APPENDIX 4

CONDITION ASSESSMENT PLAN

Prepared for
Hampton Roads Sanitation District
February 2009
Revised September 2009

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LIST OF ACRONYMS

AC	Asbestos Cement
CA	Condition Assessment
CCTV	Closed Circuit Television
CIP	Cast Iron Pipe
DEQ	(Virginia) Department of Environmental Quality
DIP	Ductile Iron Pipe
EPA	(United States) Environmental Protection Agency
ESVC	Extra Strength Vitrified Clay
FM	Force Main
HDPE	High Density Polyethylene
MACP	Manhole Assessment and Certification Program
MOM	Management, Operations and Maintenance
PACP	Pipeline Assessment and Certification Program
PCCP	Prestressed Concrete Cylinder Pipe
PE	Polyethylene
PRS	Pressure Reducing Station
PS	Pumping Station
PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
RCCP	Reinforced Concrete Cylinder Pipe
RTS	Regional Technical Standards
SCADA	Supervisory Control and Data Acquisition
SP	Steel Pipe
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
TBD	To Be Determined
VC	Vitrified Clay

1. INTRODUCTION

The Hampton Roads Sanitation District (HRSD) sanitary sewer system in southeast Virginia includes approximately 430 miles of pressure sewer mains (and associated valves and appurtenances), approximately 50 miles of gravity sewer mains (and associated manholes, siphons, and vaults), and 81 pumping facilities which include 66 wet well pumping stations and 16 pressure reducing stations (PRS), of which one station serves both as a wet well pump station and PRS. The HRSD sanitary sewer system takes pumped flow and gravity flow from surrounding communities and transports the flows to its thirteen sewage treatment plants (STPs), of which 9 are included in the Consent Decree. Tables A-1, A-2, and A-3 in Appendix A present an inventory of the HRSD sanitary sewer pipe network and pumping facilities, with sanitary sewer system infrastructure maps included in Appendix A. The information provided in these tables continues to be refined and further developed through field and other activities.

1.1 Purpose of the Plan

The purpose of this document is to describe the Condition Assessment Program for the Hampton Roads Sanitation District (HRSD) required by the pending enforcement action by the Environmental Protection Agency (EPA). This Plan is generally consistent with the Sanitary Sewer Evaluation Survey (SSES) Plan submitted to the Virginia Department of Environmental Quality (DEQ) under the Special Order by Consent. This plan will provide the methodology for conducting a condition assessment of HRSD's sanitary sewer system and an implementation schedule.

HRSD will be conducting condition assessments of assets within its sanitary sewer system for the purpose of locating conditions that present a "material risk of failure". For the purposes of this document, "failure" means any condition resulting in a sanitary sewer overflow, pipe leakage, or interruption of service to HRSD's customers, due to a physical condition defect in the system. The goal of the Condition Assessment Plan is to develop a working plan and schedule for inspecting, assessing, and prioritizing HRSD's sanitary sewer system assets. The Condition Assessment Plan will provide standard methods for evaluating the physical condition of HRSD's sanitary sewer assets in order to identify assets that present a "material risk of failure".

1.2 Approach and Process

The HRSD sanitary sewer system is comprised of five sanitary sewer asset types: force mains, pumping stations, pressure reducing stations, SCADA systems, and gravity systems. The Condition Assessment Plan includes condition assessment standards for each of the five sanitary sewer asset types. The approach for conducting the Condition Assessment Plan is organized into three distinct parts that address the asset types as described below:

1. **Force Main Condition Assessment** - The force main condition assessment will be conducted in two phases. The first phase will be an initial screening of HRSD force main assets, utilizing selected criteria, to identify segments that require further analysis, and possibly field inspection. Initial screening will be conducted using a desktop Criticality Model which assesses the likelihood and consequence of failure of each force main segment. This information along with previous failure history will be used to identify

assets that will be considered to have the **potential** for "material risk of failure," and in the second phase, these assets will undergo further assessment if the assessment is cost effective relative to rehabilitation and/or replacement. If rehabilitation or replacement of a portion of the force main is deemed more cost effective then further condition assessment activities will be discontinued.

2. **Pumping Facility Condition Assessment** - The pumping facility condition assessment will include assessment of wet well pumping station assets and pressure reducing station assets within the HRSD system. SCADA assets within the HRSD system will be assessed as part of the Pumping Facility Condition Assessment since these are predominantly located at the pumping facilities. Pumping facilities and critical components that have the **potential** for material risk of failure will be identified in a screening process for prioritization in the assessment schedule.
3. **Gravity System Condition Assessment** - The gravity system condition assessment will evaluate the gravity sewer system assets within the HRSD system, including gravity pipeline and manhole assets. Gravity sewer assets that have the **potential** for material risk of failure will be identified in a screening process for prioritization in the assessment schedule.

Once the initial screening is completed, HRSD will develop a Preliminary Condition Assessment Report that documents the results of this work and details the Condition Assessment Activities. Upon completion of field activities, the Final Condition Assessment Report will be developed that presents results along with Action Plans and schedules. The Action Plan will identify specific assets that will be rehabilitated or replaced in order to mitigate the actual material risk of failure and an associated schedule. This process is shown in Figure 1-1 below.

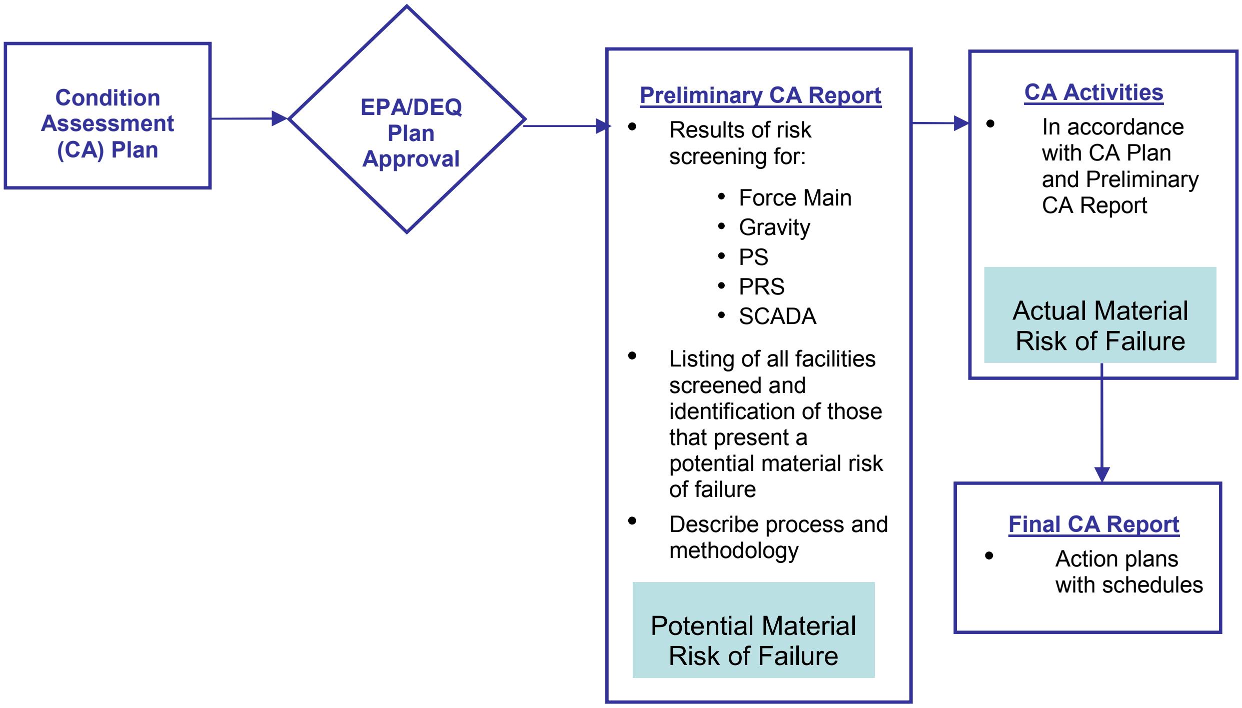

Figure 1-1. Condition Assessment Program Phasing

2. PREVIOUS CONDITION ASSESSMENT ACTIVITIES

HRSD includes Condition Assessment as part of its normal operation and maintenance of the sanitary sewer system, and has done so since its formation. As part of this Condition Assessment Plan, HRSD will research it recent records (since September 2005) to obtain pertinent existing inspection reports related to condition assessment studies that may be useful in the development of the Condition Assessment Program. Prior investigatory work conducted since September 2005 that substantially meets the requirements of this Condition Assessment Plan and is adequate to develop rehabilitation measures may be excluded from further condition assessment activities within the Condition Assessment Plan; however, the results of that work will be included in the Final Condition Assessment Report.

2.1 Pumping Stations

HRSD performs routine inspections and preventive maintenance of its pumping facilities; however, additional inspections will be performed at each Pumping Station as part of the Condition Assessment Activities. Particular aspects of HRSD's routine inspections (e.g., wet well inspections, generator testing) since September 2005 that meet industry standards will be reviewed for exclusion from the Condition Assessment Activities.

2.2 Pressure Reducing Stations

Similarly, HRSD performs routine inspections and preventive maintenance of its Pressure Reducing Stations (PRS). Additional inspections will be performed at each PRS as part of the Condition Assessment Activities. Particular aspects of HRSD's routine inspections (e.g., generator testing) since September 2005 that meet industry standards will be reviewed for exclusion from the Condition Assessment Activities.

2.3 Force Main System

HRSD routinely inspects exposed portions of its force main interceptor system as well as assets associated with the force mains within vaults or pits (i.e., in-line valves, pressure control valves, air release valves). These records that meet industry standards since September 2005 will be reviewed for exclusion from the Condition Assessment Activities.

2.4 Gravity Sewer System

HRSD routinely performs internal inspection of gravity sewer within its system, including manhole inspections. Mainline inspection using CCTV has been conducted using the NASSCO Pipeline Assessment and Certification Program (PACP) to provide standardization and consistency in the evaluation of sewer pipe condition. PACP trained and certified staff have been using PACP compliant software since September 2005. This data collected since September 2005 that meet industry standards will be reviewed for exclusion from the Condition Assessment Activities. HRSD has also implemented a NASSCO Manhole Assessment and Certification Program (MACP); however, most existing manhole inspections were conducted prior to MACP implementation and will not meet the requirements of this Plan.

2.5 SCADA System

The HRSD SCADA system exists primarily at HRSD pumping facilities. These systems have been inspected routinely by HRSD staff including alarm testing and wiring assessments. These records that meet industry standards since September 2005 will be reviewed for exclusion from the Condition Assessment Activities.

2.6 Recent Construction and Rehabilitation Efforts

For the purpose of the Condition Assessment Plan, HRSD's rehabilitations and replacement of portions of the sanitary sewer system in the previous 5 years will be reviewed. In addition, facilities constructed in that time period will be identified. These assets may be proposed for exclusion from the Condition Assessment Activities.

3. CONDITION ASSESSMENT SCREENING AND PRIORITIZATION

The first steps in the Condition Assessment process will be a screening of HRSD assets to identify those at **potential** material risk of failure and to prioritize Condition Assessment Activities.

3.1 Material Risk of Failure

The term "material risk of failure" as used herein applies to assets that have a high potential for failure based on condition assessments performed. Failure is understood to imply any condition related event that results in a sanitary sewer overflow, pipe leakage, or interruption of service to HRSD's customers.

Prior to Condition Assessment Activities in the field, the screening process described in this section will identify assets with the **potential** to be at material risk of failure. For the purposes of this Condition Assessment Plan, material risk of failure will focus on physical condition defects that could lead to failure, rather than capacity limitations. An assessment of capacity will be completed in separate evaluation which includes flow monitoring and development of a hydraulic system model.

3.2 Pump Station and Pressure Reducing Station Screening

HRSD intends to perform additional Condition Assessment Activities on pumping facilities, and has developed a screening system to prioritize these field investigations. Data available for screening the pumping facilities includes:

- Installed pumping capacity
- Pump runtime
- Wet well level data and high level alarms
- Dry well flooding alarms
- Sanitary sewer overflows
- Previous equipment failures
- Operation and Maintenance staff knowledge and documentation
- Back up power usage

Prioritization of assessment of pumping facilities will be based on those with large installed pumping capacity, a previous history of sanitary sewer overflows, a pattern of high wet well level alarms, or with known maintenance problems that could lead to failure. Sanitary sewer overflow documentation will be reviewed for those occurring since September 27, 2002 to identify SSOs at HRSD pumping facilities. SCADA data will also be reviewed to determine those facilities experiencing frequent high wet well level alarms for storm events with less than a 1-year, 24-hour recurrence interval.

Other criteria for prioritizing pumping facilities condition assessment will include high pump station run time as defined in the RTS or facilities that frequently require back up power.

3.3 SCADA Screening

SCADA screening will correspond to the pumping facility screening and the Condition Assessment Activities will be performed according to the same prioritization. Additional records of HRSD's alarms and SCADA system failures will be reviewed to identify particular assets that have a chronic history of failures, if any.

3.4 Gravity System Screening

HRSD has been conducting condition assessment activities of its gravity sewer mains for a number of years. The approximately 50 miles of gravity sewer pipes are inspected periodically and higher risk segments are inspected annually. Since September 2005, the CCTV inspections have and will continue to utilize PACP compliant terminology and methods for defect rating and categorization. This existing program has previously identified significant defects which have been scheduled for rehabilitation. New significant defects are infrequently found as a result of this ongoing program. HRSD will develop a prioritization for inspection of the HRSD gravity mains and will include this prioritization and schedule in the Preliminary Condition Assessment Report. The prioritization will be based on number of overflows, rainfall derived inflow/infiltration (RDII) totals, and peak factors on average daily flow. This flow information (RDII and peak factors) will be limited to the segments where flow monitoring has been performed to date. Condition Assessment results (including previous inspection data) will be developed by the conclusion of the Condition Assessment Activities. If a sanitary sewer overflow or line failure occurs during the execution of the Condition Assessment Program, HRSD will redirect its resources to investigate that asset in an expedited manner.

3.5 Force Main Screening

The HRSD system of Force Main Interceptors is comprised of more than 430 miles of pipes ranging from 6-inch to 60-inch. The physical inspection of every HRSD force main offers several challenges and is not a wise use of resources. The force mains are buried and difficult to access, the mains can not be taken out of service for long periods of time due to the numerous connections from Locality and private pumping stations, they are difficult to dewater and they are constructed of a variety of materials each of which may require different testing methods. Development of inspection technologies for pressure mains in the sewer industry has been underway for some time and, although there are a number of technologies available, most of these technologies are relatively new and some are very new.

In traditional force main systems, the pipeline begins at a pumping station and connects directly to a downstream manhole or treatment plant headworks. These types of pressure mains are easily isolated allowing for more flexibility in assessment approaches. The HRSD force main system is far more complex, with many interconnections and multiple beginning and end points. Therefore, it has been determined that a screening process will be implemented to identify those force main segments having the **potential** for material risk of failure.

HRSD's force main screening is based on a criticality (risk) framework that will be applied to identify which segments of force mains within HRSD's sanitary sewer system have the **potential** for material risk of failure and will need to be further evaluated and possibly field inspected. Criticality is evaluated in objective fashion using available data sources. In establishing risk, the analysis considers a variety of data from two perspectives; first, what is the **likelihood** of a particular failure to occur and second, what are the **consequences** if that failure does occur.

3.5.1 Segmentation

The first task to be undertaken in the Force Main Screening Phase is the identification and delineation of the discrete force main segments to be assessed. The purpose of the segmentation is to ensure that the Condition Assessment is performed on discrete, identifiable segments which are consistent in terms of their characteristics.

The primary sources of data for the force main segmentation effort are the HRSD Geographic Information System (GIS) and the electronic files of record drawings maintained by HRSD. These data included plans and profiles from original construction contract record drawing sets and valve guides for specific inline valves, air release valves (ARV's) and force main junctions.

The intent of the segmentation process is to assist in the development of the criticality model and to facilitate the actual field inspection of the force mains. This is necessary since the HRSD force main system is highly complex and interconnected, with many changes in material and diameter. The force main segmentation criteria are planned as follows:

- A maximum length of 5,000 feet. This was based on the maximum continuous length which can typically be inspected on a single equipment insertion.
- Consistent pipeline material. Since many inspection technologies are designed for specific pipe materials, each segment must be consistent in material type in order to facilitate inspection.
- Consistent pipeline diameter. Some inspection technologies are limited to certain pipe size ranges so each segment must be consistent in diameter. In addition, the size of the force main will have an impact on the evaluation of the consequences of a failure, with larger mains posing a greater risk.
- Between line valves. With few exceptions, internal inspection equipment can not negotiate many line valves. This criterion also applies to line valves at junctions of force mains.

Each of the HRSD Force Main Lines listed in Table A-1 of Appendix A will be segmented according to these criteria. An initial pilot test indicated that this approach to segment the lines was effective as long as the changes in pipe material type or diameter were significant changes (at least 2 pipe sizes), and not, for instance, short runs of pipe installed as point repairs. As an example, one joint length of ductile iron pipe that was used to repair a cast iron force main would not be considered a separate segment. In contrast, a short section of ductile iron pipe installed under a waterway within a longer PCCP main, for example, would be considered a significant change in material because of the significant change in installation conditions and would be identified as a separate segment for assessment.

The segment data will be maintained in a GIS database specifically set up for this work. Each segment will be given a unique identifier based on the tributary area, North or South Shore and a four digit segment number. The segment numbering will begin at the tributary area treatment facility and generally work its way upstream. As an example, the first force main segment discharging to the Nansemond STP would be given the identifier of "NA-SS-0001". Once this segment is established and identified by its end points, the attribute data would be added to the database.

3.5.2 Failure History and Likelihood of Failure

HRSD maintains a data set of all force main failures in the system extending back through 1989. An initial review of failure records and the spatial distribution of failed segments did not reveal any clear factor or combination of factors as being a consistent cause of the failures, or indicating a parameter that would increase the likelihood of failure. Pipe age, material, number of connections, and gas venting records have been reviewed for correlation with force main failures. Rather it appears to be a mix of factors that has changed somewhat with time as old materials are phased out, new materials are introduced and as operational practices are initiated, expanded or improved. The failures are distributed throughout the North Shore and South Shore service areas with no clear concentrations which could be attributed to soils, groundwater, elevation or history of urban development. Therefore, the previous occurrence of a failure will be used as the indicator of the potential for future failures.

3.5.3 Consequence of Failure

To quantitatively compare the HRSD force main segments to each other, a model will be developed to determine the consequence of failure for each segment. The rankings are developed using a numerical scoring system. The approach consists of the following steps:

- Identify the criteria for assessing the consequences of failure. Criteria that may be evaluated for consequence of failure include: pipe diameter, proximity to state waters, proximity to public drinking water supply, and difficulty/cost to repair or replace.
- For each criterion, identify a range of parameters or measures and assign values covering the range of parameters.
- Assign a weighting factor to each criterion. The weighting helps characterize the criteria that are more important than others in defining risk.
- Evaluate the ranking of each force main segment for each criterion based on field staff observations.
- Calculate the criterion score for each force main by multiplying the criterion value times the criterion weight.
- The total score for each force main is calculated as the sum of all the weighted criterion scores for the consequences of failure.
- The ranking of the force main segments is then based on the ranking of the scores, with the highest score representing the force main segment with the highest consequence of failure.

Table 3-1. Summary of Force Main Scoring Criteria

Scoring Criteria	Range of Values[1]	Criteria Weight	Max. Score
Consequence of Failure			
1. Pipe Diameter	1,5 or 10	10	100
2. Proximity to State Waters	2,4,6,8 or 10	9	90
3. Likelihood of Discharge to Water Supply	0,5 or 10	10	100
4. Difficulty of Repair – Depth or location	1,5 or 10	8	80
5. Difficulty of Repair – Material Type	2 or 10	5	50
Maximum Consequence of Failure Score			420

[1] See Appendix C for a detailed description of the range of values for each scoring criteria.

3.5.4 Screening Approach

Based on the preliminary failure history review, HRSD will base its determination of force main segments having the **potential** for material risk of failure using a set of criteria listed below:

- Group 1: Force main segments which have a recorded failure during the previous ten years (1999 though 2008). These segments present the highest potential risk for additional failures.
- Group 2: For segments that have had a failure in the previous records (from 1989 through 1998), the consequence of failure will be evaluated. The consequence of failure scores from the criticality analysis

ranged up to 420, as illustrated in Table 3.1. For this analysis, segments with a consequence of failure score of 200 or greater, that have had a failure from 1989 through 1998, will be included in the Condition Assessment Activities.

The above process will identify all force main segments which have the **potential** for material risk of failure. Any of the identified force main segments that are already scheduled for repair, replacement or rehabilitation in HRSD's 2009-2014 Capital Improvement Program (CIP) or are on the list of Interim Improvements agreed to with the EPA will be removed from the Condition Assessment Activities; however some segments that are included in the CIP may overlap with the list of segments with failures since 1989. Any portions of these segments will be added to Group 2. Inspection will not be needed on the reminder of those segments because they are already scheduled for improvement.

A second set of force mains will be included in the Condition Assessment Program if they are ferrous material pipes (cast iron or ductile iron) and within 3,000 feet downstream of an HRSD pumping station. An ultrasonic wall thickness test on the exterior of these pipes at an approximate spacing of 500 feet will be performed. The location of wall thickness testing may be modified to reflect local high points and avoid paved areas and conflicting utilities.

A third set of force mains will be included in the Condition Assessment Program if they fall within 500 feet of a Hampton Roads drinking water surface reservoir. Only the portion of each segment that is within this buffer is proposed to be included in the program.

Once identified during the screening process, the segments which are not in the Capital Improvement Program will be prioritized according to the severity of the problems (Group 1 or 2 as described above) and on their consequence of failure score, as determined by the procedure in Appendix C. The prioritization will be adjusted based on proximity and shut-down sequencing to provide efficiency in completing the field activities.

3.6 Preliminary Condition Assessment Report

Upon completion of the screening process, HRSD will prepare and submit a Preliminary Condition Assessment Report ("Preliminary Report") to the EPA and DEQ according to the schedule in Section 5 of this Plan. The Preliminary Report will describe the results of the screening and preliminary risk assessment for HRSD's force mains, gravity sewers, pumping stations, pressure reducing stations, and SCADA system. The report will include a listing of all facilities that were screened and which are identified as having the **potential** for material risk of failure. The Preliminary Report will describe the process and methodology utilized for determining the **potential** for material risk of failure.

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4. CONDITION ASSESSMENT ACTIVITIES

The Condition Assessment Activities will be performed by HRSD for the pumping stations, pressure reducing stations, SCADA system, gravity sewers, and those force mains identified in the screening process described in Section 3. The data collected during these investigations will be combined with the previous condition assessment activities described in Section 2 to prepare a Final Condition Assessment Report. The following sub-sections describe the planned field assessments that will be refined in the Preliminary Condition Assessment Report. Each asset will have a blend of characteristics that require a specific program for field investigation. These sub-sections will outline the planned approach for each asset class.

4.1 Field Investigation Approach

The objective of the Condition Assessment Activities is to provide an appropriate level of system information to support sound rehabilitation and/or replacement decisions for HRSD's sanitary sewer system. In order to accomplish this, an investigation approach must be in place which allows the tracking and evaluation of a wide range of factors. The objectives of a standardized field investigation approach are:

- Progressively evaluate sewer assets without expending unnecessary time and resources
- Previously-executed investigation and/or rehabilitation efforts are utilized, where appropriate
- Investigation activities are prioritized according to identified problem areas

As discussed in Section 1, HRSD's sanitary sewer system has been grouped into distinct asset types which will undergo condition assessment activities in three parts: Force Main Condition Assessment, Pumping Facility Condition Assessment (including pumping stations, pressure reducing stations, and SCADA systems), and Gravity System Condition Assessment. Field investigations will be conducted according to these three condition assessment groupings as shown below:

Force Main Condition Assessment

Inspection of Force Main Segments having the potential for Material Risk of Failure

Pumping Facility Condition Assessment

Inspection of Pumping Stations, Pressure Reducing Stations, and SCADA Systems

Gravity System Condition Assessment

Inspection of Gravity Pipelines and Manholes

Figure 4-1. Condition Assessment Groupings

For each condition assessment grouping, the investigation approach has been outlined herein. This section of the Plan provides details on the standardized methods for conducting the necessary field investigations within the HRSD sanitary sewer system as deemed necessary by the phased field investigation approach. Certain asset conditions will warrant prompt action when found during the course of the Condition Assessment Activities. Prompt action is warranted when asset defects are determined to meet one or more of the following criteria:

- Pose an immediate threat to the environment
- Pose an imminent threat to the health and safety of the public
- Create operational problems that may result in SSOs
- Contribute substantial inflow to the system

Section 4.5, Prompt Repairs, provides details regarding the prompt repair of defects that meet the above criteria. Information collected during field investigation activities will be documented as defined in Section 4.6, Final Condition Assessment Report.

4.1.1 Procedures for Condition Assessment Activities

The condition of assets in HRSD's sanitary sewer system will be assessed using data collection methods specific to three distinct infrastructure groups: **force mains, pumping facilities, and gravity systems.** Uniform assessments will be conducted to aid in the evaluation of data and provide a common basis for assessing rehabilitation needs. Databases and GIS systems will be used by HRSD to store and manage asset condition data collected during the assessment activities. Standardized field investigation activities will be performed as defined in the field investigation approach contained within Section 4.1. The following sections summarize the assessment activities to be implemented, and a general summary of these assessment activities is presented below:

- **Force Main Condition Assessment**
    - Force Main Field Inspection
    - Air Vent Inspection
    - Aerial Crossing Inspection
- **Pumping Facility Condition Assessment**
    - Building Condition Inspection
    - Pump, Motor, and Drive Inspection
    - Wet Well Inspection
    - Corrosion of Ancillary Equipment
    - Dry Well Inspection
    - Piping Inspection
    - Emergency Equipment Inspection
    - SCADA Equipment Inspection
    - Pump Draw-down Tests
    - Lightning Strike Protection
- **Gravity Sewer Condition Assessment**
    - Manhole Inspection
    - Pipeline Inspection using Closed Circuit Television (CCTV), Laser and/or Sonar, as appropriate
    - Smoke Testing (as needed to complement CCTV inspection in very limited areas)
    - Dye Testing (as needed to complement CCTV inspection in very limited areas)

4.2 Pumping Facility Condition Assessment

Pumping facilities within the HRSD sanitary sewer system will be inspected for physical condition, SCADA and systemic issues which may negatively impact performance. Each issue will be evaluated depending on the facility type, either pumping station or pressure reducing station. Typical issues include, but are not limited to:

- Grease: Grease buildup interferes with station operation by inhibiting the operation of level sensors
- Impeller wear: Entry of sandy soil and grit into the wet well by way of structural defects in the gravity sewers reduces the effective wet well capacity and causes excessive impeller wear
- Mechanical and electric anomalies and/or failures: Reduce reliability and performance
- Excessive pump run times: Can be an indicator of capacity issues or equipment wear
- Influent surcharge: Improper "pump on" set point or inlets constructed close to pump centerline can lead to influent pipeline surcharge. Note that some stations are set up for minimal surcharging to minimize air entrainment.
- Wet-well surcharge, SSOs: System head on manifolded networks that exceeds the pumping capability of the pumping station, or influent flow that exceeds pumping capacity can lead to overflows and excessive pump run times
- SCADA instrumentation calibration: SCADA instruments are out of calibration

Pumping facility inspections and evaluations will be conducted in a consistent manner. Some key information that may be obtained during a pumping facility inspection is outlined below:

Building Condition – Visually inspect the interior, exterior, and roof of the building for physical or structural problems and record defects that may lead to SSOs or unsafe conditions.

Pumps, Motors, and Drives – From the manufacturer's data plates and any up-to-date maintenance information, record the pump head in feet, the capacity in gallons per minute and the impeller diameter in inches for each pump. Record the listed horsepower and RPM for the motors. Observe the pumps and motors for vibrations, sounds, temperature and odor. The operating logs will be reviewed. The operations staff will be consulted to determine under what conditions and how long all pumps operate at the same time.

Wet Well – Inspect the wet well in a drawn down state to ensure a proper visual inspection. Accumulation of debris, sediment and grease buildup will be removed when the wet well is drawn down for the inspection. The walls will be observed for coating condition, spalling or softness of concrete, erosion of concrete and the condition of bottom fillets.

Corrosion of Ancillary Equipment – While the wet well is in a drawn down state and after cleaning, inspect the ventilation system ducts and fans, access hatch, interior railing, access ladder and platforms, pump control system, pump rails, and interior piping for corrosion.

Dry Well – Inspect the dry well for structural conditions of concern.

Piping – While the pump station is on-line, visually inspect the piping, valves (check, isolation, surge relief and air relief) and other fittings for corrosion, leakage, coating system condition, and proper operation.

Emergency Generator/Pump – Observe the generator/pump while running under typical daily load to verify its operation, noting excessive noise, excessive vibration, dark exhaust, and ease of generator/pump starting. Test to ensure that the device will automatically start upon loss of power.

SCADA Equipment/Programming – Check alarms in the SCADA system. The following alarms and indications at the pumping facilities will be tested or assessed, if existing:

- Wet well high level and low level alarms
- Dry well flood alarms
- Dry well sump pumping failure
- Any of the following power anomalies:
  - Loss of utility power
  - Single phase condition
  - Over-voltage and under-voltage
  - Use of standby power
  - Failure of standby power
  - Use of alternate power source
  - Loss of alternate power source
- Pump failure

Pump Draw-down Tests – Perform pump draw-down tests at HRSD wet well pumping stations to determine actual pump operating conditions. These results will be compared to manufacturers' curves to identify anomalies that may be indications of excessive wear.

Lightning Strike Protection – Evaluate the protection, if any, in place at each pumping station against lightning strikes. Grounding equipment will be inspected and documented. Records and operators' knowledge will be reviewed to identify whether a station is prone to lightning strikes which cause an outage that results in SSOs.

The procedures discussed in this section and in Appendix B provide details for assessing the condition of HRSD's pumping facilities. In this assessment methodology, pumping station assets are evaluated in terms of physical condition.

The pump station condition assessment procedure is organized as follows:

- **Pumping Facility Condition Rankings –** The condition scoring protocols are listed for each pumping facility asset;
- **Pumping Facility Condition Assessment Form –** Information regarding how to complete the *Pumping Facility Condition Assessment Form* is provided; and
- **Pumping Facility Asset Inspection Procedures –** The step by step protocol to be followed while performing the assessment. These procedures are provided in Appendix B.

4.2.1 Pumping Facility Condition Rankings

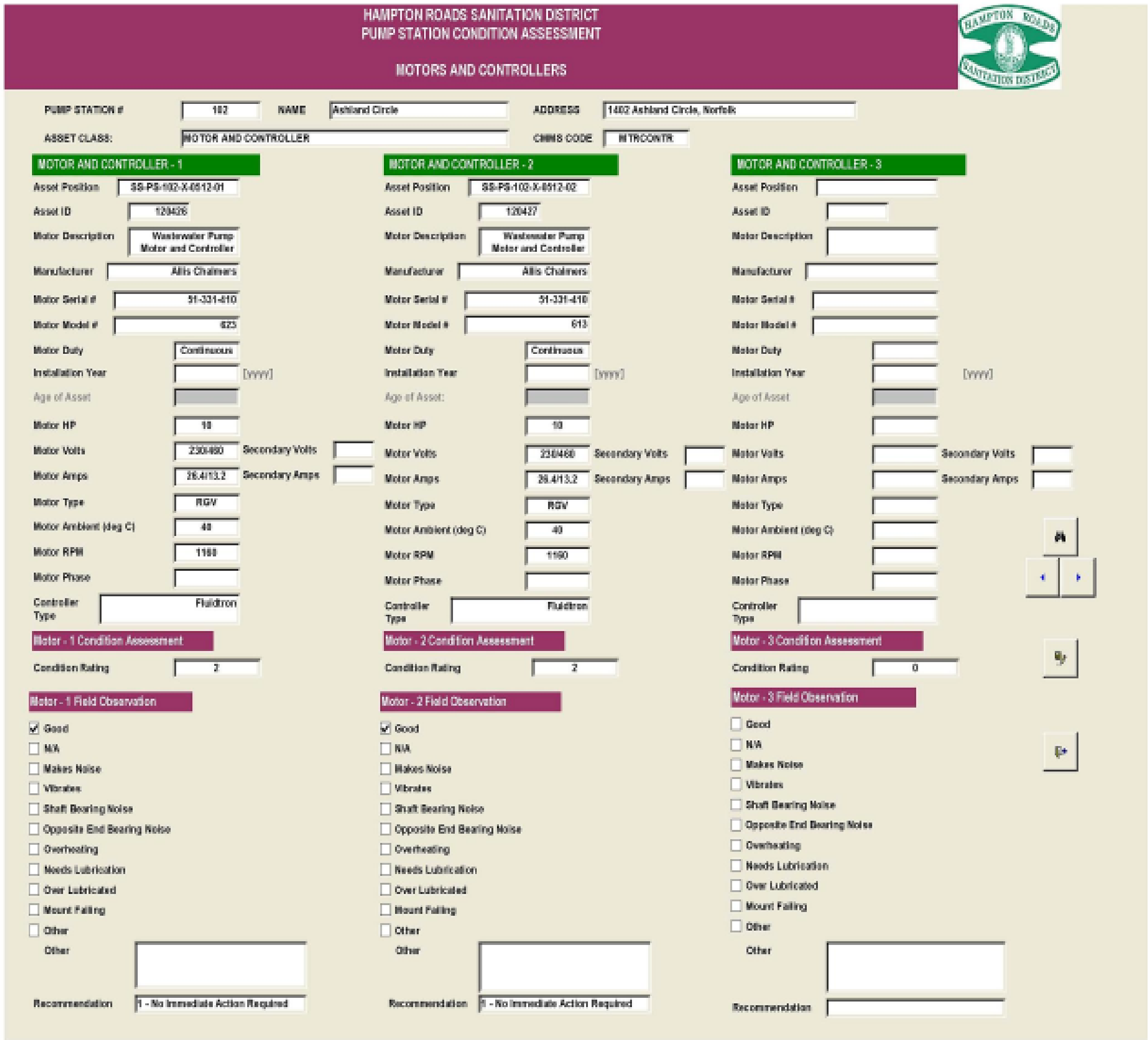
Each asset should be scored (1-5) according to the following guidelines:

Condition

1. Excellent – No Visible Degradation
2. Slight Visible Degradation
3. Visible Degradation
4. Integrity of Component Moderately Compromised
5. Integrity of Component Severely Compromised

4.2.2 Pumping Facility Condition Assessment Form

The condition assessment form (either electronic or paper version) will be completed for all pumping facilities. In order to standardize documentation, a single set of forms will be created; however, not all data on the forms is available for all pumping facilities. A screenshot of a typical condition assessment form for the Motors and Controllers asset class can be seen below.



HAMPTON ROADS SANITATION DISTRICT
PUMP STATION CONDITION ASSESSMENT

MOTORS AND CONTROLLERS

PUMP STATION # 102
NAME Ashland Circle
ADDRESS 1402 Ashland Circle, Norfolk
ASSET CLASS: MOTOR AND CONTROLLER
CMMS CODE MTRCONTR

	MOTOR AND CONTROLLER - 1	MOTOR AND CONTROLLER - 2	MOTOR AND CONTROLLER - 3
Asset Position	SS-PS-102-X-0512-01	SS-PS-102-X-0512-02	
Asset ID	120426	120427	
Motor Description	Wastewater Pump Motor and Controller	Wastewater Pump Motor and Controller	
Manufacturer	Allis Chalmers	Allis Chalmers	
Motor Serial #	51-331-410	51-331-410	
Motor Model #	623	613	
Motor Duty	Continuous	Continuous	
Installation Year [yyyy]			
Age of Asset			
Motor HP	10	10	
Motor Volts	230/460	230/460	
Secondary Volts			
Motor Amps	26.4/13.2	26.4/13.2	
Secondary Amps			
Motor Type	RGV	RGV	
Motor Ambient (deg C)	40	40	
Motor RPM	1180	1180	
Motor Phase			
Controller Type	Fluidtron	Fluidtron	
	Motor - 1 Condition Assessment	Motor - 2 Condition Assessment	Motor - 3 Condition Assessment
Condition Rating	2	2	0
	Motor - 1 Field Observation	Motor - 2 Field Observation	Motor - 3 Field Observation
Good	☑	☑	☐
N/A	☐	☐	☐
Makes Noise	☐	☐	☐
Vibrates	☐	☐	☐
Shaft Bearing Noise	☐	☐	☐
Opposite End Bearing Noise	☐	☐	☐
Overheating	☐	☐	☐
Needs Lubrication	☐	☐	☐
Over Lubricated	☐	☐	☐
Mount Failing	☐	☐	☐
Other	☐	☐	☐
Other			
Recommendation	1 - No Immediate Action Required	1 - No Immediate Action Required	

Figure 4-2. Example of Pumping Facility Condition Assessment - Screenshot

The pump station information at the top of the form includes the pumping facility number, name, and address, and the asset class and code. When using the electronic database, the asset information section includes the asset position, ID, and description, which are auto populated (if available) and require no input during field data collection.

Condition ranking will be completed for the assets that are present in the pumping facility by using the guidelines mentioned in the previous section, "Condition Rankings". These rankings will be determined by the visual inspection, and any additional observation will be mentioned in the "Field Observation / Comments" section. Any observations not listed will be noted in the "Other" text box.

Condition assessment forms similar to the example shown in Figure 4-2 will be developed for the following asset classes:

- Batteries and Charger
- Air Compressors
- Electrical Systems
- Diesel Engine
- Generator
- HVAC
- Instrumentation
- Motors, Drives and Controllers
- Pumps
- SCADA
- Structural and Wet Well
- Tanks
- Transfer Switch
- Valves

HRSD will develop Condition Assessment reports that can be output from the database to provide documentation for the Final Condition Assessment Report.

In addition, HRSD will evaluate each pumping facility for its potential for damage due to flooding. HRSD will review records for each pumping facility from the previous 5 years to identify previous instances of flooding and determine which have a material susceptibility to damage from flooding. Extreme wet weather events will not be considered. This effort will include evaluation of each pumping facility for history of flooding, consideration of steps to prevent inundation and/or to reduce the time required to bring the facility back into service, development of preliminary cost estimates for the identified measures (if any), analysis of the potential benefits of flood-proofing pumping facilities, and development of an appropriate plan for each pumping facility that is susceptible to flooding.

4.2.3 Pumping Station Capacity Evaluation

As previously discussed, HRSD has identified all of its pumping facility assets for inclusion in the Condition Assessment Activities. As part of the assessment, HRSD will evaluate the firm design capacity of the wet well pumping stations against Peak Flow Threshold values (where available) from upstream Locality service areas. The Peak Flow Threshold is defined as 775 gallons per day per equivalent residential unit plus three times actual commercial water consumption plus actual industrial water consumption. A Summary Table will be developed to document the relationship between HRSD's facilities and the Locality facilities. This table will be organized by HRSD Pump Station and includes information such as:

- Upstream HRSD gravity sewer segments, linear feet of gravity main, and number of HRSD manholes;
- Associated HRSD flow monitor if applicable;

- Occurrence of Unresolved SSOs in the gravity system or at the pump station;
- Excessive Pump Runtime. This situation exists when the total run time for all pumps within a pump station exceeds an average of 24 hours per day for a two-pump station, 48 hours for a three-pump station, or 72 hours for a four-pump station;
- Firm design capacity of the pumping facility and pump type; and
- Data on upstream Locality sewer basins as documented in their SSES Plans submitted to the DEQ, including their Peak Flow Threshold and SSES status.

The Capacity Evaluation performed in this process is intended to provide an interim assessment of the capacity as each HRSD pumping station, while the more complete Capacity Assessment will be performed using the Regional Hydraulic Model for the Regional Wet Weather Management Plan (RWWMP). Therefore, no remedial actions will be taken based on the results of this interim assessment. The RWWMP will define the level of service required for each facility and determine the necessary capacity improvements.

4.3 Force Main Condition Assessment

The HRSD sanitary sewer system contains approximately 430 miles of force mains, of varying ages, materials, diameters, and physical conditions. The HRSD force main system is unique in that the force mains are extensively interconnected with numerous in line valves and junctions and many points of inputs from Locality and private pumping stations. The force mains identified in the Condition Assessment Screening process as being at **potential** for material risk of failure will be evaluated in the field to ascertain their physical condition. HRSD will then identify whether an **actual** material risk of failure exists and repair, rehabilitation or replacement is needed, unless renewal or replacement is already scheduled for that segment.

At present there are several technologies available for inspecting pressure mains. Some of these are based on technologies developed for the gas and petroleum industry and some were originally developed for use in water mains. The effectiveness of these technologies varies considerably, especially for inspection of wastewater force mains. After critical review of the ease of use of the technology and the reliability and usefulness of the resulting inspection data, nine systems were selected for use in the HRSD Force Main Condition Assessment Program. Four technologies have been added to the original nine in the following paragraphs to provide greater detail. Broadband electromagnetic (BEM) technology has been included as more results on its applicability and reliability have been reported, and since it fills a gap in the coverage of ferrous pipes. Borescopes have been added to the list to be used in the Level 2 inspections. This is a proven technology for inspecting the interior of pipes. For discussion, two long term evaluation technologies for PCCP mains have been added (Acoustic Emission Testing and Acoustically Sensitive Fiber Optic) in order to provide better information on the remaining useful life of these pipes.

In addition, there are two technologies which are in the early stages of development, one of which, acoustic wall thickness, will soon be field tested in the HRSD system. The other, the ultrasonic crawler, will be field tested in New York City in the coming months. These technologies are listed in Table 4-1, revised from the table submitted in February 2009, to show the new technologies that are being tested (in light blue). The table shows the types and sizes of pipes which can be inspected by each system, the types and quality of the information provided and the condition of the pipe during the inspection.

Table 4-1 presents a list of selected pressure main inspection technologies which have been shown to provide reliable results and may be applicable to the HRSD system. Inclusion in the table does not mean that all technologies will be used. The final choice of technologies will be conducted using the guidelines in the text that follows.

A brief description of each technology is provided in the following paragraphs.

Acoustic Leak Detection (ALD). There are two primary technologies in this category: the Pressure Pipe Inspection Company's (PPIC's) Sahara and Echologics' LeakfinderRT. Both are capable of locating leaks. LeakfinderRT is attached to the exterior of the pipe or fittings and uses a sound correlator, whereas Sahara is inserted into the live main and records sounds directly. The Sahara technology has also been demonstrated to be capable of detecting air pockets which is of critical interest in the FM Inspection Program. For these reasons, the Sahara system is preferred and is described here.

The Sahara system consists of an acoustic sensor which is attached to a parachute and inserted through a 2 inch diameter hot tap into the live pressure main. The force of the moving liquid propels the sensor and parachute through the main. The sensor is attached to a 5/8 inch thick coaxial cable which continuously sends signals back to the monitoring operator in a van. Newer vans are equipped with up to 6,000 feet of cable. The operator listens for sounds typically made by leaks, by air pockets, entrained air or other sources of turbulence. The operator can stop the sensor and pull it back to check on specific sounds. When an anomalous sound is detected, the location of the sensor is determined by a combination of a metering wheel on the cable drum and on a operator on the surface with a device which detects a signal emitted by the acoustic sensor. In this way, anomalies can be located within several feet. The Sahara system has been successfully tested in wastewater force mains and requires a minimum of 1.0 fps of flow for most simple pipe runs, and up to 2.0 fps where there are multiple bends or fittings. Sahara can be used in pipes of any material and any diameter above 10 inches.

Free Swimming Leak Detection (FSL). There are now two technologies in this category which is for un-tethered systems: PURE Technology's SmartBall and PPIC's PipeDiver. The SmartBall has successfully undergone multiple field tests in wastewater force mains in recent years whereas the Pipediver is very new and untested. Therefore, SmartBall will be described here.

SmartBall is a roughly 2-inch diameter aluminum sphere which contains an acoustic sensor, an array of other sensors as appropriate to the application, a memory chip, a pulse emitter and batteries with up to15 hours of life. This sphere is then inserted into a foam ball of varying dimensions to suit the pipe diameter. The SmartBall is then inserted into the main through a minimum 4-inch diameter tap. The force of the moving liquid propels the ball through the main. An expandable net is used to capture the ball in potable water systems, however due to the debris in the wastewater flow, the ball is typically captured at the treatment plant headworks. On retrieval the memory chip is downloaded and analyzed with proprietary software to identify sound anomalies, including leaks, air pockets and other sources of turbulence. The ball emits a pulse which is tracked by detectors placed along the route. Location of the anomalies is determined from on-board sensors coupled with the tracking data from the run. Like Sahara, the SmartBall needs at least 1.0 fps for simple runs but a velocity of 2.0 fps is preferred for more complex pipe configurations. SmartBall can be used in pipes of any material and any diameter 10 inches or above.

It should be stressed that ALD and FSL are inspection technologies which provide indications of severe defects (leaks) or possible corrosion sites (air pockets), while no direct information on pipe wall thickness is obtained.

Acoustic Wall Thickness (AWT). AWT technology however is ***potentially*** a pipe wall condition assessment tool as it may provide data on pipe wall thickness and pitting. There are two firms with a system under development in this category: Echologics and PPIC. PPIC proposes to test the use of the Sahara system coupled with accelerometers to measure the average pipe wall thickness between sites. The first such test will be conducted in the HRSD system in October 2009. The Sahara system is inserted and operated as in the ALD system described above. A series of accelerometers are installed on the pipeline exterior at selected intervals of from 250 to 500 feet. These devices can be installed on the pipe exterior through 1 foot diameter potholes from the surface. Acoustic pulses are generated at each site and the Sahara acoustic sensor picks up the sound wave as it passes its location. The sensor is then moved and another sound pulse generated. Specially developed software analyzes the time the pulse took to arrive at the sensor and, using known or tested values for the pipe materials Young's modulus and the bulk modulus of the liquid, can calculate the average thickness of the pipe wall in the intervening length. This technology would only work in pipes of uniform material such as ferrous pipes and asbestos cement (versus PCCP).

Ultrasonic Crawler (UC). Developed in Germany by Inspector Systems, the ultrasonic crawler is currently under test in the US. It promises to be able to measure remaining wall thickness and pits in ferrous pipes. Installed on a wheeled crawler, it is adaptable to pipes up to 20 inches although larger models are under development. The technology uses circular arrays of ultrasonic emitters to measure differences in wall thickness around the circumference of the pipe. The pipe must be dry and open for insertion of the crawler. Recent testing in the US revealed that the original programming was for steel pipe, which is more typical in Germany. The firm is now retooling to use the technology in ductile and cast iron pipes.

Remote Field Eddy Current (RFEC). There is only one RFEC technology currently available for the internal inspection of ferrous pipe for evaluation of wall thickness: the Russell NDE See Snake. The See Snake can be used in pipe up to 8 inches in diameter with new models reportedly being tested in sizes up to 24 inches. The See Snake can be inserted into the live main and use the liquid flow for propulsion. The technology generates magnetic fields in the pipe wall (direct field) and outside the pipe wall (remote field). The direct field is rapidly attenuated but the remote field can be measured by a trailing detector. Variations in the remote field strength provide information on pipe wall thickness and any pitting, both internally and externally.

Broadband Electromagnetic (BEM). Originally developed in Australia by Rock Solid Pty., BEM is currently provided by a number of US firms. Internal 'pigs' have been developed down to 18 inches diameter and up to 48 inches. The pig is inserted into the dry pipe and pulled or winched through the pipe in short steps. At each step, the pig induces a field and then measures the response, collecting data on the entire circumference of the pipe. Similarly to the RFEC technology, BEM creates a magnetic field within the ferrous pipe and measures the resulting eddy current patterns. This provides a tremendous amount of data on the pipe wall thickness and the presence of both internal and external pitting.

Remote Field Eddy Current /Transformer Coupled (RFEC/TC). There are two firms providing RFEC/TC technologies for the inspection of pre-stressed concrete cylinder pipe (PCCP): PPIC and PURE. As with the RFEC technology, RFEC/TC creates a magnetic field within the pipe. In PCCP, this in turn creates a responding field in the pre-stressing wire cage which is then measured by the coupled transformer. Anomalies in the magnetic field indicate wire breaks. The technology can also detect pinholes in the steel cylinder. These technologies can be used in pipe sizes from 16 inches up to the largest PCCP made. Certain configurations of the equipment can be used in submerged conditions up to about 42-inch diameter. Above that size, the pipeline must by dry.

The RFEC/TC technologies provide information on the current condition of the pre-stressing wire and the steel cylinder in PCCP mains. Two technologies, AET and AFO, provide long term data on the rate at which the pre-stressing wires continue to break. This allows for the calculation of the remaining useful life of the main.

Acoustic Emission Testing (AET). PPIC offers the AET system for the long term testing of PCCP wire breaks. The system uses a series of hydrophones and accelerometers placed at intervals along the pipe route to listen for wire breaks. The devices must be attached to the exterior of the pipe, and can be installed using potholing techniques. The location of the breaks is calculated based on the time of arrival and the speed of sound in the liquid.

Acoustically Sensitive Fiber Optic (AFO). Several firms, including PURE, offer AFO technologies for the long term assessment of the rate of wire breaks in a PCCP main. The fiber optic cable is installed in the main with the main taken out of service. Valves and other fittings may require routing the cable outside the pipe. The pipe is then returned to service. The cable responds to the pressure wave generated by the sound of a wire breaking. The event is recorded and software identifies the location of the break. In this way, a long term picture of the rate of deterioration of the pipe segments can be developed.

Borescope (BSC). The borescope is a commonly available device much like the medical devices used for knee and other surgeries. It consists of a slender tube with fiber optics and a light source. The tube can be quite narrow and some models come with lights up to 1000 watts in power. The borescopes are inserted into hot taps with pressure glands allowing passage of the tube. The hot taps are placed at locations where acoustic testing (ALD or FSL) have indicated an air pocket at a high point in the line with no air release vent. This requires that the pipe be excavated and the crown exposed for installation of the tap and conduct of the inspection. The borescope is used to visually inspect the interior of the main in the air pocket to evaluate the extent of any damage due to corrosion. This inspection need only cover the crown of the pipe in the vicinity of the air pocket. The inspection can take place while the main is in service, taking care not to disturb the air pocket.

Sonar (SO). Sonar devices use sound waves to create a profile of the pipe interior. Since sound travels better through water than air, sonar is used to create a profile of the pipe interior under water in situations where the pipe can not be drained. The resulting sonar profile provides an indication of the pipe ovality, indicates gross wall defects and debris in the invert, all below the waterline. The sonar will not show fine defects such as small cracks. Analysis of the sonar profile is reportedly useful to indicate deterioration of the pipe wall especially in concrete pipes but this is unreliable. Sonar can be mounted on both tractors and floating platforms, depending upon the level of flow and the flow velocity. Care must be taken to ensure that the sonar housing on floating platforms will not become grounded if there is excessive debris in the invert. While only a few manufacturers actually make sonar units in the US, many inspection firms use them. Sonar systems are used in gravity mains which can not be taken out of service, in force mains and in siphons and other difficult to inspect pipelines.

Laser Profiling (LP). In a similar fashion to sonar, laser systems are used to create an interior profile of the pipeline. Where sonar is used below the water surface, lasers must be used in the atmosphere above the waterline. Lasers can be either 2-D or 3-D depending on the level of detail required in the finished ‘picture’. A typical 2-D laser profile will provide an indication of the pipe ovality above the waterline as well as gross defects in the pipe wall. Fine defects such as cracks will not be apparent. The value of both sonar and laser profiles is that they provide clear evidence of pipe ovality where the human eye is easily fooled using CCTV alone. Lasers can be deployed either on tractors or on floating platforms, similarly to sonar systems.

Closed Circuit Television (CCTV). CCTV is perhaps the most common pipeline inspection system in use. It typically must be used above the water line in wastewater systems. Most systems today are color with improved resolution and high power lighting. The camera lens should be maintained at the pipe central axis to reduce parallax effects. Cameras now are typically capable of pan and tilt motions and can be deployed on skids, tractors or floating platforms. Most CCTV units are tethered with a telemetry cable and a power cable for the lights and tractor motor. However, a recent technology, SOLO by RedZone is an untethered CCTV system which is proving to be a useful addition to the inspection toolbox. It is released into the system and either returns to the point of release or navigates to a pre-set location.

Sonar, laser and CCTV systems are often combined, especially in large diameter mains which can not be removed from service and continue to flow partially full. The combination of sonar and CCTV, with software to join the two recordings, has been marketed under the name TISCIT. Several firms now offer both crawler and floating platforms in which all three systems can be deployed as well as other sensors such as temperature, conductivity, inclinometers, etc.

Digital Sewer Scanning (DSS). Originally developed in Japan, DSS (or SSET) is similar to CCTV in that it makes a visual record of the pipe interior. Like CCTV, it must be used in the atmosphere and is typically deployed on a wheeled or tracked crawler. The DSS systems differ in that they take a continuous 360 degree image of the pipeline as it travels through the main. The operator therefore does not need to stop the inspection to code a particular defect. The resulting digital recording of the pipe interior can then be 'unfolded' and laid flat for evaluation in the office.

Table 4-1. Applicable Pressure Main Inspection Technologies (Revised Sept 8, 2009)

TECHNOLOGY		Pipe	Pipe	Flow Condition	Bypass Needed?	Pipe Condition	Testing Parameters
Name	Abbrev.	Material	Diameters				
Acoustic Leak Detection	ALD	All Pipes	All >= 10"	Hot	No	Requires 2" minimum tap	Leaks, air pockets
Free Swimming Leak Detection	FSL	All Pipes	All >= 10"	Hot	No	Requires 4" minimum tap	Leaks, air pockets
Acoustic Wall Thickness	AWT	Ferrous and AC	All diameters	Hot	No	Requires 2" Minimum tap	Wall thickness
Ultrasonic Crawler	USC	Ferrous	8" to 24"	Dry	Yes	Pipe must be opened, drained	Wall thickness, pits
Remote Field Eddy Current	RFEC	Ferrous	2" to 24"	Submerged	Yes	Pipe must be opened for access	Wall thickness, pits
Broadband Electromagnetic	BEM	Ferrous	18" to 48"	Dry	Yes	Pipe must be opened, drained	Wall thickness, pits
Remote Field Eddy Current/ Transformer Coupled	RFEC/ TC	PCCP	16" to 42"	Submerged	Yes	Pipe must be opened for access	Wire breakage, cylinder condition
			> 42"	Dry	Yes	Pipe must be opened, drained	Wire breakage, cylinder condition
Acoustic Emission Test	AET	PCCP	All diameters	Hot	No (after installed)	After installation no modification	On-going wire breakage
Acoustically Sensitive Fiber Optic	AFO	PCCP	All diameters	Hot	No (after installed)	After installation no modification	On going wire breakage
Borescope	BSC	All pipes	All diameters	Hot	No	Requires 2" tap (Install ARV after)	Evidence of internal corrosion
Sonar	SO	All pipes	> = 12"	Submerged	Yes	Pipe must be opened for access	Ovality, debris, gross defects
Laser Profiling	LP	All pipes	> = 6"	Dry	Yes	Pipe must be opened, drained	Ovality, debris, gross defects
Closed Circuit Television	CCTV	All pipes	> = 6"	Dry	Yes	Pipe must be opened, drained	Interior detail, fine defects
Digital Sewer Scanning	DSS	All pipes	> = 8"	Dry	Yes	Pipe must be opened, drained	Interior detail, fine defects
CCTV / Sonar (Unit)	TISCIT	All pipes	21" to 100"	Hot	Partial	Partially full condition	Interior detail, fine defects above water, debris and gross defects below water

Notes: Technologies shaded in light blue are potential technologies being tested

The inspection technologies that are applicable to each pipe segment in some cases depend upon the pipe material and the pipe diameter. The table above presents the pipe materials which can be inspected with each technology and the range of pipeline diameters applicable to each method. Several technologies are capable of being inserted while the pipeline is in operation, referred to as 'hot' in the table. Other technologies require that the force main be out of service but can be used while the main is flooded. The flow condition is noted as 'submerged' for these technologies. Several technologies must be used when the force main is completely dry, requiring the main to be out of service and drained. Except for those technologies which can be inserted while the force main is 'hot', the inspection technologies may require flows to be diverted or bypassed during the course of the inspection as noted. The column labeled 'Flow Condition' indicates the status of the force main during the inspection. The right column lists the testing parameters each technology will provide data for condition assessment.

The entries in Table 4-1 under the columns labeled 'Flow Condition' and 'Pipe Condition' provide an indication of the level of intrusion of each technology into the pipeline operation and status. There are three levels of intrusion which can be summarized as follows:

Level 1 and Level 2: The equipment can be inserted while the force main is operating. An insertion tap may have to be installed but the force main can be kept running, or **'hot'**. The two acoustic technologies, ALD and FLS, are the technologies which can be used in a Level 1 inspection. Level 2 requires additional effort to access the pipe but it can remain in service and is primarily for borescope evaluation and/or ultrasonic wall thickness testing of the pipeline.

Level 3: The equipment can not be inserted while the force main is pressurized. Based on the differing technologies, the pipeline may be taken out of service but not necessarily need to be drained for the inspection. Other Level 3 inspections can only be completed when the pipeline is **dry**. In certain cases when the force main is flowing partially full, such as at low flow conditions or at peak elevations in the profile, a specialized tool platform providing both CCTV and Sonar together can be utilized.

Each higher level presents a greater risk to HRSD in terms of loss of the beneficial use of the force main, inconvenience to the public, potential damage to the force main and cost. The proposed condition assessment program provides a balanced approach which will develop the data needed to assess the condition of HRSD's force main segments and which will also present minimal operational and financial risk.

4.3.1 Proposed Force Main Condition Assessment Program

The proposed Force Main Condition Assessment Activities consist of the inspection of the force main segments that will be identified per Section 3 as presenting a **potential** material risk of failure, and an assessment of the physical condition of the force main segment based on the analysis of the inspection data. The proposed program will consist of the following work flow.

4.3.1.1 Level 1 Force Main Inspection

The average and peak daily flow velocities in each segment will be determined based on hydraulic modeling and evaluated in conjunction with the number of bends and other fittings within the pipe length to be tested. In some cases during Field Activities, it may be determined that a certain segment can not be inspected with a Level 1 technology due to lower velocities than anticipated or additional bends/fittings, in which case a Level 3 technology will be used.

The acoustic technologies in a Level 1 inspection will identify leaks and gas pockets. If the Level 1 inspection identifies no leaks and no air pockets within the segment, no further inspection of the segment will be necessary. Any significant air pockets that are detected, which are not located under an air release valve (ARV), will be evaluated and scheduled for further field inspection under Level 2.

In the case where a leak is suspected, the pipe will be exposed and if the leak is confirmed, the pipe will be scheduled for prompt repair. In cases where the pipe cannot be exposed, other options will be evaluated to confirm the leak.

4.3.1.2 Level 2 Force Main Inspection

Level 2 inspections include pipe wall condition assessment while the pipeline remains in service. The technologies included in Level 2 are borescope and ultrasonic wall thickness testing. Level 2 is warranted if the Level 1 inspection indicates an air pocket not in the vicinity of an air release valve. The pipeline at the site of the air pocket will be excavated to expose the pipe crown. After reviewing the pipeline profile to determine the need for a new ARV, one will be installed at the measured high point in the pipeline, if warranted. The tap for the ARV will be used to conduct a Level 2 borescope inspection of the interior of the pipe at the high point. If the internal inspection reveals minor or no interior corrosion damage, no further inspection of this segment will be required.

If the internal inspection at any of the high points within a segment indicates major corrosion damage which might compromise the strength of the pipe wall, the feasibility of conducting a Level 3 inspection will be evaluated for the segment or portions thereof.

The second type of Level 2 inspection is the ultrasonic pipe wall thickness evaluation. Those pipes identified in the screening process as being ferrous pipes within 3,000 feet downstream of an HRSD pump station will be tested using this approach. Pits will be dug at an approximate spacing of 500 feet along the pipe alignment to access the exterior crown of the pipe, and an ultrasonic inspection will be performed. Locations for the testing will attempt to focus on potential unvented high points based on surface elevation. Paved areas and areas with conflicting utilities will be avoided. If significant wall deterioration is found, the segment will be elevated to a Level 3 inspection.

4.3.1.3 Level 3 Force Main Inspection

In those instances where a Level 1 technology can not be used, or where the results of the Level 2 inspection indicate potential corrosion, the feasibility of conducting a Level 3 inspection of the segment will be evaluated. A Level 3 inspection will require that the force main be taken out of service. The flows must either be rerouted using alternate force mains or, if an alternate route is not available, the flow must be bypassed around the length of main to be inspected. Once the force main is depressurized, the pipeline will be opened and the Level 3 technology inserted for the inspection. The costs of a Level 3 inspection and the disruption to service will be substantial. Based on a comparison of the costs of the inspection versus the costs for renewal of the segment, HRSD may opt to forego the inspection and schedule the segment for renewal.

Figure 4-3 provides a process flowchart for the Force Main Condition Assessment Activities.

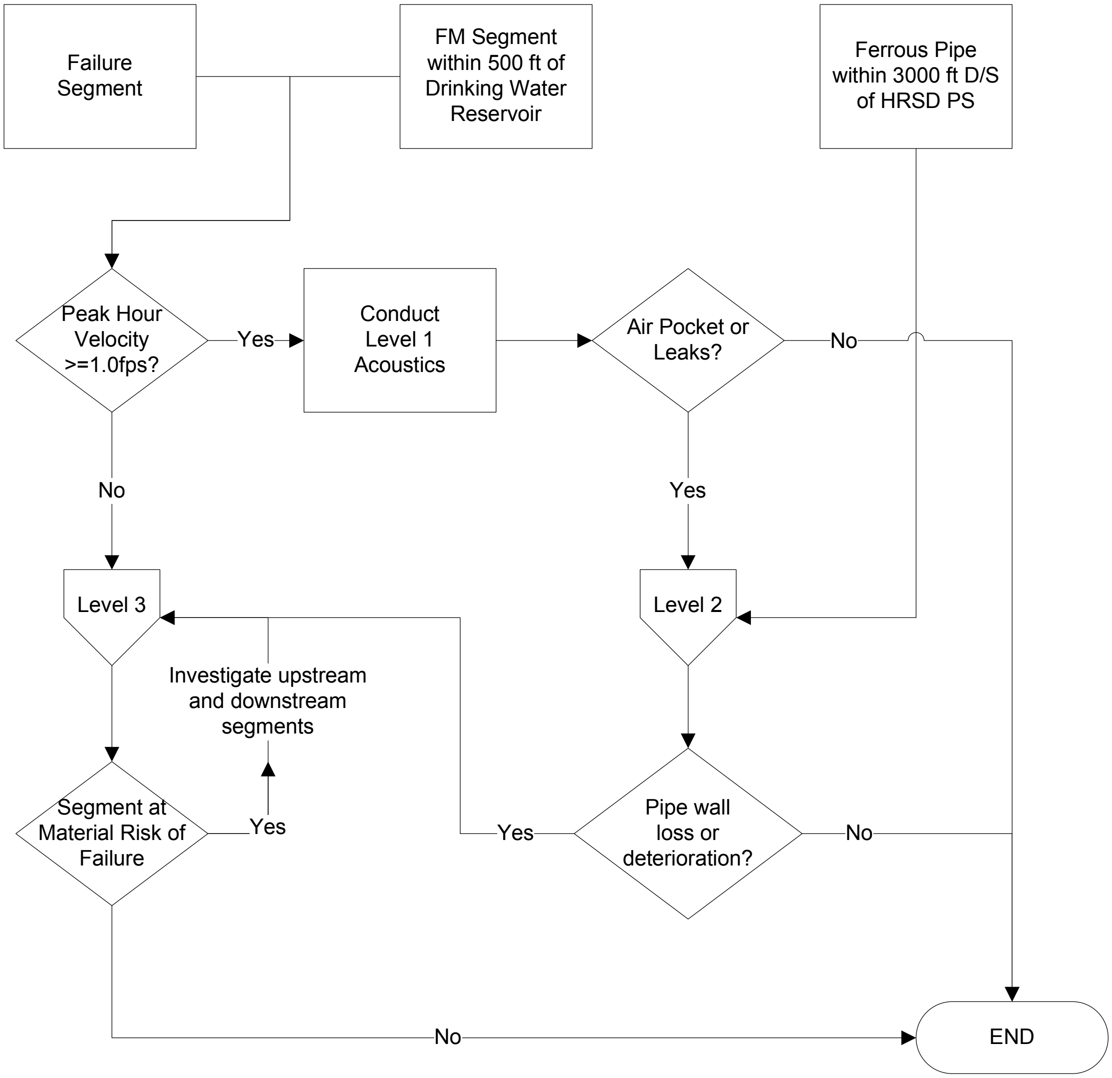


Figure 4-3. Force Main Condition Assessment Process

Note: Prior to conducting any Level 3 inspection, HRSD may elect to schedule the segment for renewal or replacement without any further inspection.

4.3.1.4 Additional Inspections

Upon completion of assessment for a force main segment, and HRSD determines that the segment is at **actual** material risk of failure due to corrosion or similar physical defects, HRSD will schedule inspection of one upstream and downstream segment. This may be determined unnecessary if the defect is clearly localized and the potential for similar conditions in the adjacent segments is low.

4.3.2 Condition Assessment of Remaining Force Mains

Those force mains determined to not have **potential** for material risk of failure, and thereby not assessed in the field, will be monitored and reviewed periodically in accordance with HRSD's Management, Operations and Maintenance (MOM) Program. If a failure occurs in the future due to a condition defect (and not from third party actions), HRSD will review the failure specifics to determine if condition assessment using the procedures detailed in this section are warranted. In addition, HRSD will develop and maintain a FM Condition database. Condition data will be collected when other invasive activities (e.g., taps, valve installation, repairs) are conducted.

4.3.3 Assessment of Force Main Appurtenances

HRSD will field inspect and conduct functional assessment of line valves, air release valves, and other accessible appurtenances in the force main system. Assets that are critical, not functioning or present a material risk of failure will be identified in the Final Condition Assessment Report. If these conditions meet the criteria, they will be addressed through the Prompt Repair program detailed in Section 4.5.

4.3.4 External Pipe Inspections

HRSD will inspect the exterior of each force main pipe at locations where the pipe is exposed, either at existing exposed locations such as aerial crossing, or during internal inspections where the pipe is exposed. These inspections will include visual assessment for structural damage and integrity of protective coatings, and spot checks with ultrasonic wall thickness testing, where appropriate. Assets that present a **potential** of material risk of failure will be identified in the Final Condition Assessment Report. If these conditions meet the criteria, they will be addressed through the Prompt Repair program detailed in Section 4.5.

4.3.5 Cathodic Protection

Where records indicate that a cathodic protection system was installed, the system will be inspected for its condition and adequacy. For those metallic force mains where no cathodic protection was recorded, the need for such a system will be evaluated based on soil conditions from soil maps. Historical data indicates that external corrosion of force mains is not a significant or widespread challenge in the HRSD system. Assets that present a material risk of failure will be identified in the Final Condition Assessment Report.

4.3.6 Force Main Condition Assessment Documentation

The data collected at each type and level of inspection will be recorded using a data management system compatible with HRSD databases and GIS, and modified as appropriate for the criteria and parameters being assessed with each technology. A modified version of a PACP-type program may be used if available at the time of the inspection. A data logging system will be developed which can be used to record the pertinent data from each inspection technology. Reports will be required from each inspection firm on a regular basis during the Force Main Condition Assessment Activities. All recordings from the inspections will be in digital form.

4.4 Gravity System Condition Assessment

Gravity sewers within the HRSD sanitary sewer system will be inspected for structural integrity and maintenance issues. These assessment activities will include manhole inspections, pipeline inspections using CCTV, laser and/or sonar, and limited smoke/dye testing where feasible and deemed necessary as designated in the field investigation approach. The work performed will be performed in accordance with applicable standards described below.

4.4.1 Assessment Standards for Gravity Sewer System

4.4.1.1 Pipeline Assessment and Certification Program (PACP)

The National Association of Sewer Service Companies (NASSCO), along with the assistance of the Water Research Centre (WRC), has developed a national certification program to establish a viable solution to standardize the identification, categorization, evaluation, and prioritization of sanitary sewer or storm sewer infrastructure through CCTV investigations. This standardized certification program can be used to ensure consistent record-keeping when compiling CCTV reports into a common database which can then be used for operation and maintenance (O&M) activities as well as pipe rehabilitation and replacement.

NASCCO PACP standards will be used to conduct CCTV investigations and document findings. The PACP defect descriptions are organized into the following general categories:

- Structural Defect Coding: This group includes the type of defects where the pipe is considered to be damaged ranging from a minor case defect to a more severe case, depicted as pipe failure. The Structural Defect Coding group includes defects described as: cracks, fractures, broken pipe, holes, deformities, collapsed pipe, joint defects, surface damage defects, weld failures, point repair codes, brickwork defects, and lining failures.
- Operation and Maintenance Coding: This group includes the various codes that involve the spectrum of defects that may impede the operation and maintenance of the sewer piping system. The Operation and Maintenance Coding group includes defects comprised of roots, infiltration, deposits and encrustations, obstacles/obstructions, and vermin.
- Construction Features Coding: This group includes the various codes associated with the typical construction of the sewer piping system. The Construction Features Coding group includes taps, intruding seal material, pipe alignment codes, and access points.
- Miscellaneous Features Coding: This group includes observation codes such as water levels (detection of sags), pipe material changes, and dye testing notes.

PACP Condition Grading System

The tables below describe the grading system for structural and O&M defects, and general guidelines regarding deterioration rates. Each defect can be scored with a grade ranging from 1 to 5, where a grade 5 has the most potential for pipe failure.

Table 4-2. Structural and O&M Defects Grading Table

Grade	Grade Description	Grade Definition
5	Immediate Attention	Defects requiring immediate attention
4	Poor	Severe defects that will become Grade 5 defects within the foreseeable future
3	Fair	Moderate defects that will continue to deteriorate
2	Good	Defects that have not begun to deteriorate
1	Excellent	Minor defects

Table 4-3. General Guidelines Regarding Deterioration Rates

Grade	Grade Definition
5	Pipe has failed or will likely fail within the next 5 years
4	Pipe will probably fail in 5 to 10 years
3	Pipe may fail in 10 to 20 years
2	Pipe unlikely to fail for at least 20 years
1	Failure unlikely in the foreseeable future

Footnote: The time estimated for pipe deterioration will vary based on local conditions. The grade definitions are to be used as a general guideline only.

4.4.1.2 Manhole Assessment Certification Program (MACP)

NASSCO has developed the Manhole Assessment Certification Program (MACP) to provide an industry standard to evaluate the overall condition of manholes or different types of sewer access points. MACP uses the same coding/grading system as PACP and incorporates much of the manhole standards from the American Society of Civil Engineers (ASCE) as well.

Manhole inspections will be conducted in accordance with NASSCO MACP standards. Personnel performing manhole inspections will be MACP-certified and will complete all inspections using standard MACP codes for all defects and observations during the inspection. Manhole inspection data will be managed in a PACP-compliant software product.

Manhole condition assessments will include the documentation of the various components of manhole construction, any structural or operations and maintenance defects, as well as identification of inflow/infiltration (I/I). In addition, influent and effluent pipe assets and condition assessments will be collected. HRSD's manhole assessment methodology utilizes an electronic database to record defect observations, defect descriptions, and a condition scoring system that is substantially consistent with the MACP certification program.

4.4.1.3 Lateral Assessment Certification Program (LACP)

HRSD is a regional collection agency, and therefore has limited directly connected laterals from individual customers tying into the HRSD gravity sewer system. Lateral Assessment will not be included in HRSD's Condition Assessment Plan.

4.4.2 Gravity Sewer Asset Identification

HRSD's sanitary sewer manholes have unique identifiers as follows: **XG-YYY-STA**, where "**XX**" represents the geographical location of the gravity sewer line on which the manhole is installed (i.e., North Gravity (NG) or South Gravity (SG)). The "**YYY**" represents the contract line number in which the manhole is located. The "**STA**" represents that station number at which the manhole is located. For example, a manhole located in the North Shore system that was constructed under contract NG-105 and is located at station number 14+60 would be assigned a manhole identifier as follows: "**NG-105-14+60**". The manhole identification numbers will be used during field investigation activities associated with the gravity sewer condition assessment.

If an identified manhole can not be located in the field, or an unidentified manhole is found in the field during condition assessment activities, HRSD will resolve the discrepancy and update its databases as required. In order to prevent delays, the personnel performing the condition assessment activities will designate an interim manhole identifier to any unidentified manholes found in the field. Unidentified manholes will be tracked using the upstream and downstream manhole identifiers. For example, if an unidentified manhole is found between manholes SG-200-6+65 and SG-200-9+75, then the unidentified manhole and connecting pipes will be tracked as "**SG-200-6+65 to SG-200-6+65-NEW and SG-200-6+65-NEW to SG-200-9+75.**" This temporary naming convention will be used during the gravity sewer system condition assessment activities and will be temporarily recorded on paper for presentation to HRSD. Upon completion of condition assessment activities, HRSD will perform surveys to capture the coordinates of the unidentified manhole(s), integrate the manhole into GIS, and assign standard manhole identifiers to the unidentified manholes as required.

4.4.3 Manhole Inspections

Sanitary sewer manhole inspections are an important component of the gravity sewer system assessment due to the susceptibility of manholes to structural defects and/or I/I which may contribute to SSOs. Manhole inspections not only provide valuable information on the physical condition of the manholes, but also an opportunity to observe pipe diameters, inverts, network connectivity, and surcharging within mainline gravity sewers. The results of manhole inspections can be used as a guide for identifying additional assessment needs such as CCTV.

The data collected during manhole inspections will be recorded using HRSD's *Manhole Field Inspection Form* (a sample of which is included in Appendix B). HRSD will manage the data collected using electronic database systems and develop its Final Condition Assessment Report using this data.

Manhole inspections may be performed using a pole camera capable of recording digital video and digital still images (in electronic format) of the manhole and each pipeline entering or exiting the manhole. **Sanitary sewer manholes are considered confined spaces.** If a pole camera is not used, any personnel entering a manhole must adhere to OSHA and HRSD protocol for confined space entry at all times while within the structure.

Color photographs (in electronic format) will be taken of the manhole to show the above ground location, looking down at the manhole invert, and looking into the incoming and outgoing pipelines. Manhole defects will be recorded using standardized observation codes as indicated on the standard *Manhole Field Inspection Form*. Manhole inspections will normally be performed during daylight hours, however, when night time inspections are required they will only be conducted when site conditions are deemed safe. HRSD will be notified when manholes are found to be surcharged at the time of inspection and downstream blockage is determined to be the probable cause of the surcharging. HRSD personnel will work to mitigate the cause of the surcharge so that a re-inspection of the manhole can be conducted. If the surcharge can not be mitigated, the surcharged manhole will be re-inspected during a lower flow period.

The sanitary sewer manhole condition assessment procedure is organized as follows:

- **Manhole Inspection Observation Codes:** Standardized codes/observations will be used to perform manhole inspections as described in this section.
- **Manhole Condition Scoring:** The manhole condition scoring protocols are described in this section.
- **Manhole Field Inspection Form:** Information regarding how to complete the *Manhole Field Inspection Form* is provided in this section.
- **Manhole Inspection Procedure:** The step by step protocol to be followed while performing the manhole inspection is described in this section.

Manhole Inspection Observation Codes – Field observation codes for identifying and/or classifying defects during manhole inspections will be recorded in a standardized manner. HRSD's standard *Manhole Field Inspection Form* is organized so that data can be collected using common observation codes that are recorded using checked boxes or free-hand comment boxes. Observations of manhole defects or points of interest that are not listed in the standard *Manhole Field Inspection Form* should be recorded in the "Additional Information" section of the form.

Manhole Condition Scoring – To assist in prioritizing any warranted maintenance or repair of sanitary sewer manholes within the HRSD system, a condition scoring system will be used to weigh the manhole defects that are observed during manhole inspections. The condition scoring system will be based on the PACP/MACP system for grading structural and O&M defects, as defined in Table 4-2. Each manhole will be scored (1-5) according to these MACP manhole condition assessment standards. These guidelines should be used at all times during the manhole inspection procedures

Manhole Field Inspection Form – The standard *Manhole Field Inspection Form* will be completed for manholes where a condition assessment is performed. After recording the manhole number, the inspector's name, and the date and time of the inspection at the top of the form, all remaining sections of the *Manhole Field Inspection Form* will be completed by checking the appropriate boxes or using free-hand descriptions where required.

Manhole Inspection Procedure – The *Manhole Field Inspection Form* will be completed by the personnel performing the manhole inspection. Prior to conducting inspections of manhole components, a non-entry (topside) manhole inspection will be conducted to determine the overall condition of the manhole as viewed from the ground surface. The surrounding area will be observed and noted if manholes or adjacent cleanouts are located in areas that are conducive to flooding, ponding, or tidal conditions that allow water to enter the sanitary sewer system. Data gathered from the topside inspection will be entered into "Additional Comments" field of the standard *Manhole Field Inspection Form*.

In lieu of manual entry, pole camera technology may be used to perform non-entry (topside) manhole inspections provided that site conditions are appropriate and that sufficient data can be captured and recorded to determine if more detailed manhole inspection activities are warranted.

The following documentation will be collected at each manhole:

<u>Manhole Photographs</u>

- The above ground location of the manhole
- The interior of the manhole looking down at the manhole invert and looking into the incoming and outgoing pipelines
- Potential issues and points of interest for documentation purposes
- Significant defects which are observed during the manhole assessment
- Photographs will be stored in electronic format
- A log of the photos taken will be included in the "Additional Information" field

<u>Field Sketches</u>

- A "profile view" field sketch of the manhole will be created, using the schematic diagram on the *Manhole Field Inspection Form*, showing changes in manhole dimensions and depths to any significant changes within the manhole structure
- A "connectivity" field sketch of the manhole will be created, using the schematic diagram on the *Manhole Field Inspection Form,* showing information regarding connecting pipes (e.g., pipe size, pipe depth to invert, connecting manhole structure identifiers, etc.)

4.4.4 CCTV Inspections

Closed circuit television (CCTV) inspection will be performed to assess the condition of most of HRSD's gravity sewer pipelines and confirm the location and magnitude of structural defects, points of inflow and infiltration, undocumented/illegal connections, existing pipe lining (if any), and blockages within the gravity sewer system. Where appropriate, laser and/or sonar inspection may be used in addition to, or in lieu of, CCTV.

CCTV inspections will be conducted in accordance with NASSCO PACP standards. Personnel performing CCTV inspections will be PACP-certified and will complete all inspections using standard PACP codes for all defects and observations during the inspection. CCTV data will be managed in a PACP-compliant software product. CCTV inspections will be recorded in color using a pan-and-tilt, radial-viewing inspection camera, and the resulting video/image must be sufficiently clear to easily observe sewer line defects and features including the location of service laterals. Blurred, foggy, or otherwise out of focus video/images are not acceptable and CCTV inspections will be re-commenced where unacceptable video/images are recorded. Simultaneous audio recording of defects observed during the CCTV inspection will also be conducted.

Prior to conducting CCTV inspections, the gravity sewer pipes and manholes may be cleaned if required. Cleaning will consist of normal hydraulic jet cleaning to facilitate the internal CCTV inspection. In general, gravity sewer lines and manholes undergoing CCTV inspections must be sufficiently clean to ensure that the CCTV equipment can easily pass through the gravity sewer system and record defects and observations per PACP standards. CCTV inspections will not be performed in sewer lines with flow depths that do not allow the CCTV equipment to freely pass through the gravity sewer system at the time of inspection.

Gravity main inspections will be identified and tracked by recording the upstream and downstream manholes using HRSD's manhole identifiers. CCTV inspections will be conducted from an upstream manhole to a downstream manhole in the direction of gravity sewer flow to minimize splashing and to allow a smoother pass of the CCTV equipment. The entire length of sewer line undergoing inspection will be recorded in this direction unless site conditions make it necessary to stop the CCTV inspection, in which case a reverse-flow set-up may be attempted. During the CCTV inspection, the CCTV camera must be temporarily stopped at each observed defect or service lateral in order to obtain a clear still picture and video image, as well as a verbal description of the observation.

Gravity Sewer Line Condition Assessment – To assist in prioritizing any warranted maintenance or repair of gravity sewer lines within the HRSD system, a condition assessment grading system compliant with PACP standards will be used to weigh the gravity sewer line defects that are observed during CCTV inspections. The PACP system assigns a distinct code (1-5) for each structural defect and operational and maintenance defect observed during the CCTV inspection. The interface software used during CCTV inspections will assign these PACP codes and record them in an information database. A sample of the CCTV inspection report for Condition Assessment is provided in Appendix B.

4.4.5 Smoke/Dye Testing

Smoke testing and/or dye testing may be conducted only in very limited areas to complement CCTV inspection work in order to identify and identify the location of possible I/I sources. Smoke testing and/or dye testing are economical and relatively fast methods for identifying the location of inflow sources such as structural damage in sewer pipes or manholes, cross connections including but not limited to roof leaders, foundation drains, yard drains, storm sewers, and undocumented/illegal connections.

Smoke Testing may be conducted on a limited basis as part of the phased field investigation approach to help determine which gravity sewer system components may require additional assessment through limited and/or comprehensive dyed water testing.

Smoke testing will be conducted during periods of dry weather with low groundwater, and with at least 24 hours having elapsed from the previous rain event. Smoke testing will not be performed during or following weather conditions that may impair the detection of escaping smoke, when groundwater is high or the ground is frozen, or on days of high winds, rain, snow, or fog.

Dye Testing may be conducted as part of the phased field investigation approach to complement smoke testing where applicable for verifying direction of flow, sources of I/I, and the presence of illicit connections to HRSD's sanitary sewer system. Dye testing is used to confirm sewer system connectivity that cannot be confirmed through smoke testing or CCTV inspection activities. Dye testing may be performed in conjunction with CCTV inspection on a limited basis.

4.5 Prompt Repairs

The Prompt Repairs concept provides a process by which critical system repairs can be made in a more timely and cost-effective fashion. Prompt Repair methodology employs the concept that when critical failures or deficiencies warranting prompt repair(s) are found during condition assessment activities, actions will be taken to correct the problem(s) either by internal personnel or external on-call contractors. It is the responsibility of the personnel conducting the Condition Assessment Activities investigation activities to identify defects that may meet the prompt repair criteria described below, and to present the findings to HRSD. HRSD will make a final evaluation against the criteria presented below. The internal personnel or external contractors performing Prompt Repair procedures will be capable of assessing and performing repairs according to acceptable HRSD standards.

A standardized Prompt Repair approach will be used for addressing critical deficiencies that have been identified during the Condition Assessment Plan investigation approach as warranting prompt corrective action. The Condition Assessment Plan investigation procedures as detailed in Section 4 of this report will facilitate consistent definitions, data collection techniques, and documentation methods regarding the nature and severity of critical defects warranting prompt repair as they are identified during the Condition Assessment investigation approach. The assets addressed by the Prompt Repair approach may include force mains, pumping facilities, gravity pipes, and sanitary sewer manholes.

Prompt repairs of sanitary sewer infrastructure assets are warranted when critical defects are found that meet the criteria presented below. The assets containing these critical defects may be operable at the time of discovery but could be at material risk of failure and have the potential for severe consequences. Defects found during the Condition Assessment investigation approach will warrant prompt repair where such defects are determined to meet one or more of the following criteria:

- Pose an immediate threat to the environment,
- Pose an imminent threat to public health and safety,
- Create operational problems that may result in SSOs, or
- Contribute substantial inflow to the system

HRSD has a system in place to address assets requiring prompt attention in the collection system. Once identified, information on the defect is reported to the responsible HRSD Chief. The HRSD Chief will either direct field crews to make a point repair or temporary repair, if feasible, or engage the Engineering Department to utilize an outside contractor.

4.6 Final Condition Assessment Report

After completion of the Condition Assessment Activities, documentation will be prepared that reviews the scope of work performed, references the field procedures used, and presents the condition assessment results. These documents will be used to prepare a prioritized rehabilitation program for the HRSD sanitary sewer system. The report will provide specific details on each asset group assessed.

4.6.1 Pumping Facilities

HRSD will provide detailed information regarding the assessment completed according to Section 4.2 for each pumping station and pressure reducing station. The Final Condition Assessment Report will include:

- A description of each pumping facility;
- Information regarding the results of the evaluation of each pumping facility;
- The results of pump draw-down test performed at each wet well pumping station;
- Information about the back up power and emergency pumping capability of each pumping facility;
- Information regarding lightning strike protection equipment at each pumping facility, where applicable;
- Descriptions of the history of failures at each pumping facility, including power-loss-related and lightning strike-related SSOs during the past 5 years;
- Information on the evaluation of flooding potential at each pumping facility and description of previous flooding events for the past 5 years, as well as the proposed actions to be taken for those facilities with a history of flooding;
- Information on the SCADA systems at each pumping facility and their ability to fulfill the designed functions;
- Details on how the existing facility equipment compares to Virginia Sewage Collection and Treatment (SCAT) Regulations (however, it is noted that DEQ has informed HRSD that pumping facilities constructed before the SCAT regulations are only required to be improved if the facility is upgraded);
- Identification of pumping station components that present a material risk of failure; and
- An Action Plan as detailed in Section 4.6.4 of this Plan.

4.6.2 Gravity System

HRSD will provide detailed information regarding the assessment completed according to Section 4.4 for the HRSD gravity system, including manholes and sewer pipelines. The Final Condition Assessment Report will include:

- A summary of the results of the PACP-compliant field investigations for HRSD's gravity sewer pipelines;
- A summary of the results of the MACP-compliant manhole inspections;
- Information on the history of all SSOs from HRSD's gravity system that occurred from 1999 to 2008;
- A list of all gravity system assets that present a material risk of failure, or are a significant source of I/I; and
- An Action Plan as detailed in Section 4.6.4 of this Plan.

4.6.3 Force Main System

HRSD will provide detailed information regarding the assessment completed according to Section 4.3 for the HRSD force main system. The Final Condition Assessment Report will include:

- Information regarding the results of the evaluation of each line valve and air release valve;
- Information about the assessment of HRSD's cathodic protection system;
- Information about the external pipeline inspections performed;
- Information about the force main pipe inspections performed, including internal inspections;

- Descriptions of the history of failures for each force main segment that resulted in an SSO from 1999 to 2008;
- A list of all HRSD force main assets that have been identified through field inspection as presenting an **actual** material risk of failure, with a characterization of the nature of the risk of failure associated with its condition; and
- An Action Plan as detailed in Section 4.6.4 of this Plan.

4.6.4 Action Plan

The output of the Final Condition Assessment Report will be a detailed list of proposed improvements to those assets in the system at material risk of failure, with a proposed implementation schedule. This Action Plan will be developed while HRSD is also, in parallel, performing a Capacity Assessment of Specified Portions of the Regional Sanitary Sewer System. It is HRSD's intent to efficiently implement appropriate improvements that address condition and capacity related issues. Therefore, HRSD will utilize the output of the Capacity Assessment during the Condition Assessment Action Plan development to minimize the rehabilitation or replacement of facilities that may need to be upgraded due to capacity challenges. The Action Plan will include a schedule for design and construction of repairs, rehabilitation, improvements or replacement, as applicable. Capital cost estimates for the improvements will be included with the Action Plan.

5. CONDITION ASSESSMENT PLAN IMPLEMENTATION

The Condition Assessment Plan described in this document includes a series of dependent tasks that will, when completed, provide a detailed evaluation of the physical condition of HRSD's sanitary sewer system. The three overall tasks are as follows with a planned project schedule in Section 5.4.

5.1 Preliminary Condition Assessment Report

As described in Section 3.6 of this document, HRSD will complete a Preliminary Condition Assessment Report ("Preliminary Report") that details the data collection and screening performed to identify those assets that have the **potential** for material risk of failure. This document will refine the methodology and provide results of the screening which will generate a list of assets for field inspection and detailed schedule for completion of those activities. Upon approval by the EPA and DEQ, HRSD will perform the Condition Assessment Activities to confirm or eliminate the asset as presenting an **actual** material risk of failure. HRSD will complete the Preliminary Report as shown in the Plan Schedule of Section 5.4.

5.2 Condition Assessment Activities

The field inspection activities specified in the Preliminary Report will be conducted by HRSD according to the schedule in that report. The schedule provided in Section 5.4 provides macro-level completion dates with general timeframes for assessment activities. HRSD has grouped the asset inspection schedule into prioritized sets that can be more fully detailed after completion of data collection and screening. The Condition Assessment Activities for the Group 1 force main segments identified as 'higher priority' will be completed earlier as shown on the schedule in Section 5.4. The 'lower priority' force main segments in Group 2 will be completed within 48 months of approval of the Preliminary Report by the EPA and DEQ. The remaining Condition Assessment Activities for pumping facilities and gravity mains will be completed by November 26, 2011.

5.3 Final Condition Assessment Report

HRSD will prepare a Final Condition Assessment Report (FCAR) that is detailed in Section 4.6 for submittal to the EPA and DEQ by February 12, 2013 for Condition Assessment Activities completed through August 15, 2012. This document will be completed along with the included Action Plan, and will provide detailed assessments, proposed improvements, implementation schedule, and cost estimates. The FCAR will be completed according to the schedule included in this section. This report will be submitted by this due date for review and approval by the EPA and DEQ. HRSD will begin implementation of the proposed Action Plan upon written receipt of approval from the EPA and DEQ.

Upon completion of the remainder of Condition Assessment Activities, HRSD will prepare a FCAR Update that will include the details of the force main assessments, proposed improvements, cost estimates, and an updated schedule that adjusts Action Plan priorities based on the new assessments. This FCAR Update will be submitted to the EPA and DEQ for review and approval by February 12, 2014. HRSD will begin implementation of the updated Action Plan upon written receipt of approval from the EPA and DEQ.

5.4 Condition Assessment Plan Implementation Schedule

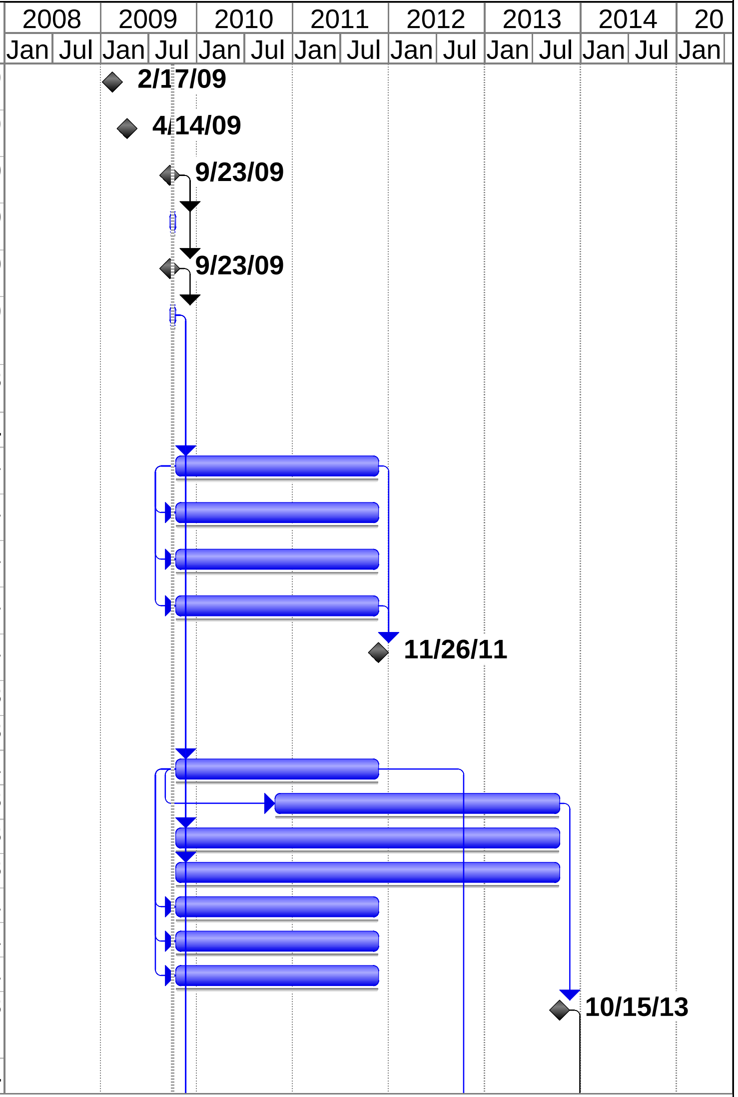
As previously described, the detailed assessment schedule can not be finalized until the screening process is completed with the Preliminary Report. Although EPA and DEQ may have comments that impact the Condition Assessment Activities, HRSD has begun the field inspections prior to approval from the EPA and DEQ. The overall Condition Assessment Plan schedule is included on the Figure 5-1.

Figure 5-1. Condition Assessment Plan Schedule

(on following page)

HRSD CONDITION ASSESSMENT PLAN
FIGURE 5-1. CONDITION ASSESSMENT PLAN SCHEDULE

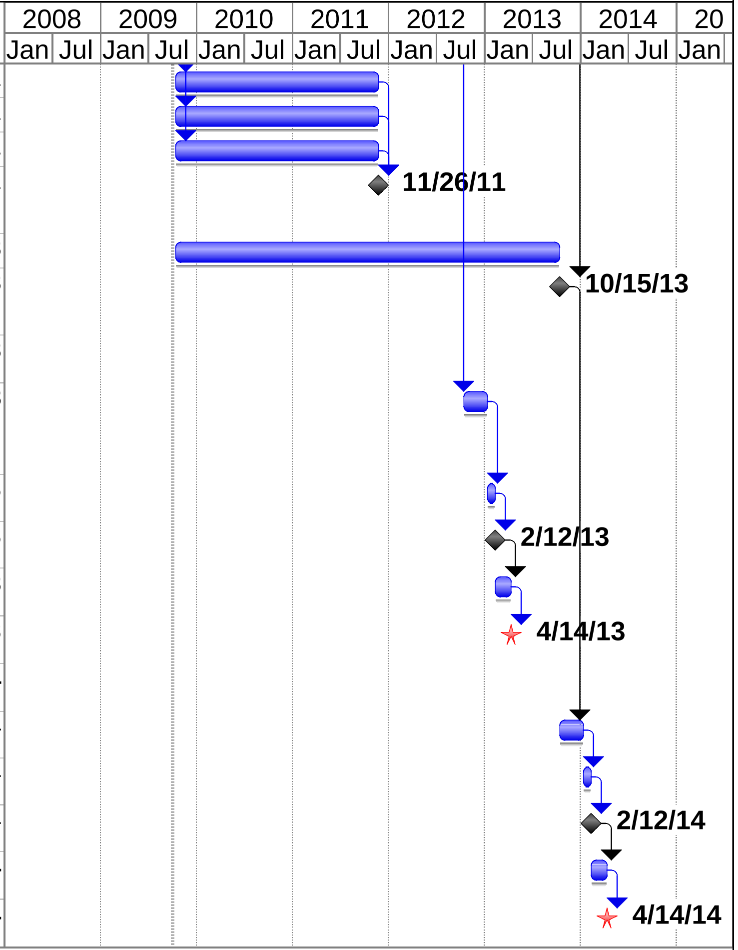
ID	Task Name	Duration	Start	Finish
1	**Submittal of Condition Assessment Plan**	0 days	Tue 2/17/09	Tue 2/17/09
2	**Receipt of Comments from EPA**	0 days	Tue 4/14/09	Tue 4/14/09
3	**Submittal of revised Condition Assessment Plan**	0 days	Wed 9/23/09	Wed 9/23/09
4	**Approval from EPA/DEQ**	22 days	Wed 9/23/09	Thu 10/15/09
5	**Submittal of Preliminary Condition Assessment Report**	0 days	Wed 9/23/09	Wed 9/23/09
6	**EPA/DEQ Approve Preliminary Condition Assessment Report**	**22 days**	**Wed 9/23/09**	**Thu 10/15/09**
7	**Condition Assessment Activities**	**1461 days**	**Thu 10/15/09**	**Tue 10/15/13**
8	**Pumping Facility Condition Assessment**	**772 days**	**Thu 10/15/09**	**Sat 11/26/11**
9	Pumping Facilities Condition Assessment	772 days	Thu 10/15/09	Sat 11/26/11
10	Pump Draw-down Tests	772 days	Thu 10/15/09	Sat 11/26/11
11	Flooding Analysis	772 days	Thu 10/15/09	Sat 11/26/11
12	Lightning Strike Potential Evaluation	772 days	Thu 10/15/09	Sat 11/26/11
13	Complete Pumping Facility Condition Assessment	0 days	Sat 11/26/11	Sat 11/26/11
14	**Force Main Condition Assessment**	**1461 days**	**Thu 10/15/09**	**Tue 10/15/13**
15	**Force Main Field Inspection**	**1461 days**	**Thu 10/15/09**	**Tue 10/15/13**
16	Group 1 Force Main Inspections	772 days	Thu 10/15/09	Sat 11/26/11
17	Group 2 Force Main Inspections	1083 days	Thu 10/28/10	Tue 10/15/13
18	Ferrous Pipe D/S of HRSD PS Inspections	1461 days	Thu 10/15/09	Tue 10/15/13
19	Reservoir FM Segments	1461 days	Thu 10/15/09	Tue 10/15/13
20	Inspect Force Main Appurtenances	772 days	Thu 10/15/09	Sat 11/26/11
21	Exposed Pipelines (Aerials, etc.)	772 days	Thu 10/15/09	Sat 11/26/11
22	Evaluate Cathodic Protection	772 days	Thu 10/15/09	Sat 11/26/11
23	Complete FM Condition Assessment	0 days	Tue 10/15/13	Tue 10/15/13
24	**Gravity Sewer System Condition Assessment**	**772 days**	**Thu 10/15/09**	**Sat 11/26/11**



Date: Tue 9/29/09 | 1 | Task ▬ | Milestone ◆

HRSD CONDITION ASSESSMENT PLAN
FIGURE 5-1. CONDITION ASSESSMENT PLAN SCHEDULE

ID	Task Name	Duration	Start	Finish
25	CCTV Inspections (PACP)	772 days	Thu 10/15/09	Sat 11/26/11
26	Manhole Inspections (MACP)	772 days	Thu 10/15/09	Sat 11/26/11
27	Smoke and Dye Testing Program	772 days	Thu 10/15/09	Sat 11/26/11
28	Complete Gravity Sewer System Condition Assessment	0 days	Sat 11/26/11	Sat 11/26/11
29	Prompt Repairs Program	1461 days	Thu 10/15/09	Tue 10/15/13
30	Complete Condition Assessment Activities	0 days	Tue 10/15/13	Tue 10/15/13
31	**Final Condition Assessment Report**	**120 days**	**Mon 10/15/12**	**Tue 2/12/13**
32	Prepare Final Condition Assessment Report (on CA Activities through 8/15/12)	90 days	Mon 10/15/12	Sun 1/13/13
33	Prepare Action Plan	30 days	Sun 1/13/13	Tue 2/12/13
34	Submit Final Report to EPA/DEQ	0 days	Tue 2/12/13	Tue 2/12/13
35	**EPA/DEQ to approve Final Report**	**60 days**	**Tue 2/12/13**	**Sat 4/13/13**
36	**Begin Implementation of Action Plan**	**0 days**	**Sun 4/14/13**	**Sun 4/14/13**
37	**Final Condition Assessment Report Update**	**120 days**	**Tue 10/15/13**	**Wed 2/12/14**
38	Prepare Final Condition Assessment Report Update	90 days	Tue 10/15/13	Mon 1/13/14
39	Prepare Action Plan Update	30 days	Mon 1/13/14	Wed 2/12/14
40	Submit Final Report Update to EPA/DEQ	0 days	Wed 2/12/14	Wed 2/12/14
41	**EPA/DEQ to approve Final Report Update**	**60 days**	**Wed 2/12/14**	**Sun 4/13/14**
42	**Begin Implementation of Action Plan Update**	**0 days**	**Mon 4/14/14**	**Mon 4/14/14**



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APPENDIX A: HRSD SEWER SYSTEM MAPS AND FACILITIES

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Table A-1. HRSD Force Mains			
Line Number	**Length (Feet)**	**Diameter (Inches)**	**Material**
NF-001	13372	8, 18, 24	PCCP
NF-001A	250	12, 14, 18,	DIP, PVC
NF-002	10260	8, 10, 12, 30, 24	DIP
NF-003	10810	4, 8, 12, 24, 30	DIP, PCCP
NF-004	4941	8, 16, 24, 36	PCCP
NF-005	14933	8, 10, 12, 36	PCCP
NF-006	10961	6, 12, 20, 36	PCCP
NF-006X	307	6, 20	CIP
NF-007	9324	8, 12, 24	DIP, CIP
NF-008	31226	4, 6, 8, 10, 12 14, 16, 24	DIP, CIP, PCCP, PE
NF-009	3098	12, 14	DIP, PE
NF-010	7695	8, 12, 16	DIP, AC
NF-011	13905	6, 8, 10, 30, 42	PCCP
NF-011X	15238	6, 8, 10, 12, 16, 30, 36, 42	AC, PCCP
NF-012	9613	2, 8, 16, 24, 48	PCCP
NF-013	3639	6, 8, 10, 14, 16	DIP, CIP, PCCP
NF-014	3480	6, 8, 10, 16	CIP
NF-015	13895	4, 6, 8, 12, 16, 24	CIP
NF-016	7307	6, 8, 18, 24, 30	DIP, CIP, PCCP
NF-017	15310	6, 8, 12, 24, 36	CIP
NF-018	5042	6, 8, 18, 24, 30	DIP, CIP, PCCP
NF-020	5537	8, 10, 12, 14, 16	DIP, CIP
NF-021	1443	10, 12	CIP
NF-022	1868	8, 16, 30	AC, PCCP
NF-023	3357	8, 12, 16, 30	AC, PCCP
NF-024	14262	4, 6, 8, 12, 30	CIP, PCCP
NF-025	7394	18, 30	CIP, RCCP
NF-027	14487	10, 16	DIP
NF-028	2674	12, 36	CIP, RCCP
NF-029	3112	8, 12, 24, 36	CIP
NF-030	3784	6, 8, 12, 36	RCP
NF-031	1061	6, 8, 12	DIP, CIP, PE
NF-032	4823	6, 8, 10, 12, 18	DIP, CIP
NF-033	7112	6, 8, 12, 18	CIP, RCCP
NF-036	3375	6, 10, 12	AC
NF-037	7383	6, 10, 12, 36	CIP, RCCP
NF-038	514	6	CIP
NF-039	6267	30, 36	CIP, SP

Table A-1. HRSD Force Mains			
Line Number	**Length (Feet)**	**Diameter (Inches)**	**Material**
NF-040	4147	6, 12, 16	DIP, AC
NF-041	6173	12	CIP
NF-042	18414	20	AC
NF-042X	624	12	CIP
NF-043	3945	12	CIP
NF-046	5491	4, 8, 10, 12, 30	CIP
NF-047	9069	30	CIP
NF-048	3351	16, 18, 24, 30	DIP, CIP
NF-049	11761	30	CIP
NF-050	2458	12	CIP
NF-055	542	6	DIP
NF-058	21755	16, 24, 30	DIP, RCCP, CIP
NF-059	2764	12, 18	AC, CIP
NF-060	4452	18	AC
NF-061	10281	30	CIP
NF-065	2719	24	DIP
NF-066	8601	24	DIP
NF-068	1426	12	DIP
NF-071	4051	12	DIP, CIP
NF-073	3676	12	AC
NF-074	2705	16	DIP
NF-077	3682	14	CIP
NF-085	4170	14	CIP
NF-089	5243	24	DIP
NF-091	4784	16	AC, CIP
NF-093	5468	16	AC, CIP
NF-093A	47	16	AC
NF-093B	44	10	ESVC
NF-096	4254	16	CIP
NF-097	6769	16	CIP
NF-100	1085	20	AC
NF-105	4308	10	CIP
NF-107	3251	16	CIP
NF-113	5588	10, 12, 14, 16	CIP
NF-119	861	20	CIP
NF-120	950	16, 24	AC
NF-121	2546	8, 12	CIP
NF-122	269	18	CIP
NF-130	4641	30	DIP

Table A-1. HRSD Force Mains			
Line Number	**Length (Feet)**	**Diameter (Inches)**	**Material**
NF-132	1058	12, 14	CIP
NF-133	5781	30	DIP, RCCP
NF-153	7890	30	DIP
NF-157	306	30	CIP, RCCP
NF-158	1767	30	RCCP
NF-162	1151	12	CIP
NF-163	9491	18	DIP
NF-165	8645	16	DIP
NF-171	7416	8, 18, 24, 30	DIP, CIP, PCCP
NF-172	14391	12, 24, 30, 36	DIP, PCCP
NF-173	18649	6, 8, 10, 16	AC
NF-177	12073	8, 20, 24	DIP
NF-178	14761	8, 12, 24	DIP
NF-178A	96	24	DIP
NF-178B	81	8, 24	DIP
NF-178C	370	12	DIP
NF-178D	379	12	DIP
NF-179	14418	6, 8, 10, 24	DIP
NF-180	5005	8, 16, 30	DIP
NF-181	3796	30	DIP
NF-182	12570	2, 4, 8, 11, 24, 30	DIP
NF-183	14075	2, 4, 8, 16	DIP
NF-184	13493	2, 4, 6, 8, 16	DIP, PVC
NF-185	13843	2, 4, 8, 20	DIP
NF-186	12846	2, 4, 8, 20	DIP
NF-187	19785	2, 4, 10, 12, 18	DIP
NF-188	6920	2, 4, 8, 16	DIP, PVC
NF-189	7705	2, 4, 8, 16	DIP, PVC
NF-190	36798	8, 20, 24	DIP
NF-191	8489	4, 8, 18	DIP, PVC
NF-191A	351	12	DIP
NF-192	4135	24, 36	DIP
NF-193	12167	30	DIP
NF-194	6955	30	DIP
NF-195	7095	8, 24, 30	DIP
NF-204	4154	20	DIP
NF-205	11675	8, 16, 30, 36	DIP
SF-002	3714	20, 24, 36	DIP, PCCP
SF-004	12100	6, 24	CIP

Table A-1. HRSD Force Mains

Line Number	Length (Feet)	Diameter (Inches)	Material
SF-005	19578	20	CIP, RCP
SF-006	2802	10, 12	CIP
SF-007	12704	20	RCP
SF-008	6146	20	CIP
SF-009	9742	20	CIP
SF-010	918	20	CIP
SF-011	2982	20	CIP
SF-012	4481	20, 24	DIP, CIP
SF-013	7805	24, 42	DIP, RCP
SF-014	4010	24, 42	DIP, RCP
SF-015	8468	4, 8, 10, 12, 20	AC, CIP, SP
SF-016	30158	6, 8, 12, 14, 16, 20, 36, 42, 48	DIP, PCCP
SF-017	5815	42	RCP
SF-018	5506	24	DIP
SF-019	4647	20	AC
SF-020	12382	16, 18	AC, CIP
SF-022	17094	16	DIP
SF-023	9483	8, 10, 12, 24, 48	DIP, PCCP
SF-024	4256	10, 42	PCCP
SF-025	8542	6, 8, 10, 36	PCCP
SF-026	9774	8, 10, 12, 30	CIP, PCCP
SF-027	14068	8, 30, 36	DIP, PCCP
SF-028	15445	6, 8, 24, 30	DIP, PCCP
SF-029	9363	6, 8, 10, 16, 30	PCCP
SF-030	5407	8, 14	AC, DIP
SF-031	5957	8, 12, 24	DIP
SF-032	2199	6, 8, 14	CIP
SF-036	1738	14	DIP
SF-037	2514	8, 12	DIP, CIP
SF-038	5038	20	CIP
SF-039	1448	6	CIP
SF-040	1510	8	CIP
SF-042	963	6, 8	CIP
SF-043	1226	8	CIP
SF-046	3740	10	CIP
SF-051	10026	18, 24	DIP, RCP
SF-052	1306	10	CIP
SF-057	3543	30, 39, 42, 48	DIP, HDPE, RCP
SF-057X	37	24	RC

Table A-1. HRSD Force Mains

Line Number	Length (Feet)	Diameter (Inches)	Material
SF-058	2190	30, 48	RCP
SF-059	5942	42	RCP
SF-060	2291	24	RCP
SF-062	981	6	CIP
SF-064	1302	6	CIP
SF-065	1381	16, 18	CIP
SF-066	7423	18	CIP
SF-069	3305	12	CIP
SF-070	2688	16	CIP
SF-071	87	42	PCCP
SF-076	1800	8	CIP
SF-080	3702	10, 24	DIP
SF-081	4129	16, 30, 36	DIP, RCP
SF-082	7199	12, 20	CIP
SF-083	1028	24	RCP
SF-084	1663	8, 24, 30	RCP
SF-086	1126	8	CIP, SP
SF-087	2157	12	CIP
SF-090	2069	12	CIP
SF-091	7753	8, 12	DIP, CIP
SF-092	3569	8	CIP
SF-093	1371	6, 8, 10	CIP
SF-094	2643	8	CIP
SF-095	2729	24	CIP
SF-097	10129	12, 20, 24, 30	DIP
SF-099	3321	8, 10, 20	CIP, PVC
SF-100	3560	6, 8, 10, 12	CIP, PVC
SF-101	2618	6, 8, 10	DIP, CIP
SF-103	5156	10, 16	AC, DIP
SF-106	9191	4, 6, 8, 12	DIP, CIP
SF-109	1983	8, 10, 16	AC
SF-110	1899	8, 10, 14	AC, DIP, CIP
SF-111	2079	4, 10	DIP, CIP
SF-114	966	8, 12, 20, 24	AC
SF-115	2250	8, 12,14	AS, CIP
SF-116	4577	8, 16	AS, CIP
SF-117	8606	24	RCP
SF-118	22618	9, 10, 24, 36, 42	DIP, PCCP, SP
SF-119	26182	36	RCP

Table A-1. HRSD Force Mains

Line Number	Length (Feet)	Diameter (Inches)	Material
SF-120	8716	24	RCP
SF-121	6279	8, 10, 24	DIP, CIP
SF-122	5057	24	DIP, RCP
SF-123	3232	16, 24	DIP, RCP
SF-124	6946	16	DIP
SF-125	3054	16	DIP
SF-126	6563	16, 30	DIP, RCP
SF-127	10960	18	AC
SF-128	5295	24	DIP
SF-129	6906	16, 24	DIP, RCP
SF-130	8273	16	AC, DIP
SF-131	10588	12, 16	AC, DIP
SF-132	1118	20	AC, CIP, PVC
SF-133	3349	6, 8, 12, 14, 18	CIP
SF-134	14272	30	RCP
SF-135	20553	18, 24, 42	RCCP
SF-136	17804	6, 8, 30	DIP, PCCP
SF-137	16389	8, 30	PCCP
SF-138	14399	8, 10, 24	DIP
SF-139	4139	6, 12	CIP
SF-140	3306	12	CIP
SF-141	6307	6, 8, 10, 16	CIP
SF-142	3831	6, 8, 16, 24	DIP, CIP
SF-143	10026	6, 8, 12, 24, 30	DIP, CIP, PCCP
SF-144	12708	8, 10, 12, 24	DIP, CIP
SF-146	2706	12	CIP, PVC
SF-147	11950	10, 12, 18, 20	DIP, PVC
SF-150	11908	6, 8, 18, 30	DIP
SF-154	929	10	CIP
SF-155	858	6, 12	CIP
SF-156	766	24	DIP
SF-158	4908	8, 10, 24	DIP
SF-159	11278	8, 36	DIP, PCCP, SP
SF-160	14480	8, 14, 16, 18, 30	DIP
SF-163	2223	10	CIP
SF-164	13138	8, 12, 30	DIP, PVC
SF-165	9833	8, 12, 16, 36	DIP, RCP
SF-166	1934	8, 12, 36, 42	PCCP, SP
SF-167	9889	42	PCCP

Table A-1. HRSD Force Mains

Line Number	Length (Feet)	Diameter (Inches)	Material
SF-168	3258	36	PCCP
SF-169	16073	36, 42	PCCP
SF-170	3036	16	DIP
SF-171	20535	42	PCCP
SF-172	13474	30, 42	DIP, PCCP
SF-173	4322	10, 12	AC, DIP
SF-174	5401	42	RCCP
SF-175	8901	42	PCCP
SF-176	2677	12	DIP
SF-177	9587	30, 42	DIP, PCCP
SF-178	7376	8, 20, 24	DIP, CIP
SF-179	946	24	CIP
SF-180	4903	4, 6, 20, 24	DIP, CIP
SF-181	2078	8, 10, 20	DIP
SF-182	9148	2, 8, 16, 20	AC, DIP
SF-183	9196	6, 12, 20	AC, DIP
SF-184	5663	8, 14, 16	AC, DIP
SF-185	1818	6, 8, 10, 24	DIP, PCCP
SF-186	9191	8, 14	AC
SF-187	4697	10, 18	DIP
SF-188	3276	6, 8, 14	AC, DIP
SF-189	7741	8, 20, 24	DIP, CIP, PCCP
SF-190	18945	8, 10, 30	PCCP
SF-194	16092	8, 24, 30	PCCP
SF-195	140	30	RCP
SF-197	6156	24, 30	RCP
SF-198	4162	14, 16, 20	CIP
SF-199	6327	8, 12	AC, DIP
SF-200	1437	6, 8, 10, 12	CIP
SF-203	2460	8, 12	DIP
SF-204	1924	12, 18	CIP
SF-206	5512	6, 8, 12, 16	DIP
SF-208	5296	16	AC
SF-209	5905	6, 8, 16	DIP, PVC
SF-210	16352	4, 8, 12, 16, 30	DIP
SF-211	5447	8, 12, 24, 30	DIP, PCCP
SF-212	8135	2, 4, 8, 10, 24	DIP
SF-213	18838	30, 36, 42	DIP, PCCP, SP
SF-214	12871	8, 12, 24	DIP

Table A-1. HRSD Force Mains

Line Number	Length (Feet)	Diameter (Inches)	Material
SF-216	8305	18, 20, 24	CIP, RCP
SF-217	4313	24	RCP
SF-218	5642	30	PCCP
SF-219	13207	24, 20	CIP, RCP
SF-220	2476	30	RCP
SF-221	10850	48	DIP, RCP
SF-222	5708	24, 48	CIP, RCP
SF-223	1405	24	RCP
SF-224	2102	24	RCP
SF-225	1632	30	RCP
SF-226	2572	30, 36	CIP, RCP
SF-227	12598	42, 48	DIP
SF-228	5122	42, 48	DIP, PCCP
SF-229	826	8, 12	DIP
SF-230	687	12, 24	DIP
SF-231	378	14	AC, DIP
SF-232	3245	12, 24	DIP
SF-233	6005	18	DIP
SF-234	16426	8, 12, 24	DIP
SF-235	7865	16, 24, 30	DIP
SF-236	22314	8, 30, 36	DIP
SF-237	12086	6, 8, 10, 16, 18, 36	DIP
SF-238	1568	36	SP
SF-239	2835	12, 24, 36	DIP
SF-240	4898	8, 12, 30, 36	DIP
SF-241	4750	30	DIP, SP
SF-242	8217	8, 12, 30	DIP
SF-243	3585	30	SP
SF-244	13205	8, 30	DIP
SF-245	20135	6, 8, 30	DIP
SF-246	6890	8, 12, 30	DIP
SF-247	1871	30	SP
SF-248	11945	10, 24, 30	DIP
SF-249	426	8, 24	DIP
SF-250	1314	24	SP
SF-251	4532	8, 10, 24	DIP
SF-252	2993	8, 18, 20	DIP
SF-253	23508	8, 18, 20, 24	DIP
SF-254	22614	8, 12, 20	DIP

Table A-1. HRSD Force Mains			
Line Number	**Length (Feet)**	**Diameter (Inches)**	**Material**
SF-255	6621	8, 20	DIP
SF-256	8518	42, 48, 54	DIP, SP
SF-258	14249	8, 20, 24	DIP
SF-259	1099	8, 16	DIP
SF-260	10743	42	DIP
SF-262	11908	42	DIP
SF-263	2548	36, 42	DIP
SF-264	5944	8, 12, 18, 30	DIP
SF-267	5938	6, 8, 12, 30	DIP
SF-268	941	30	DIP
SF-269	1589	30	HDPE
SF-270	426	30	DIP
SF-271	8789	12, 42, 48	SP
SF-272	8508	12, 48	SP
SF-273	1966	48	SP
SF-274	2777	10, 30, 48	DIP, SP
SF-275	3925	42	DIP
SF-276	10828	8, 36	DIP
SF-277	11131	8, 12, 36	DIP
SF-278	772	8, 16	DIP
SF-279	2241	16	DIP
SF-NAT	3751	54	PCCP
SF-OUT	366	14	CIP

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Table A-2. HRSD Gravity Mains

Line Number	Length (Feet)	Diameter (Inches)	Material	Number of Manholes
NG-034	2228	24	ESVC	10
NG-035	970	18	ESVC	6
NG-044	3168	18	VC	15
NG-045	3498	21	VC	13
NG-052	662	15, 18	ESVC	2
NG-053	6277	15, 18	ESVC	35
NG-054	2143	21	RCP	10
NG-056	281	10	ESVC	1
NG-057	5666	15	*TBD*	28
NG-062	119	12	VC	1
NG-063	3298	12	VC	18
NG-064	739	8, 20, 21	ESVC	2
NG-067	2860	15, 18, 20, 24	VC	5
NG-078	2362	18	VC	13
NG-082	3459	18	RCP	25
NG-083	930	15	RCP	7
NG-084	829	24, 30	RCP	4
NG-086	3754	15	CIP	22
NG-087	1311	18	ESVC	7
NG-088	4023	10, 12	VC	25
NG-092	1152	16, 18, 24	AC	5
NG-094	1277	15, 18	ESVC	7
NG-095	2752	18	ESVC	19
NG-098	4651	18, 21, 24	ESVC	6
NG-099	3089	18	*TBD*	11
NG-101	612	18, 21	VC	4
NG-102	332	18	RCP	2
NG-103	3831	27	CIP, RCP	21
NG-104	888	21	RCP	9
NG-106	3610	8, 27, 36	RCP	11
NG-108	4630	36	RCP	31
NG-109	6280	6, 10, 24	ESVC	29
NG-110	2601	39, 42	RCP	8
NG-111	1697	15	RCP	9
NG-112	911	24	RCP	3
NG-114	986	42	RCP	3
NG-115	719	24	RCP	4
NG-116	680	18	RCP	2
NG-117	398	18	RCP	3

Table A-2. HRSD Gravity Mains

Line Number	Length (Feet)	Diameter (Inches)	Material	Number of Manholes
NG-118	400	18	RCP	1
NG-123	1019	8, 12	RCP	10
NG-124	4348	48	RCP	18
NG-125	2884	48	PCCP	11
NG-126	428	18	CIP	2
NG-127	4012	18, 24, 30	DIP, ESVC	17
NG-129	203	18, 20	CIP	8
NG-130X	1063	30	DIP	*TBD*
NG-134	475	42	RCP, PCCP	3
NG-135	175	42	RCP	8
NG-136	1120	42	CIP	4
NG-137	832	24, 30	CIP	2
NG-138	829	42	RCP	6
NG-141	1249	18	VC	5
NG-142	4110	18	VC	18
NG-143	5127	8, 10, 24	RCP	23
NG-146	126	24	CIP	1
NG-147	2305	24	RCP	9
NG-148	3303	24	RCP	8
NG-149	110	24	RCP	2
NG-150	1479	24	RCP	6
NG-151	48	24	RCP	1
NG-152	1832	24	RCP	7
NG-157	613	15	RCP	2
NG-159	3772	24, 30	RCP	18
NG-160	1457	24	RCP	7
NG-164	468	8	RCP	3
NG-166	254	25, 20	RCP	8
NG-167	100	20	RCP	10
NG-168	752	20	RCP	12
NG-169	4760	42, 54	*TBD*	9
NG-174	1538	24, 27	PCCP	7
NG-175	1242	18, 21	DIP	8
NG-176	477	21	DIP	3
SG-001	6311	20, 24, 30, 36	RCP	12
SG-003	2581	42, 54	RCP	12
SG-033	1408	18	ESVC	6
SG-034	2034	27	ESVC	7
SG-035	1518	18	ESVC	7

Table A-2. HRSD Gravity Mains

Line Number	Length (Feet)	Diameter (Inches)	Material	Number of Manholes
SG-041	958	8, 12	CIP	3
SG-044	1074	10	VC	10
SG-045	4305	8, 12	CIP	*TBD*
SG-047	3404	54	RCP	13
SG-048	962	18	VC	4
SG-049	805	30	CIP	3
SG-050	4307	48, 54	RCP	11
SG-053	1108	42	RCP	4
SG-054	270	48	RCP	4
SG-055	838	30	RCP	4
SG-056	200	54	RCP	1
SG-061	3360	24, 30	ESVC	*TBD*
SG-063	2342	10	VC	13
SG-067	1595	12	VC	14
SG-068	995	8	VC	6
SG-068X	230	8	VC	*TBD*
SG-071	769	12	VC	3
SG-072	599	10	VC	4
SG-073	1463	15	VC	12
SG-074	2813	21	VC	12
SG-075	1798	12	VC	9
SG-077	161	18	VC	1
SG-078	859	12	ESVC	7
SG-079	1785	10	ESVC	5
SG-088	3382	27	CIP	21
SG-089	3706	24	CIP	19
SG-096	4203	30	RCP	16
SG-098	3133	24, 30	RCP	15
SG-102	1918	10	VCP	9
SG-104	1642	10	VCP	7
SG-105	1101	8	VCP	8
SG-107	390	8	ESVC	2
SG-108	663	12	ESVC	4
SG-112	793	18	ESVC	6
SG-113	5236	12, 16, 18, 24	CIP	24
SG-145	1293	12	VC	7
SG-148	3520	21	CIP	17
SG-149	3427	24	CIP, ESVC	16
SG-151	5408	18	DIP	16

Table A-2. HRSD Gravity Mains

Line Number	Length (Feet)	Diameter (Inches)	Material	Number of Manholes
SG-152	1289	18	VCPE	6
SG-153	2863	18	CIP, ESVC	18
SG-155	8	6	CIP	*TBD*
SG-157	2171	18	ESVC	11
SG-161	2992	18	VCP	14
SG-162	1126	15	VCP	3
SG-191	5467	24	ESVC	31
SG-192	140	18	CIP	2
SG-193	16109	18	RCP	83
SG-196	1651	36	RCP	7
SG-201	285	8	ESVC	*TBD*
SG-202	1874	12	CIP	11
SG-205	857	6, 8, 10	CIP	7
SG-207	325	12	VC	2

Table A-3. HRSD Pumping Facilities

PS/PRS Number	Name	Address	Pumping Station	PRS
101	Arctic Avenue	2814 Arctic Ave, Virginia Beach	X	
102	Ashland Circle	1402 Ashland Circle, Norfolk	X	
103	Bainbridge Blvd	801 Bainbridge Blvd, Norfolk	X	
104	Cedar Lane	5915 Cedar Lane, Portsmouth	X	
105	Chesapeake Blvd	5734 Chesapeake Blvd, Norfolk	X	
106	City Park	Ft of La Vallette Avenue, Norfolk	X	
107	Colley Avenue	715 Fairfax Avenue, Norfolk	X	
108	Dovercourt Road	948 Dovercourt Road, Norfolk	X	
109	Dozier's Corner	1121 Keats Street, Norfolk	X	
110	Ferebee Avenue	2812 Bainbridge Blvd, Chesapeake	X	
111	Granby Street	4244 Granby Street, Norfolk	X	
112	Independence Blvd PRS	4562 Southern Blvd, Virginia Beach		X
113	Luxembourg Avenue	3030 Luxembourg Avenue, Norfolk	X	
114	Monroe Place	5808 Monroe Place, Norfolk	X	
115	Newtown Road	115 Newtown Road, Norfolk	X	
116	Norchester Street	935 Norchester Street, Norfolk	X	
117	North Shore Road	1510 1/2 North Shore Road, Norfolk	X	
118	Norview Avenue	869 Norview Avenue, Norfolk	X	
119	Park Avenue	503 Park Avenue, Chesapeake	X	
120	Pine Tree PRS	2924 Virginia Beach Blvd, Virginia Beach		X
121	Plume Street	236 E. Plume Street, Norfolk	X	
122	Powhatan Avenue	1548 Buckingham Avenue, Norfolk	X	
123	Quail Avenue	800 Quail Avenue, Chesapeake	X	
124	Richmond Crescent	128 Richmond Crescent, Norfolk	X	
125	Seay Avenue	3541 Seay Avenue, Norfolk	X	
127	State Street	351 Emmett Place, Norfolk	X	
128	Steamboat Creek	1900 E. Indian River Road, Chesapeake	X	
129	Taussig Blvd	2017 Taussig Blvd, Norfolk	X	
130	Virginia Beach Blvd	3514 E. Virginia Beach Blvd, Norfolk	X	
131	Washington Plant	1728 Great Bridge Blvd, Chesapeake	X	
132	Willoughby Avenue	1912 Willoughby Avenue, Norfolk	X	
133	Providence Road PRS	5729 Old Providence Road, Virginia Beach		X
134	Pughsville Road PRS	4725 Shoulders Hill Road, Suffolk		X
135	Suffolk	1136 Sanders Drive, Suffolk	X	
137	Bowers Hill PRS	3588 South Military Hwy, Chesapeake		X
138	Deep Creek PRS	1221 Shell Road, Chesapeake		X
139	Quail Avenue PRS	822 Quail Avenue, Chesapeake		X
140	Atlantic Avenue PRS	1085 Old Dam Neck Road, Virginia Beach		X

Table A-3. HRSD Pumping Facilities

PS/PRS Number	Name	Address	Pumping Station	PRS
141	Hanover Avenue	900 Hanover Avenue, Norfolk	X	
142	Jamestown Crescent	858 Jamestown Crescent, Norfolk	X	
143	Shipps Corner PRS	1423 London Bridge Blvd, Virginia Beach		X
144	Elmhurst Lane	600 Elmhurst Lane, Portsmouth	X	
145	Rodman Avenue	2412 Rodman Avenue, Portsmouth	X	
146	Camden Avenue	2203 Camden Ave., Portsmouth	X	
147	Chesterfield Blvd	2731 Chesterfield Blvd, Norfolk	X	
148	Ingleside Road	600 Ingleside Road, Norfolk	X	
151	Kempsville Road PRS	4765 Ferrell Parkway, Virginia Beach		X
152	Terminal Blvd PRS	7808 Newport Avenue, Norfolk		X
153	Laskin Road PRS	590 Fremac Avenue, Virginia Beach		X
154	Route 337 PRS	2472 Gum Road, Chesapeake		X
201	25th Street	11 25th Street, Newport News	X	
202	33rd Street	85 33rd Street, Newport News	X	
203	Bay Shore	720 Bay Shore Lane, Hampton	X	
204	Bloxoms Corner	5 Beach Rd, Hampton	X	
205	Big Bethel PRS	1431 Big Bethel Rd, Hampton		X
206	Bridge St	4701 Victoria Blvd, Hampton	X	
207	Center Ave	315 Center Ave, Newport News	X	
208	Claremont	1210 Chesapeake Ave, Hampton	X	
209	Copeland Park	4401 City Line Rd, Newport News	X	
210	Ferguson Park	227 75th Street, Newport News	X	
211	Hampton U	54 Shore Drive, Hampton	X	
212	Hilton School	223 River Rd, Newport News	X	
213	Jefferson Ave	BHTP, Newport News	X	
214	Kingsmill	7851 Pocahontas Trl, Williamsburg	X	
215	Lee Hall PRS	17388 Warwick Blvd, Newport News		X
216	Lucas Creek PRS	750 Lucas Creek Road, Newport News	X	X*
217	Langley Circle	4 Thornrose Ave, Hampton	X	
218	Morrison	1228 Gatewood Rd, Newport News	X	
219	Newmarket	6000 Orcutt Ave, Newport News	X	
220	Normandy Lane	116 Normandy Lane, Newport News	X	
221	Patrick Henry	215 G Avenue, Newport News	X	
222	Pine Chapel	42 Freeman Drive, Hampton	X	
223	Washington Street	217 Washington St, Hampton	X	
224	Woodland Road	11 McElheney Lane, Hampton	X	
225	Willard Ave	219 National Ave, Hampton	X	
226	Williamsburg	540 South England Street, Williamsburg	X	
227	Fort Eustis	1619 Taylor Ave, Newport News	X	

Table A-3. HRSD Pumping Facilities				
PS/PRS Number	Name	Address	Pumping Station	PRS
229	Colonial Williamsburg	1000 State Route 132, York Co	X	
230	Rolling Hills	414 Rolling Hills Dr, York Co	X	
231	Ford's Colony	430 Hempstead Road, Williamsburg	X	
232	Greensprings	3900 John Tyler Mem. Hwy, Williamsburg	X	
233	Lodge Road PS	York County	X	

**Does not currently function as a PRS*

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APPENDIX B: INSPECTION FORMS AND PROCEDURES

Sample Pumping Facility Asset Inspection Procedure

Manhole Inspection Form

CCTV Inspection Form

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SAMPLE PUMPING FACILITY ASSET INSPECTION PROCEDURE

Most pumping facilities are designed in the wet well / dry well configuration style. Steps 1-15 will be performed on or in the upper level of the pump station. Steps 15-18 will be performed on the lower level (dry well) of the station, which is typically 20-40 feet below the upper level and connected by a spiral steel staircase. The dry well will contain centrifugal pumps as well as the piping, valves, and a sump pump.

Also, larger stations will have multiple levels but may not have the same layout as the duplex stations. The procedure described below should be adequate for performing a condition assessment on these larger stations.

NOTE: If immediate action is required for any pumping facility assets, record the needed action and notify HRSD Operations.

Please follow the steps below for a safe and reliable condition assessment:

Upper Level

1. **Photograph Station**
   - Capture the doorway and station number that should be mounted on the door.
   - Photograph potential issues and points of interest for documentation purposes.
2. **Pump Station Structure and Wet Well**
   - Record any structural deficiencies in the structure such as spalling or settlement.
   - Open Wet Well and determine condition. (Cleaning will likely be required. Note this on the form.)
   - Check the Influent Valve of the wet well to be sure that it is clear of debris and is exercised regularly. Record a specific assessment for this valve.
   - Fill the Condition Ranking field in the assessment form for Building, Wet Well and Influent Valve separately. Also complete the Field Observations field for Building and Wet. For the Influent Valve specify any observations/comments.
3. **Enter the station**
4. **Turn on HVAC**

***Warning* - If HVAC is not operational, DO NOT enter the dry well. The dry well constitutes a confined space if there is no ventilation. Appropriate measures should be taken if entry is necessary.**

5. **HVAC (FAN, LOUVER, and RECEIVER)**
   - Check for operation of equipment and possible vibrations. Corrosion of the duct work running from the wet well to the exhaust system should be checked, particularly in the sections that run through the station building. Corrosion within the station is of particular concern since hazardous gasses from the wet well may gather in the station.
   - Fill the Condition Ranking field in the assessment form for HVAC in general, and for (1) Exhaust Fan, (2) Scrubber Fan, (3) Wet Well Fan, (4) Intake Louvers, and (5) Air Receivers separately. Also complete the Field Observations field for HVAC. For items (1) through (5) above, specify any comments/observations.
6. **With the HVAC running, begin assessment of the remaining assets in the pump station.**
7. **Electrical Systems (ELECTEQT)**

- Check for foreign material in the control panel, dry or cracked cables, and loosened electrical connections. A general assessment of the electrical system should be recorded. Fill the general asset information fields in the assessment form.
- Fill the Condition Ranking field in the assessment form for Electrical Systems. Also complete the Field Observations field for Electrical Systems. Note that the Transfer Switch assessment should be completed on the Transfer Switch form.

8. **Transfer Switch (SWITCH)**
   - Fill the general asset information fields in the assessment form.
   - Fill the Condition Ranking field and Field Observations field in the assessment form.
9. **Generator (GENERATR)**
   - Fill the general asset information fields in the assessment form.
   - Fill the Condition Ranking field and Field Observations field in the assessment form.
10. **Engine (ENGINE)**
    - Fill the general asset information fields in the assessment form.
    - Fill the Condition Ranking field and Field Observations field in the assessment form.
11. **Instrumentation (MISCEQPT)**
    - This grouping is made up of bubbler panels and bubbler air compressors. Complete the general asset information fields in the assessment form. Review the level controls at the station and identify whether a high level float exists in addition to the bubbler system.
    - Fill the general asset information fields in the assessment form.
    - Fill the Condition Ranking field in the assessment form for the system in general, and for the bubbler panel and air compressor separately. Also complete the Field Observations field for the system in general. For each component, specify any observations/comments if there is any.
12. **Air Compressor (COMPRESS)**
    - Fill the general asset information fields in the assessment form.
    - Fill the Condition Ranking field and Field Observations field in the assessment form.
13. **Tanks (TANKS)**
    - Fill the general asset information fields in the assessment form.
    - Fill the Condition Ranking field and Field Observations field in the assessment form.
14. **Manually start the station pumps and assess the Motors and Drives.**
15. **Motors and Controllers (MTRCONTR)**
    - Each motor should be checked for abnormal noise, excessive heat, vibration and any other visual deficiencies. Use on-site run time logs to determine the approximate utilization.
    - For each motor, fill the Condition Ranking and Utilization fields in the assessment form. Also fill the Field Observations field for each motor by using the field observation codes table.

***Warning* - The dry well should never be entered without gas monitoring equipment. Leaking pumps can release wastewater into the dry well and contaminate the air supply. In this case, the HVAC may not be capable of adequately ventilating the dry well area.**

Lower Level

16. **Continue the assessment by following the stairs down into the dry well.**

17. **Pumps (PUMP)**
    - Potential issues may include overly-tight or loose packings, vibrations, cavitation, bad bearings, shaft vibration or deflection, U-joint issues and excessive noise. Check pump mountings and pump base for loose mounts or cracking. Any possible issues should be recorded. Record assessments for each individual pump.
    - For each pump, fill the Condition Ranking and Utilization fields in the assessment form. Also fill the Field Observations fields for each pump by using the field observation codes table.
18. **Valves (VALVE)**
    - Individual components include (1) Suction Isolation Valves, (2) Discharge Isolation Valves, and (3) Check Valves for each pump in the station. Check for malfunctioning or leaking valves, and whether the valves are regularly exercised.
    - Shut down the pumps.
    - Listen for leaking check valves. Leaking valves can cause impeller and pump shaft damage.
    - Check for pipe strain (typically a result of misaligned pump to pipe connections).
    - Assessments should be recorded for each individual component as well as for the general system.
    - Fill the Condition Ranking field in the assessment form for Valves in general, and for each pump fill the Condition Ranking field of Suction Isolation, Discharge Isolation and Check Valves separately. Also fill the Field Observations field for Valves in general by using the field observation codes table. For each pump, specify any observations/comments about Suction Isolation, Discharge Isolation and Check Valves.

The condition assessment should now be complete. Exit the dry well, be sure the pumps are operating automatically, shut down the HVAC, turn off lights, and exit the station. Be sure that the wet well is shut and locked, and the gate, if present, is secure before leaving the pump station grounds.

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Manhole Information

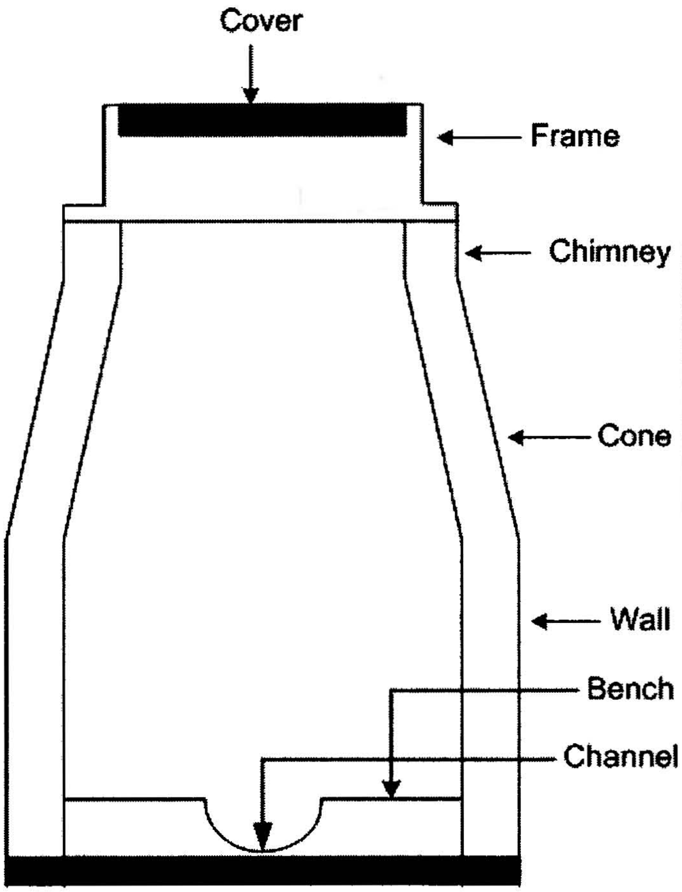
Manhole Number: SG-157-6+40 **Location:** Bainbridge Blvd @ Callow **City:** Chesapeake

Use Of Sewer: SS - Sanitary **Access Point Type:** AMH - Manhole **Year Laid:** 1950

MH Location Code: C - Light Highway **Futher Location Details:**

Year Rehabilitated: ☑ **Traffic Control** **Traffic Control Type:** Minor

Additional Information:



Status: SI - Surface Inspection **Date:** 8/6/2008

Surveyor's Name: John Cobb **Time:** 1:00

Certificate #: U-707-5293 **Weather:** 1 - Dry

Reason for Survey: F - Routine Assessment

Surface Type: Asphalt **Rim to Invert:**

Potential for Runoff: N - None

Cover
Diameter: 26
Material: CAS - Cast Iron
Condition: Sound
Fit: G - Good

Cone
Type: CC - Conical Centered
Material: BR - Brick
Depth:
Coating C - Cementitious

Frame
Material: CAS - Cast Iron
Condition: Corroded/Pitted
Diameter: 21.5in
Depth: 8in
Seal Cond: Loose/Not Attac
Seal Inflow: N - None

Wall
Diameter:
Material: BR - Brick
Depth: 82in
Coating: C - Cementitious

Bench
Bench Present ☑
Material: BR - Brick
Coating: C - Cementitious

Chimney
Material: BR - Brick
Diameter: 23in
Depth: 28in
Coating C - Cementitious
In Flow: N - None

Miscellaneous
# of Steps: 0
Steps Material
Evidence of Surcharge ☐

Channel
Installed ☑
Material: BR - Brick
Type: F - Formed
Exposure: P - Partially Ope

Structural MACP Grade: 3.27586206

O _M MACP Grade: 0

Manhole Number: SG-157-6+40 **Location:** Bainbridge Blvd @ **City:** Chesapeake

Use Of Sewer: SS - Sanitary **Access Point Type:** AMH - Manhole

Year Rehabilitated: **Year Laid:** 1950 **MH Location Code:** C - Light Highway

Futher Location Details:

Additional Information:

Surveyor's Name:	John Cobb	**Certificate Number:**	U-707-5293	**Date:**	8/6/2008
Time	1:00	**Out Going Rim to Inver**		**Outgoing Grade to Invert:**	
Rim to Grade	0	**Reason for Survey:**	outine Assessment	**Pre-Cleaning:**	N - No pre-cleaning
Date Cleaned		**Weather:**	1 - Dry	**Manhole Surface Type:**	Asphalt
Potential for Runoff:	N - None	**Inspection Status:**	SI - Surface Inspe	☐ **Evidence of Surcharge**	
Cover Shape	C - Circular	**Cover Size:**	26	**Cover Width:**	N/A
Cover Material:	CAS - Cast Iron	**Cover Type:**	Solid	**Vent Hole Diameter:**	
# of Vent Holes:	0	**Cover Bearing Surface Diam**	25.5in	**Cover Bearing Surface Widt**	N/A
Cover/Frame Fit:	G - Good	**Cover Condition:**	Sound	**Adjustment Ring Type:**	S - Solid
Adjustment Ring Conditio	Sound	**Frame Material:**	CAS - Cast Iron	**Frame Condition:**	Corroded/Pitted
Frame Bearing Surface Wi	1in	**Frame Bearing Surface D**	1.25in	**Frame Clear Opening Diamet**	21.5in
Frame Seal Condition:	Loose/Not Attach	**Frame Offset Distance**		**Frame Seal Inflow:**	N - None
Frame Depth:	8in	**Chinmey Material:**	BR - Brick	**Chimney I/I:**	N - None
Chimney Clear Opening:	23in	**Chimney Depth:**	28in	**Chimney Interior Coating/**	C - Cementitious
Chimney Exterior Coating	NA - Not Applica	**Cone Type:**	- Conical Centered	**Cone Material:**	BR - Brick
Cone Depth:		**Interior Cone Coatin**	C - Cementitious	**Exterior Cone Coating/Lin**	NA - Not Applicable
Wall Diameter:		**Wall Material**	BR - Brick	**Wall Depth:**	82in
Wall Interior Coating/Lin	C - Cementitious	**Wall Exterior Coatin**	NA - Not Applicable	☑ **Bench Present**	
Bench Material:	BR - Brick	**Bench Coating/Line**	C - Cementitious	☑ **Channel Installed**	
Channel Material:	BR - Brick	**Channel Type:**	F - Formed	**Channel Exposure:**	P - Partially Open
Manhole Steps #:	0	**Steps Material:**			

Manhole Defect Details Manhole Number: SG-157-6+40

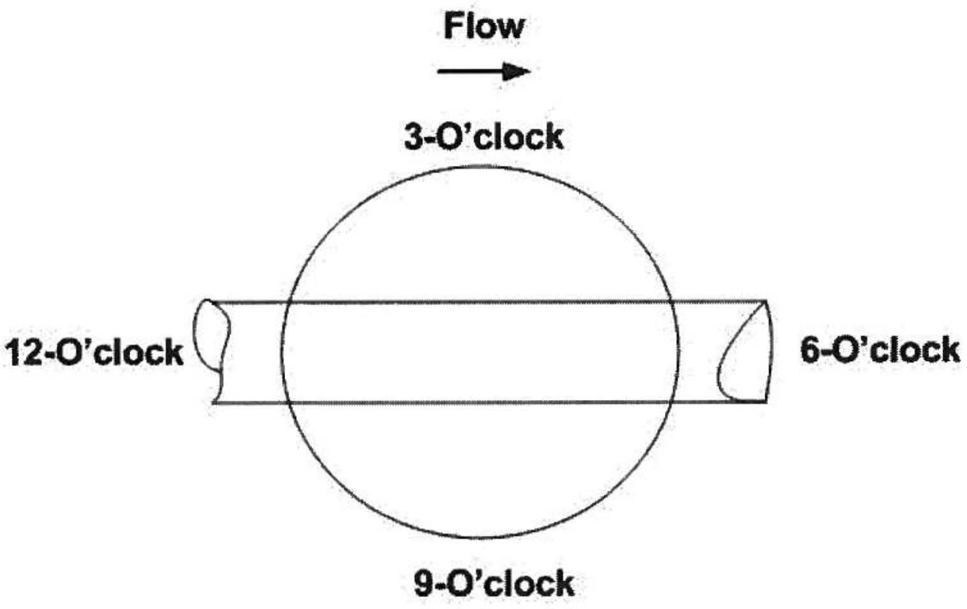
Date: 8/6/2008 **Distance:** **Video Ref.:** **Image Ref.:**
Component: Cone - Interior **Structural Defect:** MMM - Missing Mortar Medium
Structural Grade: 3 **Continuous:** ☑ **Length-Ft:** 7
O M Defect: **O M Grade:**
Continuous ☐ **Length-Ft:** 0 ft **Value -S/M/L:** **Value Inches - 1:**
Value Inches - 2: **Value - %:** **Joint** ☑ **Clock At/ From:** 6
Clock To: 12 **Remarks:** protective coating/liner deteriorated

Date: 8/6/2008 **Distance:** **Video Ref.:** **Image Ref.:**
Component: Wall - Interior **Structural Defect:** MMM - Missing Mortar Medium
Structural Grade: 3 **Continuous:** ☑ **Length-Ft:** 7
O M Defect: **O M Grade:**
Continuous ☐ **Length-Ft:** 0 ft **Value -S/M/L:** **Value Inches - 1:**
Value Inches - 2: **Value - %:** **Joint** ☑ **Clock At/ From:** 6
Clock To: 12 **Remarks:** protective coating/liner deteriorated

Date: 8/6/2008 **Distance:** **Video Ref.:** **Image Ref.:**
Component: Bench **Structural Defect:** SAM - Surface Aggregate Missing
Structural Grade: 4 **Continuous:** ☑ **Length-Ft:** 4
O M Defect: **O M Grade:**
Continuous ☐ **Length-Ft:** 0 ft **Value -S/M/L:** **Value Inches - 1:**
Value Inches - 2: **Value - %:** **Joint** ☑ **Clock At/ From:** 6
Clock To: 12 **Remarks:** protective coating/liner deteriorated/missing

Pipe Connection Details **Manhole Number:** **SG-157-6+40**

Date	Number	Position	Rim to Invert	In/Out	Material	Diameter	Seal	Type	Connects To
8/6/2008	1	6		Out	VCP - Vitrified Clay Pipe	18	C - Cracked	GR - Gravity	SG-157-9+40
8/6/2008	2	9		IN	XXX - Not Known	8	C - Cracked	GR - Gravity	City-plugged
8/6/2008	3	12		IN	VCP - Vitrified Clay Pipe	18	C - Cracked	GR - Gravity	SG-157-3+23
8/6/2008	4	3		IN	- Reinforced Plastic Pipe (T	8	C - Cracked	GR - Gravity	City
8/6/2008	5	3		IN	ZZZ - Other	8	C - Cracked	GR - Gravity	City-plugged



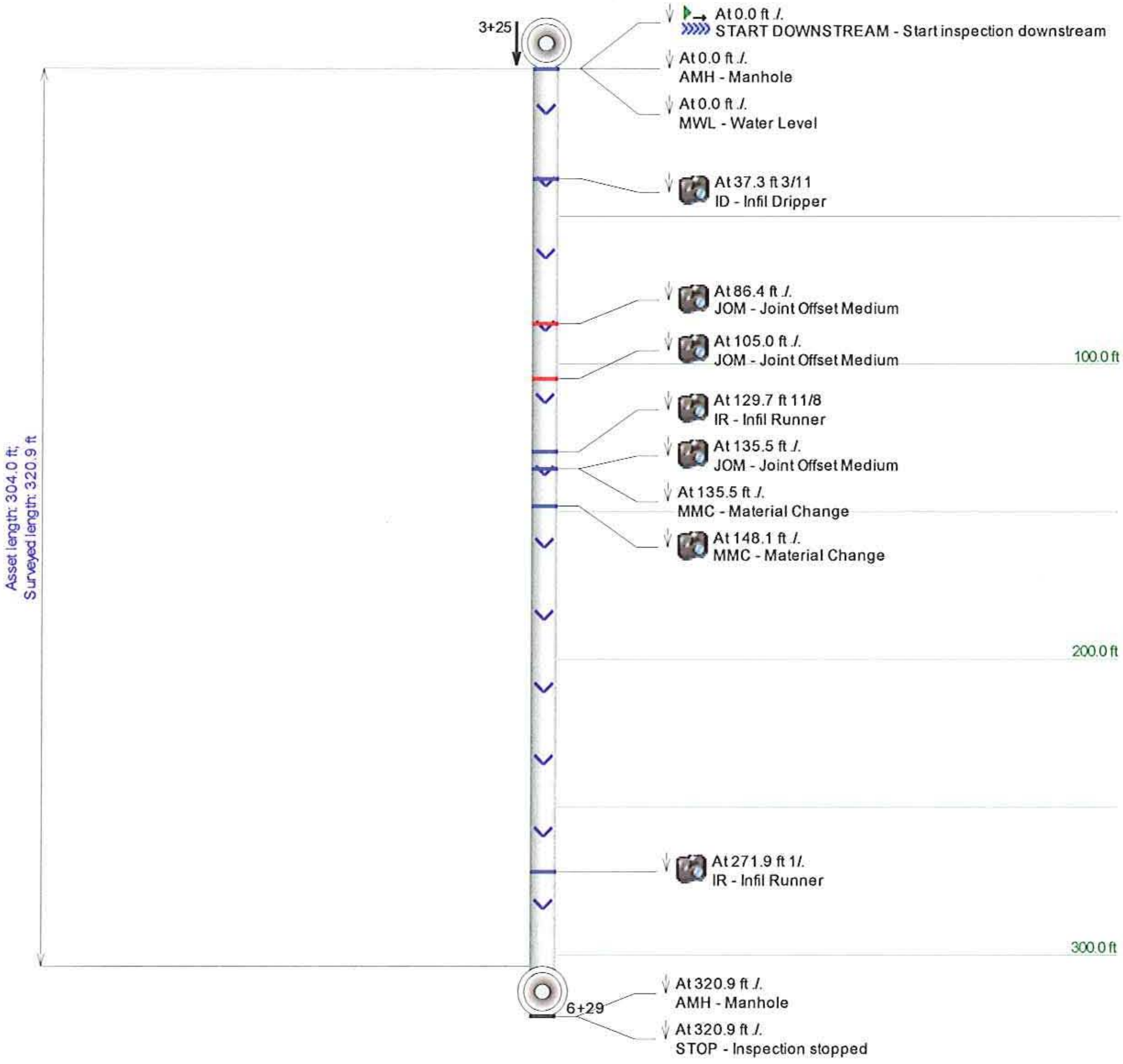
HRSD
1436 Air Rail Avenue
Va Beach, Virginia 23455
Fax 757-363-5839
Phone 757-460-2261

TV Inspection with Pipe-Run Graph

Project Name:	Asset ID:	City:	Address:
SG-207	3+25-6+29	Norfolk	Chesterfield Blvd

Date	Pipe Width:	Pipe Height:	Pipe Type:	Surface Condition:
7/19/2006		8	VCP	C

Direction:	Surveyed Footage:	Weather	Tape/Media #
Downstream	320.9	1	



At 0.0 ft /.
START DOWNSTREAM - Start inspection downstream

At 0.0 ft /.
AMH - Manhole

At 0.0 ft /.
MWL - Water Level

At 37.3 ft 3/11
ID - Infil Dripper

At 86.4 ft /.
JOM - Joint Offset Medium

At 105.0 ft /.
JOM - Joint Offset Medium

At 129.7 ft 11/8
IR - Infil Runner

At 135.5 ft /.
JOM - Joint Offset Medium

At 135.5 ft /.
MMC - Material Change

At 148.1 ft /.
MMC - Material Change

At 271.9 ft 1/.
IR - Infil Runner

At 320.9 ft /.
AMH - Manhole

At 320.9 ft /.
STOP - Inspection stopped

HRSD
1436 Air Rail Avenue
Va Beach, Virginia 23455
Fax 757-363-5839
Phone 757-460-2261

Observation Report with Still Images

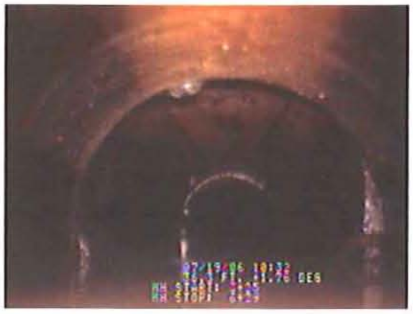
Main Asset ID: 3+25-6+29
Project Name: SG-207
Inspection Date: 7/19/2006 10:29:27 AM
Weather: 1
Operator: John Cobb

Upstream Node: 3+25
Downstream Node: 6+29
Main Length: 304.0

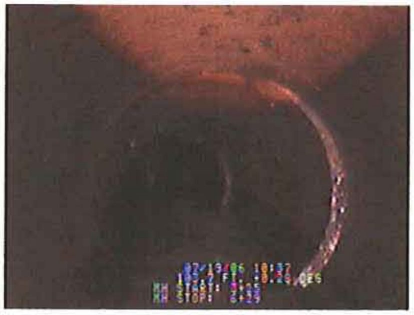
Comments:
SG-207

Observations

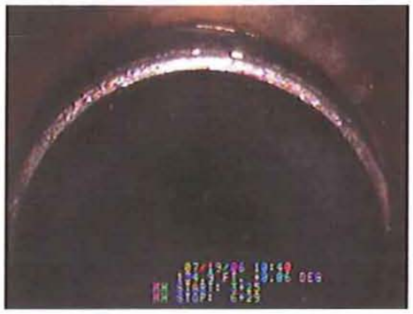
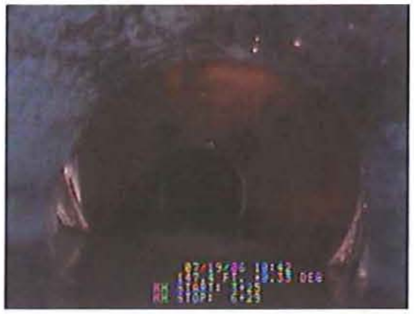
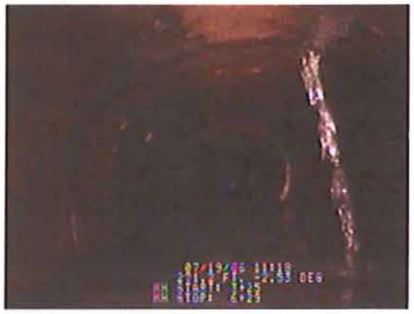
Distance	Length	Code	Reversed	Clock Pos.	Severity	Comment
0.0		START DOWNSTREAM	No	/		
0.0		AMH	No	/		3+25
0.0		MWL	No	/		
37.3		ID	No	3 / 11		



Observations

Distance	Length	Code	Reversed	Clock Pos.	Severity	Comment
86.4		JOM	No	/		
						
105.0		JOM	No	/		
						
129.7		IR	No	11 / 8		
						

Observations

Distance	Length	Code	Reversed	Clock Pos.	Severity	Comment
135.5		JOM	No	/		
						
135.5		MMC	No	/		pipe repair (pvc)
148.1		MMC	No	/		pipe changes to vc
						
271.9		IR	No	1 /		
						
320.9		AMH	No	/		6+29 Chesterfield Blvd pump station
320.9		STOP	No	/		

HRSD
1436 Air Rail Avenue
Va Beach, Virginia 23455
Fax 757-363-5839
Phone 757-460-2261

HAMPTON ROADS SANITATION DISTRICT

PACP Sewer Report

Surveyors Name	and Certificate Number	System Owner	Survey Customer	Drainage Area	Sheet No.
John Cobb	T-904-654	HRSD			1

P/O No.	Pipeline Segment Reference	Date	Time	Location (Street Name and Number)	Locality
	3+25-6+29	2006/07/19	10:29	Chesterfield Blvd	Norfolk

Further Location Details	Upstream Manhole Number	Rim to Invert	Grade to Invert	Rim to Grade
SG-207	3+25			

Downstream Manhole Number	Rim to Invert	Grade to Invert	Rim to Grade	Use of Sewer	Direction	Flow Control	Height
6+29				SS	D	L	8

Width	Shape	Material	Ln. Method	Pipe Joint Length	Total Length	Length Surveyed	Year Laid	Year Rehabilitated	Tape/Media Number
	C	VCP			304.0	320.9			SG-207

Purpose	Sewer Category	Pre-Cleaning	Cleaned	Weather	Location Code	Additional Information
F		J	2006/07/19	1	C	SG-207

	Structural					O&M					Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	3	3	3	1300	1	0	0	11	4231	3.666667	14	2.333333
2	0	0				0	0					
3	0	0				1	3					
4	0	0				2	8					
5	0	0				0	0					

HRSD
1436 Air Rail Avenue
Va Beach, Virginia 23455
Fax 757-363-5839
Phone 757-460-2261

Surveyors Name	System Owner	Date	Upstream Manhole Number	Pipeline Segment Ref	Sheet No.
John Cobb	HRSD	2006/07/19	3+25	3+25-6+29	2

Distance (Feet)	Video Ref.	Group/ Descripto	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches		%	Joint	Circumferential Location		Image Ref.	Family	Rating	Remarks
						1st	2nd			at	to				
0.0	3	AMH											O&M		3+25
0.0	15	MWL						10					O&M		
37.3	250	ID							J	3	11	2838a3b8-d80b-43d1-a26f-f19297d9e09a.jpg	O&M	3	
86.4	428	JOM			M							61ada583-eb88-418d-9c48-a3bdaec10a.jpg	S	1	
105.0	525	JOM			M							b0053b5-2a3a-413b-84fd-e1ee32c3123.jpg	S	1	
129.7	656	IR							J	11	8	beea802c-c1c6-4baa-ac94-654357c7c05b.jpg	O&M	4	
135.5	734	JOM			M							e997ecbd-5dbf-4b16-acd4-19136d5412.jpg	S	1	
135.5	769	MMC											O&M		pipe repair (pvc)
148.1	866	MMC										a88702f7-599-44d9-bbf7-f7eca9121f5f.jpg	O&M		pipe changes to vc
271.9	2043	IR								1		80b05747-f0fd-4824-8192-18ec95aad77.jpg	O&M	4	
320.9	44	AMH											O&M		6+29 Chesterfield Blvd pump station

APPENDIX C: FORCE MAIN CRITICALITY MODEL

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Scoring Methodology and Criteria

The scoring methodology is designed as follows:

- Each scoring parameter is applied to every force main segment in the HRSD system. A force main segment for the purposes of this effort will be no more than 5000' in length further delineated by changes in material type, diameter or main line valves.
- Each scoring parameter is assigned a score based upon the given value; 0 – 10 for a range of potential scores, or a 0 or 10 for yes or no.
- Each parameter is also weighted 1 – 10 depending upon the level of importance HRSD ascribes to that parameter. The weighting helps characterize the parameters that are more critical than others.
- Parameter value times the weighting value = Final score for that parameter
- All of the parameter scores for consequence are summed to derive the consequence score
  - The maximum score for consequence as the parameters are currently weighted = 420
- This is qualitative evaluation of force main consequence of failure. Risk assessment is a screening process, but it does not identify the actual vulnerability or condition of individual assets.
- Specific scoring criteria are as follows:

Consequence of Failure Scoring

1) Pipe Diameter **(WEIGHT __10__)**

Score = Selected Rank x Weight

10 – 36" – 54"

5 – 14" – 30"

1 – < 12"

2) Proximity to State Waters **(WEIGHT __9__)**

This data captured from existing GIS data.

Score = Selected Rank x Weight

10 – 0 to 100 feet

8 – 100 to 200 feet

6 – 200 to 500 feet

4 – 500 feet to 1,000 feet

2 – Greater than 1,000 feet

3) Potential for Discharge to Public Water Supply / Reservoir (WEIGHT 10)

Score = Selected Rank x Weight

10 – Within 300' of Public Water Supply and the Potential to Contaminate Water Supply

5 – 300' to 1000' from Public Water Supply/Reservoir

0 – No Potential to Discharge to Public Water Supply/Reservoir

4) Anticipated Difficulty of Repair/Depth/Highway Crossing or High Cost of Emergency Repair/Replacement (WEIGHT 8)

Score = Selected Rank x Weight

10 – High

5 – Medium

1 – Low

5) Force Main Difficulty of Repair by Material Type (WEIGHT 5)

Score = Selected Rank x Weight

10 – High Difficulty of Repair – PCCP, RC, AC, LCP, ECP, Flat Bottom RC

2 – Low Difficulty of Repair – Steel, DI, CI, HDPE, PVC

Total Consequence of Failure Score = Sum of Parameter Scores

Maximum Consequence of Failure Score = 420