www.defra.gov.uk

Annex B

National Build Standards
Design and Construction of new gravity foul sewers and lateral drains
Water Industry Act 1991 Section 106B
Flood and Water Management Act 2010 Section 42

December 2011

Department for Environment
Food and Rural Affairs

This document/publication is also available on our website at:
www.defra.gov.uk/consult/2011/12/20/new-build-sewers-1112/

Any enquiries regarding this document/publication should be sent to us at:
Sewers Automatic Adoption Implementation Team
Area 2B
Ergon House
Horseferry Rd
London
SW1P 2AL

Tel: 020 7238 4847
email: Sewer.Adoption@defra.gsi.gov.uk

Contents

Introduction

This document contains the functional standards and guidance published by the Secretary of State together with industry recommendations for the design and construction of new gravity foul sewers and lateral drains.

1 - Scope

S1. The standards give requirements for the design and construction of gravity foul sewers and lateral drains constructed in accordance with any agreement under Section 104 of the Water Industry Act 1991 in those parts of England and Wales served by water companies who operate wholly or mainly in England. They are published in accordance with Section 106B (Requirement to enter into an agreement before construction) of the Water Industry Act 1991 as amended by the Flood and Water Management Act 2010.

G.1.1. Standards are contained within the grey boxes, prefixed with the letter S and corresponding number.

G.1.2. Guidance to the standards is contained in the text beneath the standards.

G.1.3. Surface water sewer systems are outside the scope of these standards and should be constructed in accordance with the requirements of the adopting authority.

G.1.4 The standards apply to sewers intended for adoption as part of the public sewerage system under Section 104 of the Water Industry Act only.

R.1. The Secretary of State's standards given in the grey boxes (clauses prefixed by the letter S) are mandatory.

R.2. The Secretary of State's guidance is given in the clear boxes and has clause numbers prefixed with the letter G.

R.3. The industry recommendations are given below the boxes in each section and have clause numbers prefixed with the letter R. These recommendations are not mandatory but compliance with these recommendations will normally be considered by sewerage undertakers as compliance with the requirements of the standards and guidance published by the Secretary of State. Other solutions may also be used if they also satisfy the requirements of the Secretary of State's standards and guidance.

2 – Definitions

S2. In these standards –

'access point' means provision to access a sewer or drain for maintenance or inspection and includes any manhole, inspection chamber, or rodding eye.

'drain' means a pipeline, usually underground, designed to carry foul sewage from buildings within the same curtilage;

'sewer' means a pipeline, usually underground, designed to carry foul sewage from buildings

in more than one curtilage;

'lateral drain' means that part of a drain which is outside the curtilage of the property it serves;

'curtilage' means area of land around a building or group of buildings which is for the private use of the occupants of the buildings.

G.2.1. Detached, semi detached and terraced houses should each be considered as a separate curtilage for the purpose of these standards.

G.2.2. Where a building contains a number of flats, the whole block of flats should be considered to be a single curtilage for the purpose of these standards.

R.1. Separate commercial properties sited on land privately owned by a single body (e.g. a shopping centre, airport terminal, retail park etc.) will be considered as a single curtilage if the commercial properties share the site access and facilities.

3 - Separate systems

S3. Separate systems shall be provided for foul sewage and surface water.

G.3.1. Where foul and surface water sewer systems from the same area are to be connected to an existing combined sewer, the two systems may only be connected together immediately prior to the connection to the existing public combined sewer.

R.1. Watercourses or land drainage are not permitted to be directly or indirectly connected to the sewer system. Satisfactory and separate arrangements should be agreed with the Local Land Drainage Authority and confirmed with the Undertaker.

R.2. These standards do not apply to surface water sewers and drains.

4 - Layout and Access

S4. Sewers and lateral drains shall be located so that if

a) there is a structural failure of the drain, sewer; or,
b) excavation is carried out to repair the drain, sewer;

the integrity of adjacent buildings or other infrastructure is not impaired.

S5. Access points, and any inlets to drains or sewers shall be located so as to minimise the risk of damage to buildings or other infrastructure in the event of sewer flooding.

S6. The sewer system shall be designed and constructed in order to provide access for any reasonably foreseeable maintenance activities.

S7. Access points shall be located so that they are accessible and apparent to the sewerage undertaker at all times for use.

4.1 Layout

G.4.1.1. Sewers or lateral drains with a diameter of 150mm or less and laid to a depth less than 150mm above the foundation level should not be located closer to any building/structure than 100mm. For larger pipes, or where the depth of pipe exceeds that of the building foundations, the distance between pipe and building/structure should not be less than the minimum of the depth of the crown of the adoptable pipe below the foundations or 1.2m, whichever is the greater.

G.4.1.2. Foul sewers and lateral drains should not be constructed under any building/structure.

G.4.1.3. Limiting flood risk can have an impact on the layout of a development and therefore impact on the layout of drains and sewers.

G.4.1.4. Sewers and lateral drains, where practicable, should be laid in highways or public open space or a space where they are reasonable accessibility and visible. Sewers should not be laid in enclosed private land.

G.4.1.5. Sewers should be laid in straight lines both vertical and horizontal in alignment.

R.1. Minimum depths of cover to the crown of gravity pipes without protection should be as follows:

a) Domestic gardens and pathways without any possibility of vehicular access – 0.35 m.

b) Domestic driveways, parking areas and yards with height restrictions to prevent entry by vehicles with a gross vehicle weight in excess of 7.5 tonnes – 0.5 m.

c) Domestic driveways, parking areas and narrow streets without footways (e.g. mews developments) with limited access for vehicles with a gross vehicle weight in excess of 7.5 tonnes - 0.9 m.

d) Agricultural land and public open space - 0.9 m.

e) Other highways and parking areas with unrestricted access to vehicles with a gross vehicle weight in excess of 7.5 tonnes - 1.2 m.

R.2. Design of the adoptable pipelines should take account of loading from the passage of construction plant as well as normal design loading.

R.3. As far as practicable, sewers and lateral drains should be laid in highways or public open space. Where this is not practicable sewers and lateral drains with a nominal diameter of 150 mm or less may be laid:

a) In shared rear yards/parking areas or other shared areas to which all the properties served by the sewers have right of access; or where this is not reasonably practicable,

b) Where the lateral drain or sewer serves 10 properties or less, in unfenced gardens; or where this is not reasonably practicable,

c) In fenced private areas provided that the lateral drain or sewer is kept as far as is practicable from any point on a building where a future extension is likely.

R.4 Access points on sewers and lateral drains should not be laid in enclosed private land. Where this is not practicable access points of sewers and lateral drains may be laid:

a) in shared rear yards/parking areas provided there is free access at all times;

b) in enclosed shared private areas provided that all those properties served by the sewers have right of access to the area at all times. Access control systems should include provision for access by the sewerage undertaker; or

c) where the drain or sewer serves 10 properties or less, in unfenced gardens.

R.5. New sewers or lateral drains should not be located closer to any building/structure than the greater of the depth of the sewer below the foundation or 1.2 m; except that a sewer or lateral drain with a nominal diameter of 150 mm or less, with an invert level at least 150 mm above the base of the foundation and no more than 1.1 m deep, should be no less than 100 mm from the foundations (see Figure 1).

R.6. Where it is not possible to comply with clause 4.1.R.4 above because another building/structure is in such close proximity that there are no permitted locations, new sewers or lateral drains may be located between buildings/structures provided that:

a) there is at least 900 mm separating the buildings/structures;

b) the depth of the invert of the sewer or lateral drain below the ground level is no greater than the distance between the buildings/structures;

c) the sewers or lateral drains have a nominal diameter of 150 mm or less;

d) the sewers or lateral drains have an invert level at least 150 mm above the base of the foundations;

e) there is at least 350 mm cover above the pipe; and

f) there is at least 100 mm between the pipe wall and the foundations (see Figure 2).

R.7 For the purposes of paragraphs 4.1.R.5 & 4.1.R.6 the foundation level of the building/structure with piled foundations, should be the underside of the capping beam.

Note: In paragraphs 4.1.R.5 and 4.1.R.5 the recommendations are intended to allow sufficient working space for hand excavation in proximity to the building/structure if repair is necessary in the future.

R.8. Sewers and lateral drains may be laid through arches and other external openings through buildings/structures provided that they are laid as near to the centre of the opening as possible and:

a) for vehicular entries with a minimum width of 4.0 m and minimum height of arch above ground level of 2.1 m – the maximum nominal diameter of the pipe should be 225 mm with a maximum depth to invert of the pipe of 2.0 m and the invert should be at least 150 mm above the foundation level; and

b) for pedestrian access with a minimum width of 0.9 m and minimum height of 2.0 m – the maximum nominal diameter of the pipe should be 100 mm and should comply with 4.1.R.6.

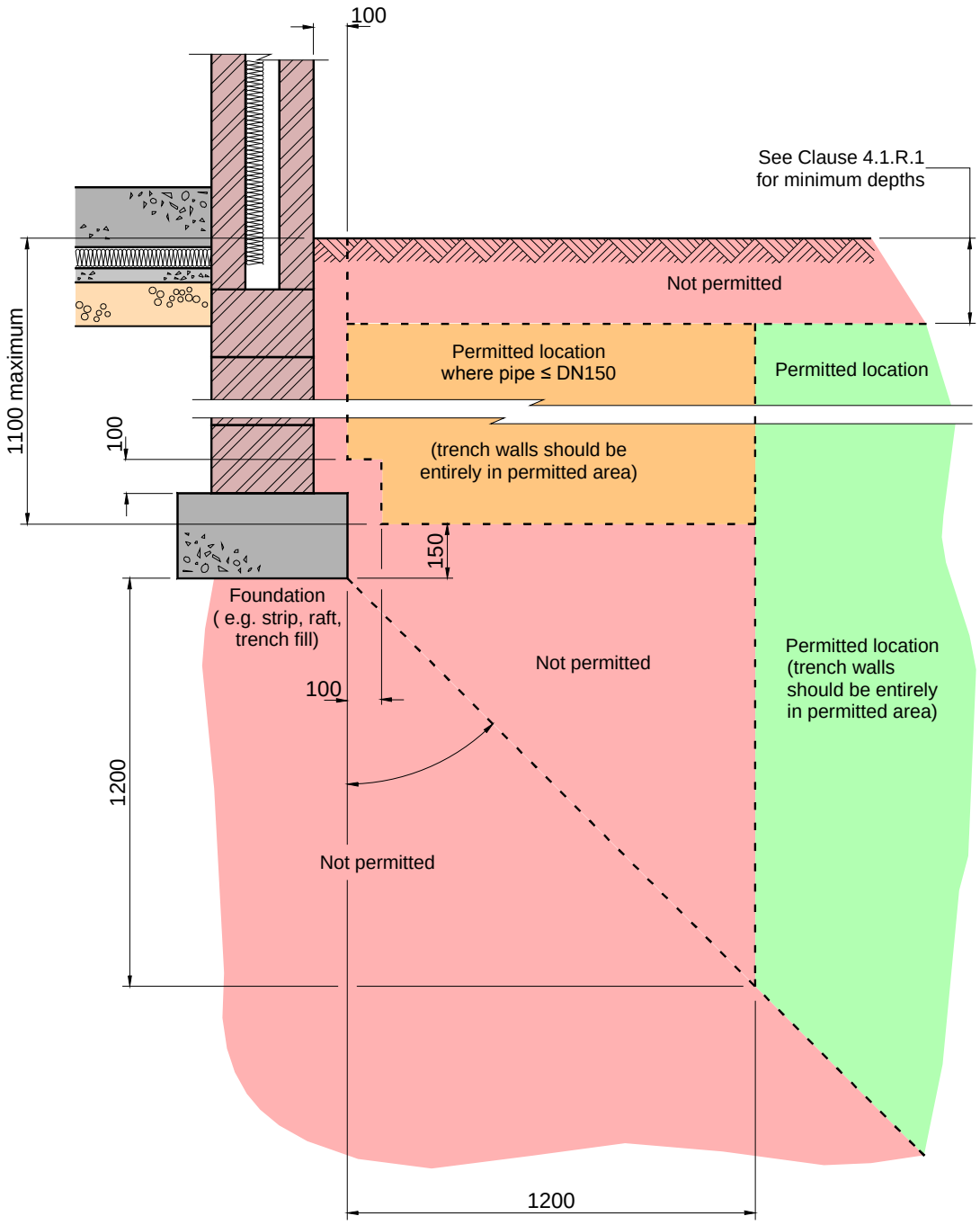
R.9 Sewers or lateral drain may pass through an opening in a boundary wall provided that there is an arch or lintelled opening to give at least 50mm space all around the pipe.

R.10. The design of landscaping should be coordinated with the design of the drains and sewers so that the impact of tree roots on sewers/drains can be considered. Where a sewer or lateral drain is to be laid in close proximity to proposed planting of trees/bushes/shrubs, they should not be located closer to trees/bushes/shrubs than the canopy width at mature height, except where special protection measures are provided in accordance with clause 7.R.4.

R.11. When in a highway, the outside of the sewer should be in the vehicle carriageway (not footway) and be at least 1.0 m from the kerb line. The outside of manholes should be at least 0.5 m from the kerb line.

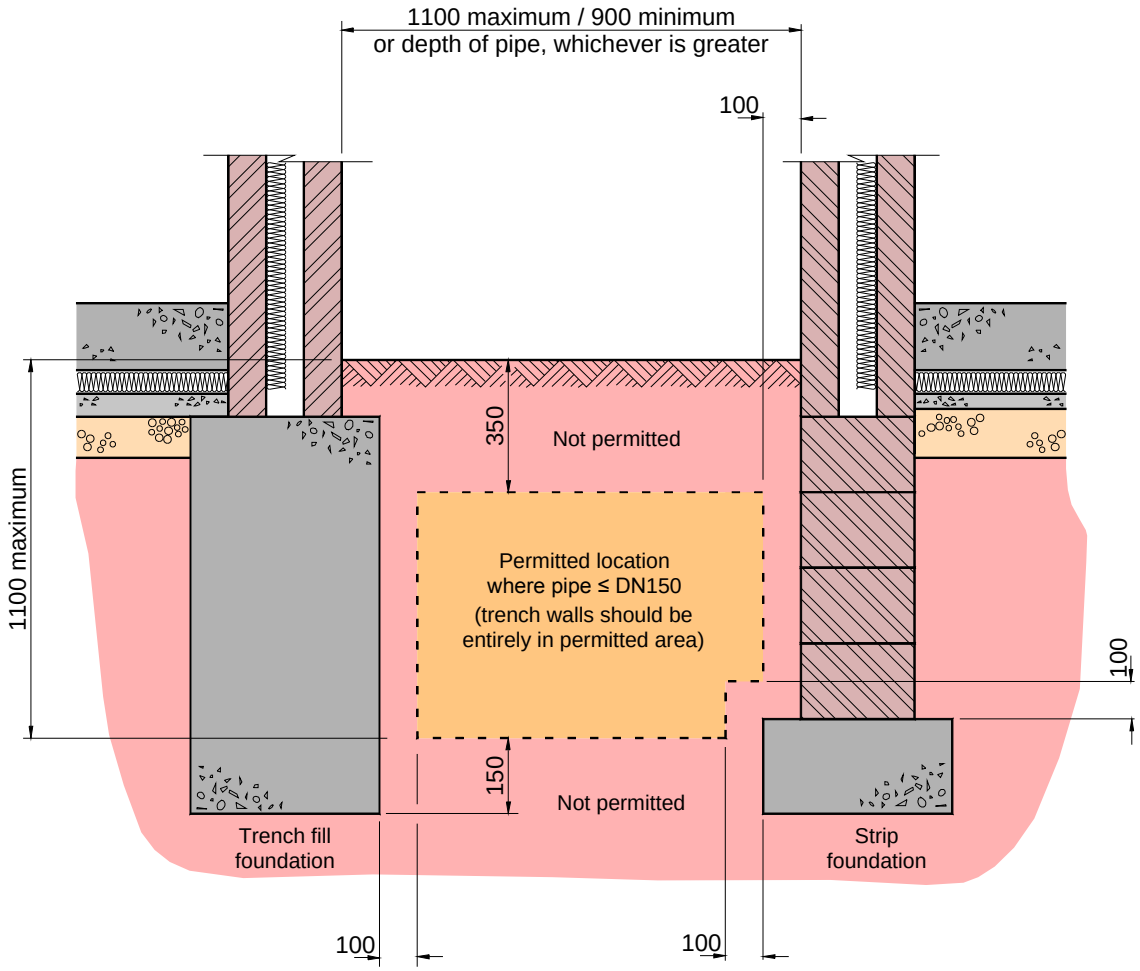
R.12. Where it is proposed to lay pipes with a nominal diameter greater than 900 mm agreement should be obtained from the owner of the land surface as to acceptable levels of predicted settlement, prior to the construction. The construction techniques should be selected to ensure that the maximum settlement is within the agreed limits.

FIGURE 1
PERMITTED LOCATION OF SEWERS AND LATERAL DRAINS IN PROXIMITY TO BUILDINGS



Not to scale, dimensions in millimetres

FIGURE 2
ADDITIONAL DETAIL - PERMITTED LOCATION OF SEWERS AND LATERAL DRAINS BETWEEN BUILDINGS (where Figure 1 is not applicable only)



Not to scale, dimensions in millimetres

4.2 Access

G.4.2.1. Access points should be sited to provide suitable access to all lateral drains and sewers for inspection and maintenance purposes.

G.4.2.2. Access points and sewers should be sited where reasonable access and visibility can be gained by the sewerage undertaker. They should avoid rear gardens or enclosed locations.

G.4.2.3. Where the adoptable sewer is within the property curtilage an access point may be constructed on the sewer at the point of connection to provide access to the individual property drains. Where property drains converge into a prior access point, and a single drain connects from this access point to the sewer, the connection to sewer may be by a saddle connection or other preformed junction.

G.4.2.4. Manholes should be provided as the means of access where;

a) the depth from the surface to the crown of the pipe is greater than 3 m,

b) there are two or more upstream pipes each serving more than 10 properties, or

c) the distance between manholes is greater than 150 m.

G.4.2.5. Manholes should be designed for safe access and egress. The minimum clear opening into any manhole should be 600 mm x 600 mm.

G.4.2.6. Inspection chambers should be designed to afford reasonable access for equipment to carry out maintenance activities. Inspection chambers should be designed to deter personnel access.

R.1. Manholes should not be further apart than 150 m. Inspection chambers should be no further than 45 m from the adjacent chamber. Access points and sewers should be sited with due regard to public utility services. An access point should be built:

a) at every change of alignment, gradient or pipe material;

b) at the head of all sewers;

c) at every junction of two or more public sewers;

d) wherever there is a change in the size of the sewer; and

e) at every junction of a public sewer with another sewer serving 3 or more properties (more than 10 properties for a manhole);

f) at or within 1 metre of the property boundary at the upstream end of each lateral drain (preferably inside the property boundary).

R.2. Four types of access point may be used (see Table 1). These are identified in the flow diagram in Figure 3, which, used in conjunction with the access structure standard details and the recommended layouts, will ensure that the sewerage system meets the required safety, operational and sustainability standards. Each junction, change of direction, change of status, or after a continuous sewer length greater than 150 m, is described here as a node. No access is required at a node if it connects less than 3 properties and there already is, or will be, sufficient access to carry out sewer maintenance.

R.3. Any pipe and associated access upstream of the point of demarcation is a private drain and should be constructed in accordance with the Building Regulations.

R.4. Figures 4 to 9 show typical details of manholes with depths from cover level to soffit of pipe not exceeding 6 m, including backdrops. No significant departure from these should be made without approval by the Undertaker.

R.5. In exceptional cases, where access is required at a greater depth than 6 m, the details should be agreed in advance with the Undertaker.

R.6. Manhole diameters (Type 1 and 2 only) should be in accordance with Table 2.

Table 1 Access types

Access Type	Application
Type 1	Man entry, depth 3-6 m
Type 2	Man entry, depth <3 m
Type 3	Non-entry, depth <3 m
Type 4	Non-entry, depth <2 m

Table 2 Manhole diameters

Nominal diameter of largest pipe in manhole (mm)	Minimum nominal internal dimension of manhole (mm)
Less than 375	1200
375 – 450	1350
500 – 700	1500
750 – 900	1800
Greater than 900	Pipe diameter + 900

R.7. The height of a Type 1 manhole (benching to slab soffit) should normally be in excess of 2000 mm. When this is impracticable, Type 2 manholes are preferred, subject to an absolute minimum height (benching to slab soffit) of 900 mm.

R.8. The internal dimensions quoted above are considered to be the minimum. Where two or more pipes enter the manhole, the internal dimensions should be increased where necessary to accommodate the minimum width of benching. Pipes of different diameters entering manholes should be installed with soffits at the same level.

R.9. The dimensions of Type 3 and 4 access points should be as shown in the relevant figure, see Figures 10 to 17.

R.10. The design of special manholes and other structures should be agreed with the Undertaker.

R.11. 'In-fill' type covers should not be used. Where a cover is located in an area of block paving the bottom of the frame should be 150 mm deep.

R.12. Manhole covers and frames should be accordance with clause E.2.32 of the Civil Engineering Specification for the Water Industry, 7th Edition, March 2011[1]

[1] "Civil Engineering Specification for the Water Industry", 7th Edition, March 2011; UKWIR Ltd, ISBN 978 1898920 687

R.13. Frames for manhole covers should be bedded in a polyester resin bedding mortar in all situations where covers are sited in trunk roads and dual carriageways, any other highly trafficked roads or a road used for bus services,

R.14 In situations where traffic loading is anticipated to be heavier than would occur on a typical residential estate distributor road (ie braking or turning near a junction), a cover with a higher specification than the standard BS EN 124 D400[2] cover should be used.

R.15. Unless the chamber is designed to withstand the vertical load acting on it, a precast concrete slab or in-situ concrete slab, acting as a collar to support the cover and frame, is required. The collar should be separate from the chamber to ensure the loading from the cover and frame is not transferred to the chamber.

R.16. The first manhole upstream from the connection to the (existing) public sewer should, when constructed, be fitted with a screen in order to prevent debris entering the public sewer. The screen should not be removed until immediately prior to the occupation of premises to be served by the sewer.

R.17. Rocker pipes should be provided at entry to, and exits from, manholes when rigid pipes are used. Their length should be as shown in Table 3.

Table 3

Nominal diameter (mm)	Effective length (m)
150 to 600	0.6
over 600 to 750	1.0
over 750	1.25

R.18. Where pipes serving a total of three properties or less connect on a pipe no greater than 150mm, connecting pipes should be set with soffits level. In all other cases branch connections should be set with soffit levels no lower than that of the main pipe. The invert levels of all connecting pipes should be a minimum of 50 mm above that of the main pipe.

R.19. The main channel should extend the whole length of the chamber, comprising a half-round section plus vertical benching from the top edge of the half round section to a height of not less than that of the soffit of the outlet where it should be rounded off and sloped upwards to meet the wall of the chamber.

R.20. Steeper gradients are preferred to the use of backdrops. Where steeper gradients are impractical, backdrops should be constructed as shown in Figure 9. Ramped backdrops should be used for manholes rather than vertical backdrops.

R.21. Where step rungs and ladders are to be used, the distance from the top rung to the surface should be a maximum of 675 mm with a minimum of 2 courses of brickwork. Where ladders are to be used, they should be positioned relative to the access so that the minimum clear opening is not obstructed.

R.22. Type 4 access chambers should allow for a minimum vertical radius of 350 mm for the entry of rods, jetting equipment or CCTV inspection equipment into the pipe (see Figures 15 & 16).

[2] "BS EN 124. Gully tops and manhole tops for vehicular and pedestrian areas - Design requirements, type testing, marking, quality control", July 2004: British Standards Institution, London

FIGURE 3
ACCESS TYPE SELECTION

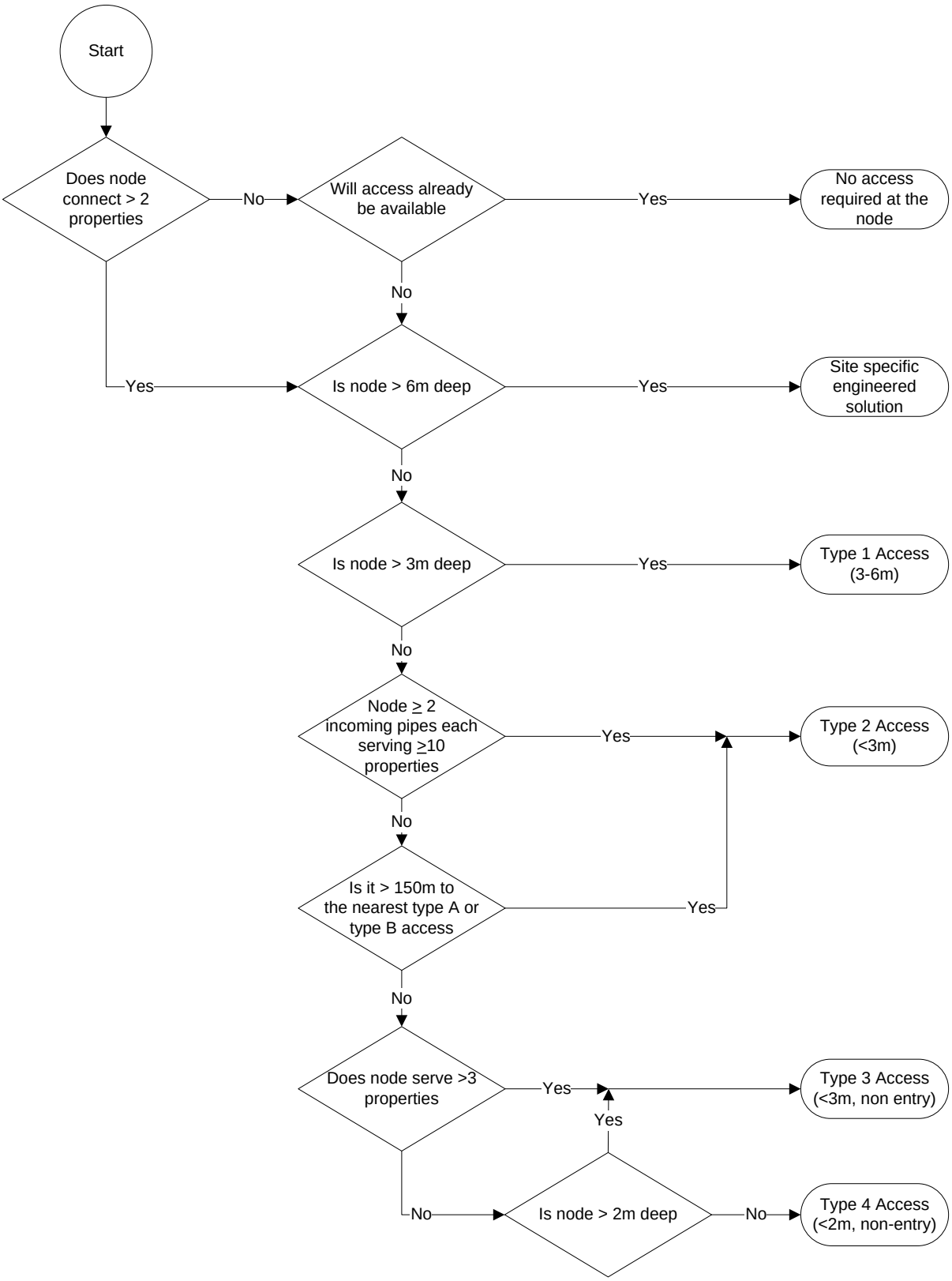
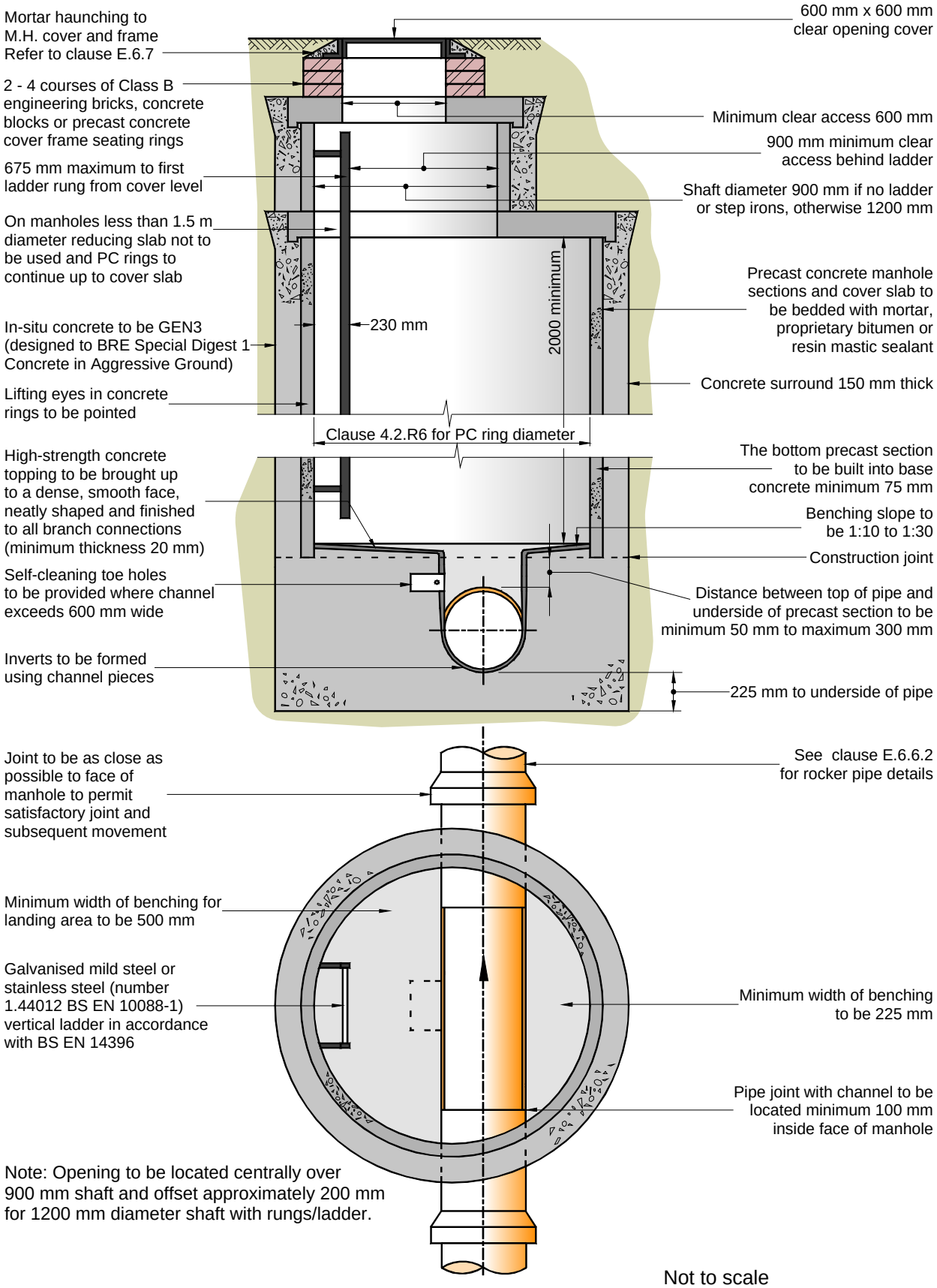


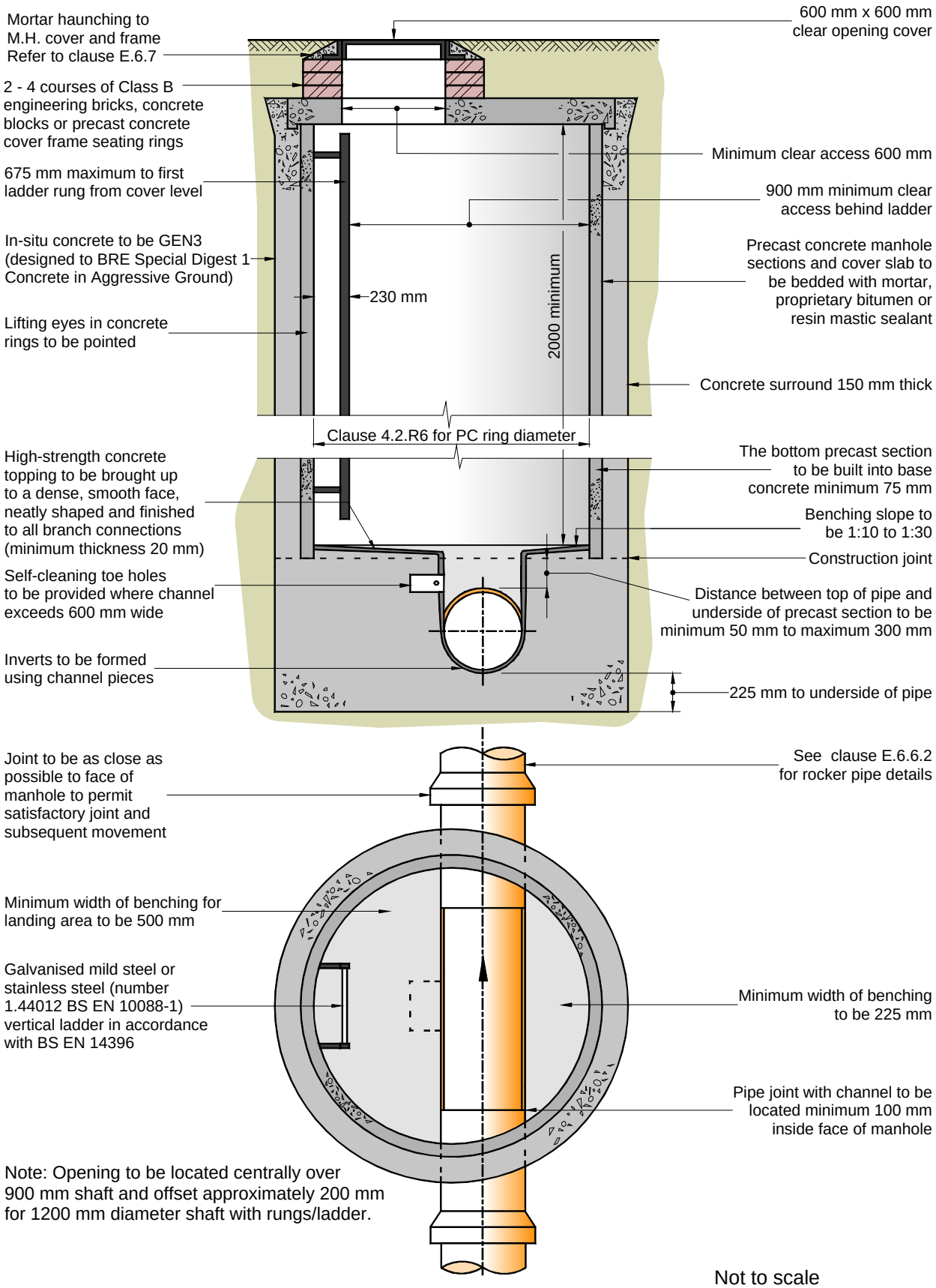
FIGURE 4
TYPICAL MANHOLE DETAIL - TYPE 1A
Depth from cover level to soffit of pipe 3 m to 6 m



Note: Opening to be located centrally over 900 mm shaft and offset approximately 200 mm for 1200 mm diameter shaft with rungs/ladder.

Not to scale

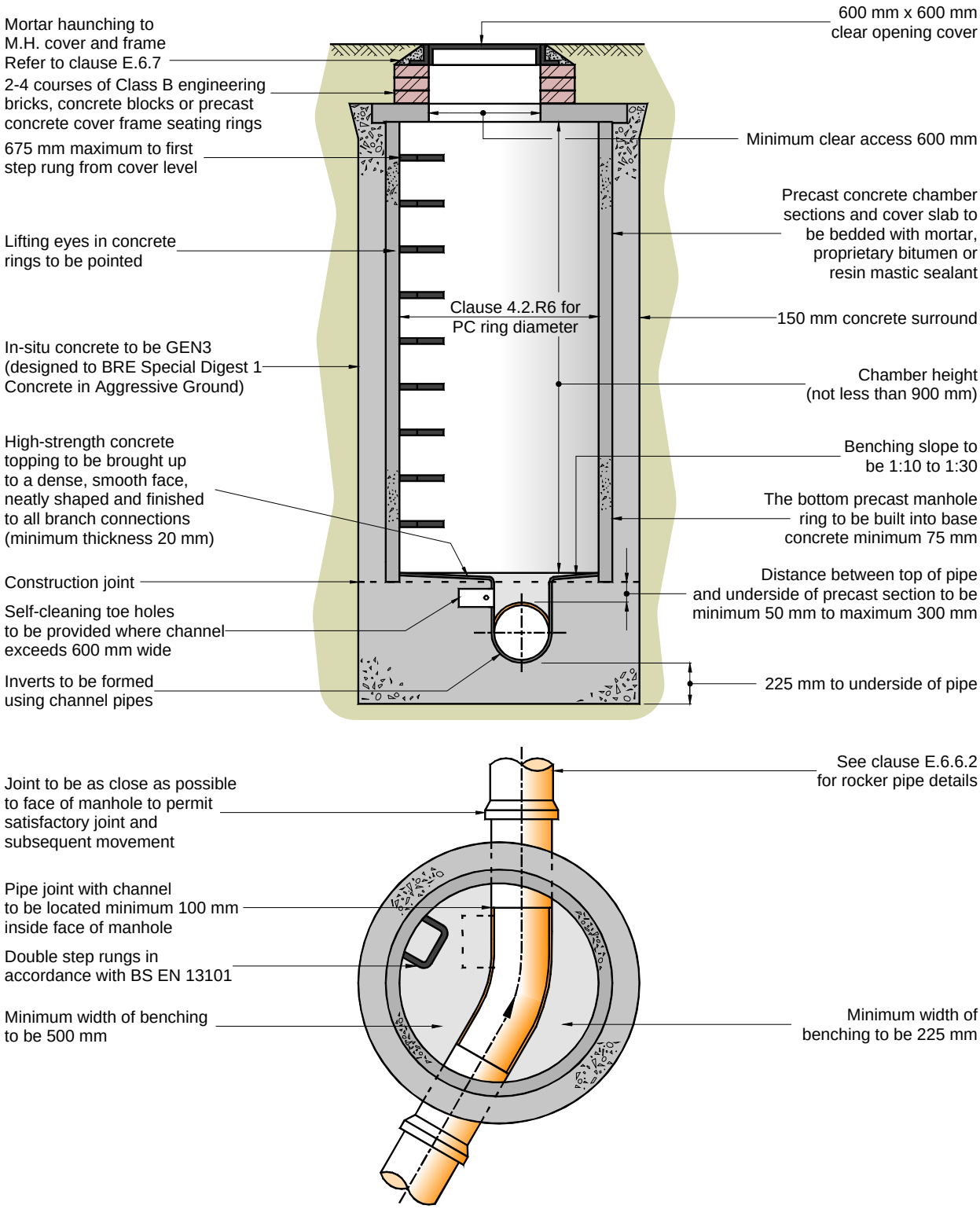
FIGURE 5
TYPICAL MANHOLE DETAIL - TYPE 1B
Depth from cover level to soffit of pipe 3 m to 6 m



Note: Opening to be located centrally over 900 mm shaft and offset approximately 200 mm for 1200 mm diameter shaft with rungs/ladder.

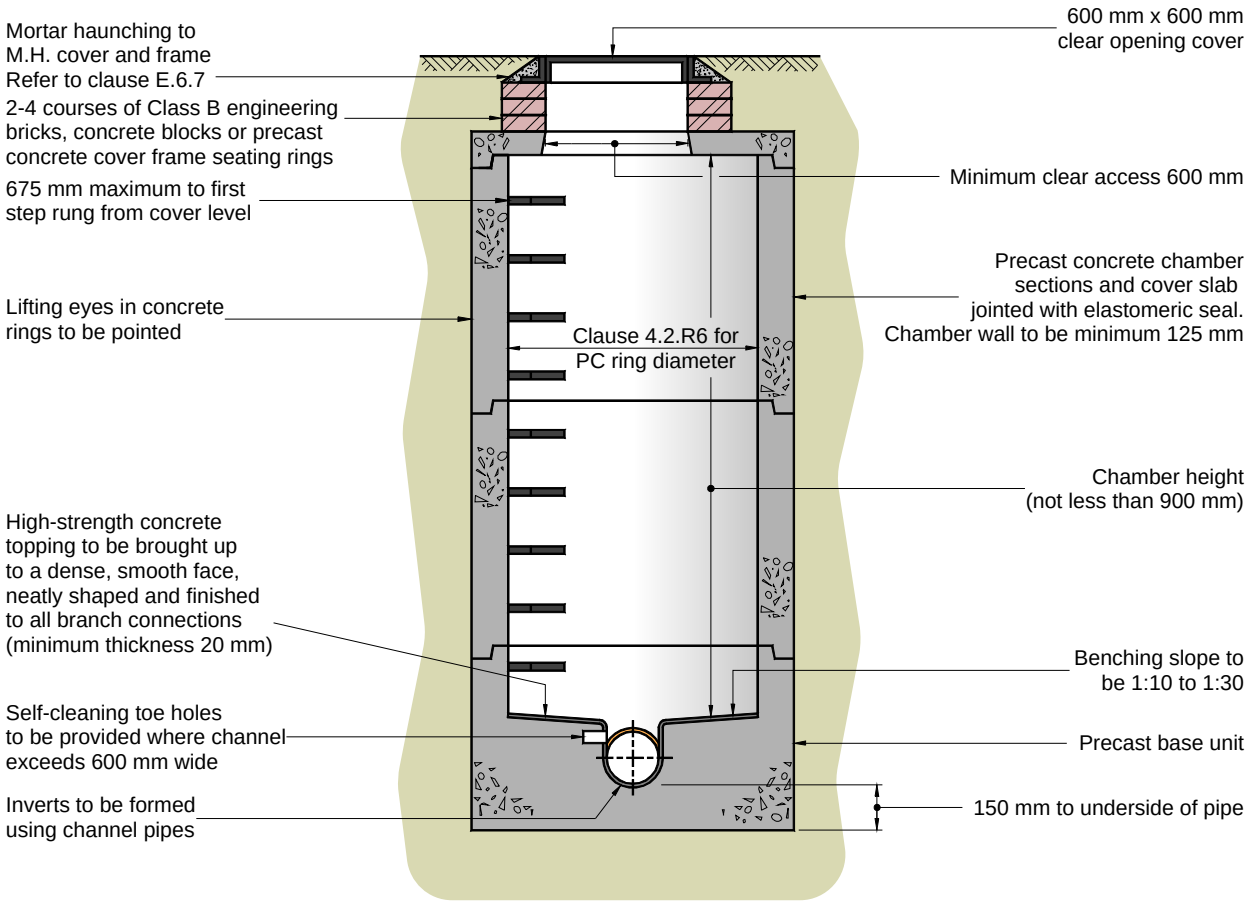
Not to scale

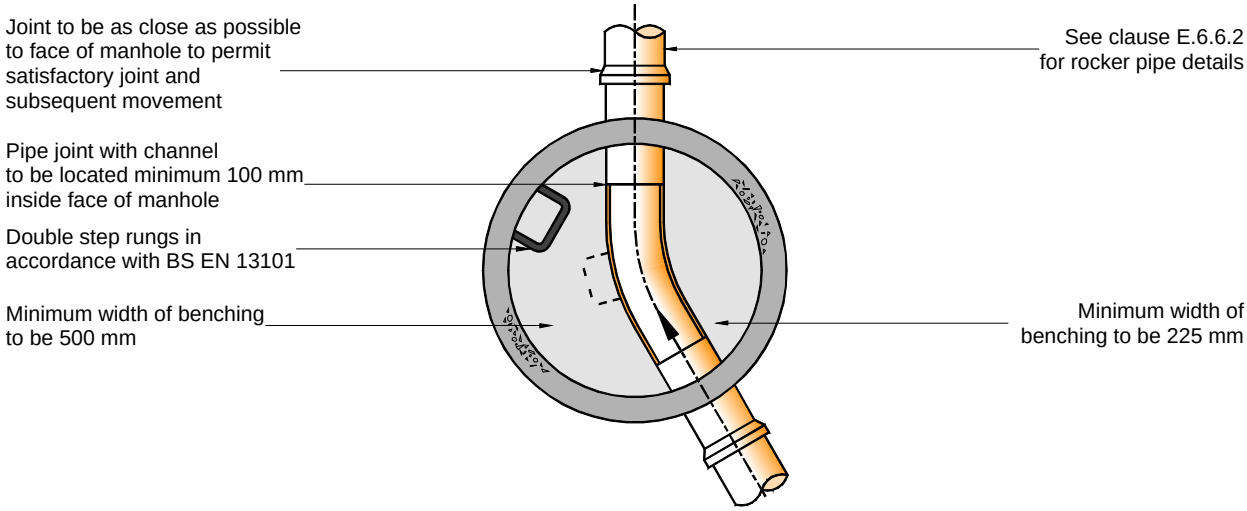
FIGURE 6
TYPICAL MANHOLE DETAIL - TYPE 2
Maximum depth from cover level to soffit of pipe 3.0 m



Not to scale

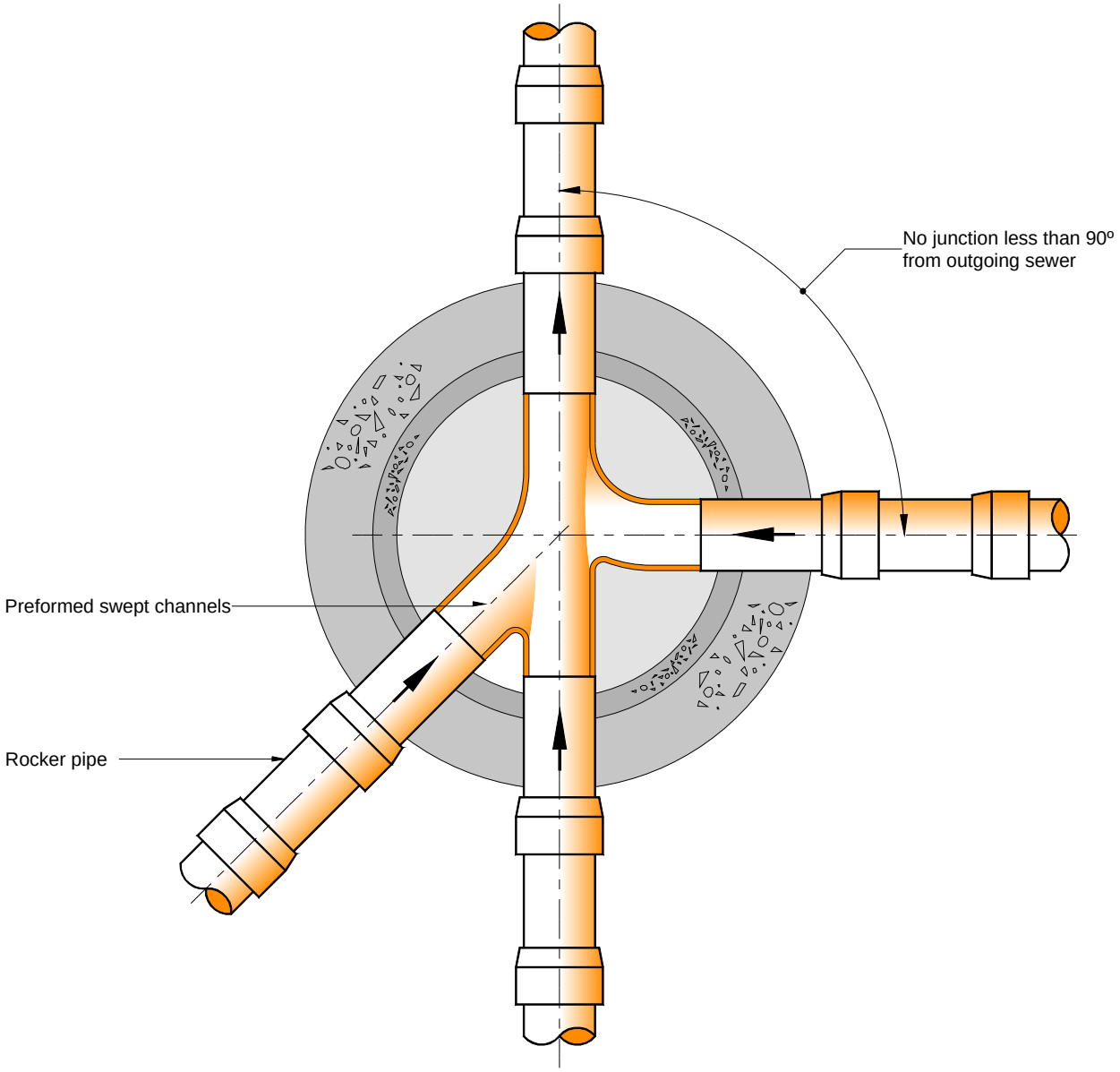
FIGURE 7
TYPICAL MANHOLE DETAIL - TYPE 2 (Alternative construction detail)
Maximum depth from cover level to soffit of pipe 3.0 m





Not to scale

FIGURE 8
TYPICAL ARRANGEMENT OF PIPE JUNCTIONS WITHIN MANHOLES



Sectional Plan

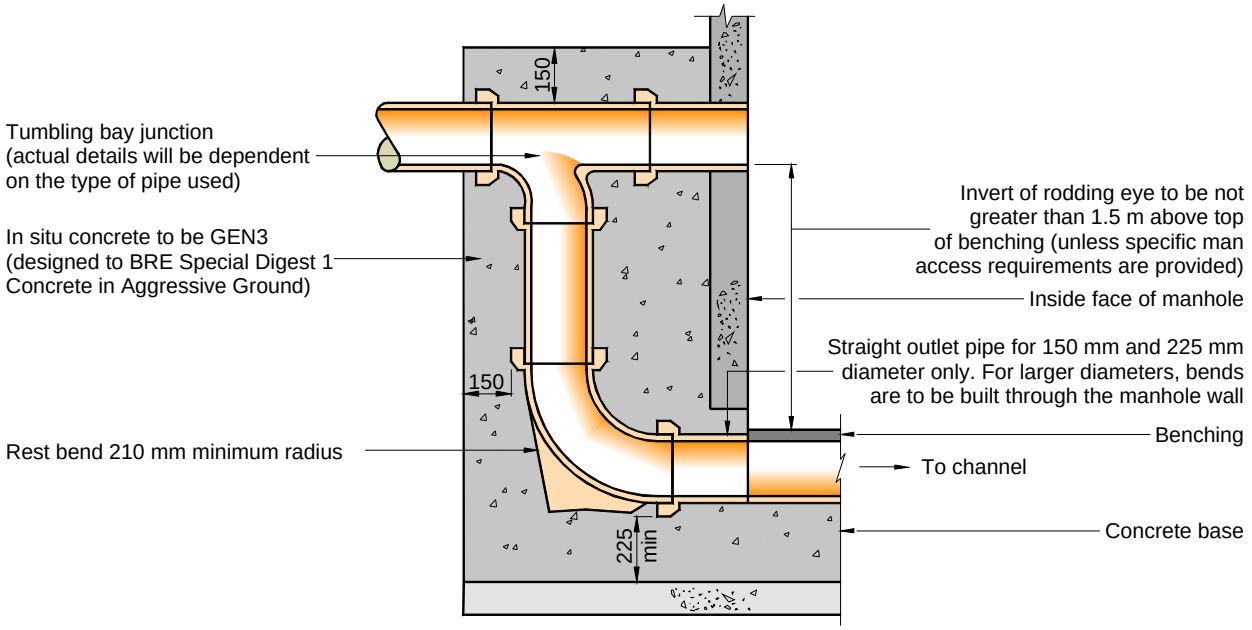
Pipes built into manhole should have a flexible joint as close as feasible to the external face of the structure and the length of the next rocker pipe should be as shown.

Nominal diameter (mm)	Effective length (m)
150 - 600	0.6
601 - 750	1.00
over 750	1.25

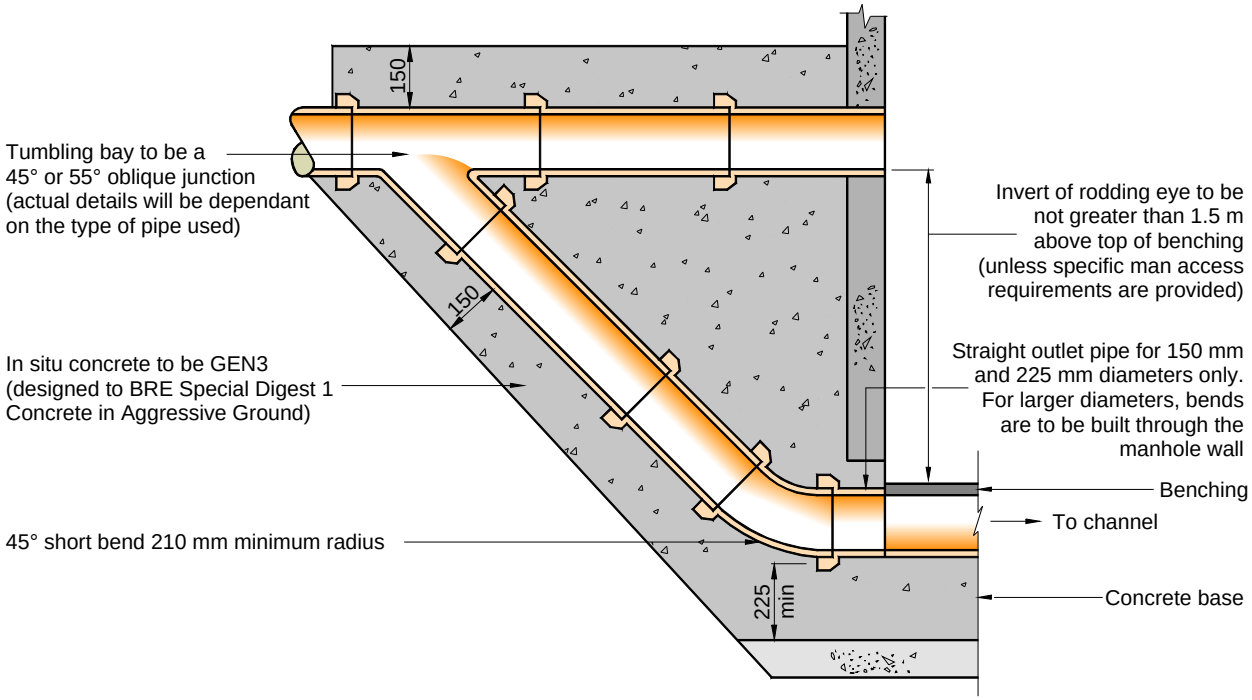
All pipes entering the bottom of the manhole to have soffits level.

FIGURE 9
TYPICAL VERTICAL AND RAMPED BACKDROP DETAIL

Note: Steeper gradients are preferred to the use of backdrops.
Type of backdrop to be used to be agreed with Undertaker.



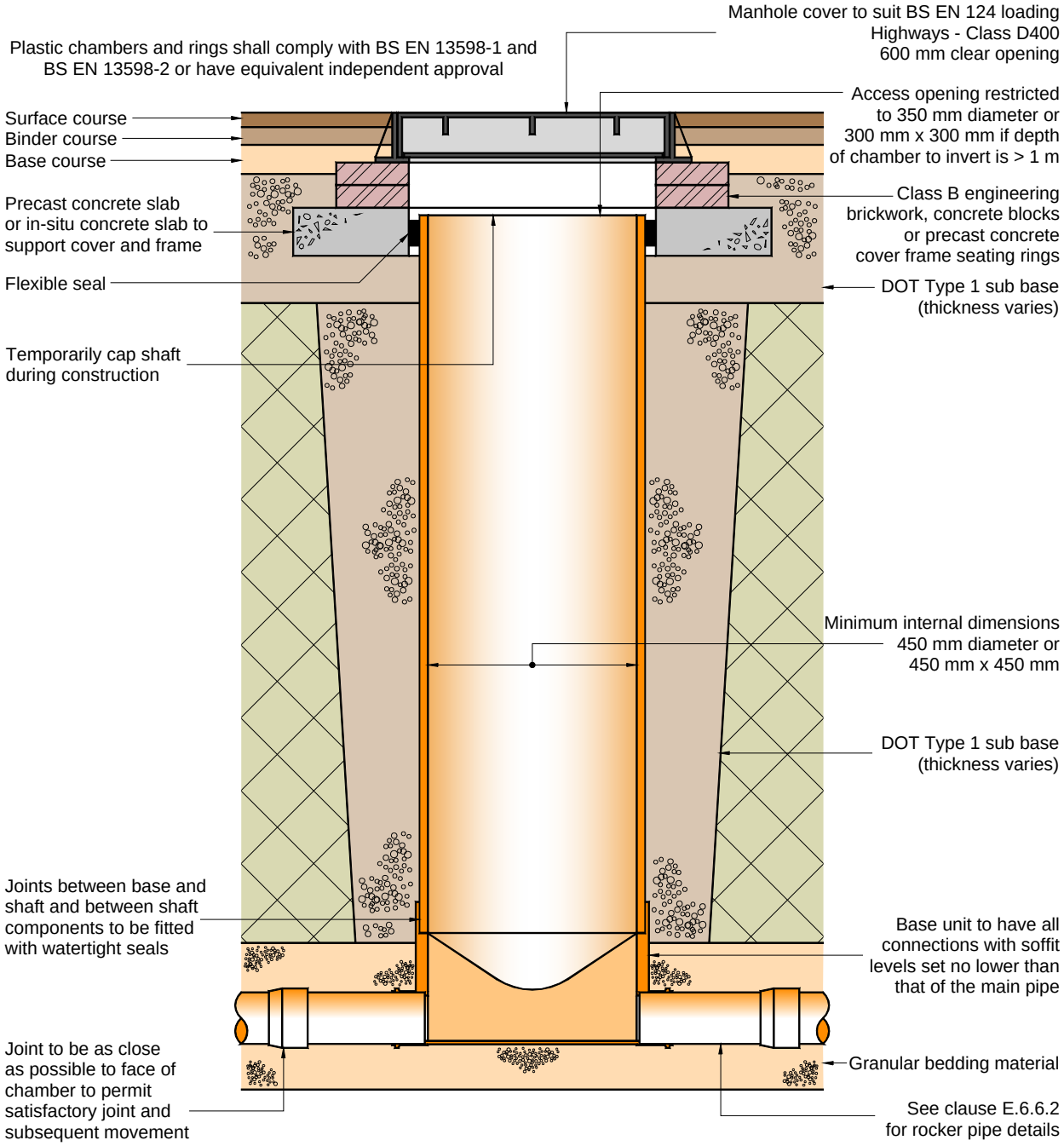
External Vertical Backdrop



External Ramped Backdrop

Not to scale, dimensions in millimetres

FIGURE 10
TYPICAL ACCESS CHAMBER DETAIL - TYPE 3 (Flexible material detail)
Maximum depth from cover level to soffit of pipe
in areas subject to vehicle loading 3 m, non entry

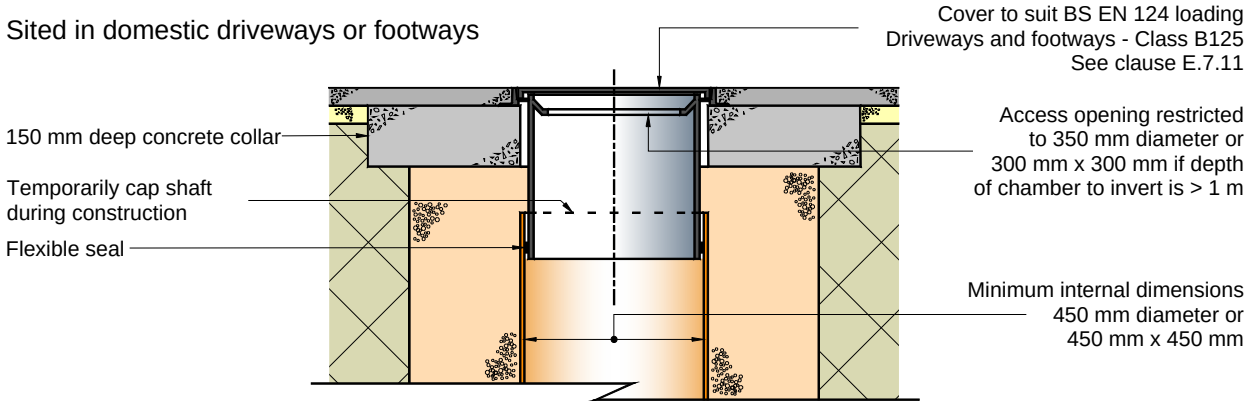


Not to scale

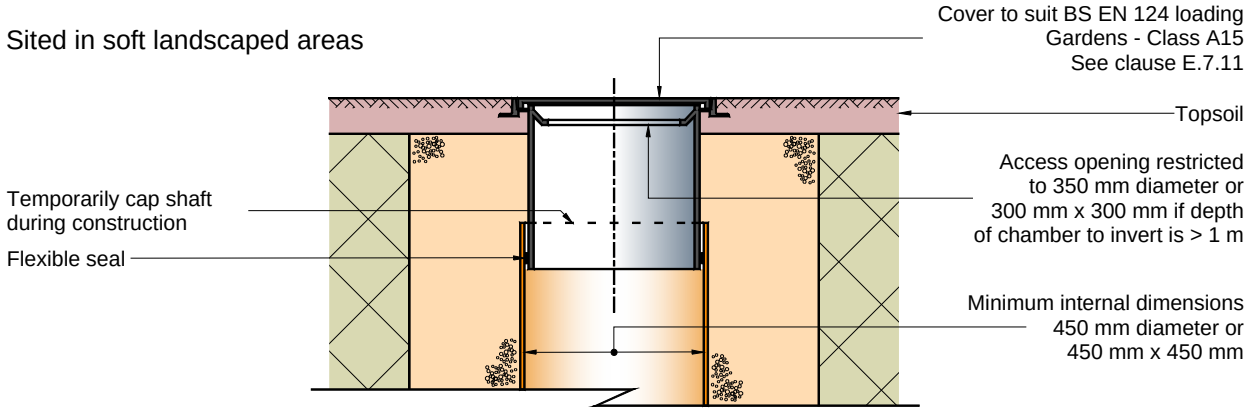
FIGURE 11
ALTERNATIVE TOP DETAILS FOR LIGHT VEHICLE LOADING AND LANDSCAPED AREAS - TYPE 3

Plastic chambers and rings shall comply with BS EN 13598-1 and BS EN 13598-2 or have equivalent independent approval

Sited in domestic driveways or footways

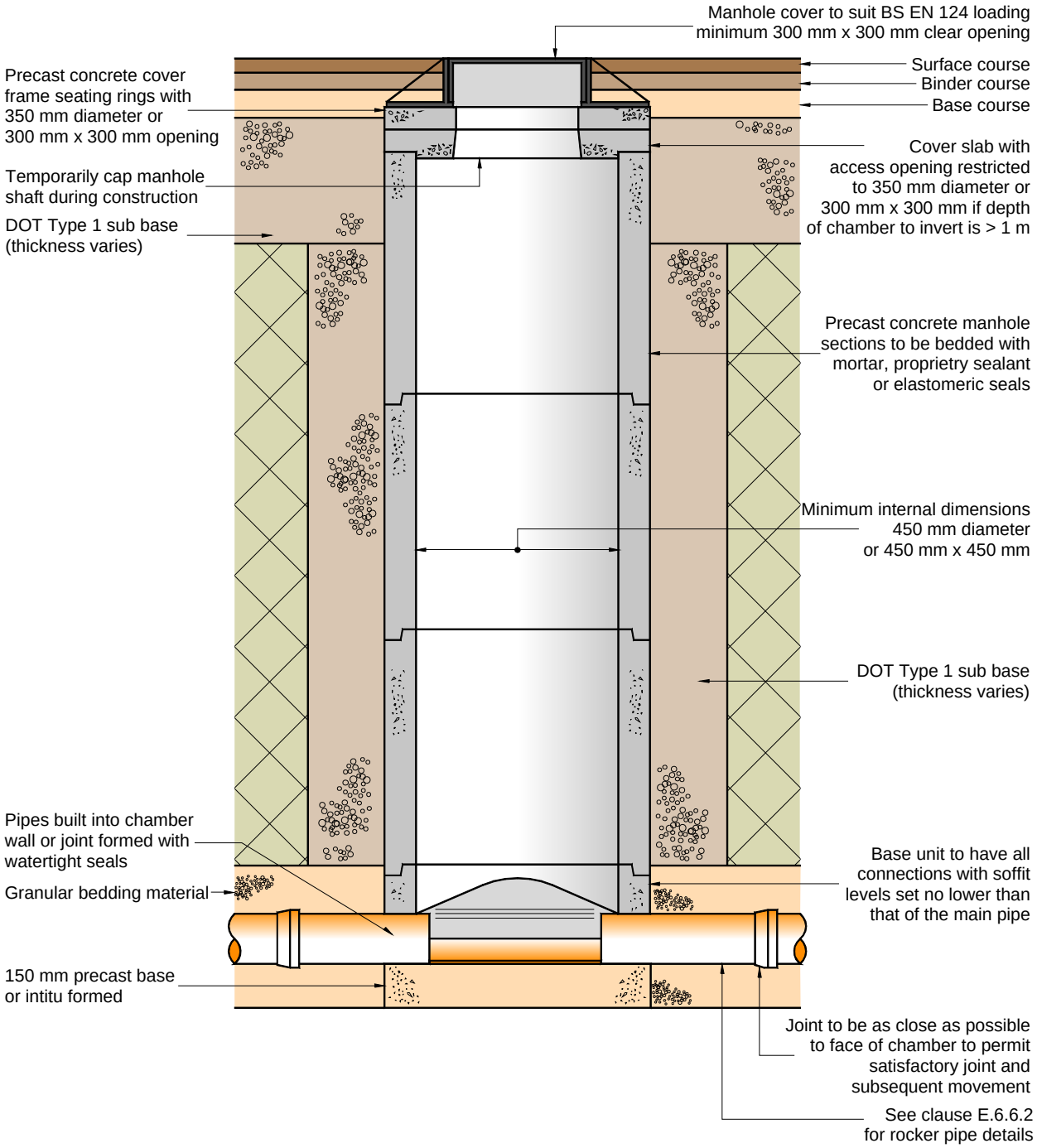


Sited in soft landscaped areas



Not to scale

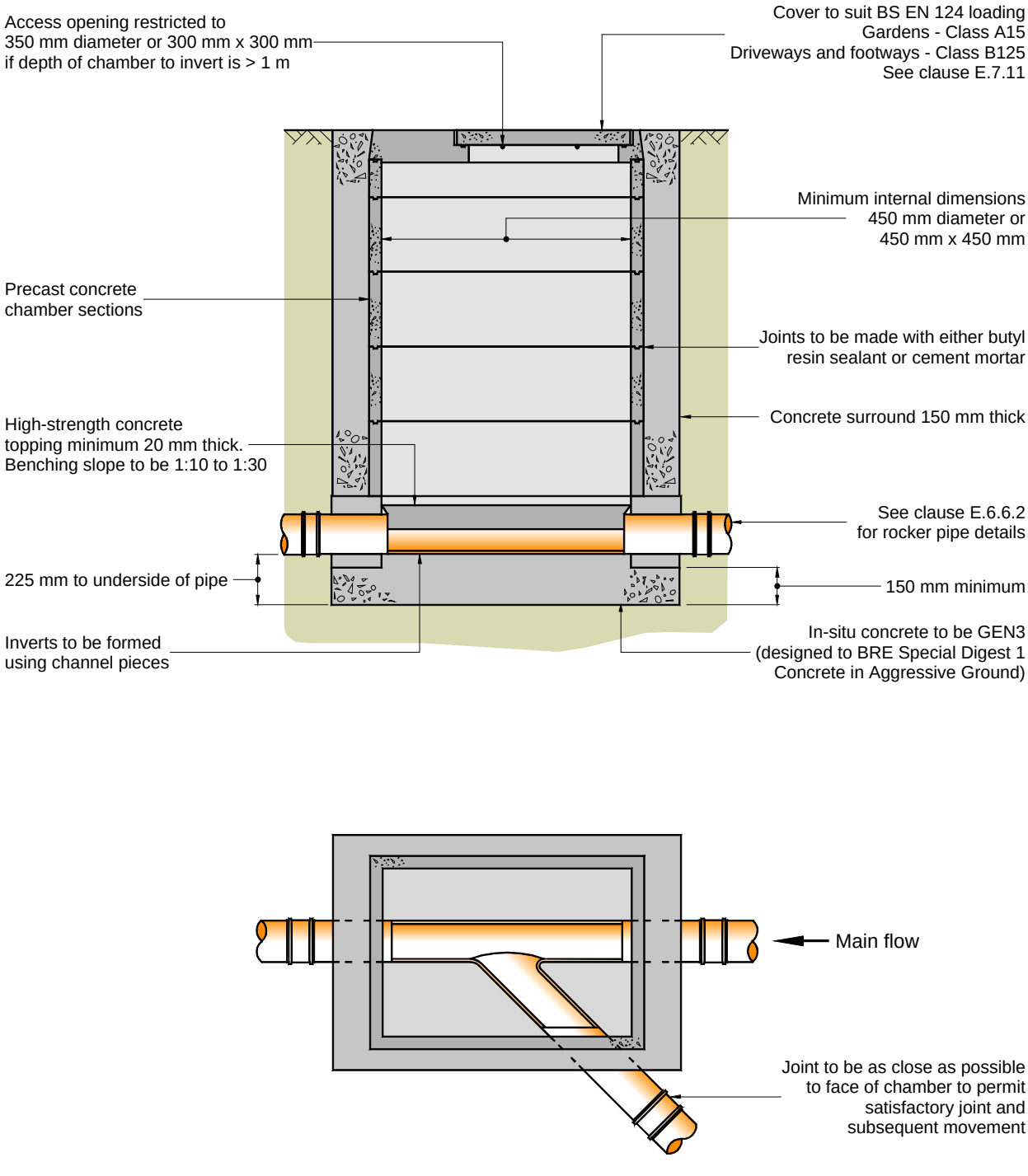
FIGURE 12
TYPICAL ACCESS CHAMBER DETAIL - TYPE 3 (Rigid material detail)
Maximum depth from cover level to soffit of pipe
in areas subject to vehicle loading 3 m, non entry



Not to scale

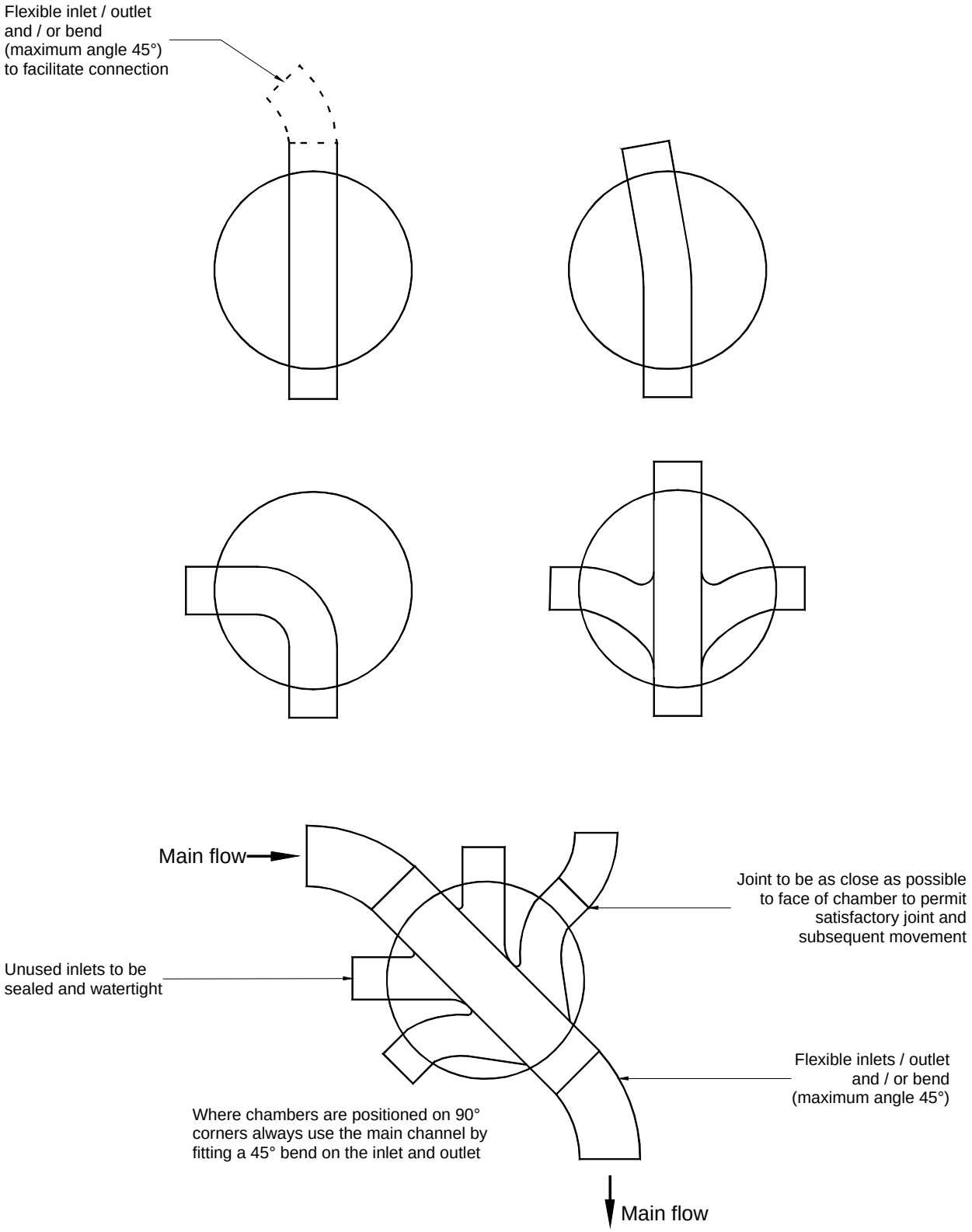
FIGURE 13
TYPICAL ACCESS CHAMBER DETAIL - TYPE 3 (Rigid material detail)

Alternative maximum depth from cover level to soffit of pipe 3 m for areas not subject to vehicle loading or areas subject to light vehicle loading, non entry



Not to scale

FIGURE 14
ALTERNATIVE BASE LAYOUTS FOR TYPE 3 CHAMBERS

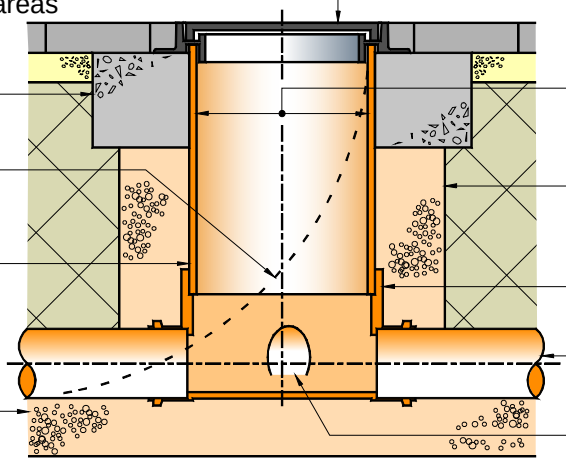


Not to scale

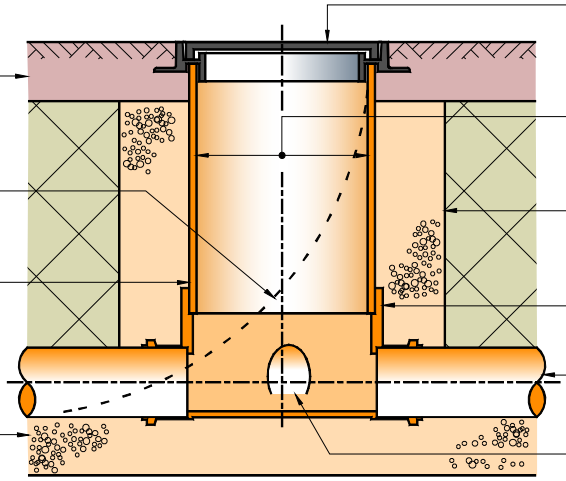
FIGURE 15
TYPICAL ACCESS CHAMBER DETAIL - TYPE 4 (Flexible material detail)
Maximum depth from cover level to soffit of pipe 2 m, non entry

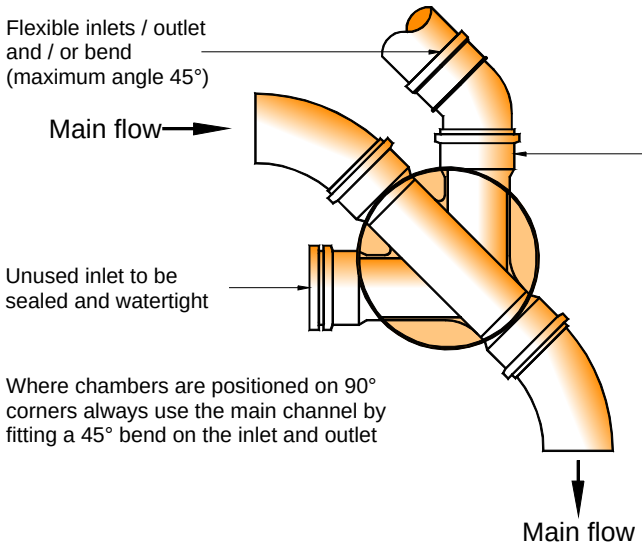
Plastic chambers and rings shall comply with BS EN 13598-1 and BS EN 13598-2 or have equivalent independent approval

Sited in driveways / paved areas



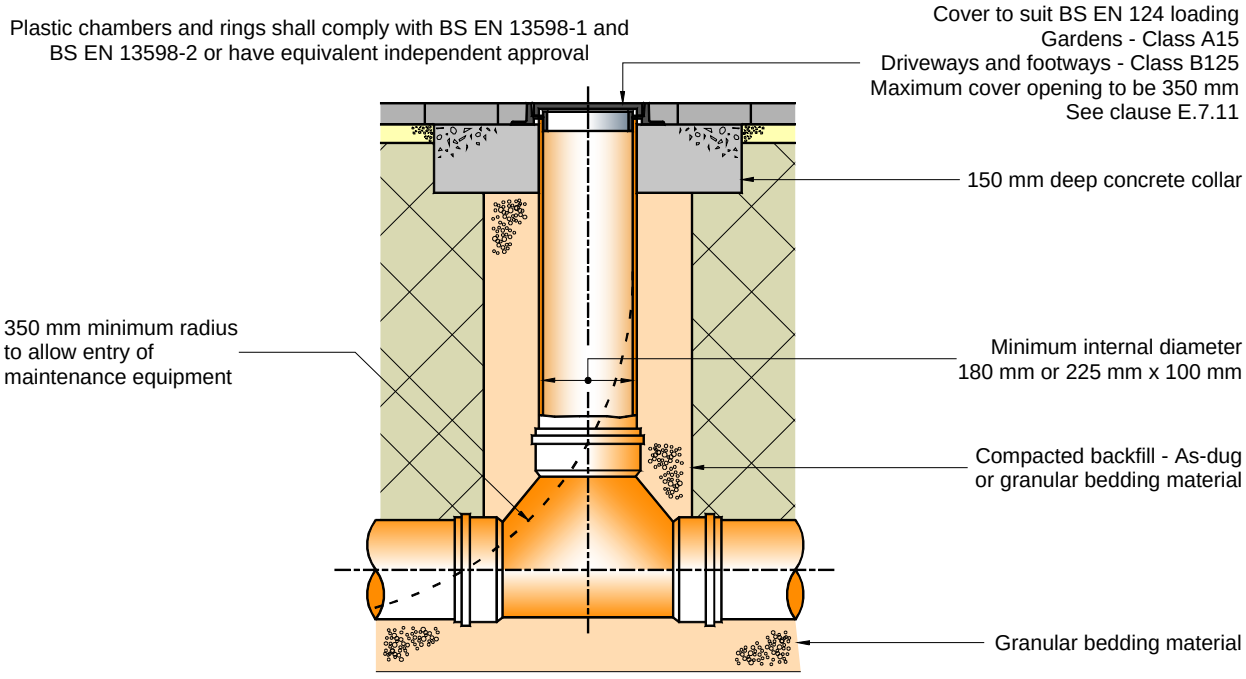
Sited in landscaped areas





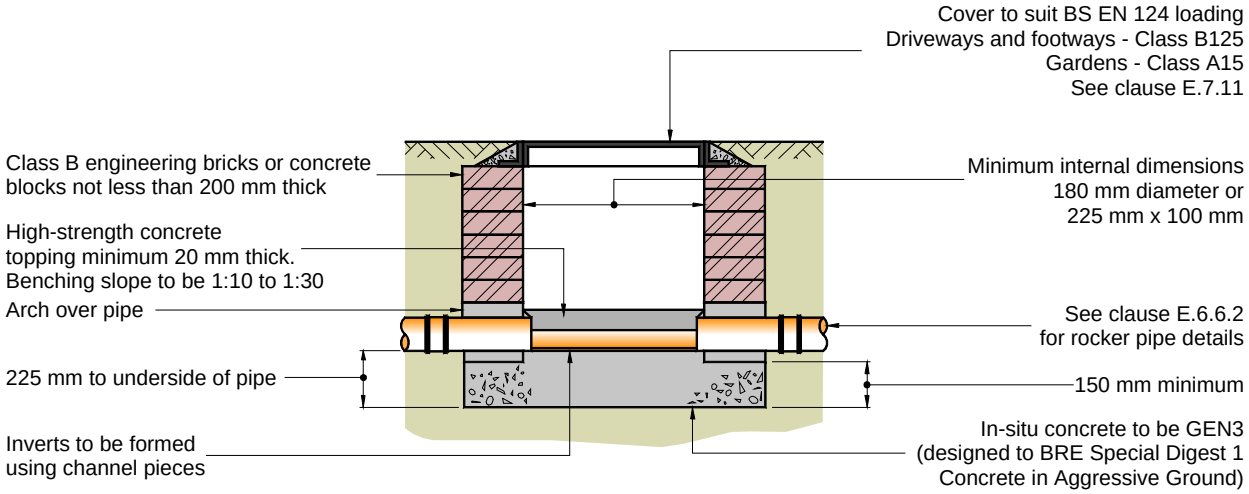
Not to scale

FIGURE 16
TYPICAL ACCESS CHAMBER DETAIL - TYPE 4 (Alternative construction detail)
Maximum depth from cover level to soffit of pipe 2 m, non entry

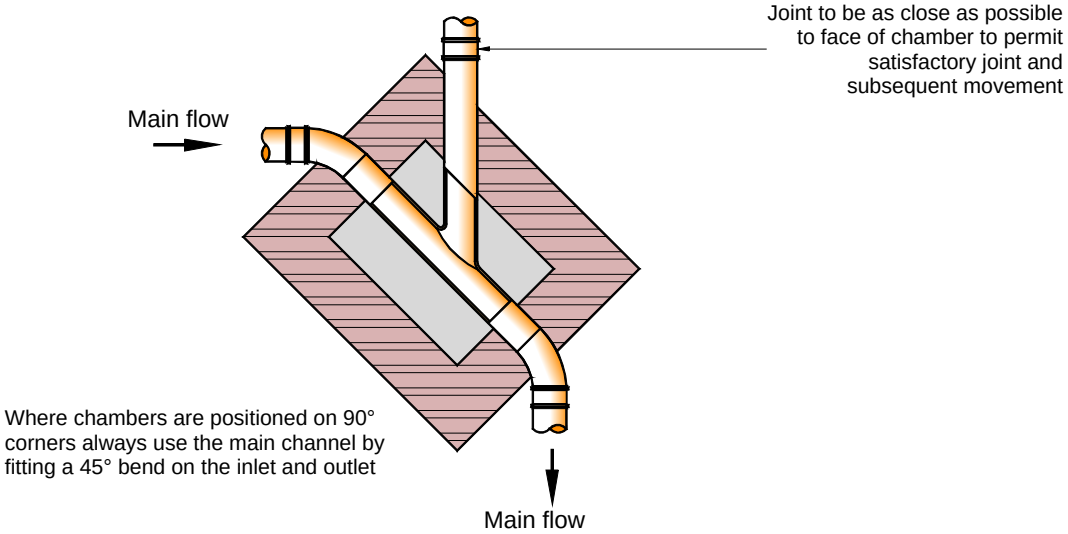


Not to scale

FIGURE 17
TYPICAL ACCESS CHAMBER DETAIL - TYPE 4 (Rigid material detail)
Maximum depth from cover level to soffit of pipe 1 m, non entry



Note: The use of precast rectangular concrete manhole units with 150 mm grade GEN3 concrete surround (designed to BRE Special Digest 1 Concrete in Aggressive Ground) is permitted.



Not to scale

5 - Reliability

S8. The system shall be designed and constructed to reliably convey the flows that can be legally discharged into the system.

G.5.1. Pipes should be free from defects or other features that might cause blockage or otherwise impede the design flow.

G.5.2. Gravity drains and sewers should have adequate gradient to maintain self cleansing conditions.

G.5.3. The minimum size for a gravity foul sewer should be:

a) 100mm nominal diameter for 10 properties or less

b) 150mm nominal diameter for more than 10 properties.

G.5.4. Sewers and laterals drains and all ancillary structures should be constructed from materials that resist tree root intrusion.

G.5.5. The mode of connection and layout of any junctions or connections between pipes, whether at manholes, inspection chambers, access points or otherwise should be designed to minimise the risk of blockage.

R.1. The minimum size for a gravity foul sewers and lateral drain should be 100 mm.

R.2. As far as practicable, junctions should be built in for anticipated future connections when sewers are constructed to avoid damage to the sewer by installing connections at a later date. Where it is necessary to make a post-construction connection to a sewer clauses 5.R.3 to 5.R.7 apply.

R.3. The vertical angle between the connecting pipe and the horizontal should be greater than 0 degrees and not more than 60 degrees (see Figure 18).

R.4. Where the connection is being made to a sewer that is 300 mm diameter or less, connections should be made using 45 degree angle or 90 degree angle curved square junctions (see Figure 18).

R.5. Connections made with junction fittings should be made by cutting the existing pipe then inserting the junction fitting and jointing with flexible repair couplings.

R.6. Where the connection is being made to a sewer greater than 300 mm in diameter:

a) where the diameter of the connecting pipe is greater than half the diameter of the sewer, the connection of an access point should be constructed; or

b) where the diameter of the connecting pipe is less than or equal to half the diameter of the sewer then the connection should be made using a preformed saddle fitting.

R.7. Connections made with saddle fittings should be made by cutting and safely removing a core out of the pipe and jointing the saddle fitting to the pipe in accordance with the manufacturer's instructions to ensure a watertight joint. Neither the saddle fitting, nor the connecting pipe should protrude into the sewer.

R.8. To provide a self-cleansing regime within gravity foul gravity sewers, the minimum flow velocity should be 0.75 m/s at one-third design flow. Where this requirement cannot be met, then this criterion would be considered to be satisfied by:

a) a 150 mm nominal internal diameter gravity sewer having a gradient not flatter than 1:150 where there are at least 10 dwelling units connected; or

b) where the sewer or lateral drain is 100 mm nominal internal diameter sewer or lateral drain serving 10 or less properties having a gradient not flatter than 1:80, where there is at least one WC connected and 1:40 if there is no WC connected.

Note: Where low water usage appliances are used, it is possible that the minimum gradients will not be sufficient and consideration should be given to using steeper gradients.

R.9. These parameters are not to be taken as a norm when the topography permits steeper gradients. Hydraulic studies indicate that these requirements may not necessarily achieve a self-cleansing regime. When a choice has to be made between gravity sewerage and pumped sewerage, these criteria should not be regarded as inflexible and the Developer should consult the Undertaker.

R.10. The roughness value (k_s) for foul gravity sewer design should be 1.5 mm.

6 - Hydraulic design

S9. The hydraulic design of sewers and lateral drains shall include an allowance for increased flows that might be reasonably foreseeable within the development over its design life.

S10. Flows that cannot be contained within the drain and sewer system as a result of failure of all or part of the drainage system shall be managed in flood conveyance routes in order to minimise the damage to people and property.

6.1 Gravity Foul Sewers and Lateral Drains

G.6.1.1. Gravity foul sewers and lateral drains should be designed to convey the projected flows together with an allowance for:

a) variations in foul flows resulting from increased occupancy or intensification of the development commensurate with the introduction of water saving measures,

b) increased trade effluent flows resulting from reasonable changes in use or intensification of development of an any industrial or commercial development,

c) levels of groundwater infiltration that might reasonably be expected over the life of the drain or sewer system;

d) inflow of surface water that might reasonably be expected due to leakage or accidental connection.

G.6.1.2. In accordance with paragraph G.6.1.1 above, design flow rates for dwellings should be a minimum of 4000 litres per dwelling per day.

G.6.1.3. Foul drain and sewer systems should be watertight to minimise the ingress of groundwater and surface water.

R.1. The following design flows for industrial developments should be used where the actual details of flows are unknown:

a) Domestic flow element – calculated in accordance with BS EN 752[3] or in the absence of appropriate information, 0.6 litres/second per hectare of developable land.

b) Trade effluent flow should be based on a metered water supply to premises similar to that proposed, or should assume 0.5 litres/second per hectare for normal industry and 1 litre/second per hectare for wet industry. Where the proportion of wet industry is unknown, an average flow of 0.7 litres/second per hectare should be used.

c) To obtain the total design flow the domestic design flow should be added to the trade effluent design flow.

6.2 Protection against flooding

G.6.2.1. The layout of the system and the development should minimise the risk of damage to property from flooding in the event of excessive flows, blockage, or failure of pumping stations on the system.

G.6.2.2. Flooding caused by blockages of foul sewers should have identified flow paths and should not cause internal property flooding.

R.1. In designing the site layout and sewerage developers should also demonstrate flow paths and the potential effects of flooding resulting from blockages, pumping station failure or surcharging in downstream combined sewers.

R.2. The designer should carry out checks to ensure that an adequate level of protection against the flooding of properties is achieved. The layout of the sewer system and/or the development should be adjusted to minimise the risk of flooding of properties.

7 - Structural Design and Integrity

S12. Sewers, lateral drains and associated structures shall be designed and constructed to ensure structural integrity over the design life.

S13. Connections to existing sewers shall be carried out in a manner that does not compromise the structural integrity of the existing sewer.

G.7.1. Buried pipes should have sufficient cover to afford adequate protection from anticipated loading, low temperatures and damage from normal use of the land. Where this cannot be achieved there should be suitable alternative protection measures provided.

G.7.2. Structural design should take account of imposed loads, support and protection.

G.7.3. As far as practicable junctions should be built in for anticipated future connections.

G.7.4. The manner of connection should not damage the structural integrity of the existing pipe.

R.1. Buried pipes should be designed in accordance with BS EN 1295-1[4] . BS 9295[5] gives information and guidance for the use of EN 1295-1 Annex A, the UK established method for the structural design of

[3] "BS EN 752:2008 Drain and Sewer Systems Outside Buildings", Published April 2008, British Standards Institution, London

buried pipelines under various conditions of loading. The procedures are explained and, where general assumptions can be made, loading tables are given. Application details for pipelines laid in various trench conditions and in poor ground are shown.

R.2. If the depth of cover to the crown of the pipe is less than the values recommended in clause 4.1.1 one of the following protection measures should be provided:

a) A concrete slab in accordance with Figure 19;

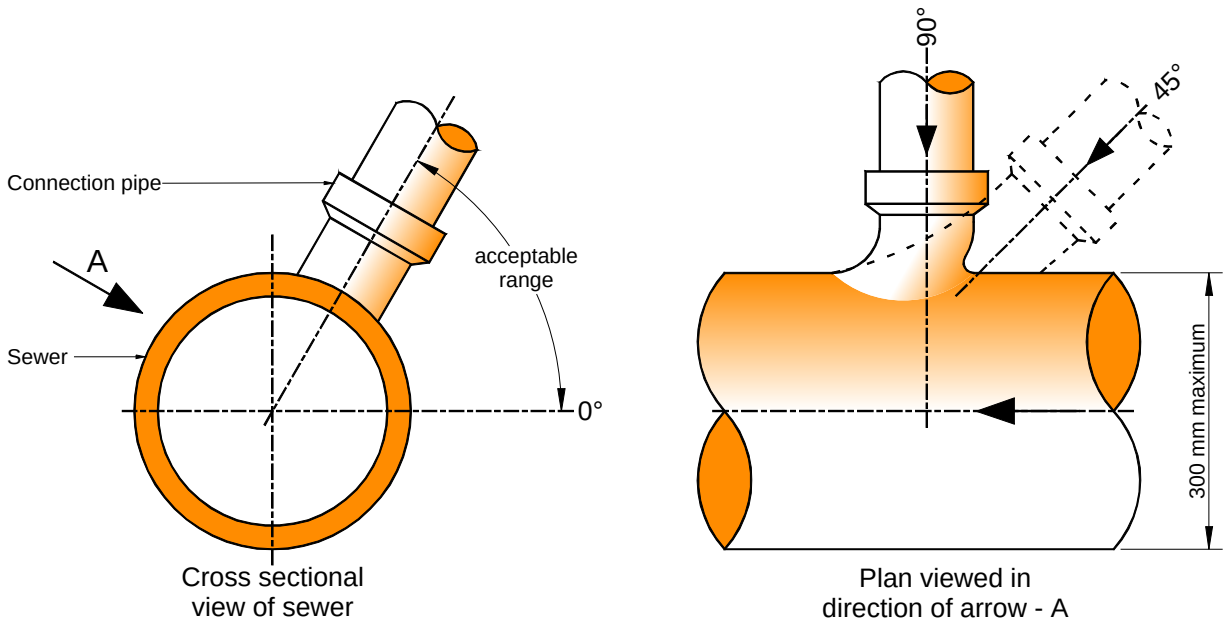
b) A concrete surround with flexible joints in accordance with Figure 20;

c) A ductile iron pipe should be used.

R.3. The structural design of all pipes should take into account the possible incidence of punching shear. The design should ensure that no vertical load is imposed by structures such as shafts onto non-load bearing components such as the pipes.

R.4. Where there is a risk of tree root intrusion (see clause 4.1.R.7) the sewer should be resistant to tree root ingress (e.g. by use of appropriate barriers, high performance joints or constructed from polyethylene with welded joints).

FIGURE 18
CONNECTIONS TO SEWER



[4] "BS EN 1295-1:1998 Structural design of buried pipelines under various conditions of loading. General requirements", Published June 1998, British Standards Institution, London
[5] "BS 9295:210 Guide to the structural design of buried pipelines", Published March 2010, British Standards Institution, London

FIGURE 19
PROTECTION OF PIPES LAID AT SHALLOW DEPTHS

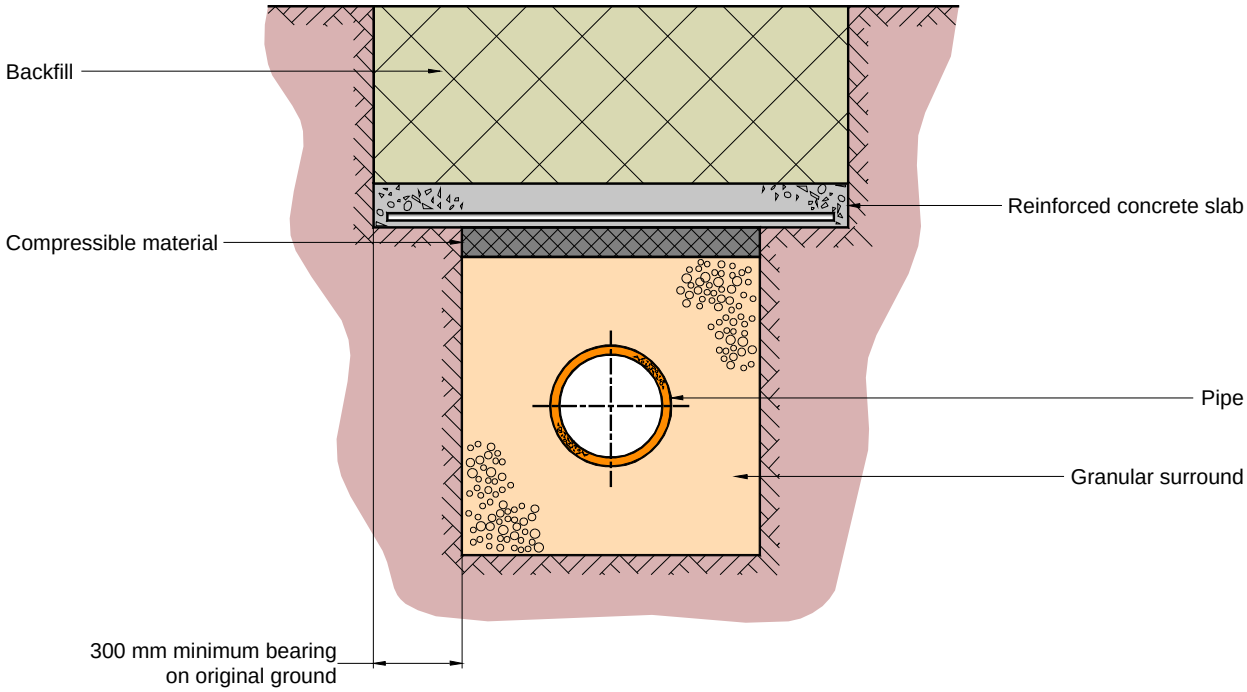
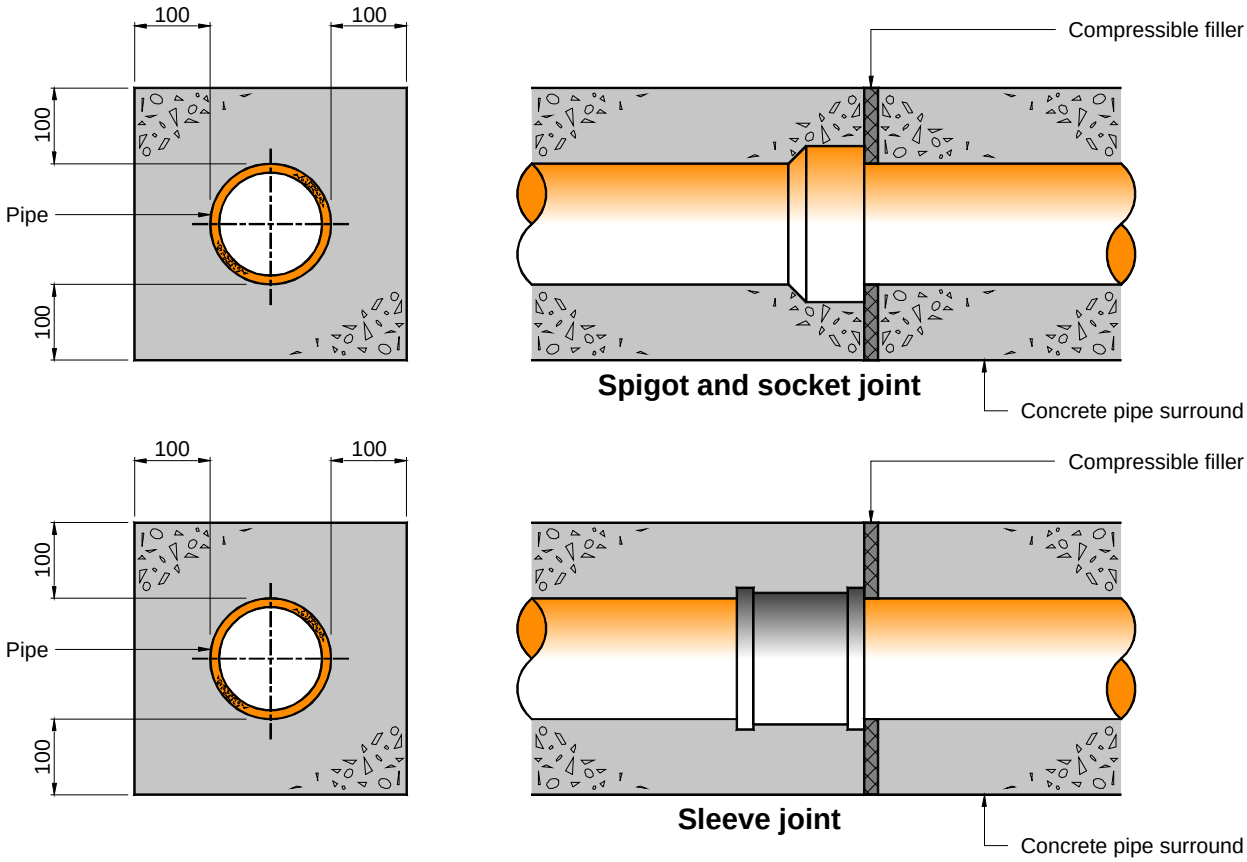


FIGURE 20
JOINTS FOR CONCRETE ENCASED PIPES



Not to scale, dimensions in millimetres
(all dimensions are minimum sizes)

8 - Materials

S14. Materials, including products, components, fittings or naturally occurring materials which are specified by the designer shall be of suitable nature and quality for their intended use.

S15. The environmental impact shall be minimised by the careful selection of materials, and where appropriate by the use of recycled and recyclable materials. The materials specified shall not have any adverse implications of health and safety of the completed drainage systems.

S16. Products, materials, and their construction methods shall be selected that minimise depletion of the finite resources having regard to the design life of the component and the potential for re-use or recycling.

S17. Sewers and lateral drains shall be designed and constructed so that:

a) pollution of surface receiving waters and groundwater is prevented;

b) for all practicable purposes, they are watertight;

c) to avoid odour nuisance or creation of toxic explosive or corrosive substances;

d) to minimise noise and vibration.

G.8.1. The suitability of materials and products can be demonstrated by appropriate use of a product bearing CE marking in accordance with the Construction Products Directive (89/106/EEC) and any other relevant Directives as amended by the CE Marking Directive (93/68/EEC) or;

a) a product complying with an appropriate technical specification (as defined in those Directives),

b) a British Standard or an alternative national technical specification of any state which is a contracting party to the European Economic Area which in use is equivalent,

c) or a product covered by a national or European certificate issued by a European Technical Approval Issuing body, and the conditions of use are in accordance with the terms of the certificate.

G.8.2. Pipe materials should be sufficiently robust so that they are not damaged by reasonably foreseeable maintenance activities.
G.8.3. Pipes should have sufficient ring stiffness to prevent deformation during storage, embedment and backfilling.

R.1. Materials should comply with the requirements of provisions in G.8.2, with the Civil Engineering Specification for the Water Industry,[1]

R.2. All Undertakers are committed to the sustainable management of the environment and should aim to meet fully their legal obligations. To this end, materials and components should comply with the following:

a) the manufacturing process should minimise the use of solvent based substances that emit volatile organic compounds;

b) the preferred product should be made from recycled material and should not produce ozone-depleting substances during manufacture; and

c) the use and/or creation of substances included in Annex X of the Water Framework Directive[6] should be avoided during the manufacturing process.

9 - Construction

S18. Sewers and lateral drains shall be constructed in a manner such that:

d) where relevant, materials are:

i) adequately mixed or prepared; and,

ii) applied, used, or fixed so as to perform adequately the functions for which they are intended.

e) no part of the drainage system is damaged or its function impaired by:

i) the method of construction; or

ii) runoff from the construction site entering the sewer system;

f) damage to existing ecosystems and major trees in the development site is prevented;

g) soil erosion is minimised.

G.9.1. The drainage system should be constructed in accordance with the approved design.

G.9.2. Run-off from the construction site should not be allowed to enter the drainage system unless the design has specifically provided for this.

G.9.3. All necessary precautions should be undertaken to avoid causing damage to, or interference with flow in, existing public sewers, and should ensure that debris, silt and mud etc do not enter the sewer.

G.9.4. All necessary precautions should be taken to avoid misconnection of foul drainage to surface water drains or sewers, or surface water drainage to foul drains or sewers.

G.9.5. On completion of construction all internal surfaces of sewers and access points should be thoroughly cleansed of all deleterious matter to prevent it passing into existing sewers or water courses.

G.9.6. Operations should be carried out in such a manner as to avoid damage to or deterioration of the integrity to adjacent buildings or other infrastructure.

G.9.7. Excavations in roads and streets should be carried out in accordance with the relevant highway authority requirements.

R.1. Construction of the drainage system should comply with the requirements of The Civil Engineering Specification for the Water Industry[1]

[6] "Directive 2008/105/EC of the European Parliament and of the Council on Environmental Quality Standards", Published 16 December 2008, Official Journal of the European Union

10 - Testing

S19. Sewers and lateral drains shall be tested and inspected to ensure that:

a) the systems is for all practical purpose, leaktight;

b) that no surface water drainage has been connected to a foul sewer system and foul drainage has not been connected to a surface water system;

c) pipes have not been damaged, deformed or subject to settlements during construction.

G.10.1. Gravity sewers, pressure pipelines, manholes and inspection chambers should be leak tight when tested after backfilling.

G.10.2. Pipelines should be inspected by means of a visual or closed circuit television (CCTV) examination to record condition and deformation.

G.10.3. Drains and sewers should be tested to check that there have been no misconnections of foul and surface water.

G.10.4 The standards do not specify who should undertake the testing. This should be agreed between the developer and the adopting undertaker.

R.1. Testing of the drainage system should comply with the requirements of the Civil Engineering Specification for the Water Industry[1],

11 - Pumping Stations

S20. The design of the system shall, so far as is reasonable practicable, minimise the use of energy over the life of the system.

G.11.1. Foul sewage pumping stations or pumped systems should only be used where their whole life cost is less than conventional gravity systems over a period of 40 years.

R.1. For guidance on the design and construction of pumping stations is contained in Sewers for Adoption 7[7] ,Part D.

[7] "Sewers for Adoption 7" Published XXX 2011 (in preparation), WRc/Water UK