

This section covers the requirements for constructing sanitary sewer disposal field perforated piping with bedding material to lines, grades and dimensions indicated or directed by the Engineer.

REFERENCES

This specification refers to the following standards, specifications, or publications:

American Association of State Highway and Transportation Offices (AASHTO)

M196-92 (R2012) Standard Specification for Corrugated Aluminium Pipe for Sewers and Drains

ASTM International

F794 Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

D698-12 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³), Method D)

CSA Group

PLUS 4012 (2010) Technical Guide: Visual Inspection of Sewer Pipe

Other

MSCC Manual of Sewer Condition Classification, Third Edition,
1993 NASSCO Certification

PART 1 - GENERAL

1.1 AS-BUILT DRAWINGS

- .1 Provide data necessary, as requested by Engineer, to produce As-Built Drawings, including details of pipe material, invert elevations at connections, location of tees, bends, clean-outs.

1.2 MEASUREMENT FOR PAYMENT

- .1 Excavation and backfill will be measured in accordance with Section 02223.
- .2 Piping will be measured through fittings after the work is completed. Measurement will be horizontally in metres over the centre line of the pipe.
- .3 Tees, caps, plugs and other fittings will be measured by unit.

- .6 No separate measurement for payment for TV camera inspection will be considered as cost for camera inspection shall be considered incidental to the per meter unit price for solid PVC pipe and perforated PVC pipe.
- .7 Granular bedding material (washed crush stone – 19 – 60 mm) will be measured in cubic metres of material incorporated into the work in accordance with Section 02223. No deduction for pipe will be made.
- .9 Locating and connecting to existing distribution box will be considered incidental to the Work with no separate payment considered. Cost for connecting to existing distribution box shall be included with the per meter unit price for solid PVC pipe.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE

- .1 Smooth wall polyvinyl pipe and fittings in accordance with ASTM D3034-14 and ASTM F679-13A. Plastic pipe and fittings in accordance with CSA B1800 Series 11 for 100/125/150 mm sizes, and for 200 mm to 675 mm sizes. Standard Dimensional Ratio (SDR): 35 for mains and SDR 28 for service pipe, unless otherwise indicated on the contract drawings, with locked-in gasket and integral bell system. Nominal lengths: 4 and 6 m.
- .2 Profile wall polyvinyl chloride pipe with locked-in gasket and integral bell system. Pipe and fittings to be certified in accordance with CSA B1800 Series 11 and ASTM F794. Pipe stiffness to be 320 kPa for sanitary sewer mains, this pipe not to be used for diameters less than 300 mm. Pipe stiffness to be minimum 210 kPa for storm sewer drains. Nominal length 4 m.

PART 3 - EXECUTION

3.1 PREPARATION

- .1 Clean pipes and fittings of debris and water before installation. Inspect materials for defects before installing. Remove defective materials from site.

3.2 TRENCHING AND BACKFILLING

- .1 Do trenching and backfill work in accordance with Section 02223.
- .2 Trench line and depth as well as condition of trench bottom require approval prior to

placing bedding material and pipe.

- .3 Do not backfill trenches until pipe grade and alignment have been checked and accepted and infiltration and ex-filtration test results are within the limits specified. If the pipe is backfilled for any reason prior to testing, accept responsibility to meet the tests or to re-excavate and repair the line and pay all costs.
- .4 Separation between sewers and watermains shall be in accordance with Section 02713.

3.3 GRANULAR BEDDING

- .1 Place granular bedding materials in accordance with details specified or directed.
- .2 Shape bed true to grade and to provide continuous, uniform bearing surface for barrel of pipe. Do not use blocks when bedding pipe.
- .3 Shape transverse depressions as required to within bell if bell and spigot pipe is used.
- .4 Compact full width of bed to at least 95% of corrected maximum dry density in accordance with ASTM D698-12 Method D.
- .5 Fill excavation below bottom of manholes or structures with specified bedding material or common backfill as directed by the Engineer.

3.4 INSTALLATION

- .1 Lay and join pipes in accordance with manufacturer's recommendations.
- .2 Handle pipe with approved equipment. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.
- .3 Use laser-type instrument to control line and grade for sewers unless otherwise approved by the Engineer.
- .4 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .5 Commence laying at outlet and proceed in upstream direction with bell ends of pipe facing upgrade.
- .6 Do not allow water to flow through pipe during construction, except as may be permitted by Engineer.

- .8 Whenever work is suspended, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .9 Position and join pipes by approved methods. Do not use excavating equipment to force pipe sections together.
- .10 Install PVC pipe and fittings in accordance with CSA B1800 Series 11 and Uni-Bell.
- .11 Joints:
 - .1 Pipe Joining:
 - .1 Install gaskets as recommended by manufacturer.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes carefully before joining.
 - .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.
 - .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace before joining is attempted. Use only manufacturers recommended lubricant.
 - .6 Complete each joint before laying next length of pipe.
 - .7 Minimize joint deflection after joint has been made to avoid joint damage.
 - .8 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
 - .9 At rigid structures, install pipe joints not more than 600 mm from side of structure.
- .12 Block pipes as directed when any stoppage of work occurs to prevent creep during down time.
- .13 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes as directed by the Engineer. Backfill to prevent flotation as required or as directed by the Engineer.
- .14 Cut pipes as required for special inserts, fittings or closure pieces in a neat manner, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave a smooth end at right angles to axis of pipe.
- .15 Make watertight connections to distribution box or other structures. Provide details of

proposed method of installing pipe stubs in structure walls to ensure a watertight joint. In the case of existing distribution box, an integral joint gasket may be cast in the box wall to receive the pipe stub. The exterior pipe surface in contact with the structure wall shall be roughened or treated to provide a bond with the concrete. Any grout used to be non-shrink type.

- .17 Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes. Joint of saddle to pipe shall be structurally sound and watertight.
- .18 Leave joints and fittings exposed for ex-filtration testing. Provide protection when required. If it is necessary to backfill sections of the sewer prior to testing, take full responsibility and bear all costs for any additional excavation and backfill to expose pipe, fittings or joints that may be necessary.
- .19 When infiltration and ex-filtration test results are acceptable to Engineer, backfill remainder of trench in accordance with Section 02223.
- .20 Hand place granular material in uniform layers not exceeding 150 mm thick to minimum 300 mm over top of pipe. Dumping of material directly on top of pipe is not permitted.
- .21 Place layers uniformly and simultaneously on each side of pipe to prevent lateral displacement of pipe.
- .22 Compact each layer to at least 95% maximum density in accordance with ASTM D698-12, Method D.

3.5 FIELD TESTING

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 Prior to TV inspection remove foreign material from sewers and related appurtenances by flushing with water.
- .3 Perform infiltration or ex-filtration testing as soon as practicable after jointing and bedding are complete.
- .4 Do infiltration and/or ex-filtration testing as directed. Perform tests in presence of Engineer. Notify Engineer 24 hrs. in advance of proposed tests.
- .5 Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.

- .6 Ex-filtration test:
- .1 Fill test section with water in such a manner as to allow displacement of air in line.
 - .2 Immediately prior to test period add water to pipeline until there is a head of 1 metre over interior crown of pipe measured at highest point of test section.
 - .3 Duration of ex-filtration test shall be one hour.
 - .4 Water loss at end of test period shall not exceed maximum allowable ex-filtration over any section of pipe between manholes.
- .8 Infiltration test:
- .1 Conduct infiltration test in addition to ex-filtration test.
 - .2 Install a watertight plug at upstream end of pipeline test section.
 - .3 Discontinue pumping operations for at least 3 days before test measurements are to commence and during this time keep thoroughly wet at least one third of pipe invert perimeter.
 - .4 Prevent damage to pipe and bedding material due to flotation and erosion.
 - .5 Place a 90° V-notch weir, or other measuring device approved by Engineer.
 - .6 Measure rate of flow over a minimum of 1 hour, with recorded flows for each 5 min interval.
- .9 Infiltration/ex-filtration shall not exceed 4.63 litres per millimetre of internal pipe diameter per kilometre per 24 hours which are the following limits in litres per hour per 100 m of pipe, including service connections.

Internal Pipe Diameter (mm)	Maximum Amount (l/hr)
100	1.93
150	2.89
200	3.86
250	4.83
300	5.79
350	6.75
400	7.72
450	8.68
500	9.65
550	10.61
600	11.58
700	13.51
800	15.44
900	17.37

- .10 Repair and retest sewer line as required, until test results are within limits specified at no additional cost to the contract.
- .11 Repair visible leaks regardless of test results.
- .12 Carry out any retesting of sewer sections which have previously passed ex-filtration and/or infiltration tests, as directed by the Engineer. If any sewer section passes this initial retest, additional payment will be made for such retest of that section. If any sewer section does not pass this initial retest, repair and retest such sewer as required until test results are again within limits specified, at no additional cost to the contract.
- .13 Deflection Test for PVC Pipe
 - .1 Carry out a deflection test on all sections of the sewer. The maximum allowable deflection under fully backfilled and compacted trench conditions shall not exceed 5% before 30 days and 7.5% after 30 days.
 - .2 Locations with excessive deflection shall be repaired and/or the pipe replaced at the contractor's expense. The equipment used for the deflection test shall be that as recommended by the manufacturer, and may include an Electronic Deflectometer or a Rigid "Go-No-Go" Device. For the purpose of deflection measurement, the base inside diameters and the deflection mandrel dimensions are provided in the following table. To ensure accurate testing the lines shall be thoroughly cleaned.
 - .3 For nominal sewer sizes not shown in above table the Mandrel dimensions shall be calculated as follows:

$$\text{Mandrel O.D.} = \frac{(100-Y)}{100} \times \text{Base I.D.}$$

$$\text{where Y} = \text{Deflection Limit in \%}$$

3.8 CCTV INSPECTION OF PIPELINES

- .1 The following information shall be submitted to the Engineer two weeks prior to the start of the CCTV inspection operations:
 - .1 A copy of the CCTV operator's NASSCO Certification Certificate. A copy of said certificate is required for each CCTV operator working on the contract.

- Operators shall have been certified or re-certified within the three years prior to the start of the contract.
- .2 A sample inspection report, resolution tests of digital video recording format, and digital data file. One submission is required for each camera proposed for use on the work. The camera make, model, and serial number shall be clearly identified on each video recording.
- .3 The details of the coding accuracy verification system that is to be used to verify inspection accuracy shall be submitted for approval.
- .2 Media storage shall be as specified in the contract documents. Digital storage device with minimum USB 2.0 or higher compatibility shall be placed inside envelopes with labels displaying the following information:
- .1 Owner's Name
 - .2 Contract Number or Project Name
 - .3 Sewer Identification Number
 - .4 City or Town
 - .5 Street Name
 - .6 Inspection Date
- .3 The digital storage device shall include a file in either Word or Text format including the information provided above. The digital storage device shall be labelled. The label shall include the information in points .1 and .2 above to identify the content. CD and DVD shall be placed in a 5.2 mm slim-line clear jewel case with permanent labels displaying all the information above or as specified in the contract documents.
- .4 Digital photograph files shall meet or exceed a resolution of at least 640 x 480 pixels. Printed photographs shall be in colour with a minimum image size of 90 x 70 mm and shall be reproduced on premium glossy photo quality paper.
- .5 Survey and camera equipment used to inspect watermains shall have been used exclusively for work in watermains only.
- .6 The survey vehicle shall contain a separate area for viewing, recording, and controlling the CCTV operation. The viewing and control area shall be insulated against noise and extremes in temperature. Cooling and heating units shall be independent from the main vehicle engine and in good working order. External and internal sources of light shall be controlled in a manner as to ensure the light does not impede the view of the monitor screen. Seating accommodation for one person

shall be provided in addition to the operator seating to clearly view the monitor screen. All equipment used within the pipeline shall be stored outside the viewing, recording, and control area. The vehicle shall include a cell phone or suitable alternative as agreed by the Engineer for the duration of the work.

- .7 The surveying equipment shall be capable of surveying a length of pipeline up to:
 - .1 300 m when entry to the pipeline may be obtained at each end of the pipeline.
 - .2 30 m when rodding is used.
 - .3 150 m when a self-propelled unit is used when entry is at only one end of the pipeline.
 - .4 200 m when being towed.
- .8 Work shall not commence in a work shift until the Engineer is satisfied that all items of the survey equipment have been provided and are in full working order. Each survey unit shall contain a means of transporting the CCTV camera in a stable condition through the pipeline.
- .9 When the CCTV camera is towed by winch and cable through the pipeline, all winches shall be stable during the entire CCTV inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera.
- .10 Each unit shall carry sufficient number of guides and rollers so that, when surveying, all cables are supported away from pipe and maintenance hole edges. All CCTV cables and lines used to measure the camera's location within the pipeline shall be maintained in a taut manner and set at right angles, when possible, to run through or over the measuring equipment.
- .11 The electronic systems, television camera, and monitor shall be of adequate quality to enable the following to be achieved:
 - .1 Camera: 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.
 - .2 Resolution: the live picture shall be visible with no interference and capable of

registering a minimum number of lines of resolution at the periphery as indicated below:

- .1 Fixed view camera 350 lines of resolution.
- .2 Pan and tilt camera 400 lines of resolution.
- .3 Colour Constancy: the lighting shall be set prior to commencing the survey to ensure the camera provides optimum results when used with its own illumination source. To ensure colour constancy, no variation in illumination shall take place during the survey.
- .4 Focus, Iris, and Illumination: the adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The illumination shall be such as to allow an even distribution of the light around the pipeline perimeter without the loss of contrast or flare out of picture shadowing.
- .5 Monitor: monitors shall be a minimum size of 21 inches and shall support resolution equal to or greater than the corresponding video camera resolution.
- .6 Digital Video Recorder: digital video recorders shall be able to capture from the live video source with the following requirements:
 - .1 MPEG-2 or higher or as required by Owner.
 - .2 NTSC 720 x 480 @ 29.97 frames per second.
- .12 When specified in the contract documents, pipelines shall be cleaned and flushed immediately prior to CCTV inspection.
- .13 Prior to the start of the CCTV inspection, the resolution of digital MPEG video playback for each camera shall be confirmed by recording a resolution chart approved by the Engineer, using the following procedure:
 - .1 Set up the camera as is done for the actual inspection.
 - .2 Show the camera being introduced and reaching its final position for the test.
 - .3 Fill the monitoring screen with the resolution chart.

- .4 Illuminate the resolution chart evenly and uniformly without reflections ensuring that the illumination source accurately simulates the lighting used in the sewer.
- .5 Record a test video for 30 seconds.
- .6 Identify the camera make, model, and serial number on the recording.
- .7 Record the test at the start of a digital recording. The resolution test shall be submitted to the Engineer.
- .14 Prior to commencement of the CCTV inspection, a formal coding accuracy verification system shall be developed and submitted to the Engineer and implemented when approved. The coding accuracy shall be based on accuracy as a function of the number of defects or construction features not recorded, and the correctness of the coding and classification shall be recorded. Verification of coding accuracy shall be completed on a random basis on a minimum of 10% of the inspection reports. A minimum of two accuracy verifications shall be completed for each operator for each week working.
- .15 Inspections not satisfying the accuracy requirements shall be re-coded to meet the accuracy requirements and the accuracy of the inspections, immediately preceding and following the non-compliant inspection, shall be verified. This process shall be repeated until the preceding and subsequent inspections meet the accuracy requirements.
- .16 Coding accuracy checks shall be submitted to the Engineer along with the corresponding video recording.
- .17 The work shall include a CCTV inspection of the pipeline and the preparation of all video, digital, and written reports. A certified, trained, and competent CCTV operator shall be used to operate the inspection equipment and code the inspection.
- .18 A fixed camera may be used for pipelines less than 300 mm in diameter. For pipelines equal to or greater than 300 mm, a pan and tilt camera shall be used. Each camera shall have an accepted sample submissions report prior to being used for inspection work. The camera lens shall be kept clean at all times during the inspection.
- .19 Flow control measures as specified in the contract documents shall be

- implemented to ensure a minimum of 80% of the height of the pipeline is visible for the entire inspection and shall be approved by the Engineer.
- .20 All fog shall be evacuated from the pipeline and the pipeline kept clear of fog during the inspection.
- .21 At the start of each pipeline being surveyed, the length of pipeline from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of one of the following:
- .1 Pipe sewer length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the pipe sewer.
 - .2 Pipe culvert length from one end of the pipe culvert to the other.
 - .3 Watermain length from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.
- .22 The position meter-reading entered on to the data display at the cable calibration point shall allow for the distance from the start of the survey to the cable calibration point so that the meter-reading at the start of the survey is zero.
- .23 In the case of surveying through a maintenance hole when a new header sheet is required, the meter- reading shall be set at zero with the camera focused on the outgoing pipe entrance.
- .24 At the start of each maintenance hole length, a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alphanumeric form containing the following minimum information:
- .1 Automatic update of the camera's meter-reading position in the pipeline from adjusted zero.
 - .2 Pipeline dimensions.
 - .3 Maintenance hole and pipe length reference numbers.
 - .4 Date of survey.
 - .5 Road name and location.
 - .6 Direction of survey.

.7 Time of start of survey.

.8 Pipeline use.

Once the survey of the maintenance hole length is underway, an automatic update of the camera's meter- reading position in the pipeline from zero in metres and tenths of a metre shall be continually displayed.

- .25 The camera shall be stopped when defects are being noted on the coding sheet. Defects in each pipeline length shall be coded according to the standard being used (i.e., CSA Plus 4012, NASSCO Canadian Edition of the Pipeline and Assessment Certification Program (PACP), or WRc) or as specified in the contract documents. Any variation from the manual shall be noted in the survey report.
- .26 The survey shall be restarted at the opposite end of the pipeline if a blockage or obstruction is encountered.
- .27 Inspections shall be recorded in colour.
- .28 Digital video recordings may be saved to a computer hard drive and transferred to a portable hard disk drive, compact disc, or digital video for submission.
- .29 A digital format video recording of an inspection shall be produced in colour from a first generation recording by one of the following methods:
- .1 A computer system and a video capture card shall be used to capture the recording continuously, regardless of the progression of the inspection. Prior to submission, the raw digital data shall be edited to remove pauses when the inspection progress was not continuous.
 - .2 A computer system and a video capture card shall be used to intermittently capture the recording. Prior to submission, the raw digital file shall be edited to form one continuous file.
 - .3 Specialized video recording equipment capable of pausing and resuming live recording shall be used to capture original recording. A single file is to be produced for submission.
- .30 Video capture equipment shall be capable of capturing digital video from first generation recordings with no frame loss.
- .31 Non-linear video editing software shall be used to edit digital videos. Edited digital files

- shall not be recompressed.
- .32 The camera lens shall be positioned centrally in a circular pipeline and at two-thirds of the vertical dimension in a non-circular pipeline with a positioning tolerance of $\pm 10\%$ of the vertical pipeline dimension. In all instances, the camera lens shall be positioned looking along the longitudinal axis of the pipeline.
- .33 The travelling speed of the camera in the pipeline shall be limited to:
- .1 0.1 m/s for pipeline of diameter less than 200 mm.
 - .2 0.15 m/s for diameters exceeding 200 mm but not exceeding 310 mm.
 - .3 0.20 m/s for diameters exceeding 310 mm.
- .34 A suitable meter-reading device shall be used that enables the cable length to be accurately measured to indicate the location of the camera. The meter-reading device shall be accurate to $\pm 1\%$ of the length of the sewer being surveyed. The tolerance shall be demonstrated using one or both of the following methods in conjunction with a linear measurement audit form that shall be completed each day during the survey:
- .1 Cable calibration device.
 - .2 Tape measurement of the surface distance between maintenance holes.
- .35 If the accuracy of the measuring device fails, it is to be replaced. The Engineer may require that the lengths of pipeline first inspected with the original measuring device be resurveyed using the new measuring device.
- .36 Survey reports shall be submitted to the Engineer in the following formats, with the noted number of copies, within 10 business days of the completion of the fieldwork:
- .1 3 copies of the printed survey report.
 - .2 2 portable hard disk drives, other digital storage devices and software database as specified in the contract documents, each containing the identical survey report information as in the printed copies.
 - .3 2 copies of the digital video recording.
- .37 Entire inspections shall be contained within one digital file on a digital storage device, as

applicable. When possible, reverse set-up inspections shall be recorded immediately after the original inspection. Each digital file shall contain the file name, as specified by the Owner and may include the following:

- .1 Tender number
- .2 E<Entity number>
- .3 F<From entity number>
- .4 T<To entity number>
- .5 M<Measured length>
- .6 I<Inspected length>
- .7 <Inspection direction:DS or US>
- .8 <Letter designating inspection sequence> .MPEG

For example: 910-200 E5329 F5328 T5350 BERRY M100.0 I39.2 US B.MPEG indicates that this is the second or “B” partial inspection of this entity, 39.2 m long.

- .38 All required header information fields shall be completed and verified for correctness. The software used to produce the survey report shall not allow the operator to continue inputting information until the preceding field has been completed. The report shall be machine printed and presented according to the standard used.
- .39 All dimensions in the survey report shall be metric.
- .40 The survey report shall identify major defects and shall include photographs when the need for photographs is specified in the contract documents.
- .41 One clean set of the Owner's drawings showing maintenance hole numbers that coincide with the coding sheets and videotapes shall be returned to the Engineer on completion of the survey. The drawings shall be clearly annotated to show any discrepancies between the drawings and the survey report. Such discrepancies shall be brought to the attention of the Engineer during the survey.
- .42 Management of excess material shall be as specified in the contract documents.

3.9 QUALITY ASSURANCE

- .1 Upon submission, printed and digital inspection reports, and digital MPEG video recordings, magnetic data files, and coding accuracy checks shall be reviewed to ensure compliance with the contract documents.
- .2 Submittals shall be reviewed by the Engineer and their acceptance confirmed within 10 business days of submission. Only inspections with minimum accuracy for header information of 95% and minimum detail accuracy for defects and features of 85% will be accepted. Non-compliant submissions will be returned for correction. Corrected submissions shall be returned to the Engineer for review within 5 business days.
- .3 Operators failing to meet the coding accuracy requirements on two occasions shall not be permitted to code on the remainder of the contract, unless they successfully re-attain NASSCO qualification based on the standard being used (i.e., Canadian Edition of PACP or WRc).

3.10 BASIS OF PAYMENT

- .1 All costs associated with the work outlined in this specification shall be deemed to be included in the appropriate unit and lump sum prices quoted as outlined in subsection 1.1 Measurement for Payment and as included in the Schedule of Quantities and Prices.
- .2 Payment will be made to the maximum of 90% of the value of sewers, fittings and appurtenances until the system (or sections of the system, if payment approved by the Engineer) has passed all tests. The 10% retained shall be called the sewer test allowance.
- .3 Infiltration and/or ex-filtration tests do not apply to corrugated storm sewer pipe unless otherwise specified.