Chapter 5.3

Drainage below ground

5.3 Drainage below ground

CONTENTS

SCOPE

This Chapter gives guidance on meeting the Technical Requirements and recommendations for the design and the construction of foul, surface water and ground water drainage systems.

DESIGN STANDARDS

5.3 - D1 Design shall meet the Technical Requirements

Design that follows the guidance below will be acceptable for drainage below ground.

STATUTORY REQUIREMENTS

5.3 - D2 Design shall comply with all relevant statutory requirements

Design should be in accordance with relevant Building Regulations and other statutory requirements.

All drainage schemes require the approval of the Building Control Authority. Local sewerage undertakers may impose additional requirements and restrictions. Both should be consulted early, especially where the drainage system is to be adopted under an agreement under Section 104 of the Water Industry Act 1991 or Sewerage (Scotland) Act 1968. The system may need to be inspected and tested by the sewerage undertaker, as well as by the Local Authority, Building Control Authority and NHBC.

Sewers which are to be adopted under an agreement under Section 104 of the Water Industry Act 1991 or Sewerage (Scotland) Act 1968 are outside the scope of this document. For information on standards required for adopted sewers, contact the local sewerage undertaker and other relevant Authorities.

Satisfactory outfall disposal is essential where a septic tank is installed. In England and Wales the Environment Agency consent may be needed to discharge effluent from a septic tank. In Northern Ireland the Department of the Environment should approve proposals, in Scotland the Local Authority and, where appropriate, the River Purification Authority should approve proposals.

Ground conditions may preclude the use of septic tanks in some locations. In all cases NHBC will require evidence of a satisfactory percolation test where a septic tank drainage system is being installed. See Appendix 5.3-B.

For surface water discharge into a watercourse the permission of the Environment Agency is required in England and Wales. A "consent to discharge" is required from the DoE in Northern Ireland. In Scotland the Local Authority and, where appropriate, the River Purification Authorities should be consulted.

DRAINAGE SYSTEM DESIGN

5.3 - D3 Drainage systems shall be designed to convey foul effluents and surface water satisfactorily to an appropriate outfall

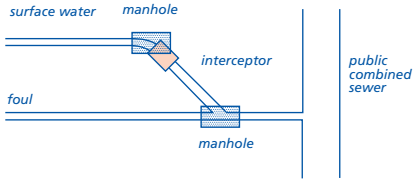
Items to be taken into account include:

(a) compliance with codes and standards
Guidance on drainage design is given in BS EN 752.

(b) compatibility with the existing main sewerage system
The drainage system should be designed to be compatible with the main sewerage system:

- as a combined system, or
- with separate systems for foul water and surface water, or
- with separate systems where foul water is connected to the main sewer, while surface water disposal is by soakaways or other suitable means.

Where the sewerage undertaker permits surface water drains to be connected to a foul water system an interceptor should be installed on the surface water side of the foul sewer junction, or trapped gullies should be used.



Where ground water drains are connected to surface water drains, there should be a silt trap on the ground water side of the junction.

(c) rights of connection to disposal systems
Ensure that a legal right exists when connecting drains to an outfall.

(d) capacity of private sewers
Private drainage systems should be sufficient to cope with the intended capacity. The design should be in accordance with BS EN 752 or similar authoritative document.

Where an existing private drainage system is to be extended, or where the capacity is to be increased, sufficient investigation, measurement and calculation should be undertaken to ensure that all parts of the private system are of adequate capacity.

5.3 - D4 Drainage shall be designed to prevent health hazards

Items to be taken into account include:

(a) ventilation of systems
Ventilation of drains is normally achieved by ventilating discharge stacks. For details, reference should be made to Chapter 8.1 'Internal services' (Design).

Air admittance valves which have been assessed in accordance with Technical Requirement R3 may be used in some dwellings to prevent trap seal siphonage. An open vent is generally required at the head of common drainage systems and where the discharge pipe is the only vent for a septic tank or cesspool.

(b) prevention of gases entering the dwelling

RADON
In certain geographical locations special precautions may be necessary to reduce the entry of radon gas, for example where drains enter buildings. Areas in England where special precautions are necessary are detailed in BRE Report 211.

LANDFILL AND OTHER GASES
Precautions to be taken when building where landfill or other gases may be present are given in BRE Report 212.

Where necessary ensure that drains are sealed where they enter the building.

(c) siting of septic tanks and cesspools
Septic tanks and cesspools should be at least 7m from a dwelling and within 30m of a vehicular access to permit emptying. In Scotland they should be at least 5m from a dwelling and a boundary.

(d) pumped systems
Where a gravity system is not possible, pumps may have to be used. Pumped systems should be designed in accordance with BS EN 752 and BS 6297. The installation should include:

- holding tank of sufficient volume to contain 24 hours domestic effluent based on 120L/150L per head per day
- suitable warning system giving visual and/or audible signals to indicate system malfunction
- suitable equipment housing.

5.3 - D5 Drainage systems shall be designed to minimise the risk of blockage

Items to be taken into account include:

(a) pipe sizes
Pipe sizes should be designed for the maximum peak load, using BS EN 752 as the basis for calculations. Ground water drains and soakaways should be designed with sufficient capacity for normal weather conditions.

(b) gradients
Design gradients should be as even as practicable, depending on the number of WCs being served (minimum one for 100mm pipes, five for 150mm pipes, with peak flows greater than 1 L/sec. at the gradients shown below).

Where flows are 1.0 L/second or less, gradients for 100mm diameter pipes should not be flatter than 1:40.

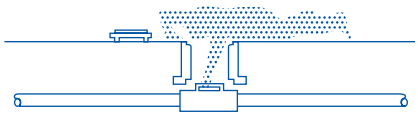
The following gradients may be used where flows exceed 1.0L/second:

Pipe diameter [mm]	Minimum gradient
100	1 : 80
150	1 : 150

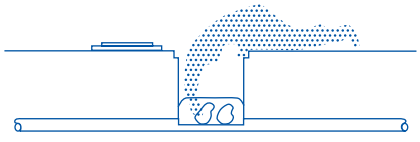
(c) pipe runs
Pipe runs should be designed to maintain self-cleansing velocity (0.7 m/s). They should be as straight as practicable with minimal changes of direction. Bends should only occur in or next to inspection chambers or manholes. Curves should be slight so that blocked pipes can be cleared.

(d) access
To ensure that every length of drain can be rodded, the design should include all necessary access points, such as:
- rodding eyes
- access chambers
- inspection chambers
- manholes.

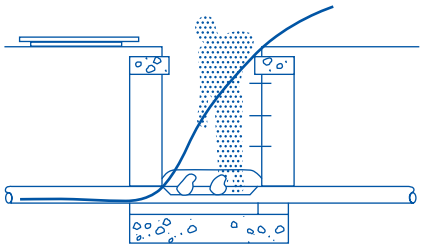
Sizes of access fittings and chambers should be specified for the depth of invert as detailed in Appendix 5.3-A.



ACCESS CHAMBER



INSPECTION CHAMBER

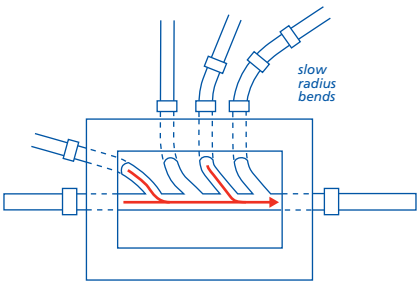


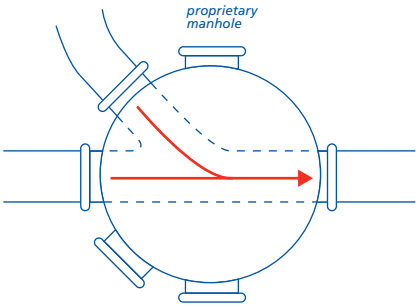
MANHOLE

Inspection chambers and manholes may be the following types:
- open, half-round section channel with suitable benching, or
- closed access - at manholes, cover panels have to be removed to gain access to the pipe.

Side branches to inspection chambers and manholes should discharge into the main channel not higher than half pipe level.

Connections should be made obliquely in the direction of flow.





For construction details of access fittings and chambers, reference should be made to clause S6.

5.3 - D6 Foul and surface water drainage systems shall be adequately watertight under test and working conditions

Items to be taken into account include:

(a) ground movement
All pipes should have flexible joints.

Where ground movement may occur, precautions against leakage are needed. In mining areas, and in other locations where movement could be significant, a flexible pipe system should be specified. Flexible systems should be flexible pipes with flexible joints. Refer to Sitework Clause S5.

Proper allowance should be made for settlement. Where there is a risk of soil movement, for example in made-up ground, design gradients should be steeper than the minimum allowed for the flow rate and pipe size.

In non-uniform or saturated soils where movements of the trench bottom can be expected, soft spots should be removed and replaced with suitable material. Protective blinding should be specified for the trench bottom, to be placed immediately following excavation.

In ground conditions where movement is likely to adversely affect the drain a support system for the drain should be designed by an Engineer in accordance with Technical Requirement R5.

Shrinkage and heave of clay soils can affect pipelines. Design gradients should be greater than the permitted minimum to allow for possible movement. Refer to Chapter 4.2 'Building near trees' for details of zones of influence of trees.

(b) flooding
Where there is a risk of flooding the advice of the relevant Rivers Authority should be followed.

(c) ground water
Foul and surface water drainage systems should prevent the ingress of ground water.

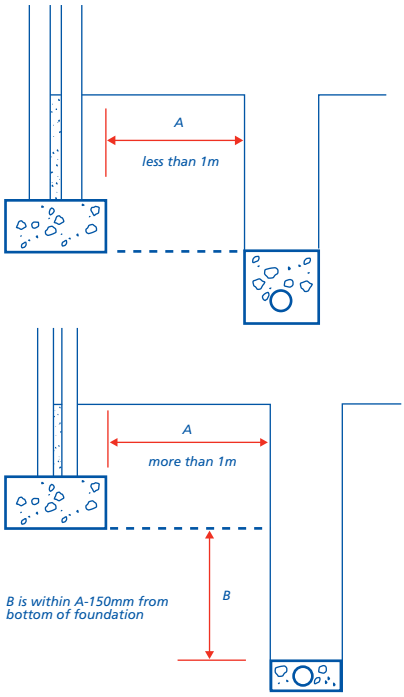
DESIGN TO AVOID DAMAGE

5.3 - D7 Drainage systems shall be designed so that they are adequately protected against damage

Items to be taken into account include:

(a) loads from foundations
Drains should be located so that foundation loads are not transmitted to pipes. Where drainage trenches are near foundations, foundation depths should be increased or the drain re-routed further from the foundations.

Where the bottom of a trench is below foundation level, the trench should be filled with concrete to a suitable level.



Where drains pass through structural elements, allowance should be made for differential movement, thermal movement and maintenance.

Pipes passing through substructure walls should accommodate movement by:
- 50mm clearance all round, or
- a sleeve with a 50mm clearance, or
- if built in, a connection on both sides of the wall to pipes with flexible joints located not more than 150mm from the face of the wall. Refer to Sitework clause S5(a).

See clause D4(b) for prevention of gas entering the building.

(b) loads from overlying fill and traffic
Pipes should be firmly supported throughout their length and bedded to resist loads from overlying fill and traffic. Small diameter rigid pipes may be laid:
- directly on trench bottoms, or
- bedded on granular material. Refer to Sitework clause S4.

For flexible pipes, and where a greater factor of safety is needed, specify the bedding class and grading of backfill as described in BS EN 13242, BS 5955 and BS EN 752. Refer to Sitework clause S4(a).

When using proprietary systems assessed in accordance with Technical Requirement R3, pipes should be supported in accordance with the assessment.

Special protection may be required where pipes are near the ground surface or where they could be damaged by the weight of backfill or traffic load from above. Guidance is given in Sitework clause S5 and in BS 5955 and BS EN 752.

Manhole covers, gully gratings and other fittings should be suitable for the traffic conditions.

(c) chemicals in ground and ground water
If the ground or ground water contains sulfates, concrete and masonry work may require special precautions as detailed in Chapters 2.1 'Concrete and its reinforcement' (Design) and 6.1 'External masonry walls' (Design).

FOUL AND SURFACE WATER DISPOSAL

5.3 - D8 Drainage systems shall be designed to connect to a suitable outfall

Items to be taken into account include:

(a) connection to a main foul sewer
All connections to a public sewer will require the agreement of the responsible authority. They should be consulted as to the type and position of the connection to be made.

All connections to a private sewer will require the agreement of the owners of the sewer. This should be obtained as part of the design process. If the main private sewer discharges into a public sewer the local sewerage undertaker should be notified of the proposal.

(b) connection to a cesspool or a septic tank
The entry flow velocity should be restricted to reduce disturbance in the tank. For drains not exceeding 150mm diameter a gradient not steeper than 1:50 for a distance of at least 12m upstream of the entry is required.

Rodding and cleaning facilities should be provided at the connection with the tank.

(c) connection to surface water disposal systems
Surface water drainage is generally required to be separated from foul water drainage. Surface water may be discharged into public surface water main drains or directly into natural watercourses, ponds or soakaways, as appropriate. Surface water should not discharge to a septic tank or cesspool, or a separate foul sewer.

For large or complicated dwellings the amount of surface water to be disposed of may be calculated by reference to BS 6367.

Siting of soakaways should take account of topography to ensure that water is drained away from the building. In soil of low permeability, soakaways should only be provided where no alternative system is available. Soakaways should be a minimum of 5m from any adjacent building.

A simple test for assessing the permeability of the soil and how to convert the result into soakaway dimensions is detailed in Appendix 5.3-E. A more refined method to determine soakaway size is given in BRE Digest 365.

(d) cesspools
A cesspool is a tank which stores effluent and has to be emptied periodically.

Cesspools should be sited within 30m of a vehicle access to permit emptying. They should be at least 7m from a dwelling.

Cesspools are required to be at least 18m^3 capacity. A 45 day holding capacity calculated at 150 litres/head/day should be provided.

(e) septic tanks
A septic tank is a form of treatment plant and requires a suitable outfall (agreed by the relevant authority) for treated effluent discharge. Septic tank design is detailed in BS 6297.

Septic tanks should be sited within 30m of a vehicle access to permit emptying. They should be at least 7m from a dwelling. In Scotland they should be at least 5m from a dwelling and a boundary.

CAPACITY
The capacity of the septic tank should be based on the number of people it will serve. This is determined by the formula:

C = 180P + 2000

where C = capacity of tank (in litres) min 2700L

and

P = design population/potential occupancy (min 4)

Appendix 5.3-C gives minimum capacities for septic tanks serving up to 10 persons.

OUTFALL
The outfall from a septic tank may require consent from the Environment Agency in England and Wales. In Northern Ireland the Environment and Heritage Service should approve proposals. In Scotland the Scottish Environment Protection Agency should approve proposals. The designer should ensure at an early stage that consent will be given, or an alternative method of drainage selected.

Copies of relevant consents are required by NHBC before work commences.

POROUS SUBSOILS
If the outfall from a septic tank is to discharge to a porous subsoil, such as gravel, sand or chalk, at a level above that of the winter water table level, a soakaway may be used.

This consists of an excavation filled with brick bats or other large pieces of inert material; or unfilled but lined, eg with dry laid brickwork or precast concrete (porous or perforated) rings, from which the effluent may percolate into the surrounding ground. Soakaways which are not filled should be covered by a slab incorporating an inspection cover.

The size of the soakaway should be determined as described in Appendix 5.3-C, the area of the bottom of the soakaway should equal the area of trench bottom in Chart 1.

Where the porous strata is overlaid by less permeable sub soil a bore hole may be permitted by the appropriate authority.

Proprietary septic tanks should be assessed in accordance with Technical Requirement R3.

LESS POROUS SUBSOILS
In less porous subsoils a sub surface irrigation system may be a possible alternative.

Such an alternative will have to be designed to determine the area of the sub surface drainage trench from which the length of land drain can be found.

First a percolation test has to be carried out to determine the percolation value (s) in seconds. Details of how to carry out the test are given in Appendix 5.3-B.

If the percolation value is less than 100s use Chart 1 to determine the field drain trench area and Chart 2 the pipe length to provide this area. For percolation values between 100s and 140s underdrains are necessary. For percolation values in excess of 140s the soil is unsuitable for field drains.

Design guidance for underdrains is given in Appendix 5.3-D.

FIELD DRAINS

These should be:

- sited taking account of topography to ensure that water is drained away from the building
- perforated pipes laid at least 500mm below the surface
- laid in trenches with a uniform gradient not steeper than 1:200 with undisturbed ground 2m wide between trenches and at least 8m from any building and 10m from any water course
- laid on a 150mm bed of clinker, clean gravel or broken stone (20 - 50mm grade) and the trenches filled to a level 50mm above the pipe and covered with strips of plastic material to prevent entry of silt
- backfilled with as dug material.

Note. If the level of the water table is expected to rise in the winter months to within 1m of the invert of the field drains, it is not acceptable to use sub-surface irrigation.

(f) small private sewage treatment works for more than one dwelling

Small sewage treatment works for more than one dwelling should be designed in accordance with BS 6297. The discharge from the waste water treatment plant should be sited at least 10m away from water courses and dwellings. The design should be carried out by a suitably qualified engineer.

GROUND WATER DRAINAGE

5.3 - D9 Ground water drainage shall be designed to convey excess ground water to a suitable outfall

(a) layout of pipes

Depending on site contours and ground conditions, ground water drainage, where required, may be designed as a:

- natural system
- herringbone system
- grid system
- fan-shaped system
- moat system.

(b) pipe construction

Pipe perforations should be holes or slots to suit the nature of the ground.

(c) outfall

Ground water drain systems connected to foul, surface water or combined drains should discharge into the drain through a catchpit. Where available, ground water drainage may discharge into a soakaway, preferably through a catchpit or into a watercourse.

In England and Wales the National Rivers Authority consent may be needed for discharge proposals. In Northern Ireland the Department of Environment should approve proposals; in Scotland the River Purification Authority should approve proposals.

PROVISION OF INFORMATION

5.3 - D10 Designs and specifications shall be produced in a clearly understandable format and include all relevant information

Drawings and specifications should include:

- proposed drain layout
- invert levels and locations of existing sewers
- junctions
- ground floor levels of dwellings
- external finished levels
- inspection and access points
- method of disposal of both foul and surface water
- position of any septic tank or cesspool in relation to adjacent buildings
- results of percolation tests where treated effluent disposal is through field drains
- length of field drains and their layout (including details of trench width, this being critical to the functioning of the system)
- depth of field drains.

Drains or sewers which are intended for adoption should be clearly identified on relevant drawings.

5.3 - D11 All relevant information shall be distributed to appropriate personnel

Ensure that design and specification information is distributed to site supervisors, relevant specialist subcontractors and/or suppliers.

MATERIALS STANDARDS

5.3 - M1 All materials shall:
(a) meet the Technical Requirements
(b) take account of the design

Materials that comply with the design and the guidance below will be acceptable for drainage below ground.

Materials for drainage below ground should comply with relevant standards, including those listed below. Where no standard exits, materials should carry a certificate of assessment from an independent authority, acceptable to NHBC. Materials of a higher standard are also acceptable.

References to British Standards and Codes of Practice include those made under the Construction Products Directive (89/106/EEC) and, in particular, appropriate European Technical Specifications approved by a European Committee for Standardisation (CEN).

DRAINAGE MATERIALS

5.3 - M2 All materials for drainage work shall ensure satisfactory service for the life of the system

Items to be taken into account include:

(a) manholes, chambers, pipes, fittings and covers

BS 65	Specification for vitrified clay pipes, fittings, joints and ducts (Note: This includes perforated pipes)
BS 437	Specification for cast iron spigot and socket drainpipes and fittings
BS 1247	Specification for manhole step irons
BS EN 588	Fibre cement pipes for sewers and drains.
BS 4660	Specification for unplasticised PVC underground drain pipes and fittings
BS 4962	Specification for plastics pipes for use as light duty sub-soil drains
BS 5911	Precast concrete pipes, fittings and ancillary products
BS 5955	Plastics pipework (thermoplastic materials)
BS 6087	Specification for flexible joints for cast iron drainpipes and fittings (BS 437) and for cast iron soil, waste and ventilating pipes and fittings (BS 416)
BS DD 76	Draft for Development, Precast concrete pipes of composite construction
BS EN 124	Gully tops and manhole tops for vehicular and pedestrian areas
BS EN 295	Vitrified clay pipes and fittings and pipe joints for drains and sewers
BS EN 1401-1	Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly (vinyl chloride) (PVC-U)

INSPECTION/MANHOLE COVERS AND FRAMES

- Group 1 - Areas which can only be used by pedestrians and pedal cyclists.
- Group 2 - Footways, pedestrian areas and comparable areas, car parks or car parking decks.
- Group 3 - For gully tops installed in the area of kerbside channels of roads which when measured from the kerb edge, extend a maximum of 0.5m into the carriageway and a maximum of 0.2m into the footway.
- Group 4 - Carriageways of roads (including pedestrian streets), hard shoulders and parking areas, for all types of road vehicles.

Covers used for manholes within buildings should be airtight and mechanically secured.

Covers used for septic tanks, cesspits and settlement tanks should be lockable.

GULLY GRIDS
- Grade B - for use in carriageways of roads with cars and slow moving normal commercial vehicles
- Grade A Class 2 - for use in carriageways of roads
- Grade A Class 1 - for use in carriageways of roads (gully grids of permanent non-rock design).

(b) bricks and blocks
Clay bricks for manholes should comply with BS EN 771 and:
- be of low active soluble salt content
- have a compressive strength not less than 48N/mm^2.

Engineering bricks are suitable.

Concrete bricks to BS EN 771 should have a minimum crushing strength of 48N/mm^2 with a minimum cement content of 350kg/m^3 for foul drainage.

Calcium silicate bricks should comprise strength class 20 or above for foul drainage situations.

(c) backfill and bedding
Granular backfill and bedding material should comply with the requirements of BS EN 13242, BS 5955 and BS EN 752, as specified.

Rigid pipes of nominal size 100mm and 110mm nominal flexible pipes should have granular material bedding to BS EN 13242 of 4/10mm pipe bedding gravel. Rigid pipes of nominal size 150mm and 160mm nominal flexible pipes should have granular material bedding to BS EN 13242 of 2/14mm pipe bedding gravel. See Sitework clause S4 (a).

Proprietary pipe systems should be supported and bedded in accordance with the manufacturer's recommendations.

SITEWORK STANDARDS

5.3 - S1 All sitework shall:
(a) meet the Technical Requirements
(b) take account of the design
(c) follow established good practice and workmanship

Sitework that complies with the design and the guidance below will be acceptable for drainage below ground.

PRELIMINARY WORK

5.3 - S2 Checks shall be made on site to ensure that the design can be achieved

Check that the following are as specified in the design:
- invert levels and locations of existing sewers
- ground floor levels of dwellings
- external finished levels.

Percolation tests should be verified where treated effluent disposal is through field drains.

The length of any field drains specified in the design should be accommodated within the site boundaries.

EXCAVATION

5.3 - S3 Excavation shall ensure that the invert levels and gradients required by the design are achieved

Items to be taken into account include:
(a) setting out dimensions
Drain runs and depths should be set out from benchmarks previously checked and verified. Any discrepancies in dimensions, and any ground conditions requiring modification to the design, should be reported immediately. Any resulting variations should be recorded and distributed to all concerned.

(b) depth of trenches
Excavate to the depths shown on the drawings. If any trench is excavated lower than the designed bottom level, it should be re-filled to the designed level to allow for the bedding to be continuous. Fill material should be:
- granular material, or
- concrete mix GEN 1 or ST 1/2 (not for field drains).

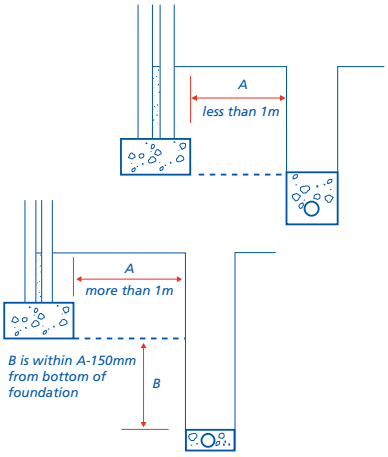
Hard spots should be undercut and removed, so that local stress points under pipes are avoided.

Soft spots should be filled with suitable well-compacted material.

(c) width of trenches
Trenches should be as narrow as possible within working limits, allowing at least 150mm working space on each side of the pipe.

(d) proximity of foundations
Foundation bottoms should be lower than adjacent drainage trenches.

Where the bottom of a trench is below foundation level, the trench should be filled with concrete to a suitable level.



LAYING PIPEWORK

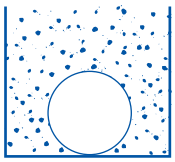
5.3 - S4 Pipework shall be laid to the designed lines and gradients

Items to be taken into account include:
(a) bedding
Pipes should be firmly supported throughout their length and bedded as specified in the design.

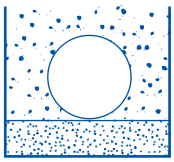
Bricks, blocks or other hard material should not be used as temporary supports to achieve the correct gradients, as they may create hard spots which can distort the completed pipe run.

Pipes should be either:
- bedded on granular material, minimum 100mm deep or
- laid directly on the trench bottom, where the trench bottom can be accurately hand trimmed with a shovel but is not so soft that it puddles when walked on.

Depressions should be formed where necessary in the trench bottom to accommodate pipe joints.



pipe supported on trench bottom



pipe supported on bed of granular material

Nominal pipe size [mm]		Granular material for bedding
rigid pipes	flexible pipes	Material (complying with BS EN 13242)
100	110	4/10mm pipe bedding gravel
150	160	2/14mm pipe bedding gravel or 4/10mm pipe bedding gravel

Proprietary pipes should be supported in accordance with manufacturers' recommendations. Some proprietary systems permit a minimum of 50mm depth of bedding in certain circumstances. Generally, for 150mm diameter and 100mm diameter drains, a bed and surround of 10mm pea gravel (to a thickness of 100mm all round the drain) will be acceptable for drains under gardens, paths and drives.

(b) jointing
Pipes should have flexible joints, installed in accordance with manufacturers' recommendations.

(c) sidefill and backfill
Sidefill and backfill should be placed as soon as the pipes have been bedded, jointed and inspected.

For proprietary systems, sidefilling and backfilling should be carried out

in accordance with manufacturers' recommendations. Sidefill should be either:

- granular material (see table to Clause S4(a)), or
- selected backfill material from the trench excavation, ie free from:
  - stones larger than 40mm
  - clay lumps larger than 100mm
  - timber
  - frozen material
  - vegetable matter.

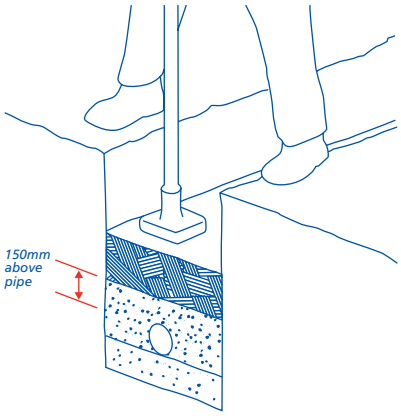
GENERAL BACKFILL

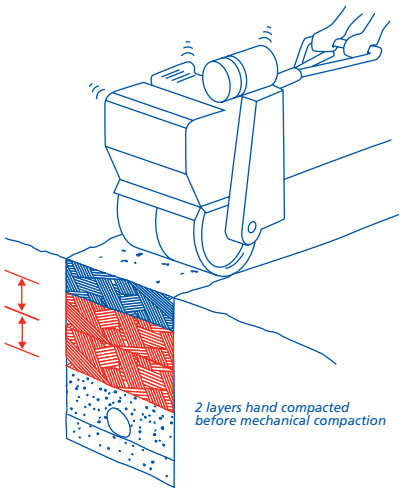
Normally the excavated material from the trench will be suitable for backfilling above the selected material. General backfill material should be free from:

- boulders
- building rubble
- timber
- vegetable matter.

PLACING BACKFILL

Backfill should be placed in layers not deeper than 300mm, and should be well compacted. Mechanical compacting should only be used when compacted backfill is at least 450mm above the crown of the pipe.





PROTECTION OF PIPEWORK

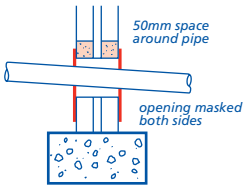
5.3 - S5 Pipework shall be adequately protected against damage

Items to be taken into account include:

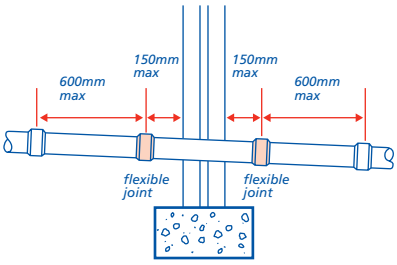
(a) pipes passing through substructure walls

Pipes passing through substructure walls should accommodate movement. This may be achieved by:

- a 50mm clearance all round, or
- a sleeve, with 50mm clearance all round and suitably sealed
- if built in, connecting on both sides of the wall to pipes with flexible joints located not more than 150mm from the face of the wall. Flexible joints should be made in accordance with the pipe manufacturer's recommendations.



PIPES PASSING THROUGH LINTELLED OPENING



PIPES BEDDED IN WALLS

(b) pipework under roads

Where drains pass under roads and drives, the final compaction should be sufficient to prevent later settlement.

RIGID PIPES

Rigid pipes less than 1.2m below the road surface should, where necessary, be protected from damage by concrete encasement not less than 100mm thick, and having movement joints formed with compressible board at each socket or sleeve joint face.

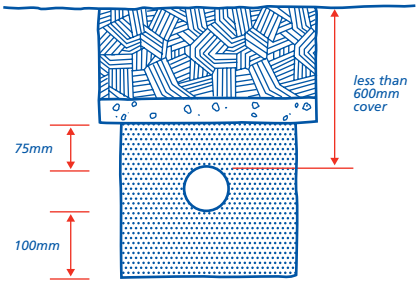
Flexible joints should remain flexible.

FLEXIBLE PIPES

Flexible pipes less than 0.9m below the road surface should be protected by concrete bridging slabs or should be surrounded with concrete reinforced as appropriate.

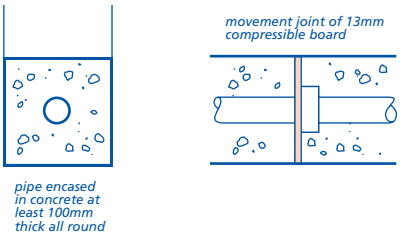
GARDEN AREAS

Where flexible pipes are not under a road and have less than 0.6m cover they should, where necessary, have concrete paving slabs laid as bridging above the pipes, with at least 75mm of granular material between the top of the pipe and underside of the slabs.



(c) movement joints

Where rigid pipes have to be encased in concrete, movement joints of 13mm thick compressible board should be provided around the spigot next to the socket, either at each joint or at not more than 5m intervals.



ACCESS POINTS AND GULLIES

5.3 - S6 Access points shall be constructed and installed as required by the design

Items to be taken into account include:

(a) size and location of access points

All access points should be located where shown on the drawings. They should:

- be accessible for rodding and cleaning
- not cross boundaries or kerb lines.

Ensure that inspection chambers and manholes are of sufficient size for the depth of invert. Do not exceed the invert depth for the particular fitting or chamber. Reference should be made to Appendix 5.3-A.

(b) covers of the drainage system

Manholes should be constructed or installed at the correct level, so that the covers will align with the adjacent ground. Gullies should be adequately bedded, set level and square and kerbed, where necessary.

(c) traditional construction

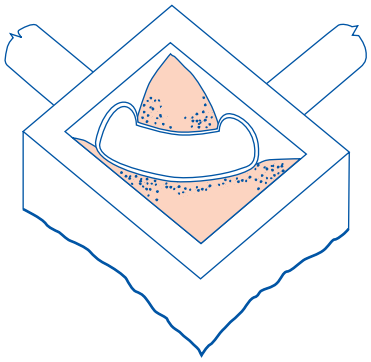
The minimum specification for traditional manholes and inspection chambers is as follows:

BASE
Concrete not less than 100mm thick.

WALLS
Brick, blockwork or concrete should be appropriate for ground conditions. Generally 100mm minimum thickness is suitable for depths up to 0.9m where no vehicular traffic loads are encountered and there is no ground water pressure. Elsewhere, 200mm minimum thickness should be provided.

RENDERING
Rendering, if required, should be applied to the external faces of the wall.

BENCHING
Benching should be steel trowelled to provide:
- a smooth finish
- rounded corners
- a fall of not less than 1:12
- a good foothold.



(d) proprietary systems
Proprietary systems should be installed strictly in accordance with manufacturers' instructions. Adaptors, couplers and sealing rings should be installed correctly and only the lubricants and solvents specified by the manufacturer used.

Proprietary manholes should not be used at a depth greater than that for which they have been assessed as suitable.

(e) type of cover/grid
Manhole covers and gully grids should be of the correct type for the proposed location. Proprietary items (eg covers to plastic manholes) should be in accordance with manufacturers' recommendations.

INSPECTION/MANHOLE COVERS AND FRAMES
- Group 1 - Areas which can only be used by pedestrians and pedal cyclists
- Group 2 - Footways, pedestrian areas and comparable areas, car parks or car parking decks
- Group 3 - For gully tops installed in the area of kerbside channels of roads which when measured from the kerb edge, extend a maximum of 0.5m into the carriageway and a maximum of 0.2m into the footway
- Group 4 - Carriageways of roads (including pedestrian streets), hard shoulders and parking areas, for all types of road vehicles.

Covers used for manholes within buildings should be airtight and mechanically secured.

Covers used for septic tanks, cesspits and settlement tanks should be lockable.

CESSPOOLS

5.3 - S7 Cesspools shall be sited and constructed to prevent contamination of water and health hazards

Items to be taken into account include:

(a) resistance to the passage of water
Cesspools should be impermeable to their contents and to subsoil water. They may be constructed of brickwork, concrete, glass reinforced concrete, glass reinforced plastics or steel.

Brickwork should be of engineering bricks, laid in cement mortar and at least 220mm nominal thickness.

In-situ concrete should be at least 150mm thick.

(b) cover and ventilation
Cesspools should be covered and ventilated.

(c) siting, access and inspection
Cesspools should be sited at least 7m from a dwelling, but within 30m of a vehicle access to facilitate emptying.

Cesspools should be provided with access for emptying or de-sludging and cleaning. All such access points should have no dimension less than 600mm and be provided with lockable covers.

The inlet of a cesspool should be provided with access for inspection.

Cesspools should have no openings except the inlet, the vent and the inspection access.

SEPTIC TANKS

5.3 - S8 Septic tanks shall be sited and constructed to prevent contamination of water and health hazards

Items to be taken into account include:

(a) outfall disposal
Satisfactory outfall disposal is essential where septic tank sewage disposal is installed. Environment Agency consent may be needed in England and Wales. In Northern Ireland the Environment and Heritage Service should approve proposals, in Scotland the Scottish Environment Protection Agency should approve proposals. Check that this approval has been obtained before starting drainage work.

Ground conditions may preclude the use of septic tanks in some locations. NHBC will require evidence of a satisfactory percolation test where a septic tank drainage system is to be installed. See Appendix 5.3-B.

Septic tanks should be sited taking account of topography to ensure that water is drained away from the building.

(b) impermeability to liquids
Septic tanks should be impermeable to their contents and to sub-soil water. They may be constructed of brickwork, concrete, glass reinforced concrete, glass reinforced plastics or steel.

Brickwork should be of engineering bricks, laid in cement mortar and at least 220mm thick.

In-situ concrete should be at least 150mm thick.

(c) cover and ventilation
Septic tanks should be covered and ventilated.

(d) siting, inspection and access
Septic tanks should be sited at least 7m from a dwelling, but within 30m of a vehicle access to facilitate emptying. In Scotland, they should be at least 5m from a dwelling and a boundary. Septic tanks should be provided with access for emptying or de-sludging and cleaning. All such access points where entry is required should have no dimension less than 600mm and be provided with lockable covers.

The inlet and outlet of a septic tank should be provided with access for inspection.

(e) velocity of flow
Provision should be made to limit the velocity of the flow to a septic tank. For drains up to 150mm diameter, the velocity may be limited by laying the last 12m of the incoming drain at a gradient not steeper than 1:50. A dip pipe should be provided, with the top limb rising above scum level and the bottom limb extending about 450mm below top water level.

SURFACE WATER SOAKAWAYS

5.3 - S9 Soakaways shall be sited and constructed to provide adequate short term storage for surface water and adequate percolation into the surrounding ground

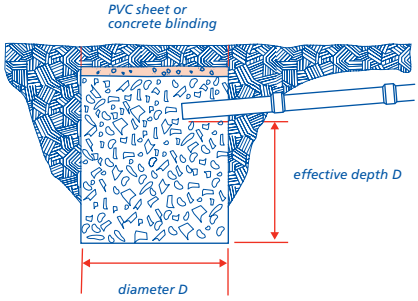
Items to be taken into account include:

(a) location
Where possible soakaways should be built on land lower than, or sloping away from, buildings. Soakaways should generally be sited at least 5m from the foundations of a building.

NHBC may require a percolation test for a soakaway. If the ground is free draining and granular, a test may not be necessary. However, if there is any doubt about the ground, or if there is a large quantity of run-off into the soakaway which may swamp the ground, a percolation test may be required.

Information on percolation tests is given in Appendix 5.3-E.

(b) small soakaways
Small soakaways are holes filled with granular material, eg broken brick, crushed rock or gravel, with particle size 10mm to 150mm. PVC sheet or concrete blinding should be laid over the fill to prevent topsoil being washed down into the soakaway.



(c) large soakaways
For large soakaways, a pit is lined with dry jointed or honeycomb brickwork.

Alternatively, perforated precast concrete rings or segments may be laid dry and surrounded with granular material.

The volume of large soakaways should be calculated to ensure they are of suitable capacity. Refer to Appendix 5.3-E or BRE Digest 365.

TESTING

5.3 - S10 All foul and, where appropriate, surface water drainage systems shall be tested prior to handover

Inspection and testing should be arranged when required by the Local Authority, the sewerage undertaker and NHBC.

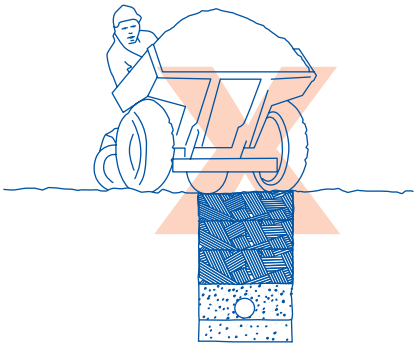
Before backfilling, visual inspections are required and the Builder is advised to test.

When the dwelling is handed over, the system must be in full working order and free from obstruction.

PROTECTION OF WORK

5.3 - S11 All completed work shall be suitably protected from damage by construction work

Damaged drainage will not be accepted. It is recommended that no heavy loading or underground work is permitted above or near unprotected drainage, and that dumpers, trucks, fork lifts or other heavy vehicles are not driven along or near pipe runs.



APPENDIX 5.3-A

Minimum dimensions for access fittings and chambers

Type		Depth to invert from cover level (m)	Internal sizes		Cover sizes	
			Length x Width (mm x mm)	Circular (mm)	Length x Width (mm x mm)	Circular (mm)
Rodding eye			As drain but min 100			Same size as pipework[1]
Access fitting						
small	150 diam 150 x 100	0.6 or less, except where situated in a chamber	150 x 100	150	150 x 100[1]	Same size as access fitting
large	225 x 100		225 x 100	225	225 x 100[1]	
Inspection chamber						
shallow		0.6 or less 1.2 or less	225 x 100 450 x 450	190[2] 450	- Min 430 x 430	190[1] 430
deep		greater than 1.2	450 x 450	450	max 300 x 300[3]	Access restricted to max 350[3]

Notes

1 The clear opening may be reduced by 20mm in order to provide proper support for the cover and frame.
2 Drains up to 150mm.
3 A larger clear opening cover may be used in conjunction with a restricted access. The size is restricted for health and safety reasons to deter entry.

Minimum dimensions for manholes

Type	Size of largest pipe (DN) (mm)	Min internal dimensions[1]		Min clear opening size[1]	
		Rectangular length and width (mm)	Circular diameter (mm)	Rectangular length and width (mm)	Circular diameter (mm)
Manhole					
less than 1.5m deep to soffit	equal to or less than 150 225 300 greater than 300	750 x 675[7] 1200 x 675 1200 x 750 1800 x (DN+450)	1000[7] 1200 1200 The larger of 1800 or (DN+450)	750 x 675[2] 1200 x 675[2]	na[3]
greater than 1.5m deep to soffit	equal to or less than 225 300 375 - 450 greater than 450	1200 x 1000 1200 x 1075 1350 x 1225 1800 x (DN+775)	1200 1200 1200 The larger of 1800 or (DN+775)	600 x 600	600
Manhole shaft[4]					
greater than 3.0m deep to soffit pipe	Steps[5]	1050 x 800	1050	600 x 600	600
	Ladder[5]	1200 x 800	1200		
	Winch[6]	900 x 800	900	600 x 600	600

Notes

1 Larger sizes may be required for manholes on bends or where there are junctions.
2 May be reduced to 600 by 600 where required by highway loading considerations, subject to a safe system of work being specified.
3 Not applicable due to working space needed.
4 Minimum height of chamber in shafted manhole 2m from benching to underside of reducing slab.
5 Min clear space between ladder or steps and the opposite face of the shaft should be approximately 900mm.
6 Winch only - no steps or ladders, permanent or removable.
7 The minimum size of any manhole serving a sewer (i.e any drain serving more than one property) should be 1200mm x 675mm rectangular or 1200mm diameter.

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APPENDIX 5.3-B

Percolation test procedure for septic tank installations

1 Excavate a hole 300mm square x 250mm deep below the proposed invert level of the land drain.
2 Fill the hole with water to a depth of 250mm and allow to drain away over night.
3 Refill to a depth of at least 250mm and note the time taken (in seconds) to drain away completely.
4 Repeat the exercise two more times and calculate the average of the three results, as follows:

$$\text{percolation value (s)} = \frac{\text{time to drain away (seconds)}}{\text{depth of water (mm)}}$$

Results

percolation value	suitability
up to 100	use Appendix 5.3-C Chart 1 to determine field drain area
100 to 140	use Appendix 5.3-C Chart 1 but with underdrains*
over 140	field drains unsuitable

* Where underdrains are necessary, drainage trenches should be constructed not less than 600mm deeper than the pipe level specified in the design, and the lower part filled with pea gravel (see Appendix 5.3-D)

A second system of drainage pipes should be laid on the bottom of the trenches to convey surplus drainage to an outfall in a surface ditch or watercourse.

Underdrains are costly, and a secondary treatment system able to produce an effluent suitable for surface discharge may be preferable.

APPENDIX 5.3-C

Septic tank field drain design

Capacity based on Potential Occupancy

Minimum capacity (litres)	Number of persons/bed spaces
2700	< 4
2720	4
2900	5
3080	6
3260	7
3440	8
3620	9
3800	10

Chart 1 Field Drains Trench Area

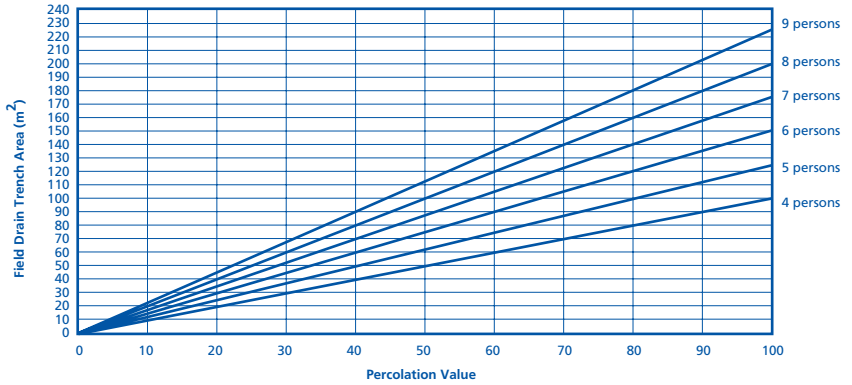
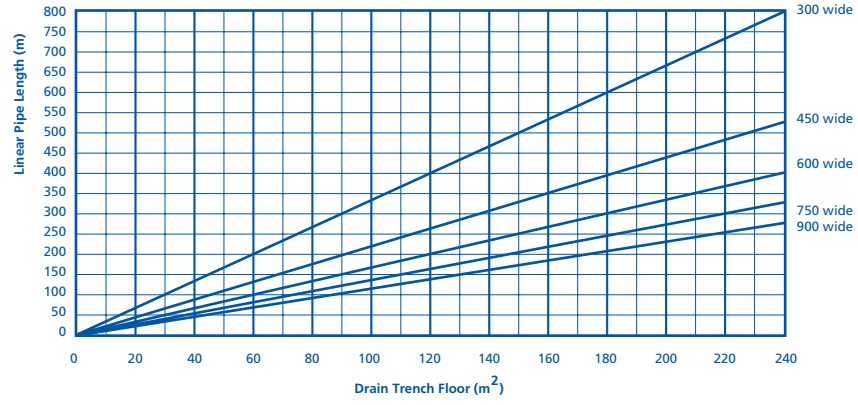
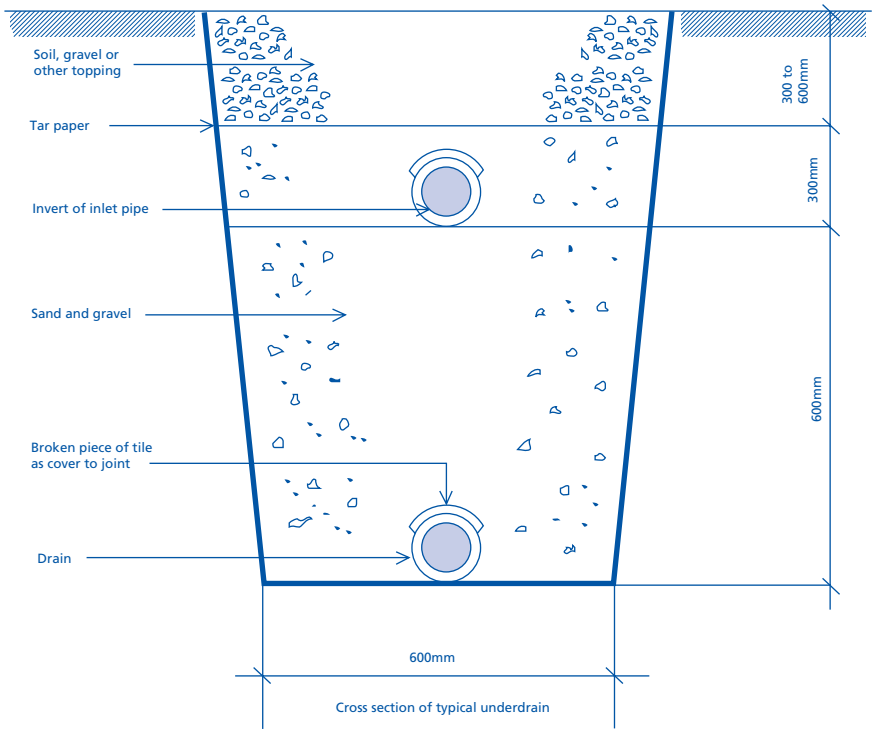


Chart 2 Field Pipe Length



APPENDIX 5.3-D

Cross section of typical underdrain



Cross section of typical underdrain

APPENDIX 5.3-E

Percolation tests and design method for surface water soakaways

PERCOLATION TEST

The rate at which water will disperse into the ground depends on the permeability of the ground, which varies with the soil type.

The test will give a fairly accurate assessment of how the ground drains. As the test hole can be used as part of a soakaway, it should be dug in a place that would be suitable for a soakaway, at least 5m from the foundations of a building.

A summary of the test procedure is given below:

TEST PROCEDURE

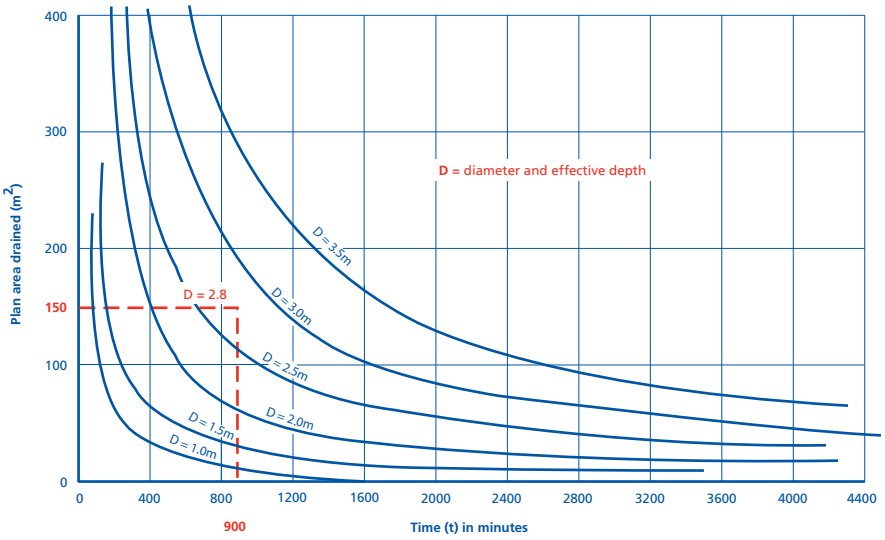
A trial hole in a similar location and to the same depth as the proposed soakaway or septic tank land drain will give a measured rate of percolation.

The procedure is as follows:

1. Bore a hole 150mm in diameter with an auger to a depth of one metre.
2. Fill with water to depth of 300mm above the bottom. As an aid, mark a stick 300mm from one end, place in the hole and fill up to the mark on the stick (it takes approximately 5.5 litres to fill a 150mm diameter hole to a depth of 300mm).
3. Observe the time taken in minutes for the water to soak away (this may take several hours, in some cases need to be left overnight).
4. If possible the test should be repeated and the average time used.
5. A second group of tests are carried out after the hole has been bored out to a depth of 2 metres, still using 300mm of water above the bottom of the hole.
6. If the soil appears to become more permeable with depth, it may be useful to deepen and retest the bore in one metre stages.

DESIGN OF SOAKAWAY

The relationship between the diameter or effective depth required for a soakaway to suit a given area of roof and/or paved area, and the average time (t) given by the test outlined on the previous page, is shown on the graph below. The diameter and effective depth below invert level are assumed to be the same dimension (D).



EXAMPLE

Test time (**t**)	= 900 minutes
Plan area to drain	= 150m²

Therefore, using the graph, the diameter and effective depth of the soakaway (D) are both 2.8m.

Notes

- If the ground is of low permeability, dig separate soakaways to drain smaller but distinct parts, for example:
  - one side of a roof to one soakaway
  - the other side to a second soakaway
  - the driveway or yard to a third soakaway.
- Where the permeability of the ground increases with depth, tests in the deepened trial holes will give shorter percolation times, so it may be cheaper to build a smaller soakaway at a greater depth below the surface.
- Where possible, soakaways should be built on land lower than, or sloping away from, buildings. They should also be kept a "safe" distance away from buildings. This should be at least 5m from building foundations. In chalk and other soil and fill material subject to modification or instability, the advice of a specialist geotechnologist should be sought regarding the siting and advisability of soakaways.

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