CHAPTER 11: INSPECTION & TESTING

Figure 11-1: Pipe Laser Beam Unit

Inspection

Inspectors are an important link between the engineer's design and an accurately completed project. The inspector is responsible for monitoring and control of the project by measuring actual construction against the plan and specifications. Inspectors must be thoroughly familiar with good practice in sewer construction, have the ability to read and understand detailed plans and specifications, translate that information to an understanding of the complete scope of work

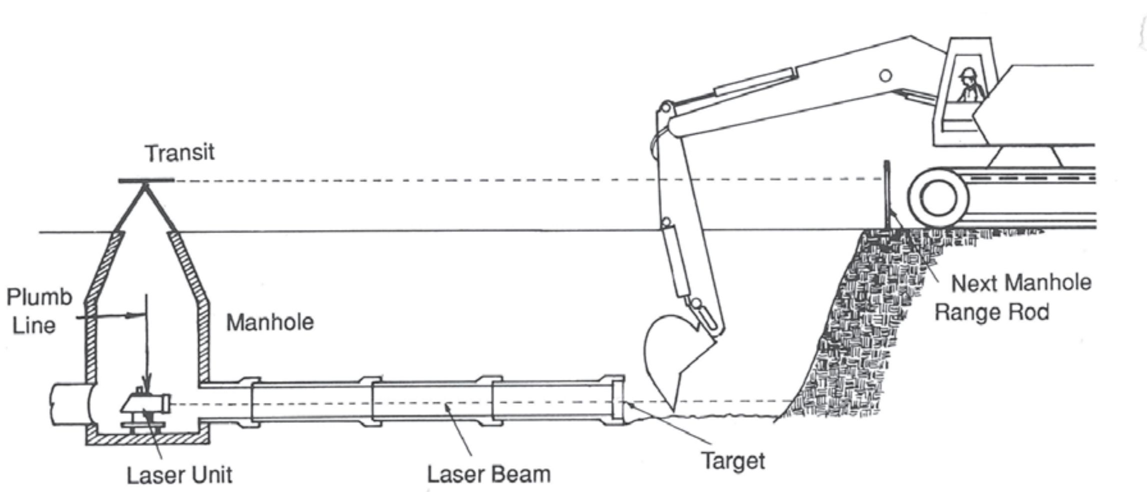

Figure 11-2: Laser Beam Setup

and make computations as needed to interpret the drawings and field conditions. The inspector must be familiar with excavation and foundation development, required bedding materials with their proper application, and recommended bedding application process. They must have knowledge of safety regulations for construction sites and see that all regulations and proper procedures are followed.

The project engineer has the overall responsibility for project design and implementation. It is therefore necessary that they be fully acquainted with the project plans, related specifications and construction contract documents. They must be sufficiently experienced to review the means and methods chosen by the contractor and evaluate their impact on design plans and specifications.

Tools

There are a variety of tools an inspector should use to ensure the proper implementation of the projects design and specifications. Typical tools used by inspectors include:

- *NCPI's Vitrified Clay Pipe Engineering Manual*
- Related industry standards and regional specifications (ASTM)
- Manufacturer handling requirements
- *NCPI's Toolbox* (ncpi.org/ncpi-toolbox.html)
- *NCPI's Installation & Inspection Handbook*
- *NCPI's Low-Pressure Air Test Booklet*
- *NCPI's Tips for Laying Vitrified Clay Pipe*
- *NCPI's Guide to Analyzing CCTV Inspection*
- Manufacturer Representatives

Duties

The long-term efficiency of sewer systems depends upon the combined efforts of the engineers, the inspector, the contractors and the material suppliers.

The inspector has many duties included in their work. They must make a complete record of all occurrences related to the construction of the pipe line and maintain a daily log.

These records are integral to any required changes that must be made in the original construction plans. Such changes may involve extra work and payment for this can be computed only after the work is done. Any deviation between design work and actual construction must be noted.

Figure 11-3: *Inspectors are a vital link between specification and construction.*

Material Evaluation

This process includes reviewing scheduled deliverables with the contractor to ensure acceptance of pipe by the owner of the project. This procedure includes:

- Verify proper pipe configuration and sizes.
- Inspect pipe at delivery and before installation.
- Ensure inspected pipe is stored in a manner to avoid damage.
- Damaged pipe may NOT be marked or defaced.
- Notify the supplier immediately of pipe rejected or damaged pipe.

Testing

Acceptance testing is the process of formalizing acceptance of a completed pipeline. Methods commonly used are CCTV Inspection, Low-Pressure Air Testing, and Hydrostatic Infiltration Testing. Common practice is to test each section from manhole to manhole after it is backfilled.

The first section of any sewer project should be tested immediately upon completion to ensure that the installation procedure will produce the results required by the specifications.

Experience demonstrates that continual testing as a job progresses improves adherence to good job site practices, increases contractor productivity and ensures compliance with engineering plans.

All acceptance tests must be performed by qualified personnel. These tests should be witnessed by the inspector or engineer's representative.

CCTV Inspection

Television has been growing in popularity as a means of investigating the condition of all types of buried sewer lines. As an investigative tool, it is unmatched in enabling operators to pinpoint many differing conditions and provides a record of construction results. Many agencies have begun requiring television as a means of determining the acceptability of newly constructed lines.

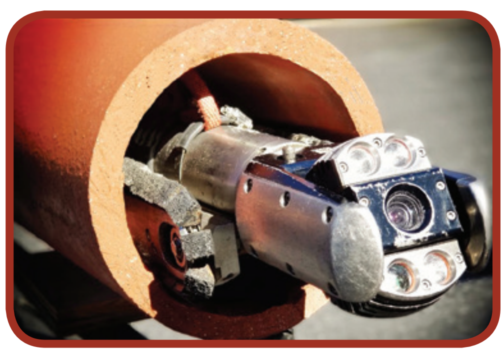

Figure 11-4: *A CCTV camera in an 8" pipe. Photo courtesy of Plumbers Depot Inc.*

In some instances, assumptions regarding structural damage have been made erroneously. Operators of television equipment are looking for problems. These unintentional errors can lead to conclusions that become unproductive while being quite expensive. There have been instances where dig-ups have shown the problem described in the log to be either non-existent or of significantly less magnitude than originally indicated. For this reason, the low-pressure air test is the preferred method of acceptance testing.

See the NCPI document *A Guide to Analyzing CCTV Inspection* (available online).

Low-Pressure Air Testing

When the measured water table is 5 ft. or less above the pipe barrel at the midpoint of the test section, a low-pressure air test is an accurate method of testing a sewer line for acceptance (for 5 ft. or greater see "Hydrostatic Infiltration Testing" on page 11-5).

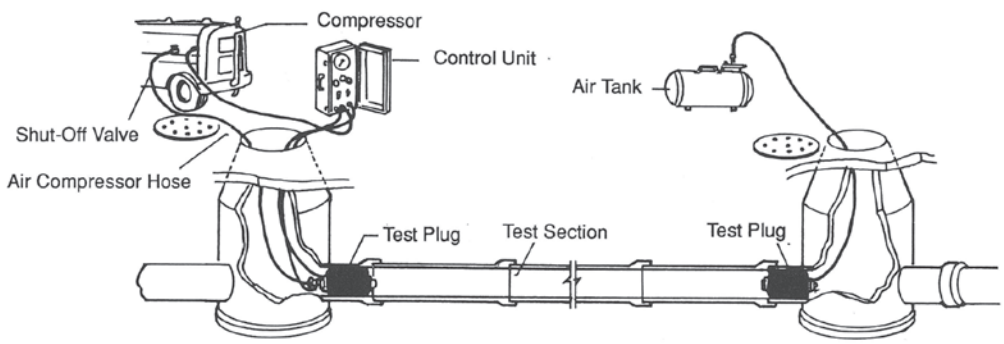

Figure 11-5: *Line Acceptance Testing*

Acceptance or failure of a line is determined by a specific drop in air pressure over a specified length of time (See Low-Pressure Air Test Booklet).

Test Procedure

Clean the sewer line by flushing before testing to wet the pipe surface and clean out any debris. Plug all pipe outlets to establish the required test pressure. All stoppers in laterals should be braced.

ASTM C828 *Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines* describes the procedure for air testing sewer lines. Air test tables found in the NCPI low pressure air test booklet are derived from this standard.

Figure 11-6: *Test Plug*

The pressure-holding time is based on an average holding pressure of 3 psi gauge or a drop from 3.5 psi to 2.5 psi.

Add air until the internal air pressure of the sewer line is approximately 4.0 psi gauge. After an internal pressure of approximately 4.0 psi is obtained, allow time for the air pressure to stabilize. The pressure will normally show some drop until the temperature of the air in the test section stabilizes.

When the pressure has stabilized above the 3.5 psi gauge reading, reduce the pressure to 3.5 psi to start the test. Record the drop in pressure for the test time. If the pressure does not drop more than 1.0 psi during the test time, the line is presumed to have passed. It is not necessary to continue the test for the total time when it is clearly evident that the rate of air loss is less than the allowable.

This procedure can be used as a presumptive test, which enables the installer to determine the acceptability of the line before backfill and subsequent construction activities.

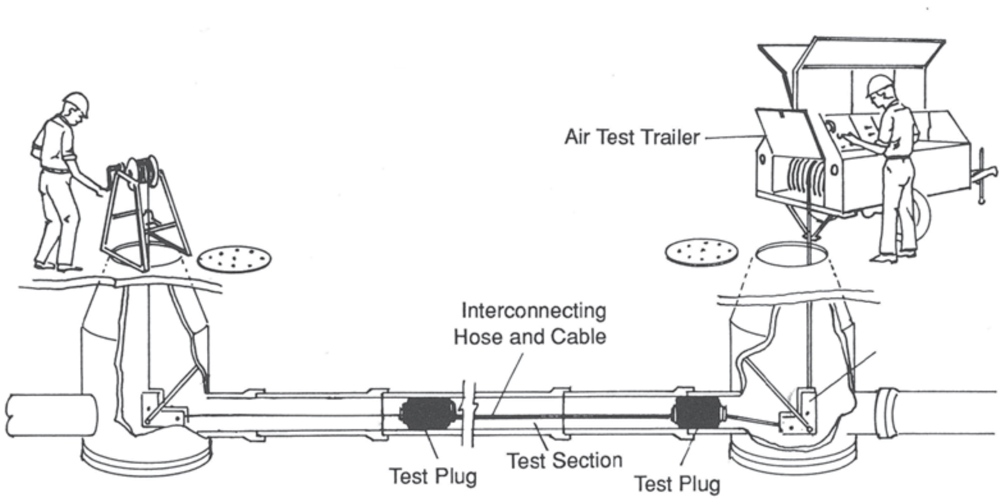

Figure 11-7: *Segmental Air Testing*

Safety During Testing

The air test can be dangerous if a line is improperly prepared due to improper training, a lack of understanding or carelessness.

Calculate the amount of back pressure the plug must withstand and be certain the plug being used is designed to withstand this pressure. Always use a pressure gauge and regulator when inflating a sewer plug. Under-inflated plugs will not be able to withstand the required back pressure. Over-inflated plugs can rupture causing possible damage and injury.

It is extremely important to install and brace the various plugs to prevent blowouts. A force of 250 Lbf is exerted on an 8-inch plug by an internal pipe pressure of 5 psi. The sudden expulsion of a poorly installed plug, or of a plug that is partially deflated before the pipe pressure is released, can be dangerous.

As a safety precaution, pressurizing equipment should include a regulator or relief valve set at 10 psi to avoid over pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

Hydrostatic Infiltration Testing

When the measured water table is 5 ft. or greater above the pipe barrel at the midpoint of the test section, infiltration testing is the preferred and least expensive method of acceptance testing. The infiltration test measures the ground water, entering the pipeline. Manholes should be tested independent of the sewer line.

ASTM C1091 *Standard Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines* describes the procedure for Infiltration Testing and allowable rate of infiltration.

If water is present in the line, isolate the section of pipeline being tested from the upstream side. Discontinue pumping of ground water for a minimum of 24 hours prior to testing. Determine the infiltration flow rate in the sewer line at the furthest downstream point of the section being tested.

It is necessary to collect and measure the infiltration over a period of time. A convenient collection time is one hour. This measurement can be converted to gallons per hour and to gallons per inch diameter per mile, per day and compared to the specified standard.

Collection of the infiltration may be obtained by using a dam at the invert of the pipe and removing the collected water, by collecting water through a flow through plug, or other convenient method.

The set up in Figure 11-8 is recommended to achieve this result. After the leakage for the pipe is determined, the lower plug in the upstream manhole can be removed and the combined infiltration from the pipeline and the manhole can be measured. The manhole infiltration is calculated by simply subtracting the pipeline infiltration from the combined pipeline and manhole infiltration. Other procedures for infiltration testing may be equally satisfactory.

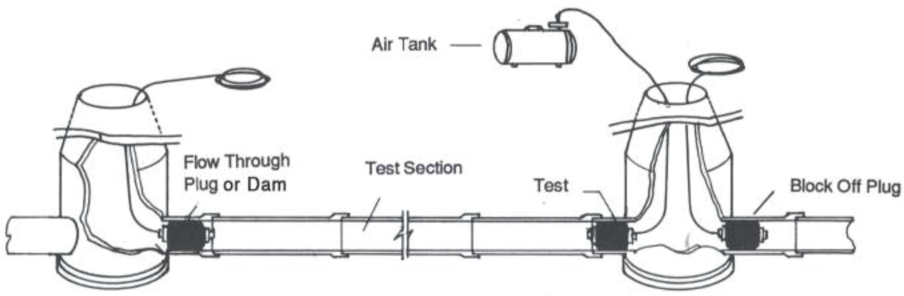

Figure 11-8: *Recommended set up for Infiltration Testing*

Example 11-1: Calculation of Infiltration Rate

Pipe Size	8 in.
Quantity Collected	0.7 gals.
Length of Test Section	485 ft.
Elapsed Time	1 hour

Infiltration Rate in Gallons/Inch Dia./Mile/Day

$$= (0.7\ gals)\left(\frac{1}{8\ in.\ dia.}\right)\left(\frac{5280\ ft./mile}{485\ ft.}\right)\left(\frac{24\ hr./day}{1\ hr.}\right)$$

$$= (0.7\ gals)\left(\frac{1}{8\ in.\ dia.}\right)\left(\frac{10.9}{mile}\right)\left(\frac{24}{day}\right)$$

$$= \frac{183.1}{8}\ gals/in.\ dia./mile/day$$

$$= 23\ \text{gals}/in.\ dia.\ /mile/day$$