PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

This Practice is subject to revision at any time by the responsible Function Team and will be reviewed every 5 years. This Practice will be revised, reaffirmed, or withdrawn. Information on whether this Practice has been revised may be found at www.pip.org.

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PIP will not consider requests for interpretations (inquiries) for this Practice.

PRINTING HISTORY

April 1995 Issued
August 2000 Complete Revision
October 2004 Complete Revision

Not printed with State funds
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1. Introduction

1.1 Purpose

This Practice provides requirements for the installation contractor for fabricating and installing underground gravity sewers.

1.2 Scope

This Practice describes the requirements for materials, installation, and testing of underground gravity sewers. Requirements for pipe, inlet structures, manholes, and appurtenances for sanitary, storm, and industrial process sewers are included. Requirements for pressurized pipe, double-contained, and emission-controlled industrial process sewers in environmental applications are not included.

2. References

Applicable parts of the following Practices, industry codes and standards, and references shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles will be used herein where appropriate.

2.1 Process Industry Practices (PIP)

- PIP CVC01015 - Civil Design Criteria
- PIP CVS02100 - Site Preparation, Excavation, and Backfill Specification
- PIP CVI02720 - Sewer Details
- PIP STS03001 - Plain and Reinforced Concrete Specification

2.2 Industry Codes and Standards

- American Society for Testing and Materials (ASTM)
  - ASTM A36 - Standard Specification for Carbon Structural Steel
  - ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
  - ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections
– ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
– ASTM C1433 - Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
– ASTM D422 - Standard Test Method for Particle - Size Analysis of Soils
– ASTM D1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
– ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
– ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
– ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

• American Association of State Highway and Transportation Officials (AASHTO)
  – AASHTO M 36 - Interim Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
  – AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter (for Storm Sewers and Culverts)

2.3 Government Regulations

• Occupational Safety and Health Administration
  – 29 CFR 1926 Subpart P - Excavations

3. Definitions

contract documents: Any and all documents, including design drawings, that purchaser has transmitted or otherwise communicated, either by incorporation or by reference, and made part of the legal contract or purchase order agreement between purchaser and supplier

supplier: The party responsible for performing excavation, backfill, and pipe installation, including work executed through the use of sub-contractors
owner: The party who owns the facility wherein the underground gravity sewer will be installed

purchaser: The party who awards the contract to the supplier. The purchaser may be the owner or the owner’s authorized agent.

flowable fill: An engineered blend of materials (controlled low-strength material) used as self-leveling and self-compacting backfill and bedding

standard dimension ratio (SDR): The ratio of the pipe outside diameter (inches) to the minimum wall thickness (inches)

4. Requirements

4.1 General

4.1.1 Quality Control

4.1.1.1 Sewers shall be fabricated, installed, and tested in accordance with this Practice; with codes, standards, and procedures specified in this Practice; and with all applicable codes and regulations of the controlling federal, state, and local jurisdictions.

4.1.1.2 Purchaser shall have the right to inspect, at purchaser’s expense, all materials and workmanship and shall have unrestricted entry to the fabrication shop at all times work is being performed.

4.1.1.3 Purchaser can reject improper, inferior, or defective materials and workmanship at any stage of production.

4.1.1.4 All defective materials and workmanship shall be repaired or replaced at no additional cost to purchaser.

4.1.1.5 Purchaser inspection shall not replace the supplier’s quality control procedures and responsibility for compliance with all applicable requirements for the material, fabrication, and installation.

4.1.1.6 Unless directed otherwise by purchaser, if at any time during installation and testing, weather or any other factor causes the degradation of the pipe foundation, pipe and/or fitting installation, bedding, or backfill, all affected materials shall be removed and the work shall be reinstalled in accordance with this Practice.

4.1.2 Submittals

4.1.2.1 The following documentation shall be submitted to the purchaser 2 weeks before installation:

a. Fabrication drawings and instructions for the installation of pipe and appurtenances

b. Certification that an OSHA-defined excavation-competent person (ECP) shall oversee all excavation
c. Documentation of all trench work requiring an ECP

d. Certification in writing that the materials to be used under the contract satisfy all the requirements of the project.

4.1.2.2 As-built documentation showing location, line, and grade of newly installed sewer systems shall be submitted to purchaser within 4 weeks after installation.

4.1.3 Safety

4.1.3.1 Field construction activities on owner’s property shall conform to owner’s safety requirements, including any special rules that may be in effect at a specific site.

4.1.3.2 Good housekeeping practices shall be maintained in and around the work site throughout the duration of the work.

4.1.3.3 Hazardous and hot work permits for chemical exposure, open flames, spark-producing mechanical equipment, potential explosive mixtures, and any other hazardous conditions shall be required in areas specified by owner.

4.1.3.4 All excavation and trenching shall be in accordance with OSHA standards and owner’s local requirements and guidelines (as applicable) for the following:

   a. Shoring, bracing, and/or sloping wall construction
   b. Marking and flagging open excavations
   c. Permitting and confined space entry requirements

4.1.4 Environmental

4.1.4.1 All sewer outfalls are required to be permitted by applicable regulations.

4.1.4.2 Before discharging any liquid into drains, catch basins, or manholes in connection with trench dewatering activities, testing, or other activities for which liquids need to be disposed, the owner shall verify that the applicable permit will allow intermittent non-storm flows into storm sewers.

4.1.4.3 Excavated material shall be managed in accordance with a soil management plan.

4.1.4.4 Unless provided by owner, the soil management plan shall be developed by supplier and approved by owner before the start of excavation activities.

4.2 Materials

4.2.1 Pipe and Joints

4.2.1.1 Specifications for materials other than those listed in the following section (such as welded, coated, and wrapped carbon steel) that are
required for the project shall be as specified in the contract documents.

4.2.1.2 Concrete Pipe/Reinforced Concrete Pipe (CP/RCP) - Rigid Pipe

1. Concrete sewer pipe 10 inches (250 mm) and smaller shall be in accordance with ASTM C14 (class as specified in the contract documents) non-reinforced, bell and spigot, or tongue and groove sewer pipe.

2. Concrete sewer pipe 12 inches (300 mm) and larger shall be in accordance with ASTM C76, reinforced sewer pipe (class and wall as specified in the contract documents).

3. Joints shall be sealed using elastomeric “O” rings in accordance with ASTM C443 unless otherwise specified in the contract documents.

4. Joints may be sealed with cement grout if the service is for storm sewer lines that are 24 inches (600 mm) in diameter and larger.

4.2.1.3 Corrugated Steel Pipe (CSP) - Flexible Pipe

1. CSP shall be metallic-coated (galvanized) pipe in accordance with AASHTO M 36 (sheet metal thickness and corrugation size as specified in the contract documents).

2. CSP shall be connected with locking corrugated coupling bands of the design indicated in AASHTO M 36, “Coupling Bands” section.

3. Connecting bands shall be coated in accordance with the pipe coating requirements.

4.2.1.4 Vitrified Clay Pipe (VCP) - Rigid Pipe

1. VCP shall be used only to the extent required to tie into existing VCP systems. Alternative materials should be selected for new piping installations.

2. VCP shall be extra strength in accordance with ASTM C700.

3. Joints shall be compression type in accordance with ASTM C425, unless otherwise specified in the contract documents.

4.2.1.5 Polyvinyl Chloride Plastic (PVC) Pipe - Flexible Pipe

1. PVC pipe 12 inches (300 mm) or less in diameter shall be minimum schedule 40 pipe in accordance with ASTM D1785.

2. Joints shall be solvent cemented in accordance with ASTM D2855, using cement in accordance with ASTM D2564 or shall have elastomeric ring gaskets in accordance with ASTM D3212.
4.2.1.6 Cast Ductile Iron Soil Pipe (DISP) - Rigid Pipe

1. Cast DISP and fittings shall be hub and plain end coated service weight in accordance with ASTM A74.

2. Joints shall be neoprene sleeve gasketed, push-on type in accordance with ASTM C564.

4.2.1.7 High-Density Polyethylene (HDPE) Pipe - Flexible Pipe

1. HDPE pipe and fittings shall be manufactured from virgin high-density polyethylene resin, in accordance with ASTM D3350, Cell Class PE345434C minimum, with a standard dimension ratio (SDR) as specified in the contract documents.

2. Joints shall be butt fusion welded, socket fusion welded, or flanged.

3. Alternate joining method shall consist of arch-band split sleeve couplings made of carbon steel conforming to ASTM A36 or stainless steel grade 304L or 316L. The coupling shall be designed with closure plates and sealing pads for installation and a leak-proof seal. O-Ring gaskets shall be used and shall consist of ethylene propylene diene monomer (EPDM), nitrile, silicon, or polyisoprene as required for the service intended. Couplings shall allow for angular deflection, expansion, and vibration if required. If a restrained joint is required, it shall be accomplished with restraining rings welded to the exterior of the pipe and a restraining-type coupling.

4. HDPE mechanical coupling joints are also acceptable if approved by the purchaser.

5. Wall thickness shall be specified as follows:

<table>
<thead>
<tr>
<th>NPS</th>
<th>SDR</th>
</tr>
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<tr>
<td>4 – 16 inches</td>
<td>17</td>
</tr>
<tr>
<td>18 – 48 inches</td>
<td>32.5</td>
</tr>
</tbody>
</table>

4.2.1.8 Reinforced Concrete Box (RCB) Sections - Rigid Pipe

1. RCB sections shall be in accordance with ASTM C1433 unless otherwise specified in the contract documents.

2. The appropriate table of section requirements from the listed ASTM standard shall be used for the design loading specified in the contract documents.

3. Joints shall be pre-formed plastic gasket-type joint sealant, unless specified otherwise in the contract documents.

4.2.1.9 Corrugated Polyethylene Pipe (CPP) - Flexible Pipe

1. CPP and fittings shall be bell and spigot type, manufactured in accordance with AASHTO M 294. Bell shall be an integral part of the pipe.
2. Pipe shall be Type S with a smooth inner liner unless otherwise specified in the contract documents.

3. Joints shall be sealed using elastomeric gaskets in accordance with *ASTM F477* unless otherwise specified in the contract documents.

### 4.2.2 Manholes, Inlet Structures, Frames, and Covers

4.2.2.1 Manholes and inlet structures (catch basins) shall be precast (monolithic) with integral bottom. See *PIP CVC01015* for manhole-spacing criteria.

4.2.2.2 Precast concrete manholes shall conform to *ASTM C478*.

4.2.2.3 HDPE plate used for manholes and inlet structures shall be manufactured from virgin high-density polyethylene resin in accordance with *ASTM D1248-IIIC5-P34 pipe grade resin*.

4.2.2.4 HDPE pipe components used for manholes and inlet structures shall be as specified in Section 4.2.1.7 (this Practice).

4.2.2.5 Site-built concrete manholes shall be in accordance with the contract documents.

### 4.2.3 Cast-in-Place Concrete

Cast-in-place concrete used for sewers shall be constructed in accordance with *PIP STS03001*.

### 4.3 Construction

#### 4.3.1 Receiving and Handling

4.3.1.1 Care shall be taken during handling and storage so as not to damage or to cause stresses or deformation in pipe materials.

4.3.1.2 Pipe materials shall be inspected before installation. Any damaged materials that are not acceptable to purchaser shall be rejected and replaced at no cost to purchaser.

#### 4.3.2 Trench Excavation

4.3.2.1 All excavation and trenching shall be made in accordance with *PIP CVS02100*, OSHA standards, and owner’s local requirements and guidelines (as applicable) for the following:

   a. Shoring, bracing, and/or sloping wall construction
   b. Marking and flagging open excavations
   c. Permitting and confined space entry requirements
   d. Employing excavation-competent person (ECP)
   e. Handling and storing excavated materials

4.3.2.2 Proper care and protection shall be provided to prevent damage to all existing facilities (e.g., foundations, services, pipelines, etc.) on,
above, or below the surface of the area where excavation and backfill operations are to be performed.

4.3.2.3 Underground obstructions (e.g., piping, foundations, structures, etc.) shall not be removed or altered without owner’s approval.

4.3.2.4 Trench depth shall be based on the specified invert of the pipe plus the bedding requirements as specified in this Practice and in the contract documents.

4.3.2.5 Trench width shall be as narrow as possible while still permitting proper access for bedding and assembly of the pipe. If practical, maximum trench width from bottom of the trench to 12 inches (300 mm) above the pipe shall be 4/3 the nominal diameter of the pipe plus 8 inches (200 mm).

4.3.2.6 If rock or other unyielding material is encountered, the bottom of the trench shall be over-excavated 1/6 of the pipe diameter but in no case less than 4 inches (100 mm).

4.3.2.7 If unacceptable soil is encountered, as determined by owner, such soils shall be removed. The resulting over-excavation shall be backfilled with suitable material to the specified grade. (See bedding requirements specified in this Practice.)

4.3.2.8 The bottoms of trenches or bedding material (as applicable) shall be firm and graded to provide uniform bearing of the pipe.

4.3.2.9 If pipe joint diameter exceeds pipe outside diameter (e.g., bell and spigot piping), bell holes shall be manually excavated after the trench bottom has been graded.

4.3.2.10 Erosion control measures shall be incorporated as required by applicable regulations and by owner’s requirements.

4.3.2.11 Flexible Conduit

1. Only as much trench shall be opened as can be safely maintained by available equipment.

2. All trenches shall be backfilled as soon as practicable but not later than the end or each working day.

3. The space between the conduit and trench wall shall be wider than the compaction equipment used in the conduit zone; however, in no case shall it be wider than the conduit diameter times 1.5 plus 12 inches (300 mm).

Comment: Flexible conduit requires stable trench walls to assure proper embedment of pipe and compaction of the bedding materials.
4.3.2.12 Wall Supports

1. If trench wall supports such as sheeting are required, these supports must be left in place to preclude loss of support for the pipe.
2. If sheeting is to be cut off, cuts shall be made a minimum of 1.5 ft (450 mm) above the crown of the pipe.
3. Rangers, whalers, and braces shall be left in place as required to support cutoff sheeting.
4. If timber sheeting is used, it shall be treated as a permanent structure and treated against biological degradation.

4.3.2.13 If ledge rock, hard pan, shale, or other unyielding material, cobbles, rubble, debris, boulders, or stones larger than 1.5 inches (40 mm) are encountered in the trench bottom, the trench shall be excavated to a minimum depth of 6 inches (150 mm) below the bottom of pipe elevation. The excavated materials shall be replaced with proper embedment material.

4.3.3 Dewatering

4.3.3.1 Equipment necessary to collect and discharge water away from excavations, such as pumps, sumps, suction and discharge lines, and all other dewatering system components, shall be provided, installed, and maintained.

4.3.3.2 All water encountered shall be disposed of in such a manner that property is not damaged and no nuisance or health menace results.

4.3.3.3 If required by owner, a means of desilting the water before disposal shall be provided.

4.3.3.4 At any time, the length of open trench shall be limited to that which can be dewatered with methods and equipment available.

4.3.3.5 Dewatering methods shall be used to minimize softening of the soil supporting the pipe and changes in soil characteristics that are detrimental to subgrade stability.

4.3.3.6 Water shall not be allowed to accumulate in excavations. Subsurface water flowing into excavations shall be removed by pumping or if possible by gravity drainage.

4.3.3.7 Surface water shall be diverted away from the work area as directed by owner.

4.3.3.8 The trench shall not be used as a temporary drainage ditch.

4.3.4 Bedding

4.3.4.1 Bedding material shall be granular and well graded. All material shall pass a 1/2-inch (12.5-mm) sieve and shall be at least 90% retained on No. 200 (75 microns) sieve as determined in accordance with ASTM D422.
4.3.4.2 Bedding material shall be placed under and equally along both sides of the pipe in uniform layers not exceeding 6 inches (150 mm) loose depth to a height of the centerline of the pipe and compacted by hand, pneumatic tamper, or other owner-approved means.

4.3.4.3 Bedding material shall be compacted to a density approximately that of the undisturbed site soil materials or as specified in the contract documents.

4.3.4.4 If compacted, the pipe bed shall provide uniform bearing for the bottom of the pipe (see trenching requirements specified in this Practice).

4.3.4.5 Localized loading and differential settlement shall be minimized where the pipe crosses other utilities or subsurface structures or in areas having special foundations such as pile caps or sheeting. A cushion of bedding shall be provided between the pipe and any such point of localized loading.

4.3.4.6 Bedding shall conform to one of the following classes. Class C bedding shall be used if no class is specified in the contract documents. See Figure A for details.

   a. Class A - concrete cradle bedding - requires embedment of the lower part of the pipe in plain or reinforced concrete of suitable thickness and extending up to the sides of the pipe a distance not less than 25% of the pipe outside diameter.

   b. Class B - first class bedding - requires the pipe to be placed on the fine granular materials foundation extending up to the center line of the pipe. The trench shall then be filled to 1 ft (300 mm) over the top of the pipe with granular material in 6-inch (150-mm) layers and compacted to fill all the space around the pipe.

   c. Class C - ordinary bedding - requires placing the pipe on fine granular material cradle extending up to the sides of the pipe a distance not less than 1/6 of the pipe outside diameter. The trench shall then be filled to 6 inches (150 mm) over the top of the pipe with granular material placed and compacted to fill all space around the pipe.

   d. Class D - impermissible bedding - allows the pipe to be placed on the bottom of the trench with no effort to shape the trench to fit the pipe. Fill shall be placed around the pipe.

4.3.4.7 Bedding for box culverts shall conform to one of the following classes. Class C bedding shall be used if no class is specified in the contract documents.

   a. Class B bedding shall be obtained by installing the box section on a minimum thickness of fine granular material of at least 2 inches (50 mm). Compacted granular material shall be placed
on each side of the box section and up to at least 1 ft (300 mm)
over the top of the box.

b. Class C bedding shall be obtained by placing the box section on
a flat trench bottom. Lightly compacted fill shall be placed on
each side of the box section and up to 6 inches (150 mm) over
the top of the box.

4.3.4.8 Flowable fill (controlled low-strength material, CLSM) may be used
for Class B, C, or D bedding material. CLSM shall be in accordance
with PIP CVS02100.

4.3.5 Pipe Laying and Jointing

4.3.5.1 Pipe shall be laid beginning at the lowest point in trenches.

4.3.5.2 Pipes with spigot or tongue ends shall be laid with spigot ends
pointing in the direction of flow.

4.3.5.3 Pipe types other than those with spigot or tongue ends shall be laid
in accordance with the pipe manufacturer’s recommendations or
instructions.

4.3.5.4 Pipe shall be laid true to line and grade and kept clean and sound.

4.3.5.5 Pipe laying and joining shall be carried out in a dry trench.

4.3.5.6 Each length of pipe shall be inspected for loose gaskets, cracks, and
other defects before installation.

4.3.5.7 After inspection, each acceptable length of pipe shall be carefully
placed to the line and grade specified and nested in the bedding in
such a manner as to provide uniform support throughout its entire
length.

4.3.5.8 If pipe laying is suspended, the ends of the pipe shall be kept closed
and sealed to keep out soil and foreign materials.

4.3.5.9 After the joints have been made, the pipe shall not be disturbed in
any manner.

4.3.5.10 HDPE pipe shall be welded by experienced, qualified welders. All
welds shall be fusion welds except at manholes, where extrusion
welds are permitted.

4.3.5.11 Manholes, catch basins, dry boxes, etc., shall be constructed in
accordance with PIP CVI02720.

4.3.5.12 Bell and spigot joints shall be clean and dry. A lubricant
recommended by the pipe manufacturer shall be applied to the joint
materials. The spigot shall have full bell penetration.

4.3.6 Backfilling

4.3.6.1 Backfill and compaction material shall be in accordance with
PIP CVS02100 and this Practice and shall be similar to in-situ
material.
4.3.6.2 The trench shall be backfilled and compacted to a density equal to that specified on the contract documents or equal to that of the adjacent in situ material.

4.3.6.3 As soon as possible after pipe joints are made, backfill material shall be placed along the sides of the pipe with care to prevent movement of the line or grade.

4.3.6.4 Joints shall be left exposed until completion of leak testing.

4.3.6.5 Backfilling of trenches shall be completed immediately after testing.

4.3.6.6 Backfilling shall be compacted in a manner that avoids displacement or damage to the pipe.

4.3.6.7 Construction machinery or vehicles shall not be allowed to pass over the trench until the trench is backfilled and compacted sufficiently to prevent damage to the pipe.

4.3.6.8 Flowable fill (CLSM) may be used for backfill material if specified in contract documents.

4.3.7 Embedment of Flexible Conduit

4.3.7.1 Embedment configuration, materials, and compaction requirements shall be in accordance with the contract documents.

4.3.7.2 If embedment materials are not specified in the contract documents, Class II or Class III materials shall be in accordance with Table 1 of ASTM D2321, determined to be compatible with pipe and suitable to prevent migration of adjacent soils.

4.3.7.3 If embedment installation requirements are not specified in the contract documents, installation shall be in accordance with the recommendations given in Table 2 of ASTM D2321.

4.3.7.4 Embedment materials shall be placed into the trench, using methods that will not disturb or damage the conduit.

4.3.7.5 Material in the area between the bedding and the underside of the conduit shall be worked in and tamped before placing and compacting the rest of the embedment.

4.3.7.6 Compaction equipment shall not be allowed to contact the conduit and damage the conduit wall.

4.3.7.7 Embedment shall not be compacted by running over the materials with earthmoving equipment.

4.3.7.8 To preclude damage to the installed conduit and disturbance of the conduit embedment, a minimum depth of at least 24 inches (600 mm) or 1 pipe diameter of cover, whichever is greater, shall be maintained over the top of conduit before allowing vehicles to traverse the conduit trench.

4.3.7.9 To preclude potential floatation of the installed conduit, a minimum depth of backfill over the top of conduit of at least 24 inches
(600 mm) or 1 pipe diameter of cover over the pipe, whichever is greater, shall be maintained.

4.4 Exfiltration Test

4.4.1 Setup

1. Exfiltration shall be measured at a manhole.
2. The section of pipe to be tested shall be plugged at the downstream end of pipe (e.g., as at a manhole).
3. The lateral pipe in the section being tested shall be plugged with removable stoppers.

4.4.2 Procedure for Process and Sanitary Sewers

1. Sections of pipe shall be filled, 400-ft (122-m) maximum length at a time, with water to the top of the manhole but not less than 5 ft (1.5 m) above the top of the pipe.
2. If required, a standpipe shall be used to bring the water level to 5 ft (1.5 m) above the top of the pipe.
3. Water shall be allowed to stand for 4 hours.
4. Manhole shall be refilled and the drop shall be measured after 1 hour.
5. Maximum allowable exfiltration shall be as follows:
   a. Process sewers - no measurable amount
   b. Sanitary sewers - 0.0008 gallons/inch diameter/ft/hour
      (0.00039 liters/mm diameter/m/hour)

4.4.3 Exfiltration testing of storm sewers shall be done in accordance with ASTM C969.

4.5 Considerations for Existing Facilities

4.5.1 If construction of new sewers interferes with existing sewers, satisfactory temporary bypass facilities shall be provided.

4.5.2 Open ends of existing sewers that are cut or abandoned in place shall be securely closed with a plug or wall of concrete having a minimum thickness of 3 pipe diameters.
Figure A - Bedding Methods for Trench Conduits

**CLASS "A"**
- Reinforced $A_S = 1.0\%$ $L_f = 4.8$
- Reinforced $A_S = 0.4\%$ $L_f = 3.4$
- Plain $L_f = 2.8$

- $4/3 B_c + 8$ inches (200 mm) min.

**CLASS "B"**
- $L_f = 1.9$

**CLASS "C"**
- $L_f = 1.5$

**CLASS "D"**
- $L_f = 1.1$

**Legend**
- $B_c$ = outside diameter
- $H$ = backfill cover above top of pipe
- $D$ = inside diameter
- $d$ = depth of bedding material below pipe
- $A_s$ = area of transverse steel in the cradle or arch expressed as a percent of area of concrete at invert or crown.
- $L_f$ = bedding factor

<table>
<thead>
<tr>
<th>Depth of bedding material below pipe</th>
<th>$D$</th>
<th>$d$ (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 inches (690 mm) &amp; smaller</td>
<td>3 inches (75 mm)</td>
<td></td>
</tr>
<tr>
<td>30 inches (760 mm) to 60 inch (1.53 m)</td>
<td>4 inches (100 mm)</td>
<td></td>
</tr>
<tr>
<td>66 inches (1.68 m) &amp; larger</td>
<td>6 inches (150 mm)</td>
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