The Corporation of the City of London
P.O. Box 5035
300 Dufferin Avenue
London, ON N6A 4L9

Chapter 5
Storm 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.

Index

Contents

Figures

Tables

5 Storm Sewer Collection System

5.1 Definition and Purpose

Storm sewers are commonly thought of as closed conduit drainage systems below the surface of the ground that collect surface water created from rainfall or other forms of precipitation. However, storm systems may consist of one or any combination of pipes, ditches, culverts, open channels and storm water management facilities that carry storm water flows.

Chapter 5 provides details on the storm sewer system, while Chapter 6 provides further information on stormwater management including SWM Ponds, LIDs, ditches, channels, and culverts.

5.2 Permitted Uses

Storm sewers shall be designed to collect storm water discharge from pervious and impervious areas both on private lands and public lands via catchbasins and storm private drain connections. Indirect connections of foundation drains (footing tile) via sump pumps to storm PDCs are permitted. Drainage of foundation drains (footing tiles) shall be in accordance with City of London Drainage By-law (WM-4).

Storm Drainage on private property requires a building permit before installation.

Watermain flushing into the storm sewer may be permitted, any flushing works shall meet water quality standards outlined in 7.4.5.7 of the Design Specification and Requirements Manual.

5.3 Location and Alignment

Generally storm sewers are to be located in front of, or are in locations accessible to each lot and block facing a City Street. Storm sewers and maintenance holes 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).

Storm sewers are to be located on the outside loop of a proposed crescent with the maintenance holes at a 1.5 metre offset from the centre line of the road.

Where a maintenance hole is designed to be located within the area of a roundabout, storm maintenance holes are permitted to be located within the grassed area of the roundabout, provided any proposed landscaping does not hinder the access to the maintenance hole.

5.3.1 Storm Sewers on Private Property

Storm 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.

5.4 Drainage / Subdrainage 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 coefficients are to be shown for each drainage/sub-drainage areas.

5.5 External Watershed Limits and Drainage Areas

When design abuts undeveloped areas, identify the external watershed limit to be designed for.

Note: All areas, coefficients and time of concentrations are to be shown for all drainage areas within external watershed limits.

5.6 Design Chart

Storm sewer design calculations are to be completed on the standard design chart. See **Figure 5.1** for details and additional information.

5.7 Peak Flow Calculation

Flows shall be calculated using the formula:

$$Q = 2.78 \times A \times C \times I$$

where: Q = peak flow (L/s)
A = area (hectares)
C = runoff coefficient
I = average rainfall intensity (mm/hr)

5.8 Design Criteria

5.8.1 Storm Design Curve

The criterion used in the design of storm sewers is generally to be based on the 1 in 5-year City of London Rainfall Intensity curve (see **Figure 5.2**). Major overland flow routes are to be designed for storms greater than a 5-year storm. This is explained further in **Section 9.0, Grading**.

5.8.2 Time of Concentration

a) The time of concentration for residential areas (single family / semi detached) at the upstream end of a system shall be 19.0 minutes. For all other areas refer to **Figure 5.3**.

b) The time of concentration is to be adjusted when lateral flows account for 50% or more in the design flows.

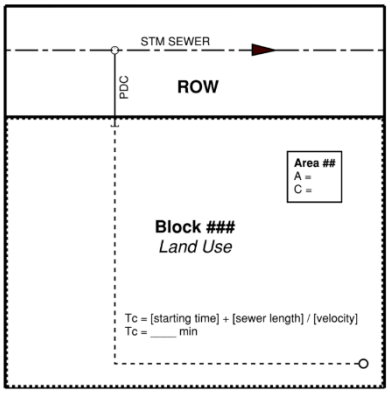
   i. Adjusted time of concentration shall be calculated using the formula:

$$T_{c-adj} = \frac{(T_{ct})(Q_t) + (T_{cl})(Q_l)}{(Q_t + Q_l)}$$

   where: $T_{c\text{-}adj}$ = adjusted time of concentration (min.)
   T_{ct} = time of concentration in the trunk sewer (min.)
   Q_t = design flow in the trunk sewer (l/s)
   T_{cl} = time of concentration in the lateral sewer (min.)
   Q_l = design flow in the lateral sewer (l/s)

   ii. The adjusted time of concentration is used downstream of the junction maintenance hole.

c) Example: time of concentration shown on a block within a drainage area plan



Notes:

- Starting time is to be determined by referring to Figure 5.3.
- The line showing the approximate length of the sewer is to be the worst-case scenario.
- Rationale for the assumed velocity should be noted in the servicing report/brief.

5.8.3 Runoff Coefficients

Runoff coefficients for minor storm events are based on the land characteristics (i.e., amount of impervious area, soil, slope) for a particular land use:

- Parks, open space and playgrounds 0.20
- Single family/semi detached 0.50
- Townhouse/row house 0.65
- Apartments 0.65 - 0.70
- Commercial, institutional, and industrial 0.70 - 0.90
- Densely built, paved, gravel 0.90

Notes:

1. when calculating flows related to higher order storm events (e.g., 100-year event), increased runoff coefficients shall be used in accordance with MTO standards.
2. For development proposals incorporating right-of-way into stormwater run off calculations, a composite runoff coefficient shall be calculated and utilized as part of the stormwater design.

5.8.4 Intensity

Rainfall intensity is to be taken from **Figure 5.2**.

5.9 Manning's Roughness Coefficient

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

5.10 Pipe Size

Storm sewer pipe sizing is based on the following formula, where the pipe design flow is equal to or greater than the calculated peak sewage flow:

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

where: Q = Design flow (m³/sec.)
n = Mannings 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 size storm sewer pipe permitted is 300 mm.

Downstream pipe diameters shall not decrease in diameter.

On private property, the minimum size for storm building sewer shall be 100mm, in accordance with Part 7 of the Ontario Building Code.

5.11 Flow Velocity

Velocity shall be calculated using the following formula:

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

where: V = flow velocity (m/sec)
Q = Design flow (m^3/sec)
A = cross sectional area of flow (m²)

5.11.1 Minimum Velocity

The minimum velocity permitted in storm sewers is 1.0 m/sec.

5.11.2 Maximum Velocity

The maximum velocities permitted in storm sewers are:

- 4.5 m/sec for 300 mm to 825 mm diameter sewers, and
- 6.0 m/sec for 900 mm diameter and larger storm sewers.

To determine velocities based on actual flow, refer to **Figure 5.4 Hydraulic Elements Graph for Circular Sewers**.

Additional protection against erosion, scouring, and pipe displacement must be provided by a Licensed Engineering Practitioner where flow velocities exceed 4.5 m/s. Where velocities in the storm sewers approaching or exceeding 3 m/s due to steep grades and providing a drop maintenance hole is not possible, the sewer shall be designed for protection against maximum scouring velocity and erosion measures acceptable to the City of London.

Note: Storm sewers on 20 percent slope or grated shall be anchored securely with concrete anchors or equivalent and shall be designed by a Licensed Engineering Practitioner.

5.11.3 Minimum Grades

a) The minimum grade on a 300 mm diameter storm sewer is 0.54%.

b) The minimum grade on all other sewer sizes shall be established by determining the minimum grade necessary to achieve a velocity of at least 1.0m/sec.

5.12 Pipe Material

Both rigid and flexible pipe are permitted in the construction of storm sewer systems including private drain connections and catchbasin leads. These materials include concrete, polyvinyl chloride and high-density polyethylene.

Storm Sewer pipes shall be colour coded white to avoid cross connections. Color coding method includes pipe color, wrapping, demarcation tape, or stenciling.

The criteria for using these materials is described in the City of London Standard Contract Documents for Municipal Construction Projects - Section 410.05.01.

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

5.13 Pipe Depth and Bedding Material

5.13.1 Minimums

The minimum depth of a storm sewer shall be 1.5m from the finished ground elevation to the obvert of the pipe. Where minimum depths cannot be achieved and therefore frost protection is warranted, insulation is required as per City of London W-CS-68.

5.13.2 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
- rsdp = 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 4.5m - Type 1 (see City of London SW-1.0)
- for up to 10.5m Type 2 (see City of London SW-1.0)

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

5.13.3 Crossing Clearances

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

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

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

5.13.4 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 constraints and depths.

5.13.5 Trenchless Technologies

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

5.14 Maintenance Holes

5.14.1 Spacing of Maintenance Holes

The maximum spacing between storm maintenance holes is dependent on the pipe size. The maximum spacing between maintenance holes when the pipe is 300-975mm diameter shall be 99m measured horizontally or 110m 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.

Following are the maximum allowable horizontal spacing for the corresponding pipe sizes:

Table 5.1 Maximum allowable horizontal spacing of maintenance holes based on storm sewer diameter

Length	Sewer Diameter
99m	300 – 975mm
130m	1050 – 1350mm
160m	1500 – 1650mm
305m	1800mm & larger

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.**

5.14.2 Pre-cast Maintenance Hole Sizing Criteria

All sizing of storm pre-cast maintenance holes are based on incoming and outgoing pipe sizes and should be sized and conform to Figure 5.5.

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

5.14.3 Maintenance Hole Diameters

Pre-cast 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.

5.14.4 Maintenance Hole Tees

Maintenance hole tees can be constructed in lieu of regular maintenance holes on 1200mm diameter or greater trunk sewers. See City of London SW-5.1 for details and additional design information.

Notes:

a) No deflections or lateral connections are to be constructed within the proposed maintenance hole tee.

b) Maintenance hole tees are to be located upstream to a deflection or change in sewer sizes.

5.14.5 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.

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 plan view on the engineering drawings, represented by a solid circle reflecting the above requirements.

Note, maintenance hole frame & covers are to be clear of curb & gutters on bends in the road.

5.14.6 Lockable Maintenance Hole Cover

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.

5.14.7 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 aluminum.

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

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.

iv. Refer to **Section 5.14.5** for alignment information for location requirements for the Maintenance hole frame and cover.

5.14.8 Maintenance Hole Drop Structures

Storm 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 0.9m. See City of London SW-2.0 (1-2) for details and any additional design information.

5.14.9 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 5.0m and 10.0m. Additional safety landings are required at third-point depths, when the maintenance hole is equal to or greater than 10.0 m to 15.0 m 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.

5.14.10 Benching

All maintenance holes require benching at the bottom of the maintenance hole and shall 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.

5.14.11 Steps in Benching

Steps in maintenance hole benching are required when the pipe diameter is greater than 900mm and benched to spring line, 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.

5.14.12 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.

5.14.13 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 5.6** for quick reference for head losses in maintenance holes, and **Section 5.14.10** for benching.

c) Head loss coefficients (KL) 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.

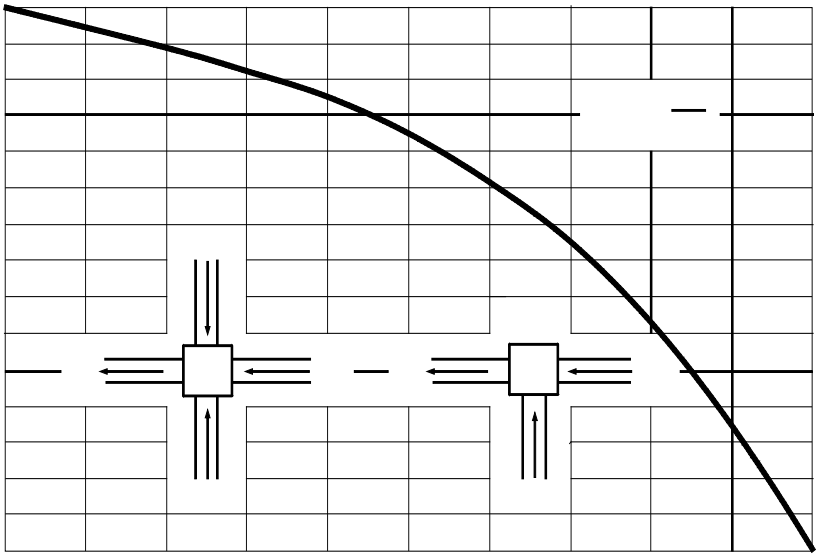
K_L = 1.5

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. For K_L values for calculating head losses in curved sewers (radius pipe), see **Figure 5.7**.

5.14.14 Maintenance Hole Access

A 3.0m to 4.6m wide topsoil and sodded access without trees, plantings or other obstructions is required for maintenance vehicles and equipment used to access and service all storm maintenance holes with easements, open space areas, designated blocks and existing right-of-ways (i.e. boulevard). Adequate curves and turn-around facilities are required for maintenance vehicles to maneuver. Slopes (10% maximum), crossfalls (2% minimum) and drainage of access roads are also to be addressed in the design.

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

See Section 5.17 for easement requirements.

5.14.15 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 manufactures specifications.

b) All pre-cast maintenance hole section joints shall contain an approved rubber gasket.

c) A minimum 300 mm 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 pre-cast adjustment ring. Metal shims are to be at least 75 mm x 200 mm (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 pre-cast maintenance hole is to be at minimum the thickness of one adjustment unit and at maximum 300 mm. 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 5.2 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.

5.14.16 Sampling/Inspection Maintenance Holes

a) Requirements

Sampling/Inspection Maintenance Holes are required where Commercial, Industrial and sometimes Institutional developments outlet to storm sewers owned and maintained by the City. The requirement for sampling/inspection maintenance holes will be reviewed on a site specific basis, through the Site Plan Review Group.

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.

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.

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

Maintenance Holes shall be to OPSD standards – see Section 5.14.13, and Figure 5.10 for further details.

5.15 Private Drain Connections (PDCs)

5.15.1 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 (townhousing, rowhousing and apartments), commercial and industrial developments are to be connected to a maintenance hole or sewer within the right-of-way. See section 5.15.3 for further details.

PDCs shall be installed at 90° to the sewer main where possible. Under no circumstance 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.

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.

5.15.2 Minimum Size and Grade

a) The minimum diameter and grade of a PDC for a residential, single family and semi-detached lot is 150mm @ 2%.

b) The minimum diameter and grade of a PDC for a residential multi-family block is 300mm diameter @1.0%.

c) The minimum diameter and grade of a PDC for a non-residential block is 375mm diameter @ 1.0%.

d) The minimum diameter and grade of a PDC for a commercial block is 300mm diameter @ 1.0%

e) The minimum diameter and grade of a PDC for an institutional block is 375 mm @ 1.0%.

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

5.15.3 Connections to Sewers/Maintenance Holes

a) Residential

Storm PDCs 150mm, 200mm and 250mm in diameter are to be constructed to the main sewer, except in cases where a maintenance hole is located at the top end of a system (i.e. cul-de-sac).

b) Multi-family, Commercial and Institutional

Storm PDCs 300mm in diameter and larger are to be connected to the main sewer at the maintenance hole, except in cases where the main sewer is 900 mm in diameter or larger, in which case the PDC may be connected directly into the sewer.

c) Connections to Existing Sewers for Lot Infill Situations

i. In a situation where a lot severance or lot infill condition exists, and a new storm service will be connected to an existing storm mainline, the advocate of the severance/infill, or their agent, must determine if the existing storm sewer is a combined or poorly separated sewer and is therefore at risk of surcharging. This information can be obtained from Wastewater 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 pre manufactured 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 Construction Projects.

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

5.15.4 Vertical Clearance

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

5.15.5 PDC Detail

Typical PDC installation to the main, as per City of London SW-6.0.

5.15.6 PDC Risers

a) Type I

Required for sewer depths greater than or equal to 4.5 m 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 45º and 67.5º, an approved controlled settlement joint shall be installed at the tee.

b) Type II

Required for sewer depths greater than or equal to 4.5 m 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 45º and 67.5º, an approved controlled settlement joint shall be installed at the tee.

5.15.7 PDC Cleanouts

Where removal 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.

5.15.8 Pipe Material

See Section 5.12 for acceptable pipe material.

5.15.9 Depth and Bedding

The minimum depth of a storm PDC shall be 1.5 m from the finished property line elevation to the obvert of the PDC. The maximum cover on a storm PDC shall be based on the following:

a) Concrete Pipe

The maximum allowable cover permitted on concrete PDCs is to be as per Section 5.13.2 a.)

b) Flexible Pipe

The maximum allowable cover permitted on flexible PDCs is to be as per Section 5.13.2.b).

5.15.10 Marking and Recording PDC Service Connections

Green painted surface stakes 40mm X 90mm (standard 2" X 4") shall be placed after trench restoration to mark the termination of storm 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 orange PVC adhesive tape (50mm wide) labeled continuously in black lettering (40mm wide) **"CAUTION STORM SEWER"**

New PDCs to Existing Properties – To be constructed to approximately 2m beyond the curb (or sidewalk).

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

PDCs Not Required – When the Geotechnical Engineer certifies that storm PDCs are not required, as per the City of London Drainage By-law (WM-4).

5.16 Catchbasins

Catchbasins are to be provided to collect drainage from both pervious and impervious areas. The following are the general guidelines to be used in the provision of catchbasins and catchbasin leads.

5.16.1 Location

a) Street — On street corners and intersections, the catchbasin is to be located 0.6m from the BC or EC of the curvature, and/or located on the lot/property line or 1.5m from the centre of the lot to avoid conflicts with driveway and lot servicing respectively.

b) Lot/Rear Yard — The catchbasin and lead are to be located 0.6 m from the property line, entirely on one lot or block.

c) Parks — Catchbasins are to be located to minimize flow across pathways and provide positive drainage from park facilities.

5.16.2 Minimum Lead Diameter and Grade

a) Street — The minimum diameter and grade of a catchbasin lead on a street is 250mm at 0.69% (velocity of 1.0 m/s).

b) Lot — The minimum diameter and grade of a catchbasin lead in a rear yard is 300 mm at 0.54% (velocity of 1.0 m/s).

c) Parks — The minimum diameter and grade at the catchbasin lead in a park is 250mm at 0.69% (velocity of 1.0m/s).

5.16.3 Spacing

Catch basin spacing will vary with the street width, grade and cross fall, the location of pedestrian crossing points, intersections, low points, location of sanitary maintenance holes and driveway depressions.

Following are the maximum catch basin spacing for the corresponding road gradient:

Table 5.3 Maximum Catch Basin Spacing

Road Gradient (%)	Maximum Spacing (m)
Under 4.5	90
Over 4.5	75

5.16.4 Types of Catchbasins

a) Catchbasin - 600 mm x 600 mm

Catchbasins (CB) are to typically be constructed on all streets and some rear yards, see OPSD 705.010 for details and additional design information. Also, refer to Section 5.16.7 for details and additional design requirements.

b) Curb Inlet Catchbasin

Curb inlet catchbasins (CICB) are to be typically constructed at all low points in the curb and gutter on Neighbourhood Street and Neighbourhood Collectors. Curb inlet catchbasins are to be constructed exclusively on all Rapid Transit Boulevard, Urban Thoroughfare, Civic Boulevard, Urban Thoroughfare/Civic Boulevard in Primary Transit Area and Main Streets. See City of London SW-3.0.

Note: Driveway locations are to be identified where curb inlet catchbasins are required.

c) Catchbasin Maintenance Hole

Catchbasin maintenance holes (CBMH) are to typically be constructed in rear yards, see City of London SW-4.0 for details and additional design information. Also, refer to 5.16.7 for additional design requirements.

d) Ditch Inlet Catchbasins

Ditch inlet catchbasins (DICB) are to be typically constructed for ditch drainage along major roads, where Rapid Transit Boulevard, Urban Thoroughfare, Civic Boulevard, Urban Thoroughfare/Civic Boulevard in Primary Transit Area and Main Streets grading cannot be provided. They are also to be constructed for temporary block drainage and for outlets/inlets within a stormwater management pond. See OPSD 702.040 and OPSD 702.050 or OPSD 705.030 and OPSD 705.040 for details and additional design information.

e) Twin Inlet Catchbasins

Twin Inlet catchbasins (OPSD 705.020) are to be typically used in lieu of curb inlet catch basins under specific circumstances such as:

i. At a sag in a street with no curb and gutter

ii. In industrial subdivisions where barrier or mountable curb is specified, where driveway locations are not determined.

iii. As approved on a site specific circumstance by the City engineer.

5.16.5 Depth of Cover

The minimum depth of cover over a catchbasin lead is to be 1.5 m within the road allowance and 1.2 m off the road allowance.

Note: Where minimum depths cannot be achieved and therefore frost protection is warranted, insulation is required as per City of London W-CS-68.

5.16.6 Allowable Ponding

a) No surface ponding is allowed to develop under a 5-year design storm event. Ponding on major overland flow routes allows for 300 mm for catchbasins within impervious catchment areas and 450 mm for catchbasins within grassed catchment areas. See Grading Section 9.2 and 9.4 for further design information.

b) In new developments, flat see-saw profiles (identical high and low points) will not be allowed in either road profile designs or rear yard swale designs. See-saw profiles must slope in a cascade that allows major storm flows (Overland Flows) to drain along the road or lots to an acceptable Overland Flow Outlet.

c) Flat see-saw profiles (identical high and low points) will not be allowed in either road profile designs or rear yard swale designs. See-saw profiles must slope in a cascade that allows major storm flows (Overland Flows) to drain along the road or lots to an acceptable Overland Flow Outlet.

d) In reconstruction projects within existing developed areas of the City, where the existing profile and driveway conditions cannot accommodate a cascading see-saw profile, the proposed profile must provide for adequate road drainage and be acceptable to the City Engineer.

5.16.7 Requirements for Length of Leads

Standard catchbasins (600 x 600), maintenance hole catchbasins and maintenance holes are to be constructed/connected in accordance with the following:

a) Catchbasin leads up to 15.0 m in length may be constructed by:
    i. connecting into the main sewer using an approved connection, or by,
    ii. connecting into a maintenance hole.

b) Catchbasin leads 15.0 to 30.0m in length may be constructed by:
    i. having a catchbasin at one end and the other connected into a maintenance hole or a sewer 900mm in diameter and larger, or by
    ii. having the lead connected into a sewer 825mm in diameter or smaller at one end with a maintenance hole catchbasin at the other end.

c) Catchbasin leads over 30.0m in length, are to be connected into a maintenance hole or a sewer 900mm in diameter or larger at one end and have a maintenance hole catchbasin at the other end.

d) All private catchbasin leads servicing rear yards are to be in accordance with section 5.16.2 and Chapter 7 of the Ontario Building Code.

5.16.8 Catchbasin Frame and Grates

a) Catchbasin Cast Iron Frame and Flat Square Grate

To be constructed in conjunction with a catchbasin - 600 mm x 600 mm and a catchbasin maintenance hole. See OPSD 400.02 for details and additional design information.

b) Catchbasin Cast Iron Curb Inlet Overflow Plate

To be constructed in conjunction with a curb inlet catchbasin. See OPSD 400.09 for details and additional design information.

c) Ditch Inlet, Galvanized Steel, Honeycomb – Grating

To be constructed in conjunction with a ditch inlet catchbasin. See OPSD 403.01 for details and additional design information.

5.16.9 Catchbasin Steps

a) Maintenance Hole Steps – Hollow

To be constructed in conjunction with a pre-cast catchbasin maintenance hole. See OPSD 405.010 for details and additional design information.

b) Maintenance Hole Steps – Solid

To be constructed in conjunction with a catchbasin maintenance hole. See OPSD 405.020 for details and additional design information.

5.16.10 Catchbasin Connections

a) Catchbasin Connection - Rigid Pipe Sewer

To be constructed in conjunction with a catchbasin - 600 mm x 600mm. See OPSD 708.010 for details and additional design information. Catchbasin lead bedding Class B & Class C to be in accordance with City of London Standard SW – 1.0. Structural design of concrete catch basin leads to be in accordance with section 5.13.

b) Catchbasin Connection - Flexible Pipe Sewer

To be constructed in conjunction with a catchbasin - 600 mm x 600mm. See OPSD 708.030 for details and additional design information.

c) Flexible Pipe:

Catchbasin lead bedding type 1 (up to 4.5m) & type 2 (up to 10.5m), in accordance with City of London Drawing Standard SW-1.0.

d) Vertical Requirements

Where Catch Basin leads are to be installed at greater than 45° vertically, installation shall be as per OPSS 410.07.13, as amended by City of London Supplemental Standards for Sewer and Water.

5.16.11 Maintenance Hole Adjustment Unit

Maintenance adjustment units are required to ensure that the difference in grade between the top of the catchbasin maintenance hole lid and the first ladder rung does not exceed 600 mm. See City of London SW-5.0 for details and additional design information.

5.16.12 Catchbasin Lead Material

Both rigid and flexible pipes are permitted for the construction of catchbasin leads. These materials include concrete and polyvinyl chloride. In most cases flexible catchbasin leads are constructed.

The criteria for using these materials are described in the Standard Contract Documents for Municipal Construction Projects, Section 410.05.01.

5.16.13 Concrete Curb Setbacks

Concrete curb setbacks are to be constructed in conjunction with all catchbasins (600 mm X 600 mm and curb inlet catchbasins) located within curb and gutter within the right-of-ways**.** Concrete curb setbacks shall not be implemented when curb face sidewalk is specified. See City of London SR-3.0 for details and additional design information.

5.16.14 Minimum Building Setbacks

Required for all catch basin leads which abut a lot line adjacent to a building. These setbacks are to be equivalent to the City of London sewer easement setbacks. If setbacks cannot be achieved, then the following is required:

a) Reduced setbacks and adjacent underside of footing elevations (i.e. footings to be outside of the trench excavation)

b) A separation of at least 3.0m between buildings adjacent to the catch basin lead.

c) A minimum 1.0m offset from the face of the wall of the building to the catch basin must be provided.

Details - plan & profiles of all rear yard catch basin leads are required together with all pertinent details.

5.16.15 Mini Catchbasins

Mini Catchbasins shall only be installed on Rapid Transit Boulevard, Urban Thoroughfare, Civic Boulevard, Urban Thoroughfare/Civic Boulevard in Primary Transit Area, Main Streets as per a), b) and c) below. Mini catchbasins shall not be used on Neighbourhood Street and Neighbourhood Collectors or lower classification roads unless otherwise directed by the Engineer.

a) Mini Catchbasins shall be installed to collect runoff water when major roadways are reconstructed during the period between installation of base asphalt and surface asphalt. The mini catchbasins shall conform to the ABT Polydrain 900 Series. (See Fig. 5.9)

b) Mini catchbasins shall only be installed at the sag points of vertical curves, directly in front of the Curb Inlet Catchbasin, and finished flush with the base asphalt. The mini catchbasin shall be connected to the CICB with a 150mm PVC lead. The frame and grate of the mini catchbasin shall be D.I., with stainless steel latches, have a nominal 67% open area, be bicycle proof, and meet HS25 load ratings for roads and highways. Mini catchbasins are to be retrofitted, installed after the base asphalt is applied.

c) Prior to surface asphalt placement, the mini catchbasin frame and grate shall be removed and the catchbasin pot and lead shall be completely filled with concrete. The CICB shall be completely sealed with concrete and parged.

5.16.16 Catch Basin Subdrains

Pipe subdrains shall be provided on both sides of all catchbasins installed in hard surface areas. Subdrains are not required in rear lot catch basins or in catch basins located in grassed areas, with the exception of parks and open spaces.

All subdrains shall be 150mm diameter, minimum 3.0m long, either of perforated corrugated steel pipe or PVC pipe. Perforations shall consist of 6mm holes in four rows positioned at 4, 5, 7 and 8 o'clock and 75mm apart longitudinally in both materials.

Pipe subdrains shall be connected to the 200mm knockout provided in the catch basin pot, typically at subgrade elevation, shall be laid parallel with the curb, and at the same grade as finished road grade. Pipe subdrains shall be capped at the upstream end with a premanufactured end cap or with cement brick and non shrink grout.

Where pipe subdrains are required for use as a French drain in lot drainage situations, pipe subdrains shall be fully bedded in 19mm stone, which, in turn, will be completely surrounded by geotextile.

For all other conditions, pipe subdrains shall be completely wrapped in Terrafix 270R or approved equivalent.

All connections should be in accordance with City of London Drawing Standards SW-3.1.

5.17 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 surface access. Refer to Section 5.14.14 for access details. Maintenance vehicle access is not required for rear lot catch basin maintenance holes.

5.17.1 Types of Easements

a) Multi-purpose Easement for Municipal Services

Are required for watermains, sanitary & storm sewers, catchbasins, drains, stormwater management ponds, channels and/or access roads that cross a site and which are maintained by the City.

Note: Typically, easements are not required for rear yard catchbasins. If rear yard catchbasins are designed to receive water from municipal lands, such as parklands, easements are required.

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 storm sewers, access roads and other private services that cross a parcel of land to service other private lands. A joint access and maintenance agreement between interested parties shall be entered into.

d) Temporary and Working Easements

Temporary easements are required for watermains, sanitary & storm sewers, drains, stormwater management ponds, channels and/or 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 restoration of the disturbed surface area. Once construction is completed, the working easement is released.

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

5.17.2 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 determined. The minimum width of a sewer easement shall be 4.8m (2.4m per side).

5.18 Storm Sewer Inlet and Outlet Structures – Headwalls

Headwalls are required at the end of all storm sewer systems which provide for a transition from the storm sewer to an open channel, river, creek, SWM pond or other receiving body of storm water. In some cases headwalls are required at the inlet of a storm sewer and/or large storm drain.

5.18.1 Types of Headwalls

The following headwall designs are based on the velocity and in certain cases the diameter of the storm sewer, which was taken from Municipal Works Design Manual (Municipal Engineers Association - MEA) and Ontario Provincial Standard Drawings.

There are five types of headwall designs and they are as follows:

a) **Under 1.3 m/s with pipes diameters under 600 mm** - see OPSD 804.03 for details and additional design information.

b) **Under 2.1 m/s** – MEA Type I (using OPSD 804.04 where applicable, or detail design modifying OPSD 804.04)

c) **2.1 m/s to 2.7 m/s** - MEA Type II (using OPSD 804.04 where applicable, or detail design modifying OPSD 804.04; and 1 baffle post)

d) **2.7 m/s to 4.6 m/s** - MEA Type III (using OPSD 804.04 where applicable, or detail design modifying OPSD 804.04; and 3 baffle posts)

e) **4.6 m/s to 10.0 m/s** - MEA Type IV (stilling basin), or detail design.

5.18.2 Concrete Strength

The concrete for all headwalls is to have a minimum strength of 30 MPa with a 5% to 7% air entrainment and 70 to 90 mm slump.

5.18.3 Chamfers

All exposed corners of all headwalls should be chamfered 25 mm or more depending on the size of the headwall.

5.18.4 Weeping Tiles

Weeping tiles are to be provided on each side at the base of the sewer outlet and extended through the headwall. On larger headwalls they are placed on the side or wing walls.

5.18.5 Baffle Posts

Baffle posts are to be provided for sewer flows between 2.1 m/s and 4.6 m/s. The location of the posts are per the type of headwall (refer to Municipal Works Design Manual). The height of the baffle posts should be equal to the full depth of flow. Sizing of the posts are 1/6 the size of the pipe diameter together with reinforcing bars.

5.18.6 Grill/Grates

Hot dipped galvanized grills/grates are to be placed over the storm outlets horizontally or vertically as required and should be fixed to the headwall with anchor bolts. Grills and grates shall comply with OPSD 804.05.

5.18.7 Railing

A railing is required on all headwalls which exceed 1.0m in height from the top of the headwall to the proposed top of slope. See OPSD 980.101 for details and additional design information. All headwalls are to have a swale at the top of the structure to allow for surface drainage.

5.18.8 Rip Rap/Rock Protection

Rip rap is to be constructed at the end of all headwalls of all storm sewer systems and is to be placed in accordance with OPSD 810.01 and the following design criteria:

a) on the bottom and sides up to design water levels;

b) downstream until the projection of the side walls meet the channel side slopes at half the design water depth of flow; and

c) for headwalls at creeks and rivers, extend rip rap or gabion protection to creek or river.

Protection is to provide a smooth hydraulic flow for headwall discharge and creek or river flows.

Note: Rip rap design information etc. is to be in compliance with OPSS-1004. The minimum size of rip rap is 100mm and the maximum size is 200 mm. Rock protection shall be well-graded in sizes ranging from 100mm to 500mm.

5.19 Erosion & Sediment Control

The City of London requires an Erosion & 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 – Sediment & Erosion Control, within this manual.

5.20 Standard Drawings for Storm Sewer Design

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

Figure 5.1 Storm Sewer Design Chart

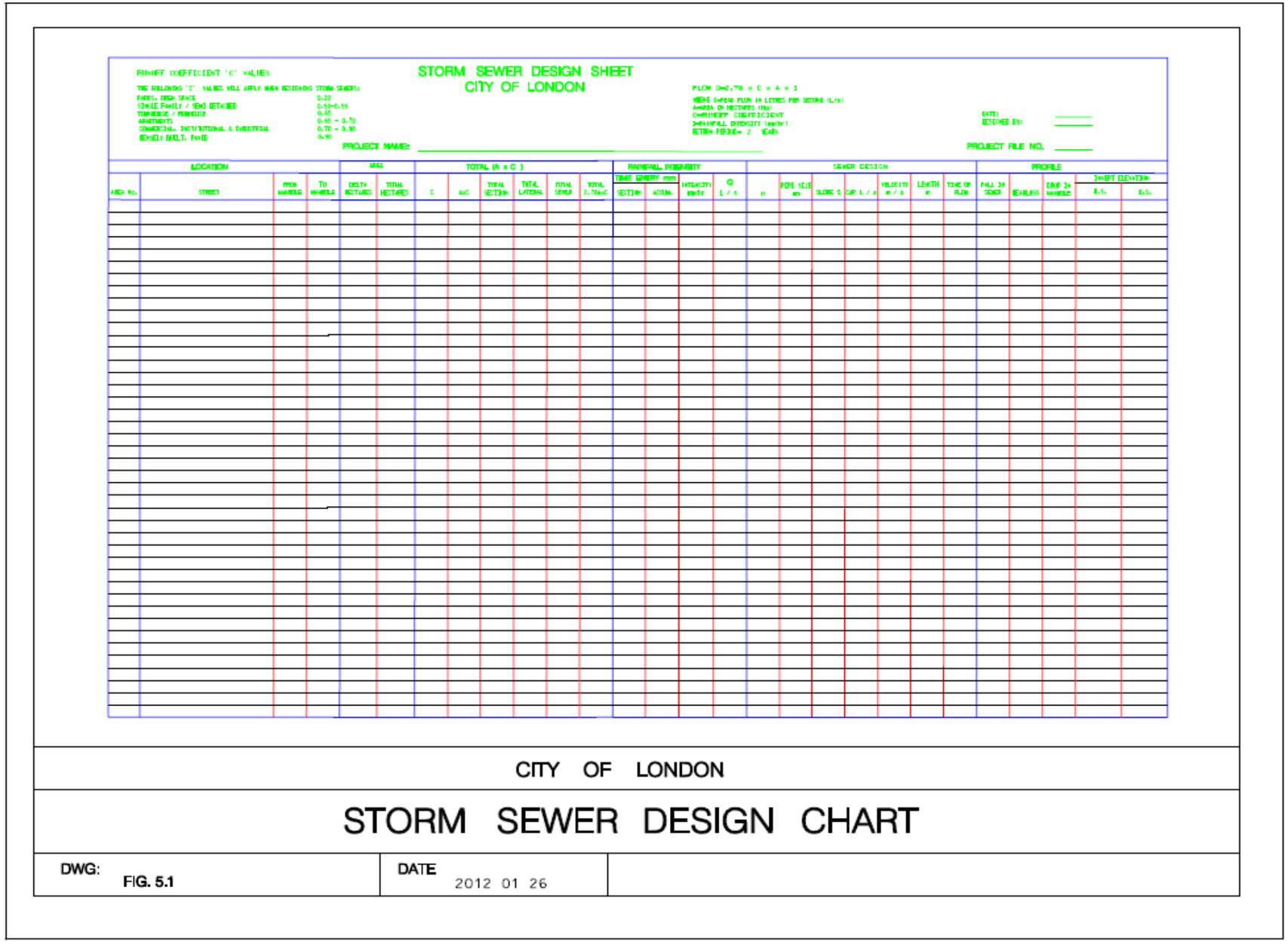


Figure 5.2 Rainfall Intensity-Duration Curves for Storm Sewer Design

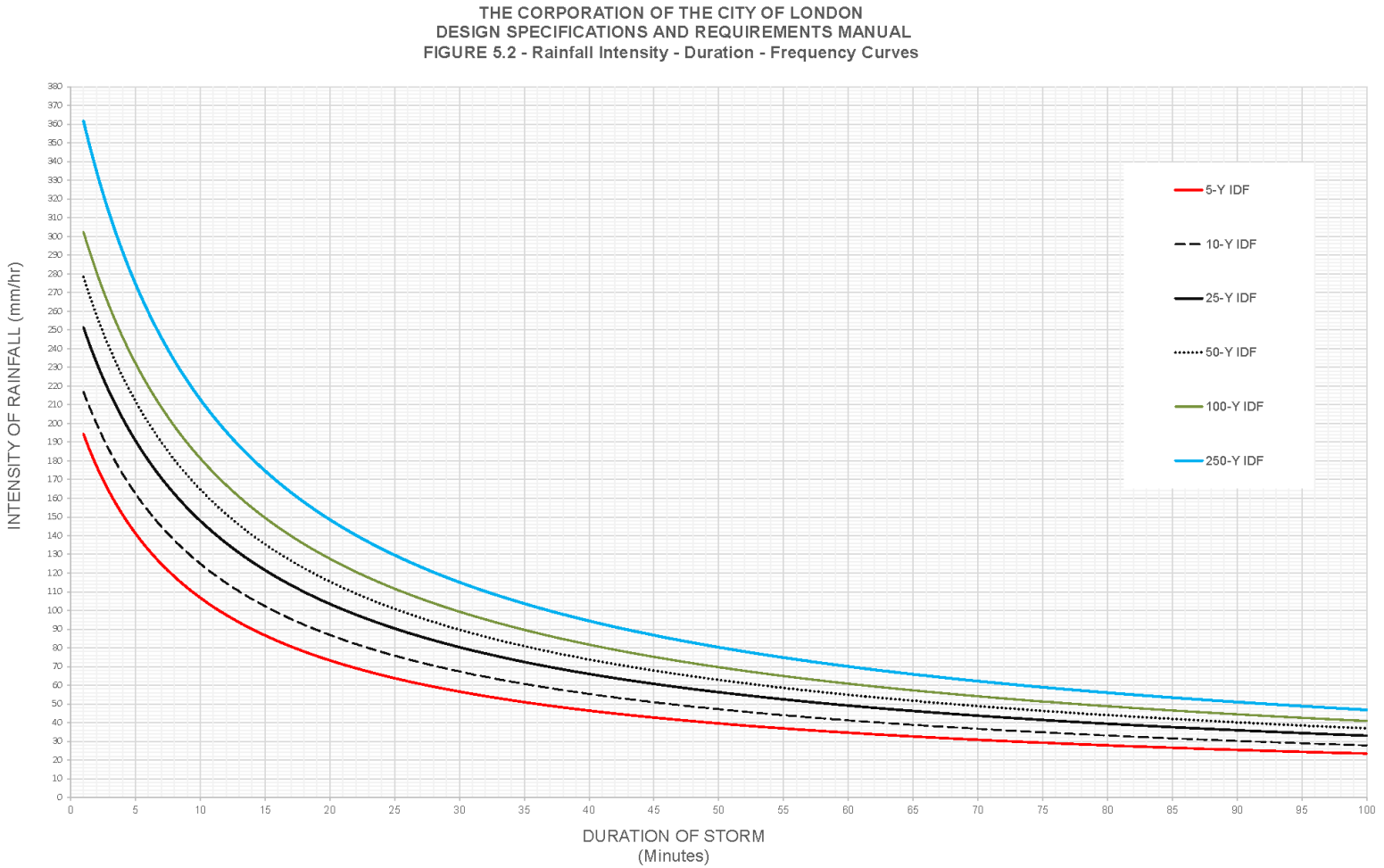


Figure 5.3 Average Runoff Coefficient to Time of Concentration

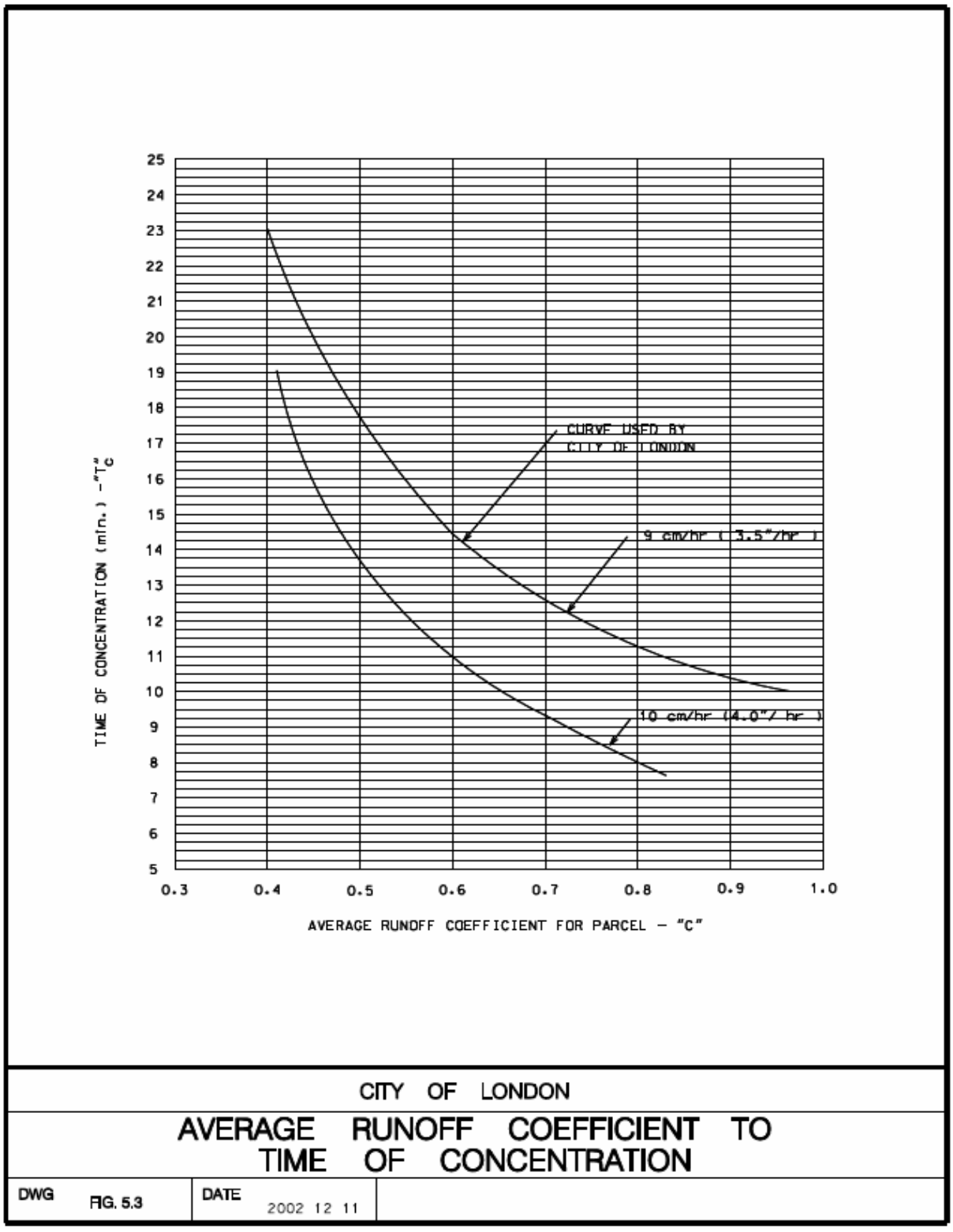


Figure 5.4 Hydraulic Elements Graph for Circular Sewers

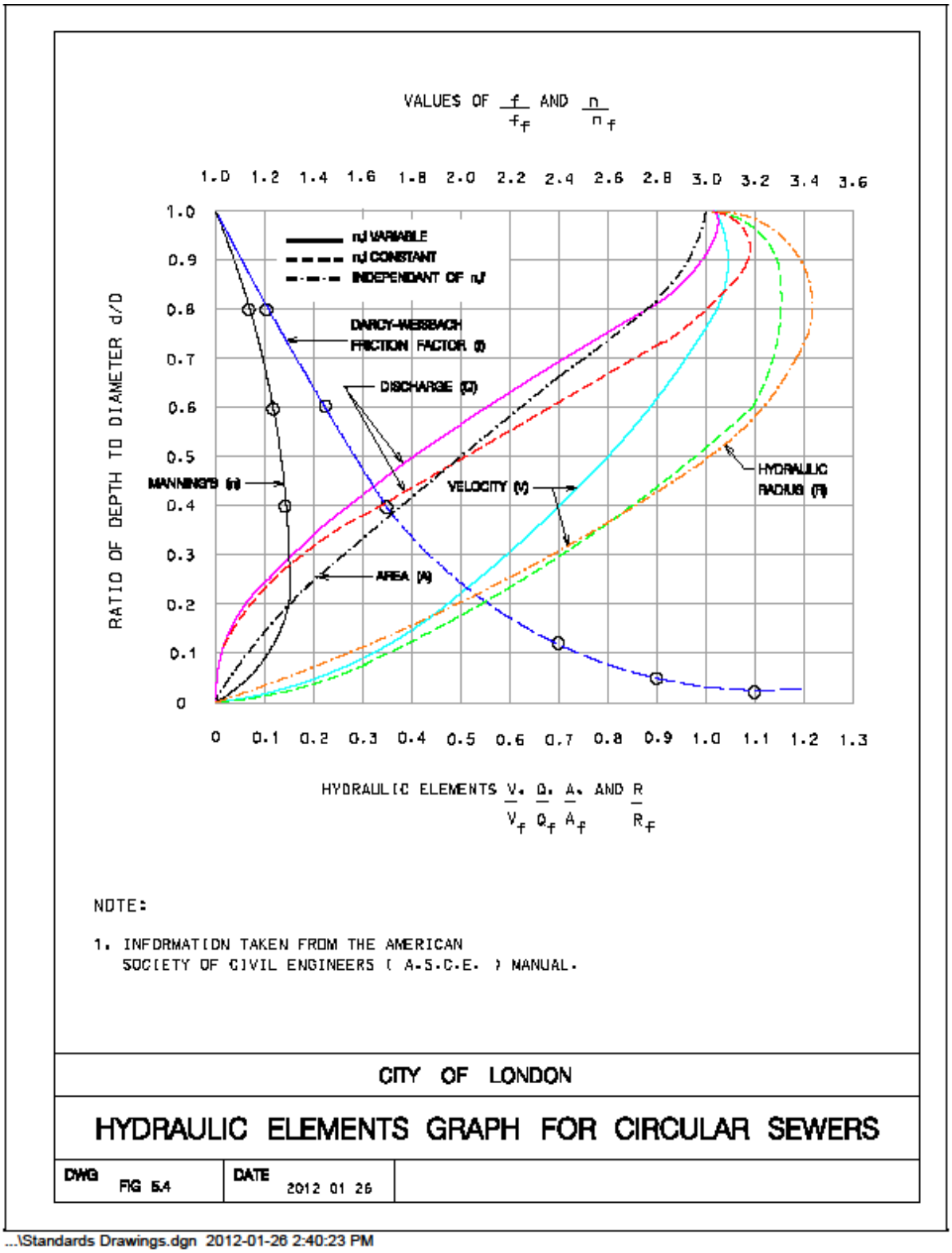
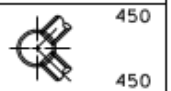
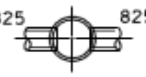
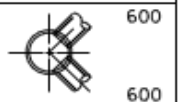
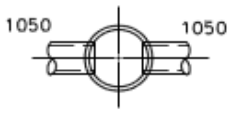
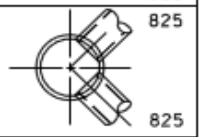
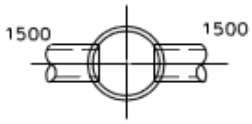
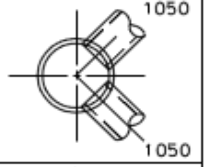
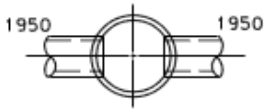
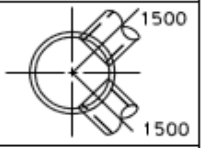
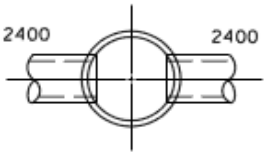
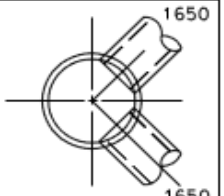
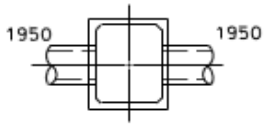
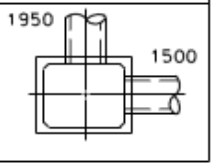


Figure 5.5 Maximum Pipe Sizes for Precast Maintenance Holes

MAINTENANCE HOLE INSIDE DIAMETER (mm)	MAX. PIPE SIZE FOR STRAIGHT THROUGH INSTALLATION (mm)	MAX. PIPE SIZE FOR RIGHT ANGLE INSTALLATION (mm)
1200		
1500		
1800		
2400		
3000		
3600		
3000 x 2400		

NOTES

1. ALL DIMENSIONS ARE FOR CONCRETE PIPE.
2. ALL DIMENSIONS ARE IN MILLIMETRES
3. KNOCKOUTS FOR SMALL DIAMETER CATCH BASINS LEAD SIZES 300mm OR LESS COULD BE PROVIDED IN ADDITION TO WHAT IS SHOWN.
4. INFORMATION TAKEN FROM THE ONTARIO CONCRETE PIPE ASSOCIATION (O.C.P.A.)

CITY OF LONDON

MAXIMUM PIPE SIZES FOR PRECAST MAINTENANCE HOLES

DWG	DATE	
FIG. 5.5	2002 12 17	

Figure 5.6 Head Losses in Maintenance Holes

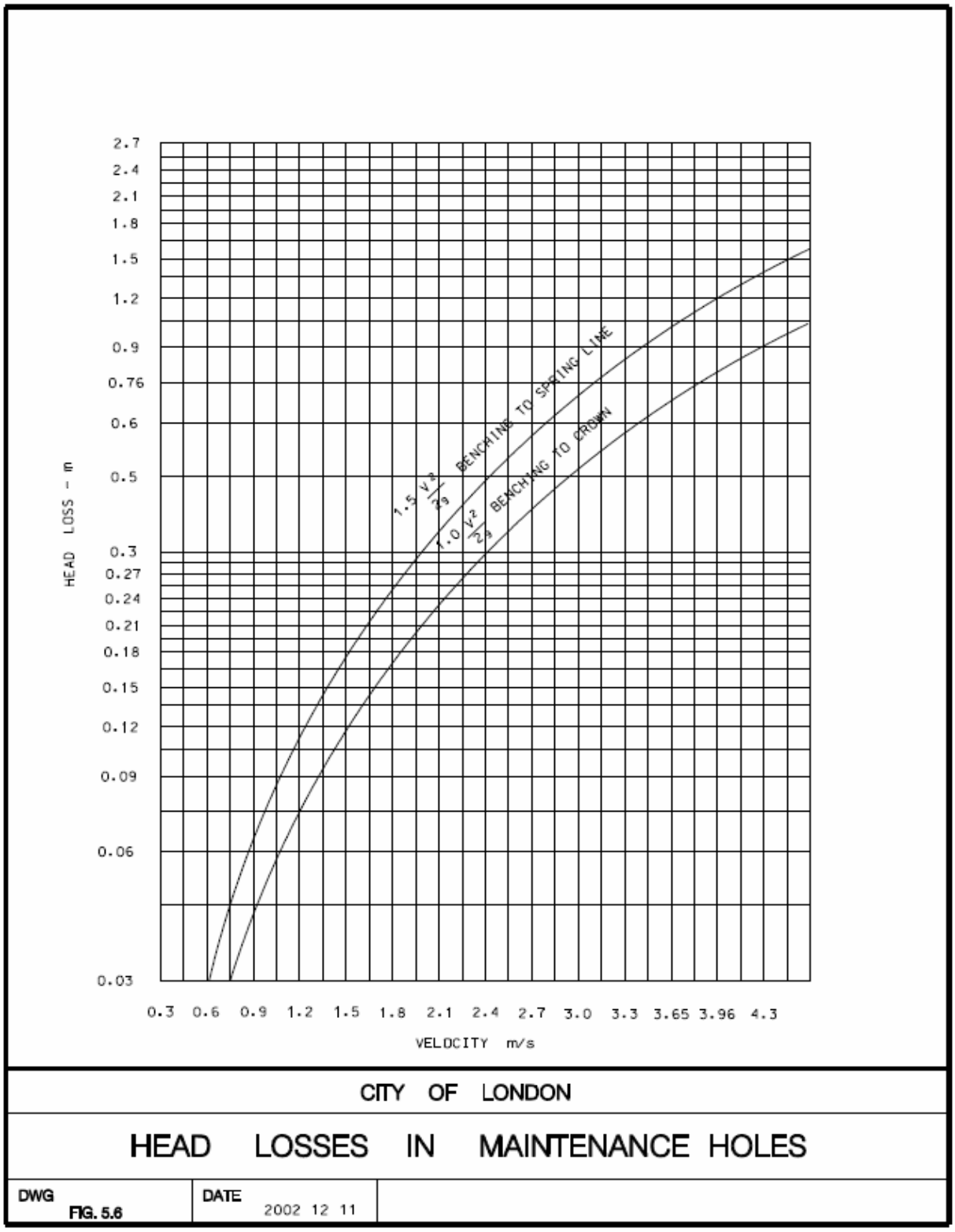


Figure 5.7 K_L Values for Calculating Head Losses in Curves Sewers

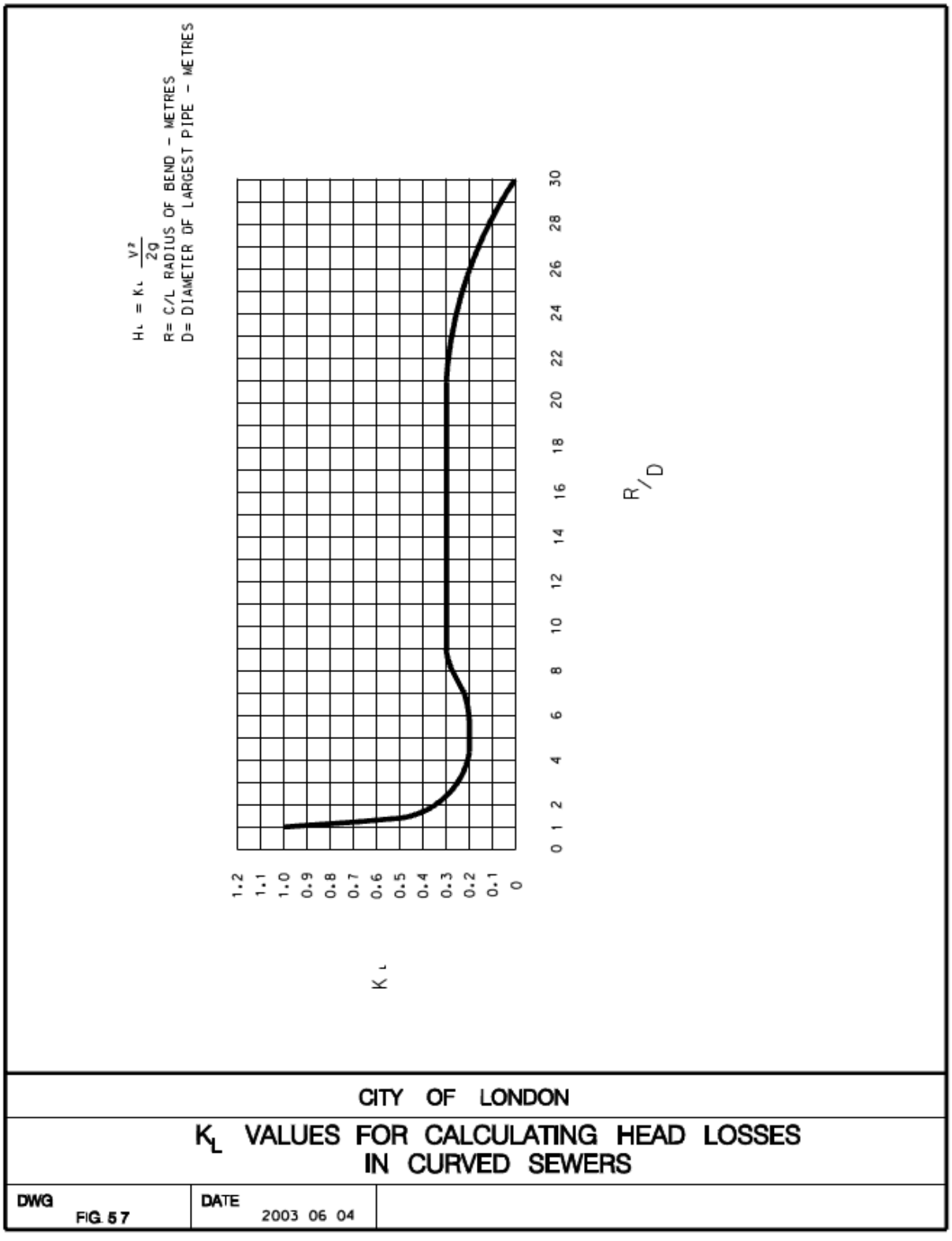


Figure 3.6 Minimum Easement Width

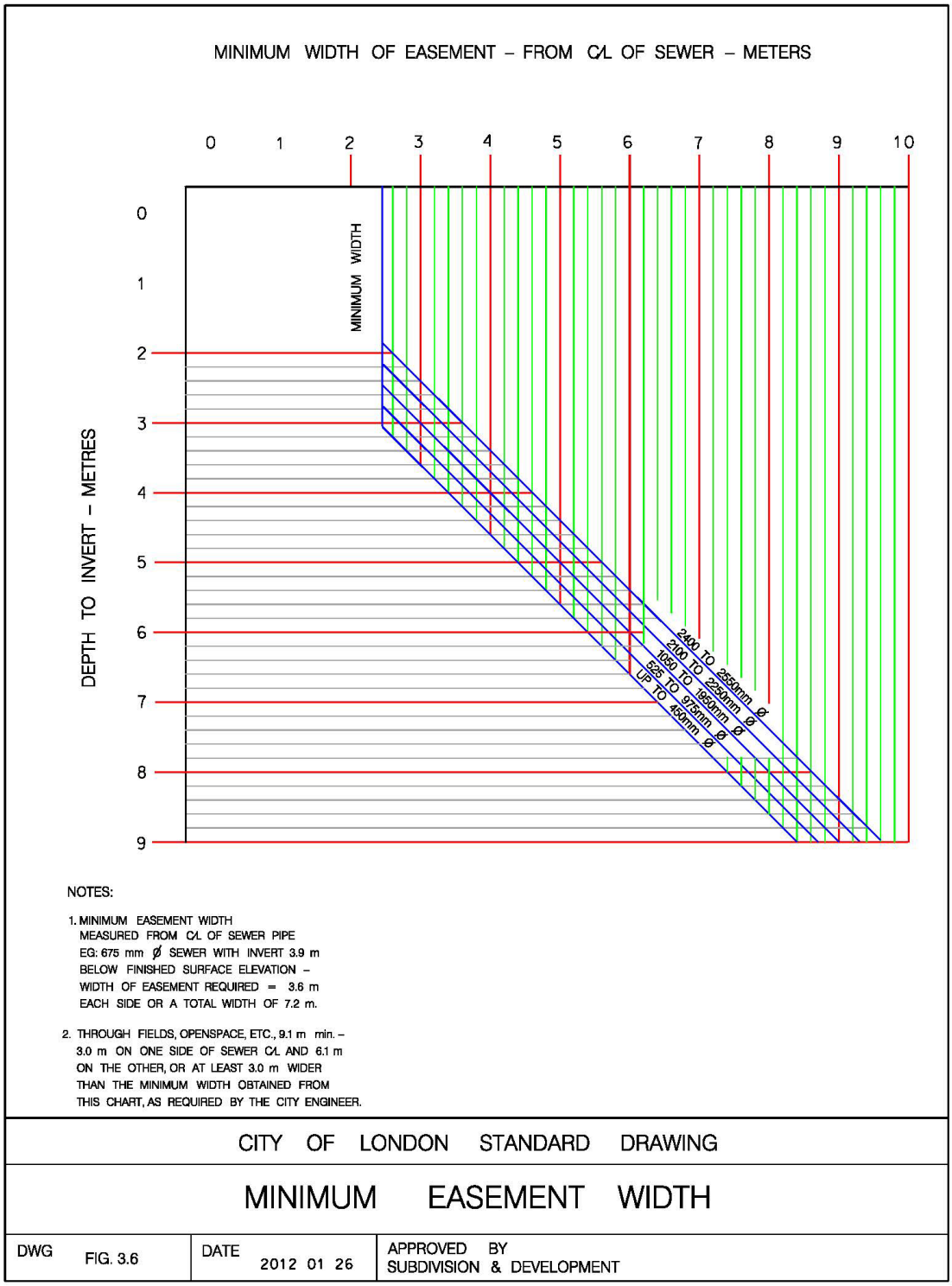


Figure 5.9 ABT Series 900 Mini Catch Basins

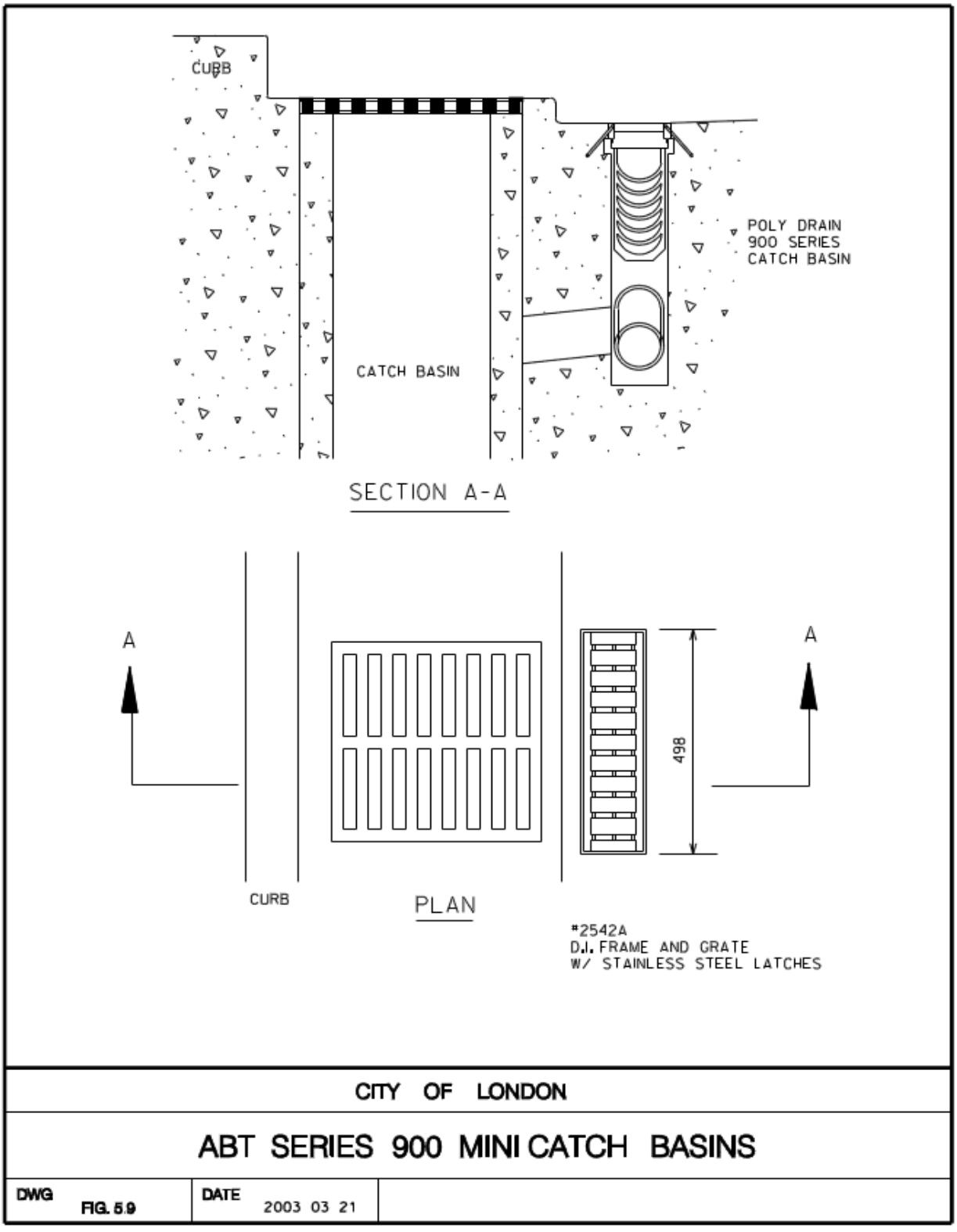


Figure 5.10 Sampling Maintenance Hole Sanitary & Storm Sewers