Aqua Pennsylvania Wastewater, Inc.
Sanitary Sewer and Force Main Acceptance Testing
July 13, 2020

General

The Contractor shall furnish all labor, tools, material, including water, and equipment, including pumps, compressors, stopwatch, gauges, and meters, subject to the approval of Aqua for testing in accordance with these Specifications. Prior to any testing the contractor shall clean all manholes and sewers in the manner discussed below.

Testing Requirements and Procedures

1) Lamping or Mirror Test

a) Upon completion of pipe laying and backfilling, Aqua will conduct a lamping test to check for defects, and for horizontal or vertical misalignment. Lamping testing shall consist of directing sunlight or artificial light via mirrors through the completed section of pipeline, which, in order to be accepted, shall be true and straight in horizontal and vertical alignment to allow for the full passage of the reflected light.

2) Deflection Testing

a) Sanitary sewers shall be tested in the presence of Aqua's inspector and the Contractor's representatives to determine the amount of vertical deflection in the completed pipeline.

b) Deflection testing as specified hereinafter shall be conducted by the Contractor on all sanitary sewers installed. Deflection shall be considered excessive if the pipeline deflection measured is greater than 5 percent of the pipeline diameter. Should significant deflections of more than 5 percent be detected, additional deflection testing shall be performed by the Contractor to determine the actual deflection amount.

c) Installation of sanitary sewers shall be complete prior to the start of deflection testing. All sheeting and shoring shall be removed except where written approval by Aqua has been obtained. All backfill shall be placed and compacted and dewatering operations ceased 14 days prior to the start of deflection testing. One of the following methods of testing shall be utilized:

i) Mandrel. The mandrel shall be approved by Aqua prior to its use. Mandrels shall have an odd number of gauging plates. The minimum number of plates shall be nine (9) with a contact surface length equal to the inside pipe diameter plus two (2) inches for pipelines 10 inches in diameter and smaller. On larger diameters, the contact surface length shall equal the inside pipe diameter. A mandrel with a diameter equivalent to 95 percent of the inside diameter of the pipe to be tested shall be pulled by hand through the pipeline, from manhole to manhole. If the mandrel is unable to pass through the pipe without applying excessive force (as judged by the Aqua Inspector), it will be construed as evidence that the pipe has deflected more than 5 percent of the inside pipe diameter. A permanent record of all testing with locations where excessive pipeline

deflections occur shall be kept by the Contractor and forwarded to Aqua after completion of the testing on each line.

ii) Deflectometer. A deflectometer or a similar instrument, either of which must be approved for use by Aqua, shall be pulled through the pipeline from manhole to manhole. The instrument shall measure the vertical deflection in the pipeline to the nearest tenth of one percent. A permanent record of all testing with locations where excessive pipeline deflection (greater than 5% of inside diameter of pipe) occur shall be kept by the Contractor and forwarded to Aqua after completion of testing on each line.

d) The Contractor shall immediately replace all sections of pipe, which deflect more than 5 percent as measured by one of the foregoing methods.

3) Sanitary Sewer: Low-Pressure Air Test

a) Sanitary sewers shall be tested in the presence of Aqua's inspector and the Contractor's representatives to determine whether the pipeline is watertight. One of two test methods will be selected at Aqua's sole discretion. The low-pressure air testing procedure below should not be used for concrete pipes due to safety concerns. Aqua may allow the vacuum test method as described in ASTM C-1214 for concrete pipes.

i) Low Pressure Air Acceptance Test. The Contractor shall furnish all equipment and personnel necessary to conduct this test. The procedure for the low-pressure air test shall conform to the procedures described in ASTM C-828, ASTM F1417 or other appropriate procedures except for the testing times. Refer to the table below for the testing times required by Aqua. Aqua reserves the right to provide the pressure gage which will be used for the test.

(1) All branch fittings and ends of lateral stubs shall be securely plugged to withstand the internal test pressures. The section of line being tested shall also be securely plugged at each manhole. All stoppers shall be adequately braced for safety purposes.

(2) A determination will be made as to the presence of groundwater on the pipeline exterior. If groundwater is present, the air pressure to be used for the test shall exceed the maximum pressure exerted by the groundwater in the section of pipeline being tested by 4.0 psi. The pressure, in psi, exerted by the groundwater shall be determined by dividing the maximum distance the groundwater is determined or assumed to be above the top of the pipe (in feet) by 2.31. The resulting number will be the external groundwater pressure in psi. For example, if 5 feet of groundwater were present, the groundwater pressure would be 2.2 psi. The test pressure used in the pipeline would therefore be 2.2 psi + 4.0 psi = 6.2 psi in this example. In cases where no groundwater is present, the air shall be slowly supplied to the plugged pipeline until the internal air pressure reaches 4.0 pounds per square inch. At least 2 minutes shall be allowed for temperature stabilization before proceeding further.

(3) The air hose used to introduce the air into the pipe shall be removed and the rate of air loss shall then be determined by measuring the time interval required for the internal pressure to decrease from 3.5 to 2.5 pounds per square inch in pipelines not having groundwater conditions. For pipelines having external groundwater pressure conditions, the time required for the internal pressure to drop from 0.5 psi

to 1.5 psi less than the established test pressure shall be determined. The line shall be considered acceptable if the time required to reduce the air pressure per the above is not less than the time shown in the table below.

Pressure Test Time (min:sec)									
Pipe Diameter	**Length of Test Section (ft)**								
	≤100	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**
4"	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6"	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07
8"	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	12:40
10"	9:26	9:26	9:26	9:54	11:52	13:51	15:50	17:48	19:47
12"	11:20	11:20	11:24	14:15	17:06	19:57	22:48	25:39	28:30
15"	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31
18"	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06
21"	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15
24"	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58
Consult ASTM F-1417 for Pipe Diameters Greater than 24” and lengths longer than 500’									

(4) The Contractor shall not make any connections to the existing sanitary sewers until after the acceptance tests have been performed and accepted by Aqua.

ii) Alternate Acceptance Test – Sewers in Wet Locations. Aqua reserves the right to utilize as an alternate method for pipe with a diameter of 39 inches or less the following Test for Leakage. The Contractor shall furnish all equipment and personnel necessary to conduct this test in accordance with the following procedure:

(1) Sewer mains constructed in wet locations (i.e., water table above crown of pipe) subject to infiltration / exfiltration shall be tested by infiltration /exfiltration method. All other sewer mains shall use the air test method.

(2) Infiltration shall not exceed a rate of 100 gallons of water per inch diameter of pipe per mile of sewer pipe per day in any section of pipe between manholes. The amount of leakage shall be measured by a suitable weir or other device acceptable to Aqua. When measurement of infiltration is not possible because of dry conditions, an exfiltration test shall be made on each section if so directed by Aqua. The duration of each test shall be six (6) hours, unless a shorter test is permitted by Aqua. If leakage exceeds a specified rate in a section, corrections satisfactory to Aqua shall be made and the test repeated. 4’ M.H. = 93.9 gal/ft deep or 7.825 gal/inch;1 cu. ft. = 7.48 gallons.

(3) Sewers shall be tested in sections of not more than 1,000-foot lengths unless otherwise approved by Aqua. Each section shall meet the infiltration or exfiltration requirements specified herein.

(4) All sheeting shall be removed, except as may be indicated otherwise, backfill placed to finished grade, and dewatering operations ceased at least 3 days prior to infiltration tests.

(5) The Contractor shall replace or repair all defects on section of sewers failing to meet the requirements of these tests.

4) Sanitary Manhole Vacuum Test

a) Manhole Negative Air Pressure (Vacuum) Test: shall be in accordance with ASTM C1244.

b) All lift holes and any pipes entering the manhole are to be plugged. A vacuum will be drawn and the vacuum drop over a specified time period is used to determine the acceptability of the manhole.

c) Preparation of the Manhole:

i) All lift holes shall be plugged. All pipes entering the manhole shall be temporally plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole. The test head shall be placed at the very top of the manhole in accordance with the manufacturer's recommendations.

d) Procedure.

i) A vacuum of 10 in. of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. of mercury.

ii) The manhole shall pass if the time for the vacuum reading to drop from 10 in. of mercury to 9 in. of mercury meets or exceeds the required time values indicated in the table below. For other manhole diameters or greater depths, refer to ASTM C1244.

iii) If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.

iv) Minimum Test Times for Various Diameter Manholes:

Manhole Depth (ft.)	**Test Time Required, seconds**		
	Manhole Diameter (in.)		
	48"	**60"**	**72"**
8'	20	26	33
10'	25	33	41
12'	30	39	49
14'	35	46	57
16'	40	52	67
18'	45	59	73
20'	50	65	81
22'	55	72	89
24'	59	78	97

5) Sewer Cleaning, Jetting and Televising

a) Prior to testing, all manholes and all sections of pipe shall be cleaned by jetting. All bedding stone which may have been deposited on manhole benches shall be removed. All debris shall be flushed out of the sewer and shall be removed and disposed of properly; an inflatable plug which has been tethered to prevent loss shall be installed at the low end of the sewer(s) being cleaned to prevent debris from entering active portions of Aqua's collection system. Any alternate methods of cleaning sewers shall be submitted to Aqua for approval, and shall not be used unless approved.

b) Cleaning of the existing sanitary sewer shall be performed prior to the television inspection by a separate operation. After all testing specified in this section has been satisfactorily completed, the entire tested sewer shall be given a television inspection. The Contractor shall inspect and record internal sanitary sewer mains by color television camera and the inspection shall be recorded in digital format as specified hereinafter.

c) **Aqua reserves to right to require that the contractor flood the sanitary sewer with water prior to CCTV inspection if there is a suspicion that a belly or low spot may exist in any portion of the sewer.** Jetting shall not be substituted under these circumstances.

d) CCTV Inspection: inspection shall be recorded with on-screen footage readout on the lower part of the screen.

i) The pan and tilt camera shall have the capability of panning the pipe at 360° with tilt capability of 275° to ensure complete inspections and view of all laterals and deficiencies. The camera shall specifically be directed toward laterals so that a view up the lateral may be obtained.

ii) Digital video format recordings of the CCTV inspection shall be submitted to Aqua on USB Type A Flash Drives. The flash drives must be labelled to clearly indicate the name or location of the project and the date of inspection. If multiple flash drives are submitted to Aqua, they must be also numbered in an appropriate manner. The file names for videos saved on the flash drives must be descriptive.

iii) A log shall accompany the digital format submission saved as a PDF file on each flash drives which notes:

(1) Date
(2) Flash Drive Label/Number and File Name
(3) Location including Manhole Numbering
(4) Direction of inspection
(5) Pipe Material and Size
(6) Lateral Locations
(7) Observed defects with onscreen footage
(8) Name of Equipment Operator
(9) Name of Firm Performing the Inspection

6) Sanitary Sewer Defects to be Made Good

a) The following deficiencies in sanitary sewer liner installation shall be corrected by the Contractor at no cost to Aqua:
   i) Bellies and low points
   ii) Improper grade
   iii) Joint separation
   iv) Offset joints
   v) Cracked or damaged pipe
   vi) Cracked or damaged precast structures and appurtenances
   vii) Infiltration points
   viii) Debris in the line

b) If, at any time before the expiration of the guarantee period under the Contract, any broken pipe, or any other defects are found in any of the lines or in any of the appurtenances, the Contractor shall cause the same to be removed and replaced by proper material and workmanship. All materials shall be carefully examined by the Contractor for defects prior to installation, and any found defective shall be rejected for use.

c) Aqua will not accept a credit, maintenance bond, or any other form of compensation in lieu of corrective measures that may be required to correct any sections of sewer that are improperly installed or do not meet the requirements of these specifications. In addition, all corrective measures proposed by the Contractor shall be approved by Aqua. In addition, should repairs of the sewers be accomplished by the use of any unauthorized materials or procedure, Aqua will require replacement of those substandard portions or repairs made, to conform to the requirements of these specifications. Upon completion of repairs the sewer main shall be CCTV inspected and the recorded CCTV inspection will be reviewed by Aqua. This process shall be repeated until the review of the recorded television inspection reveals a satisfactory installation.

7) Force Main Testing and Inspection

a) All new pressure pipes shall be leakage tested as specified herein. The contractor shall be responsible for furnishing all labor, tools, equipment, materials, including water, pumps, compressors, pressure gauges, meters, and stopwatch subject to the approval of Aqua. **Aqua shall reserve the right to supply the pressure gauge to be used in the test.**

b) Test Restrictions:
   i) All tests shall be conducted in the presence of an Aqua inspector or duly authorized representative.
   ii) Testing of all pressure pipes shall be conducted in accordance with AWWA Publication M-23 or AWWA C600 testing requirements.
   iii) The hydrostatic pressure test shall be two hours duration.
   iv) Test pressure shall not vary by more than 5 psi for the duration of the test.
   v) Line valves at cleanouts shall not be operated in either direction at a differential pressure exceeding the rated valve working pressure. The test pressure shall not exceed the rated pressure of the valves when the pressure boundary of the test section includes closed, resilient-seated gate valves.

c) Pressurization
   i) After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of 150 psi for a two hour duration. Each valved section of pipe shall be slowly filled with water, and the specified test pressure (based on the elevation of the highest point of the line or section under test and corrected to the elevation of the test gauge) shall be applied by means of a pump connected to the pipe. It is good practice to allow the system to stabilize at the test pressure before conducting the leakage test.
   ii) Before applying the specified test pressure, air shall be expelled completely from the section of piping under test. If permanent air relief valves are not located at all high points temporary valves shall be installed at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the temporary valves shall be closed and the test pressure applied.
   iii) All exposed pipe, fittings, valves, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, or joints that are discovered during or following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until satisfactory results are obtained.
   iv) Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi (34.5 kpa) of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.
   v) The testing procedure shall include the continued application of the specified pressure to the test system, for the entire testing period by way of a pump taking supply from a container suitable for measuring water loss. The amount of loss shall be determined by measuring the volume displaced from said container.
   vi) Hydrostatic testing shall be performed at 150 psi for all sizes of force mains; the test pressure shall not exceed the rated capacity of the pipe to be tested. The testing procedure shall continue for an uninterrupted period of not less than two (2) hours. Testing shall be in accordance with the applicable AWWA provisions for PVC-AWWA Publication M-23 and for DIP-AWWA Standard C600, Section 4. The allowable rate of leakage shall be less than the number of gallons per hour determined by the following formulas:

For PVC Pipe:

$$L = \frac{N \times D \times P^{1/2}}{7,400}$$

For DIP:

$$L = \frac{S \times D \times P^{1/2}}{133,200}$$

Where,

L = allowable leakage in gallons per hour
N = number of joints in section tested
S = length of pipe tested, in feet
D = nominal diameter of the pipe in inches
P = average test pressure maintained during the leakage test in pounds per square inch (gauge)

d) Acceptance of installation
   i) Acceptance shall be determined on the basis of allowable leakage. Should the test fail, necessary repairs shall be accomplished by the contractor and the test repeated until within the established limits specified.
   ii) If any test of laid pipe discloses leakage greater than that specified above, repairs or replacements shall be accomplished and testing shall be repeated until acceptable results are obtained.

8) Force Main Defects to be Made Good

a) All visible leaks are to be repaired regardless of the amount of leakage.
b) Any defective work, which shows up while conducting tests shall be replaced or repaired by the contractor as dictated by Aqua at his own cost in a manner satisfactory to Aqua.

END OF ACCEPTANCE TESTING