Each time a sample is collected and measured, the single monthly value for the current calendar month will be re-calculated to include the new measurement, and the RAA will subsequently be re-calculated using the updated current single monthly value.

If, after measuring a sample and re-calculating the RAA, the PMCL is exceeded, the facility is in violation of the PMCL and recharge must cease.

Once a PMCL violation has occurred and SWIFT water has been diverted, HRSD may collect follow-up samples no more frequently than once per day. Each time a sample is measured, the single monthly value and RAA will be re-calculated as described above. Once the RAA is reduced to below the PMCL, the facility is no longer in violation and may resume recharge. Note that data collected during the PMCL shutdown is not to be omitted from future compliance calculations.

2.1.1.2. Constituents Regulated on a Single Instance Basis

This category includes the following constituent groups: nitrate and nitrite, radionuclides.

Compliance for these constituent groups is to be determined based on individual sample results. If any single sample exceeds the numerical PMCL, the facility is in violation and must stop recharging.

Once a PMCL exceedance has occurred and SWIFT Water has been diverted, HRSD may collect follow-up samples no more frequently than once per day. Each time a follow-up sample is collected, the results of the initial sample that triggered the exceedance and all follow-up samples will be averaged. If this average is below the PMCL, the facility is no longer in violation and may resume recharge.

2.2 Performance Indicators

Table 2.3 provides a list of performance indicators. These constituents are separated into those that are of public health interest and those that provide information on the effectiveness of treatment (*Final Report of an NWRI Independent Advisory Panel: Recommended DPR General Guidelines and Operational Requirements for New Mexico, 2016*). Table 2.3 provides information on where the criteria for each public health constituent was developed (many from the EPA contaminant candidate list [CCL4]) and the type of performance indicator. If the running annual average for any of the threshold values shown in Table 2.3 is exceeded, an investigation will be conducted to determine the best action to address the issue. This could include sampling at the monitoring well to determine removal by soil aquifer treatment (SAT), source control, modifying wastewater treatment, modifying advanced treatment, no action, or an alternative approach.

HRSD is currently evaluating the occurrence of a broader suite of non-regulated parameters in order to develop an indicator list that reflects the characteristics of local wastewater sources. The collection and evaluation of this data is on-going, and an additional list of indicators will be developed prior to the start of JR SWIFT recharge operations and provided to the PAROC/PARML for review. The Hampton Roads-specific list of indicators will be evaluated in parallel with the indicators in Table 2.3 to confirm the suitability of this new list for performance monitoring.

Table 2.3: JR SWIFT Non-Regulatory Performance Indicators

Constituent	Category	Threshold Value	Unit	Notes
1,4-Dioxane	Public Health	1	µg/L	CCL4; CA Notification Limit
17-β-Estradiol	Public Health	0.9[1]	ng/L	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	280[1]	ng/L	CCL4
NDMA	Public Health	10	ng/L	CCL4; CA Notification Limit
Perchlorate	Public Health	6	µg/L	CA Notification Limit
PFOA+PFOS[2]	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

[1] Threshold value identified in *Monitoring Strategies for Constituents of Emerging Concern (CECs) in Recycled Water, Recommendations of a Science Advisory Panel, 2018; SCCWRP Technical Report 1032.*

[2] Though no thresholds have been established, monitoring and reporting will include PFBA, PFHpA, PFHxS and PFNA.

2.3 Design Pathogen Log Removal Value

JR SWIFT will be designed and operated (using CCPs) to achieve at least 12 log removal value (LRV) for viruses and 10 LRV for *Cryptosporidium* and *Giardia* through a combination of advanced treatment processes and soil aquifer treatment. Table 2.4 provides a treatment process pathogen LRV summary for JR SWIFT. Monitoring at the SRC will be used to verify the claimed credits for each process unit. The following key design and operational considerations and regulatory references are provided for context for Table 2.4:

- Two-log removal of viruses and 2.5-log *Giardia* removal is granted per the *Surface Water Treatment Rule Guidance Manual*, 1991 edition, section 5.5.2, for a well operated conventional filtration treatment plant.
- Three-log *Cryptosporidium* removal is granted per the *Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual* section 1.4.1 if the combined filter effluent (CFE) is less than 0.3 NTU 95% of the time and never greater than 1.0 NTU. An additional 0.5-log credit is granted in section 7.2.1 for achieving individual filter effluent (IFE) of 0.15 NTU 95% of the time and having no two consecutive measurements 15 minutes apart greater than 0.3 NTU. One more additional 0.5-log credit is granted in section 7.2.1 for achieving CFE of 0.15 NTU 95% of the time. CCPs will be enacted to ensure that these turbidity requirements are met.
- The ozone system will not be operated specifically to achieve pathogen removal credit. It is anticipated that ozone operation to achieve oxidation of organics will also achieve very high levels of pathogen removal, but this will not be a programmed CCP or operational goal at JR SWIFT. If ozone is operated in AOP mode, there will be no ozone residual and no way to demonstrate pathogen log removal under the current EPA guidance, although research is being and will be conducted in the future to demonstrate removal using other verification methods.
- The design Ultraviolet "UV" dose of 186 mJ/cm2 provides 4 LRV for viruses according to Table 1.4 of the *Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*. Significantly greater inactivation of *Cryptosporidium* and *Giardia* would be achieved at this design dose, though only 4-log removal is claimed in Table 2.4. If UV is operated in AOP mode, significantly more pathogen removal credit could be achieved, but that is not claimed in Table 2.4.
- At least 6-log credit for viruses, *Cryptosporidium*, and *Giardia* is expected through SAT based on the modeled travel time of the recharge water in the PAS. Literature has demonstrated additional treatment of recharge water as it moves through an aquifer system; the California Department of Health Regulations Related to Recycled Water section 60320.108 states that 1-log virus reduction credit is granted for every month the water is in the ground up to 6-log reduction. A minimum 6-log removal of *Cryptosporidium* and *Giardia* is expected when achieving 6-log virus reduction. HRSD's soil column testing has confirmed this assumption.

Table 2.4: JR SWIFT Design Pathogen LRV

Parameter	Floc/Sed (+BAF)	Ozone	BAF+GAC	UV	Cl2	SAT	Total
Enteric Viruses	2	0	0	4	0	6	12
Cryptosporidium	4	0	0	4	0	6	14
Giardia	2.5	0	0	4	0	6	12.5

2.4 Future SWIFT Facility Considerations

The SRC and the soil column testing will continue to provide significant operational data on the performance of the advanced treatment processes with respect to both microbial and chemical contaminant controls while JR SWIFT is being designed and constructed. Prior to design of other full-scale facilities and prior to operation of JR SWIFT, AWT design and operational parameters will be reevaluated. For example, if significant reduction of organics is demonstrated at the SRC monitoring wells or by soil column testing, HRSD may seek credit for Total Organic Carbon (TOC) reduction through SAT and modify the SWIFT Water TOC regulatory limit accordingly assuming concurrence from the PAROC. It is intended that all water quality targets will be treated with this adaptive management approach.

3.0 Critical Control Points

JR SWIFT will incorporate CCPs and critical operating points (COPs) throughout the treatment process, similar to the SRC, to ensure public health protection and to verify that treatment goals are being met at each of the individual processes. A violation of any CCP means that JR SWIFT 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 wells. In most instances, JR SWIFT will continue to operate through the CCP violation, but the SWIFT Water will be diverted back to the JR chlorine contact tank and will not be recharged into the aquifer. CCPs specifically protect public health and ensure compliance with regulatory parameters while COPs can be adapted as needed to ensure proper treatment performance throughout the SWIFT process.

CCPs have alert values at which point the operator is expected to take action to correct the performance as well as alarm values at which point an automated response will trigger action and prevent flow from going to the recharge wells. Both the alert and alarm values will be measured for a specified duration or computed as a running average 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 and optimized as needed to meet the water quality requirements.

Table 3.1 provides the current, preliminary list of CCPs for JR SWIFT, which is largely the same as the current list for the SRC. During the first year of SRC operation, several CCPs have been adjusted (and documented with EPA) based on lessons learned during operation. It is anticipated that there will be additional changes to Table 3.1 as the SRC continues in operation.

Table 3.1: Critical Control Points for JR SWIFT

Parameter	Alert Value	Alarm Value	Unit	Type[1]	Action
Critical Control Points (CCPs)					
SWIFT Feed Turbidity	3.5	5	NTU	Latched	Place Biofilters in Filter To Waste
SWIFT Feed Conductivity	1,500	2,000	microSiemens per centimeter	Latched	Place Biofilters in Filter To Waste
SWIFT Feed Total Inorganic Nitrogen	4.0	5.0	mg/L-N	Latched	Place Biofilters in Filter To Waste
Preformed Chloramine Failure (if used for bromate suppression)	N/A	Failure	mg/L	Latched	Divert SWIFT Water
Total Chlorine Upstream of Ozone (if used for bromate suppression)	2.0	1.0	mg/L	Latched	Divert SWIFT Water
Monochloramine Upstream of Ozone (if used for bromate suppression)	2.0	1.0	mg/L	Latched	Divert SWIFT Water
Ozone Feed Failure	N/A	Failure	N/A	Latched	Open Biofilter Backwash Waste Valve
High Ozone Dose	7.0	8.0	mg/L	Latched	Place Biofilters in Filter To Waste
Biofilter Individual Effluent Turbidity	0.1	0.15	NTU	Running Average	Place Biofilter in Filter To Waste
Biofilter Combined Filter Effluent Turbidity	0.1	0.15	NTU	Running Average	Place Biofilters in Filter To Waste
GAC Combined Effluent TOC, Instantaneous Online Analyzer	4.0	5.0	mg/L	Latched	Divert SWIFT Water
GAC Combined Effluent Nitrite	0.25	0.5	mg/L-N	Latched	Divert SWIFT Water
GAC Combined Effluent Ammonia[2]	0.1	0.3	mg/L-N	Latched	Divert SWIFT Water
UV Reactor Dose	<120% of Dose Setpoint	<105% of Dose Setpoint	%	Latched	Divert SWIFT Water
SWIFT Water Total Nitrogen	4.5	5.0	mg/L-N	Latched	Divert SWIFT Water

[1] A latched CCP requires the measured value to be above/below the limit for a specified duration before alerting or alarming. A running average will generate an alert or alarm if the running average over a specified duration is above/below the limit. Running averages were implemented for specific CCPs to more conservatively protect against water quality requirements.

[2] Ammonia control of GAC CE is applicable only when using free chlorine post-UV for well biofoulant control. Refer to table 4.2, footnote 9 for additional information.

The following CCPs were removed or adjusted from the current CCPs in use at the SRC:

- Ozone Contactor Calculated LRV – Virus (CCP): As JR SWIFT will not operate ozone to achieve disinfection credit, the LRV has been removed from the CCP list.
- Free Chlorine CT (CCP): As JR SWIFT will not add free chlorine for disinfection of SWIFT Water, the required CT has been removed from the CCP list. SWIFT Water Chlorine Residual remains a COP to prevent biofouling in the recharge wells.
- CCPs associated with the tasting system at the SRC have been removed as JR SWIFT will not be designed for tastings.

4.0 JR SWIFT Regulatory Sampling Plan

Sampling will be performed throughout the treatment process to verify treatment performance, online analyzer accuracy, and compliance with regulatory limits. A detailed sampling plan has been generated that addresses these purposes. Sampling will consist of a combination of onsite analysis, lab analysis performed by HRSD, and specialized analysis performed by outside contract labs. Table 4.1 provides the additional monitoring required to document compliance with the targeted LRV for the UV system. Table 4.2 provides the sampling plan specific to the proposed regulatory limits and performance indicators including the location and frequency of each sample.

Table 4.1: Additional Monitoring to Support UV LRV [1]

UV LRV
UV Intensity, each reactor
UVT, GAC Combined Effluent
Reactor Flow, each
Calculated Dose (validated), each reactor
Status, each

[1]All continuous measurements. Calculated dose and LRV will be reported as part of the quarterly monitoring reports. Calculations will be based on 15 min data.

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Regulatory Parameters								
Total Nitrogen		Weekly				Monthly	Monthly	5x/week
Turbidity					Continuous[4]	Continuous[4]		
TOC		Weekly	3x/week			3x/week		3x/week
pH[5]								Continuous
TDS[5]								Monthly
Regulatory Parameters: EPA Primary MCLs								
Microorganisms								
Male-specific and somatic coliphages[5]		Quarterly						Quarterly
Cryptosporidium	Quarterly	Quarterly						Quarterly
Giardia lamblia	Quarterly	Quarterly						Quarterly
Legionella		Quarterly						Quarterly
Total Coliform		Weekly						5x/week
E. coli		Weekly						5x/week
Disinfection Byproducts								
Bromate				5x/week				Weekly
Chlorite	Quarterly	Monthly						Monthly
Haloacetic acids (HAA5)								Monthly
Total trihalomethanes								Monthly
Disinfectants[6]								
Chloramines (as Cl_2)								Continuous[7]
Chlorine (as Cl_2)								Continuous[7]

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2, 3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Inorganic Chemicals								
Antimony, Total	Quarterly	Monthly						Monthly
Arsenic, Total	Quarterly	Monthly						Monthly
Asbestos		Quarterly						Quarterly
Barium, Total	Quarterly	Monthly						Monthly
Beryllium, Total	Quarterly	Monthly						Monthly
Cadmium, Total	Quarterly	Monthly						Monthly
Chromium VI	Quarterly	Monthly						Monthly
Chromium, Total	Quarterly	Monthly						Monthly
Copper, Total	Quarterly	Monthly						Monthly
Cyanide, Total	Quarterly	Monthly						Monthly
Fluoride	Quarterly	Monthly						Monthly
Lead, Total	Quarterly	Monthly						Monthly
Mercury, Total	Quarterly	Monthly						Monthly
Nitrate -N		Weekly				Monthly	Monthly	5x/week
Nitrite-N		Weekly				Monthly	Monthly	5x/week
Selenium, Total	Quarterly	Monthly						Monthly
Thallium, Total	Quarterly	Monthly						Monthly
Organic Chemicals								
Acrylamide	Quarterly	Monthly						Monthly
Alachlor	Quarterly	Monthly						Monthly

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Atrazine	Quarterly	Monthly						Monthly
Benzene	Quarterly	Monthly						Monthly
Benzo(a)pyrene (PAHs)	Quarterly	Monthly						Monthly
Carbofuran	Quarterly	Monthly						Monthly
Carbon Tetrachloride	Quarterly	Monthly						Monthly
Chlordane	Quarterly	Monthly						Monthly
Chlorobenzene	Quarterly	Monthly						Monthly
2,4-D	Quarterly	Monthly						Monthly
Dalapon	Quarterly	Monthly						Monthly
1,2-dibromo-3-chloropropane (DBCP)	Quarterly	Monthly						Monthly
1,2-Dichlorobenzene (o-dichlorobenzene)	Quarterly	Monthly						Monthly
1,4-Dichlorobenzene (p-dichlorobenzene)	Quarterly	Monthly						Monthly
1,2-Dichloroethane	Quarterly	Monthly						Monthly
1,1-Dichloroethylene	Quarterly	Monthly						Monthly
cis-1,2-Dichloroethylene	Quarterly	Monthly						Monthly
trans-1,2-Dichloroethylene	Quarterly	Monthly						Monthly
Dichloromethane (Methylene chloride)	Quarterly	Monthly						Monthly
1,2-Dichloropropane	Quarterly	Monthly						Monthly
Di(2-ethylhexyl) adipate	Quarterly	Monthly						Monthly

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Di(2-ethylhexyl) phthalate	Quarterly	Monthly						Monthly
Dinoseb	Quarterly	Monthly						Monthly
Dioxin (2,3,7,8-TCDD)	Quarterly	Monthly						Monthly
Diquat	Quarterly	Monthly						Monthly
Endothall	Quarterly	Monthly						Monthly
Endrin	Quarterly	Monthly						Monthly
Epichlorohydrin	Quarterly	Monthly						Monthly
Ethylbenzene	Quarterly	Monthly						Monthly
Ethylene dibromide (EDB)	Quarterly	Monthly						Monthly
Glyphosate	Quarterly	Monthly						Monthly
Heptachlor	Quarterly	Monthly						Monthly
Heptachlor Epoxide	Quarterly	Monthly						Monthly
Hexachlorobenzene	Quarterly	Monthly						Monthly
Hexachlorocyclopentadiene	Quarterly	Monthly						Monthly
Lindane (Gamma-BHC)	Quarterly	Monthly						Monthly
Methoxychlor	Quarterly	Monthly						Monthly
Oxamyl (Vydate)	Quarterly	Monthly						Monthly
Polychlorinated biphenyls	Quarterly	Monthly						Monthly
Arochlor (AR)1016	Quarterly	Monthly						Monthly
AR1221	Quarterly	Monthly						Monthly
AR1232	Quarterly	Monthly						Monthly

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
AR1242	Quarterly	Monthly						Monthly
AR1248	Quarterly	Monthly						Monthly
AR1254	Quarterly	Monthly						Monthly
AR1260	Quarterly	Monthly						Monthly
Pentachlorophenol	Quarterly	Monthly						Monthly
Picloram	Quarterly	Monthly						Monthly
Simazine	Quarterly	Monthly						Monthly
Styrene	Quarterly	Monthly						Monthly
Tetrachloroethylene	Quarterly	Monthly						Monthly
Toluene	Quarterly	Monthly						Monthly
Toxaphene	Quarterly	Monthly						Monthly
2,4,5-TP (Silvex)	Quarterly	Monthly						Monthly
1,2,4-Trichlorobenzene	Quarterly	Monthly						Monthly
1,1,1-Trichloroethane	Quarterly	Monthly						Monthly
1,1,2-Trichloroethane	Quarterly	Monthly						Monthly
Trichloroethylene	Quarterly	Monthly						Monthly
Vinyl Chloride	Quarterly	Monthly						Monthly
Xylene, Total	Quarterly	Monthly						Monthly
Radionuclides								
Alpha particles		Monthly						Monthly
Beta particles and photon emitters		Monthly						Monthly

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
Radium 226		Monthly						Monthly
Radium 228		Monthly						Monthly
Uranium		Monthly						Monthly
Regulatory Parameters: Virginia Groundwater Standards[8]								
Aldrin/Dieldrin	Quarterly	Monthly						Monthly
DDT	Quarterly	Monthly						Monthly
Kepone	Quarterly	Monthly						Monthly
Mirex	Quarterly	Monthly						Monthly
Phenols	Quarterly	Monthly						Monthly
Strontium-90		Monthly						Monthly
Tritium		Monthly						Monthly
Non-regulatory Parameters: Performance Indicators								
Public Health Indicators								
1,4-dioxane	Quarterly	Quarterly						Quarterly
17-β-estradiol	Quarterly	Quarterly						Quarterly
DEET	Quarterly	Quarterly						Quarterly
Ethinyl estradiol	Quarterly	Quarterly						Quarterly
NDMA	Quarterly	Quarterly		Weekly		Weekly		Weekly[9]
Perchlorate	Quarterly	Quarterly						Quarterly
PFOA + PFOS	Quarterly	Quarterly						Quarterly
PFBA	Quarterly	Quarterly						Quarterly

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**
PFHpA	Quarterly	Quarterly						Quarterly
PFHxS	Quarterly	Quarterly						Quarterly
PFNA	Quarterly	Quarterly						Quarterly
tris(2-carboxyethyl)phosphine (TCEP)	Quarterly	Quarterly						Quarterly
Treatment Efficacy Indicators								
Cotinine	Quarterly	Quarterly						Quarterly
Primidone	Quarterly	Quarterly						Quarterly
Phenytoin	Quarterly	Quarterly						Quarterly
Meprobamate	Quarterly	Quarterly						Quarterly
Atenolol	Quarterly	Quarterly						Quarterly
Carbamazepine	Quarterly	Quarterly						Quarterly
Estrone	Quarterly	Quarterly						Quarterly
Sucralose	Quarterly	Quarterly						Quarterly
Triclosan	Quarterly	Quarterly						Quarterly
Non-regulatory Parameters: Aquifer Characteristics and/or Compatibility								
Unregulated Contaminant Monitoring Rule (UCMR)[10]								TBD[10]
Dissolved Oxygen								Monthly
Temperature								Monthly
Specific conductivity								Continuous
ORP								Monthly

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	JR Influent	SWIFT Feed	Floc/Sed Effluent	Ozone Effluent	BAF IFE	BAF CFE	GAC CE	SWIFT Water
Iron, Total								Continuous[11]
Aluminum, dissolved								Monthly
Aluminum, total								Monthly
Arsenic, dissolved								Monthly
Iron, dissolved								Monthly
Manganese, dissolved								Monthly
Manganese, total								Monthly
Magnesium, total								Monthly
Potassium, total								Monthly
Sodium, total								Monthly
Calcium, total								Monthly
Sulfate								Monthly
Chloride								Monthly
Bromide		Weekly						
Alkalinity								Monthly
Total Kjeldahl Nitrogen		Weekly				Monthly		Weekly
Ammonia as N								Weekly
Total Phosphorus			Weekly			Weekly		Weekly
Orthophosphate as P			Weekly			Weekly		Weekly
Silica as SiO_2								Monthly
Hardness, Total								Monthly

Table 4.2: JR SWIFT Regulatory and Process Monitoring Plan, Sample Location and Minimum Monitoring Frequency

HRSD JR SWIFT Regulatory and Process Monitoring Plan[1,2,3]								
Parameter	**JR Influent**	**SWIFT Feed**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**SWIFT Water**

[1] Compliance samples are collected during periods of recharge. Point of compliance for all regulatory parameters is SWIFT Water with the exception of turbidity. Compliance point for turbidity monitoring is BAF Individual and Combined Filter Effluents (BAF IFE, BAF CFE).

[2] Non-compliance process monitoring may be modified based on operational needs.

[3] All samples are collected as grabs unless denoted as "Continuous". 15-minute data will be reported for each continuous measurement.

[4] All in service turbidimeters will be verified with daily lab grabs. Only 15-min online turbidimeter data will be submitted for IFE and CFE. If a turbidimeter is out of service, unreliable or suspect, turbidity samples will be collected by grab for lab analysis every 4 hours, and those data will be submitted.

[5] Monitoring requirement with no limit imposed.

[6] ClO_2 not used for disinfection and therefore is not included in monitoring.

[7] Continuous measurements of chlorine and chloramines will be confirmed with a daily grab sample.

[8] Virginia Ground Water Standards (9VAC25-280-40) not included as a PMCL under the Safe Drinking Water Act (SDWA) and considered critical for inclusion by the Virginia Department of Health (VDH).

[9] In addition to monitoring NDMA concentration, NDMA Formation Potential (FP) tests will be as follows:

- when monochloramine is being added following UV disinfection the frequency shall be monthly for one year. NDMA FP frequency will be reduced in years 2 – 3 to quarterly, followed by annual testing for the duration of the permit, provided the contingencies for phased reduction continue to be met. Phased reduction is contingent upon (i) NDMA concentrations under agreed-upon conditions in FP testing remaining < 10 ng/L, and (ii) NDMA concentrations in the monitoring wells remaining < 10 ng/L. Exceedance of either of these conditions will "reset" the phased reduction schedule.
- when free chlorine is being added following UV disinfection, NDMA FP testing will be conducted monthly for three months and will be ceased if (i) NDMA concentrations under agreed-upon conditions in FP testing remain < 10 ng/L, and (ii) NDMA concentrations in the monitoring wells remain < 10 ng/L. NDMA FP is expected to be minimal when using free chlorine post-UV and HRSD will further mitigate this risk by incorporating ammonia monitoring of the GAC combined effluent with a CCP for SWIFT Water diversion (Table 3.1).
- All NDMA FP data will be evaluated by PARML and PAROC to ensure concurrence with phased reductions.

[10] HRSD shall monitor currently effective UCMR parameters at the frequency required for large water systems.

[11] Continuous measurements of total iron will be confirmed with a weekly grab sample.

Appendix B: James River SWIFT Aquifer Monitoring and Contingency Plan

1.0 Introduction

HRSD's James River Treatment Plant (JR; Newport News, VA) will be the site of a full-scale SWIFT facility. This document describes the monitoring and contingency plans for evaluating the hydraulic and water quality response of the Potomac Aquifer System (PAS) to recharging SWIFT Water. The Aquifer Monitoring and Contingency Plan ("Monitoring Plan") is a detailed supplement to HRSD's Class V Underground Injection Control (UIC) permit application for James River SWIFT (JR SWIFT).

1.1 General Description

The JR SWIFT facility will accept secondary effluent from the existing JR treatment plant and send it through the Advanced Water Treatment process (AWT). Ten managed aquifer recharge (MAR) wells will receive a nominal flow of 16 MGD of SWIFT Water for recharge into the PAS. Construction of managed aquifer recharge (MAR) wells and the AWT should commence in 2021 and 2022, respectively.

Key topics presented in the Monitoring Plan include the following:

1) HRSD will recharge SWIFT Water from the JR SWIFT facility into the upper (UPA) and middle (MPA) zones of the PAS through ten (10) MAR wells. Proposed locations are identified on Figure 1.1.
2) HRSD will monitor water levels and water quality during MAR operations through two clusters of monitoring wells, each located approximately 500 feet from a MAR (Figure 1.1).
3) The monitoring well clusters will each consist of four wells, screened within the UPA and MPA. The UPA and MPA contain six and three discrete sand intervals, respectively at the test well installed at JR. Screens in monitoring wells will, to the extent practical, match the closest MAR wells. Thus, screens in the monitoring wells will likely fully represent the UPA and MPA at each cluster. Samples collected from individual monitoring wells located in clusters JR_MC1 and JR_MC2 will represent groundwater chemistry or migrating recharge water in the UPA or MPA. If a water quality issue arises, HRSD may decide to collect depth discrete samples from individual sand intervals in the UPA or MPA by removing the affected well's sampling pump and conducting packer testing.
4) Once the baseline groundwater chemistry in the UPA and MPA is established, HRSD will sample the monitoring wells in the JR_MC1 and JR_MC2 clusters at a routine frequency (See Table 3.1). Each of the eight monitoring wells will contain a permanent sampling pump, facilitating the purging and collection of representative groundwater samples.
5) HRSD will analyze samples of the SWIFT Water for a comprehensive list of analytes on a regular basis to evaluate its compatibility with the UPA and MPA (See Table 4.2 of JR SWIFT Water Quality Targets for list of SWIFT Water monitoring).
6) HRSD will monitor water levels in the MAR and monitoring wells, facilitating the tracking of specific capacity during recharge (injectivity), backflushing, and changes in aquifer transmissivity and storage coefficients.
7) Depending on the final chemistry of SWIFT Water at JR SWIFT relative to the native groundwater (NGW) at a specific monitoring well, chloride, specific conductivity, sulfate, or fluoride may serve

as a non-reactive or minimally-reactive tracer for tracking SWIFT recharge water to the monitoring wells. A tracer in the SWIFT Water should not react with minerals in the PAS while displaying concentrations that differ sufficiently from constituent concentrations in the NGW.

Figure 1.1: Proposed locations of Managed Aquifer Recharge (MAR) Wells for JR SWIFT and monitoring wells. MAR and monitoring well locations may be adjusted based on site specific conditions but will lie within the area of the wellfield denoted by the blue boundary. Private wells are identified in blue and red. The three private wells that have been constructed within the AOR are less than 50 feet deep and screen the surficial Columbia Aquifer. All existing and potential future wells based on available permit applications are classified as non-potable and each of these private well users is connected to the public water supply for potable water use (Newport News Waterworks). The brackish groundwater quality contained in the UPA and MPA makes using these aquifers for potable, irrigation, commercial, or industrial supplies impractical. Note well features are not to scale.

2.0 James River SWIFT Well Facilities

The facilities associated with MAR activities (Figure 1.1) at JR SWIFT include the MAR wells (MAR 1-10), and eight conventional monitoring wells clustered in two nests. Monitoring wells in both nests (JR_MC1 and JR_MC2), will screen the UPA and MPA. The ten MAR wells will each screen across the UPA and MPA. To the extent practical, screen intervals in monitoring wells located at monitoring nests JR_MC1 and JR_MC2 will match intervals in the closest MAR wells. Thus, screens in the monitoring wells will likely fully represent the available sand intervals (productive zones) in the UPA and MPA.

A test program at JR SWIFT, comprising drilling, aquifer testing, coring, mineralogic analysis, and water quality sampling indicated that the Lower Zone of the Potomac aquifer (LPA) was unsuitable for MAR applications. The LPA displayed a relatively small (40 feet) effective sand thickness, while packer testing conducted in the LPA yielded relatively low permeability. Accordingly, HRSD will not use the LPA for MAR operations at JR SWIFT.

To discriminate between monitoring associated with the SWIFT AWT processes and monitoring the aquifer response to MAR, this plan describes water exiting the AWT as "SWIFT Water", and describes water injected into the MAR wells as "recharge water".

Water level monitoring instrumentation installed in the MAR and monitoring wells will record the hydraulic water level and display the levels on the JR Distributed Control System (DCS).

2.1 Managed Aquifer Recharge Wells

The following section describes MAR and monitoring wells, including designated locations and construction details.

2.1.1 Recharge Well – location and construction

HRSD plans to install ten MAR wells distributed across the JR SWIFT site (Figure 1.1). Eight MAR wells will recharge the UPA and MPA at rates approaching 2 MGD each, while HRSD will bring the other two wells into service as needed. Alternatively, HRSD could use all wells simultaneously, at a lower recharge rate. Either approach should facilitate removing one well from service for maintenance at any time. Considering more routine maintenance, the JR SWIFT facility design will accommodate backflushing at frequencies of up to once daily for each MAR well in service, although a less frequent backflushing schedule of several times weekly is more likely.

To preclude excessive hydraulic interference, HRSD will maintain an approximate 1,000-ft spacing between MAR wells. A small 20 by 40-foot building will protect each MAR well, wellhead, and equipment. HRSD will control recharge rates at JR SWIFT using a foot valve connected to the base of each vertical turbine pump. The foot valve backs recharge water up the pump column preventing recharging under a vacuum and entraining air in the recharge water. Foot valves for MAR wells contain orifice holes drilled in the valve face that facilitate recharge around a narrow range of rates. Thus, foot valves at JR SWIFT will contain orifices designed for 2 MGD. The valves slide along a center shaft and slide upward when the pump is running, allowing water to pass.

Each MAR well will consist of 30-inch diameter 2205 duplex or Type 316L stainless steel casing (Figure 2.1 MAR well) that extends to the top of the UPA, encountered around 400 feet below grade (fbg). A 20-inch inner casing and screen assembly will screen across the UPA and MPA, extending to around 1,125 fbg, and comprising around 270 feet of screen, including 180 and 90 feet screening the UPA and MPA respectively. The screen assembly will consist of 18-inch x 20-inch diameter, pre-packed, dual-wall screen separated by stainless steel blanks and ending in a 50-foot long, stainless steel sump. The material for the pre-pack well screen, blank sections and sump will consist of 2205 duplex or Type 316L stainless steel. Estimated screen length and depths are based upon data gathered at the James River test well and will be adjusted depending on highly localized conditions of each MAR.

Test drilling at JR SWIFT revealed that no single, sand interval exceeded 65 feet in thickness and most ranged between 20 and 30 feet, restricting screen lengths and increasing the number of blanks separating individual screen intervals. The total number of screen intervals could range between 7 and 9. At the request of the Virginia Department of Environmental Quality (VDEQ), in each MAR well

HRSD will install a minimum 20-foot thick bentonite grout seal adjacent to a blank section between the UPA and MPA to isolate the two aquifer zones.

Each MAR well will include a 20-inch diameter inner casing that will extend approximately 60 above the top of a 20-foot length of pipe-based relief screen. The inner casing and relief screen material will be 2205 duplex or 316L stainless steel with site-specific requirements for corrosion resistivity as the determining factor for selecting the final material.

Employing a pre-packed screen may enable HRSD to recharge at higher injection pressures as water levels rebound and injection level elevations exceed the ground surface. With a conventional well screen and filter pack, high injection pressures combined with a clogging well screen can promote micro-channel formation in the filter pack, ultimately connecting the screen with formation. Micro channel formation allows fine, well sorted sands to enter the MAR well during backflushing. Eventually, catastrophic sand pumping can bury the well screen up to the elevation of the sand source. The situation requires removing the pumping equipment and rehabilitating the MAR well. Often the situation grows repetitive as the well ages, typically requiring reductions in the injection rate.

Because of its dual wall construction and tightly packed, artificial filter pack, a pre-packed screen prevents channel formation. Additionally, extensive testing in MAR wells across the United States has shown the pre-packed to be more resilient under higher injection pressures. Also, the compartmental nature of a pre-packed screen allows customizing the filter pack and screen slot size to discrete sand intervals, rather than sizing the filter pack and screen openings to the smallest grain size distribution encountered in the aquifer as in wells equipped with a conventional screen and filter pack.

HRSD will equip each MAR well with a pump capable of backflushing at rates approaching approximately 2,800 gallons per minute (gpm), approximately two times the anticipated injection rate. Backflushing removes total suspended solids (TSS) that accumulate in the well screen and filter pack during MAR operations. MAR wells screening the sandy Atlantic Coastal Plain aquifer typically require backflushing twice weekly, or more. Backflushing frequency depends on the injection rate and TSS concentrations in recharge water (TSS loading), while well depth, well diameter and pumping rate determine the duration of each backflushing event. HRSD currently backflushes the test well (TW-1) at the SWIFT Research Center (SRC) at a daily frequency.

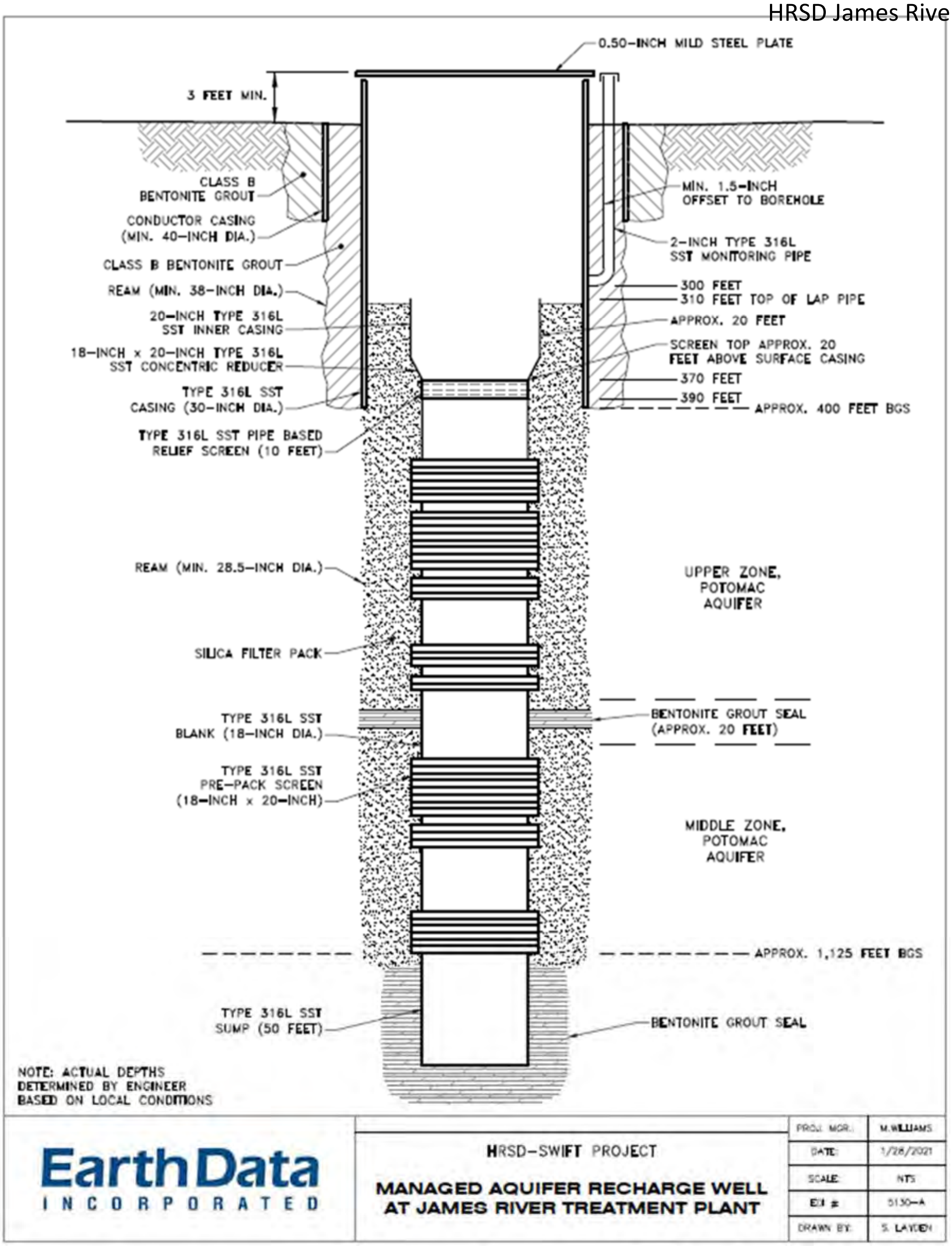

Figure 2.1: Proposed Managed Aquifer Recharge Well at JR SWIFT. Elevations and materials of construction may change according to site specific conditions.

2.1.2 Pre-Recharge Aquifer Conditioning around MARs

The United States Geological Survey has described extensive formation damage during MAR operations in the PAS of southeastern Virginia (Brown and Silvey, 1977). USGS conducted test cycles at a pilot aquifer storage and recovery (ASR) facility in Norfolk, Virginia during the early 1970s. Recharge exhibiting an ionic strength of 0.0001 moles per liter (mol/L) was injected into a test well screening the UPA and MPA, where the ionic strength of the native groundwater equaled 0.01 mol/L.

The specific capacity (injectivity) of the test well declined by nearly 80 percent in the first 90 minutes after commencing recharge, reducing the capacity of the ASR well by a similar amount, and effectively ending the viability of the facility. The project continued for several years, but injectivity and injection capacity losses proved irreversible.

Pre-recharge aquifer conditioning was successfully employed at HRSD's SRC at the Nansemond Treatment Plant where the ionic strengths of the SWIFT Water and the NGW differed by one order of magnitude or more. The difference in the ionic strengths of the recharge at JR SWIFT (0.02 moles per liter (mol/L) compared to NGW in the UPA (0.081 mol/L) and MPA (0.1 mol/L), both fall close to or greater than one order of magnitude. Therefore, the UPA and MPA at JR SWIFT will require conditioning with aluminum salts prior to starting MAR operations. Local native groundwater characteristics were determined through test well monitoring at the James River site and are detailed in Table 2.1.

2.2. Conventional Monitoring Wells

HRSD plans to install eight monitoring wells at JR SWIFT in two clusters. Each cluster will include four monitoring wells, three screened in the UPA and one in the MPA; two of the wells in the UPA will be nested in one borehole, their screen zones separated by a minimum 20-foot long bentonite grout seal. These wells may lie up to 50 feet apart to preclude interference during drilling. HRSD will locate well cluster JR_MC1 on the boundary of the JR SWIFT facility approximately 500 ft from the nearest recharge well. Likewise, JR_MC2 will lie approximately 500 feet (1.5 aquifer thicknesses) away from any MAR well. Moreover, with their locations within the Area of Review (AOR), samples from JR_MC1 and JR_MC2 should provide representative water quality of recharge water chemistry exiting the AOR in the UPA and MPA. Considering a distance equaling around 500 feet, an aquifer thickness totaling 270 feet and recharge rate approaching 2 MGD, it has previously been determined that recharge water should not reach JR_MC1 and JR_MC2 for approximately 0.9 years in the absence of dispersion and 0.7 years considering dispersion typical in sand aquifers.

The monitoring well network design captures conditions equidistant between two operating MAR wells and at MAR wells located both inside and outside the area housing the JR SWIFT AWT. The ambient hydraulic gradient determined from a synoptic survey map developed by USGS runs around 0.00001 ft/ft. Analytical modeling (CAPZONE and GWPATH) performed to predict recharge levels at the MAR wells produced a gradient of approximately 0.02 ft/ft at individual MAR wells after 50 years of operation.

Scenarios performed using the VDEQ regional model demonstrate the groundwater flow direction with and without SWIFT. The modeling indicates that local to JR, within the monitoring well network, the gradient will be controlled by SWIFT recharge. The recharge at JR MAR wells will produce a mound of pressure in a radial morphology, everywhere away from the MAR well will be

Table 2.1: Native groundwater chemistry, test well at James River

Test Intervals		72 HR CRT[1]	Packer Test 1 (398-524 fbg[2])	Packer Test 2 (570-636 fbg)	Packer Test 3 (735-790 fbg)	Packer Test 4 (960-1000 fbg)	Packer Test 5 (1048-1122 fbg)	Packer Test 6 (1240-1280 fbg)	Estimated Recharge Chemistry[3]	PMCL/ SMCL
Analyte	**Units**	**12/19/18**	**5/2/19**	**5/6/19**	**5/8/19**	**5/10/19**	**5/15/19**	**5/20/19**	**1/6/15**	
pH	standard units	6.32	6.76	7.71	6.14	7.20[6]	7.26	7.62	7.2 to 7.8	6.5 to 8.5
ORP[4]	mV	54.9	-133.8	-95	-70.3	-108	-103.2	-99.6	NA	
Eh (corrected)[5]	mV	254.9	66.2	105	129.7	92	96.8	100.4	NA	
Specific Conductivity	µs/cm	3113	4635	4088	5200[7]	6230	6690[7]	8700[7]	NA	
Temperature	ºC	20.27	25.97	23.57	26.77	25.87	25.8	26.59	15 to 26	
Turbidity	NTU	1.51	1.63	2.12	5.53	0.52	0.43	6.19		
Field Sulfide as S	mg/L	0	0	0	0.04	0	0	0.01	NA	
Field Sulfate as SO_4	mg/L	58	70	69	106	90	104	183	NA	
Field Iron (ferrous as Fe^{2+})	mg/L	0.22	2.35	2.31	1.35	1.34	2.07	2.22	NA	
Field Iron (total)	mg/L	0.91	2.04	2.01	1.7	1.79	2.22	3.14	NA	
Aluminum, dissolved	mg/L	<0.010	<0.010	0.014	<0.010	<0.010	<0.010	<0.010	<0.04	0.1
Aluminum, total	mg/L	0.063	<0.010	0.014	0.036	<0.010	<0.010	<0.010	<0.04	0.1
Arsenic, dissolved	µg/L	<1.00	0.25	<0.50	<0.50	<0.50	0.27	<0.50	0.7	10
Arsenic, total	µg/L	<1.00	0.24	<0.50	<0.50	<0.50	0.27	<0.50	0.7	10
Iron, dissolved	mg/L	0.203	2.49	2.74	1.39	1.46	2.07	2.28	0.07	0.3
Iron, total	mg/L	0.241	2.45	2.79	1.58	1.48	2.05	2.25	0.07	0.3
Manganese, dissolved	mg/L	0.0217	0.0518	0.0575	0.0527	0.0533	0.0829	0.142	0.01	0.05
Manganese, total	mg/L	0.0226	0.0504	0.0581	0.0539	0.0542	0.0852	0.142	0.01	0.05
Magnesium, total	mg/L	4.78	6.71	6.93	9.00	10.6	15.8	25.6	3.6	
Potassium, total	mg/L	15.4	19.6	19.6	20.4	24.6	29	36.9	13	
Sodium, total	mg/L	777	970	979	1060	1240	1500	1930	68	
Calcium, total	mg/L	13.2	19.8	20.7	25.4	29.6	42.1	63.8	34	
Sulfate	mg/L	70.3	90.6	91.6	119	126	175	275	53	250
Chloride	mg/L	825	1460	1490	1770	1830	2290	3070	106	250
Alkalinity	mg/L	326	273	265	258	240	222	217	38	
Nitrate/Nitrite-N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5.7	
Nitrate as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	3.1	10
Total Kjeldahl Nitrogen	mg/L	0.52	0.69	0.66	0.78	0.79	0.92	1.03	2.6	
Fluoride	mg/L	2.16	0.913	0.920	0.863	0.793	0.601	<0.500	0.65	4
Silica as SiO_2	mg/L	25.5	38.5	38.1	36.6	40.5	39.4	33.9	NE	
Silicon as Si	mg/L	11.9	18.0	17.8	17.1	18.9	18.4	15.8	NE	
Dissolved organic carbon	mg/L	0.16	0.13	0.11	<0.10	0.21	0.14	0.13	4	
Total organic carbon	mg/L	0.14	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	4	

Table 2.1: Native groundwater chemistry, test well at James River

Test Intervals		**72 HR CRT[1]**	**Packer Test 1 (398-524 fbg[2])**	**Packer Test 2 (570-636 fbg)**	**Packer Test 3 (735-790 fbg)**	**Packer Test 4 (960-1000 fbg)**	**Packer Test 5 (1048-1122 fbg)**	**Packer Test 6 (1240-1280 fbg)**	**Estimated Recharge Chemistry[3]**	**PMCL/ SMCL**
Analyte	**Units**	**12/19/18**	**5/2/19**	**5/6/19**	**5/8/19**	**5/10/19**	**5/15/19**	**5/20/19**	**1/6/15**	
Total phosphorus	mg/L	0.20	0.14	0.17	0.17	0.13	0.08	0.04	0.02	
Orthophosphate as P	mg/L	0.19	0.04	0.03	0.05	0.02	0.02	0.01	0.01	
Total dissolved solids	mg/L	1880	2990	3060	3470	3590	4460	5800	420	
Total suspended solids	mg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.8	0.05	
Hardness, Total	mg eq	52.6	77.1	80.2	100	118	170	265	99	
Ammonia as N	mg/L	0.44	0.56	0.54	0.60	0.61	0.86	0.91	0.52	
BOD5	mg/L	<2	<2	<2	<2	<2	<2	<2	1	
COD	mg/L	<9.0	<12.0	<12.0	<12.0	<12.0	<15.0	<15.0	<10	
Gross Alpha	pCi/L	9.3	6.8	9.7	13	14	14	16	NE	15
Gross Beta	pCi/L	15	16	23	27	27	28	30	NE	
Ra 226 + Ra 228	pCi/L	1.1	ND	ND	1.4	1.6	4.8	8.8	NE	5
Uranium	µg/L	<0.200	<0.100	<0.100	<0.100	<0.100	<0.100	<0.500	NE	
Calculated species										
Ionic strength	mol/L	0.047	0.07475	0.0765	0.08675	0.08975	0.1115	0.145	0.0105	
Ionic balance (Stuyfzand, 1993)	%	4.3	5.5	5.7	9.3	2.8	2.3	3.6	6.6	
Ca + Mg/Na + K	meq/L ratio	0.028	0.025	0.027	0.031	0.029	0.052	0.063	0.597	
Organic phosphorous	mg/L	0.137	0.127	0.160	0.153	0.123	0.073	0.037	0.01	
Organic nitrogen	mg/L	0.08	0.13	0.12	0.18	0.18	0.06	0.12	2.08	

Notes:
[1] CRT - constant rate test
[2] fbg - feet below grade
[3] Estimated Recharge Chemistry based on JRTP effluent sampling in January 2015 and 2019 and mathematical modeling to estimate chemistry of JR SWIFT Water.
[4] ORP - oxidation/reduction potential
[5] Eh = ORP + 200 mV
[6] Instrument issue, pH estimated using PHREEQC
[7] Instrument issue, specific conductivity estimated by 1.5 x TDS
NA - Not applicable
ND – Non-detect
NM – Not measured
NE – Not estimated

downgradient. Therefore, this placement of the monitoring well clusters equidistant between two MAR wells will represent downgradient conditions of those two wells. The eight monitoring wells will feature a single-cased design (Figures 2.2, 2.3 and 2.4) with an 8-inch diameter stainless steel upper casing installed to a depth of 10 fbg and a 4.5-inch diameter carbon steel or fiberglass reinforced plastic (FRP) casing extending to the top screen. The screen and blank assembly will match the recharge intervals in the closest MAR wells. Screens will either be Type 316L stainless steel wire wrap or fiberglass reinforced continuous slot well screen surrounded by U.S. Silica (or equivalent) filter pack. Each well will include a minimum 10-foot long sump at the base of the deepest well screen

The 4.5-inch diameter monitoring well casings will accommodate a permanently installed, sampling pump, set to around 200 fbg each well. The sampling pumps will deliver a steady purging rate of 10 gpm against a total dynamic head (TDH) of 275 feet. As water levels rebound in the UPA and MPA, purging rates should increase as the TDH declines. In addition to the sampling pump, each monitoring well will be equipped with a pressure transducer that will record water levels to the plant’s DCS.

Should water quality issues emerge in samples collected from a monitoring well, HRSD may elect to collect depth discrete samples from individual sand intervals through packer testing. A water quality issue could represent the following situations:

- A constituent contained in migrating SWIFT recharge water.
- A constituent released during a reaction related to mixing between native groundwater and SWIFT recharge water.
- Reactions between SWIFT recharge water and aquifer releasing metals or other potentially harmful constituents.

HRSD will remove the sampling pump and install a packer testing assembly to sample individual screens in the affected monitoring well. At JR SWIFT test well TW-4 (DEQ: 2161-07; USGS: 58E7), the UPA and MPA contained six and three sand intervals, respectively.

The wells will be completed with a sanitary seal and housed in a secure, locked structure. The structure will be large enough to accommodate sample pumps, wellhead assembly and any necessary monitoring equipment. The protective structure is not included in the typical construction schematics below.

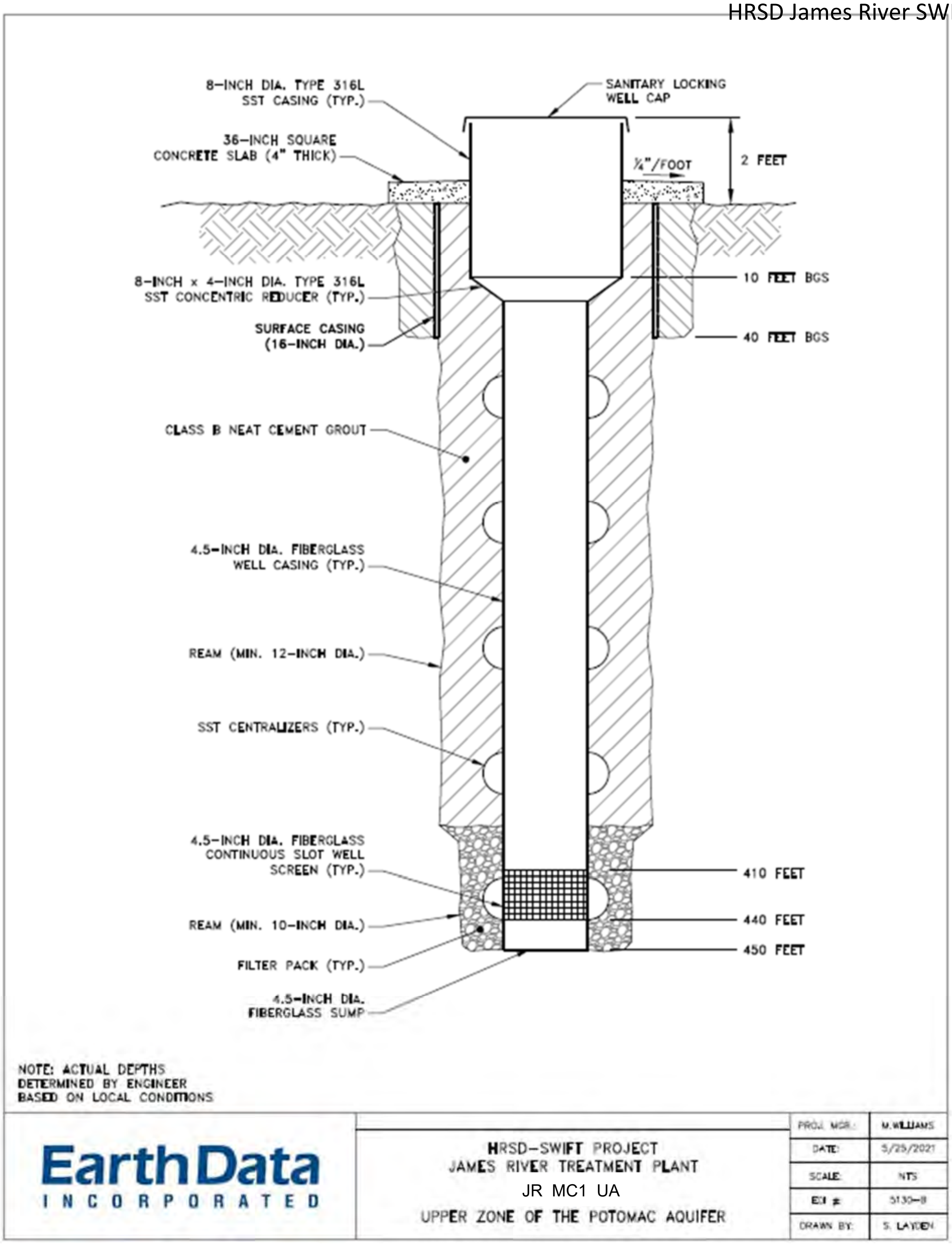

Figure 2.2: Typical Shallowest Well Construction Diagram for James River SWIFT monitoring well clusters (JR_MC1 and JR_MC2). Elevations may change according to site specific conditions.

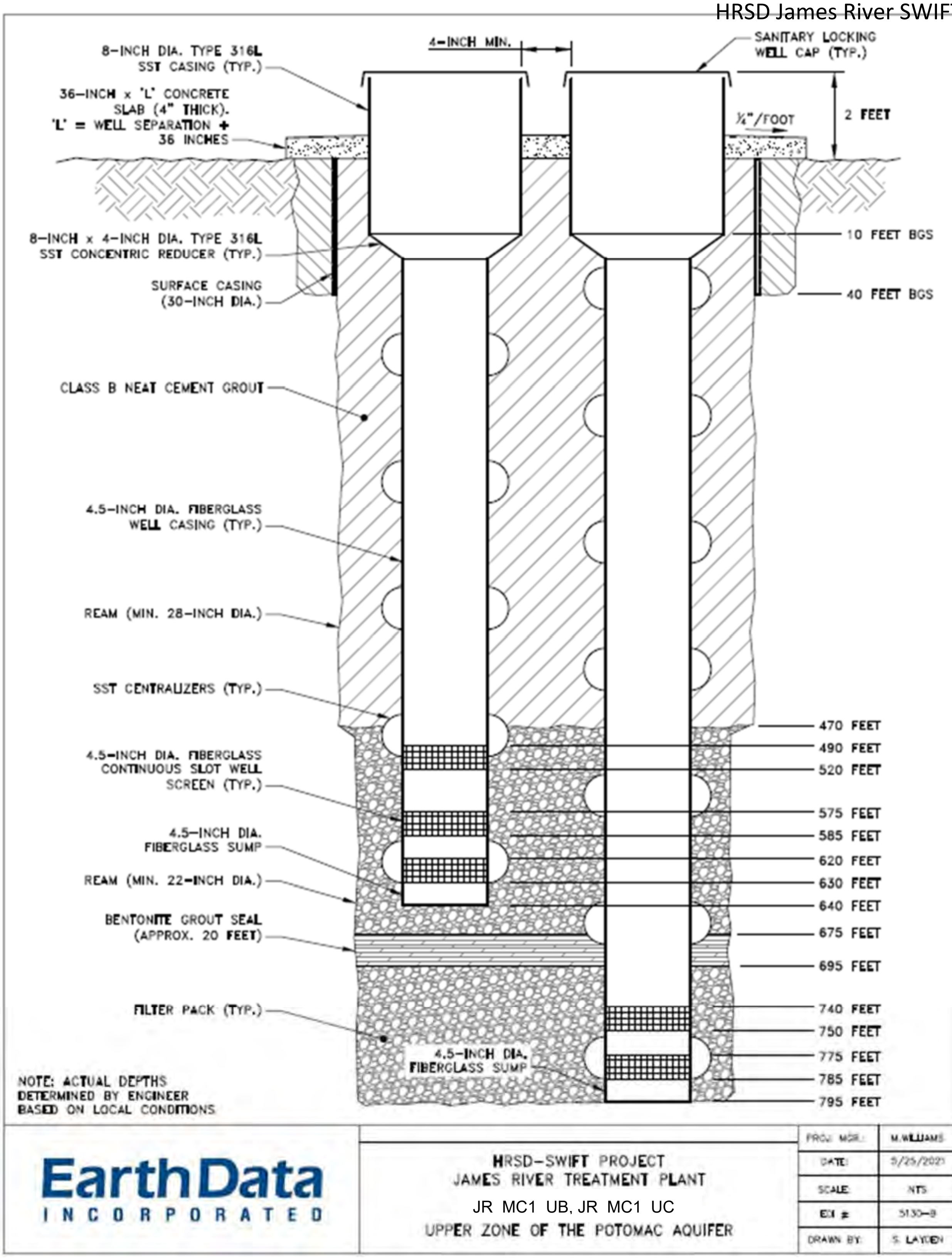

Figure 2.3: Typical deeper Upper Zone Nest Well Construction Diagram for James River SWIFT monitoring well clusters (JR_MC1 and JR_MC2). Elevations may change according to site specific conditions.

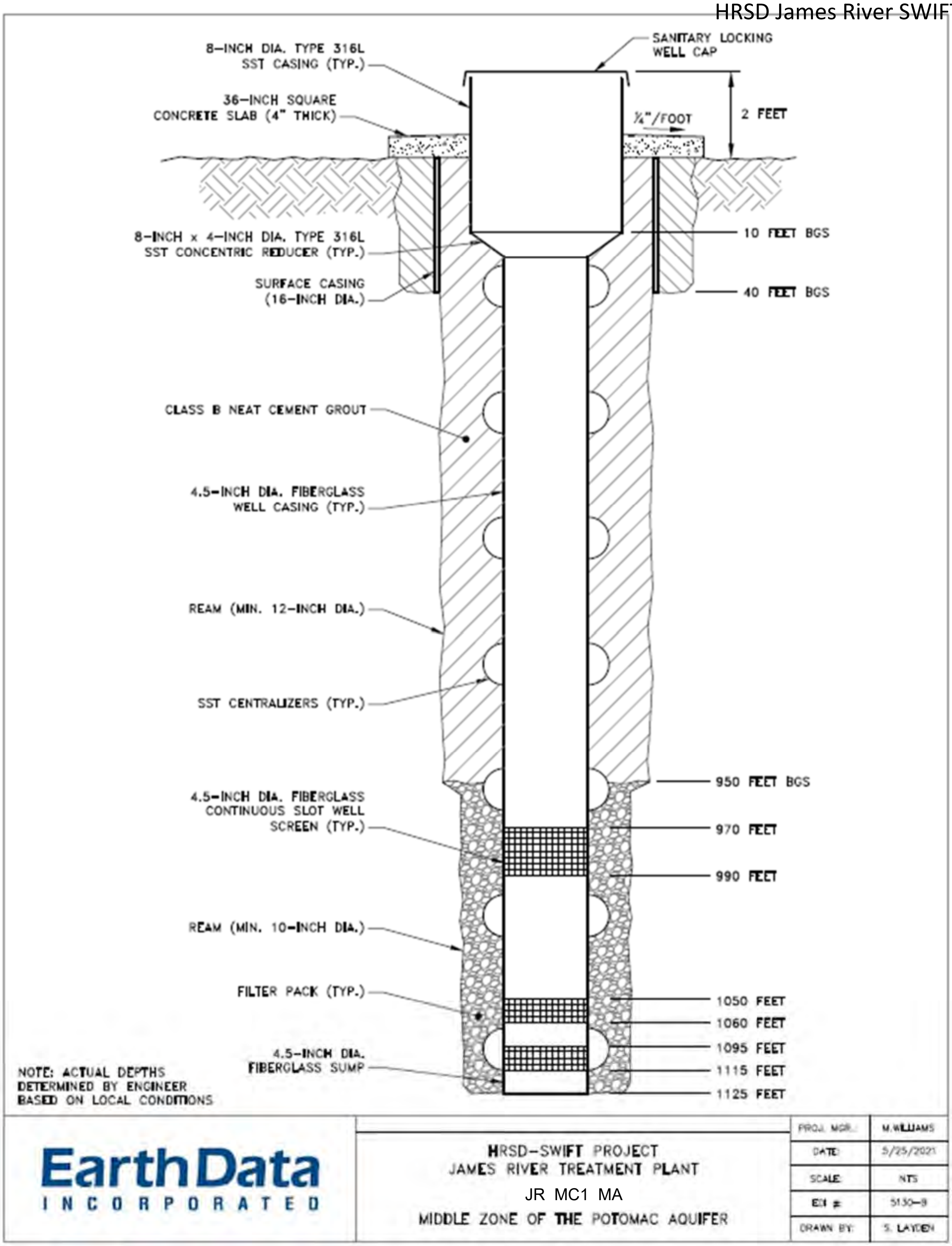

Figure 2.4 Typical Middle Zone Well Construction Diagram for James River SWIFT monitoring well clusters (JR_MC1 and JR_MC2). Elevations may change according to site specific conditions.

3.0 Monitoring Plan

This section describes the hydraulic and water quality monitoring plan for the JR SWIFT MARs. Table 3.1 identifies the monitoring analytes. Quarterly monitoring is identified for disinfection by-products (DBPs), indicator compounds and regulated parameters frequently detected in SWIFT Water in addition to other parameters of interest (e.g., iron, manganese, etc.). Quarterly monitoring of all regulatory and indicator compounds is targeted in the uppermost zone of the Potomac Aquifer System as it represents the zone of the PAS most likely used for potable water supply. The groundwater monitoring plan may be modified during the term of the permit based upon input from the Potomac Aquifer Recharge Oversight Committee. Laboratory analyses will be conducted by a Virginia Environmental Laboratory Accreditation Program (VELAP) accredited laboratory. Accredited laboratories will utilize EPA-approved test methods for all regulatory parameters. Non-regulatory analytes will be analyzed utilizing the same approach when approved test methods are available and appropriate for the groundwater matrix.

Table 3.1: Groundwater Monitoring Plan. Baseline (B), Quarterly (Q) and Annual (A) monitored analytes are identified in the table below.

Parameter	JR_MC_UA	JR_MC_UB	JR_MC_UC	JR_MC_MA
Regulatory Parameters				
Total Nitrogen	B, Q	B, Q	B, Q	B, Q
Turbidity	B, Q	B, A	B, A	B, A
TOC	B, Q	B, Q	B, Q	B, Q
TDS	B, Q	B, Q	B, Q	B, Q
Regulatory Parameters: EPA Primary MCLs				
Microorganisms				
Male-specific and somatic coliphages	B, Q	B, A	B, A	B, A
Cryptosporidium	B, Q	B, A	B, A	B, A
Giardia lamblia	B, Q	B, A	B, A	B, A
Legionella	B, Q	B, A	B, A	B, A
Total Coliform	B, Q	B, A	B, A	B, A
E. coli	B, Q	B, A	B, A	B, A
Disinfection Byproducts				
Bromate	B, Q	B, A	B, A	B, A
Chlorite	B, Q	B, A	B, A	B, A
Haloacetic acids (HAA5)	B, Q	B, Q	B, Q	B, Q
Total trihalomethanes	B, Q	B, Q	B, Q	B, Q
Inorganic Chemicals				
Antimony, Total	B, Q	B, A	B, A	B, A
Arsenic, Total	B, Q	B, Q	B, Q	B, Q
Asbestos	B, Q	B, A	B, A	B, A
Barium, Total	B, Q	B, A	B, A	B, A
Beryllium, Total	B, Q	B, A	B, A	B, A
Cadmium, Total	B, Q	B, A	B, A	B, A

Parameter	JR_MC_UA	JR_MC_UB	JR_MC_UC	JR_MC_MA
Chromium VI	B, Q	B, A	B, A	B, A
Chromium, Total	B, Q	B, A	B, A	B, A
Copper, Total	B, Q	B, A	B, A	B, A
Cyanide, Total	B, Q	B, A	B, A	B, A
Fluoride	B, Q	B, Q	B, Q	B, Q
Lead, Total	B, Q	B, A	B, A	B, A
Mercury, Total	B, Q	B, A	B, A	B, A
Nitrate -N	B, Q	B, Q	B, Q	B, Q
Nitrite-N	B, Q	B, Q	B, Q	B, Q
Selenium, Total	B, Q	B, A	B, A	B, A
Thallium, Total	B, Q	B, A	B, A	B, A
Organic Chemicals				
Acrylamide	B, Q	B, A	B, A	B, A
Alachlor	B, Q	B, A	B, A	B, A
Atrazine	B, Q	B, A	B, A	B, A
Benzene	B, Q	B, A	B, A	B, A
Benzo(a)pyrene (PAHs)	B, Q	B, A	B, A	B, A
Carbofuran	B, Q	B, A	B, A	B, A
Carbon Tetrachloride	B, Q	B, A	B, A	B, A
Chlordane	B, Q	B, A	B, A	B, A
Chlorobenzene	B, Q	B, A	B, A	B, A
2,4-D	B, Q	B, A	B, A	B, A
Dalapon	B, Q	B, A	B, A	B, A
1,2-dibromo-3-chloropropane (DBCP)	B, Q	B, A	B, A	B, A
1,2-Dichlorobenzene (o- dichlorobenzene)	B, Q	B, A	B, A	B, A
1,4-Dichlorobenzene (p- dichlorobenzene)	B, Q	B, A	B, A	B, A
1,2-Dichloroethane	B, Q	B, A	B, A	B, A
1,1-Dichloroethylene	B, Q	B, A	B, A	B, A
cis-1,2-Dichloroethylene	B, Q	B, A	B, A	B, A
trans-1,2-Dichloroethylene	B, Q	B, A	B, A	B, A
Dichloromethane (Methylene chloride)	B, Q	B, A	B, A	B, A
1,2-Dichloropropane	B, Q	B, A	B, A	B, A
Di(2-ethylhexyl) adipate	B, Q	B, A	B, A	B, A
Di(2-ethylhexyl) phthalate	B, Q	B, A	B, A	B, A
Dinoseb	B, Q	B, A	B, A	B, A
Dioxin (2,3,7,8-TCDD)	B, Q	B, A	B, A	B, A
Diquat	B, Q	B, A	B, A	B, A

Parameter	JR_MC_UA	JR_MC_UB	JR_MC_UC	JR_MC_MA
Endothall	B, Q	B, A	B, A	B, A
Endrin	B, Q	B, A	B, A	B, A
Epichlorohydrin	B, Q	B, A	B, A	B, A
Ethylbenzene	B, Q	B, A	B, A	B, A
Ethylene dibromide (EDB)	B, Q	B, A	B, A	B, A
Glyphosate	B, Q	B, A	B, A	B, A
Heptachlor	B, Q	B, A	B, A	B, A
Heptachlor Epoxide	B, Q	B, A	B, A	B, A
Hexachlorobenzene	B, Q	B, A	B, A	B, A
Hexachlorocyclopentadiene	B, Q	B, A	B, A	B, A
Lindane (Gamma-BHC)	B, Q	B, A	B, A	B, A
Methoxychlor	B, Q	B, A	B, A	B, A
Oxamyl (Vydate)	B, Q	B, A	B, A	B, A
Polychlorinated biphenyls	B, Q	B, A	B, A	B, A
Arochlor (AR)1016	B, Q	B, A	B, A	B, A
AR1221	B, Q	B, A	B, A	B, A
AR1232	B, Q	B, A	B, A	B, A
AR1242	B, Q	B, A	B, A	B, A
AR1248	B, Q	B, A	B, A	B, A
AR1254	B, Q	B, A	B, A	B, A
AR1260	B, Q	B, A	B, A	B, A
Pentachlorophenol	B, Q	B, A	B, A	B, A
Picloram	B, Q	B, A	B, A	B, A
Simazine	B, Q	B, A	B, A	B, A
Styrene	B, Q	B, A	B, A	B, A
Tetrachloroethylene	B, Q	B, A	B, A	B, A
Toluene	B, Q	B, A	B, A	B, A
Toxaphene	B, Q	B, A	B, A	B, A
2,4,5-TP (Silvex)	B, Q	B, A	B, A	B, A
1,2,4-Trichlorobenzene	B, Q	B, A	B, A	B, A
1,1,1-Trichloroethane	B, Q	B, A	B, A	B, A
1,1,2-Trichloroethane	B, Q	B, A	B, A	B, A
Trichloroethylene	B, Q	B, A	B, A	B, A
Vinyl Chloride	B, Q	B, A	B, A	B, A
Xylene, Total	B, Q	B, A	B, A	B, A
Radionuclides				

Parameter	JR_MC_UA	JR_MC_UB	JR_MC_UC	JR_MC_MA
Alpha particles	B, Q	B, A	B, A	B, A
Beta particles and photon emitters	B, Q	B, A	B, A	B, A
Radium 226	B, Q	B, A	B, A	B, A
Radium 228	B, Q	B, A	B, A	B, A
Uranium	B, Q	B, A	B, A	B, A
Regulatory Parameters: Virginia Groundwater Standards				
Aldrin/Dieldrin	B, Q	B, A	B, A	B, A
DDT	B, Q	B, A	B, A	B, A
Kepone	B, Q	B, A	B, A	B, A
Mirex	B, Q	B, A	B, A	B, A
Phenols	B, Q	B, A	B, A	B, A
Strontium-90	B, Q	B, A	B, A	B, A
Tritium	B, Q	B, A	B, A	B, A
Non-regulatory Parameters: Performance Indicators				
Public Health Indicators				
1,4-dioxane	B, Q	B, Q	B, Q	B, Q
17-β-estradiol	B, Q	B, Q	B, Q	B, Q
DEET	B, Q	B, Q	B, Q	B, Q
Ethinyl estradiol	B, Q	B, Q	B, Q	B, Q
NDMA	B, Q	B, Q	B, Q	B, Q
Perchlorate	B, Q	B, Q	B, Q	B, Q
PFOA + PFOS	B, Q	B, Q	B, Q	B, Q
PFBA	B, Q	B, Q	B, Q	B, Q
PFHpA	B, Q	B, Q	B, Q	B, Q
PFHxS	B, Q	B, Q	B, Q	B, Q
PFNA	B, Q	B, Q	B, Q	B, Q
tris(2-carboxyethyl)phosphine (TCEP)	B, Q	B, Q	B, Q	B, Q
Treatment Efficacy Indicators				
Cotinine	B, Q	B, Q	B, Q	B, Q
Primidone	B, Q	B, Q	B, Q	B, Q
Phenytoin	B, Q	B, Q	B, Q	B, Q
Meprobamate	B, Q	B, Q	B, Q	B, Q
Atenolol	B, Q	B, Q	B, Q	B, Q
Carbamazepine	B, Q	B, Q	B, Q	B, Q
Estrone	B, Q	B, Q	B, Q	B, Q
Sucralose	B, Q	B, Q	B, Q	B, Q

Parameter	JR_MC_UA	JR_MC_UB	JR_MC_UC	JR_MC_MA
Triclosan	B, Q	B, Q	B, Q	B, Q
Non-regulatory Parameters: Aquifer Characteristics and/or Compatibility				
Dissolved Oxygen	B, Q	B, A	B, A	B, A
Temperature	B, Q	B, A	B, A	B, A
pH	B, Q	B, A	B, A	B, A
Specific conductivity	B, Q	B, A	B, A	B, A
ORP	B, Q	B, A	B, A	B, A
Aluminum, dissolved	B, A	B, A	B, A	B, A
Aluminum, total	B, A	B, A	B, A	B, A
Arsenic, dissolved	B, A	B, A	B, A	B, A
Iron, dissolved	B, A	B, A	B, A	B, A
Iron, Total	B, Q	B, Q	B, Q	B, Q
Manganese, dissolved	B, A	B, A	B, A	B, A
Manganese, total	B, Q	B, Q	B, Q	B, Q
Magnesium, total	B, A	B, A	B, A	B, A
Potassium, total	B, A	B, A	B, A	B, A
Sodium, total	B, A	B, A	B, A	B, A
Calcium, total	B, A	B, A	B, A	B, A
Sulfate	B, A	B, A	B, A	B, A
Chloride	B, A	B, A	B, A	B, A
Bromide	B, A	B, A	B, A	B, A
Alkalinity	B, A	B, A	B, A	B, A
Total Kjeldahl Nitrogen	B, Q	B, Q	B, Q	B, Q
Ammonia as N	B, Q	B, Q	B, Q	B, Q
Total Phosphorus	B, A	B, A	B, A	B, A
Orthophosphate as P	B, A	B, A	B, A	B, A
Silica as SiO_2	B, A	B, A	B, A	B, A
Hardness, Total	B, A	B, A	B, A	B, A

3.1. Managed Aquifer Recharge Wells

This section describes water quality sample collection and water level monitoring and recording for each of the MAR wells (1-10).

3.1.1. Water Quality Monitoring

Water quality monitoring for each MAR will occur prior to start-up of recharge well operations at JR SWIFT and will consist of baseline monitoring (Table 3.1). HRSD will collect a single sample from each of the MAR wells (MAR 1-10) prior to initiating MAR operations. Analytical results will represent the native groundwater chemistry at each MAR well. Results of this analysis will be reviewed prior to initiating recharge to allow for an assessment of variability and collection of additional samples if warranted.

3.2 Monitoring Wells

This section describes water quality sample collection and water level monitoring and recording from the two clusters of monitoring wells, JR_MC1 and JR_MC2. Each cluster will include four conventional monitoring wells screened in the UPA and MPA. Screen intervals in each monitoring well will to the extent practical match screens in the closest MAR wells. Thus, screens in each monitoring well will likely fully penetrate the UPA or MPA.

Samples collected from individual monitoring wells at JR_MC1 or JR_MC2 will represent native groundwater or migrating SWIFT recharge in the UPA or MPA. Should a water quality issue emerge at any monitoring well, HRSD could elect to collect samples from individual sand intervals through packer testing. A water quality issue could represent the following situations:

- A constituent contained in migrating SWIFT recharge.
- A constituent released during a reaction related to mixing between native groundwater and SWIFT-recharge.
- Reactions between SWIFT recharge and aquifer releasing metals or other potentially harmful constituents.

Exploration conducted at JR SWIFT TW-4 (DEQ: 2161-07; USGS: 58E7), revealed the UPA and MPA contained six and three sand intervals, respectively. The 4.5-inch diameter casing and screen assemblies used in the monitoring wells will accommodate packer testing assemblies from most commercial manufacturers.

3.2.1 Water Quality Monitoring

HRSD will conduct baseline and ongoing monitoring at the clustered monitoring wells (Refer to Table 3.1 for a summary of planned baseline, quarterly and annual monitoring). The baseline monitoring will entail collecting samples over four quarters prior to initiating MAR operations to establish the baseline water chemistry in the UPA and MPA aquifers. Field chemistry and lab results from 32 samples will characterize the groundwater chemistry in the UPA and MPA. This baseline sampling will begin at least one - two years prior to initiating MAR operations.

Once MAR operations commence, HRSD will conduct on-going monitoring at each of the eight monitoring wells as described in Table 3.1 to evaluate any changes in water quality that may result from mixing between the recharge water and the native groundwater as well as reactions between the recharge water and aquifer minerals.

3.2.2 Hydraulic Monitoring

HRSD will install pressure transducers in each of the eight monitoring wells, enabling the tracking of water levels during MAR operations. The water levels will represent potentiometric head in the UPA and MPA and will likely climb toward the ground surface during MAR operations as potentiometric head in the aquifers rebound. These data also provide a platform for comparing the draw-up in the UPA and MPA aquifers with draw-up in the MAR wells. Differences in the two values represent head losses due to well effects, helping to evaluate well clogging and the required frequency for backflushing.

3.2.3. Tracer Selection

Evaluating advection, dispersion, diffusion, and the mixing between recharge water and native groundwater in the screened intervals of each monitoring well requires tracking the migration of a conservative constituent, or tracer. Several analytes at JR SWIFT could serve as a tracer including fluoride, sulfate, chloride, and specific conductance. The use of a tracer(s) will allow HRSD to monitor the migration of recharge water past the monitoring well locations, distinguishing between groundwater and recharge water at each monitoring well location.

A tracer should exhibit the following two important characteristics:

- Non-reactive behavior between water types and minerals in the aquifer
- Significantly differing concentrations in the recharge water and NGW.

Because it displays elevated concentrations in NGW from the UPA and MPA, fluoride behaves conservatively in the aquifer environment, while exhibiting low concentrations in treated water, studies often use fluoride as a tracer during groundwater projects performed in the Virginia Coastal Plain. Data collected from the James River test well indicated that the fluoride concentrations in groundwater from the UPA and MPA range from 1.23 to 2.93 mg/L, compared to 0.57 mg/L in the projected recharge water chemistry (Table 2.1). In addition to fluoride, chloride, a relatively inert ion, displays differing concentrations (14 times) between the projected recharge water (106 mg/L) and groundwater produced from the UPA and MPA (1,460 to 2,290 mg/L).

Sulfate has worked as an effective tracer at HRSD's SRC, where sulfate concentrations provided a well-defined breakthrough curve at a monitoring well screening the UPA, located over 250 feet from the test MAR well. However, reactive sulfide minerals elevate sulfate during oxidation reactions with oxygenated recharge water, usually creating sulfate at twice the concentrations found in the SWIFT recharge water. Zones screening the MPA at the SRC produced the recognizable sulfide oxidation signature.

Compared to chloride, sulfate concentrations in the recharge water (53 mg/L) are predicted to be approximately 30 to 60 percent of concentrations encountered in the NGW of the MPA and UPA, respectively. Thus, elevated concentrations of sulfate, from sulfide oxidation reactions, might obscure the leading edge of the SWIFT recharge migrating past a monitoring well screening the UPA or MPA. Pyrite, the most common sulfide mineral found in the PAS, appeared in cores samples collected from the UPA and MPA.

Specific conductance displays a similar relationship, projecting around 900 µS/cm in the recharge water and from 4,088 to 8,700 µS/cm in NGW from UPA and MPA. Moreover, other researchers have pointed to the correlation between specific conductivity and chloride concentrations in a water sample (Hem, 1985). Often chloride concentrations make up 20 percent of a specific conductivity measurement. Consistent with this relationship, the SWIFT Water and NGW are expected to exhibit markedly differing specific conductivity measurements. Yet, a specific conductivity measurement involves ions other than chloride that can react in the aquifer environment. Thus, a specific conductivity measurement may not qualify as an acceptably inert tracer but, with its relative ease of measurement could serve as a screening indicator of chloride concentrations.

As JR_MC1 and JR_MC2 will serve as long-term monitoring locations for JR SWIFT, the timing when recharge water first passes the monitoring wells will register minimal influence on the monitoring schedule.

4.0 Contingency Plan

The contingency plan describes measures for responding to non-routine situations arising during MAR operations. Obvious situations might involve recharging compromised water quality into the PAS or encountering a constituent that exceeds Safe Drinking Water Act (SDWA) Primary Maximum Contaminant Levels (PMCL) in one of the monitoring wells. Operational contingency plans to address well performance, such as declining injectivity, will be outlined in HRSD's Operations and Maintenance (O&M) manual.

As MAR operations progress at JR SWIFT, HRSD personnel may amend this plan to add situations not covered in this version of the Contingency Plan.

4.1. Water Quality

The regulatory monitoring and the critical control point protocols are intended to prevent exceedances of any PMCLs within the PAS resulting from recharging SWIFT Water. If PMCL exceedances are confirmed in the SWIFT Water prior to injection, HRSD will divert SWIFT Water to the JRTP until compliance with the PMCL is demonstrated (refer to SWIFT Water Quality Targets, Table 2.2 for PMCL exceedance determination). Similarly, exceeding certain critical control point action values will result in a diversion of water away from the AWT or away from the MAR wells.

HRSD will monitor the quality of recharge water migrating in the PAS at monitoring well nests JR_MC1 and JR_MC2 as identified in Table 3.1. After the recharge front has migrated past any of the monitoring wells, if any of the regulated parameters are elevated above the PMCL in groundwater samples, HRSD will enact the following contingencies.

- HRSD will collect and submit a confirmation sample for analysis as soon as practical and no later than one week after receiving the initial sample results. If the results appear related to sampling error or other factors, HRSD will provide an explanation in a report submitted to EPA. Depending on the parameter of concern, data turnaround after sample submission can range from 2 – 4 weeks.
- If results are confirmed, HRSD will contact the EPA Region III 's UIC Case Manager and the Potomac Aquifer Recharge Oversight Committee (PAROC) within 24 hours of confirmation to provide notification and will provide a report to EPA and the PAROC within 14 days of confirmation describing in detail the potential cause and any corrective measures that may be implemented to mitigate the issue.
- In the case of an exceedance, HRSD will make all efforts to track the source of a potential contaminant.
- If necessary, HRSD may adjust the treatment process to reduce the reactivity (passivate) of minerals in the PAS in situ. HRSD will increase the sampling frequency at monitoring the wells, as appropriate, to track concentrations of the potential contaminant. HRSD will work with the PAROC and EPA to determine what additional measures may be needed including halting recharge operations until an alternative solution is developed.

- As described above, HRSD may decide to conduct packer testing in an affected monitoring well to determine if the constituent originates from a discrete sand interval or from the entire UPA or MPA.

5.0 References

Hem, J.D. Study and Interpretation of the Chemical Characteristics of Natural Water. 3rd Edition, US Geological Survey Water-Supply Paper 2254, University of Virginia, Charlottesville, 1985.