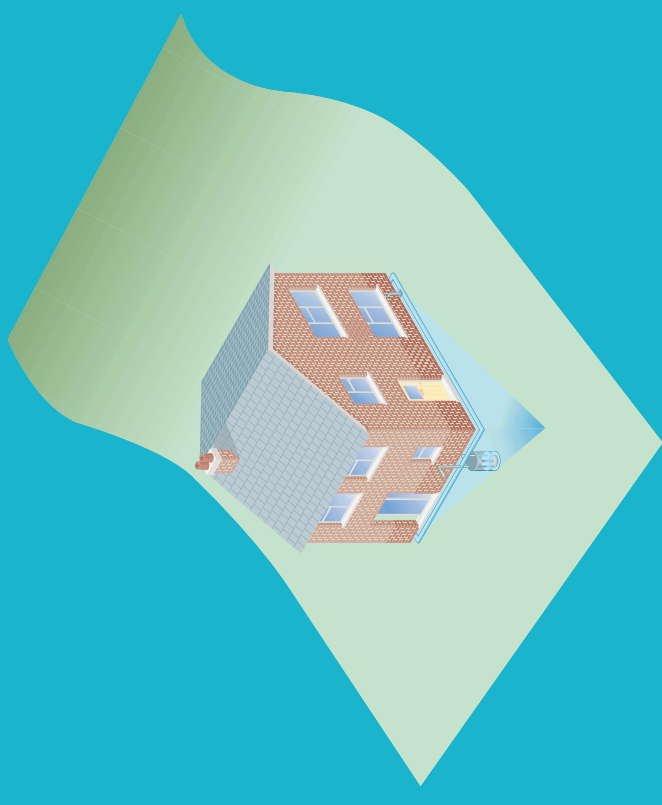


APPENDIX 2

Floodline
0845 988 1188
ENVIRONMENT AGENCY

Groundwater flooding

A guide to protecting your home
from flooding caused by groundwater



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Flooding can arise from many different sources. This guide is specifically aimed at protecting your home from flooding caused by groundwater, i.e. water emerging from underground. Traditional flood protection methods are ineffective against groundwater, which can come up through the floor and remain high for long periods of time. Flooding can also occur when rainwater runs off fields or roads during heavy rainfall and some of the advice in this guide will be applicable to this runoff situation.

Other advisory booklets are available from Floodline:

- 'Damage Limitation' - How to make your home flood resistant
- 'After a Flood' - How to restore your home
- 'Flood Products' - Using Flood Protection Products A guide for homeowners'
- 'Preparing for Flooding' - Information manual offering advice from making a flood plan to detailed information on protecting property.



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What is groundwater flooding?

'Groundwater flooding' is the result of a rise, either natural or man-made, in the water table. The water table is the level of water within rock or soil that makes up the land surface. When the water table reaches ground level, water starts to emerge on the surface and flooding occurs. Groundwater flooding can arise for many reasons. It is often difficult to distinguish from unexpected flooding caused by, for example, blocked or overwhelmed drains or sewers, or standing water due to poor surface drainage. In some locations, where works have been carried out to prevent flooding from a river, the former flood plain may still become inundated, due to high groundwater levels.

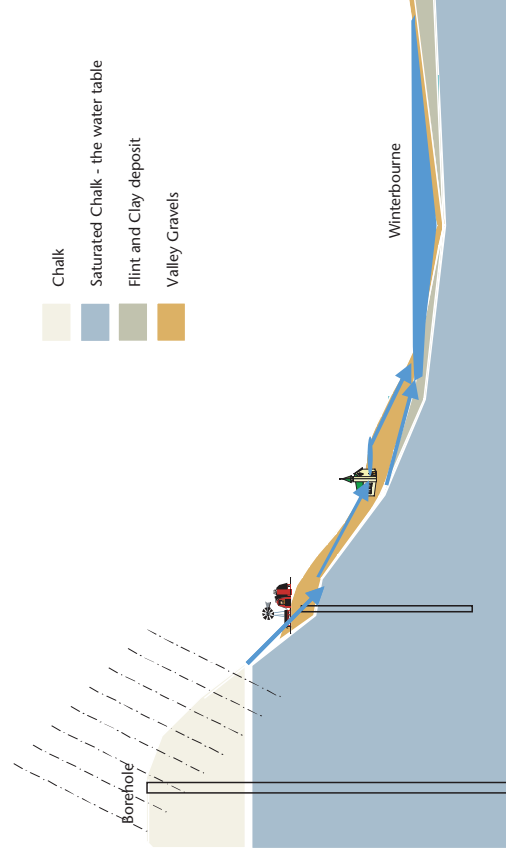
Also referred to as spring water or springs, groundwater flooding occurs where the subsoil is permeable and allows water to pass through it. The problem is most common in areas with chalk strata. Chalk is common in

England particularly in the south. Chalk is a soft limestone composed of minute particles of algae skeletons deposited beneath ancient seas. Chalk is a porous material; it absorbs water like a sponge but will only transmit water when it is fissured, which it commonly is at the upper levels.

Sands and gravels are also permeable deposits often found in river valleys and can be the source of groundwater flooding.

Groundwater flooding is characterised by three main features:

- Flooding will usually occur days or even weeks after heavy rainfall, thus lulling the householder into a false sense of security.
- The flooding will be of long duration often lasting several weeks.
- It does not always emerge where you would expect (i.e. valley bottoms). It may also emerge on hillsides.



How groundwater flooding occurs

More than half annual rainfall in this country evaporates. 80% of evaporation occurs between April and September. Rainfall which does not evaporate or run-off, percolates downwards to be stored in the 'Zone of Saturation', commonly known as the 'Water Table'.

The water table generally follows the ground profile in a uniform soil but if less permeable strata are encountered water will often emerge at the surface as a spring.

The fluctuating level of the water table is affected by long term rainfall and by water abstraction. From the industrial revolution until the 1980s there was an overall lowering of the groundwater level, but in recent years

we have experienced a period of increased rainfall and a decline in traditional industries. This has resulted in groundwater levels recovering which is starting to cause problems.

This rising groundwater phenomenon has been very noticeable in villages on the chalk downs where the sources of many winterbournes have moved up their valleys to locations not seen for many years. There are however many older residents who will remember these locations because they were commonplace before 1950 and can often be seen in old place names for example 'Springhead' or 'Watery Lane'.



Salisbury Cathedral, winter 1915

Housing is often situated in valley bottoms for historic reasons associated with water supply and shelter. In the bottom of a valley the water table is often close to the surface.

Many older properties had floors at ground level for ease of construction and often low ceilings. Previous generations accepted wet floors in winter as the norm and benefited from the guaranteed water supply, but modernisation and changing standards have made this unacceptable. Extensions have often been built back into the side of the hill to gain extra space and floors lowered to gain headroom. These modifications can result in damp and in some cases flooding.

Further problems have been caused by road improvements, which frequently involve widening the road and sometimes raising levels to achieve better road drainage and improved gradients. In some cases this has left properties below road level.

Following a relatively tranquil 30-year period, during which much development took place often in sites historically prone to groundwater flooding, the last two decades have been characterised by a series of wet winters, most notably 2000/2001 and these caused some old, often forgotten problems and many new ones to be revealed.

It follows that most groundwater vulnerable areas are now known and problems arising should not come as a surprise.

These problems, although well known locally, are not necessarily well documented, therefore a precautionary approach should be taken to purchasing or developing in vulnerable areas.

The Environment Agency is working on a new system to give advance warning to householders by means of a network of Flood Wardens. These are volunteers with local knowledge who have taken on the task of relaying the warnings broadcast by the Environment Agency.

To help determine whether a property is at risk you may obtain useful information from the following:

- Environment Agency
- Local Authority
- Parish or Town Council
- Highways Authority

If you are still unsure whether your home is at risk you can contact a professional to carry out a 'flood risk assessment'. These would normally be consulting engineers or chartered surveyors and can be found listed in the Yellow Pages under Engineers - Consulting or Surveyors - Building. The Association of Consulting Engineers (telephone 020 7222 6557) will recommend a selection of consultants.

The best way to deal with any flooding problem is to anticipate it and take precautions in advance. This is of course not always possible and emergency action is sometimes required.

The Environment Agency or local authority may offer advice and help but there is no statutory obligation on them to do so.

Sandbags can be used to form a barrier as a temporary preventative measure against fast moving water. They are more effective when used to hold down plastic sheeting. Details on the use of sandbags can be found in the Floodline advisory booklet 'Damage Limitation'.

Alternative flood protection systems are also available and a comprehensive guide - Flood Products - can be requested free of charge from Floodline or downloaded from our website www.environment-agency.gov.uk.

Temporary barriers, including sandbags, may prevent major flooding but will not prevent water seeping through the subsoil and entering the property through unsealed service openings and the floor itself.

A pump will often be required and care must be taken about safety if a mains powered electric pump is to be used in flood conditions. Petrol or diesel powered pumps are available and may be the only option if the power supply is interrupted. These carry their own risks of carbon monoxide poisoning from the exhausts and should only be used in well ventilated conditions.

Pumps are at their most efficient when the inlet is installed in a sump (a low point into which water can drain).

The fire and rescue service may pump out a flooded property but, in the case of

groundwater flooding, pumping will be required over a long period of days or weeks and this service is unlikely to be available.

Care must be taken to ensure that the discharge from a pump will not cause a nuisance to neighbours and consultation with the highway authority is essential if water is to be discharged onto a road or into a highway drain.

Floodwater must not be pumped into the public foul sewer, as this will cause flooding elsewhere.

All carpets and furniture should be removed upstairs if possible on the assumption that water may get around the temporary defences.

Turn off the electricity supply if water is likely to affect circuits or equipment.

If any flooding in excess of 50mm (two inches) is experienced or anticipated, turn off the gas supply and disconnect gas appliances which can float causing damage to rigid gas pipework.

If you are on main drainage, your local water company should provide assistance if the toilets will not flush.

Septic tanks are unlikely to work in flood conditions and it may be necessary to hire portable facilities. Cess pits can also fail in flood conditions (see, Chapter 8 'Foul Drainage').

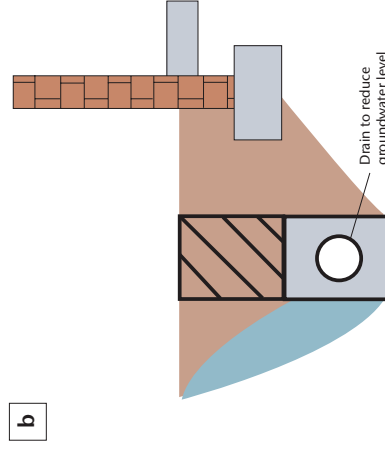
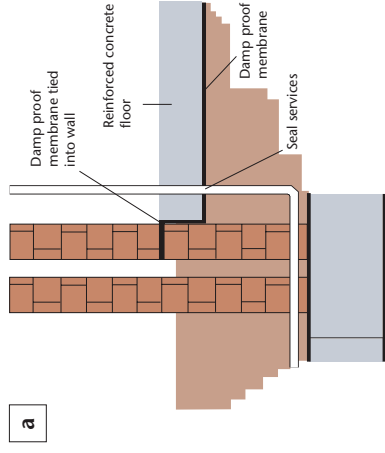
Your insurer should be notified as soon as possible.

All floodwater should be treated as potentially contaminated. Take precautions by wearing protective clothing and disinfecting afterwards.

The most vulnerable part of the property to groundwater flooding is the floor and the lower parts of the walls above the damp-proof course. This includes openings for service pipes, cables and also airbricks.

Preventative measures fall into two main categories,

- a Accepting the presence of the water and defending against it.
- b Reducing the level of the water or raising the building above it.



The following Sections give an overview of some possible long term solutions to flooding but you should be aware that all cases are individual and we would recommend taking specialist advice before implementing improvements. Specialist advisors are listed at the end of this guide.

The Floor

Solid floors bearing onto the ground may be constructed from brick, stone or concrete and may, or may not, have a damp proof membrane. None of these types of floor are likely to stop water ingress unless they are reinforced concrete built to a high standard with this purpose in mind.

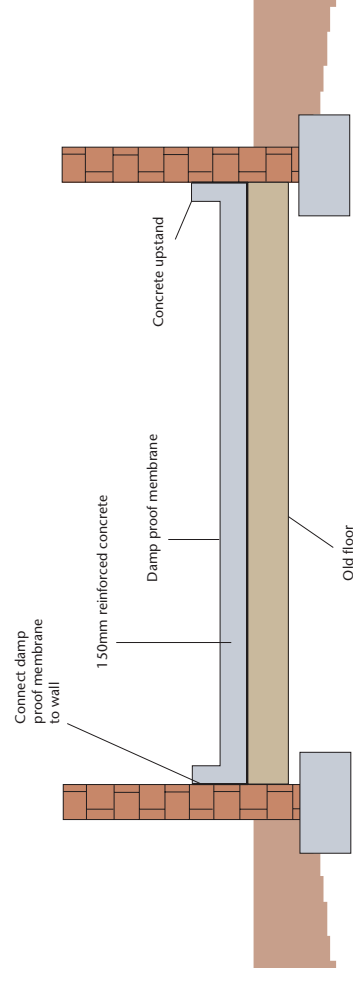
Existing floors can be waterproofed to resist very limited water pressure by the use of proprietary sealing agents. These are however best regarded as 'damp proofing' systems rather than flood prevention measures. They can however be useful in conjunction with measures to lower the water pressure.

A replacement floor constructed to a high standard with reinforced concrete and with a continuous damp proof membrane can be an effective solution where ground water pressures are low. Particular care must be taken at the joint between the floor and the walls where water can penetrate.

It will sometimes be necessary to have an upstand to the flood constructed monolithically with the floor inside the existing walls.

Suspended Floors

Suspended floors may be constructed of timber or concrete, the latter either in-situ or precast. There will be a void beneath the floor which will flood before water rises to enter the house. Flooding beneath wooden floors will often cause the timber to rot and specialist advice should be sought. The 'oversite' beneath a suspended floor will be finished with a concrete blinding in more recent houses and this can be laid to fall to a sump from which water can be pumped. This can form a permanent solution but is better regarded as an emergency measure or for very infrequent use.

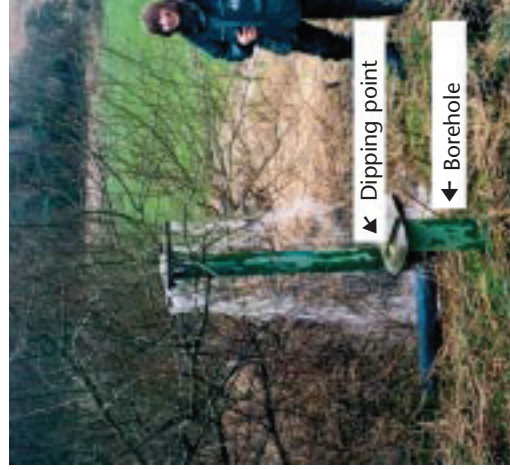


Raised Floor Levels

If headroom is available, raising the floor level is an effective solution and this can be done by either laying a new reinforced concrete floor, bearing directly onto the existing, or, by creating a suspended floor above the existing. New plastic materials are available which can provide a drainage path between the two slabs.

It is important to remember that water exerts considerable pressure. A 300mm depth (1 foot) of water pressure will lift a 125mm thick (5 inch) concrete slab.

The photograph below shows an example of groundwater (artesian) pressure. If the pipe was extended, almost to the height of the water table in the hills behind, water would still emerge from the top. The water table may be tens of metres higher than the point of emergence. It's this pressure that makes groundwater flooding difficult to prevent.



Basements

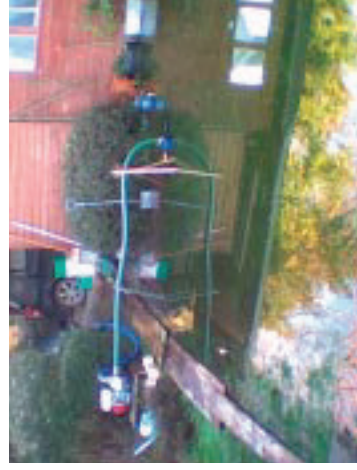
Basements are particularly prone to flooding and remedial measures are often difficult to implement. There are a range of 'tanking' materials available but these are best applied on the outside face. This is often impractical and it is sometimes necessary to construct an inner wall to achieve a satisfactory result. Specialist advice is strongly recommended because sealing the walls can lead to an increase in water pressure which may cause structural damage.

Reduce the Water Level

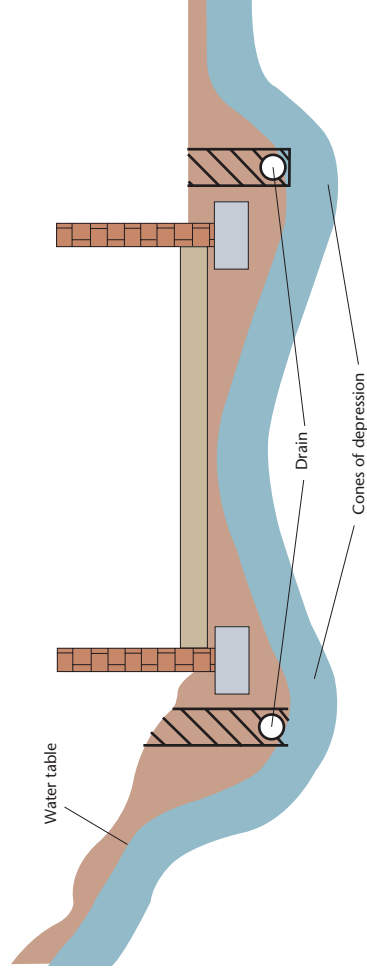
The most effective method of keeping groundwater out of property is to intercept the water by means of a drainage system and divert it away from the house. The technique involves creating a 'cone of depression' beneath the property to prevent groundwater rising to floor level.

In some cases this can be achieved with a gravity drainage system but often a pump will be required.

The diagram opposite illustrates the principle of the system.

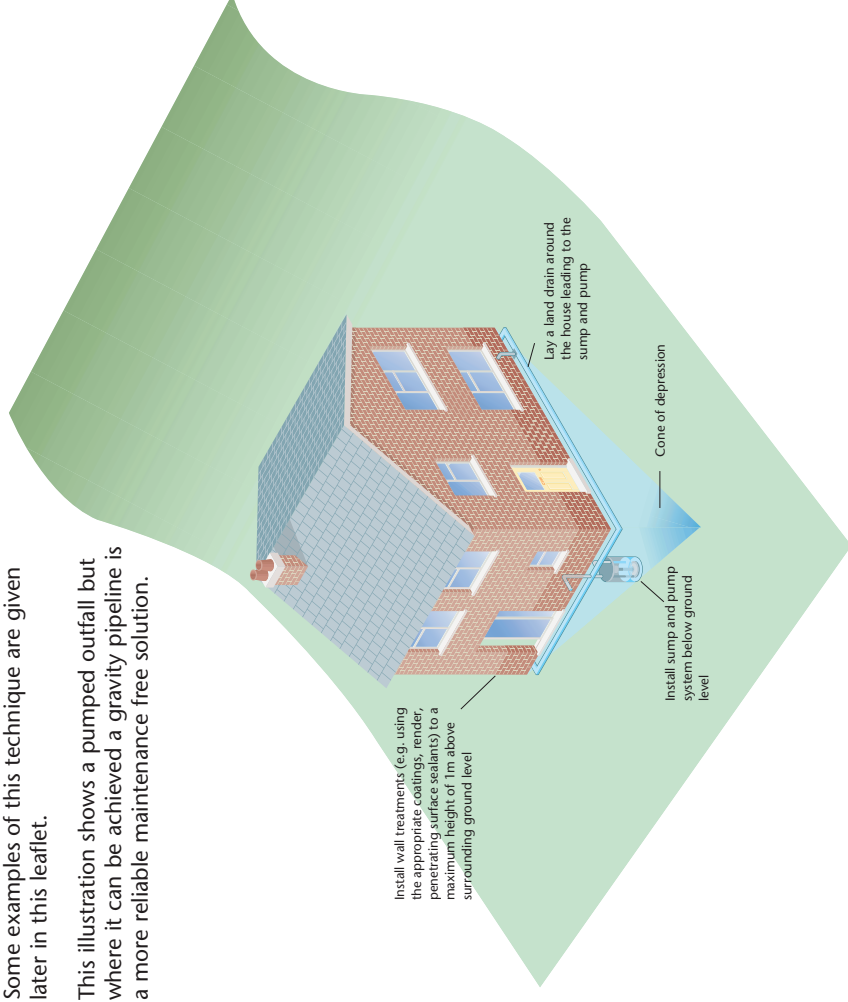


A submersible pump in operation



Some examples of this technique are given later in this leaflet.

This illustration shows a pumped outfall but where it can be achieved a gravity pipeline is a more reliable maintenance free solution.



Pumps can be electric or petrol/diesel driven. Electric power is the most convenient but there is a danger of power cuts in flood conditions and consideration should be given to providing a back up generator. Single-phase supply of less than 1Kw is usually adequate for domestic groundwater flood situations.

A qualified electrician should be employed to provide a separate circuit which need not be isolated during a flood.

Petrol or diesel pumps are possible alternatives but groundwater problems are often of long duration and noise and refuelling may become a burden.

Pump discharge is a serious issue and can be very hard to resolve. Possible discharge points are:

a Surface Water Sewers: These fall into three categories.

- i Public surface water sewers - controlled by the water companies, they are generally reluctant to allow land drainage into their systems but may allow an emergency discharge.
- ii Highway drain - These systems are for highway drainage and owned by the highway authority, usually the County Council. Highway authorities are reluctant to allow other drainage into their systems but will sometimes make an exception. To contact see ROADS in the telephone directory.
- iii Piped watercourse - many rural areas have a piped watercourse, often running beneath the highway. These are distinguished from the above systems by a continual flow of water during dry weather. Control of these systems is normally with the local authority.

b Ditches and Watercourses: Discharge to ditches and watercourses are regulated under land drainage law. Start by consulting your local authority who may refer you to the Environment Agency if a formal consent is required.

c Rivers: Discharge to main rivers requires formal Land Drainage Consent from the Environment Agency. To contact see Environment Agency in the telephone directory white pages.

d Boreholes: Occasionally groundwater can be perched in a permeable layer overlying clay strata. It is sometimes possible to drill a borehole through the clay layer and discharge groundwater into the lower layer. This technique requires specialist knowledge and the Environment Agency should also be consulted to obtain the necessary consents.

e Foul Sewer: Foul sewers are controlled by water companies and they are very unlikely to permit any surface water to enter even in an emergency. They have power to prevent any such discharge. To contact your local service provider see WATER in the telephone directory white pages.

The waste from sinks, baths and toilets, collectively known as foul sewage frequently backs up and causes problems during groundwater flooding. Foul sewerage systems fall into two categories.

a Main Drainage: Piped systems operated by a water company or occasionally by a housing association or maintenance company in the case of shared private systems. These are sealed systems and should be unaffected by groundwater but in practise older systems will often leak. Problems with these systems should be referred to the relevant organisations. If the response is unsatisfactory an approach can be made to OFWAT (telephone 0121 625 1381).

If you have a recurrent problem with sewage flooding which the relevant authorities are unable to solve, a range of non-return valves is available and guidance on these can be obtained from CIRIA (Construction Industry Research Information Association).

b Private Systems: These are usually septic tanks or occasionally cess pits.

i Septic tanks are simple treatment systems which trap solids and then discharge semi-treated fluid to soakaways or land drains. These systems frequently give trouble when groundwater levels rise. It is often possible to introduce a pump on the outlet side of the tank to keep the system operational. Ideally this should pump the effluent to high ground above the groundwater table. Consent to discharge is required for effluent disposal and the Environment Agency should be consulted. The design of pumped effluent systems is quite complex and specialist advice should be sought.

ii Cess pits are sealed tanks of 14 cu.metres (3,000 gallons) capacity or more which store five or six weeks of effluent which is then tankered away. If these are well built, they should not be a problem, but rising groundwater will test the integrity of the structure above the level to which it was designed to be watertight and small leaks can quickly fill the tank.

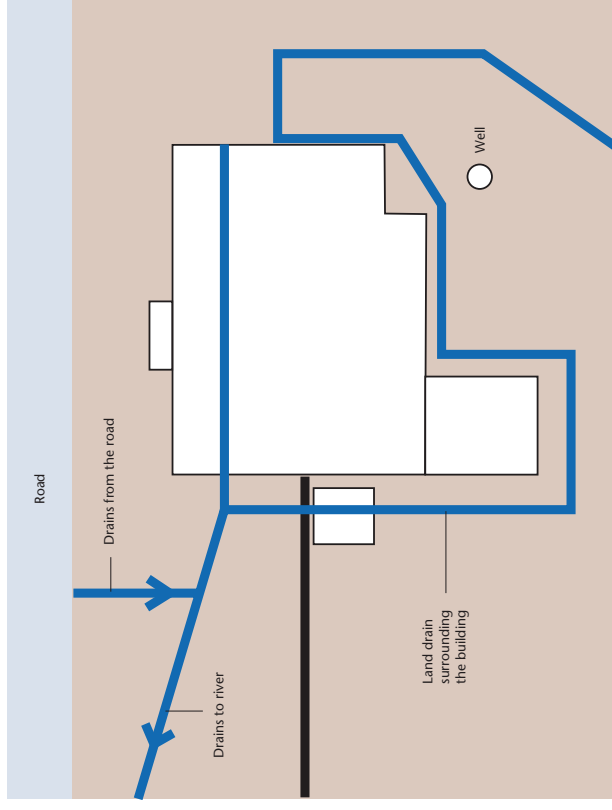
Warning

It is tempting to call a tanker to empty a septic tank or cesspit when the toilet will not flush. There is a danger that if the tank has not been installed with a sufficient mass of concrete surround, it will suffer an upthrust causing flotation of the tank. Alternatively it will very quickly fill with groundwater and nothing will be gained.

Case study 1

A cottage on chalk subsoil, where the road has been raised and widened leaving the property in a 'hollow', suffered severe flooding. The technique employed was to lay a land drain around the perimeter of the cottage discharging to a nearby stream. This system has been in use for a number of years and is reported to be working effectively.

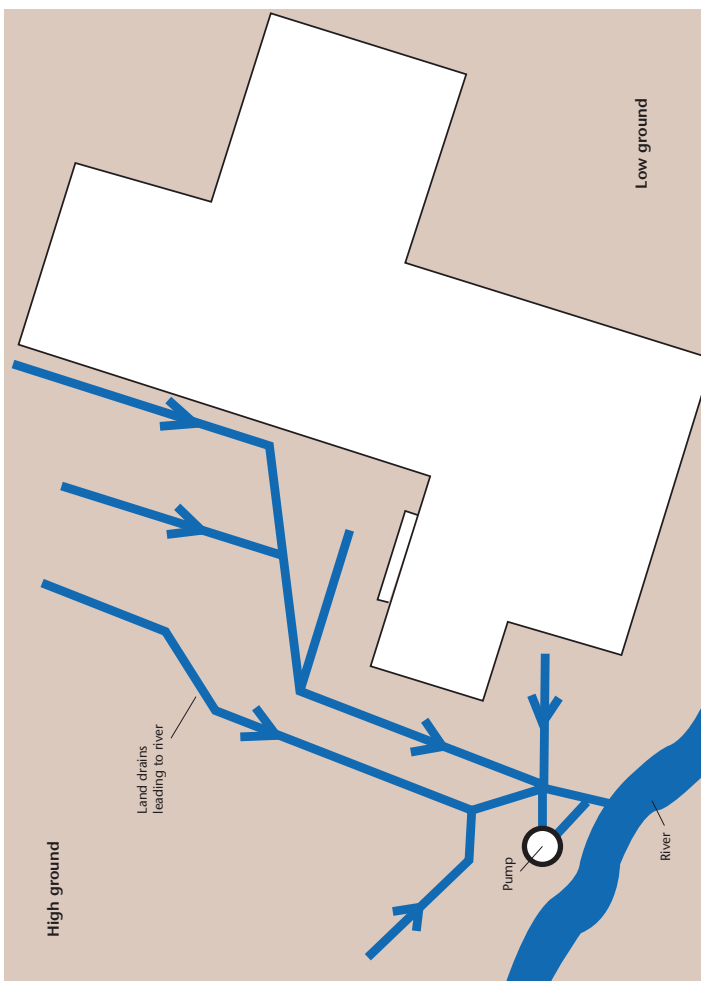
The topography at this site enabled the system to drain by gravity.



Case study 2

A former mill building has been modernised with a reduced floor level to provide greater headroom. The new floor was of reinforced concrete and with a damp proof membrane, but flooding still occurred. A land drain was installed on the uphill side only, with a gravity

discharge to a stream. A pump was also provided, designed to operate when levels in the stream prevented a free gravity discharge. In addition the floor was sealed with a proprietary epoxy sealant. These measures are reported to be working well.



Help and advice

A number of individuals and organisations can provide specialist advice or undertake practical work to make your property more resistant to flooding. Some of these are listed below, together with services that they provide.

Organisation	Services
Building companies and builders	Good local building companies can undertake general work to improve the water-resistance of a property. This could include pointing of brickwork, sealing joints around door and window frames, fitting flood protection products, etc. Where possible, obtain recommendations or references prior to commissioning builders.
Consulting engineer/ Building surveyors	The installation of tanking (render or sheet material intended to prevent water entry, usually into basements) is a specialist task, which should not be attempted by a general builder. Advice and specification from a surveyor / engineer is likely to be necessary to ensure appropriate products are used.
Association of Consulting Engineers	Consulting civil engineers and local building surveyors can undertake surveys of a property to assess its current condition. These will identify whether the property requires adaptation to strengthen it to resist the loads (pressure of water) likely to be imposed upon it during a flood or whether other remedial works to the walls and floors etc are necessary to minimise water entry through them. They can also prepare formal specifications and a contract for the work to be carried out by a competent building company and supervise the works whilst they are being undertaken. Employing specialist advisors in this way where the risk and cost of flooding are considered to be high is a sensible precaution.
Royal Institute of Chartered Surveyors (RICS)	The Association can advise on suitable companies to approach for surveys and design work. www.istructe.org The RICS can advise on suitable property surveyors. www.rics.org.uk

Organisation	Services
The Association of British Insurers (ABI)	Can advise on what to do if you have been flooded and provide information on insurance company helplines. However your first point of contact should be your broker or claims contact listed in your insurance policy. www.abi.org.uk 020 7600 3333
CIRIA	The CIRIA website provides useful guidance on preparing for and dealing with the after effects of flooding. www.ciria.org/flooding You can download advice sheets from the CIRIA website. These provide additional information on improving the flood resistance of your property and provide competent DIY enthusiasts, builders and contractors with technical information.
English Heritage	English Heritage can advise on the repair and protection of listed buildings. www.english-heritage.org.uk 0870 333 1181
Highways Agency	The Highways Agency may be able to provide information on the drainage of major trunk roads. www.highway.gov.uk 08457 50 40 30
National Flood Forum (NFF)	Can offer support to those affected by flooding including general information about all types of flood products, possible sources of help and strategies for coping. www.floodforum.org.uk 01299 403055
The British Damage Management Association (BDMA)	Can provide information on suitable companies to approach for assistance in the repair or renovation of your property. www.bdma.org.uk
Water companies, drainage and sewerage undertakers	Your local water company (sewerage undertaker) may be able to provide information on drains and drainage in your area. www.water.org.uk

The Environment Agency builds and maintains the majority of permanent flood defences in low-lying areas of England and Wales, to reduce the risk to homes and businesses. We are also responsible for warning the public about flooding from rivers and the sea in England and Wales and raising awareness of flood risk. Other responsibilities include pollution prevention, water resource management and waste regulation.

More copies of this guide and other booklets 'Damage Limitation – how to make your home flood resistant', 'After A Flood – how to restore your home', and 'Flood Products – using flood protection products' and a technical manual 'Preparing for Floods' are available free from Floodline. They can also be downloaded from our website www.environment-agency.gov.uk

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www.environment-agency.gov.uk/flood

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 Environment Agency
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 Exminster
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SOUTH WESSEX AREA OFFICE
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 Sunrise Business Park
 Higher Shaftesbury Road
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CORNWALL AREA OFFICE
 Environment Agency
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 Bodmin PL31 1EB

NORTH WESSEX AREA OFFICE
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