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Chapter 3
Sanitary Sewer Collection System

Design Specifications & Requirements Manual

October 2003

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City of London
Design Specifications and Requirements Manual

The design information contained in this manual is intended to provide guidance beyond legislative and standard design practices for use in the City of London (the City). There will be site specific situations where the design will depart from these practices as it is not possible nor is it the intention of the City to anticipate every situation. The City intends to review and revise the Manual from time to time. The City also acknowledges that other references such as the 'Standard Contract Documents for Municipal Construction Projects' are to be used in conjunction with this manual. The 2012 update of this manual incorporates design information from the City's former 'Subdivision & Development Guide Manual' to provide consistent and current design information for development projects.

The City of London maintains its right to accept or refuse any design submissions and requires an acceptable design for any given circumstance.

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3 Sanitary Sewer Collection System

3.1 Definition

3.1.1 Public Sewage Systems

A piped collection system that transports wastes of domestic origins which is human body waste, toilet or bathroom waste, waste from other showers and tubs, liquid or water borne culinary and sink water or laundry waste, and such other waste as is suitable for treatment at a sewage treatment facility in accordance with City of London Waste Discharge By-law (WM-16) and Drainage By-law (WM-4).

3.1.2 Private Sewage Systems

A sewage system (or systems), with a total design capacity of 10,000 litres per day or less, shall be designed, constructed, operated and maintained in accordance with Part 8 of the Ontario Building Code.

A sewage system (or systems), with a total design capacity greater than 10,000 litres per day, falls under the jurisdiction of the Ministry of the Environment, Conversation and Parks.

3.2 Non-Permitted Flows

Connections from foundation, weeping tile drainage or roof drainage are not permitted to enter the sanitary sewer system, in accordance with City of London Drainage By-law (WM-4), or any hazardous waste as defined under the EPA Regulation 347.

3.3 Location and Alignment

Generally sanitary sewers are to be located in front of, or are in locations accessible to each lot and block facing a City Street. Sanitary sewers are to be located 1.5 metres from the centreline of the road (see DWG. U.C.C.-1M and U.C.C.-2M for details and additional design information). Sanitary sewers are to be located on the inside loop of a proposed crescent with the maintenance hole located at a 1.5 metre offset from the centreline of the road.

3.3.1 Sanitary Sewers on Private Property

Sanitary sewers on private property are regulated by the Ontario Building Code (OBC). Where there are no specific regulations in the OBC, details from this manual will apply.

3.4 Drainage / Sub-Drainage Area Plans

Drainage/sub-drainage area limits for which sewers are to be designed for are to contain and follow the lot/block lines to the proposed maintenance holes located on the R.O.W.

Note: All areas and populations are to be shown for each drainage/sub-drainage areas.

3.5 External Sewershed Limits and Drainage Areas

When design abuts un-developed or un-serviced areas, identify the external sewershed limit to be designed for.

Note:

a) All areas and populations are to be shown for all drainage areas within external sewershed limits; and

b) For new subdivisions, references should be made to **Chapter 18, Drafting and Design Requirements**.

3.6 Design Chart

Sanitary sewer design calculations for approved drainage area plans are to be completed on the standard design chart. See **Figure 3.1** for details and additional design information.

3.7 Peaking Factor Calculation

Peaking factor calculations are to be determined based on the Harmon formula:

Harmon formula

$$M = 1 + \frac{14}{4 + P^{1/2}}$$

where: M = ratio of peak flow to average flow
P = tributary population in thousands

3.8 Design Criteria

For determining the peak sanitary flows contributing to a sanitary sewer, different criteria are followed depending on the size of the catchment area. These areas are defined as those less than 200 hectares and those greater than 200 hectares.

3.8.1 Tributary Areas Less Than 200 ha

When designing for parcels of land less than 200 hectares, the following criteria will apply:

a) Residential Commercial & Institutional

i. Zoning

- Low Density = 30 units/hectare at 3 people/unit
- Medium Density = 75 units/hectare at 2.4 people/unit
- High Density = 150-350 units/hectare at 1.6 people/unit

Table 3-1 Densities with and without bonusing

Location	Density (Unit/Hectare)	Density with bonusing provision (25%)	People/Units
Downtown Area	350	432.5	1.6
Central Area	250	312	1.6
Outside Central Area	150	187.5	1.6

(Allowance needs to be made for the bonusing provision in the City's Official Plan and Zoning By-Law. The minimum density which may be used in the sewer design is 187.5 units per hectare)

ii. Lot Basis

- Single Family = 3 people/unit
- Semi-detached = 6 people/unit

iii. Area Basis

- Single Family = 30 units/hectare at 3 people/unit
- Semi-detached = 30 units/hectare at 3 people/unit
- Multi-family = 75 units/hectare at 2.4 people/unit

iv. Commercial/Institutional = 100 people/hectare

v. Elementary School = maximum design number of students and employees, with consumption at 30 Litres/person/day. In calculating the peak flow, it is assumed that the total daily flow will occur over an 8 hour day and an equivalent population will be determined by dividing the total flow by the

standard per capita flow of 230 Liters/day. If the design number is not known, the population will be assumed to be 600.

vi. Secondary School = maximum design number of students and employees, with consumption at 30 Litres/person/day. In calculating the peak flow, it is assumed that the total daily flow will occur over an 8 hour day and an equivalent population will be determined by dividing the total flow by the standard per capita flow of 230 Liters/day. If the design number is not known, the population will be assumed to be 1500.

vii. Church = 100 people/hectare

viii. Per Capita Flow = 230 litres/capita/day

ix. Uncertain Development Factor = 1.1

x. Peaking Factor = Harmon

xi. Infiltration = 8640 litres/hectare/day (0.100 l/s/ha).

Note: The Sewer Engineering Division may request an alternative infiltration allowance based on site conditions

Note: The above maximum densities under subsection i) Zoning correspond to the maximum densities for each type of residential land use which is permitted by the City of London Official Plan/London Plan (as applicable). The density of residential land use for sanitary sewer design purposes may be adjusted where deemed appropriate by the City Engineer as more information becomes available in terms of the development proposed for a specific parcel(s) of land and the proposed residential land use densities. For specific development applications, the above populations and/or per capita flow may be adjusted where deemed appropriate by the City Engineer. In such cases, the adjustment will be supported by alternate design standards (e.g. Ontario Building Code, Ministry of the Environment, Conservation and Parks).

b) Industrial

i. Flow Allowance – industrial = 25,000 litres/hectare/day. This equals 100 pph.

Note: Industrial users with water consumption/sewage discharge design criteria greater than this will be considered heavy water users. Heavy water users should consult with the City of London with respect to their specific requirements for water use and sewage discharge in terms of confirming capacity is available within the municipal infrastructure to meet their needs. Heavy water users should also consult with the City of London prior to any upgrades which will increase their discharge rates to the municipal sewer system.

ii. Uncertain Development Factor = 1.1

iii. Peaking Factor = 0.8 x Harmon

iv. Infiltration = 8640 litres/hectare/day (0.100 l/s/ha).

Note: The Sewer Engineering Division may request an alternative infiltration allowance based on site conditions.

3.8.2 Tributary Area 200 ha and Larger

When designing for parcels of land 200 hectares and larger, the following criteria will apply:

a) Residential, Commercial, and Institutional

i. Population Allowance = 55 people per hectare (gross area with any ESA areas netted out)

Note: The above maximum density is from the City of London Official Plan. The density may be adjusted by the City Engineer as more information becomes available on a specific parcel of land.

ii. Per Capita Flow = 230 litres/capita/day

iii. Peaking Factor = Harmon

iv. Uncertain Development Factor = 1.0

v. Infiltration Allowance = 8640 litres/hectare/day (0.100 l/s/ha).

Note: The Sewer Engineering Division may request an alternative infiltration allowance based on site conditions.

b) Industrial

i. Flow Allowance – industrial = 20,000 litres/hectare/day [for our internal discussion as to whether this should be 20 or 25,000]

Note: Industrial users with water consumption/sewage discharge design criteria greater than this will be considered heavy water users. Heavy water users should consult with the City of London with respect to their specific requirements for water use and sewage discharge in terms of confirming capacity is available within the municipal infrastructure to meet their needs. Heavy water users should also consult with the City of London prior to any upgrades which will increase their discharge rates to the municipal sewer system.

ii. Peaking Factor = 0.8 x Harmon

iii. Uncertain development factor = 1.0

iv. Infiltration allowance = 8640 litres/hectare/day (0.100 l/s/ha).

Note: The Sewer Engineering Division may request an alternative infiltration allowance based on site conditions.

3.9 Peak Flow Calculation

Peak flow calculations are to be determined based on the following formula:

$$Q = \frac{population \times per\ capita\ flow\ \times peaking\ factor \times uncertainty}{24\ \times 60\ \times 60} + infiltration$$

where: Q = Peak Flow (litres/second)
Per Capita Flow = 230 litres/capita/day
Peaking Factor (H) = Harmon (**Section 3.7**)
Uncertain Development Factor = 1.0 or 1.1 (situation dependant)
Infiltration Allowance = 8640 litres/hectare/day (0.100L/ha/s)

3.10 Manning's Roughness Coefficient

A coefficient of 0.013 is to be used for all concrete and PVC pipe.

3.11 Pipe Size

Pipe size is determined using the formula where the pipe design flow is equal to or greater than the calculated peak design flow:

$$Q = \frac{1}{n} \times A \times R^{2/3} \times S^{1/2}$$

where: Q = Design flow (m³/sec.)
n = Manning's roughness coefficient
A = cross sectional area of flow (m²)
R = hydraulic radius (area/wetted perimeter)
S = slope of pipe (m/m)

Notwithstanding the above, the minimum allowable size of a sanitary sewer shall be 200mm.

On private property, the minimum size for sanitary building sewer shall be 100mm, in accordance with Part 7 of the OBC.

3.12 Flow Velocity

Velocities in sanitary sewers shall be calculated using the following formula:

$$V = \frac{Q}{A}$$

where: V = flow velocity (m/sec)
Q = Design flow (m3/sec)
A = cross sectional area of flow (m²)

3.12.1 Minimum and Maximum Velocities

The minimum velocity permitted in sanitary sewers is 0.6 m/sec.

The maximum velocity permitted in sanitary sewers is 4.5 m/sec.

Where velocity in the Sanitary Sewers approaching or exceeding 3 m/s due to steep grades and providing a drop maintenance hole is not possible, receiving sewers shall be designed for protection against maximum scouring velocity and erosion control measures, that are acceptable to the Owner shall be taken.

To determine velocities based on actual flow, refer to **Figure 3.2 Hydraulic Elements Graph for Circular Sewers.**

3.12.2 Minimum Grades

a) The minimum grade on a 200mm diameter sanitary sewer is 0.33%. Where there are only a few dwelling units connected to the upper section of a 200mm sanitary sewer, the minimum grades shall be adjusted as follows:

1 to 5 units	0.61%
6 to 8 units	0.52%
9 to 12 units	0.43%
13 or more units	0.33%

b) Shall be established by determining the minimum grade necessary to achieve a velocity of at least 0.6m/sec.

3.13 Pipe Material

Both rigid and flexible pipe are permitted in the construction of sanitary sewer systems including private drain connections. These materials include concrete and polyvinyl chloride.

Prior to specifying pipe material, soils shall be assessed for contamination and for the presence of compounds that may negatively impact the suitability of the proposed materials. Nitrile gaskets or equivalent shall be specified for soils contaminated with hydrocarbons unless soil remediation prior to construction provides satisfactory results.

The criteria for these materials are described in City of London Standard Contract Documents - Section 410.05.01.

On private property, materials for sanitary building sewers and private sewers shall comply with Part 7 of the OBC.

3.14 Pipe Depth and Bedding Material

3.14.1 Minimums

The minimum depth of a sanitary sewer shall be 2.4m from the finished ground elevation to the obvert of the pipe unless otherwise approved by the City Engineer.

Note: where frost protection is warranted, insulation is required, as per the City of London Drawing Standard W-CS-68.

3.14.2 Maximum Depth of Cover

a) Concrete Pipe

i. See City of London SW-1.0 and SW-1.1 for details and additional design information for bedding standards for Class A, B and C beddings.

ii. Municipal Projects

The maximum allowable cover permitted on concrete pipe to be constructed under a Municipal or Capital Works Project is to be based on OPSD 807.010, 807.030, 807.040 and 807.050.

Where the pipe required exceeds the OPSD charts, the Pipe Pac Program 2000 will be used, utilizing the following variables:

- all units are in metric and conform to C.S.A. standards
- wall thickness is based on C.S.A A257.2M, Type B wall
- soil density = 2000 kg/m3
- Ontario Highway Bridge Design Code (OHBDC)
- live load magnitude = 25 tons
- projection ratio = 0.70
- lateral pressure ratio = 0.33
- lateral pressure friction ‘m’ = 0.70
- settlement ratio = 0.70
- k-mu(μ) = 0.1924
- variable bedding factors B - Lf = 1.9 C - Lf = 1.5
- $r_{sd}p$ = 0.49 (calculated)
- factors of safety
  - 0.3mm crack D-load = 1.00
  - ultimate earth and live load = (ASTM C 76M)
  - DL.03 ≤ 100 N/m/mm = 1.50
  - DL.03 ≥ 140 N/m/mm = 1.25

- DL.03 between 100 and 140 N/m/mm = interpolated
- positive projection embankment installation
- maximum depth of cover is based on transition width design
- depth of ground is measured from the ultimate finished ground elevation to the outside top of pipe.

iii. New Subdivisions:

The maximum allowable cover permitted on concrete pipe to be constructed in a new subdivision is to be designed based on transition width, and utilize reinforced concrete pipe only, in accordance with OPSD 807.030 and 807.050 (Positive Projecting Embankment Installation only).

Where the pipe required exceeds the OPSD Charts, the Pipe Pac Program 2000 utilizing the variables noted in 3.14.2.ii) or 5.13.2.ii) above, or First Principles (using City of London Variables) will be used.

b) Flexible Pipe

The maximum allowable cover permitted on flexible pipe is 10.5 m. The following bedding types are to be used:

- for up to 4.5 m - Type 1 (see City of London SW-1.0)
- for up to 10.5 m Type 2 (see City of London SW-1.0)

c) Maximum Depth of Cover

Where trench conditions are expected to exhibit seeping ground water in silt or fine sand, specified bedding will be defined as 19mm crushed stone entirely surrounded by geotextile.

3.14.3 Crossing Clearances

There are minimum clearances required when sanitary sewers cross other services. In all cases this is measured from outside wall diameter to outside wall diameter.

When crossing over or under a storm sewer, 230mm clearance is required.

For vertical clearances from the sanitary sewer to the watermain see **Water Design Standards, Chapter 7, Section 7.4.7.2.**

3.14.4 Minimum Distance Between Sewers

The minimum distance between sewers shall be 3.0m as per drawing UCC-1M and UCC-2M. Special cases to be reviewed for site specific design choices and depths.

3.14.5 Trenchless Technologies

When trenchless installation methods are being considered for new works, please refer to **Chapter 17, Trenchless Technologies (for New Construction).**

3.15 Maintenance Holes

3.15.1 Spacing of Maintenance Holes

The maximum spacing between sanitary maintenance holes shall be 99 metres measured horizontally or 110 metres measured vertically from the top of the maintenance hole, to the springline of the pipe, along the springline to the next maintenance hole and vertically to the top of the maintenance hole.

When spacing of a maintenance hole dictates that the maintenance hole should be placed within the vicinity of a roundabout, sanitary maintenance holes are not permitted to be located within the grassed area of the roundabout. Sanitary maintenance holes must be located within the apron of the island, for maintenance purposes.

Maintenance holes are required where there is a change in the direction of the flow, slopes, a change in the diameter of sewers, and/or a lateral sewer connection. **Note, a minimum 300mm clearance is required between services within a maintenance hole.**

3.15.2 Precast Maintenance Hole Sizing Criteria

All sizing of sanitary precast maintenance holes are based on incoming and outgoing pipe sizes and should be sized and conform to **Figure 3.3**.

Note, a minimum 300mm clearance is required between services within a maintenance hole.

3.15.3 Maintenance Hole Diameters

Precast maintenance hole diameter requirements are as follows:

a) 1200mm Diameter

See OPSD 701.010 and OPSD 701.030 for details and additional design information.

b) 1500mm Diameter

See OPSD 701.011 and OPSD 701.040 for details and additional design information.

c) **1800mm Diameter**

See OPSD 701.012 and OPSD 701.050 for details and additional design information.

d) **2400mm Diameter**

See OPSD 701.013 and OPSD 701.060 for details and additional design information.

e) **3000mm Diameter**

See OPSD 701.014 and OPSD 701.070 for details and additional design information.

f) **3600mm Diameter**

See OPSD 701.015 and OPSD 701.080 for details and additional design information.

Poured Maintenance Holes

Required for maintenance holes which exceed the above maximum pipe sizes for precast maintenance holes. **Note, certification by a Structural Engineer is required for all poured maintenance holes.**

3.15.4 Maintenance Hole Tees

Maintenance Hole tees are not allowed for any sanitary sewer less than 1200mm diameter. For sanitary trunk sewers greater than 1200mm diameter, refer to the storm sewer section 5.14.4. Ensure sewers which slope away from the maintenance hole but are not intended to take flows from the maintenance hole, have the inverts high enough to not accept sewage.

3.15.5 Maintenance Hole Frame and Covers

Maintenance hole frames and covers are required for all maintenance holes and shall conform with OPSD 401.01. See OPSD 401.01 for details and additional design information.

a) Maintenance hole frames and covers are to be clear of curb and gutters on bends in the road for new construction. Maintenance hole frames and covers may be located in the curb and gutter on reconstruction projects, only as approved.

b) Maintenance hole frames and covers and by association steps must be aligned to avoid being located in the wheel path of the street, and to be located above a benching platform, i.e. to avoid conflict with an inletting or outletting sewer pipe, respectively. Proposed location of maintenance hole frames and covers and by association steps must be shown in plain view on the engineering drawings, represented by a solid circle reflecting the above requirements.

3.15.6 Maintenance Hole Inserts

3.15.6.1 Use of Maintenance Hole Inserts Required During Construction

The use of inserts in sanitary maintenance holes will be required in areas of new construction until such time as the roadway is paved with the top asphalt layer.

3.15.6.2 Watertight Maintenance Hole Lids/Covers

Watertight maintenance hole lids are required when sanitary maintenance holes are located within stormwater overland flow routes and stormwater ponding areas. These locations are within flood plain areas, within gutter locations and within an easement and/or open space area where overland flow is directly over and or adjacent to the maintenance hole lids. Watertight maintenance hole lids are also required under sanitary surcharge conditions. (See City of London SW-5.3 for details and additional design information).

Watertight maintenance hole lids are not required under the following circumstances:

a) Where design dictates that the maintenance hole lids end up in the curb and gutter and where it is possible to rotate the cone so that the maintenance hole lid is clear of the gutter, the cone should be rotated such that a watertight lid would not be required;

b) Where, in the profile design of the street, the maintenance hole is located in the low point of an overland flow route, the maintenance hole may be in standard location, but would be submerged under a greater than two year storm event. Maintenance holes located in a standard location on streets that carry an overland flow route with a continuous grade, or cascading grade (even though some of these may be briefly submerged) do not require watertight lids.

3.15.7 Lockable Maintenance Hole Covers

Lockable maintenance hole covers are required to reduce access by the public. They can be located through park blocks, open space blocks, pumping stations or pollution control plants. See OPSD 401.06 for details and additional design information.

3.15.8 Maintenance Hole Steps

Maintenance hole steps are required for access and are to conform with one of the following:

a) Maintenance Hole Steps - Hollow

   See OPSD 405.010 for details and additional design information.

b) Maintenance Hole Steps - Solid

   See OPSD 405.020 for details and additional design information.

   Note:

   i. All steps are to be galvanized steel or aluminium; and

   ii. A detail or restoration plan is required for the relocation of maintenance hole steps within existing maintenance holes, where applicable; and

   iii. Maintenance hole steps shall be located to avoid conflict with an inletting or outletting sewer pipe. Access to maintenance holes must be above the benching platform.

c) Reference to **Section 3.15.5** for alignment information for location requirements for the maintenance hole frame and cover.

3.15.9 Maintenance Hole Drop Structures

Sanitary drop structures are required when the difference in invert elevations between the upstream and outlet sewers in the maintenance hole is equal to or greater than 0.6 metres. (See City of London SW-2.0 (1-2) for details and any additional design information).

3.15.10 Maintenance Hole Safety Landings

Maintenance hole safety landings are required at the mid-point depth of the maintenance hole when the depth of the maintenance hole is between 5.0 and 10.0 metres. Additional safety landings are required at third-point depths, when the maintenance hole is equal to or greater than 10.0m to 15.0m deep. See City of London SW-2.5 for details and additional design information.

Note: Incoming pipes are to be below safety landings, where possible.

3.15.11 Benching

All maintenance holes require benching at the bottom of the maintenance hole and should conform to OPSD 701.021. Benching height should be increased to obvert to increase hydraulic benefit as required.

Note: Where benching is different from OPSD 701.021, a benching detail is required.

3.15.12 Steps in Benching

Steps in maintenance hole benching are required when the pipe diameter is greater than 900mm and benched to springline, and when the pipe diameter is greater than 450mm and benched to crown. See City of London SW-5.2 for details and additional design information.

3.15.13 Adjustment Units

Maintenance hole adjustment units are required on all maintenance holes to ensure that proper grade is provided between the top of the maintenance hole and the maintenance hole lid. Ensure that the difference in grade between the maintenance hole lid and the first ladder rung does not exceed 600mm. See City of London SW-5.0 for details and additional design information. Clay brick will not be allowed for use as maintenance hole adjustment units.

3.15.14 Head Losses

a) Generally, when velocities in the downstream pipe from a maintenance hole exceed a velocity of 1.2 m/s, head losses must be accounted for in the design of the sewer and larger PDC's. In order to absorb head losses that may exist in maintenance holes, it may be necessary to improve the benching in the maintenance hole or increase the size of the downstream pipe where possible. Lowering the crown of the outgoing sewer below the crown of the incoming sewer by the amount equal to the head loss, however, is the most effective method of accounting for head loss in most cases.

b) Drops in maintenance holes to compensate for Head Loss (H_L) shall be calculated using the following formula:

$$H_L = K_L \frac{V^2}{2g}$$

where: K_L = Head loss coefficient
V = downstream velocity (m/s)
g = 9.8 m/sec^2

Note: Also see **Figure 3.1** for quick reference for head losses in maintenance holes, and Benching **Section 3.15.11** for benching.

c) Head loss coefficients (K_L) are to be applied as follows:

i. **90 degrees**

No benching or deflector, or where they are only up to spring line.

K_L = 1.5

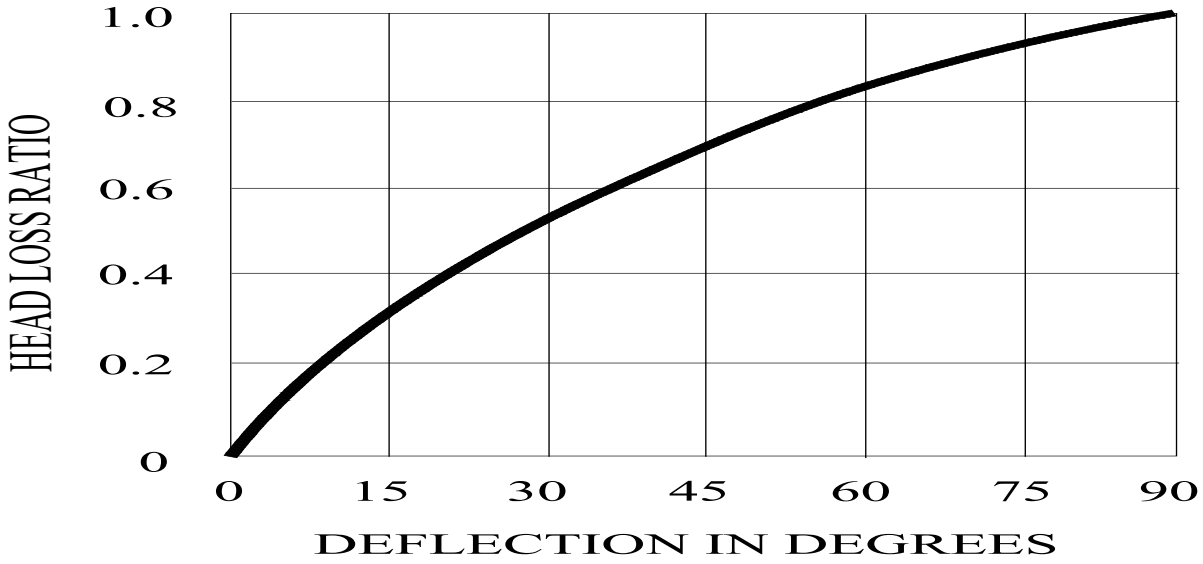
ii. **90 degrees**

Benching or deflector to crown of sewers.

K_L = 1.0

iii. **Less than 90 degrees**

Multiply the head loss coefficient (K_L) for a 90 degree bend by a head loss ratio factor from the following chart:



iv. **Junctions**

- Tee

  Outlet at right angles to inlets and no deflector between inlets.

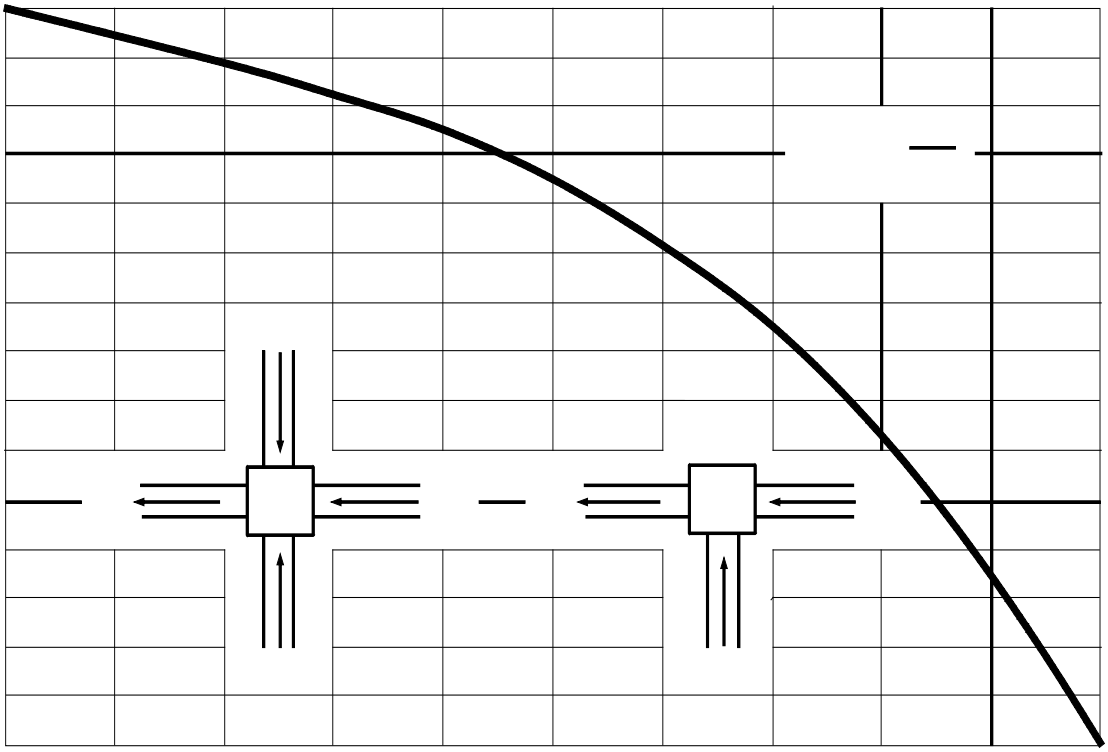
  K_L = 1.5

- Deflector between inlets for full height and width of incoming flows.

  K_L = 1.0

- Side and Cross Junctions

  Value of K_L is obtained from the following chart:



v. **Curved Sewers**

For K_L values for calculating head losses in curved sewers (radius pipe), see **Figure 3.5**.

3.15.15 Maintenance Hole Access

1. Maintenance Hole Access for Municipal Sewers Located within **Easements or Where Sewers Located Outside of Paved Road Surface**

   a) Access to maintenance holes for the purpose of maintenance is to be provided in all circumstances. When designing maintenance access roads for sewers, generally the maintenance access road/path will have a 3.0 metre wide hard asphalt surface with a 4.0 metre wide granular base.

   Adequate curves and turn-around facilities are required for maintenance vehicles to manoeuvre. Slopes (4% maximum), cross falls (2% minimum to 4.5% maximum) and drainage of access roads are also to be addressed in the design.

b) Where sanitary sewer maintenance holes are installed below the flood line, the engineer shall be consulted and access road alternatives may be considered in this situation. In this situation, maintenance hole lids must conform to **Section 3.15.6**.

Note:

i. A 0.3m separation is required between the maintenance access and the top/bottom of any slopes; fences; and property line(s); and

ii. The design and construction of sewer maintenance access roads in City Parks and Open Spaces will require the review and approval of both Parks Planning & Design and the Environmental & Engineering Services Department. Wherever possible, sewer access roads in City Parks and Open Spaces shall be integrated into the public open space pathway networks and respect the City's natural heritage features.

See **Section 3.17** for easement requirements.

3.15.16 Maintenance Hole Construction Practices

a) The void between the sewer pipe and the cored hole of the precast maintenance hole section shall be filled with cement bricks and approved non-shrinkable grout. Pre booted maintenance holes will be allowed but only with previous approval by the City. All joints between bricks are to be completely filled with concrete mortar. Bricks are to be parged on the outside. Parging shall contain an approved bonding agent. All mortar and approved non-shrinkable grout shall be mixed and placed in accordance with the manufacturer’s specifications.

b) All precast maintenance hole section joints shall contain an approved rubber gasket. In areas of high groundwater, exterior joint collars or external wrapping (e.g., ‘Cretex’ waterproofing or equivalent, installed as per manufacturer’s specifications) of the maintenance hole joints will be required. This requirement may be waived if it can be demonstrated that, based on specific groundwater conditions, the standard rubber gasket is sufficient to prevent infiltration.

c) A minimum 300mm vertical/horizontal clearance between openings on the inside of the maintenance hole is required for all sewer and PDC connections.

d) All maintenance hole frame and covers shall be adjusted to the finished road grade by means of metal shims at each corner or by means of an approved precast adjustment ring. Metal shims are to be at least 75mm x 200mm (3" x 8") and their thickness is to be determined by the adjustment required. The space between the bottom of the maintenance hole frame and cover and the top of the precast maintenance hole is to be at minimum the thickness of one adjustment unit and at maximum 300mm. See City of London SW-5.0 for details and additional design information.

e) Where adjacent maintenance holes are located in close proximity to one another, the area between the adjacent maintenance holes shall be backfilled in accordance with the specifications in the following table:

Table 3-2 Backfill material based on distance between maintenance holes

Distance Between Adjacent Maintenance Holes	Material
0.6 metres or less	concrete or crushed stone
0.6 metres to 2.4 metres	granular material
more than 2.4 metres	approved native material or granular material

The above noted backfill shall be compacted to the standard Proctor Density specified in the soils report, or as approved by the City Engineer.

3.15.17 Sampling/Inspection Maintenance Holes

a) Requirements

Sampling/Inspection maintenance holes are typically required where Institutional, Commercial and Industrial developments outlet to sanitary sewers owned and maintained by the City. Sampling/inspection maintenance holes are required for all industrial and commercial sites.

b) Location

If required, Sampling/Inspection Maintenance Holes shall be located on private property as close as possible to the property line, or as approved by the City Engineer.

c) Minimum Size

Sampling/Inspection Maintenance Holes shall be a minimum of 1200mm diameter. A larger diameter Maintenance Hole may be required if noted on the Building Permit Application Drawings.

d) Sampling/Inspection Maintenance Holes that have more than one inlet sewer shall be increased in size to ensure that there is a minimum of 0.9m of straight benching length downstream of all inlet sewers.

e) There are to be no drop structures (internal or external) located at sampling/inspection maintenance holes that are required for City sampling purposes.

f) Maintenance Holes shall be to OPSD standards – see **Section 3.15.3**, and **Figure 3.7** for further details.

3.16 Private Drain Connections (PDCs)

3.16.1 Location

PDCs to single family and semi-detached lots are to be located in accordance with City of London SW-7.0.

PDCs to multi-family (town housing, row housing and apartments), commercial and industrial blocks are to be connected to a maintenance hole on the R.O.W. See section 3.16.3 for further details.

PDC's shall be installed at 90° to the sewer main where possible. Under no circumstances will flow from the PDC enter the main against the flow in the main. Where horizontal or vertical bends are required, long radius sweeps shall be used. Short bends are not acceptable. Single family and semi-detached lot Sanitary PDC's shall NOT be connected to a maintenance hole.

Note: Where design constraints arise (i.e. top end of cul-de-sac or crescent), PDCs may have to be located in reverse location and identified as such on the servicing drawings.

3.16.2 Minimum Size and Grade

a) The minimum diameter and grade of a PDC for residential, single family and semi-detached lots is 100mm at 2.0%.

b) The minimum diameter and grade of a PDC for a residential multi-family block is 150mm diameter at 1.0%.

c) The minimum diameter and grade of a PDC for a non-residential block is 150mm diameter at 1.0%.

d) The minimum diameter and grade of a PDC for a commercial block is 150mm diameter at 1.0%.

e) The minimum diameter and grade of a PDC for an institutional block is 200mm diameter at 1.0%.

Note: The actual size of the PDC required for multi-family, non-residential, commercial and institutional blocks is dependent on the flows.

All PDC's must have a minimum slope of 1% at a constant gradient.

3.16.3 Connections to Sewers/Maintenance Holes

a) Residential

PDCs 100mm and 150mm in diameter must be connected to the main sewer. Residential sanitary PDCs are **not** to be constructed into any sanitary maintenance hole.

b) Non-Residential

PDC's 150mm in diameter are to be connected to the main sewer.

c) Multi-family, Commercial, Institutional, and Industrial

PDCs 200mm in diameter and larger are to be connected to the main sewer at maintenance holes.

d) Connections to Existing Sewers for Lot Infill Situations

i. In a situation where a lot severance or lot infill condition exists, and a new sanitary service will be connected to an existing sanitary mainline, the advocate of the severance/infill, or their agent, must determine if the existing sanitary sewer is a combined or poorly separated sewer and is therefore at risk of surcharging, or if the sewer is a dedicated sanitary sewer but has a history of surcharging. This information can be obtained from Sewer Engineering Division. If it is determined that there is a surcharge risk, the development advocate must provide surcharge protection to their development.

ii. When connecting PDC's to existing sewers in a lot infill situation, connections must be made utilizing an approved saddle or premanufactured tee, in accordance with OPSS 410, as amended by the Supplemental Standards for Sewer and Water (SW) in the City of London Standard Contract documents for Municipal Connection Projects.

e) Maximum Depth of Sewer Where Direct PDC Connections Permitted

Direct connection of private drain connections to sanitary sewers greater than 8 metres in depth will not be permitted. Where a sanitary sewer is greater than 8 metres in depth, and local servicing is required, it will be required to provide a shallower local sewer to which private drain connections may be made. Deviations from this will require the approval of the Director of Water, Wastewater, and Stormwater or the City Engineer.

f) Sanitary sewer systems which are installed lower than 0.6m below the Seasonally High Groundwater Table (SHGWT) shall be designed to minimize infiltration using the following methods:

   a. The sewer pipes, pipe joints, and connections shall be designed to withstand a pressure of at least 45 psi without leakage.

   b. The sanitary maintenance holes shall be externally wrapped with waterproof membrane placed externally around all precast joints, including joints below the maintenance hole frame and cover, with a minimum 300mm wide strip.

   c. Buoyancy of sewers and maintenance holes shall be considered in the design, and where required, adequate provisions shall be made to prevent flotation.

Note: When any sewer has services (PDC's) attached to it, Operations requires a maintenance hole at the top end.

3.16.4 Vertical Clearance

For vertical clearances from the sanitary PDC to the watermain see **Water Design Standards, Chapter 7, Section 7.4.7.2**.

3.16.5 PDC Detail

Typical PDC connection to the main shall be as per City of London SW-6.0.

3.16.6 PDC Risers

a) Type I

   Required for sewer depths greater than or equal to 4.5m and for excavations in stable bank conditions, see City of London SW-6.1 for details and additional design information. When the PDC is installed between 45° and 67.5°, an approved controlled settlement joint shall be installed at the tee.

b) Type II

   Required for sewer depths greater than or equal to 4.5m and for excavations in unstable bank conditions, see City of London SW-6.2 for details and additional design information. When the PDC is installed between 45° and 67.5°, an approved controlled settlement joint shall be installed at the tee.

3.16.7 PDC Cleanouts

Where removal of an existing PDC cleanout is requested and approval is granted by the City Engineer, the cleanout and tee must be removed entirely. The owner may be required to install a new PDC. Approval will be given on a case-by-case basis and will apply to the entire phase of development.

3.16.8 Pipe Material

Refer to **Section 3.13**.

3.16.9 Depth and Bedding

The minimum depth of a sanitary PDC shall be 2.4 metres from the finished property line elevation to the obvert of the PDC. The maximum cover on a sanitary PDC shall be based on the following:

a) Concrete Pipe

   The maximum allowable cover permitted on concrete PDCs is to be as per **Section 3.14.2 a)**.

b) Flexible Pipe

   The maximum allowable cover permitted on flexible PDCs is to be as per **Section 3.14.2 b)**.

3.16.10 Marking and Recording PDC Service Connections

Brown painted surface stakes 40mm X 90mm (standard 2" X 4") shall be placed after trench restoration to mark the termination of sanitary PDC's. These stakes shall extend from PDC invert to minimum 450mm above finished boulevard grade.

Plugged or capped service connections shall be marked on the top surface of the last 3m of the upstream end of the pipe with yellow PVC adhesive tape (50mm wide) labeled continuously in black lettering (40mm wide) **"CAUTION SANITARY SEWER".**

New PDCs to Existing Properties – To be constructed to approximately 2.0m beyond the curb (or sidewalk).

PDCs to Parklands – Location, design and where warranted to be reviewed and approved by Parks Planning & Design.

Sanitary sewer laterals shall be colour coded green to avoid cross connections. Colour coding methods includes pipe colour, wrapping, demarcation tape, or stenciling.

3.17 Easements

Easements are required for all sewers to be assumed by the municipality located outside a road allowance on privately owned property.

An easement is required to ensure the municipal services and utilities crossing the site can be properly installed and maintained by the appropriate authority (municipality or private). An easement provides the right to use private land for a specific purpose which is in the public's interest.

All maintenance holes located within easements require hard surface access. Refer to **Section 3.15.15** for hard surface details.

3.17.1 Types of Easements

a) Multi-purpose Easement for Municipal Services

Are required for sanitary sewers and access roads that cross a site and which are maintained by the City.

b) Utility Easement

Utility easements are required for telephone, hydro, gas and cable television services. Each utility company should be consulted for their specific requirements.

c) Private Easements

Private easements are required for private sanitary sewers and access roads that cross a parcel of land to service other private lands. A joint access and maintenance agreement between the interested parties shall be entered into.

d) Temporary Easements and Working Easements

Temporary easements are required for sanitary sewers and access roads that cross a site temporarily. The services in the easement are to be maintained by the owner of the services.

Working easements are required, as necessary during construction, to allow for the safe construction and finishing of the surface restoration. Once construction is completed, the working easement is released**.**

3.17.2 Minimum Easement Widths

Easement widths are determined by the diameter of the pipe being installed and the depth of cover from the centreline of the road/ground over the pipe to the invert of the sewer or watermain. **Figure 3.6** shows how an easement width is to be determined. The minimum width of a sewer easement at a depth of up 2.4 metres, shall be 4.8 metres (2.4 metres each side of sewer).

3.18 Odour Control

Odour Control and Design Considerations for Sanitary Sewers/Systems to Reduce Sewer Gas and H2S Creation

The MECP Design Guidelines for Sewage Works also provides information and guidelines with respect to odours and corrosion in sewers.

In general, problems have been experienced with the development of sewer gases which cause odours and corrosion of concrete sewer infrastructure due to:

a) hydraulic design which induce turbulence in flow and encourage the release of sewer gases (i.e. sewer forcemains which jet into maintenance holes or chambers, poor benching or transitions where sewers outlet into an existing sewer, high sewer slopes which induce hydraulic jumps, elevation changes with poor transitions)

b) long residence time of sewage in sewer systems (i.e.: sewer systems, pumping stations and forcemains which service new developments and have low flows initially, pumping stations and forcemains with long forcemains)

It should be noted that effluent quality which exceeds Waste Discharge By-laws also contributes to the potential to create sewer gases.

Every effort should be made to minimize the conditions or designs which may lead to the creation of sewer gases (odours and corrosion). Where it is not possible to avoid these types of situations, it will be a requirement to mitigate the impacts through the use of means acceptable to the City of London. Examples of this may be:

1. The use of chemical dosing of City approved or accepted oxidizing agents to address pumping stations and forcemains with long retention times, either on a short term or long term basis.
2. The use of corrosion resistant materials (such as plastic pipe or liners) in situations where it is not possible to improve hydraulic conditions which will introduce turbulence and sewer gas creation.

3.19 Erosion & Sediment Control Plan

The City of London requires an Erosion and Sediment Control Plan (E&SC Plan) be designed for most Capital Works, Operational and Development Projects. The complexity of the E&SC Plan is determined by the sensitivity of the area that is to be protected.

For reconstruction or resurfacing of existing roads, or for infill sites less than 3.0 ha in land area within existing urbanized areas, that are not in close proximity to an open watercourse, woodlands, ESA's, steep slopes or other natural area; an E&SC Plan is not required, unless otherwise directed by the City Engineer. Where an E&SC Plan is not required, all reasonable protective measures must be taken during construction to control sediment and prevent erosion from occurring.

For further information on the requirements of the E&SC Plan, please refer to Section 10 – Erosion & Sediment Control, within this manual.

3.20 Standard Drawings for Sanitary Sewer Design

The following charts, tables and images and their contents illustrate City of London design standards used in sanitary sewer collection systems.

Figure 3.1 Sanitary Sewer Design Sheet

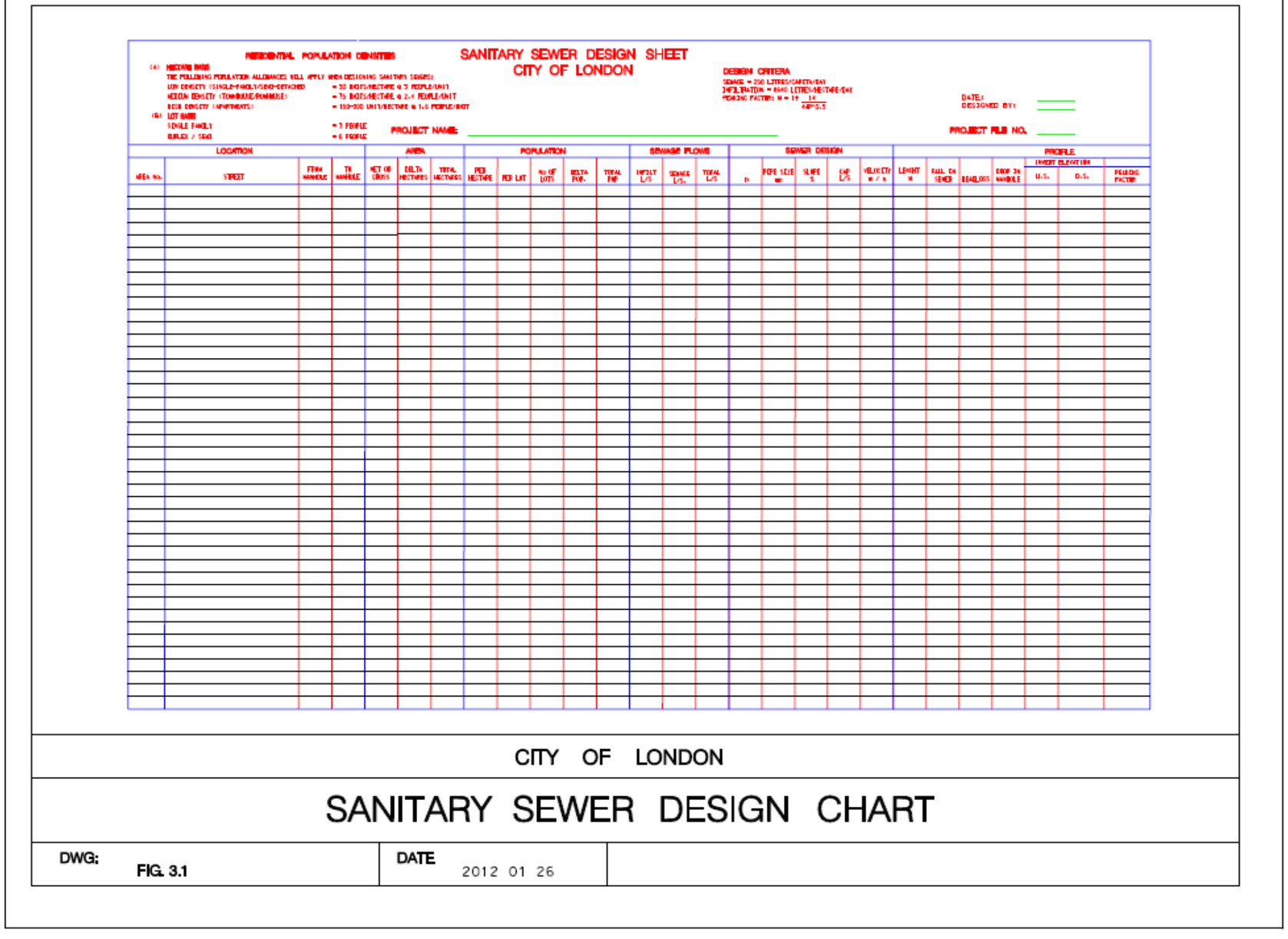


Figure 3.2 Hydraulic Elements Graph for Circular Sewers

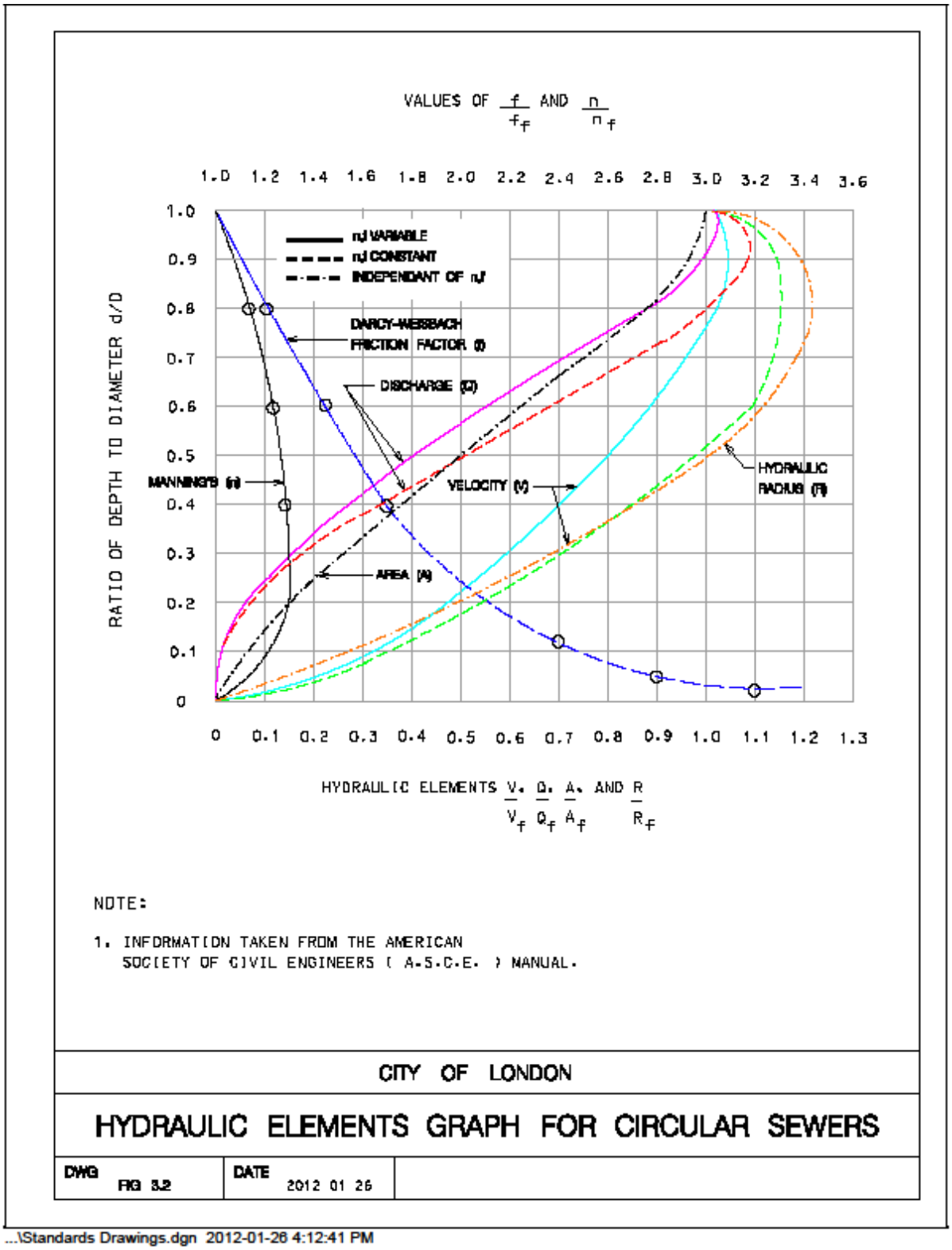


Figure 3.3 Maximum Pipe Sizes for Precast Maintenance Holes

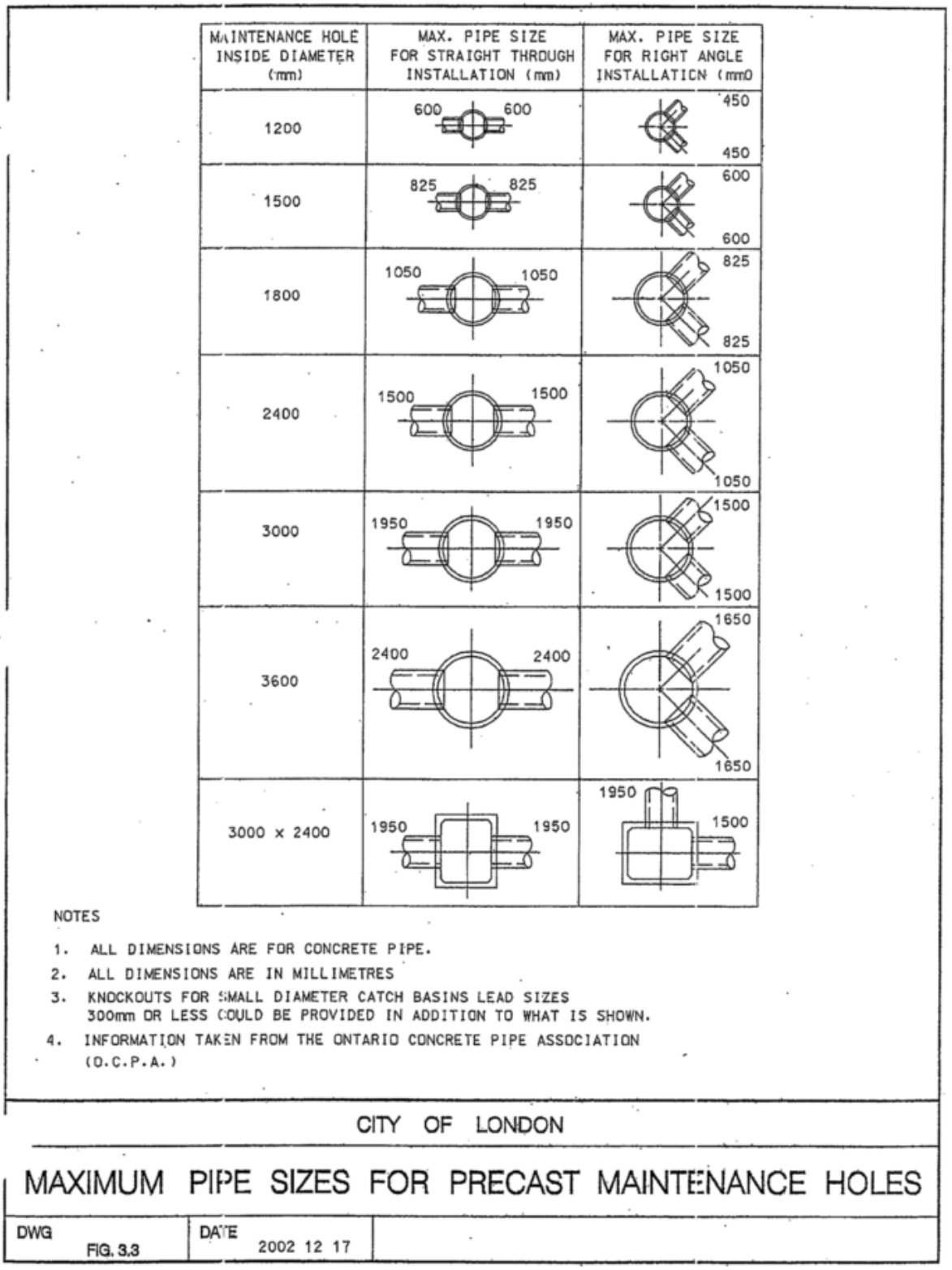


Figure 3.4 Head Losses in Maintenance Holes

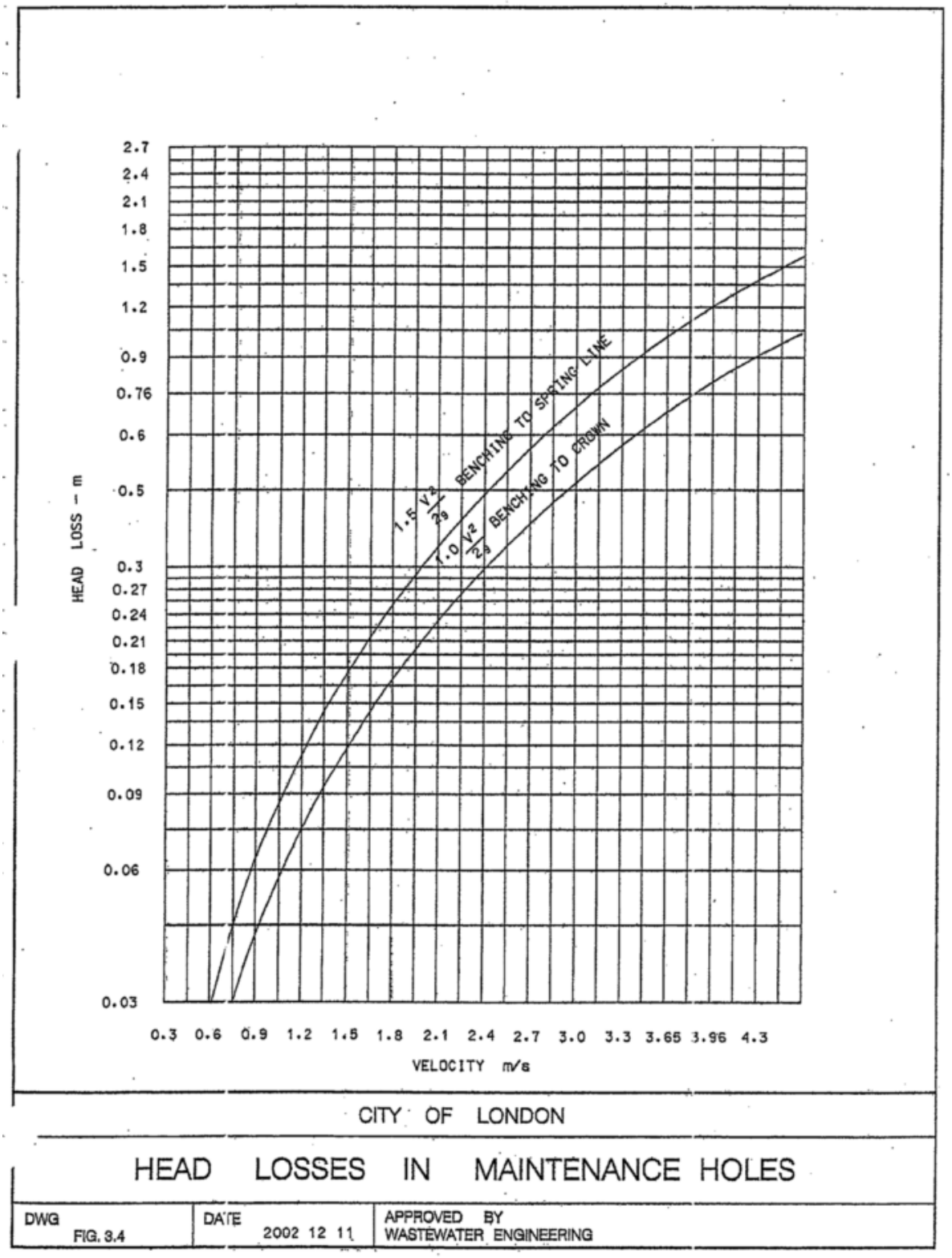


Figure 3.5 K_L Values for Calculating Head Losses in Curved Sewers

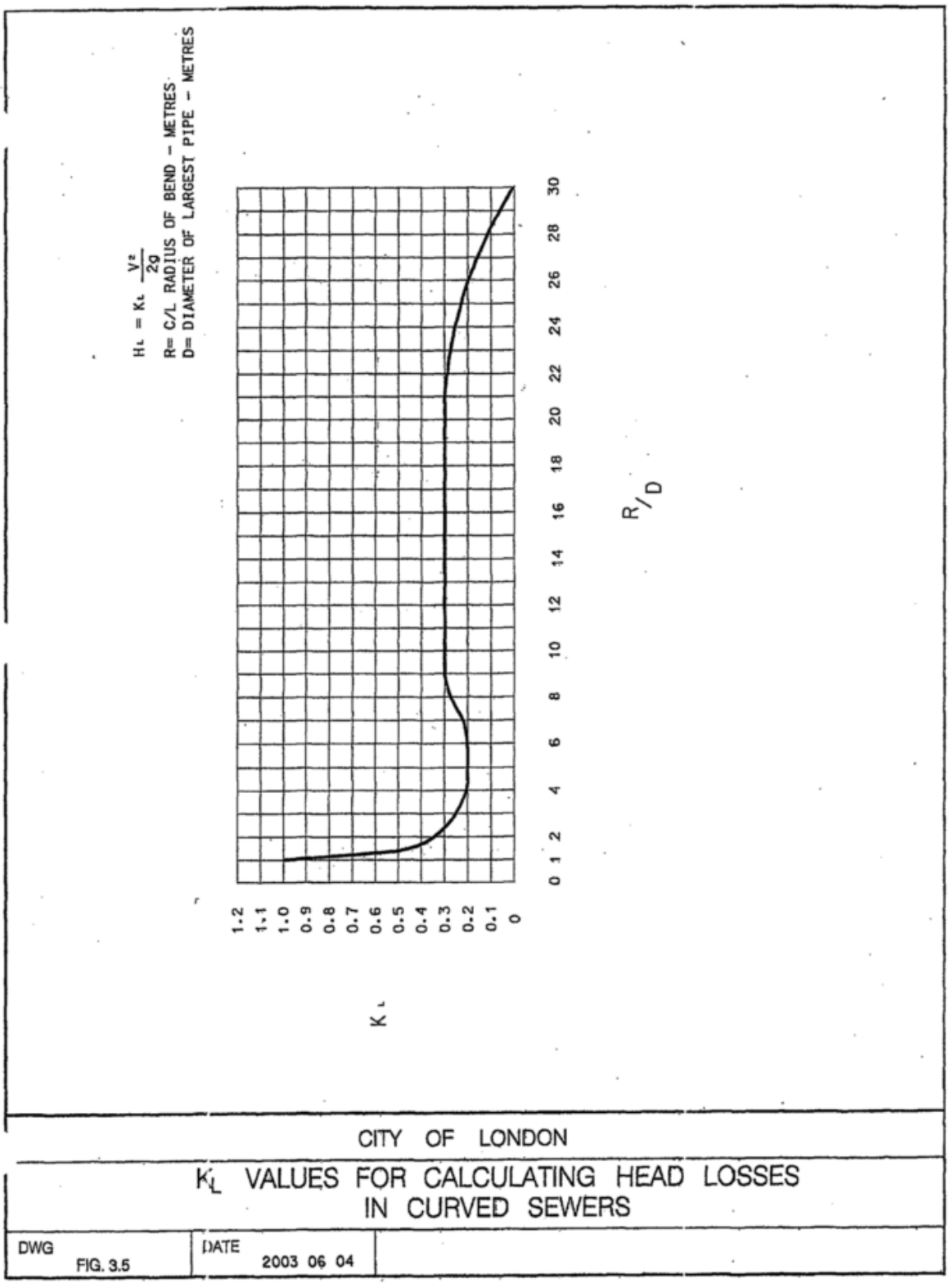


Figure 3.6 Minimum Easement Width

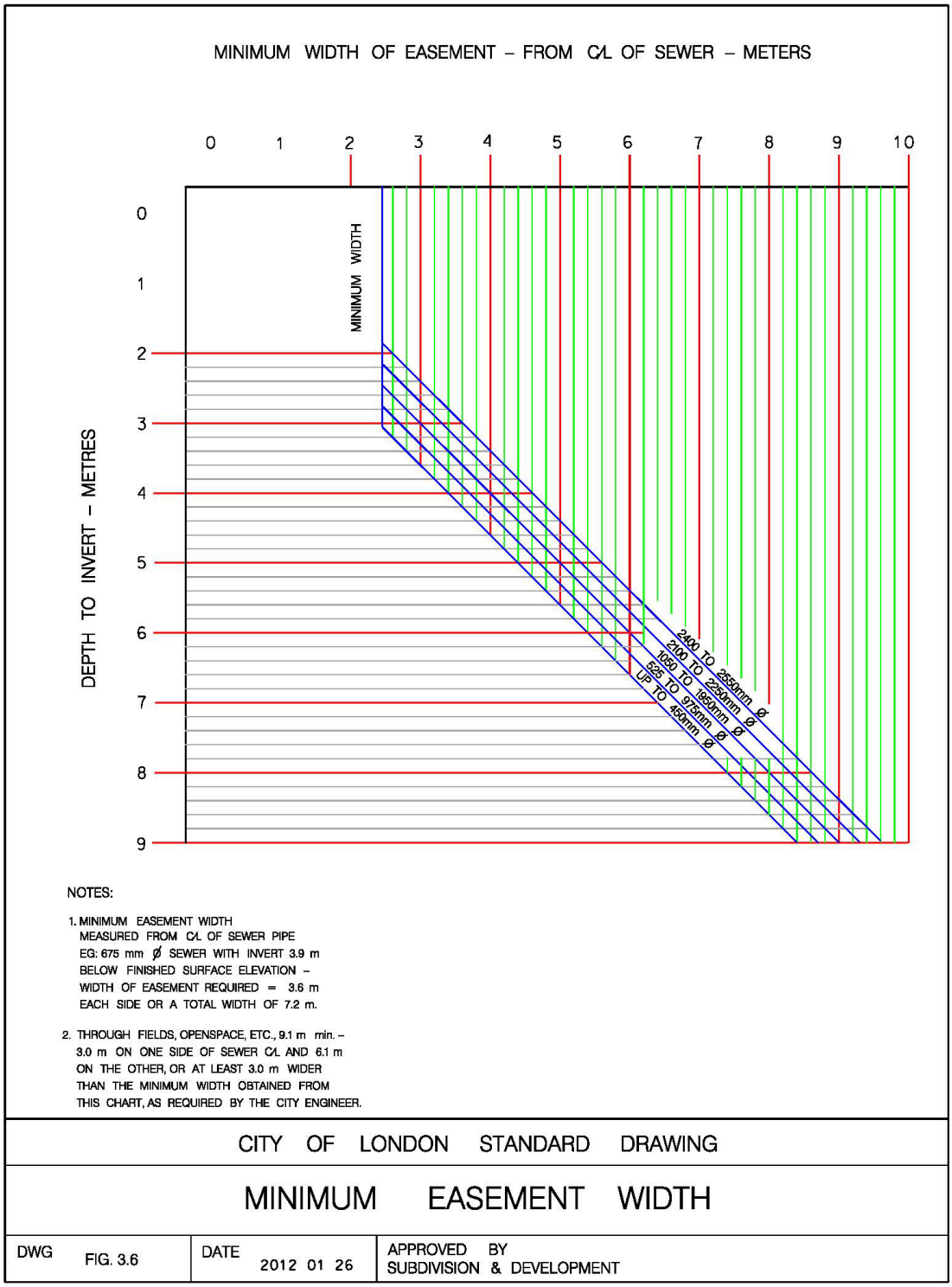


Figure 3.7 Sampling Maintenance Hole Sanitary & Storm Sewer