Data Quality Standards and Procedures (DQSAP)

Version 1.1

December 2010

Previous Versions

Version 1.0 March 9, 2010

DATA QUALITY STANDARDS AND PROCEDURES

1. Introduction

The Hampton Road Sanitation District (HRSD) is implementing a flow, pressure, and rainfall monitoring program in support of regional planning, system operation, and development of a Regional Hydraulic Model. Paragraphs 12 and 13 of the Amended Consent Decree (Consent Decree), entered February 23, 2010, require HRSD to implement a Flow, Pressure, and Rainfall (FPR) Monitoring Program. This program includes measurement of wastewater flows at approximately 156 sites, system pressure at approximately 117 sites, and rainfall at approximately 64 locations for a period of 12 months. This document outlines the Data Quality Standards and Procedures (DQSAP) for HRSD's FPR Monitoring Program and is intended to satisfy the requirements of Paragraph 13 of the Consent Decree calling for a Quality Assurance Program Plan (QAPP). This DQSAP document addresses:

- Monitoring location selection and acceptability criteria;
- Rain gauge, flow meter and pressure sensor calibration and installation, including in-place calibration checks, verification, and maintenance activities;
- Data review and QA procedures;
- Data quality objectives; and
- Response measures - measures to be taken to address problems such as insufficient rainfall, instrument failures, inappropriate monitoring locations, and the need to "qualify" specific data.

2. Monitoring Location Selection and Acceptability Criteria

HRSD has identified a large number of monitoring locations throughout the regional system to collect data in support of development of the Regional Hydraulic Model (RHM). These sites have been selected to capture system wastewater flow rates at or near major collection and junction points in the system, as well as providing wide-scale coverage of pressure monitoring to calibrate and verify the RHM output. The flow, pressure, and rainfall sensors were listed in the approved FPR Monitoring Plan (April 2009) with changes, additions and deletions identified in the Interim and Final FPR Monitoring Reports. The sensors at these sites fall into two groups:

- Sensors owned and maintained by HRSD; and
- Sensors owned and maintained by others. This group includes flow meters at IWD sites where HRSD is only logging data captured from an IWD-owned meter, as well as a small number of sensors installed at Norfolk pumping stations and HRSD pump stations serving Fort Eustis and the Naval Station at Taussig Blvd pump station. Although some of these flow meters are at HRSD facilities, they are owned and maintained by others. A complete list and identification of these sites will be provided in the Final FPR Monitoring Report.

Existing flow monitoring locations have been evaluated to determine acceptability of meter position (e.g., sufficient upstream pipe diameters) based on manufacturer's recommendations. New flow monitoring locations are designed and installed per the manufacturer's recommendation. If a site is determined to be unacceptable during the data collection effort, a suitable substitute will be identified and implemented promptly, where necessary and feasible.

Rainfall gauge sites are distributed throughout the system to provide local coverage of the regional sewer system. In general, gauges are placed to cover a 10 square mile area; however, radar rainfall data for events used for model calibration and verification will be purchased and calibrated using the 60-plus HRSD gauges and other available gauges to provide complete coverage. Rain gauges are installed in clear areas free of obstructions and as described in the FPR Monitoring Plan.

The specific locations are documented as described in the following section with details on sensor position and other information reviewed to determine acceptability.

As part of the overall FPR Monitoring Program, approximately 47 flow monitoring locations and 72 pressure monitoring sites have been identified as RHM calibration and verification points. As data is collected and analyzed, sites may be added, deleted or substituted based on the actual monitoring results in order to adequately calibrate the model.

3. Rain Gauge, Flow Meter and Pressure Meter Calibration and Installation

HRSD will document both the initial installation and setup of sensors, as well as ongoing maintenance, calibration, and condition assessment, to verify that sensors are operating within the manufacturers' specifications. A summary of the manufacturers' specifications are given in Table 2.

3.1 Installation Documentation

Flow, pressure, and rainfall data collection sites have been documented including information on:

- Site
    - Location and address
    - GIS maps
    - Site type
    - Photographs
    - Record Drawings (where available)
- Distance of sensors to bends, pumps and other hydraulic features
- Elevation of sensors
- ID numbers
- Date of installation

An example of a site record document can be seen in Attachment A.

During documentation of installation, the location selection and acceptability will be reviewed based on the manufacturers' specifications (summary in Table 2).

3.2 Calibration Documentation

In addition to Installation Documentation, information on sensor calibrations is documented. The information captured in this documentation is specific to the sensor type and generally includes:

- Date of inspection/calibration, and responsible technician
- Calibration procedures
- Analog readings before and after calibration, for upper and lower range

- Verification of network transmission of test signals to data historian

An example calibration sheet for two types of flow meters, a pressure sensor, and a rainfall gauge are provided in Attachment B.

As described in Section 4 and Appendix C of the approved Flow, Pressure, and Rainfall (FPR) Monitoring Plan, HRSD performs calibration of each device in accordance with manufacturer's specifications and at least once per year. Gravity flow monitors are inspected and calibrated monthly. The specific work performed in the maintenance and calibration of each unit is dependent on the unit type. Outside of the annual calibration schedule, the thorough data quality review process being implemented can provide early detection of variation and drift in meter output which results in a work order for sensor investigation.

4. Data Review and QA Procedures

4.1 Data Trend Analysis and Alerts

The majority of all flow, pressure and rainfall data collected in the FPR Monitoring Program are being managed using equipment and software developed by Telog Instruments, Inc. The monitoring equipment in the field is connected to remote Telog data recorders that transmit the information back to a server at HRSD's offices where it is stored in a database. This system has been programmed to generate automatic alerts if the measured data deviates from expected norms. In addition, alerts can be manually generated based on visual review of trend data on a periodic basis. These alerts may be unique to each instrument and location due to the differing properties of the interceptor system at each flow, pressure and/or rainfall site. In addition, it is anticipated that data from each location will progressively define "normal operating ranges" over time. As more data are collected, the range of "normal" data will become clearer for each location. Variables that influence the range of normal data include system valving configurations, locality pump station operations, weather, seasonal groundwater trends and other factors.

The goal of the trend analysis and alerts is to quickly identify potentially anomalous data that may be indicative of instrument problems (failure, drift, variation from calibration standards, etc.). Once an anomaly has been identified, staff can intervene to correct the problem and either restore or replace the instrument to provide reliable data. This process also provides for identification of data that should be discarded and not used for calibration or system performance analysis.

The list of alerts proposed for use in the FPR Monitoring Program is presented in Table 1 on the following page.

Table 1 – Preliminary Data Alerts

Alert	Potential Anomaly	Regime	Time step
Flow, sensor	Potential sensor fouling and/or failure as indicated by flat-lining and where there is insufficient difference between minimum, average, and maximum values.	Wet and dry weather	Hourly
Flow, deviation	% deviation from a 4 to 12 week dry weather rolling average	Dry weather	Hourly, Daily
Flow, upstream	Upstream flow exceeds downstream	Wet and dry weather	Daily
Flow, downstream	Downstream flow less than upstream	Wet and dry weather	Daily
Flow, wet weather peak	Peak factor outside of expected range	Wet weather	Daily
Gravity Flow, Flat line	Poor velocity signal	Wet and dry weather	Daily
Gravity Flow, 0 value	Poor level or velocity value	Wet and dry weather	Daily
Pressure, dry weather peak	Peak pressure compared to a 4 to 12 week dry weather rolling average	Dry weather	Hourly
Pressure, sensor	Potential sensor fouling and/or failure as indicated by flat-lining and where there is insufficient difference between minimum, average, and maximum values.	Wet and dry weather	Hourly
Pressure Deviation	% deviation from a 4 to 12 week dry weather rolling average	Dry weather	Hourly, Daily
Pressure, wet weather peak	Peak pressure outside of expected range	Wet weather	Daily
Rain, greater than adjacent gauge	% deviation from nearest neighboring gauge	Wet and Dry weather	Daily
Rain, less than adjacent gauge	% deviation from nearest neighboring gauge	Wet and Dry weather	Daily

After a trial review period, an initial set of deviation percentages were developed for flow and pressure. Alerts are automatically generated when the percent deviation is exceeded. For flow, nearly all of the sensors were set up with 40% deviation from the 4 week rolling average. A small number of sensors with slightly more variable flow were set to 50 and 60%. Similar values were established for pressure deviation with nearly all set at 40% and a small number at 50 to 60%. More stringent values were tested but resulted in an unacceptable number of false alerts. HRSD will review the values periodically and make adjustments to refine the alerting process.

It is probable that some of these alerts may prove to be not useful at some locations. If a particular alert produces excessive false positive results at a specific location, then HRSD reserves the right to eliminate the alert. The first effort will be to adjust the alert level to reduce false positives. If this does not resolve the problem then the alert may be eliminated at specific locations. This process provides sufficient alerts and review of data to collect adequate quantities of valid data necessary to develop, calibrate, and verify the Regional Hydraulic Model.

4.2 Validation Process

The data validation process used by HRSD is diagrammed in Figure 1. In general, checks occur in the order of most common causes to least common. The outcomes from this process are that data will be identified as valid, invalid, or qualified.

Valid data are any data points collected which have not been determined to be invalid or qualified. Invalid data are points with values determined to not represent the actual field conditions using a series of analytical steps described in this section. Qualified data include data which either represent actual but not typical conditions (e.g., a valve is temporarily closed at a pump station which creates a zero pressure gauge reading) or data which have been recovered or manually adjusted (e.g., a gravity flow meter has two level sensors and one sensor failed creating a skewed flow rate). Valid and qualified data are considered reliable data for the reliability calculations.

The data validation process follows these steps:

1. Anomalies will be identified using two methods: an automated trend analysis and manual review.
    a. The automated data trend analysis and alert generation as described in Section 4.1 is performed. On a monthly basis, a spot check of the trends for every sensor will be performed to provide quality control of the automated process.
    b. Manual review of specific data points has been identified where automated alert generation is not feasible. This is necessary when a sensor normally observes sporadic or inconsistent readings, such as a flow meter on a pump in a pressure reducing station that only activates during wet weather. Automated trending in this situation is not possible. HRSD has identified sensors where this may occur and will be performing manual reviews of these trends several times throughout each week.

    If data has been flagged indicating an anomaly was identified as defined by the trend logic or through manual periodic reviews, then the process continues to step 2. If no flag occurs, then the data will be classified as valid: normal trend.
2. A desktop analysis using various tools is performed including review of the HRSD computerized maintenance management system (CMMS), review of data from adjacent sensors, and evaluation of historical data from the specific sensor. A decision will be made after the desktop analysis whether sufficient information is available to determine if the data are valid. If sufficient information is available, the data will be classified as valid, invalid, or qualified depending on the situation. If insufficient information is available, the process continues to step 3 or 4 based on the type of data anomaly found. Step 3 includes a review of the anomaly by the Interceptor Systems Division, while Step 4 involves Instrumentation.
3. Interceptor Systems reviews the anomaly to determine if any operational changes (e.g., venting, line maintenance, valve changes, bypassing, taking a pump off-line, reprogramming, etc.) have occurred which could affect data readings. If no operational changes occurred which could cause the anomaly then the process continues on to step 4.

    If a change did occur, the data is reviewed to see if the trend is deemed reasonable based on the operational change. If so, the data are classified as valid or qualified depending on the operational change. If not, the process continues on to step 4.

    The sensor is physically verified by Instrumentation staff for changes in local site conditions (e.g., fouling, sedimentation, damaged equipment, etc.) that could affect sensor performance.

    A process specific to each type of measurement based on manufacturer's recommendations is followed to determine if a sensor issue is causing the data anomaly. This can include, among other work,

cleaning grease from a sensor, bleeding localized air pockets at the meter, and adjusting mounting position. Temporary sensors may also be installed in some instances to evaluate the existing meter.

If a sensor issue is discovered, and data can be adjusted mathematically (e.g., incorrect range used in previous calibration), then the data is adjusted in the historian and data is resolved as qualified. If it can not be adjusted, then it is resolved as invalid: sensor failure. If no sensor issue is found, the process continues on to step 5.

4. The data recording and network path back to the data historian are checked by verifying site readings with values being recorded. If they match, the process continues on to step 6. If not, data are resolved as invalid: networking issue.
5. If no cause for the data anomaly is found after the previous steps, a final engineering review of the anomaly is performed. If the data trend appears within the likely realm of possibility, the data is resolved as valid, and the reasoning behind the decision is documented and used to adjust the trend logic that identified the anomaly, if necessary. If the final engineering review determines that the data trend appears outside the likely realm of possibility, the data are resolved as invalid, and the reasoning is documented.

Any data found to be invalid that cannot be mathematically corrected or interpolated will be flagged as invalid and will not be used for calibration or verification of the RHM. In addition, HRSD will maintain documentation of any data that has been manually adjusted and considered valid as qualified data.

HRSD will be using database software tools for tracking each data flag and identifying and documenting the final resolution determined. Routine audits of each site and each type of data flag will be performed to determine patterns and trends in the flagging process itself to improve the system.

5. Data Quality Objectives

It is anticipated that some data will be determined to be invalid, but that the core performance goals for data reliability will be met. Paragraph 14 of the Consent Decree identifies data quality objectives that are expected to be achieved. HRSD will monitor each site for a period of 12 months in increments between 2 minutes and 15 minutes depending on the sensor type.

Based on requirements in the Consent Decree and subsequent discussions with the EPA and VADEQ regarding Paragraph 14.b of the Consent Decree, all of the flow and pressure sensors owned and maintained by HRSD that are part of the Consent Decree FPR Monitoring Program (those in the approved FPR Monitoring Plan and as modified by the Final FPR Monitoring Report) are expected to have at least 75% reliable data in at least 90% of each type of site (flow or pressure) each month. In addition, all flow and all pressure sensors used for calibration of the Regional Hydraulic Model are expected to have at least 75% reliable data in at least 90% of each type of site (flow or pressure) each month. This requirement is met at a particular sensor when the total reliable data points from that sensor for a month is divided by the total number of data points from that sensor and this value meets or exceeds 75% for the month. As an example, the flow meter at MMPS-009 may have 8,928 data points in 5 minute increments for a month. At least 6,696 data points would need to be determined reliable to meet the 75% criteria for that month. The main purpose of this criterion is to have adequate information for dry weather calibration.

A similar requirement exists in Consent Decree Paragraphs 14.c and 14.d for wet weather monitoring; however, the requirement is increased to 90% reliable data during the duration of system response to a rainfall event used for calibration or verification of the RHM. In addition, this requirement is in the aggregate for each type of monitoring equipment (flow or pressure). This requirement is met for the pressure sensors when all pressure sensors owned and maintained by HRSD which are part of the FPR Monitoring Program have a total sum of reliable data points divided by the total number of all pressure data points (for the duration of system response to a rainfall event at the treatment plant service area level) that is greater than or

equal to 90%. Similarly for the flow meters owned and maintained by HRSD which are part of the FPR Monitoring Program, the total number of valid data points from all flow meters must have at least 90% reliable data. As an example, a rainfall event occurs from 8:00 a.m. on February 5 through 7:00 p.m. on February 6 that causes a system response at the treatment plant service area level to occur from 9:00 a.m. on February 5 through 9:00 a.m. on February 8. HRSD has twelve flow meters in the portion of the RHM affected by the rainfall event. These twelve flow meters would typically capture 864 data points each in 5 minute increments over the three day system response for a total of 10,368 data points. In order for HRSD to meet the 90% standard, at least 9,332 of the 10,368 data points would need to be determined reliable. If the sensor data reliability ratio falls to within 5% of the minimum required (95% during wet weather or 80% overall), a meeting or coordination efforts with the involved departments will occur promptly to determine cause and effect, and corrective actions.

HRSD performs this data reliability calculation for all meters owned and maintained by HRSD. As mentioned previously in this document, there are flow meters listed in the FPR Monitoring Plan that are either IWD sites (which are owned by the IWD customer), Norfolk Pump Station meters (owned by the City of Norfolk), and military meters (e.g., Fort Eustis and Taussig Blvd. that are owned by the Army and Navy, respectively). HRSD will collect this data and perform manual reviews, but no data reliability calculations are performed. The flow and pressure meters included in the data reliability calculations will be clearly identified in the Interim and Final Flow, Pressure, and Rainfall Monitoring Reports.

6. Response Measures

In order to maintain the 75% and 90% data reliability standard, HRSD will be responding to data alerts in a timely manner. The process to review the data and investigate the situation has been highly prioritized by HRSD staff due to the consequences of potentially invalidating data from the start of an individual sensor problem. Depending on the situation, sensors may be replaced if found to be defective in the field or adjusted/cleaned and returned to service with a calibration performed, if necessary. HRSD maintains a goal of beginning action on data reliability issues within 24 hours of the anomalies occurrence; however, actual repair or resolution often can take longer.

It may be found that during the monitoring period as data is collected and analyzed that a particular site or sensor is not providing reliable or pertinent data or is not useful in calibration of the Regional Hydraulic Model. In that case, HRSD may select another existing site and/or a substitute location to collect the pertinent data and implement installation of a new meter in an expedited manner. The details of this relocation as well as any additions, deletions, or modifications will be provided in the Interim and Final Flow, Pressure, and Rainfall Monitoring Reports.

If insufficient rainfall is observed during the monitoring period to adequately calibrate and verify the Regional Hydraulic Model, HRSD will follow the requirements of Paragraph 18 of the Consent Decree and submit a revised plan and schedule for additional monitoring to achieve the objectives of the program.

Table 2. Manufacturer Sensor Installation Requirements										
Flow	Flow	Flow	Flow	Flow	Flow	Pressure	Pressure	Pressure	Rain	Rain
Fuji FLW, FLV	**ABB Magmaster**	**Siemens Milltronics Echomax XRS-5**	**ISCO (ADFM) HTI**	**ADS Flowshark (Gravity)**	**GE Panametrics DF 868**	**GE Druck PTX, RTX, 730 series**	**Foxboro IGP10, 841GM**	**KPSI 700 Series**	**ISCO 674**	**MetOne 300 Series**
Straight pipe 10*D upstream and 5*D downstream	Straight pipe 5*D upstream and 2*D downstream	Mount such that the axis of transmission is perpendicular to surface of liquid	Requires a 2" pipe tap	Laminar flow	10* D Straight pipe upstream and 5 * D straight pipe downstream	Keep air vent clear of oil or water contamination	Keep air vent clear of oil or water contamination	Keep air vent clear of oil or water contamination	Distance to nearby objects to be at least twice the difference in height between the gauge and the object	Distance to nearby objects to be at least twice the difference in height between the gauge and the object
No flow disturbances (pump, valves, elbows, etc.) 30*D upstream	No vibration or electrical noise		Requires proper alignment so that sensor extends into flow stream by 1/8"	Low Siltation	Avoid mounting the sensors at 12 and 6 orientation				Avoid sites with heavy vegetation	
No bubbles	No bubbles				Avoid routing cables along high-power AC lines					
Within +/- 45 deg of horizontal plane of pipe	Avoid temperature extremes									
Maintenance space on both sides of pipe										
Avoid deformed sections, welds, or flanges										
Z-type mounting alignment of sensors										
Avoid temperature extremes										

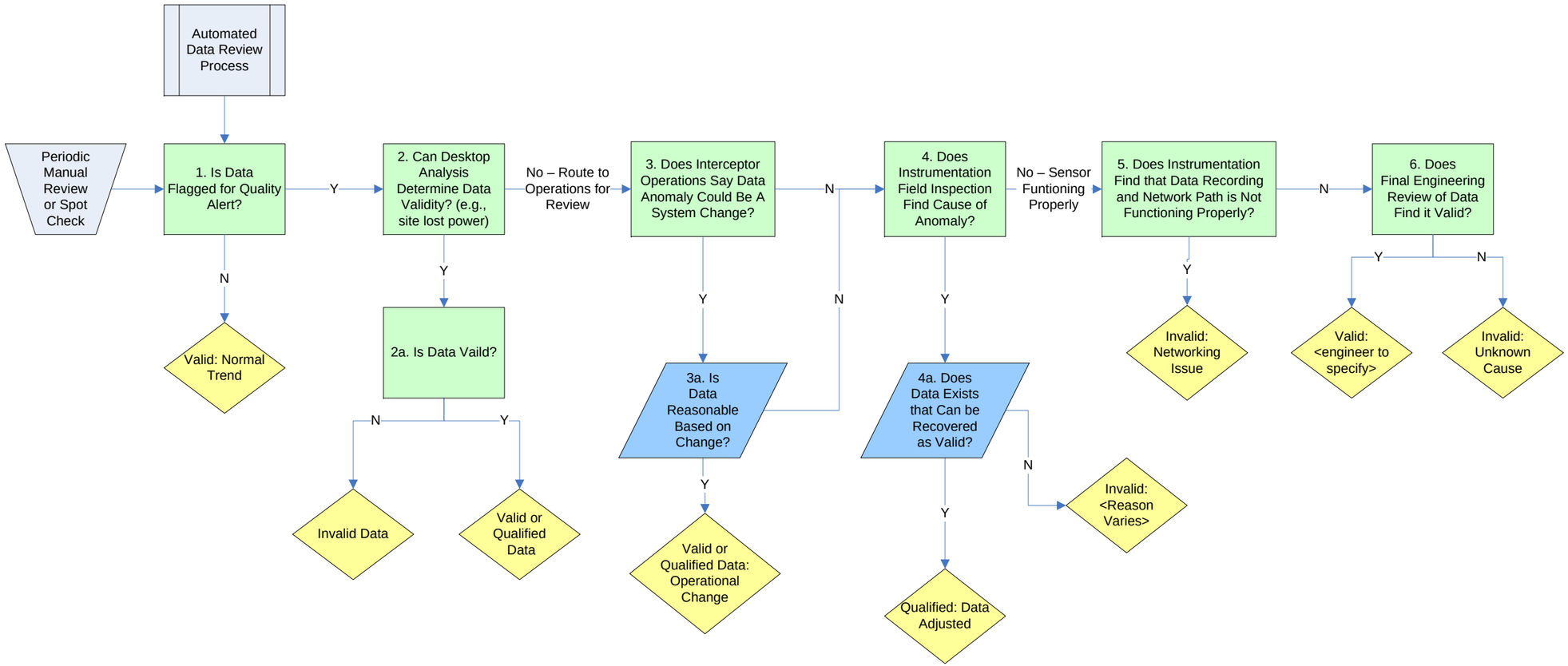


Figure 1. Data Validation SOP

ATTACHMENT A – SITE RECORD DOCUMENT

MMP Site Installation Documentation Example

HRSD MMP Site Installation Quick Sheet

HRSD Colley Avenue PS

Site ID:
MMP- 127

Address:
Colley Avenue - 715 Fairfax Avenue

Locality:
Norfolk

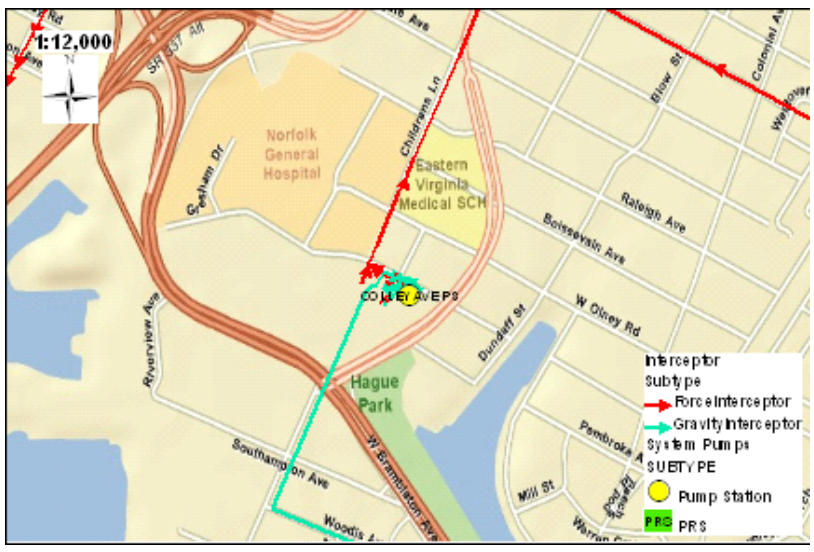
	Flow Sensor 1	Flow Sensor 2	Flow Sensor 3	Flow Sensor 4
Model:	FUJI FLVS 4213	FUJI FLVS 4213	FUJI FLVS 4213	
Serial #:	A8A9526T	A8A9545T	A8A9649T	
Telog ID:				
Pipe diameter:	18	12	12	
Pipe material:	CI	CI	CI	
Pipe thickness:				
Pipe liner	NA	NA	NA	
Clock position:	NA	NA	3/9	
Distance to US bend:	11' 0"	8' 0"	9' 6"	
Distance to US pump:	18' 0"	17' 0"	15' 0"	
Distance to DS bend:	3' 6"	6' 6"	5' 0"	
Distance to DS pump:	NA	NA	NA	
Documents:				
Notes:	ULTRASONIC FLOW MET	ULTRASONIC FLOW MET	ULTRASONIC FLOW MET	

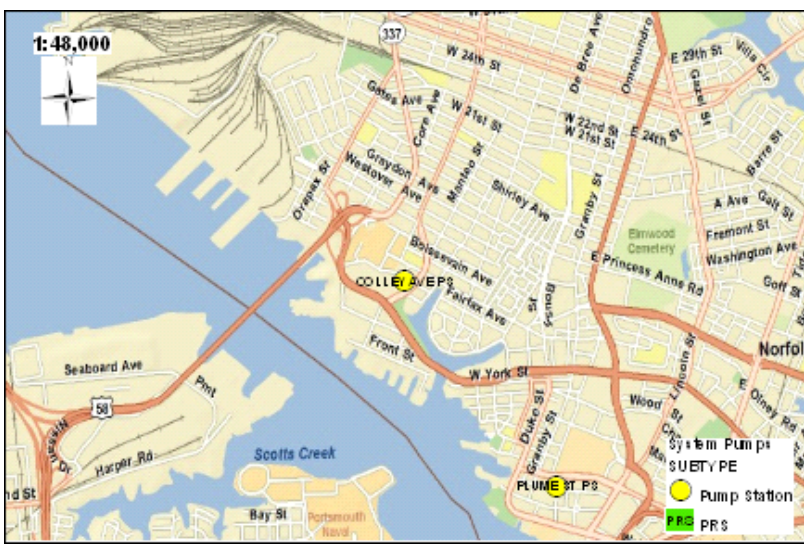
	Pressure Sensor 1	Pressure Sensor 2
Model:	IGP10-D22D1F-M2L1V1	
Serial #:	09020147	
Telog ID:		
Pipe diameter:	18	
Pipe material:	DI	
Documents:		
Notes:	INSTALLED ON 18" DISCH	

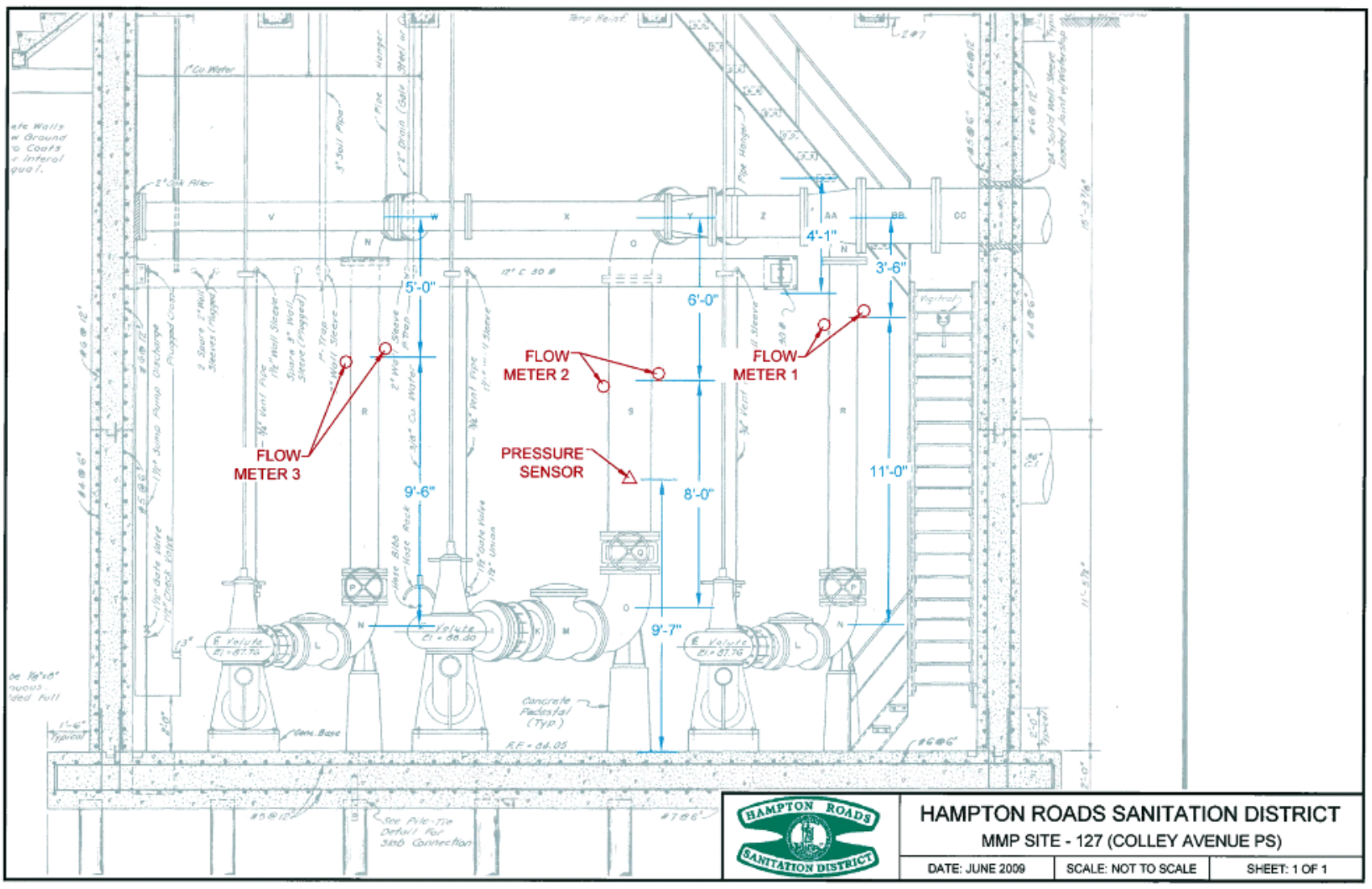
	Rain Gauge
Model:	
Serial #:	
Telog ID:	
Elevation from ground:	
Distance to object of equal elevation:	
Documents:	
Notes:	

Location Coordinates and Maps

Latitude: 36.85968 Longitude: 0





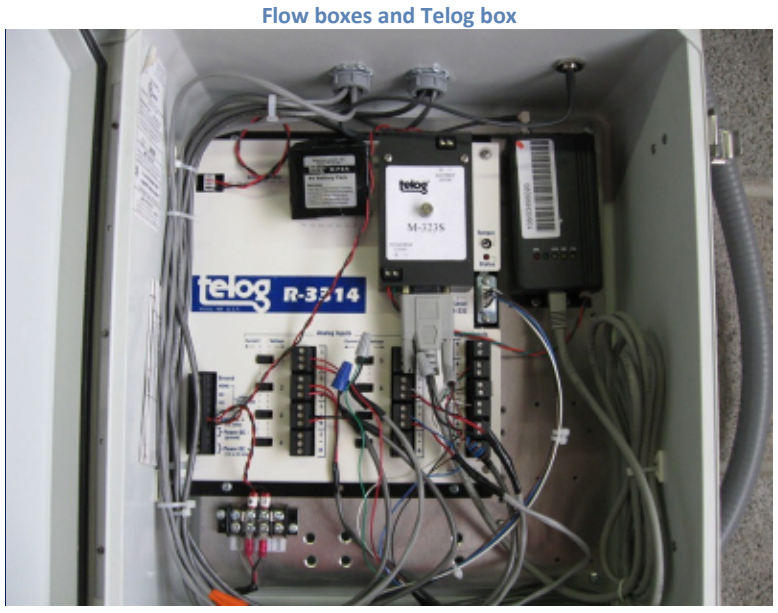

FLOW METER 3
FLOW METER 2
FLOW METER 1
PRESSURE SENSOR
5'-0"
9'-6"
6'-0"
8'-0"
9'-7"
4'-1"
3'-6"
11'-0"
HAMPTON ROADS SANITATION DISTRICT
MMP SITE - 127 (COLLEY AVENUE PS)
DATE: JUNE 2009
SCALE: NOT TO SCALE
SHEET: 1 OF 1

Site photo 1

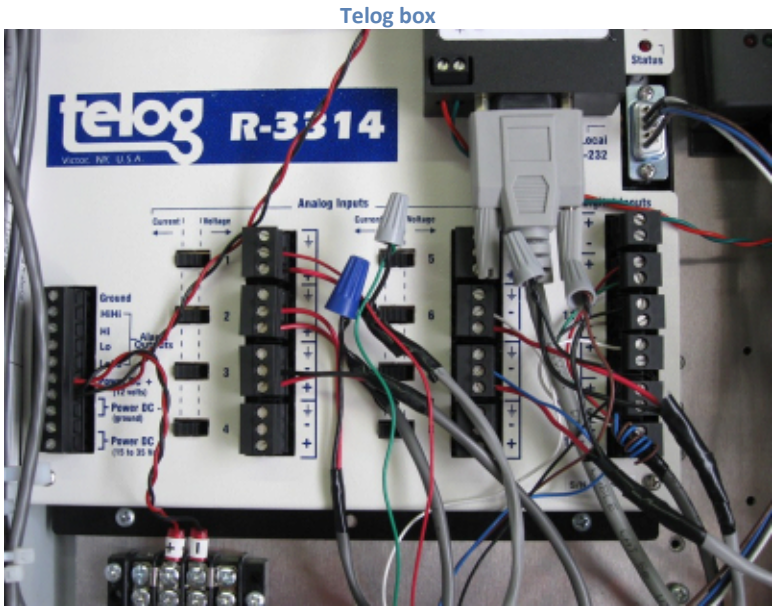
Site photo 2

Flow boxes and Telog box

Telog box



Telog box, inside

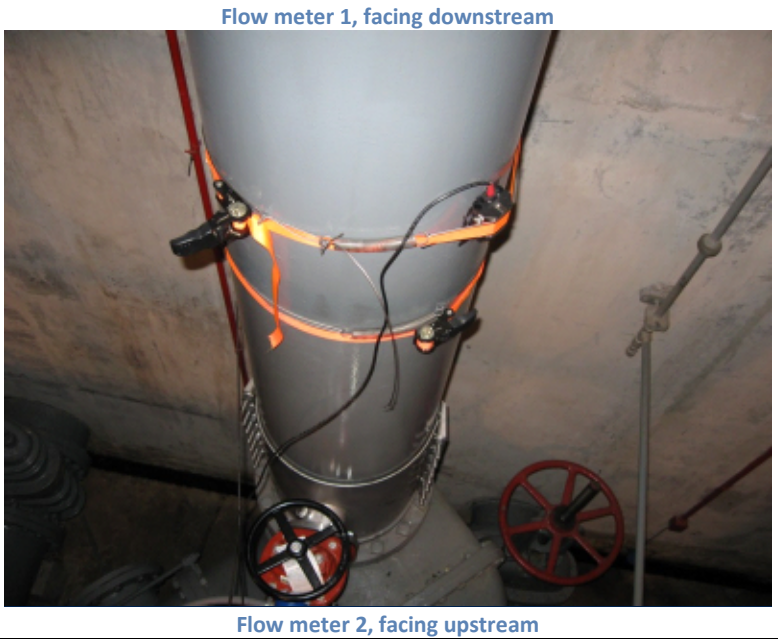


Telog wiring

Flow meter 1, facing upstream

Flow meter 1, facing downstream

Flow meter 1, face



Flow meter 2, facing upstream

Flow meter 3, facing upstream

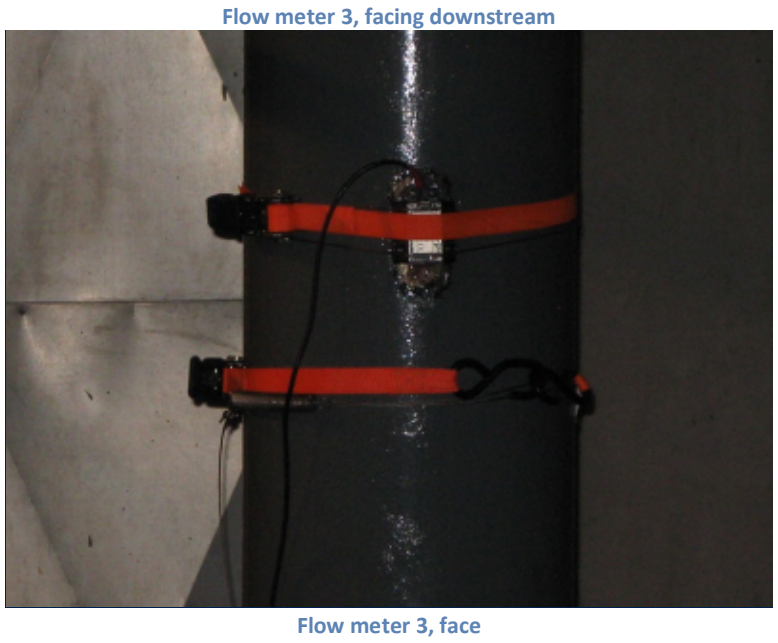
Pressure sensor, facing upstream

Flow meter 2, facing downstream

Pressure sensor, facing downstream

Flow meter 3, facing downstream

Flow meter 2, face



Flow meter 3, face

ATTACHMENT B – CALIBRATION DOCUMENTATION EXAMPLES

Flow

Pressure

Rain Gauge

PRS Calibration/Setup Sheet

PS Name/ COLLEY **Location Sta#:** MMPS 127
Meter Name Meter Type: **Model/Serial #:** 09020147 **Range Pressure** 0-100psi
Other :

Suction Calibration Results to Controller							
% Of Scale	Reading Before Calibration	Units	Milli-Amp Reading	Reading After Calibration	Units	Milli-Amp Reading	Reading after Calibration Scada Verify
0		PSI			0 PSI		N/A
50		PSI			5 PSI		N/A
100		PSI			10PSI		N/A

Meter Name: **Meter Type:** **Model/Serial #:**
Range Pressure : **Other:**

Suction Calibration Results to Moscad							
% Of Scale	Reading Before Calibration	Units	Milli-Amp Reading	Reading After Calibration	Units	Milli-Amp Reading	Reading after Calibration Scada Verify
0		PSI			PSI		
50		PSI			PSI		
100		PSI			PSI		

Meter Name: DISCHARGE **Meter Type:** **Model/Serial #:**
Other:

Discharge Calibration Results							
% Of Scale	Reading Before Calibration	Units	Milli-Amp Reading	Reading After Calibration	Units	Milli-Amp Reading	Reading after Calibration Scada Verify
0	0.05	PSI	4.007		PSI		
50	50.32	PSI	12.049		PSI		
100	100.23	PSI	20.049		PSI		

Set Point Name	Station Settings	Settings in P Register Yokogawa
2nd Pump On		
2nd Pump Off		
Lag Pump On		
Lag Pump Off		
Lead Pump On		
Lead Pump Off		

Technician(s): Date: 7-15-09 Rector / Brzezowski

Note: Verify scaling of point(s) in the database. **CHECK BY** cal check only

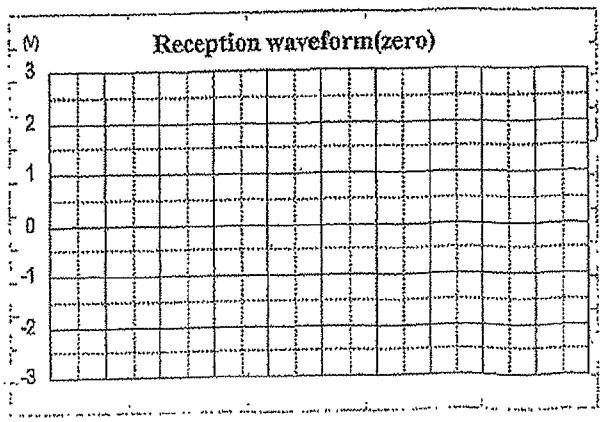
Parameter setting table for ultrasonic flowmeter (FLV-3/FLW-2/FLD-1)

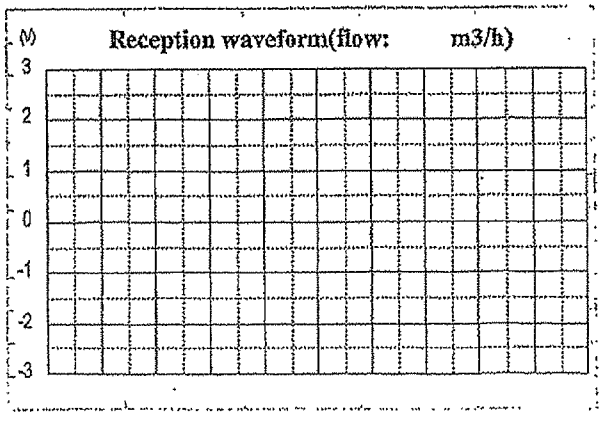
Data of entry	10-19-09
Person in charge	Troy Hemm

			Product type	Serial No.
Customer	COLLY AVE PS	Converter	FLVS4213-0YYY	ABA9526T
Apparatus name	FUJI USED PUMP 1	Sensor	FLW 4	
TAG. No.	MMPS 127			

Piping data	Outer diameter	13.20 in ~~mm~~	Condition	Damping: 50 sec
	Pipe material	CAST IRON		Low flow cut: 25.0 gpm
	Wall thickness	.40 in ~~mm~~	Total output	Total mode: TOTAL STOP
	Pipe sound velocity (other)	m/s		Total constant & unit: ft3
	Lining material	MORTAR		Total preset value: Forward: OFF3
	Lining thickness	.13 in ~~mm~~		Reverse: OFF3
	Lining sound velocity (other)	m/s		Total switch: Forward: OFF3
Fluid data	Type	SEAWATER		Reverse: OFF3
	Fluid sound velocity (other)	m/s		Total pulse width: 50 ms
	Kinematics viscosity	1.150 x 10^{-6} ~~m2/s~~	Flow switch	Low limit: 0.00 gpm
Sensor	Mounting method	Z method		High limit: 37876.504 gpm
	Sensor spacing	5.11 in ~~mm~~		Hysteresis: 10 %
	Transmission voltage	4 times	Output calibration	Zero point: 0.000 gpm
Output setting	Range type	SINGLE RANGE		Span: 100.0 %
	Range unit	gal/m	Status	CH1 output: Select: NOT USED
	Base scale	0.000 gal/m		Mode: PULSE
	Full scale 1	2100.000 gal/m		CH2 output: Select: NOT USED
	Full scale 2	N/A		Mode: PULSE
	Hysteresis	%	System	Measurement unit: ENGLISH
	Low limit	-20 %		Language: ENGLISH
	High limit	120 %	Display	First line of display: VELOCITY ft/s
	Burn-out	409		Second line of display: FLOW RATE gal/m
	Burn-out timer	10 sec		Decimal point position (2nd): 0 0 0 0 0 0 0 0 0

Note: Set in full scale 1 for single range.





Adjustment and Confirmation item

Key operation	Item		Initial value	Setting value	Remarks
F,/π,1	Check data	Fluid sound velocity	4808.62		~~m/s~~ ft/s
		Total time	255.593		micro sec
		Forward direction time	255.594		micro sec
		Reverse direction time	255.595		micro sec
		Delay time	25.936		micro sec
		Strength of waveform	68.1~~4~~%		
		Propagation time (ref.)	247		micro sec
F,/π,3	Window opening control (Case of manual operation)	Forward time	AUTO		micro sec
		Reverse time	AUTO		micro sec
F,/π,4	Waveform Trigger level		25		%
F,/π,5	Waveform A/D low limit		4096		
F,/π,*	Measurement method		2		
F,/π,±	Wave form balance limit		~~50~~	25	%

Inspection report

1. Establishment environment

	Establishment Place	Length of straight pipe	Power supply & Mounting	Environment
Converter	Outdoor, Indoor Exposure, Panel inside	Up stream : 8 D Down stream: 3 D	AC100-120V,AC200-240V Meas. Voltage: 24VDC	Humidity: Yes, No Induction: Yes, No
Sensor	Indoor, Road under, Pit	Devices of plumbing: Piece water stoppage: Yes , No	V method , Z method Angle: Level, Deg.	Humidity: Yes, No

2.Inspection result and Contents

Item	Standard		Measured value	Judge	Remarks
Appearance	Clean, strangle screw increase, etc.		Adjustment		
Supply voltage	5V	4.75～ 5.25V	V		
Current output	0%(4mA)	3.92～ 4.08mA	mA		
	50%(12mA)	11.92～12.08mA	mA		
	100%(20mA)	19.92～20.08mA	mA		
Status output	Channel 1 (CH1)	On/off, normal/Reversal	Normal , abnormal		
	Channel 2 (CH2)	On/off, normal/Reversal	Normal , abnormal		
RGV voltage	4.5V over		V		
Reception waveform	Amplitude fluctuation: Yes , No	Time axis fluctuation: Yes , No	Noise: V		

3.View ✓

1	✓	No problem
2		Although there is no problem a little obstruction
3		Part exchange/addition is needed
4		Repair is necessary
5		Improvement/measure is needed

4.Description item

Rain Gauge Test Certification

Model: MET ONE 8" heated rain gauge 0.01"

Serial No. H5244

Job Number: #443231

Customer: Greensprings SCADA 239/MMPS136

Test Date: 25-Jun-09

Next Calibration Due: 25-Jun-2010

Tested by: Reese

OK	Calibration:	8.24 ml H2O for each bucket tip.
N/A	Switch Test:	Switch check on oscilloscope. Confirm clean signal and no double actuations.
OK	Final Test:	1000 ml of H2O to tip bucket 121 times +/-1 tip (registered on a digital counting fixture) at a rate equivalent to average 3" per hour rainfall.
N/A	Heater Test:	Instrument run in cold cycle; verified that thermostat cycles on and off and that heater functions properly. Instrument then warmed up to room temperature; verfified that thermostat shuts off and heater does not operate.
OK	Final Inspection:	Instrument inspected for proper assembly, wire and cable dressing, hardware torque, proper labels, and finish (paint, anodizing.

Test Procedure #370/375-6100

The Standards used for calbration have accuracies equal to or greater than the instruments tested. These standards are on record and traceable to NIST to the extent allowed by the institutes calibration facility. Unless other wise stated hereon, all instruments are calibrated to meet manufacturers published specifications. The calibration system complies with MIL-STD-45662A.