



# DENVER

## THE MILE HIGH CITY

CITY AND COUNTY OF DENVER  
DEPARTMENT OF PUBLIC WORKS | ENGINEERING DIVISION

## Storm Drainage and Sanitary Sewer Construction Detail and Technical Specifications

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### 9.0 Testing, Inspection and Acceptance

#### 9.1 General

In addition to any other testing or inspection requirements set forth elsewhere in these Specifications, all testing, inspection and acceptance of the completed work will be as specified herein.

Test for water-tightness of sanitary sewers shall be conducted by the Contractor at his own expense, except as noted, with the assistance and under the direction of the Project Construction Engineer prior to final acceptance.

Unless otherwise specified, storm sewer systems normally will not be required to be tested for leakage. All leakage tests shall be completed and approved prior to placing of permanent resurfacing. Where the difference in elevation between the inverts of adjacent structures(manholes) exceeds 20 feet, no exfiltration leakage tests will be required.

#### 9.2 Testing and Inspection

##### 9.2.1 Exfiltration Test

Unless otherwise noted on the plans, each section of sewer will be tested between successive manholes by closing the lower end of a sewer reach by plugging the pipe at the inlet to the lower manhole and then by filling the sewer and the upper manhole(s) to the proper level

with water. The water level in the upper manhole shall be a minimum of 4 feet above the level of the ground water. The maximum exfiltration rate for any section of sewer line shall not exceed the limits specified below:

Pipe Material	Maximum Rate of Exfiltration
Clay, Concrete	200 gal per day/inch diam/mile
PVC	50 gal per day/inch diam/mile

For the purposes of exfiltration leakage, manholes shall be considered to be concrete pipe of the same diameter as the manhole i.e. 48, 60 or 72 inch diameter. Air pocket entrapment shall be avoided when filling the line with water. Once filled with water, the system shall be allowed to stabilize for a period of one or two hours before starting the test. Exfiltration leakage rate is determined by measuring the amount of water required to maintain a constant level in the upper manhole. Test duration is to be no less than two hours.

If the leakage, as shown by the test, exceeds the allowable value, the Contractor shall make the necessary corrections at his expense to reduce the exfiltration to within the permissible limits. The Contractor shall furnish all water, material and labor required to perform the test. All tests shall be made in the presence of the Project Construction Engineer.

### 9.2.2 Infiltration Test

If the Project Construction Engineer determines that excessive ground water is encountered during construction of a sanitary sewer section, the infiltration test for leakage shall be used. The maximum allowable infiltration for sanitary sewers shall not exceed the following limits for the type of projects specified:

Type of Pipe	Max. Allowable Infiltration
Clay, Concrete	200 gal per day/inch diam/mile (3.8 d/inch/100 ft)
PVC	50 gal per day/inch diam/mile (0.95 gpd/inch/100 ft)

Unless otherwise specified, infiltration will be measured by the Project Construction Engineer, using measuring devices furnished by the City.

If the infiltration is found to exceed the prescribed amount, the Contractor shall make the appropriate repairs as approved by the City and shall continue to test the sewer until it meets requirements.

### 9.2.3 Air Pressure Test

When directed by the Project Construction Engineer and prior to acceptance of any segment of newly constructed sanitary sewers, the pipe will be subjected to an air pressure test, which

will be conducted after densification of the backfill and prior to installation of any sanitary taps. The City shall furnish all equipment and materials for conducting the air test, and all costs will be borne by the City. The air pressure test requirement will normally apply to sanitary sewers only, unless otherwise directed by the Project Construction Engineer.

The test shall conform to the recommended practice and calculations established by the ASTM C-828. After a manhole to manhole reach of pipe has been backfilled, the line should be flushed and cleaned with the interior walls moist. Plugs shall be placed in the line at each manhole and low pressure shall be introduced into this sealed line until the internal pressure reaches 4 psig (pounds per square inch gage) greater than the average back pressure of any ground water that may be surrounding the pipe. At least two minutes shall be allowed for the air pressure to stabilize. The test shall then be run with the drop in pressure from 3.5 to 2.5 psig. The calculations generated by ASTM C-828 shall then be used to check the adequacy of the pipe installation. If the installation fails to meet the requirements, the Contractor shall at his own expense determine the source of leakage and then shall repair or replace all defective materials and/or workmanship at his own expense to the satisfaction of the Project Construction Engineer.

Safety precautions shall be used at all times. It is extremely important that the plugs be installed and braced to prevent blowouts. No one shall be allowed into the manholes during testing.

#### **9.2.4 Television Inspection**

Prior to acceptance of any segment of newly-constructed sewers, all pipes will be televised and physically inspected by the City for any observable defects. This requirement will apply to sanitary sewers and to small storm sewers which are too small to be physically inspected will also be televised. Any defects discovered during this inspection shall be corrected prior to acceptance of the sewer.

The Contractor shall request these televised inspections through the Chief Construction Project Construction Engineer with at least 48 hours advance notification. The cost of initial inspection and the first re-inspection to confirm correction of previously identified deficiencies will be borne by the City. If additional inspections are required due to inadequate or otherwise unacceptable repairs, the costs for such inspections shall be charged to the Contractor.

#### **9.2.5 Deflection Test (Plastic Pipe)**

The City shall conduct deflection tests of all flexible pipes after completion of the work and again 30 days prior to the end of the guarantee period. The Contractor shall, at his expense, furnish a multiarmed test mandrel having an odd number of arms, nine or more in number. The mandrel will be pulled through the lines to be tested by City personnel using the ASTM testing procedure. The Contractor may witness the tests and may receive a copy of the test logs and reports if desired. All test equipment, calibration data, procedures, etc. shall be subject to approval by the Project Construction Engineer.

The maximum allowable deflection after installation and backfilling shall not exceed that specified elsewhere in these Specifications for the particular pipe installed. Any segments of the pipe deemed necessary to be unsatisfactory shall be replaced or reworked by the Contractor in accordance with the requirements of the Project Construction Engineer. Such repair shall be at the Contractor's expense.

## 9.2.6 Hydrostatic Test

Cast Iron, Ductile Iron, PVC Pressure Mains and Force Mains

### 9.2.6.1 Hydrostatic Tests

Hydrostatic tests consisting of a Pressure Test and a Leakage Test shall be performed prior to final backfilling. Thrust blocks, anchors, and partial backfill sufficient to anchor the pipeline in place but leaving joints, valves and fittings exposed for inspection shall be performed before testing.

### 9.2.6.2 Pressure Test

After the pipe has been laid and partially backfilled, all newly laid pipe, or any valved section thereof, shall be subjected to a pressure test. The test pressure shall be determined by the Engineer. For PVC Pressure mains and Force Mains the test pressure shall be defined in general accordance with the requirements of AWWA-900 or UNI Bell B-3-77. The duration of the pressure test shall be at least one hour with no discernable loss of pressure.

- a. **Procedure.** Each valved section of pipe shall slowly be filled with water to the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation on the test gage. Air shall be applied by means of a pump connected to the pipe in a satisfactory manner satisfactory to the Engineer. The pump, pipe connections, gages and all necessary test equipment shall be furnished by the Contractor who will make all taps into the pipe. The Contractor shall furnish all necessary assistance for conducting the tests.
- b. **Air Removal.** Before applying the specified air pressure, all air shall be expelled from the pipe. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points so the air can be expelled as the line is filled with water. After the air has been expelled, the corporation cocks shall be closed and the test pressure applied.
- c. **Examination Under Pressure.** All exposed pipe fittings, valves and joints shall be carefully examined prior to placement of backfill. Any cracked or defective pipe, pipe joints, fittings, or valves discovered in consequence of the pressure test shall be removed and replaced by the Contractor, and the test shall be repeated to the satisfaction of the Project Construction Engineer.

### 9.2.6.3 Leakage Tests

A leakage test shall be conducted after the pressure test has been satisfactory completed. The Contractor will furnish the gage, measuring device, pump, and pipe connections, other necessary apparatus and the necessary assistance to conduct the test. The duration of each

leakage test shall be two hours with an average test pressure determined by the Engineer being maintained during this period.

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 the specified leakage test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = ND\sqrt{P} \text{ divided by } 3700$$

For mechanical joints and push-on joints, where L is the allowable leakage in gallons per hour, N is the number of joints in the length of pipeline tested, D is the nominal diameter of the pipe in inches, and P is the average test pressure applied during the test in pounds per square inch gage.

The allowable leakage for 1,000 feet of 18-foot length of mechanical joint or push-on joint pipe at various pressures and diameters is shown in Table 1 of this section.

- a. **Variation from Permissible Leakage.** If any pipe laid discloses leakage greater than that specified above, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance.
- b. **Pressure and Leakage Tests after Backfilling.** After the trench has been completely backfilled, the test connections made, and the main filled with water, the pipe shall be subject to a final pressure and leakage test as specified above. If defects are found, the Contractor shall immediately make the repairs and the test repeated until satisfactory to the Engineer.

A final leakage test shall then be conducted after satisfactory completion of the pressure tests. Should any section fail to meet the final leakage test, the Contractor shall make the necessary repairs at his expense.

The duration of the final pressure test and leakage test shall be a minimum of one hour each.

#### 9.2.6.4 Test Report

The Project Construction Engineer shall be furnished a written report of the reports of the Hydrostatic Tests performed, identifying the specific length of the pipe tested, the pressure, the duration of the test and the amount of leakage.

## 9.2 Acceptance

Portions of the work completed may be placed in operation after all cleaning, and inspection requirements have been fulfilled. Final acceptance of the work will not be made until all requirements set forth in the Contract documents have been completed.

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Any items of work which the Contractor considers as extra shall be reported to the Project Construction Engineer during the progress of the testing and inspection. No consideration of any work items will be made unless substantiating records of the work exist. Any work which the Contractor considers to be extra shall be considered in accordance with General Condition 1101, "Change Order".