

“INTENSIVE” SMOKE TESTING SPECIFICATIONS & PROCEDURES

1.0 OVERVIEW AND RATIONALE

1.1 Basic Smoke Testing

Smoke testing is an efficient and effective technique that can conclusively reveal the existence of specific undesired connections to the sanitary sewer. The types of sources revealed by it are also generally the most readily correctable.

The technique basically consists of blowing smoke / mist into the sewer under pressure and observing where smoke reappears. It should appear at neighbouring maintenance hole vent holes (pick holes) and at house vent pipes and such appearances reveal the penetration of the “smoke/mist” (i.e. is there is enough “smoke/mist” to fill the sewer portion being tested). If “smoke” appears from catch basins (street, ditch or driveway) or eaves troughs, it is conclusive evidence that such are effectively & incorrectly connected to the sanitary sewer, rather than the storm sewer system.

It should be remembered the “smoke” testing is a “one way” test. If “smoke” appears at an eaves trough, it is definitely connected in some way to the sewer. If “smoke” does not appear at an eaves trough it might still be connected. “Smoke” penetration can be blocked by standing water, which blocks a pipe (water trap). Such a water trap will prevent “smoke” from coming out of an eaves trough or driveway catch basins even if they are connected.

Smoke testing used to be carried out by lighting a smoke “bomb” (similar in appearance to a roadside flare), placing it in a pail and lowering it down a manhole. A manhole ventilator would then be placed on top of the manhole to blow the smoke through the system. Such smoke “bombs” were designed to produce a non-staining mist with a high concentration of atmospheric moisture and high visual obscurity. The mist was primarily “seeded” with zinc chloride. Such smoke bombs are seldom used now due to factors such as:

- Concerns about having a burning item in the manhole (in case there are explosive gases present – these were tested for previously).
- Short shelf life of the smoke bombs and their high costs.

- Concerns regarding zinc chloride.
- Difficulty of quickly shutting down a smoke bomb if necessary.
- Development of better techniques.

Now smoke generators are normally used in conjunction with a manhole ventilator. Such smoke generators vaporize a fluid to produce a mist.

1.2 Additional Factors in Intensive Smoke Testing:

The effectiveness of smoke testing and its benefits to the municipality can be greatly increased by using a more “intensive” technique. The cost will be greater than that for the simple, traditional approach but the extra benefits outweigh the costs, making it more cost effective than the traditional approach. This involves the following elements:

- Greatly increasing the smoke pressure in the sewer so that it can better penetrate cracks in pipes/laterals, manhole chimneys, pavement etc. and force its way through soil to the surface, thereby helping to locate both direct and indirect sources of I/I.

This first requires isolating a small portion of the system (approx. 200m) by largely blocking the air space above the flow. It is important that the flow itself not be blocked by sandbags or sewer plugs. If the flow is blocked at the downstream end of a test segment the flow will back up the pipe and can block the smoke thereby preventing findings in addition to creating a flooding hazard. If flow is blocked at the upstream end of a test segment then a flooding hazard is created upstream.

The normal duration of a single test (with few or no findings) may be only 10-15 minutes but if there are extensive findings, proper documentation of them can cause a single test to extend to nearly an hour.

- A smoke generator/blower unit with a power roughly 4 times that of a manhole ventilator must also be used. These sit directly on a manhole (eliminating pressure losses in a ventilator hose), and put out 6000 cfm in free air or over 4000 cfm against normal sewer backpressure that develops(head equivalent to 3 inches of water). This requires a 5 to 5.5 horsepower motor and a 20inch fan blade. A 120 volt motor running off a generator can only develop about 25% of this power.

- Checking sunken driveway catch basins (where found) for elbow pipes and standing water and pumping these down as necessary so that the elbow pipe is clear of water allowing mist penetration. Without this measure connected sunken driveway catch basins will seldom be identified and these can be a very severe source of inflow.
- When testing areas with flat roofs (schools, commercial/industrial buildings, and apartment buildings) an observer with a video camera must be stationed on the roof to be able to check for connected roof drains vs. vent pipes and collect conclusive evidence of connections. With sewer segment isolation and use of a 5 hp blower the smoke can readily reach the roof of a 20 storey apartment building within 5-10 minutes. Low roofs can be accessed with an extension ladder and higher roofs require access from the building interior (Arrangements can be made with Superintendents/Owners). When working in a cluster of flat roofed buildings, an observer on the highest roof with a zoom lens video camera can usually cover several buildings.
- Isolating test segments will require opening about 75% of the manholes in the system and doing confined space entries into about 50% of the manholes. It is highly probable that numerous system problems will be revealed by simple observation during this part of the work. Examples of such problems are missing rungs, missing benching, flow going in a direction different from the plan, displaced manhole frames and/or lids (possible evidence of severe surcharge), damaged adjusters, active infiltration, location in an area susceptible to ponding(ditch, depression, or gutter), etc. Such things must also be identified and documented as their importance is sometimes greater than normal smoke findings.
- If sewer blockages are found at manholes they must also be documented. If the blockage is simple to correct it should be cleared by the smoke test crew. If the blockage is severe/difficult to correct then the operations group of the municipality should be immediately notified of the problem and its location.
- Provision of readily usable documentation. This must include figures showing the extent of the testing area, and the approximate location of findings. In detailed documentation of findings the objective is to provide conclusive proof of the finding and information to allow finding it again in the field (to correct the problem). Recommendations to correct the defect must also be provided.

Since it can often be very difficult to see smoke against a grey sky or concrete in a still photo, edited video must also be provided wherein the moving smoke is easily seen against a still background. Field video is often difficult to view and understand due to background noise, camera “jumping”, occasional errors in street names, overly long or short segments etc. This can be greatly improved in an edited video with “voice-over”. To be readily usable such a video (which may be an hour or more long) must have sub menus that allow a user to directly go to the documentation for a specific finding. Still photos in the report will better show “smoke” if they are “captured” frames from the video.

2.0 OBJECTIVES

The City intends to carry out an “intensive” smoke testing program in areas of known or suspected high I/I throughout the city to locate sources of extraneous flows. The smoke testing will be used to locate sources of storm water inflow and infiltration in the sanitary collection system and is expected to result in works to reduce the amount of inflow into the sanitary sewer system. The types of sources that may be identified by the smoke testing include but are not limited to:

- Stormwater connections such as catch basins, storm laterals, building roof drains, sump pumps, window wells, yard and foundation drains
- Broken sewer lines
- Leaking maintenance holes
- Unplugged abandoned sewer lines
- Broken or missing sewer cleanout plugs
- Maintenance holes susceptible to excessive inflow
- Problems in maintenance holes opened during the work

3.0 SCOPE OF WORK

The Contractor will be required to carry out a complete smoke testing program including but not limited to handing out notifications to affected residents of the proposed smoke testing activities, conducting smoke tests in an environmentally friendly manner, documenting the results of the smoke testing, and submitting three

hard copies and one electronic copy report in Adobe Acrobat format (.pdf) with comments and recommendations, on a timely basis.

The scope of work shall include but not be limited to the following:

3.1 Public Notification

The City will prepare a flyer/letter to notify the public about the smoke testing program. The Contractor shall deliver the flyer/letter to residents in the testing area roughly seven days before the testing takes place. The Contractor will be required to bring extra copies of the notification on the days of testing and shall provide the same to the public upon request. The flyer will include contact information for the City contact person for the work. In the event that specific residents contact the City about specific concerns/health issues, etc. the City will provide such resident's contact info to the Contractor.

The Contractor shall then contact the resident to discuss their concern if possible (ie. if they can be reached by phone) 1 or 2 days before their street is to be tested. The Contractor shall also notify the resident if possible (ie. if they are home) immediately before testing their street. The Contractor will also notify all schools and the fire department of the work locations and liaise with the fire service each day to ensure fire officials are apprised of the work areas and the beginning/end of the work period for the day.

The Contractor must be courteous at all times when meeting with the public. If the Contractor, for any reason, enters a private residence, care shall be taken to ensure that floors are protected from dirt and dust. This will include measures such as removing footwear, using "slippers", using plastic sheets and boot covers as necessary.

3.2 Smoke Testing

3.2.1 Pre-testing Work

Prior to the public notification process the Contractor shall satisfy themselves that maintenance hole covers can be opened and that there are not line blockages etc., that would prevent successful smoke testing. If the Contractor finds that such conditions exist and should be corrected before the testing they shall report same to

the City. The City shall not be liable for extra costs resulting from the failure of the Contractor to carry out such checks before the public notification process.

The Contractor shall also check driveway catch basins for elbow pipes and standing water before the testing so that they are prepared to pump these down before testing if necessary so that the elbow pipe is clear of water allowing smoke to egress.

3.2.2 Smoke Testing Specification and Procedure

The Contractor shall perform the smoke testing in a safe and environmentally friendly manner. The specifications for the smoke testing include but are not limited to the following:

- A current Material Safety Data Sheet (MSDS) must be readily available during smoke testing covering materials used during the testing (copies of the MSDS shall be readily available to handout to the public as required).
- Smoke shall not contain zinc chloride or other hazardous compounds.
- The smoke testing system shall have a powerful blower that sits directly on top of the maintenance hole and includes a rubber pad to help seal the unit to the MH rim. This eliminates pressure losses associated with use of an air duct.
- The blower unit shall deliver over 4000 CFM against an air pressure equal to 3 inches of water (over 6000 CFM in free air). This will require a motor of 5 to 5.5 horsepower. A 120 volt electric motor driven blower cannot deliver this much power and will not be acceptable.
- Each test shall be carried out for at least 10 minutes to allow time for smoke to appear from “indirect” as well as “direct” connections. Connections with a delayed response shall be noted as such (see Section 3.2 on documentation).

- Testing is to be performed during dry conditions as much as possible. When preparing the cost quotation and schedule, allowance shall be made for 1 poor weather day in 5 when conditions will not be good enough for testing.
- Each test shall cover a maximum of 200 metres (2-3 pipes). Entry shall be made into the maintenance holes upstream and downstream of the centre maintenance hole and flaps placed to largely block the air space above the flow in the pipe. **Sand bags and sewer plugs are not to be used** as these can lead to flooding and/or compromise the test (see Section 1.2 – “factors in intensive smoke testing”). Proper Confined Space Entry Procedures shall be adhered to at all times when entering the maintenance holes. Confined space entry sheets shall be completed for all entries and made available to the City.
- When testing areas having buildings with flat roofs (schools, industrial/commercial, apartment buildings, etc.) the contractor must station an observer on the roof of the building with a video camera & record sheets during the test. The contractor shall have ladders capable of safely accessing a roof of 6 metres in height and arrange for access to roofs from building interiors for higher roofs (this can be done during delivery of notification flyers).
- High powered smoke testing equipment as required for this project requires significant and frequent maintenance and it can often take a week or more to obtain spare parts. This can easily become a problem once notification flyers have been delivered and a commitment has been made to test a given area in a specific time period. In order to avoid such problems the contractor shall have on site a complete backup smoke testing unit that meets the specifications herein.
- A high number of confined space entries into maintenance holes will need to be made during the course of this work and these require a fully functioning atmospheric gas detector. In order to avoid schedule disruptions in the event of a gas detector failure (which like smoker units can take some time to correct), the Contractor shall have on site a backup gas detector.

- During the course of carrying out the testing the contractor will need to open about 75% of the maintenance holes in the system and enter about 50% of them. The Contractor shall take note of and document any problems that are readily apparent and include these in the report. These include missing or poor benching, damaged adjusters, displaced manhole rims, location in an area susceptible to temporary ponding (eg. ditch, gutter, in line with and close to a paved driveway, in a depression, etc), the wrong type of lid (open grid instead of closed grid), etc. The contractor shall also note whether flow directions in the sewers match those shown on the plan and document any differences in the report.
- During the course of opening and entering the majority of manholes in the system the Contractor may come upon instances of pipe/maintenance hole partial blockage. If the blockage is simple, the Contractor shall clear it. If the blockage is complex the operations group at the City shall be immediately notified and the blockage shall be documented in the report.

3.3 Documentation of Findings

The Contractor crew shall walk along the length of the line being tested to take note of and document all locations where smoke appears. If relevant, they shall also note roughly how long it takes for smoke to appear at specific locations. Of prime importance in this regard are locations where it takes smoke 5-10 minutes to appear. This is an indication that the discovered source is “indirect” rather than “direct”, which is an important piece of information. Such findings shall be videoed using a digital video camera and photographs also obtained. Contractors are encouraged to capture video “frames” for still photos providing they have good clarity at a size of approximately 50mm by 75mm. The problems of capturing smoke exiting a source in a still photo can be largely overcome by searching through and using digital video “frames”.

The contractor shall also document the findings on a record sheet which includes a diagram of the source location. Such diagrams shall include a depiction of the building configuration & address, the street location/name etc. The record sheet shall include enough information that City personnel can readily find it in the future to take corrective action.

Equivalent documentation shall also be taken of any problems noted at maintenance holes as described in the preceding section.

3.4 Reports

A preliminary/summary report shall be submitted within 2 weeks of the completion of the smoke testing field work. This report shall include a listing of all findings along with a few captioned photos of key findings. The preliminary report will also include a plan/map showing the area tested and the approximate location of findings.

The smoke testing work carried out for a given area will be fully documented in a final report which is expected to be submitted to the City within 2 months of the completion of the field work. The report will include but not be limited to the following:

- Plans/maps clearly showing the extent of area tested and the approximate location of numbered findings.
- Description of each finding and its significance along with captioned photo(s) of it and recommendations for corrective action.
- A full description of the smoke testing method and equipment utilized.
- An edited video disk which includes “voiced over” documentation of all findings. This video must include menus/submenus that allow a viewer to readily go directly to the documentation/proof of a specific finding.
- Copies of all field record sheets covering each finding, in an appendix.

The objective of the report is to provide conclusive proof of each finding and enough information that City personnel can readily find it in the field to take corrective action.