APPENDIX 2

FLOW, PRESSURE AND RAINFALL MONITORING PLAN

Original Document September 2007
Revised February 2008
Revised November 2008
Revised April 2009

HAMPTON ROADS
SANITATION DISTRICT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Purpose

1.1.1 General

The purpose of this Flow, Pressure, and Rainfall (FPR) Monitoring Plan is to describe the Hampton Road Sanitation District (HRSD) monitoring system that will:

- Monitor pipeline pressures and flows in the wastewater collection (and transmission) system;
- Monitor collection system health and integrity;
- Provide data to calibrate HRSD's Regional Hydraulic Model ("Model"); and
- Provide data for the Regional Wet Weather Management Plan (RWWMP).

1.1.2 Coordination with Localities

The HRSD sanitary sewer system ("SS System") and Specified Portions of the Localities' systems (those portions of the Localities' systems that are required to be included in the Model) can be monitored to collect hydrologic and hydraulic data under various operating conditions to be used in developing, calibrating and validating the Model. As this is a regional effort with HRSD and the Localities responsible for developing wastewater system models and a RWWMP, the collection of the flow, pressure and rainfall data is a regional effort.

Under the VDEQ Special Order by Consent (SOC), effective September 26, 2007, Localities are required to collect flow and rainfall data in their systems to support Sanitary Sewer Evaluation Survey (SSES) basin identification and hydraulic model calibration. In addition, Localities are required by the SOC to provide input hydrographs characterizing expected flow from their systems. These data, together with data collected by HRSD in the HRSD SS System, will be used to develop and calibrate the Model.

Following detailed review and discussions with the EPA and Virginia Department of Environmental Quality (VDEQ), HRSD has determined that 17 significant Locality Overflow Points (LOPs) need to be addressed via modeling. These 17 sites are identified in the figures of Appendix A. The calibrated Model will be used to predict overflow volumes from these points providing more accurate results.

HRSD continues to coordinate and collaborate development of flow, pressure, and rainfall monitoring with Localities through regular Capacity Team meetings. Detailed discussions are held in these meetings regarding flow monitoring and hydraulic modeling. The Capacity Team consists of representatives from several of the Localities who have made a commitment to develop and provide guidance to the entire group of Localities on issues related to the SOC. Membership has included representatives from Suffolk, Hampton, Chesapeake, JCSA, Norfolk, Newport News, Virginia Beach, HRSD, and the Hampton Roads Planning District Commission (HRPDC). Meetings are held at least monthly, or as necessary, based on the topics of discussion.

1.1.3 Regional Hydraulic Model and Regional Wet Weather Management Plans

As part of the RWWMP development, HRSD has prepared a Regional Hydraulic Model Plan that documents how the flow and pressure data collected under the FPR Monitoring Plan will be used in model development, calibration, and verification.

The proposed FPR Monitoring Program provides the coverage necessary to calibrate and verify the Regional Hydraulic Model and characterize the operation of the existing system as required for the preparation of the Regional Wet Weather Management Plan (RWWMP) and other related activities.

Pressure sensors are strategically located at the upstream end of force main segments and other locations as needed. Additional pressure sensors are distributed at a density sufficient to characterize pressures throughout the network. The pressure data, combined with information on the pressure sensor elevations, provide a detailed description of the hydraulic grade line elevation throughout the HRSD SS System.

Flow monitors are strategically placed to document the flows within major HRSD pressure and gravity sewer system segments. Gravity sewer monitoring locations were selected to document the flows in the major HRSD gravity sanitary sewer segments. As such, they provide information required to calibrate the Regional Hydraulic Model and characterize the flows in these segments to support other activities required for the development of the RWWMP. Flow monitors in the pressurized force main system document the flows within major sewer segments and near major junctions with other major force main segments. These monitors directly measure the flows in major sewers and allow total flows in other major force main segments to be determined by addition or subtraction. These flow monitors therefore provide the data necessary to calibrate and validate the Regional Hydraulic Model with sufficient accuracy to meet the objectives and goals defined in the Regional Hydraulic Model Plan.

An important source of dry-weather and wet-weather flows will be the flow and rainfall monitoring performed by the Localities as described in their Flow Monitoring Plans approved by the VDEQ in 2008. Flow data will be evaluated by the Localities to determine dry-weather flows, base sewage flow, and dry-weather infiltration. These data will also determine wet-weather flow model parameters to be used in the Regional Hydraulic Model. HRSD will continue to work closely with the Localities throughout the process which is described in the Regional Hydraulic Model Plan.

1.2 Scope

The FPR Monitoring Plan has been designed to:

- Measure flow rates and total amounts of wastewater flow at significant locations in HRSD's force mains;
- Measure flow rates and hydraulic grade lines (i.e., surcharge) at significant locations in HRSD's gravity sewers;
- Characterize the performance of HRSD's pump stations and pressure reducing stations;
- Measure pressure conditions in HRSD's force mains; and
- Measure rainfall rates and total rainfall amounts so as to adequately characterize spatial and temporal variations in rainfall across the modeled portions of HRSD's service area.

HRSD has prepared this FPR Monitoring Plan to collect data of sufficient amount, scope and quality to support HRSD's development, calibration and verification of the Regional Hydraulic Model, HRSD's assessment of HRSD SS System capacity, and HRSD's development of a Regional Wet Weather Management Plan. The number and location of rainfall, flow and pressure monitors are sufficient to allow HRSD to calibrate all portions of the Regional SS System included in the Regional Hydraulic Model. The duration,

amount and quality of the monitoring proposed in this plan will be adequate to allow the collection of (i) sufficient dry weather data to facilitate adequate dry-weather model calibration and validation activities, and (ii) a sufficient number and appropriate range of wet-weather events to facilitate adequate wet weather model calibration and validation activities.

HRSD has coordinated the development of its FPR Monitoring Plan with Locality Flow Monitoring Plans, such that together the Localities' plans and the FPR Monitoring Plan will generate all data necessary for HRSD to develop an appropriate Regional Wet Weather Management Plan.

2. MONITORING SITE LOCATIONS

HRSD will measure flow, pressure, and rainfall at specific and useful locations in the Regional SS System. In total, HRSD will measure flow at 175 sites (which includes 44 Industrial Waste Dischargers) and pressure at 122 sites, as shown on Figures 1 through 48 and summarized in Tables 1 through 3. Figures 1 and 2 present large scale maps – one for the North Shore System and one for the South Shore System. Figures 3 through 48 present more detailed views of the same information.

These sites were selected from the HRSD SS System to be significant for development and calibration of the Model. The FPR Monitoring Plan adds to the existing network of HRSD flow, pressure, and rainfall monitoring sites, and provides the additional coverage for Model development and calibration. As part of the SOC, Localities are responsible for providing flow parameters and hydrographs for connection points to HRSD's SS System. HRSD will use the Model and regional flow and pressure data to verify total flows in portions of HRSD's system.

For HRSD's FPR Monitoring Plan, each site is either a:

- **Pump Station Service Area (PS SA) Monitors** – These sites were selected because they are located at HRSD Pump Stations or Pressure Reducing Stations;
- **Intermediate Monitors** – These sites were selected because they are either an intermediate point on a relatively long run of HRSD interceptor, they are located near the junction of two or more HRSD interceptors, or they represent a significant point in the HRSD SS System for modeling or operational purposes;
- **Gravity Flow Monitor** – These sites were selected to characterize flow in HRSD's gravity sewer interceptors and this data will be used for Model development. Ten sites that had been previously identified for flow monitoring on the pressure-side of an HRSD pump station have been converted to gravity flow monitoring per consensus with the EPA and VDEQ at a meeting on September 11, 2008;
- **End of Line Pressure Monitor** – These sites were selected because they are near the upstream end of an HRSD force main and may be used for Model calibration and system operation; and
- **Industrial Waste Discharger (IWD)** – These sites measure wastewater flows from major military and other large government and commercial wastewater dischargers into the HRSD SS System.
- **Rainfall Gauge** – Rainfall will be measured at 64 sites, shown on Figures 50 and 51 of Appendix D and summarized in Table 4.

2.1 Flow Monitoring

During development of the SOC, a Flow and Rainfall Monitoring and Reporting System plan, also referred to as the Master Meter Program, was submitted to the VDEQ on June 29, 2007, and subsequently approved. This document was the basis for the Flow, Pressure, and Rainfall Monitoring and Reporting System (FPRMRS) Plan originally prepared, but has been superseded by this FPR Monitoring Plan. Previous versions of this document and the document submitted to the VDEQ in 2007 should not be relied upon, as discussion between HRSD, the EPA, and VDEQ have updated the program.

2.1.1 HRSD SS System

2.1.1.1 Pressure System Program

HRSD is implementing a program to install flow monitors in the pressure portions of the HRSD SS System. These monitors consist of ultrasonic, transit time, Doppler, Venturi, or other flow measurement devices to measure the flows at critical sites within the HRSD force main system. Flows will also be monitored at HRSD's pump stations and PRSs. These flows, in combination with the observed pressure data, will characterize the operation of the HRSD pump stations and PRSs. Design of the sites was initiated in 2007 with installation planned according to the schedule in Section 5 of this Plan. Location, monitor type, justification, and product specifications are also provided in this Plan. Detailed design documents for each site are under development and are available upon request. Each general site location was selected to achieve a benefit for Model development and calibration, or for operation data collection, as described in the monitor types at the beginning of Section 2.

Table 2 presents information for flow monitors and Table 3 presents information for pressure monitors included in the pressure system monitoring portion of the program. As the FPR Monitoring Plan implementation progresses, HRSD may determine that a different monitor type (selected from the list on Table 4) is more appropriate for a particular site than the model identified in Tables 2 and 3 and will adjust the design as necessary.

2.1.1.2 Gravity SS System

Although HRSD's system is largely comprised of pressurized force mains, there exist a number of gravity interceptors that will be subjected to flow monitoring. Gravity flow monitoring is being performed along the majority of HRSD's gravity interceptors and these sites are identified as part of the gravity system Flow Monitoring Plan (see Appendix E). This gravity system Flow Monitoring Plan has been submitted to VDEQ per the SOC. Ten additional gravity flow monitoring sites have been recently added to the program due to a switch in technology following meetings with the EPA and VDEQ as recent as September 11, 2008. Maps in Appendix A and Table 2 identify the proposed locations of the gravity flow monitors.

2.1.1.3 Other Methods

HRSD does not intend to use pump run times as a primary source of data for the FPR Monitoring Program. This type of information may be used to verify or corroborate flow values based on known system pressures as necessary in Model development.

2.1.2 Industrial Wastewater Dischargers

Industrial Wastewater Discharge (IWD) sites measure wastewater flows from major military and other large government and commercial wastewater dischargers. As a matter of HRSD policy, IWD sites that contribute more than 100,000 gallons per day to the system will be monitored for flow. HRSD will notify the EPA during the FPR Monitoring Program of new IWD sites that are added to the system, if any.

Table 1 summarizes the IWD flow monitors by discharger. Dischargers are responsible for installing and maintaining a monitor, calibrating it, and reporting the results to HRSD annually. As part of the FPR Monitoring Program, many of the IWD sites that have an existing totalizing flow monitor are being upgraded with the addition of data reporting communication devices if none existed previously. IWD sites with an existing flow monitor and telemetry are identified in Table 1 as "Existing" in the Status column. Those sites where a flow monitor or telemetry system is being added are identified as "Planned."

Table 1. Industrial Wastewater Dischargers

ID	Status	Monitor Manufacturer	Monitor Model	Jurisdiction	Location Description	Map Location
MMPS-010-1	Existing	ABB	TBD	GOVT	NAS Oceana PS 600	SS-B-8
MMPS-012-1	Existing	Khrone	TBD	PRIV	Smithfield foods, 200 Commerce St	SS-A-3
MMPS-044-1	Existing	TBD	TBD	GOVT	Ben Morell Housing, NOB PS #BM-138 Effluent	SS-A-5
MMPS-045-1	Existing	TBD	TBD	GOVT	Camp Allen, NOB PS #CA-6 Effluent	SS-A-5
MMPS-046-1	Existing	TBD	TBD	GOVT	Camp Allen, NOB PS #CA-470 Effluent	SS-B-5
MMPS-047-1	Existing	Bailey Fischer-Porter	50XM13N	GOVT	D&S Piers "C" Ave, NOB PS #CEP-167 Effluent	SS-A-5
MMPS-048-1	Existing	ABB	Unknown	GOVT	Little Creek PS 1518	SS-B-6
MMPS-049-1	Existing	Bailey Fischer-Porter	50XM13N	GOVT	Little Creek PS 2115	SS-B-6
MMPS-051-1	Existing	Bailey Fischer-Porter	50XM13N	GOVT	Navy Housing South , NOB PS #NH-200 Effluent	SS-B-5
MMPS-054-1	Planned	Siemens Milltronics (Monitor Existing)	HydroRanger	PRIV	Sara Lee Coffee and Tea, 1370 Progress Rd	SS-C-3
MMPS-055-1	Planned	Magflo (Monitor Existing)	Mag3100	PRIV	Norfolk Environmental, 150 S Main St	SS-B-6
MMPS-056-1	Planned	Tigermag Sparling (Monitor Existing)	TBD	PRIV	Pepsi Cola Bottling, 17200 Warwick Blvd	NS-C-4
MMPS-057-1	Planned	Mobrey (Monitor Existing)	MCU901	PRIV	Gwaltney, 2175 Elmhurst Lane	SS-C-5
MMPS-058-1	Planned	Endress & Hauser (Monitor Existing)	ProMag 33F	PRIV	CIBA, 2301 Wilroy Rd,	SS-C-3
MMPS-059-1	Planned	Danfoss (total of 3) (Monitor Existing)	TBD	PRIV	Norshipco, 2401 Kimball Ter	SS-B-6
MMPS-060-1	Planned	Marsh McBirney Flo-Station (Monitor Existing)	TBD	PRIV	NN Shipyard main met, 34 ST METER	NS-E-5
MMPS-061-1	Planned	ISCO (Monitor Existing)	4230 bubbler	PRIV	Tidewater Area Hospital, 3530 Elmhurst Lane	SS-C-5
MMPS-062-1	Planned	AT-868 Aqua Trans Ultrasonic Flow Transmitter (Monitor Existing)	TBD	PRIV	SPSA waste to energy Steam Plant, 3809 Elm Avenue	SS-C-5
MMPS-063-1	Planned	McCrometer (Monitor Existing)	4" 06-02957-4	PRIV	Ecolochem, 4545 Patent Rd	SS-B-6
MMPS-064-1	Planned	Endress & Hauser Prosonic S Parshall flume (Monitor Existing)	TBD	PRIV	Perdue Farms, Chesapeake, 501 Barnes Rd	SS-C-6
MMPS-065-1	Planned	Tigermag Sparling (Monitor Existing)	TBD	PRIV	NN Shipyard North Yard, 58 St/Warwick	NS-E-5
MMPS-066-1	Planned	Milltronics (Monitor Existing)	OCM-111	PRIV	Moores Bridges WTP, 6040 Waterworks Road	SS-B-6
MMPS-067-1	Planned	Allen Bradley PLC (bubbler system) (Monitor Existing)	TBD	PRIV	Anheuser Busch, 7801 Pocahontas Trail	NS-C-4
MMPS-068-1	Planned	MF 90 Transit Time Ultrasonic Flow Meter (Monitor Existing)	TBD	PRIV	Ball Metal, 8935 Pocahontas Trail	NS-C-4
MMPS-073-1	Planned	Hersey B.E.P. Magnetic Flow Meter (Monitor Existing)	TBD	PRIV	BASF, BASF Drive	NS-C-4
MMPS-089-1	Planned	Bailey Fischer Porter (Monitor Existing)	TBD	GOVT	Camp Peary (Dept. of Defense)	NS-B-3
MMPS-100-1	Planned	Bailey Fischer Porter (Monitor Existing)	TBD	GOVT	FCTC Dam Neck	SS-C-8
MMPS-102-1	Planned	Rosemount Magnetic (Monitor Existing)	TBD	GOVT	Ft. Monroe	NS-E-6
MMPS-103-1	Planned	Bailey Fischer Porter (Monitor Existing)	TBD	GOVT	Ft. Story	SS-B-8
MMPS-186-1	Planned	Sparling magnetic flow meter with digital readout (Monitor Existing)	TBD	GOVT	Langley PS 1370	NS-D-6
MMPS-187-1	Planned	Sparling magnetic flow meter with digital readout (Monitor Existing)	TBD	GOVT	Langley PS 1791	NS-D-6
MMPS-188-1	Planned	Sparling magnetic flow meter with digital readout (Monitor Existing)	TBD	GOVT	Langley PS 2099	NS-D-6
MMPS-191-1	Planned	Bailey Fischer-Porter (Monitor Existing)	50XM13N	GOVT	Little Creek PS 3879	SS-B-7
MMPS-192-1	Planned	Bailey Fischer-Porter	TBD	GOVT	Little Creek PS 5000	SS-B-7
MMPS-193-1	Planned	Bailey Fischer-Porter (Monitor Existing)	50XM13N	GOVT	Little Creek PS 751	SS-B-7
MMPS-195-1	Planned	GE Panametrics ultrasonic flow meter with digital readout (Monitor Existing)	TBD	GOVT	NASA Research Center	NS-D-6
MMPS-196-1	Planned	Honeywell magnetic flow meter with chart recorder (Monitor Existing)	TBD	GOVT	Naval Weapons Station PS 1894	NS-C-4
MMPS-200-1	Planned	Siemens magnetic flow meter with digital readout (Monitor Existing)	TBD	GOVT	Norfolk Naval Shipyard (Portsmouth)	SS-C-5
MMPS-205-1	Planned	Unknown (Navy replacing monitor)	TBD	GOVT	Portsmouth Naval Hospital	SS-B-5
MMPS-212-1	Planned	InstruLogic Corporation Flow Converter (Monitor Existing)	MJK 713	PRIV	Near Colley Ave PS, Sentara Norfolk	SS-B-5
MMPS-218-1	Planned	Bailey-Fischer-Porter (BFP) magnetic flow meter with digital readout (Monitor Existing)	TBD	GOVT	St Julian Annex	SS-C-5
MMPS-219-1	Planned	Bailey-Fischer-Porter (BFP) with digital readout and chart recorder (Monitor Existing)	TBD	GOVT	US Coast Guard Support, US Coast Guard Support Command	SS-B-5
MMPS-220-1	Planned	GE Panametrics with digital readout (Monitor Existing)	TBD	GOVT	US Navy Cheatham Annex	NS-B-4
MMPS-221-1	Planned	Bailey-Fischer-Porter mag meter with digital readout and chart recorder (Monitor Existing)	TBD	GOVT	USCG Yorktown	NS-C-5
					TOTAL NUMBER OF IWD SITES	**44**

2.1.3 Locality Monitoring

The Localities are working under the VDEQ Special Order by Consent, which required the submittal of Flow Monitoring Plans by December 26, 2007. All plans were submitted on or before this date. Following receipt of comments from the VDEQ, all Localities finalized their plans and resubmitted, having received no further comment from VDEQ. These plans have been implemented by the Localities in 2008.

HRSD monitoring, together with Locality monitoring will provide the data necessary for development of the Regional Wet Weather Management Plan. HRSD is continuing ongoing coordination with Localities related to the monitoring efforts.

2.1.4 Seasonal Variability

Daily flow records for HRSD sewage treatment plants (STPs) together with available groundwater data will be evaluated to identify seasonal trends in groundwater infiltration and wet-weather flow response. The STP flow records are the sole source of long-term flow data within the HRSD SS System. The correlation between STP flow and groundwater-level data will be documented as part of the Regional Hydraulic Model development. Monthly groundwater levels are available throughout the HRSD service area at 24 locations beginning in 1993. These groundwater monitoring locations are shown on Figures 1 and 2 of Appendix A. Available data from the U.S. Geological Survey, Localities, and other wells that monitor shallow groundwater levels may also be to supplement the HRSD data, if necessary, in these analyses. Development of the Model will take into account variations in groundwater as described in the Regional Hydraulic Model Plan.

Daily flow data from 1999 through the present at the nine HRSD STPs will be used to document seasonal flow variations within the Regional SS System. These data will be filtered to eliminate the effect of system operations that change the STP service areas. These operational changes are relatively infrequent and are limited in scope.

As the flow monitoring period in this FPR Monitoring Plan is 12 months, seasonal dry-weather flow variability can be captured in areas such as resorts, colleges, schools, and military facilities which can have fluctuating seasonal flow independent of groundwater levels. These data will be used to evaluate dry-weather flows during high-groundwater conditions relative to the flows observed during the Locality and FPR Monitoring Program periods. These results will be used to adjust dry-weather flows as appropriate during high-groundwater dry-weather flow conditions to reflect seasonal variability.

Table 2. Flow Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-003-1	Existing	TBD	TBD	VIP Main Flow	Intermediate	Yes	NORF	SS-B-5
MMPS-005-1	Planned	Fuji Electric	FLVS1213	Beltline Railroad	Intermediate		CHES	SS-C-6
MMPS-006-1	Planned	Fuji Electric	FLVS1213	Near State Street PS	Intermediate		NORF	SS-B-6
MMPS-009-1	Existing	ABB	Magmaster	Elbow Road	Intermediate	Yes	VBCH	SS-C-7
MMPS-011-1	Existing	ABB	Magmaster	HRSD Copeland Park PS	Intermediate		NNEW	NS-E-6
MMPS-013-1	Existing	GE Panametrics	DF868	16th./Walnut	Intermediate	Yes	NNEW	NS-E-6
MMPS-014-1	Existing	ABB	Magmaster	Smithfield High School	Intermediate		SFLD	SS-A-3
MMPS-015-1	Existing	ABB	Magmaster	Gatling Point	Intermediate		SFLD	SS-A-3
MMPS-016-1	Existing	ABB	Magmaster	Poquoson (NASA)	Intermediate		HAMP	NS-D-6
MMPS-018-1	Existing	Sigma	950	Orcutt/80th. Street	Intermediate		NNEW	NS-E-5
MMPS-019-1	Existing	ABB	Magmaster	Big Bethel	Intermediate		HAMP	NS-D-5
MMPS-020-1	Existing	ABB	Magmaster	North Ave	Intermediate		NNEW	NS-E-5
MMPS-021-1	Existing	ABB	Magmaster	Pinners Point	Intermediate	Yes	PORT	SS-B-5
MMPS-023-1	Existing	ABB	Magmaster	Williamsburg TP	Intermediate	Yes	JCSA	NS-C-4
MMPS-023-2	Existing	ABB	Magmaster	Williamsburg TP	Intermediate	Yes	JCSA	NS-C-4
MMPS-024-1	Existing	ABB	Magmaster	HRSD Kingsmill PS	PS SA Monitor		JCSA	NS-B-4
MMPS-025-1	Existing	ABB	Magmaster	HRSD Fort Eustis PS	Intermediate	Yes	NNEW	NS-C-4
MMPS-026-1	Existing	ABB	Magmaster	HRSD Colonial Williamsburg PS	Intermediate	Yes	WILL	NS-B-3
MMPS-027-1	Existing	TBD	TBD	Norfolk PS #18 Effluent	Intermediate		NORF	SS-B-6
MMPS-028-1	Existing	TBD	TBD	Norfolk PS #23 Effluent	Intermediate		NORF	SS-A-6
MMPS-029-1	Existing	TBD	TBD	Norfolk PS #51 Effluent	Intermediate		NORF	SS-B-6
MMPS-030-1	Existing	TBD	TBD	Norfolk PS #52 Effluent	Intermediate		NORF	SS-B-6
MMPS-031-1	Existing	TBD	TBD	Norfolk PS #57 Effluent	Intermediate		NORF	SS-B-6
MMPS-032-1	Existing	Fuji Electric	FLVS1213	Norfolk PS #81 Effluent	Intermediate		NORF	SS-B-6
MMPS-032-2	Existing	Fuji Electric	FLVS1213	Norfolk PS #81 Effluent	Intermediate		NORF	SS-B-6
MMPS-034-1	Existing	Teledyne ISCO	ADFM HTI	HRSD Quail PRS	Intermediate	Yes	NORF	SS-C-6
MMPS-035-1	Existing	TBD	TBD	ABTP Main Flow	Intermediate	Yes	NORF	SS-B-5
MMPS-036-1	Existing	Fuji Electric	FLVS1213	Northampton Blvd.	Intermediate		VBCH	SS-B-6
MMPS-037-1	Existing	Fuji Electric	FLVS1213	Boundary-Shore Drive	Intermediate	Yes	VBCH	SS-B-6
MMPS-038-1	Existing	Fuji Electric	FLVS1213	Curlew Drive	Intermediate		VBCH	SS-B-6
MMPS-039-1	Existing	Fuji Electric	FLVS1213	Bancker Rd	Intermediate	Yes	NORF	SS-B-6
MMPS-040-1	Existing	Teledyne ISCO	4250	Easton Place Gravity	Intermediate		NORF	SS-B-6
MMPS-041-1	Existing	Fuji Electric	FLVS1213	Norfolk PS #65 Effluent	Intermediate		NORF	SS-B-6
MMPS-042-1	Existing	Fuji Electric	FLVS1213	Bluestone at 25th.	Intermediate	Yes	NORF	SS-B-5
MMPS-043-1	Existing	Fuji Electric	FLVS1213	HRSD Chesapeake Blvd. PS	PS SA Monitor	Yes	NORF	SS-B-6
MMPS-050-1	Existing	Fuji Electric	FLVS1213	Berkley Ave	Intermediate		CHES	SS-C-6
MMPS-052-1	Existing	Fuji Electric	FLVS1213	Campostella Middle School	Intermediate		NORF	SS-C-6
MMPS-053-1	Existing	Fuji Electric	FLVS1213	City of Chesapeake/Ford Plant	Intermediate		CHES	SS-B-6
MMPS-053-2	Existing	Fuji Electric	FLVS1213	City of Chesapeake/Ford Plant	Intermediate		CHES	SS-B-6
MMPS-070-1	Planned	Fuji Electric	FLVS1213	Army Base 36" FM (ABTP)	Intermediate	Yes	NORF	SS-B-5
MMPS-071-1	Existing	TBD	TBD	ATP Main Flow	Intermediate		VBCH	SS-C-8

Table 2. Flow Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-075-1	Existing	TBD	TBD	BHTP Main Flow	Intermediate		NNEW	NS-E-6
MMPS-077-1	Planned	Fuji Electric	FLVS1213	Boundary WILL/YORK	Intermediate		WILL	NS-B-3
MMPS-081-1	Planned	Fuji Electric	FLVS1213	Boundary-JCSA/WILL	Intermediate	Yes	JCSA	NS-B-3
MMPS-082-1	Planned	Fuji Electric	FLVS1213	Boundary-JCSA/WILL	Intermediate		JCSA	NS-B-3
MMPS-085-1	Planned	Fuji Electric	FLVS1213	Boundary-YORK/GLOU	Intermediate		GLOU	NS-B-5
MMPS-087-1	Planned	Fuji Electric	FLVS1213	Bridge Road	Intermediate	Yes	SUFF	SS-B-4
MMPS-088-1	Planned	Fuji Electric	FLVS1213	Callison/GB LOCKS	Intermediate	Yes	CHES	SS-D-6
MMPS-093-1	Existing	TBD	TBD	CETP Main Flow	Intermediate		VBCH	SS-B-7
MMPS-096-1	Planned	Fuji Electric	FLVS1213	City Farm Road IFM (JRTP)	Intermediate	Yes	NNEW	NS-D-5
MMPS-110-1	Planned	Fuji Electric	FLVS1213	HRSD 25th Street PS	PS SA Monitor		NNEW	NS-E-5
MMPS-111-1	Planned	Teledyne ISCO	ADFM HTI	HRSD 33rd Street PS	PS SA Monitor		NNEW	NS-E-5
MMPS-112-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Arctic Avenue PS	PS SA Monitor		VBCH	SS-B-8
MMPS-113-1	Planned	Gravity Flow – Sigma	910/950	HRSD Ashland Circle PS	PS SA Monitor		NORF	SS-B-6
MMPS-114-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Atlantic PRS	PS SA Monitor	Yes	VBCH	SS-C-8
MMPS-115-1	Planned	Fuji Electric	FLVS1213	HRSD Bainbridge Blvd. PS	PS SA Monitor		NORF	SS-C-6
MMPS-116-1	Planned	Fuji Electric	FLVS1213	HRSD Bay Shore Lane PS	PS SA Monitor		HAMP	NS-E-7
MMPS-117-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Big Bethel PRS	PS SA Monitor	Yes	HAMP	NS-D-5
MMPS-118-1	Planned	Fuji Electric	FLVS1213	HRSD Bloxoms Corner PS	PS SA Monitor		HAMP	NS-D-6
MMPS-119-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Bowers Hill PRS	PS SA Monitor	Yes	CHES	SS-C-5
MMPS-120-1	Existing	Sigma	910	HRSD Bridge Street PS	PS SA Monitor		HAMP	NS-E-6
MMPS-120-2	Planned	Teledyne ISCO	ADFM HTI	HRSD Bridge Street PS	PS SA Monitor		HAMP	NS-E-6
MMPS-121-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Camden Ave PS	PS SA Monitor		PORT	SS-C-5
MMPS-122-1	Planned	Fuji Electric	FLVS1213	HRSD Cedar Lane PS	PS SA Monitor		PORT	SS-B-5
MMPS-123-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Center Avenue PS	PS SA Monitor		NNEW	NS-E-5
MMPS-125-1	Planned	Fuji Electric	FLVS1213	HRSD City Park PS	PS SA Monitor		NORF	SS-B-6
MMPS-126-1	Planned	Fuji Electric	FLVS1213	HRSD Claremont PS	PS SA Monitor		HAMP	NS-E-6
MMPS-127-1	Planned	Fuji Electric	FLVS1213	HRSD Colley Avenue PS	PS SA Monitor		NORF	SS-B-5
MMPS-128-1	Planned	Fuji Electric	FLVS1213	HRSD Deep Creek PRS	PS SA Monitor	Yes	CHES	SS-C-5
MMPS-129-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Dovercourt Road PS	PS SA Monitor		NORF	SS-B-6
MMPS-130-1	Planned	Gravity Flow – Sigma	910/950	HRSD Dozier's Corner PS	PS SA Monitor		NORF	SS-C-6
MMPS-131-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Elmhurst Lane PS	PS SA Monitor		PORT	SS-C-5
MMPS-132-1	Planned	Gravity Flow – Sigma	910/950	HRSD Ferebee Avenue PS	PS SA Monitor		CHES	SS-C-6
MMPS-133-1	Planned	Gravity Flow – Sigma	910/950	HRSD Ferguson Park PS	PS SA Monitor		NNEW	NS-E-5
MMPS-134-1	Planned	Fuji Electric	FLVS1213	HRSD Fords Colony PS	PS SA Monitor		JCSA	NS-B-3
MMPS-135-1	Planned	Fuji Electric	FLVS1213	HRSD Granby Street PS	PS SA Monitor		NORF	SS-B-6
MMPS-136-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Greensprings PS	PS SA Monitor		JCSA	NS-B-3
MMPS-137-1	Planned	Fuji Electric	FLVS1213	HRSD Hampton Institute PS	PS SA Monitor		HAMP	NS-E-6
MMPS-138-1	Planned	Gravity Flow – Sigma	910/950	HRSD Hanover Avenue PS	PS SA Monitor		NORF	SS-B-5
MMPS-139-1	Planned	Gravity Flow – Sigma	910/950	HRSD Hilton School PS	PS SA Monitor		NNEW	NS-E-5
MMPS-140-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Independence PRS	PS SA Monitor	Yes	VBCH	SS-B-7
MMPS-141-1	Planned	Fuji Electric	FLVS1213	HRSD Ingleside Road PS	PS SA Monitor		NORF	SS-B-6

Table 2. Flow Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-142-1	Planned	Gravity Flow – Sigma	910/950	HRSD Jamestown Crescent PS	PS SA Monitor		NORF	SS-B-5
MMPS-143-1	Planned	Gravity Flow – Sigma	910/950	HRSD Jefferson Avenue PS	PS SA Monitor		NNEW	NS-E-6
MMPS-144-1	Existing	TBD	Venturi	HRSD Kempsville PRS	PS SA Monitor	Yes	VBCH	SS-C-7
MMPS-145-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Langley Circle PS	PS SA Monitor		HAMP	NS-E-6
MMPS-146-1	Existing	TBD	Venturi	HRSD Laskin PRS	PS SA Monitor	Yes	VBCH	SS-B-8
MMPS-148-1	Planned	Fuji Electric	FLVS1213	HRSD Lucas Creek PS	PS SA Monitor	Yes	NNEW	NS-D-5
MMPS-149-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Luxembourg Avenue PS	PS SA Monitor		NORF	SS-B-6
MMPS-150-1	Planned	Fuji Electric	FLVS1213	HRSD Monroe Place PS	PS SA Monitor		NORF	SS-B-5
MMPS-151-1	Planned	Fuji Electric	FLVS1213	HRSD Morrison PS	PS SA Monitor		NNEW	NS-D-5
MMPS-152-1	Planned	Fuji Electric	FLVS1213	HRSD Newmarket Creek PS	PS SA Monitor		NNEW	NS-E-5
MMPS-153-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Newtown Road PS	PS SA Monitor	Yes	VBCH	SS-B-6
MMPS-154-1	Planned	Fuji Electric	FLVS1213	HRSD Normandy Lane PS	PS SA Monitor		NNEW	NS-D-5
MMPS-155-1	Planned	Fuji Electric	FLVS1213	HRSD North Shore Road PS	PS SA Monitor		NORF	SS-B-5
MMPS-156-1	Planned	Fuji Electric	FLVS1213	HRSD Norview Avenue PS	PS SA Monitor		NORF	SS-B-6
MMPS-157-1	Planned	Fuji Electric	FLVS1213	HRSD Park Avenue PS	PS SA Monitor		CHES	SS-C-6
MMPS-158-1	Planned	Fuji Electric	FLVS1213	HRSD Patrick Henry PS	PS SA Monitor		NNEW	NS-D-5
MMPS-160-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Pine Tree PRS	PS SA Monitor	Yes	VBCH	SS-B-7
MMPS-161-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Plume Street PS	PS SA Monitor		NORF	SS-B-6
MMPS-162-1	Planned	Fuji Electric	FLVS1213	HRSD Powhatan Avenue PS	PS SA Monitor		NORF	SS-B-5
MMPS-163-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Providence PRS	PS SA Monitor	Yes	VBCH	SS-C-6
MMPS-164-1	Planned	Fuji Electric	FLVS1213	HRSD Pughsville PRS	PS SA Monitor	Yes	SUFF	SS-B-4
MMPS-165-1	Planned	Gravity Flow – Sigma	910/950	HRSD Quail Avenue PS	PS SA Monitor		NORF	SS-C-6
MMPS-166-1	Planned	Gravity Flow – Sigma	910/950	HRSD Richmond Crescent PS	PS SA Monitor		NORF	SS-B-5
MMPS-167-1	Planned	Fuji Electric	FLVS1213	HRSD Rodman Avenue PS	PS SA Monitor		PORT	SS-C-5
MMPS-168-1	Planned	Fuji Electric	FLVS1213	HRSD Rolling Hills PS	PS SA Monitor		WMBG	NS-B-4
MMPS-169-1	Existing	Teledyne ISCO	ADFM HTI	HRSD Route 337 PRS	PS SA Monitor	Yes	CHES	SS-C-4
MMPS-170-1	Planned	Fuji Electric	FLVS1213	HRSD Seay Avenue PS	PS SA Monitor		NORF	SS-B-6
MMPS-171-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Shipps Corner PRS	PS SA Monitor	Yes	VBCH	SS-C-7
MMPS-172-1	Planned	Teledyne ISCO	ADFM HTI	HRSD State Street PS	PS SA Monitor		NORF	SS-B-6
MMPS-173-1	Planned	Fuji Electric	FLVS1213	HRSD Steamboat Creek PS	PS SA Monitor		NORF	SS-B-6
MMPS-174-1	Planned	Fuji Electric	FLVS1213	HRSD Suffolk PS	PS SA Monitor	Yes	SUFF	SS-D-3
MMPS-175-1	Existing	Bailey Fischer-Porter	50XM13N	HRSD Taussig Blvd. PS	Intermediate	Yes	NORF	SS-A-5
MMPS-175-2	Existing	Bailey Fischer-Porter	50XM13N	HRSD Taussig Blvd. PS	Intermediate	Yes	NORF	SS-A-5
MMPS-175-3	Existing	Bailey Fischer-Porter	50XM13N	HRSD Taussig Blvd. PS	Intermediate	Yes	NORF	SS-A-5
MMPS-176-1	Planned	Teledyne ISCO	ADFM HTI	HRSD Terminal PRS	PS SA Monitor		NORF	SS-B-6
MMPS-177-1	Planned	Fuji Electric	FLVS1213	HRSD Va. Beach Blvd. PS	PS SA Monitor		NORF	SS-B-6
MMPS-178-1	Planned	Fuji Electric	FLVS1213	HRSD Washington District PS	PS SA Monitor		NORF	SS-C-6
MMPS-179-1	Planned	Fuji Electric	FLVS1213	HRSD Washington Street PS	PS SA Monitor		HAMP	NS-E-6
MMPS-180-1	Planned	Fuji Electric	FLVS1213	HRSD Willard Avenue PS	PS SA Monitor		HAMP	NS-E-6
MMPS-181-1	Planned	Fuji Electric	FLVS1213	HRSD Williamsburg PS	PS SA Monitor		WMBG	NS-B-3
MMPS-182-1	Planned	Fuji Electric	FLVS1213	HRSD Willoughby Avenue PS	PS SA Monitor		NORF	SS-B-6

Table 2. Flow Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-183-1	Planned	Fuji Electric	FLVS1213	HRSD Woodland Road PS	PS SA Monitor		HAMP	NS-D-6
MMPS-184-1	Existing	TBD	TBD	JRTP Main Flow	Intermediate	Yes	NNEW	NS-D-5
MMPS-185-1	Planned	Fuji Electric	FLVS1213	Lago Mar IFM at ATWTP	Intermediate		VBCH	SS-C-8
MMPS-197-1	Planned	Fuji Electric	FLVS1213	Near Suffolk PS	Intermediate		SUFF	SS-D-3
MMPS-198-1	Planned	Fuji Electric	FLVS1213	Newtown Road IFM	Intermediate	Yes	VBCH	SS-B-6
MMPS-201-1	Existing	GE Panametrics	DF868	Norfolk PS #27 Discharge	Intermediate		NORF	SS-B-6
MMPS-202-1	Existing	TBD	TBD	Nansemond STP Main Flow	Intermediate		SUFF	SS-B-4
MMPS-210-1	Planned	Fuji Electric	FLVS1213	Rte 17 West of Town Pt Rd	Intermediate	Yes	SUFF	SS-B-4
MMPS-213-1	Planned	Fuji Electric	FLVS1213	Shell Road	Intermediate		CHES	SS-C-5
MMPS-214-1	Planned	Fuji Electric	FLVS1213	Shore Drive/Gator	Intermediate	Yes	VBCH	SS-B-7
MMPS-215-1	Planned	Fuji Electric	FLVS1213	Shore Drive/Joslin	Intermediate	Yes	VBCH	SS-B-7
MMPS-217-1	Planned	Fuji Electric	FLVS1213	South of Goodwin Neck and Wolf Trap	Intermediate	Yes	YORK	NS-C-5
MMPS-222-1	Existing	TBD	TBD	WBTP Main Flow	Intermediate	Yes	WMBG	NS-C-4
MMPS-235-1	Existing	TBD	TBD	YRTP Main Flow	Intermediate		YORK	NS-C-5
						TOTAL NUMBER OF FLOW MONITORING SITES		**131**

2.1.5 Gravity Flow Monitoring Calibration Sites

More than thirty sites were identified for gravity sewer flow monitoring as part of the SOC Flow Monitoring Plan included in Appendix E to this Plan. The SOC requires flow monitoring until specific criteria are met with a minimum record of 6 months of flow data. Monitoring for this program was initiated in June 2008 and is complete for nearly all sites.

HRSD has identified 5 of the original set of gravity sewer flow monitoring sites in the SOC Flow Monitoring Plan that will be monitored concurrently with the other Calibration Sites identified in Tables 2 and 3. These sites will be monitored for a period of 12 months using flow monitoring equipment listed in Section 4. As this monitoring work will be contracted out from HRSD, the specific equipment type cannot be identified for each site; however, it will be one of the units listed in Section 4.1.5 through 4.1.8.

Table 2.1. Calibration Gravity Flow Monitoring Sites

Site Number	Location	Jurisdiction
GFM-02	Intersection of Jefferson Avenue and Temple Lane	Newport News
GFM-04	Terminal Avenue	Newport News
GFM-06	Claremont Avenue (HRSD PS #208)	Hampton
GFM-12	Willard Avenue (HRSD PS #225)	Hampton
GFM-28	Norchester Street (HRSD PS #116)	Norfolk

2.2 Pressure Monitoring

Pressure sensors will be located at various sites in HRSD's SS System and have been chosen to characterize the pressures within the force main system. Pressure sensors will be placed near the furthest upstream terminus of HRSD's pressure system. Additional sensors are placed to monitor pressures at intermediate locations where the Locality flows enter into the system and to characterize pressures in other areas of the force main system. These general locations were selected by HRSD to provide sufficient input for Model development and calibration.

Pressure will be monitored at the discharge side of HRSD wastewater pump stations that discharge to pressurized systems and that are sufficiently distant from PRSs and STPs to warrant installation. This data will be used to characterize the operation of these stations and to measure the pressures in the force main system.

Pressure will be monitored at the suction and discharge side of active HRSD pressure reducing stations. These data will be used to characterize the operation of the pressure reducing stations and to measure the pressures in the force main system.

Figures 1 through 48 in this revised FPR Monitoring Plan provide greater detail about the current and proposed pressure monitoring locations. Table 3 summarizes the monitor characteristics and site justifications.

The pressure data, combined with information on the pressure sensor elevations, provide a detailed description of the hydraulic grade line elevation throughout the HRSD SS System. The identified pressure monitoring network configuration will achieve the following primary goals:

- Define pressure conditions that are occurring throughout the system.
- Define pressures at HRSD wastewater pump stations. Pressure sensors are located at HRSD wastewater pump stations that discharge to pressurized systems and that are sufficiently distant from PRSs and STPs to warrant installation, as well as PRSs to define the pressures at these critical locations.
- Define pressures proximate to the discharge from Locality terminal wastewater pumping stations, including those that may be associated with Locality Overflow Points. Pressure sensors are located sufficiently close to define the pressures at many Locality terminal pump stations. At other pump stations, hydraulic grade line elevations at upstream sensors will be used to define an estimate of pressures. The Regional Hydraulic Model results will be used to interpolate hydraulic grade line elevations between pressure sensors where more refined estimates are required.
- Calibrate and validate the Regional Hydraulic Model verifying that it is a sufficiently accurate representation of the modeled portions of the Regional SS System to support the model objectives and capabilities documented in the Model Plan.

Table 3. Pressure Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-001-1	Existing	TBD	TBD	Ashley	End of Line		CHES	SS-D-6
MMPS-002-1	Existing	TBD	TBD	Bainbridge	Intermediate		CHES	SS-C-6
MMPS-004-1	Existing	Druck	PTX530	John B.Dey MLV-AT side	End of Line	Yes	VBCH	SS-B-7
MMPS-005-1	Planned	Druck	RTX1930	Beltline Railroad	Intermediate		CHES	SS-C-6
MMPS-006-1	Planned	Druck	RTX1930	Near State Street PS	Intermediate		NORF	SS-B-6
MMPS-007-1	Existing	TBD	TBD	Courthouse	End of Line	Yes	VBCH	SS-C-7
MMPS-008-1	Existing	TBD	TBD	49th. Street	End of Line	Yes	VBCH	SS-B-8
MMPS-011-1	Planned	Foxboro	IDP-10	HRSD Copeland Park PS	Intermediate		NNEW	NS-E-6
MMPS-013-1	Existing	Druck	RTX1930	16th./Walnut	Intermediate		NNEW	NS-E-6
MMPS-016-1	Planned	Druck	RTX1930	Poquoson (NASA)	Intermediate		HAMP	NS-D-6
MMPS-017-1	Existing	Druck	RTX1930	Smithfield PSI	End of Line	Yes	SFLD	SS-A-3
MMPS-020-1	Existing	Druck	RTX1930	North Ave	Intermediate		NNEW	NS-E-5
MMPS-022-1	Existing	KPSI	730	Lightfoot	End of Line		JCSA	NS-A-3
MMPS-024-1	Planned	Foxboro	IDP-10	HRSD Kingsmill PS	PS SA Monitor		JCSA	NS-B-4
MMPS-025-1	Planned	Foxboro	IDP-10	HRSD Fort Eustis PS	Intermediate	Yes	NNEW	NS-C-4
MMPS-026-1	Existing	TBD	TBD	HRSD Colonial Williamsburg PS	Intermediate	Yes	WILL	NS-B-3
MMPS-033-1	Existing	Foxboro	IDP-10	HRSD Norchester Street PS	PS SA Monitor		NORF	SS-B-6
MMPS-034-1	Existing	Foxboro	IGP-10	HRSD Quail PRS	Intermediate	Yes	NORF	SS-C-6
MMPS-034-2	Existing	Foxboro	IGP-10	HRSD Quail PRS	Intermediate	Yes	NORF	SS-C-6
MMPS-036-1	Existing	Foxboro	IDP-10	Northampton Blvd.	Intermediate		VBCH	SS-B-6
MMPS-037-1	Existing	Foxboro	IDP-10	Boundary-Shore Drive	Intermediate	Yes	VBCH	SS-B-6
MMPS-038-1	Existing	Foxboro	IDP-10	Curlew Drive	Intermediate		VBCH	SS-B-6
MMPS-039-1	Existing	Foxboro	IDP-10	Bancker Rd	Intermediate	Yes	NORF	SS-B-6
MMPS-042-1	Existing	Foxboro	IDP-10	Bluestone at 25th.	Intermediate	Yes	NORF	SS-B-5
MMPS-043-1	Existing	Foxboro	IDP-10	HRSD Chesapeake Blvd. PS	PS SA Monitor	Yes	NORF	SS-B-6
MMPS-050-1	Existing	Foxboro	IDP-10	Berkley Ave	Intermediate		CHES	SS-C-6
MMPS-069-1	Planned	Druck	RTX1930	Achilles	End of Line	Yes	GLOU	NS-B-5
MMPS-070-1	Planned	Druck	RTX1930	Army Base 36” FM (ABTP)	Intermediate		NORF	SS-B-5
MMPS-072-1	Planned	Druck	RTX1930	Barhamsville	End of Line	Yes	JCSA	NS-A-2
MMPS-077-1	Planned	Druck	RTX1930	Boundary WILL/YORK	Intermediate		WILL	NS-B-3
MMPS-081-1	Planned	Druck	RTX1930	Boundary-JCSA/WILL	Intermediate	Yes	JCSA	NS-B-3
MMPS-082-1	Planned	Druck	RTX1930	Boundary-JCSA/WILL	Intermediate		JCSA	NS-B-3
MMPS-085-1	Planned	Druck	RTX1930	Boundary-YORK/GLOU	Intermediate	Yes	GLOU	NS-B-5
MMPS-087-1	Planned	Druck	RTX1930	Bridge Road	Intermediate	Yes	SUFF	SS-B-4
MMPS-088-1	Planned	Druck	RTX1930	Callison/GB LOCKS	Intermediate	Yes	CHES	SS-D-6
MMPS-091-1	Planned	Druck	RTX1930	Carolina Road	End of Line		SUFF	SS-D-3
MMPS-092-1	Existing	Foxboro	IDP-10	Carolina Road PCV/2nd Ave	Intermediate	Yes	SUFF	SS-D-3
MMPS-099-1	Planned	Druck	RTX1930	Dupont MLV-East side	End of Line	Yes	CHES	SS-D-6
MMPS-105-1	Planned	Druck	RTX1930	George Washington Highway	End of Line		CHES	SS-C-5
MMPS-106-1	Planned	Druck	RTX1930	Gloucester CH	End of Line	Yes	GLOU	NS-A-5
MMPS-108-1	Planned	Druck	RTX1930	Hickory	End of Line	Yes	CHES	SS-D-6

Table 3. Pressure Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-109-1	Planned	Druck	RTX1930	Holland Road	End of Line	Yes	SUFF	SS-D-3
MMPS-110-1	Planned	Foxboro	IDP-10	HRSD 25th Street PS	PS SA Monitor		NNEW	NS-E-5
MMPS-111-1	Planned	Foxboro	IDP-10	HRSD 33rd Street PS	PS SA Monitor		NNEW	NS-E-5
MMPS-112-1	Planned	Foxboro	IDP-10	HRSD Arctic Avenue PS	PS SA Monitor		VBCH	SS-B-8
MMPS-114-1	Existing	Foxboro	861	HRSD Atlantic PRS	PS SA Monitor	Yes	VBCH	SS-C-8
MMPS-114-2	Existing	Foxboro	841	HRSD Atlantic PRS	PS SA Monitor	Yes	VBCH	SS-C-8
MMPS-115-1	Planned	Foxboro	IDP-10	HRSD Bainbridge Blvd. PS	PS SA Monitor		NORF	SS-C-6
MMPS-116-1	Planned	Foxboro	IDP-10	HRSD Bay Shore Lane PS	PS SA Monitor	Yes	HAMP	NS-E-7
MMPS-117-1	Existing	Foxboro	IGP-10	HRSD Big Bethel PRS	PS SA Monitor	Yes	HAMP	NS-D-5
MMPS-117-2	Existing	Foxboro	861	HRSD Big Bethel PRS	PS SA Monitor	Yes	HAMP	NS-D-5
MMPS-118-1	Planned	Foxboro	IDP-10	HRSD Bloxoms Corner PS	PS SA Monitor	Yes	HAMP	NS-D-6
MMPS-119-1	Existing	Foxboro	IGP-10	HRSD Bowers Hill PRS	PS SA Monitor	Yes	CHES	SS-C-5
MMPS-119-2	Existing	Foxboro	IGP-10	HRSD Bowers Hill PRS	PS SA Monitor	Yes	CHES	SS-C-5
MMPS-120-1	Planned	Foxboro	IDP-10	HRSD Bridge Street PS	PS SA Monitor		HAMP	NS-E-6
MMPS-121-1	Planned	Foxboro	IDP-10	HRSD Camden Ave PS	PS SA Monitor	Yes	PORT	SS-C-5
MMPS-122-1	Planned	Foxboro	IDP-10	HRSD Cedar Lane PS	PS SA Monitor	Yes	PORT	SS-B-5
MMPS-123-1	Planned	Foxboro	IDP-10	HRSD Center Avenue PS	PS SA Monitor		NNEW	NS-E-5
MMPS-125-1	Planned	Foxboro	IDP-10	HRSD City Park PS	PS SA Monitor		NORF	SS-B-6
MMPS-126-1	Planned	Foxboro	IDP-10	HRSD Claremont PS	PS SA Monitor		HAMP	NS-E-6
MMPS-127-1	Planned	Foxboro	IDP-10	HRSD Colley Avenue PS	PS SA Monitor		NORF	SS-B-5
MMPS-128-1	Existing	Foxboro	IGP-10	HRSD Deep Creek PRS	PS SA Monitor	Yes	CHES	SS-C-5
MMPS-128-2	Existing	Foxboro	IGP-10	HRSD Deep Creek PRS	PS SA Monitor	Yes	CHES	SS-C-5
MMPS-129-1	Planned	Foxboro	IDP-10	HRSD Dovercourt Road PS	PS SA Monitor	Yes	NORF	SS-B-6
MMPS-131-1	Planned	Foxboro	IDP-10	HRSD Elmhurst Lane PS	PS SA Monitor	Yes	PORT	SS-C-5
MMPS-134-1	Existing	TBD	TBD	HRSD Fords Colony PS	PS SA Monitor	Yes	JCSA	NS-B-3
MMPS-135-1	Planned	Druck	RTX1930	HRSD Granby Street PS	PS SA Monitor		NORF	SS-B-6
MMPS-136-1	Existing	TBD	TBD	HRSD Greensprings PS	PS SA Monitor	Yes	JCSA	NS-B-3
MMPS-137-1	Planned	Foxboro	IDP-10	HRSD Hampton Institute PS	PS SA Monitor		HAMP	NS-E-6
MMPS-138-1	Planned	Foxboro	IDP-10	HRSD Hanover Avenue PS	PS SA Monitor		NORF	SS-B-5
MMPS-140-1	Existing	Foxboro	IGP-10	HRSD Independence PRS	PS SA Monitor	Yes	VBCH	SS-B-7
MMPS-140-2	Existing	Foxboro	IGP-10	HRSD Independence PRS	PS SA Monitor	Yes	VBCH	SS-B-7
MMPS-141-1	Planned	Druck	RTX1930	HRSD Ingleside Road PS	PS SA Monitor		NORF	SS-B-6
MMPS-142-1	Planned	Druck	RTX1930	HRSD Jamestown Crescent PS	PS SA Monitor		NORF	SS-B-5
MMPS-144-1	Existing	Foxboro	IGP-10	HRSD Kempsville PRS	PS SA Monitor	Yes	VBCH	SS-C-7
MMPS-144-2	Existing	Foxboro	IGP-10	HRSD Kempsville PRS	PS SA Monitor	Yes	VBCH	SS-C-7
MMPS-145-1	Planned	Foxboro	IDP-10	HRSD Langley Circle PS	PS SA Monitor		HAMP	NS-E-6
MMPS-146-1	Existing	Foxboro	IGP-10	HRSD Laskin PRS	PS SA Monitor	Yes	VBCH	SS-B-8
MMPS-146-2	Existing	Foxboro	IGP-10	HRSD Laskin PRS	PS SA Monitor	Yes	VBCH	SS-B-8
MMPS-148-1	Planned	Foxboro	IDP-10	HRSD Lucas Creek PS	PS SA Monitor	Yes	NNEW	NS-D-5
MMPS-149-1	Planned	Foxboro	IDP-10	HRSD Luxembourg Avenue PS	PS SA Monitor		NORF	SS-B-6
MMPS-150-1	Planned	Foxboro	IDP-10	HRSD Monroe Place PS	PS SA Monitor		NORF	SS-B-5

Table 3. Pressure Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-151-1	Planned	Foxboro	IDP-10	HRSD Morrison PS	PS SA Monitor		NNEW	NS-D-5
MMPS-152-1	Planned	Foxboro	IDP-10	HRSD Newmarket Creek PS	PS SA Monitor		NNEW	NS-E-5
MMPS-153-1	Planned	Foxboro	IDP-10	HRSD Newtown Road PS	PS SA Monitor	Yes	VBCH	SS-B-6
MMPS-154-1	Planned	Foxboro	IDP-10	HRSD Normandy Lane PS	PS SA Monitor	Yes	NNEW	NS-D-5
MMPS-155-1	Planned	Foxboro	IDP-10	HRSD North Shore Road PS	PS SA Monitor	Yes	NORF	SS-B-5
MMPS-156-1	Planned	Foxboro	IDP-10	HRSD Norview Avenue PS	PS SA Monitor		NORF	SS-B-6
MMPS-157-1	Planned	Foxboro	IDP-10	HRSD Park Avenue PS	PS SA Monitor		CHES	SS-C-6
MMPS-158-1	Planned	Foxboro	IDP-10	HRSD Patrick Henry PS	PS SA Monitor		NNEW	NS-D-5
MMPS-160-1	Existing	Foxboro	IGP-10	HRSD Pine Tree PRS	PS SA Monitor	Yes	VBCH	SS-B-7
MMPS-160-2	Existing	Foxboro	IGP-10	HRSD Pine Tree PRS	PS SA Monitor	Yes	VBCH	SS-B-7
MMPS-161-1	Planned	Foxboro	IDP-10	HRSD Plume Street PS	PS SA Monitor	Yes	NORF	SS-B-6
MMPS-162-1	Planned	Foxboro	IDP-10	HRSD Powhatan Avenue PS	PS SA Monitor		NORF	SS-B-5
MMPS-163-1	Existing	Foxboro	IGP-10	HRSD Providence PRS	PS SA Monitor	Yes	VBCH	SS-C-6
MMPS-163-2	Existing	Foxboro	IGP-10	HRSD Providence PRS	PS SA Monitor	Yes	VBCH	SS-C-6
MMPS-164-1	Existing	Foxboro	IGP-10	HRSD Pughsville PRS	PS SA Monitor	Yes	SUFF	SS-B-4
MMPS-164-2	Existing	Foxboro	IGP-10	HRSD Pughsville PRS	PS SA Monitor	Yes	SUFF	SS-B-4
MMPS-167-1	Planned	Foxboro	IDP-10	HRSD Rodman Avenue PS	PS SA Monitor	Yes	PORT	SS-C-5
MMPS-168-1	Planned	Foxboro	IDP-10	HRSD Rolling Hills PS	PS SA Monitor	Yes	WMBG	NS-B-4
MMPS-169-1	Existing	Foxboro	IDP-10	HRSD Route 337 PRS	PS SA Monitor	Yes	CHES	SS-C-4
MMPS-169-2	Existing	Foxboro	IDP-10	HRSD Route 337 PRS	PS SA Monitor	Yes	CHES	SS-C-4
MMPS-170-1	Planned	Foxboro	IDP-10	HRSD Seay Avenue PS	PS SA Monitor		NORF	SS-B-6
MMPS-171-1	Existing	Foxboro	IGP-10	HRSD Shipps Corner PRS	PS SA Monitor	Yes	VBCH	SS-C-7
MMPS-171-2	Existing	Foxboro	841	HRSD Shipps Corner PRS	PS SA Monitor	Yes	VBCH	SS-C-7
MMPS-172-1	Planned	Foxboro	IDP-10	HRSD State Street PS	PS SA Monitor		NORF	SS-B-6
MMPS-173-1	Planned	Foxboro	IDP-10	HRSD Steamboat Creek PS	PS SA Monitor		NORF	SS-B-6
MMPS-174-1	Planned	Foxboro	IDP-10	HRSD Suffolk PS	PS SA Monitor		SUFF	SS-D-3
MMPS-175-1	Planned	Foxboro	IDP-10	HRSD Taussig Blvd. PS	Intermediate		NORF	SS-A-5
MMPS-176-1	Existing	Foxboro	IGP-10	HRSD Terminal PRS	PS SA Monitor		NORF	SS-B-6
MMPS-176-2	Existing	Foxboro	IGP-10	HRSD Terminal PRS	PS SA Monitor		NORF	SS-B-6
MMPS-177-1	Planned	Foxboro	IDP-10	HRSD Va. Beach Blvd. PS	PS SA Monitor	Yes	NORF	SS-B-6
MMPS-178-1	Planned	Foxboro	IDP-10	HRSD Washington District PS	PS SA Monitor		NORF	SS-C-6
MMPS-179-1	Planned	Foxboro	IDP-10	HRSD Washington Street PS	PS SA Monitor		HAMP	NS-E-6
MMPS-180-1	Planned	Foxboro	IDP-10	HRSD Willard Avenue PS	PS SA Monitor		HAMP	NS-E-6
MMPS-181-1	Planned	Foxboro	IDP-10	HRSD Williamsburg PS	PS SA Monitor		WMBG	NS-B-3
MMPS-182-1	Planned	Foxboro	IDP-10	HRSD Willoughby Avenue PS	PS SA Monitor		NORF	SS-B-6
MMPS-183-1	Planned	Foxboro	IDP-10	HRSD Woodland Road PS	PS SA Monitor		HAMP	NS-D-6
MMPS-190-1	Planned	Foxboro	IDP-10	Poquoson PS 6	End of Line	Yes	PQSN	NS-D-6
MMPS-194-1	Planned	Druck	RTX1930	Little Neck	End of Line		VBCH	SS-B-7
MMPS-197-1	Planned	Druck	RTX1930	Near Suffolk PS	Intermediate	Yes	SUFF	SS-D-3
MMPS-198-1	Planned	Druck	RTX1930	Newtown Road IFM	Intermediate		VBCH	SS-B-6
MMPS-203-1	Planned	Druck	RTX1930	Oak Grove MLV-West side	End of Line		CHES	SS-D-6

Table 3. Pressure Monitors

ID	Status	Manufacturer	Model	Location	Justification	Calibration Site	Jurisdiction	Map Location
MMPS-204-1	Existing	TBD	TBD	Ordinary PCV	Intermediate		GLOU	NS-B-5
MMPS-209-1	Existing	TBD	TBD	Route 199 PCV	Intermediate	Yes	JCSA	NS-B-3
MMPS-210-1	Planned	Druck	RTX1930	Rte 17 West of Town Pt Rd	Intermediate	Yes	SUFF	SS-B-4
MMPS-211-1	Planned	Druck	RTX1930	RTE 17/Cedar Road	Intermediate		CHES	SS-D-6
MMPS-213-1	Planned	Druck	RTX1930	Shell Road	Intermediate		CHES	SS-C-5
MMPS-214-1	Planned	Druck	RTX1930	Shore Drive/Gator	Intermediate	Yes	VBCH	SS-B-7
MMPS-215-1	Planned	Druck	RTX1930	Shore Drive/Joslin	Intermediate	Yes	VBCH	SS-B-7
MMPS-217-1	Planned	Druck	RTX1930	South of Goodwin Neck and Wolf Trap	Intermediate	Yes	YORK	NS-C-5
MMPS-223-1	Existing	TBD	TBD	WBTP PCV	Intermediate	Yes	JCSA	NS-C-4
MMPS-230-1	Planned	Druck	RTX1930	Windsor	End of Line	Yes	WIND	SS-C-2
MMPS-231-1	Existing	TBD	TBD	Windsor PCV	Intermediate	Yes	SUFF	SS-C-3
MMPS-234-1	Existing	TBD	TBD	Wolf Trap PCV	Intermediate	Yes	YORK	NS-C-5
MMPS-237-1	Existing	Druck	RTX1930	Littles Supermarket	Intermediate		SFLD	SS-A-3
						TOTAL NUMBER OF PRESSURE MONITORING SITES		**122**

2.3 Rainfall Monitoring

2.3.1 Rain Gauges

HRSD's existing 20-rainfall-gauge network will be expanded to adequately evaluate wet-weather flows and to provide input to the development of the Regional Hydraulic Model. The network for the FPR Monitoring Plan includes 64 HRSD rainfall gauges: 24 on the North Shore and 40 on the South Shore.

The existing and planned rainfall gauges are shown on Figures 50 and 51 of Appendix D and listed in Table 4. Field visits at each of the sites prior to installation will confirm proper conditions exist for accurate rainfall measurements. The majority of rainfall gauge sites are at HRSD pump stations or PRSs; however, to provide adequate coverage, some gauges have been proposed at Locality facilities where no HRSD facility exists in the vicinity. Each gauge will be capable of recording rainfall in 0.1-inch intervals or less.

The following site types were considered as potential rainfall gauge locations to supplement the existing rainfall gauges:

- HRSD flow and pressure monitoring stations. The use of these sites will lessen the installation and maintenance costs of the rainfall gauges by reducing the need for additional recording and telemetry equipment. Maintenance can be performed on all installed equipment in a single visit, thereby potentially reducing maintenance costs.
- Other HRSD infrastructure, such as maintenance yards, offices, etc. It is likely that these sites have electrical power available, which may ease the installation of recording and telemetry equipment. These sites may also offer a higher level of security.
- HRSD wastewater treatment plants. These sites have electrical power available, which may ease recording and telemetry equipment. These sites may also offer a higher level of security.
- Locality wastewater infrastructure sites, including pump stations, maintenance yards, offices, etc. These sites have electrical power available, which may ease the installation of recording and telemetry equipment. These sites may also offer a higher level of security.

Locations have been selected to minimize the exposure of the precipitation gauges to wind turbulence and eddy currents caused by structures and trees near the gauge that tend to carry away the precipitation.

Each planned rainfall gauge will be located at the proper distance from trees, buildings, and other features that would inhibit accurate rainfall measurements. Generally, in sheltered areas where the height of the objects and their distance to the instrument is uniform, the obstacle height will not exceed twice the distance from the instrument. In open areas, the distance to obstructions will be at least two, and preferably four, times the height of the obstruction. The gauge will also be located a sufficient distance from overhanging obstacles that could either block precipitation from reaching the gauge or cause precipitation to splash toward it. It may be difficult to achieve these distances and the best compromise is to stay as far away as possible from such objects and have the objects no closer than half their height.

The rain gauges will be mounted on a vibration-free surface in a relatively level spot representative of the surrounding area. The ground surface around the rain gauge will generally be natural vegetation (preferably short grass) or gravel with no paving. Gauges will not be mounted where sprinklers or other sources of artificial precipitation can affect the data. Rain gauges will also be sited relatively close to the ground, but not so close that precipitation falling next to the rain detector splashes into it.

It is possible that some of the planned locations may not meet all suitability requirements. Therefore, the rainfall gauge locations presented herein may be modified as site visits are made and the rainfall gauges are deployed. If re-siting a planned gauge is necessary, the new location will be selected to yield coverage similar to the network identified in this plan.

The proposed rainfall monitoring provides sufficient rain gauge coverage to meet the calibration requirements of the radar rainfall data without additional rainfall gauges. The rainfall data will be of uniform quality and located in a central database managed by HRSD. However, additional rainfall data sources within the service area, including monitoring performed by the Localities, NOAA, private organizations, citizens, and other state, local, and federal agencies, may be utilized, as appropriate, to supplement the rainfall gauge coverage.

2.3.2 Weather Radar

In addition to the rainfall monitoring using a network of physical rain gauges, rainfall will also be characterized over the HRSD service area utilizing radar imagery calibrated with data obtained from the physical rainfall gauges. This technology—gauge-adjusted radar rainfall—will be used for wet-weather flow analyses and for input to the Regional Hydraulic Model.

Radar rainfall data will be calibrated with the rainfall gauge data to provide accurate and spatially detailed rainfall data throughout the HRSD service area to serve two primary purposes:

- Provide a "virtual" rain gauge network with a density of 1-square-kilometer for model calibration and verification and for analyzing wastewater flows.
- Provide a means to interpolate rainfall among the installed rainfall gauges to improve the accuracy of the rainfall estimates across the HRSD service area.

Radar rainfall data will be developed for a selected number of storm events for model calibration and verification using radar imagery. A vendor that specializes in processing radar data and calibrating and verifying the data using rainfall gauge data will perform this work. HRSD will notify the EPA and VDEQ when a radar rainfall vendor has been selected.

2.4 Calibration Sites

Although all of the data gathered in the FPR Monitoring Program will be considered in development of the Model, HRSD has identified a sub-set of sites that are likely to be used for calibration and verification. This set includes 79 sites to monitor flow and/or pressure which will be prioritized in the installation process ahead of the sites not necessary for Model calibration and verification. Tables 2, 2.1, and 3 in this section identify the sites that have been preliminarily identified as Calibration Sites; however, HRSD may add or remove sites from this list during FPR Monitoring Plan implementation or model calibration as field or other conditions warrant adjustment.

Table 4. Rainfall Gauges

ID	Status	Location	Jurisdiction	Shore	Site Type	MMP Site
RG-01	Existing	Gloucester, old treatment plant site	Gloucester County	North	Rain Gauge	
RG-02	Planned	Ordinary PCV, along Route 17 near Providence intersection	Gloucester County	North	Pressure Monitor	MMPS-204
RG-03	Planned	Achilles, on Maryus Rd west of Guinea Circle	Gloucester County	North	Pressure Monitor	MMPS-069
RG-04	Existing	Toano, on Rochambeau Drive near Sand Hill Road	James City County	North	Rain Gauge	
RG-05	Planned	Fords Colony PS	James City County	North	HRSD Pump Station	MMPS-134
RG-06	Planned	Greensprings PS	James City County	North	HRSD Pump Station	MMPS-136
RG-07	Planned	Williamsburg STP	James City County	North	HRSD Treatment Plant	
RG-08	Existing	Williamsburg PS	Williamsburg	North	HRSD Pump Station	MMPS-181
RG-09	Planned	York River crossing Route 17 George Washington Memorial Bridge	York County	North	Intermediate Site	MMPS-085
RG-10	Planned	York County Skimino Hills PS (York County at I-64 and Route 199)	York County	North	Locality Pump Station	
RG-11	Planned	Wolf Trap PCV (near Wolf Trap Road and Hornsbyville)	York County	North	Pressure Monitor	MMPS-234
RG-12	Planned	York County PS 15 (off Woodland Drive near Lindsay Landing)	York County	North	Locality Pump Station	
RG-13	Planned	York County Kiln Creek 1 PSA (off Kiln Creek near Lexington)	York County	North	Locality Pump Station	
RG-14	Planned	Poquoson PS 6 (off Little Florida Road near Robert Bruce Road)	Poquoson	North	Locality Pump Station	
RG-15	Planned	Lee Hall PS	Newport News	North	HRSD Pump Station	MMPS-147
RG-16	Planned	Fort Eustis PS	Newport News	North	HRSD Pump Station	MMPS-025
RG-17	Existing	Lucas Creek PS	Newport News	North	HRSD Pump Station	MMPS-148
RG-18	Planned	James River STP	Newport News	North	HRSD Treatment Plant	
RG-19	Existing	Morrison PS	Newport News	North	HRSD Pump Station	MMPS-151
RG-20	Planned	Copeland Park PS	Newport News	North	HRSD Pump Station	MMPS-011
RG-21	Existing	Big Bethel PRS	Hampton	North	HRSD PRS	MMPS-117
RG-22	Planned	Hampton PS 151 (30 Village Drive)	Hampton	North	Locality Pump Station	
RG-23	Existing	Bay Shore Lane PS	Hampton	North	HRSD Pump Station	MMPS-116
RG-24	Existing	Hampton Pine Chapel PS	Hampton	North	Locality Pump Station	
RG-25	Existing	Littles Supermarket (near Courthouse and Route 258)	Isle of Wight	South	Rain Gauge	MMPS-237
RG-27	Planned	Windsor (off Windsor Blvd at MMP site)	Isle of Wight	South	Pressure Monitor	MMPS-230
RG-28	Planned	Smithfield High School	Smithfield	South	Intermediate Site	MMPS-014
RG-29	Planned	Boundary-Crittenden off Route 17 (at HRSD rectifier site)	Suffolk	South	Rain Gauge	
RG-30	Planned	Nansemond STP	Suffolk	South	HRSD Treatment Plant	
RG-31	Existing	Pughsville PRS	Suffolk	South	HRSD PRS	MMPS-164
RG-32	Planned	Suffolk PS 87 (224 Bridgewater Court)	Suffolk	South	Locality Pump Station	
RG-34	Planned	Windsor PCV (on Kings Fork west of Route 10)	Suffolk	South	Pressure Monitor	MMPS-231

Table 4. Rainfall Gauges

ID	Status	Location	Jurisdiction	Shore	Site Type	MMP Site
RG-35	Existing	Suffolk PS	Suffolk	South	HRSD Pump Station	MMPS-174
RG-36	Planned	Holland Road (planned MMP site near Route 13 and Route 58)	Suffolk	South	Pressure Monitor	MMPS-109
RG-37	Planned	Suffolk PS 81 (1601 Meadow Country Rd)	Suffolk	South	Locality Pump Station	
RG-38	Planned	Cedar Lane PS	Portsmouth	South	HRSD Pump Station	MMPS-122
RG-39	Existing	Rodman Avenue PS	Portsmouth	South	HRSD Pump Station	MMPS-167
RG-40	Planned	Taussig Blvd PS	Norfolk	South	HRSD Pump Station	MMPS-175
RG-41	Existing	Dovercourt Road PS	Norfolk	South	HRSD Pump Station	MMPS-129
RG-42	Existing	Luxembourg Avenue PS	Norfolk	South	HRSD Pump Station	MMPS-149
RG-43	Existing	Virginia Beach Blvd PS	Norfolk	South	HRSD Pump Station	MMPS-177
RG-44	Planned	State Street PS	Norfolk	South	HRSD Pump Station	MMPS-172
RG-45	Planned	Route 337 PRS	Chesapeake	South	HRSD PRS	MMPS-169
RG-46	Planned	Ferebee Avenue PS	Chesapeake	South	HRSD Pump Station	MMPS-132
RG-47	Planned	Chesapeake PS 158 (east of Hampton Roads Airport)	Chesapeake	South	Locality Pump Station	
RG-48	Planned	Bowers Hill PRS	Chesapeake	South	HRSD PRS	MMPS-137
RG-49	Existing	Deep Creek PRS	Chesapeake	South	HRSD PRS	MMPS-128
RG-50	Planned	Dozier's Corner PS	Chesapeake	South	HRSD Pump Station	MMPS-130
RG-51	Planned	Route 17/Cedar Road	Chesapeake	South	Pressure Monitor	MMPS-211
RG-52	Existing	Callison Drive, GB Locks	Chesapeake	South	Intermediate Site	MMPS-088
RG-53	Planned	Chesapeake PS 189 (on Mount Pleasant and Centerville Tpke)	Chesapeake	South	Locality Pump Station	
RG-54	Planned	Chesapeake PS 254 (near Battlefield Blvd and Hillcrest Rd)	Chesapeake	South	Locality Pump Station	
RG-55	Planned	Shore Drive/Gator (west of Independence Blvd)	Virginia Beach	South	Intermediate Site	MMPS-214
RG-56	Planned	John B.Dey MLV-AT side (Route 279 near Addington)	Virginia Beach	South	Pressure Monitor	MMPS-004
RG-57	Planned	Northampton Blvd. east of I-64 at Wesleyan	Virginia Beach	South	Intermediate Site	MMPS-036
RG-58	Planned	Laskin PRS	Virginia Beach	South	HRSD PRS	MMPS-146
RG-59	Existing	Pine Tree PRS	Virginia Beach	South	HRSD PRS	MMPS-160
RG-60	Planned	Independence PRS	Virginia Beach	South	HRSD PRS	MMPS-140
RG-61	Existing	Providence Rd PRS	Virginia Beach	South	HRSD PRS	MMPS-163
RG-62	Planned	Kempsville PRS	Virginia Beach	South	HRSD PRS	MMPS-144
RG-63	Existing	Shipps Corner PRS	Virginia Beach	South	HRSD PRS	MMPS-171
RG-64	Planned	Virginia Beach PS 602 (on Hubbell west of General Booth)	Virginia Beach	South	Locality Pump Station	
RG-65	Planned	Virginia Beach PS 472 (Kempsville Rd near Kempsville Crossing Rd)	Virginia Beach	South	Locality Pump Station	
RG-66	Planned	Elbow Road just west of Indian River	Virginia Beach	South	Intermediate Site	MMPS-009

3. DATA MANAGEMENT

3.1 Data Transfer

Data will be collected from the FPR Monitoring Program sites through HRSD's SCADA or Telog communications units. The Telog data loggers store information for a short time until they are transmitted via cellular 1x digital network back to the HRSD's Telog server, where the information is available for viewing and analysis. The planned sites in this FPR Monitoring Program will include Telog units either with the new installation or added to an existing facility. The SCADA system utilizes a separate network for collecting and transfer of data to HRSD's data storage facility. Full data transfer occurs typically each hour or more frequently depending on the site.

Gravity flow monitors will be manually downloaded from local data loggers on a weekly basis. This data is manually transferred from the field to the HRSD data storage facility.

3.2 Data Review

HRSD is developing data screening tools to identify potential problems or deficiencies with the data collected from the FPR Monitoring Plan sites. These tools will be automated and the output will be reviewed by HRSD periodically.

HRSD will perform two levels of review as detailed in Figure 49. One level of review is checking the equipment and data for correctness and completeness. The other level of technical review is conducted for the portion of the service area where the data was collected. These reviews will include the following:

- Adherence to manufacturer details—precision, calibration drifts, etc.
- Calibration data are appropriate and complete.
- Data are ready for incorporation in final report.
- Data package is complete and ready for archive.

3.3 Database Storage

HRSD utilizes both their Telog server and an EDS system developed by Emerson for data storage. All data are stored with a time and date stamp and a unique identifier for the device. Data can then be retrieved, displayed, graphed, used to perform calculations, and used in report generation. The EDS data are archived and backed up every month, while the Telog data are backed up daily and archived weekly.

3.4 Data Verification

As data is received, it is verified using a Data Verification Standard Operating Procedure (SOP). This SOP is shown on Figure 49.

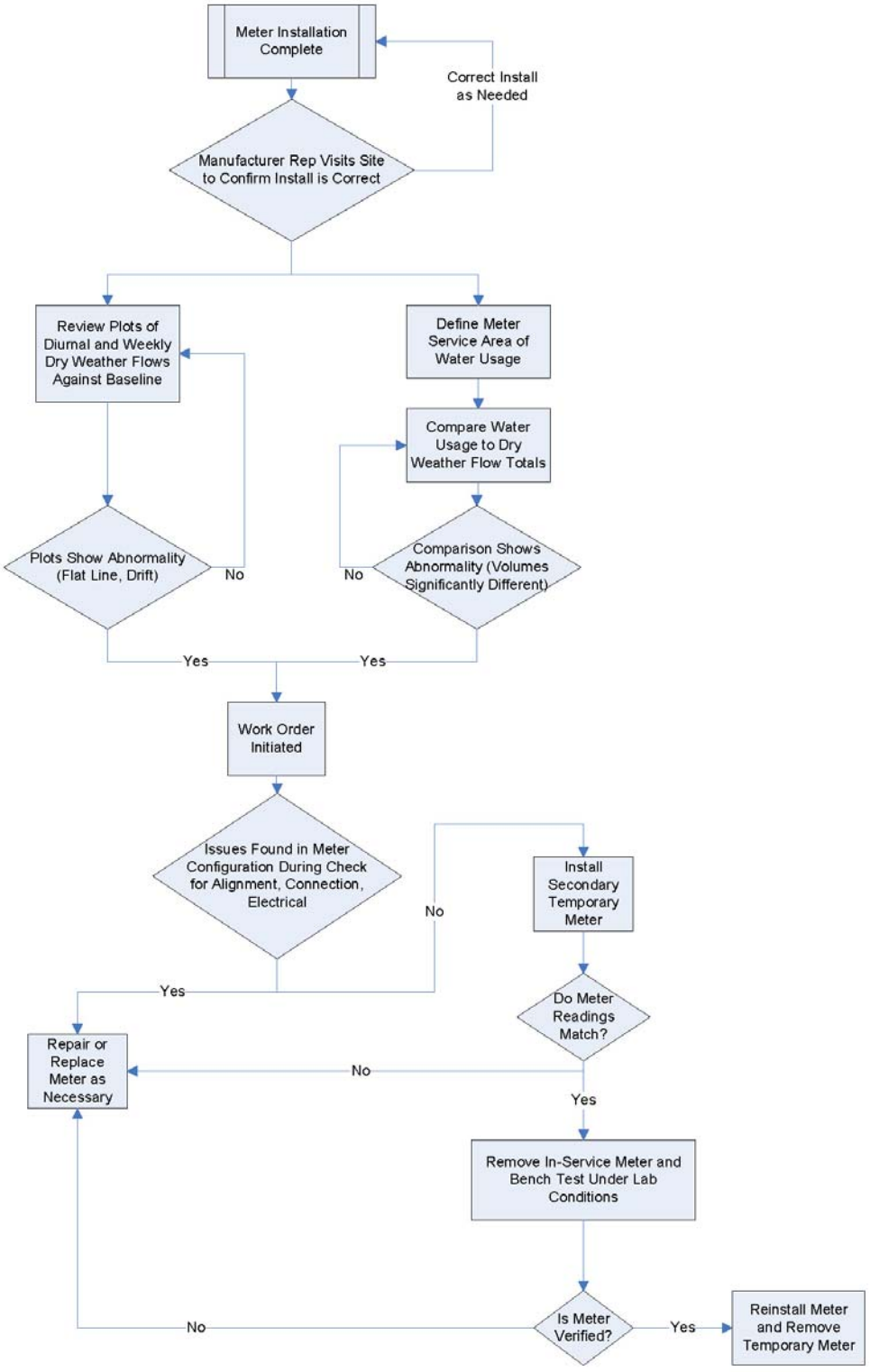

Figure 49. Data Verification SOP

3.5 Data Reporting

Data collected at each monitoring station will undergo a quality review. After the data has been approved for use, HRSD will prepare and submit to EPA an Interim Report six months after initiating the monitoring period, which summarizes the first 5 months of data collection. A final report that summarizes the 12-month monitoring period will be prepared and submitted to EPA at the conclusion of the program.

The Interim and Final Data Reports will contain the following for each monitoring point:

- Summaries of the data collected;
- Descriptions of all substantive deviations from the approved Plan, including any changed, deleted, or additional monitoring locations;
- Summaries of monitoring equipment operational status history (in-service, out-of-service, and any operational/accuracy issues) during the monitoring period;
- Summaries of the results of Data Quality Assurance/Quality Control reviews including identification and characterization of data for which quality issues were identified; and
- Adequacy of collected data to satisfy the requirements of the Plan.

If the collected data are not adequate to satisfy the requirements of the Plan, then HSRD will include the following in the Interim and Final Reports:

- A plan and schedule for additional proposed monitoring that will meet the requirements.
- A description of the impact the additional monitoring will have on the overall schedule.

4. MONITORING EQUIPMENT

Table 5 summarizes all the monitors being used by HRSD in the FPR Monitoring Program, listed by manufacturer. Some monitors exist at IWD sites that are owned by the private or government discharger, which are not included in Table 5.

The FPR Monitoring Plan has standard off-the-shelf equipment planned for implementation. The equipment being used and planned for the flow, pressure, and rainfall monitoring sites are described below. In addition, a brief description of the telemetry environment is also described.

4.1 Flow Monitoring Equipment

To adequately measure flow in HSRD's force main/gravity interceptor system, a variety of monitor types are used. Currently, there are seven types of flow monitors either used or planned for HRSD's monitoring system.

4.1.1 Fuji Electric Systems Co., Ltd.

- FLV—Clamp-on Transit Time Ultrasonic flow meter (Reference: Fuji Electric Ultrasonic Flow Meter Type: FLV, FLW, FLD Instruction Manual).

4.1.2 ABB (Bailey Fischer Porter)

- MagMaster—In-Line Magnetic flow meter (Reference: ABB Instruction Manual Electromagnetic Flow Meters MagMaster TM).

4.1.3 GE Panametrics

- DF868 Fixed-Installation Ultrasonic flow meter

4.1.4 Teledyne ISCO ADFM Hot Tap Insertion (HTI)

- The ADFM Hot Tap Flow Meter provides flow rate measurement in full and pressurized pipe applications where the pipe diameter is 18" (460 mm) or greater. The Hot Tap can be used in the difficult hydraulic conditions often found in force mains, siphons, process lines, and other full-pipe applications.

4.1.5 Teledyne ISCO 2150

- The ISCO 2150 is a gravity flow monitor that uses continuous wave Doppler technology to measure mean velocity and submerged pressure transducer to measure level.

4.1.6 Teledyne ISCO 4250

- Doppler area velocity flow measurement with submerged pressure/level sensor.

4.1.7 Marsh-McBirney Flo-Dar

- Flo-Dar is a non-contact open channel velocity/area type flow meter available for measurement of flows in municipal wastewater. Flo-Dar consists of a radar-based velocity measurement system and an ultrasonic-based pulse echo depth measurement system.

4.1.8 SIGMA 910/950

- Doppler area velocity flow measurement with submerged pressure/level sensor.

4.2 Pressure Monitoring Equipment

There are three types of pressure monitors either used or planned for HRSD's system.

4.2.1 GE Druck

- RTX1930 series - The RTX1930 series combines micro-machined silicon diaphragms with fully welded stainless steel to provide an accurate, stable-pressure transmitter with the materials and environmental protection required for industrial applications.
- PTX530 Series – Some PTX530 series models exist in the HRSD system which was the model previously used before the RTX1930.

4.2.2 Foxboro

- Model IDP10-D/C—This intelligent, two-wire pressure transmitter measures gauge pressure and transmits a 4-20 mA, 1 to 5 Vdc, or digital output signal.
- Model IGP-10 – Existing pressure sensors in HRSD's system which was the previous model used before the IDP-10.

4.2.3 KPSI

- Model 730 — A stability-enhancing charged "Field Shield" is vapor deposited directly to the pressure cell. A welded 316 Stainless Steel diaphragm, with a spring rate ratio of 1000:1 with the piezoresistive pressure cell, is used for contact with the media.

4.3 Rain Gauge Equipment

The following rain gauge equipment has been installed within the HRSD service area:

- Manufacturer: Met One Instruments, Inc.
- Model: 375C Tipping Bucket style.
- Reference: Met One Instruments Model 375C 8-inch Rain Gauge Operation Manual Document No. 375-9801.

Further details regarding these monitoring devices are included in Appendix C. Installation will be guided by manufacturers' recommendations and detailed plans and specifications of the MMP contracts. A manufacturer's representative will visit each flow monitor site following installation to confirm that the installation meets their requirements and is appropriate.

Each unit is factory calibrated for repeatability and accuracy prior to shipment to HRSD. Routine device calibration is performed according to the manufacturer's recommendations, and full system calibration from the sensor in the field to the HRSD server is completed yearly. System calibration procedures for each device are included in Appendix C.

HRSD will maintain records of maintenance and recalibration for all FPR Monitoring sites for five years following the completion of the monitoring period.

Table 5. Monitor Manufacturers

Monitor Manufacturer	Models	Type	Accuracy (includes Linearity, Hysteresis, and Repeatability, as reported by Manufacturer)	Sensor Technology	Environmental Constraints	Maintenance Procedures and/or Recalibration Schedule
Fuji	Time Delta S Ultrasonic ECNO618, EDSX6-71j, TN3FLVa-E	Flow	0.5% of velocity for velocities >1.0 ft/sec. typical on calibrated system; ±1.5% to ±2.0% of velocity for velocities <1.0 ft/sec. typical on calibrated system	Doppler ultrasound	-40 to 212°F (-40 to 100°C), Calibrated system conditions include a minimum of 10 inner pipe diameters of upstream straight pipe run and a minimum of 5 inner pipe diameters of downstream pipe run. Longer runs may be necessary due to pipe configurations	None required
ABB (Bailey Fischer Porter)	50XM13D, MagMaster	Flow	+/- 0.08% of reading/10°C	Electromagnetic	14 to 158 °F (-10 to 70 °C)	None required
GE Panametrics	DF868	Flow	Velocity >1 ft/s, 2% of reading typical; 0.5 to 1% of reading with calibration, Velocity < 1 ft/s, ±0.03 ft/s	Doppler ultrasound	14° to 122°F (–10° to 50°C)	None required
Teledyne ISCO	ADFM Hot Tap Insertion Flow Meter	Flow	+/- 0.5% of reading +/- 0.01 fps	Doppler velocity profiling	-15 to 125º F (-26 to 52º C)	None required
Teledyne ISCO	4250 and 2150 Area Velocity	Flow	Velocity: +/- 0.1 fps and 2% accuracy Level: +/- 0.01 ft	Velocity: Doppler ultrasonic Level: Submerged pressure transducer	32° to 140°F	Calibrated monthly for gravity flow monitoring period, Desiccant replacement as needed
Marsh-McBirney	Flo-Dar	Flow	Velocity: +/- 0.5% Level: +/- 0.25 inches 1% accuracy	Velocity: Radar Level: Ultrasonic	14° to 125°F	Calibrated monthly for gravity flow monitoring period
Sigma	910/950	Flow	±0.25% full scale ±2.1% of reading from 0 to 70 °C	Doppler ultrasound AV, pressure bubbler	-40 to 60°C (-40 to 140°F)	Replace battery every 30 days; replace desiccant annually or as needed
GE Druck	RTX 1930, PTX 530	Pressure	+/- 0.1% FS BSL maximum	Silicon diaphragm	-40 to 185 °F (-40 to 85 °C)	None required
Foxboro	IDP10, IGP10, 861, 841	Pressure	+/- 0.20% of Span	Diaphragm	Not submersible rated, limited to pump stations (-30 - 300 psi), -50 and +250°F	Recalibrate once every 5 years
KPSI	730	Pressure	+/- 0.1% FSO BFSL	Stainless Steel Diaphragm	-20 to 60°C (-4 to 140°F)	None required
Met One	375C	Rain	+/- 1% at 1" to 3" per hour at 70deg F	Tipping Bucket, magnet, reed switch	Remove strainer if snow is expected	Check for level and check for tip using 8.25ml water, twice (one tip in each direction), once per year

5. IMPLEMENTATION SCHEDULE

The flow, pressure, and rainfall monitoring system will be installed and operational by January 2010. The monitor data will be verified and made available to the Hampton Roads Localities approximately 90 days after each group of monitors is installed and operational with the data from the final monitor installation provided by April 2010.

A significant influence on the implementation schedule for the FPR Monitoring Program is the planning for and execution of pipeline replacement to accommodate the installations of a portion of the flow monitors. HRSD has selected an appropriate flow monitor type for each site, taking into account the need for pipe replacement and piping configuration. Where the Fuji clamp-on flow monitor is recommended over the other monitoring technologies, certain pipe materials (concrete and cast iron) must be replaced with pipe materials such as ductile iron or PVC. Where technically appropriate, a different monitor type (i.e., Teledyne ISCO ADFM HTI) has been selected to avoid pipe replacement, but this is not possible in some locations. Pipe replacement is a significant undertaking when the following issues are considered:

- Availability of qualified heavy utility contractors serving this market;
- Maintaining continuous service in the pipeline via line stops and bypass piping;
- Availability of specialized contractors providing line stop services;
- Handling wastewater flow at pump stations taken off line when a pipeline is shutdown;
- Maintaining vehicular traffic flow around an excavation;
- Plan review and approval by local jurisdictions; and
- Pipe material procurement including adapters and other specialized fittings.

Site design has been divided among four separate engineering firms under the oversight of HRSD and a consulting engineer serving as a program manager. Each firm has been assigned a collection of flow and/or pressure monitoring sites grouped together as follows:

- Contract A: HRSD Pump Stations and Pressure Reducing Stations within the City of Norfolk that are Calibration Sites. The work includes the installation of both flow and pressure monitoring equipment. (Approximately 5 sites)
- Contract B: HRSD Pump Stations and Pressure Reducing Stations within the City of Norfolk that are not Calibration Sites. The work includes the installation of both flow and pressure monitoring equipment. (Approximately 17 sites)
- Contract C: End of line pressure monitoring sites and flow and pressure monitoring sites, located throughout the North Shore Interceptor System, that are Calibration Sites. (Approximately 6 sites)
- Contract D: End of line pressure monitoring sites and flow and pressure monitoring sites, located throughout the North Shore Interceptor system, that are not Calibration Sites. The contract also includes the replacement of an existing flow monitor at one privately owned Industrial Waste Discharge site. (Approximately 6 sites)
- Contract E: HRSD Pump Stations and Pressure Reducing Stations within the South Shore Interceptor System (outside the City of Norfolk) that are Calibration Sites. The work includes the installation of both flow and pressure monitoring equipment. (Approximately 4 sites)

- Contract F: HRSD Pump Stations within the North Shore Interceptor System that are Calibration Sites. The work includes the installation of both flow and pressure monitoring equipment. (Approximately 6 sites)
- Contract G: HRSD Pump Stations within the North Shore Interceptor System that are not Calibration Sites. The work includes the installation of both flow and pressure monitoring equipment. (Approximately 6 sites)
- Contract H: HRSD Pump Stations within the South Shore Interceptor System (outside the City of Norfolk) that are not Calibration Sites. The contract also includes the installation of pressure and flow monitoring equipment at one site on an interceptor force main. The work includes the installation of both flow and pressure monitoring equipment. (Approximately 5 sites)
- Contract J: End of line pressure monitoring sites and flow and pressure monitoring sites, located throughout the South Shore Interceptor System, that are Calibration Sites. (Approximately 5 sites)
- Contract K: End of line pressure monitoring sites and flow and pressure monitoring sites, located throughout the Interceptor System in the City of Virginia Beach, that are not Calibration Sites. (Approximately 5 sites)
- Contract L: End of line pressure monitoring sites and flow and pressure monitoring sites, located throughout the South Shore Interceptor System outside the City of Virginia Beach, that are not Calibration Sites. (Approximately 10 sites)
- Contract M: Instrumentation and Electrical Commissioning contract for sites in the South Shore Interceptor System including privately-owned and government-owned Industrial Waste Discharge sites but excluding HRSD Pump Stations and Pressure Reducing Stations. (Approximately 45 sites)
- Contract N: Instrumentation and Electrical Commissioning contract for sites in the North South Shore Interceptor System including privately-owned and government-owned Industrial Waste Discharge sites but excluding HRSD Pump Stations and Pressure Reducing Stations. (Approximately 26 sites)

These groupings are based on geographic distribution and site similarities. These sites will be further divided as the design phase progresses to create more manageable construction packages that attract the interest of a larger, more diverse pool of contractors. The packaging and phasing of this program is dynamic and will most certainly change as the program progresses.

A detailed schedule is included in Appendix B. This schedule is monitored monthly and adjustments made as necessary to complete the work in an expeditious manner. The following are some of the factors associated with the duration of the schedule:

- Easement Acquisition: This can range from 90 days to 6 months per easement. This covers the range from willing participant to condemnation or federal government sites.
- Jurisdictional Site Plan Review: This can vary greatly from jurisdiction to jurisdiction. Some jurisdictions have stringent requirements and a considerable backlog of plans to review. This will take some time in certain locations.
- Dominion Virginia Power Procurement: This is not required at every site. Where it is required, the timeline can range from 6 to 9 months from initiation of the request for service to completion of installation.
- Material/Equipment Procurement: Pipes, valves, fittings, instrumentation equipment, etc., are not necessarily off the shelf items and can have significant lead times for manufacture and delivery.

- Specialty Contractors: Many of the monitor installations will require pipe replacement while maintaining continuity of service in the pipeline. This is typically accomplished by using a system of line stops and temporary bypass pumping around the pipe replacement location. There are a limited number of contractors with the specialized equipment to complete this work. The need for this type of service will need to be spread out to ensure contractors are available to provide it.

- Contractor Availability: The pool of contractors qualified and available to perform the construction required by this program can be limited. Contracts may be let in packages that will increase the number of qualified bidders. This can be governed by bonding capacity and grouping of sites by the type of contract.

Upon completion of the flow, pressure, and rainfall monitoring system installation in January 2010, HRSD will collect data for the purpose of model development, calibration, and verification for a period of 12 months. Details on the Regional Hydraulic Model development schedule are provided in the Regional Hydraulic Model Plan submitted separately.