GEBERIT

# WASTE WATER HYDRAULICS
## COMPETENCY BROCHURE

KNOW HOW INSTALLED

# Table of contents

# 1 About this document

## 1.1 Foreword

The Geberit waste water hydraulics competence brochure provides you with basic knowledge on building drainage technology. Starting with the basic concepts of waste water technology, it presents a step-by-step introduction of the function and features of the individual components which form a building drainage system. Thanks to our long-standing experience in sanitary technology, we offer a training and reference guide based on practical expertise which is intended for practical work.

## 1.2 Disclaimer

All information contained in this document, which is based on standards, ordinances or regulations etc., has been thoroughly researched and compiled with the greatest possible care. However, we cannot guarantee that such information is correct, complete or up to date. Geberit is not liable for damage resulting from the use of this information.

## 1.3 Copyright

# 2 History of drainage

## 2.1 History of the sewage system

The first drainage systems were developed as far back as 3000 BC in the cities of antiquity in order to properly drain waste water for hygienic reasons. At that time, the drainage systems consisted of discharge pipes or channels that worked on the principle of waterborne sewage systems. With waterborne sewage systems, waste and waste water are washed away by rain, streams or rivers. The waterborne sewage system was one of the main reasons why many settlements developed near waterways.

In ancient times, the Romans continued to develop the drainage technology. Every urban settlement in the Roman Empire had its own drainage system. As a rule, these were open drainage channels that were still based on the waterborne sewage principle.

In Rome, the open drainage channels which were originally created by the Etruscans were gradually developed into a closed drainage system: the Cloaca Maxima. In addition to supplying the population with service water, aqueducts supplied the city with water from the surrounding area in order to flush out the Cloaca Maxima. The waste water from the Cloaca Maxima flowed untreated into the River Tiber, which, over time, became heavily contaminated.

In the early Middle Ages, after the end of the Roman Empire, the knowledge of the hygienic importance of systematically draining waste water was largely lost in Europe. The continual growth of the population and – in some cases – dreadful hygienic conditions caused devastating epidemics to occur again and again.

It was only in modern times, as cities grew rapidly due to the industrialisation of Europe, that the development and construction of drainage systems was driven forwards. In 1739, Vienna (Austria) was the first European city to feature a complete sewage system. In 1882, the first waste water treatment plant on the European mainland was put into operation in Frankfurt-Niederrad (Germany). Just a few decades later, we saw the beginning of the development of biological waste water treatment.


5037289099 ©
int.en 21169-19/358

## 2.2 History of building drainage

It has been proven that building drainage systems were already used by advanced civilisations of antiquity. Excavations in Mohenjo-daro in Pakistan, the central site of the Indus civilisation from around 2500 BC, revealed toilets in houses which were connected with masonry drainage channels. Household toilets were also built in ancient Greece and the Roman Empire, especially in the palaces and houses of the rich upper classes.

Along with the knowledge of systematically draining waste water, the knowledge of sanitary installations in buildings was also lost during the Middle Ages. People usually relieved themselves outdoors. Only detached buildings such as fortresses and castles featured niches or bay windows with an opening to the outside. In the late Middle Ages, the desire for more privacy and comfort meant that the methods for disposing of faeces shifted from outdoors to inside buildings.

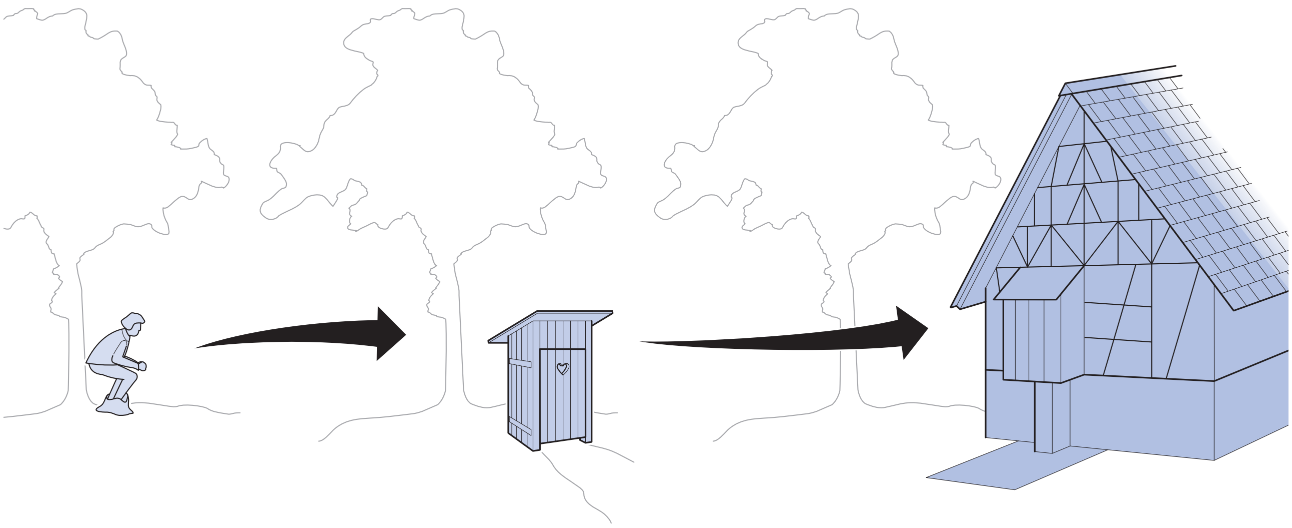


Figure 1: The development of building drainage up to the Middle Ages

In 1850, the development of pipes and their installation in buildings enabled toilets to be flushed. However, traps had not been invented at this time, meaning that odour emissions could not be prevented.

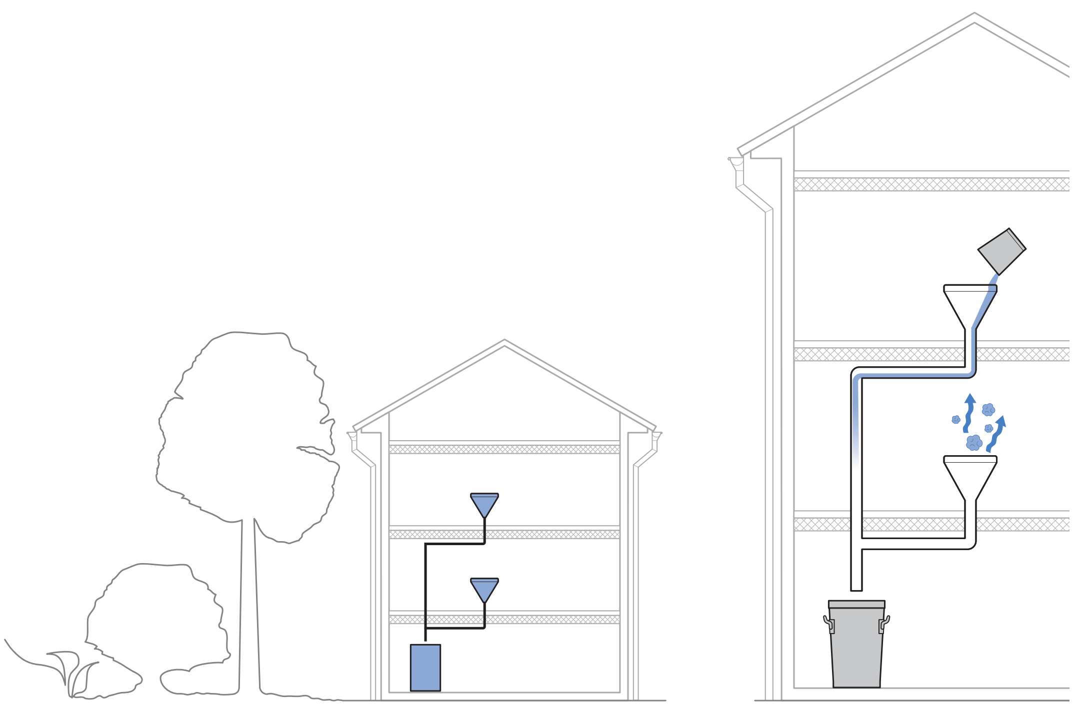


Figure 2: Building drainage around 1850

It was only from around 1870 that it was possible to prevent odour emissions in buildings by laying the cesspit outside and introducing traps.

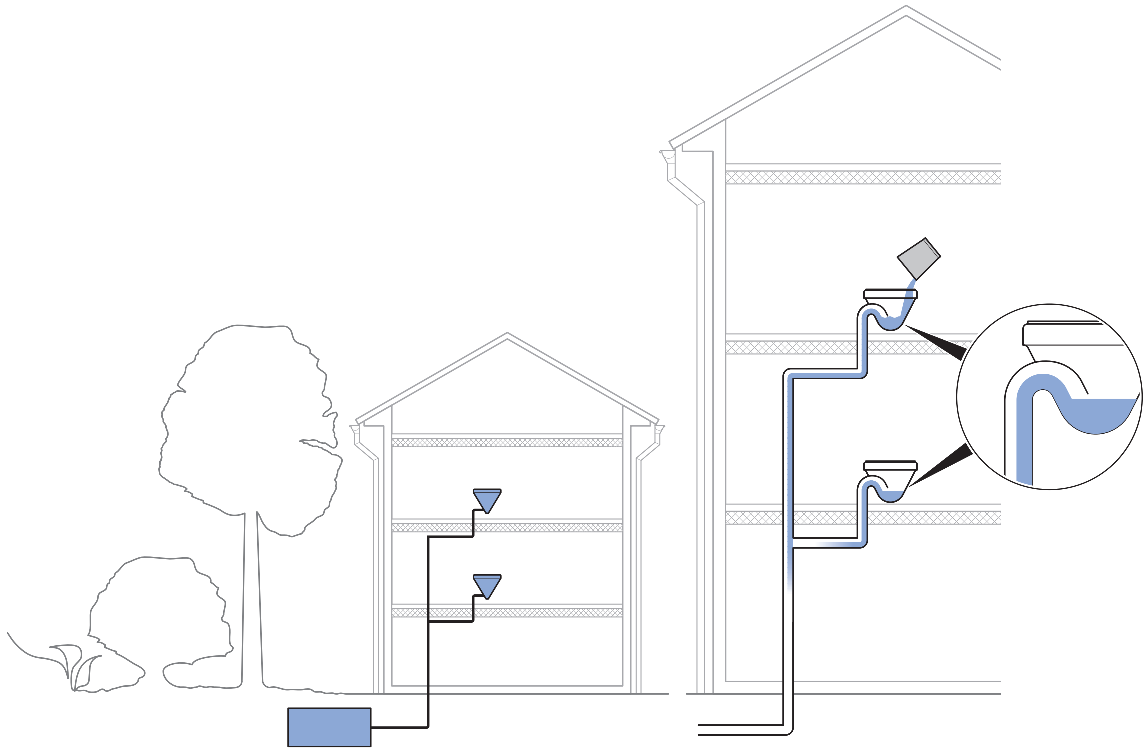


Figure 3: Building drainage around 1870

At the end of the 19th century, the cistern was invented and the toilet was developed into its present shape. Due to the large amount of water needed to flush the toilet, the drainage system had to be ventilated through the roof. The ventilation prevented unfavourable flow conditions and thus ensured that the waste water was drained freely.

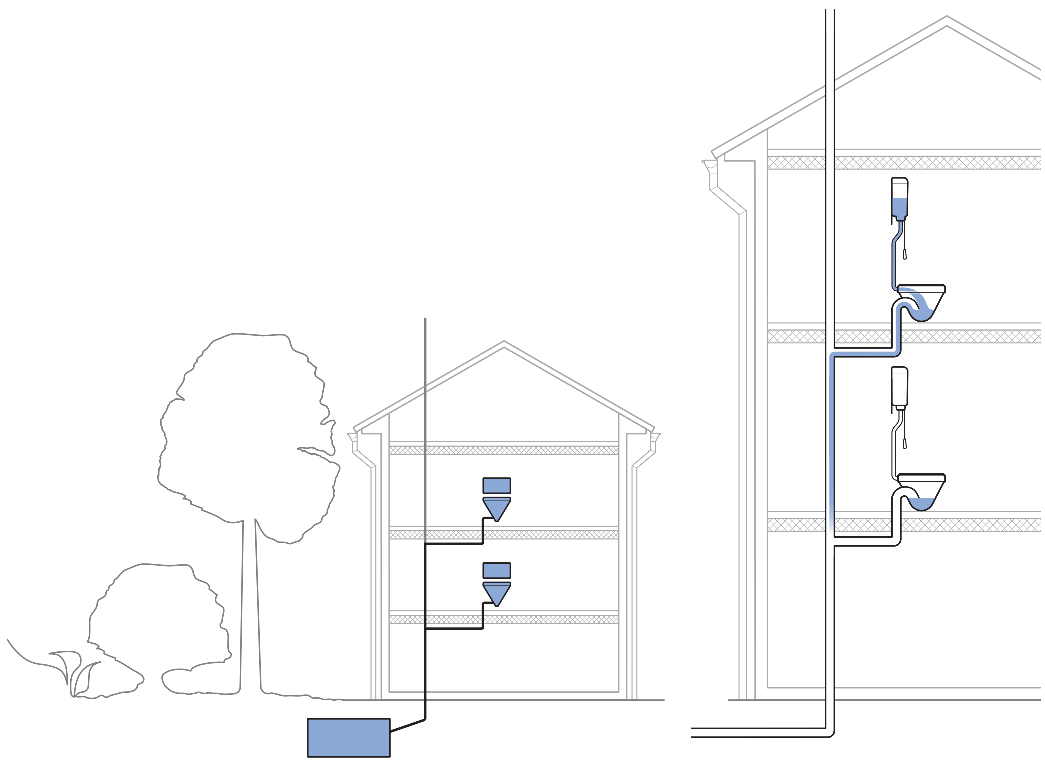


Figure 4: Building drainage at the end of the 19th century

At the beginning of the 20th century, connection of the building drainage system to the sewage system increasingly replaced cesspits. Buildings were getting higher and the drainage systems became more and more complex. The size of buildings also increased the waste water load which created new challenges regarding the pressure conditions in the pipe system.

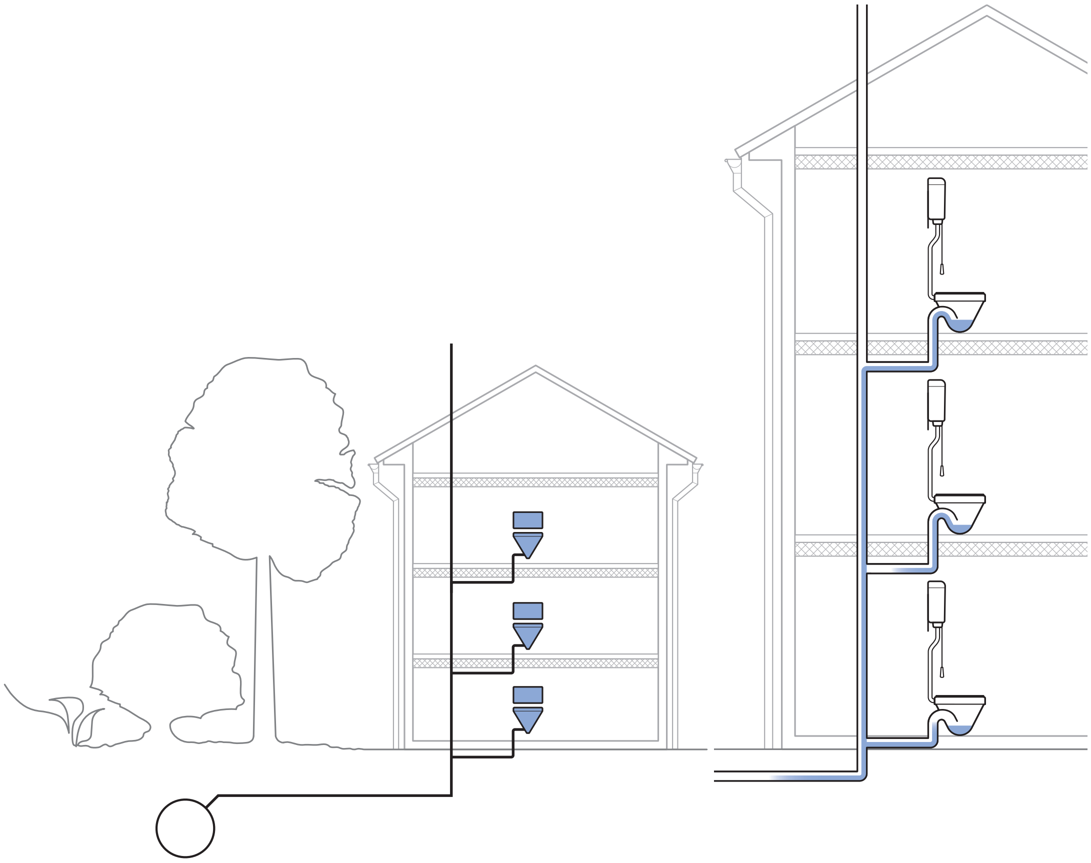


Figure 5: Building drainage as we know it today

Dimensioning drainage systems for large buildings is a complex task. The difficulty and the challenge is to design a system that does not cause unfavourable pressure conditions, as these can result in the water held in the traps being extracted or the waste water flowing back into sanitary appliances.

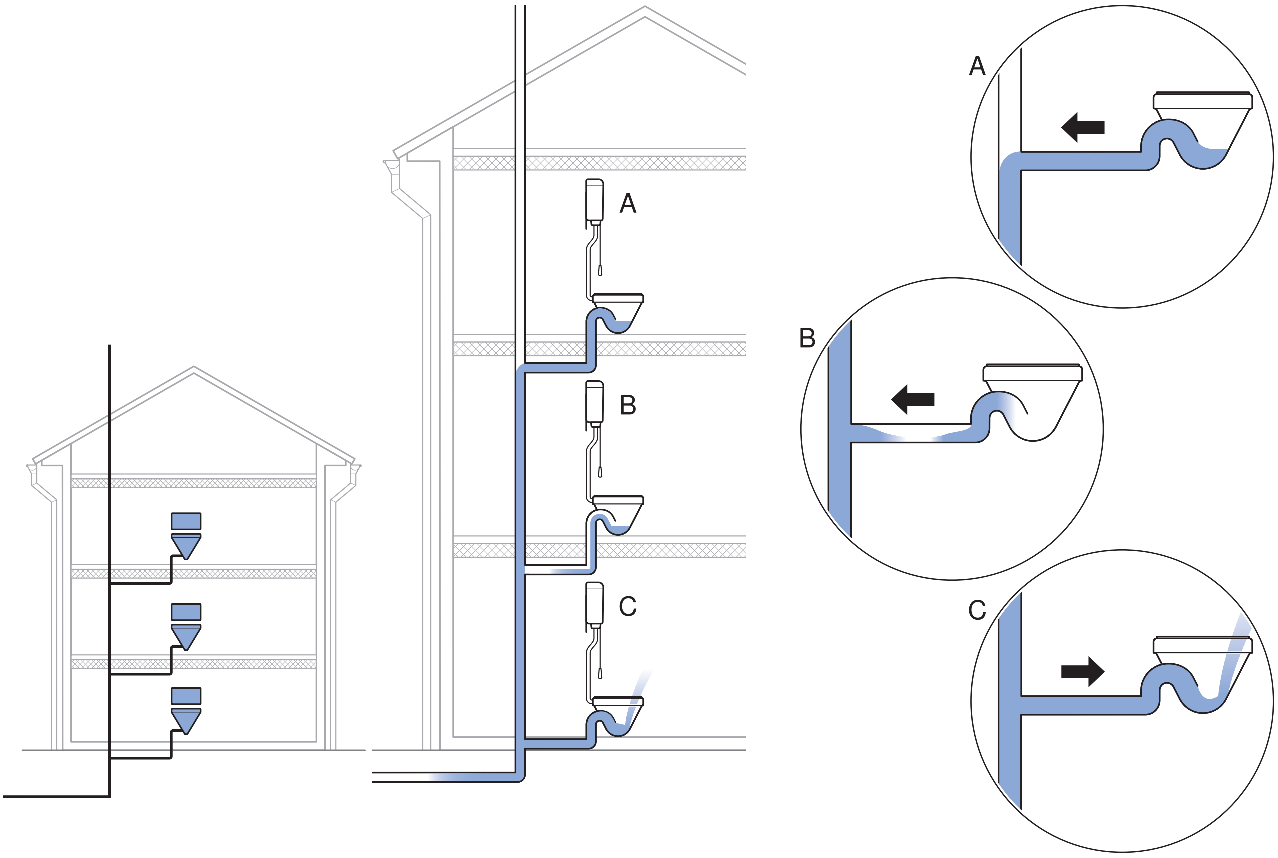



Figure 6: Consequences of unfavourable pressure conditions in building drainage systems

A Sealing water extracted because the branch discharge pipe is completely filled

B Sealing water extracted due to negative pressure in the stack

C Backflow of waste water into the sanitary appliance due to overpressure in the deflection zone

# 3 Natural water cycle

## 3.1 Definition of the natural water cycle

The “natural water cycle” refers to the natural circulation of water on earth. Essentially, the water circulates between the oceans and the land. The special feature of the water cycle is that the quantity of water remains the same and no water is lost. The water only changes between its aggregate states: liquid (water), gaseous (steam) and solid (ice).

## 3.2 Principle of the natural water cycle

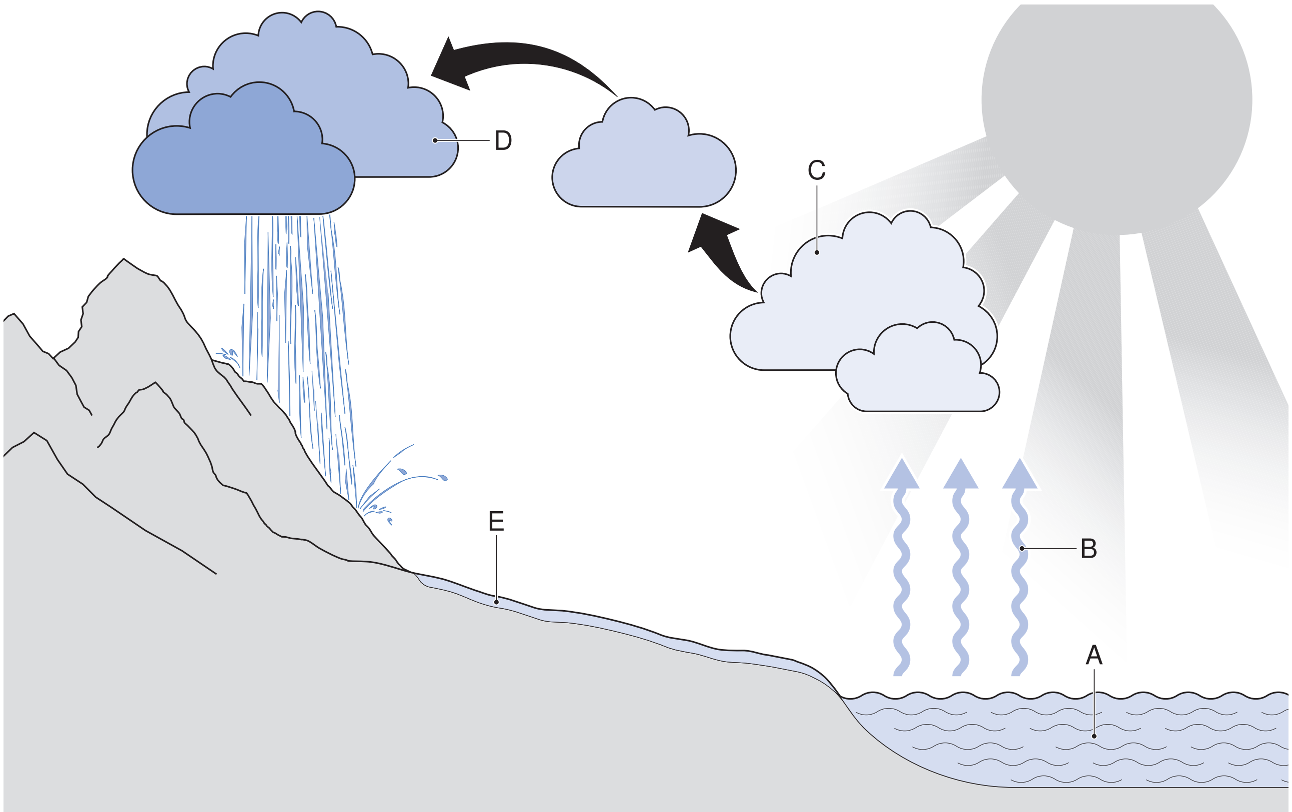



Figure 7: Principle of the natural water cycle

The natural water cycle is basically driven by the sun radiating on the oceans (A). Due to the exposure to sunlight, the water in the oceans heats up to such an extent that it partially evaporates as steam. As steam is lighter than air, it rises into the atmosphere (B). In the atmosphere, the temperature drops when the altitude above the earth's surface increases, so that at a certain point the steam condenses into tiny water droplets. If there is a concentration of water droplets in the atmosphere, clouds (C) are formed.

Currents in the atmosphere (wind) move the clouds around the earth. If the clouds hit cold air layers or mountains while they are moving, they rise into cooler air layers and cool down. Since cold air can absorb less moisture than warm air and the air in clouds is already saturated with water, the excess amount of water falls out, creating precipitation (D) in the form of rain, hail or snow. In the countryside, the precipitated water collects as groundwater in lakes and deeper layers of the earth or it flows back into the oceans via the groundwater flow, springs and rivers. This closes the natural water cycle and the whole process can start again from scratch.

## 3.3 Using the natural water cycle

The natural water cycle is used to produce potable water. In general, precipitation collected on land in lakes, rivers or in the form of groundwater is used for this purpose. In coastal regions with little rain, people also sometimes resort to collecting seawater; however, this has to be treated using complex desalination processes.

In order to create potable water, the precipitation is fed into reservoirs, treated and supplied to consumers via pipes (A). Potable water contaminated by use flows via discharge pipes into waste water treatment plants where it is treated and drained into lakes or rivers (B). Process (A) is referred to as drinking water supply and process (B) as drainage.

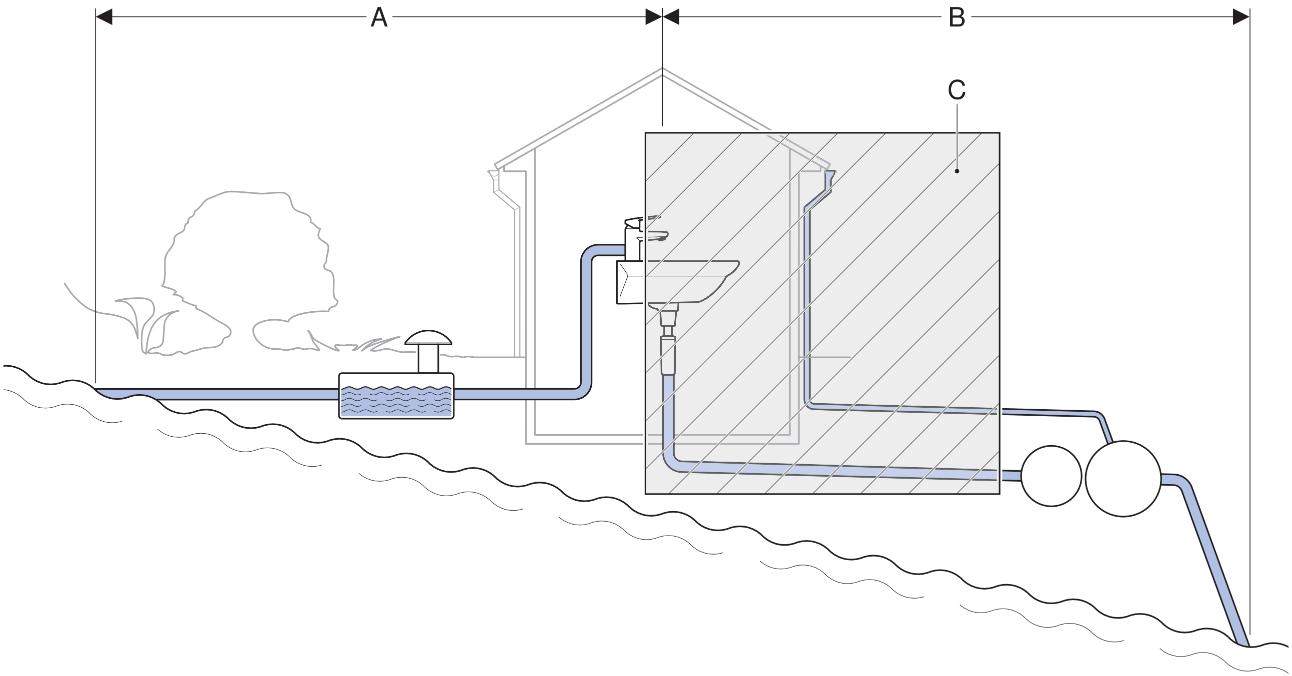



Figure 8: Using the natural water cycle

| | |
|---|---|
| A | Water supply |
| B | Drainage |
| C | Building drainage |

# 4 Types of waste water

Waste water is produced when water is taken from the natural water cycle and contaminated by use. Due to its impurity, waste water must be safely drained and treated. Depending on the legislation, precipitation that runs off buildings or paved surfaces can also be considered as waste water.

According to DIN EN 12056-2:2001-01, waste water is “water which is contaminated by use and all water discharging into the drainage system, e.g. domestic and trade effluent, condensate water and also rainwater when discharged in a waste water drainage system”.

Waste water can be divided into the following types:

- domestic waste water
- trade effluent
- rainwater

## 4.1 Domestic waste water

According to DIN EN 12056-2:2001-01, domestic waste water is waste water “normally discharged from kitchens, laundry rooms, bathrooms, toilets and similar rooms”. Domestic waste water can be divided into:

- greywater
- black water

Greywater is waste water not containing faecal matter which is discharged from showering, bathing, washing hands or laundry. It can be treated for secondary use as service water. Service water can be used, for example, for watering the garden, cleaning the house or flushing the toilet. In Europe, service water usually has a suitable level of quality so that it can also be safely used for washing laundry.

Black water is waste water containing faecal matter from toilets.

This distinction between greywater and black water is designed to enable the development of techniques for the separate collection and treatment of waste water flows.

## 4.2 Trade effluent

According to DIN EN 12056-2:2001-01, trade effluent is waste water “contaminated/polluted after industrial use and processes including cooling water”.

The discharge of trade effluent into a drainage system must meet strict requirements to protect the drainage system from harmful impurities. The requirements are determined by local authorities.

## 4.3 Rainwater

According to DIN EN 12056-2:2001-01, rainwater is “water resulting from natural precipitation that has not been deliberately contaminated”.

Rainwater can absorb dirt particles in the atmosphere or when flowing from buildings or paved surfaces. Country-specific rules and regulations determine the cases in which rainwater is considered to be waste water.

# 5 The purpose of drainage

## 5.1 The safe drainage of waste water

Waste water contains substances that can be harmful to people and the environment. For example, infectious diseases can be transmitted by human excretions from toilet facilities. For this reason, waste water must be safely drained in a hygienic and ecological manner and treated before it is discharged into lakes or rivers.

## 5.2 Legal principles and requirements

The requirement to drain waste water safely, hygienically and ecologically has been adopted by the legal regulations of many countries. Even though the legal regulations may differ in terms of their details, they share the same principles for safe waste water drainage:

- contaminated waste water must not be discharged or allowed to seep into waterways.
- if there is a public sewage system, waste water must be discharged into the public sewage system.

The following drainage system requirements arise from the legal principles:

- suitable for collecting and draining waste water
- resistant to approved types of waste water
- prevents contact between the user of the drainage system and the waste water
- fast and direct draining of the waste water into the sewage system

## 5.3 Prohibited substances for drainage systems

In order to comply with the legal principles and requirements, substances which cause the drainage system to malfunction or which cannot be removed from the waste water through conventional treatment processes must not be discharged into drainage systems. Such substances must be retained at the source and drained or disposed of appropriately. These include:

- gases and vapours
- toxic, flammable, explosive and radioactive substances
- malodorous substances
- discharges from cesspits, manure pits and feed silos
- substances that can cause the sewage system to malfunction such as sand, scree, debris, ash, slag
- viscous and muddy substances such as bitumen, limescale, cement slurry
- oils, lubricants, gasoline, benzene, petroleum ether, kerosene, solvents, halogenated hydrocarbons, etc.
- acids and alkalis in harmful concentrations
- waste water above 60 °C which, after mixing, raises the temperature of the waste water in the sewage system to over 40 °C.

The use of rubbish and kitchen waste grinders is not recommended in drainage systems and can even be prohibited by country-specific regulations. Substances and liquids from these types of grinders can lead to increased deposits and subsequently block the drainage system.

# 6 Drainage areas

Waste water is generated in and on buildings and paved surfaces. From there, it must be safely drained and guided to a waste water treatment plant. This sequence gives rise to three drainage areas:

- building drainage: draining waste water in and on buildings and discharging it into the sewage system
- sewage system: draining waste water from a settlement and supplying it to the waste water treatment plant
- waste water treatment: treating the waste water and discharging the purified water into receiving waters.

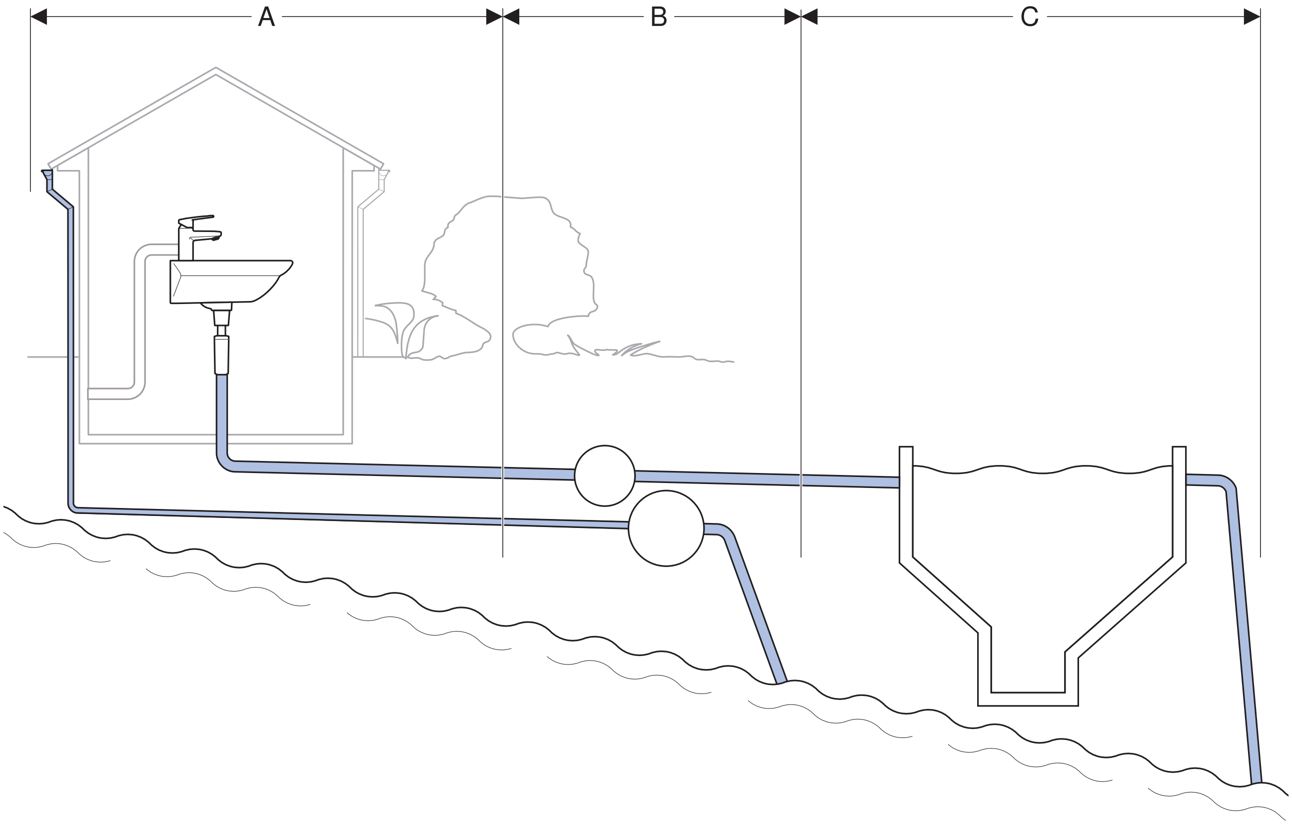



Figure 9: Drainage areas

| | |
|---|---|
| A | Building drainage |
| B | Sewage system |
| C | Waste water treatment |

## 6.1 Building drainage

In building drainage systems, waste water is generally produced at drinking water abstraction points. After use, the contaminated potable water is discharged from a sanitary appliance to the building drainage system. A sanitary appliance must be assigned to each drinking water abstraction point.

Sanitary appliances represent the beginning of a building drainage system. The waste water collected by sanitary appliances is collected via a connected pipe system and discharged into the sewage system.

Drainage systems use the effect of gravity on liquids to drain waste water. In the area of building drainage, DIN EN 12056-2:2001-01 describes 4 system types of building drainage systems which operate by means of gravity. The 4 types differ in the filling of the branch discharge pipes which can be partially filled or completely filled.

For types 1 and 2, the sanitary appliances are connected to partially filled branch discharge pipes, which discharge the waste water from the respective floor to the stacks. Building drainage systems of types 1 and 2 generally consist of four sections:

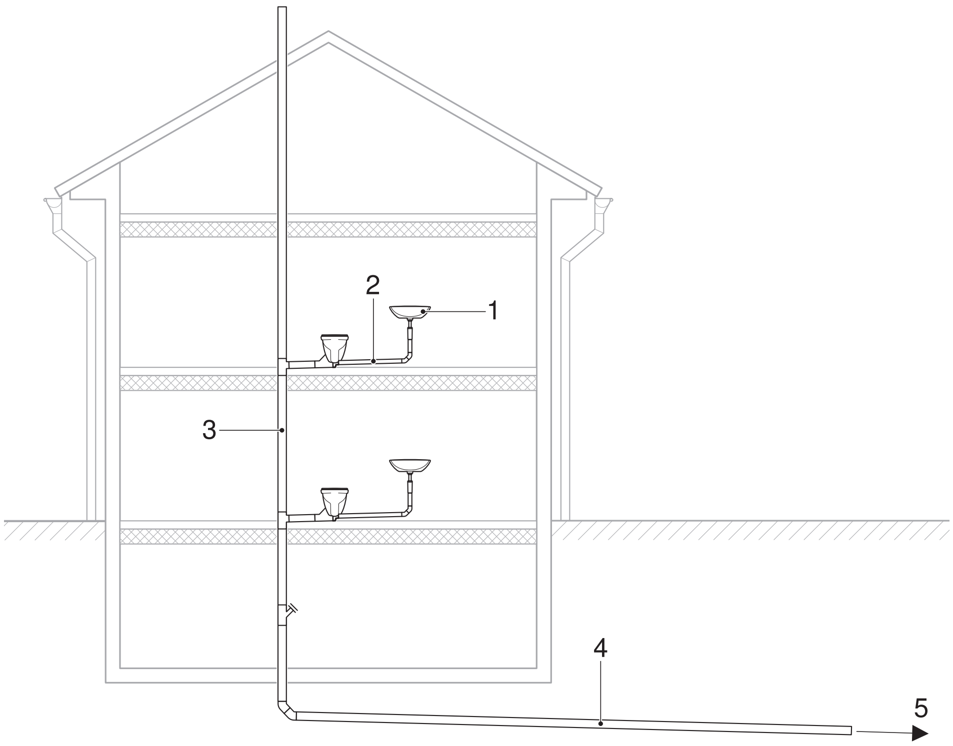



Figure 10: Basic structure of a building drainage system

1 Sanitary appliance
2 Branch discharge pipe
3 Stack
4 Underground and collector pipe
5 To the sewage system

The waste water from sanitary appliances is directed via branch discharge pipes to the stack. Stacks transfer the waste water to underground and collector pipes from where it is finally discharged into the sewage system.

Depending on whether the water flows in a horizontal or vertical section, there are different hydraulic conditions in the individual pipe sections. Branch discharge pipes and underground and collector pipes are horizontal sections with the same hydraulic conditions. In contrast, the vertical stacks feature other hydraulic conditions.

## 6.2 Sewage system

The sewage system absorbs the waste water produced in buildings and on paved surfaces and supplies it to the waste water treatment plant. In building drainage systems, rainwater is collected in addition to domestic waste water. Due to its low degree of contamination, rainwater does not need to undergo waste water treatment. This means that two different types of sewage systems have been developed:

- separate system: waste water and rainwater are drained into two separate sewage systems.
- combined system: waste water and rainwater are drained into the same sewage system.

Both systems have advantages and disadvantages. Which system is used for draining waste water is determined by country-specific rules and regulations and the relevant authorities.

### 6.2.1 Separate system

In the separate system, domestic waste water and rainwater are drained into two separate sewage systems:

- waste water sewage system
- rainwater sewage system

In the waste water sewage system, the domestic waste water and pretreated trade effluent are drained and supplied to a waste water treatment plant.

The rainwater sewage system collects the uncontaminated rainwater from roofs and it can generally be drained directly into receiving waters.

A separate system is structured as follows:

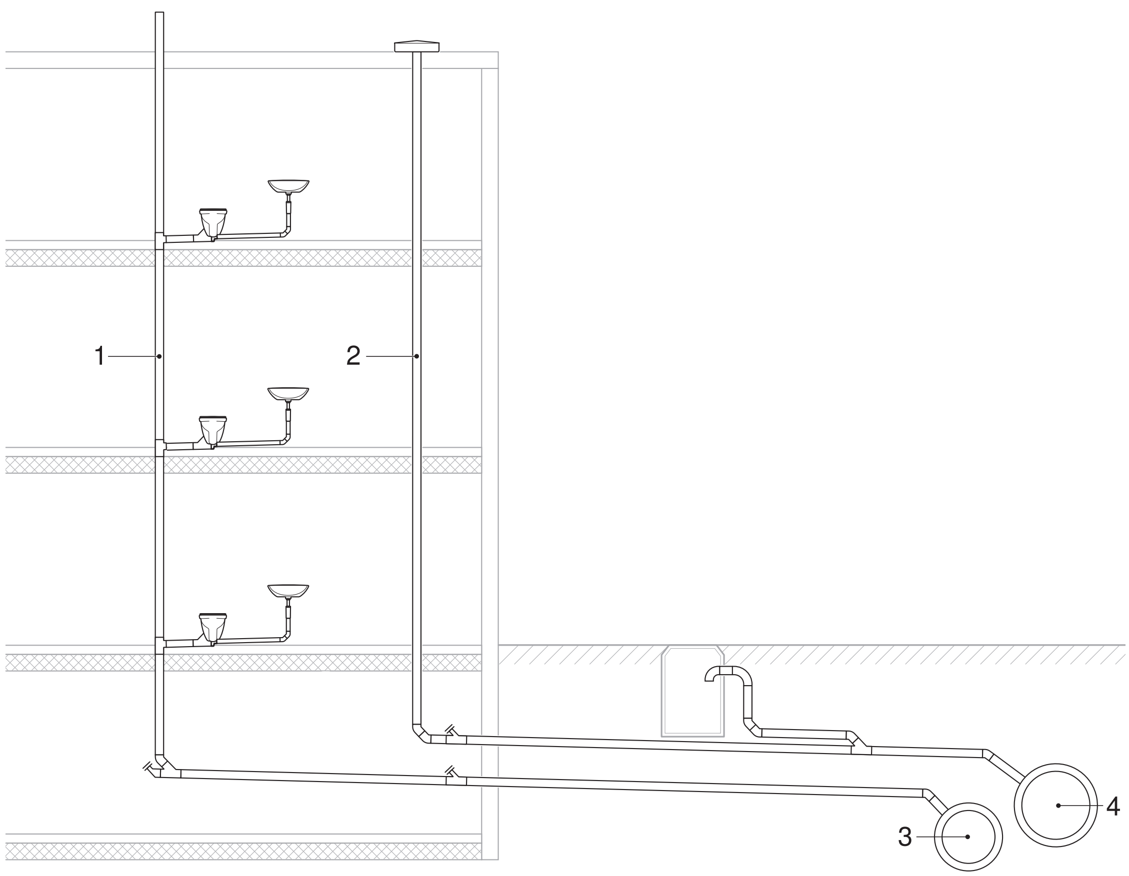



Figure 11: Structure of a separate system

| | |
|---|---|
| 1 | Waste water |
| 2 | Rainwater |
| 3 | Waste water sewage system |
| 4 | Rainwater sewage system |

### 6.2.2 Combined system

In the combined system, waste water and rainwater are drained into a common sewage system and supplied to a waste water treatment plant.

In order to keep the dimensions of the sewage system within reasonable economic limits and not to overload the waste water treatment plant, the size of the sewage system is limited. As a result, there is the risk that the sewage system may become overloaded during heavy rain. To avoid this risk, combined systems are equipped at suitable points with discharge units such as storage or rain overflow basins that hold back the water which exceeds the load bearing capacity of the combined system in case of heavy rain.

The combined system is structured as follows:

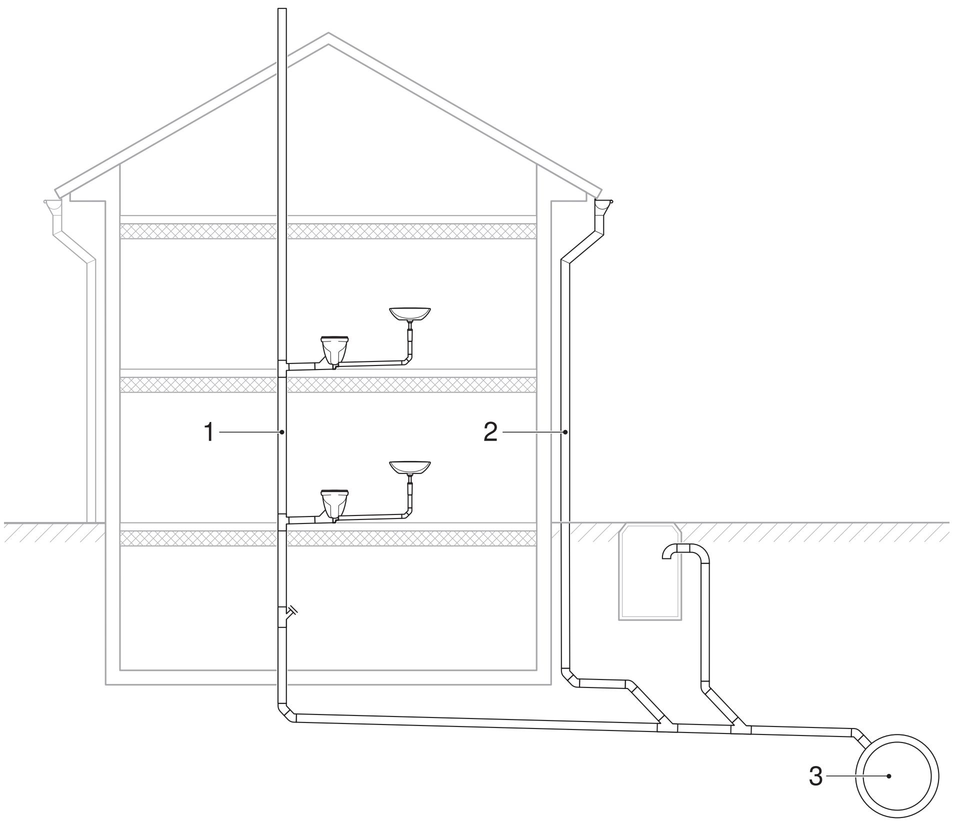



Figure 12: Structure of a combined system

1 Waste water

2 Rainwater

3 Sewage system

## 6.3 Waste water treatment

Waste water treatment is the final step at the end of the drainage process. It has the task of extracting the pollutants from the waste water from the sewage system and restoring the natural quality of the water

Waste water treatment plants are used for treating waste water and include one or more of the following treatment processes:

- mechanical and physical processes
- chemical processes
- biological processes

In areas that are not connected to a central waste water treatment plant, the waste water is treated in small waste water treatment plants.

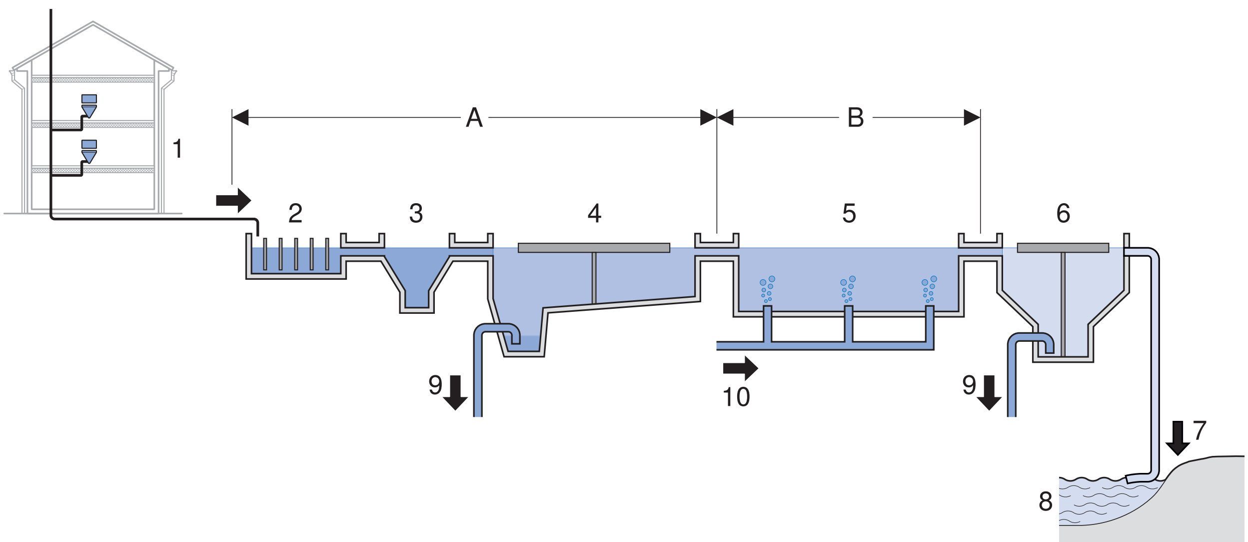



Figure 13: Sample structure of a waste water treatment plant

| | |
|---|---|
| A | Mechanical and physical treatment |
| B | Biological treatment |
| 1 | Domestic waste water |
| 2 | Bar screen |
| 3 | Grit chamber |
| 4 | Settling tank |
| 5 | Aeration tank |
| 6 | Secondary settling tank |
| 7 | Purified water |
| 8 | Receiving waters |
| 9 | Sludge (further processing, e.g. in a digester) |
| 10 | Air |

# 7 Hydraulic principles of partially filled building drainage systems

## 7.1 Transported substances

Partially filled building drainage systems are characterised by the fact that the pipes transport air in addition to waste water. A significant amount of air is drawn in, particularly in stacks, and carried along by the flowing waste water. The waste water pushes the air that is present in the pipe forwards and into the pipes connected to the stacks. In a discharge pipe, up to 20–35 $m^3$ of air is supplied to 1 $m^3$ of water.

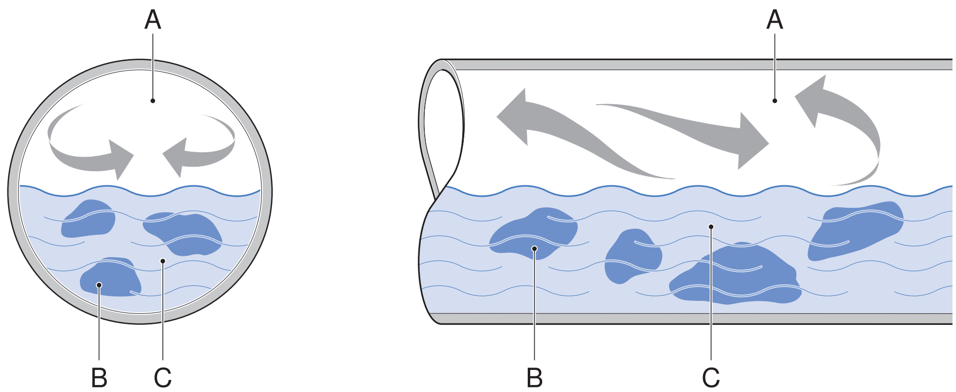



Figure 14: Transported substances in a partially filled discharge pipe

A Air

B Dirt particles

C Water

## 7.2 Hydraulics in horizontal pipe sections

### 7.2.1 Flow conditions

Branch discharge pipes and underground and collector pipes form part of the horizontal pipe sections in a building drainage system. Branch discharge pipes discharge the waste water from the trap of one or several sanitary appliances to the stack. Underground and collector pipes collect the waste water from one or more stacks and drain it into the sewage system.

Due to gravity, a layered flow is generated in horizontal pipe sections. In a layered flow, the water flows in the bottom of the pipe, while the air flows above the flowing water.

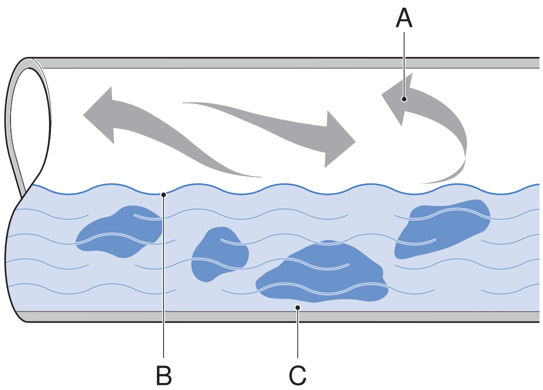



Figure 15: Flow conditions in horizontal pipe sections

A Air

B Layered flow

C Pipe bottom

In underground and collector pipes, a stationary flow, which can be calculated according to the Prandtl-Colebrook formula, is generated after a certain length.

## 7.2.2 Filling level

The waste water's capacity to flow in horizontal pipe sections depends on the filling level and the flow velocity or the volumetric flow rate.

The filling level is defined as the ratio of the filling height h of the waste water to the pipe inside diameter $d_i$ of the pipe and is abbreviated with the symbol $h/d_i$.

A drainage system must be designed in a such a way that the filling level is within an optimal range. The optimal filling level is 0.5–0.75; this means that horizontal pipe sections must be filled at least halfway with water. In this range, there is a favourable air-to-water ratio which allows solids to be transported easily in the pipe.

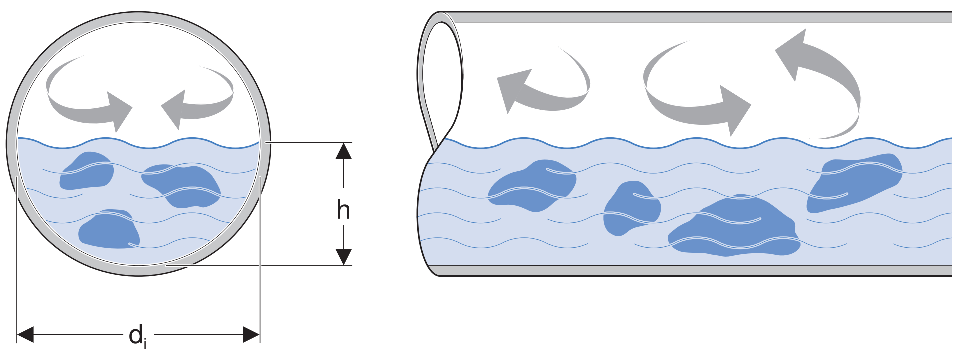



Figure 16: Optimal filling level in horizontal pipe sections

If the filling level is too high, there may not be enough air circulating in the pipe sections. Negative pressure develops in the branch discharge pipes which leads to the water held in the connected traps being extracted.

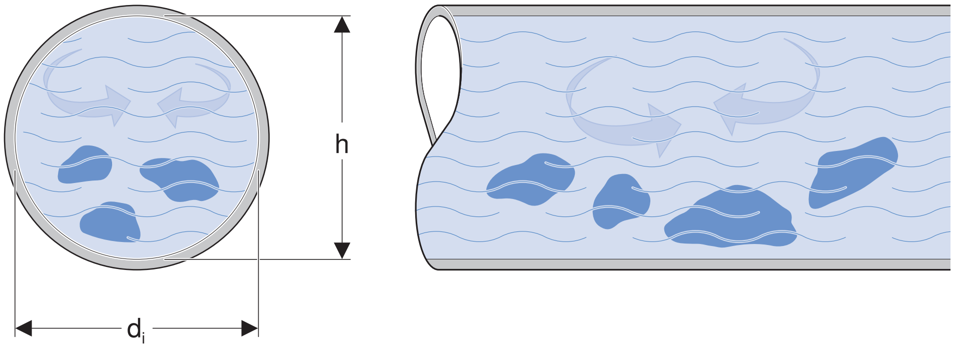



Figure 17: Too high a filling level in horizontal pipe sections

If the filling level is too low, the solids are not sufficiently flushed out by the waste water. The solids remain in the pipe and can lead to deposits or blockages.

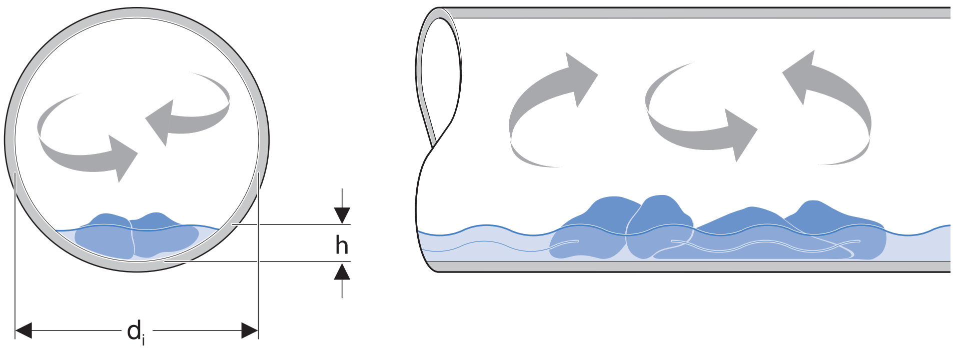



Figure 18: Too low a filling level in horizontal pipe sections

The filling level depends on slope J of the horizontal pipe section and the dimensions of the drainage system.

### 7.2.3 Slope

The slope influences the filling level and therefore the waste water's capacity to flow. The range of an optimal slope cannot be specified as a general rule as an ideal slope depends on the volumetric flow rate, pipe dimension and the filling level in the building drainage system. For example, DIN EN 12056-2:2001-01 provides tables in the appendix which enable the optimal slope to be determined as a function of these 3 parameters. The tables are based on the Prandtl-Colebrook formula.

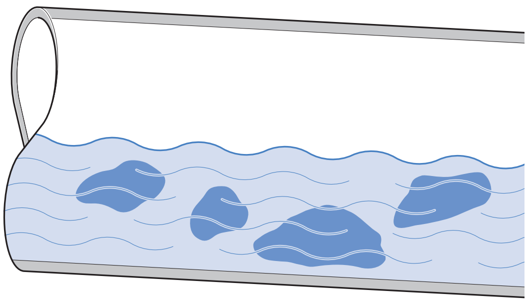


Figure 19: Optimal slope for the horizontal pipe section

If the slope is too steep, the waste water's flow velocity is too high which means that the filling level is too low. The solids are not sufficiently flushed out.

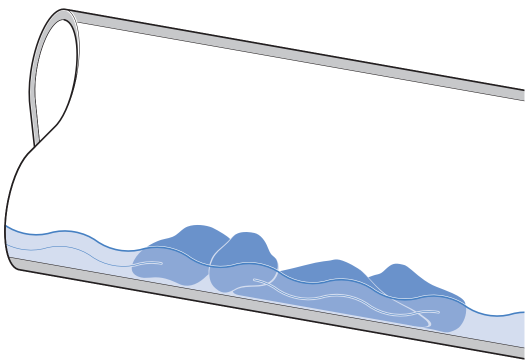


Figure 20: Too high a slope for the horizontal pipe section

If the slope is too low, the waste water's flow velocity is too low which means that the filling level is too high. There is not enough air circulating in the pipe sections which can cause critical overpressure or negative pressure.

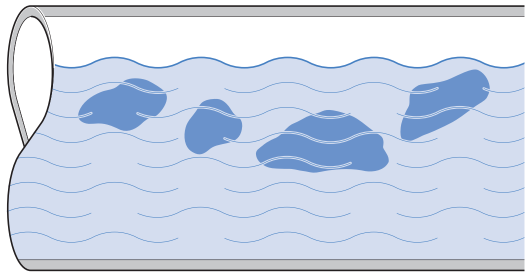


Figure 21: Too low a slope for the horizontal pipe section

### 7.2.4 Dimensioning

In addition to the slope, the dimensions of horizontal pipe sections are a decisive factor in establishing an optimal filling level. These are described in local standards such as DIN EN 12056-2:2001-01 (Germany) or SN 592000:2012 (Switzerland).

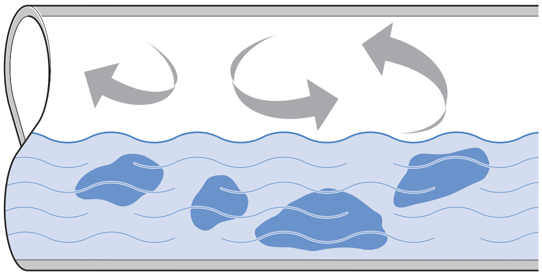


Figure 22: Pipe with ideal dimensions

If the pipe is too large, the filling level is too low and the solids are not sufficiently flushed out.

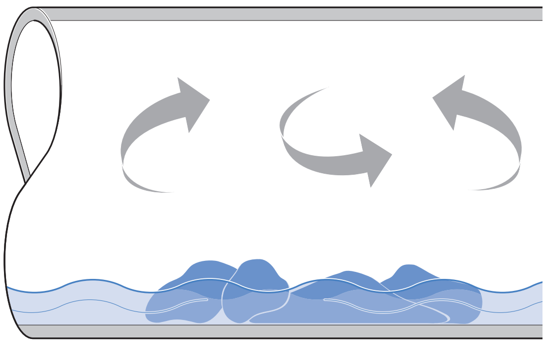


Figure 23: Pipe is too large

If the pipe is too small, the filling level is too high. There is not enough air circulating in the pipe sections which can cause critical overpressure or negative pressure.

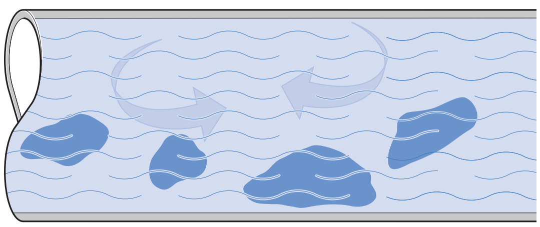


Figure 24: Pipe is too small


5037289099 ©
int.en 21169-19/358

# 7.3 Hydraulics in vertical pipe sections

## 7.3.1 Flow conditions

Stacks form the vertical pipe sections in a building drainage system. They collect the waste water from the branch discharge pipes of the individual floors and channel it into the underground and collector pipe.

After a fall line from the branch discharge pipe into the stack, the waste water flows along the pipe wall as a water jacket, creating an air core in the middle. This flow behaviour is typical of stacks and only changes when there are interferences due to the inflow from other branch discharge pipes or stack offsets.

The air core moves with the waste water towards the underground and collector pipe. To prevent negative pressure in the drainage system, air must be able to flow in the stack. The faster the waste water drains away in the stack, the thinner the annular flow along the pipe jacket and the greater the air volume flow rate required.

## 7.3.2 Falling velocity in stacks

Without air resistance and pipe friction, the falling velocity of water would increase as a function of the height of fall h in the following ratio:

$$v = \sqrt{2 \cdot g \cdot h}$$

v Falling velocity [m/s]

g Gravity [m/s$^2$]

h Height of fall [m]

Due to the pipe friction and air resistance, the falling velocity reaches its maximum value of approx. 13 m/s after a height of fall of approx. 35 m and remains constant from then on. As a result, the required air volume flow rate does not increase from this point on.

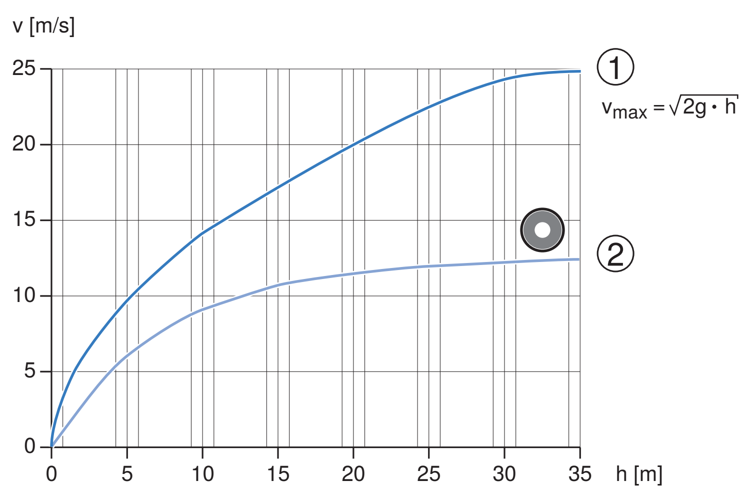



Figure 25: Theoretical falling velocity and falling velocity in stacks

v Falling velocity [m/s]

h Height of fall [m]

1 Theoretical falling velocity

2 Falling velocity in stacks (water jacket with air column)

Stacks can therefore be dimensioned independently of the stack height. The dimensions depend only on the number of connected sanitary appliances and the type of building. These two factors determine the maximum flow rate of a stack which is used as the basis for dimensioning stacks.

## 7.4 Influence of sanitary appliances on flow conditions

The type and number of sanitary appliances in a building determine the amount of waste water in a building drainage system and influence the hydraulic conditions in the system. Among all the sanitary appliances, the toilet has the greatest impact, since flushing the toilet discharges the largest amount of waste water per unit of time.

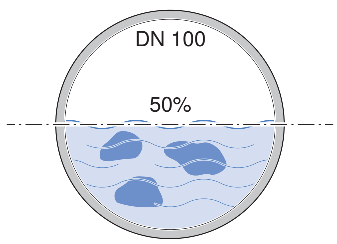
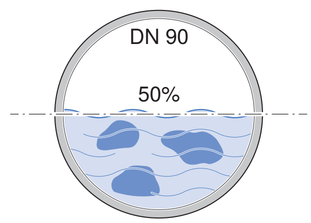
### 7.4.1 WC

The flush volume of cisterns and WC ceramics has an effect on the filling level of a branch discharge pipe and thus on the waste water's flow properties.

Cisterns are normally delivered with a default flush volume of 6 l and installed with a standard WC ceramic that is suitable for this flush volume. An optimal filling level of the discharge pipe is achieved in this configuration with the dimension DN 100.

A reduced flush volume of 4.5 l can be required for legal or ecological reasons, or reasons relating to the technical building system. If the discharge pipe is designed in the dimension DN 100 as in the standard configuration, there is a risk that the optimal filling level is not attained due to the reduced flush volume. Depending on factors such as the slope and type of pipe laying, it may be necessary to reduce the dimension of the discharge pipe to DN 90.

Table 1: Effects of the flush volume on filling level and pipe dimension

| | 6 l flush volume | 4.5 l flush volume |
|---|---|---|
| Decisive factors | Standard solution | • Ecological building<br>• Local legal provisions<br>• Building management |
| Cistern | Factory setting | Manual setting |
| WC ceramic appliance | Standard WC ceramic | WC ceramic certified for 4.5 l |
| Pipe dimension | DN 100<br> | DN 100 or DN 90<br> |
| | – | Dimensioning depends on:<br>• slope<br>• offset<br>• number of bends<br>• distance of WC to stack<br>• pipe laying, e.g. laying in concrete |

The dimensioning of a building drainage system with toilets with a reduced flush volume of 4.5 l must be considered individually due to the influencing factors. Geberit has long-standing experience in this area and can assist with individual dimensioning tasks.

# 8 Components of a partially filled building drainage system

A building drainage system consists of a large number of components. The components vary depending on the type of building and the building drainage system requirements. The following figure shows the key components:

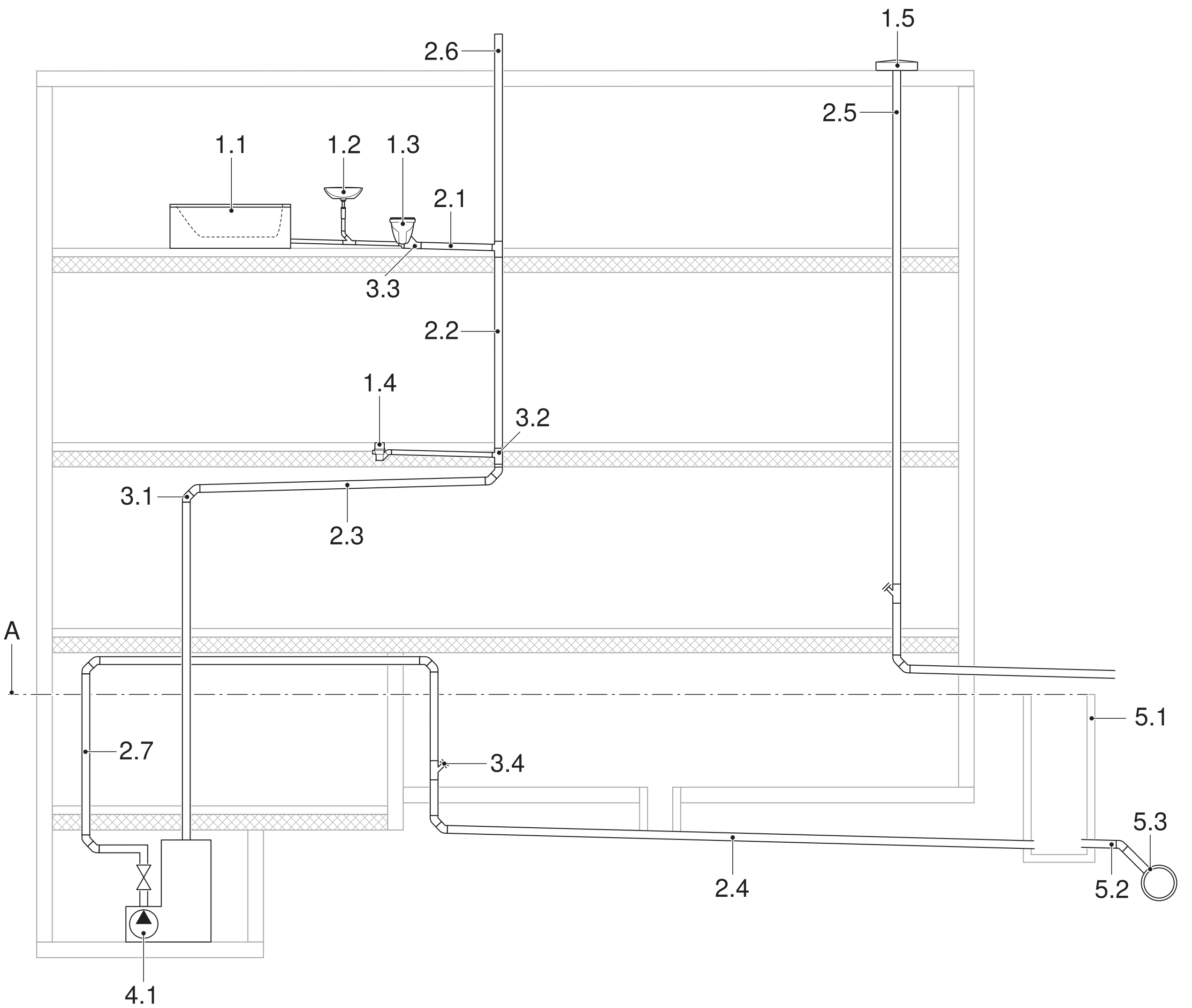



Figure 26: Components of a partially filled building drainage system

Sanitary appliances

| | |
|---|---|
| 1.1 | Bathtub |
| 1.2 | Washbasin |
| 1.3 | WC |
| 1.4 | Floor drain |
| 1.5 | Roof outlet |

Pipe sections

| | |
|---|---|
| 2.1 | Branch discharge pipe |
| 2.2 | Stack |
| 2.3 | Stack offset |
| 2.4 | Underground and collector pipe |
| 2.5 | Rainwater pipe |
| 2.6 | Ventilation pipe |
| 2.7 | Pump pressure pipe |

Fittings

| | |
|---|---|
| 3.1 | Bend 45° (direction change) |
| 3.2 | Branch fitting |
| 3.3 | Reducer |
| 3.4 | Access pipe |

Systems for preventing backpressure

| | |
|---|---|
| 4.1 | Faeces lifting system |

Not belonging to the building drainage

| | |
|---|---|
| 5.1 | Duct |
| 5.2 | Underground pipe connection |
| 5.3 | Sewage system |

Hydraulic parameters

| | |
|---|---|
| A | Flood level |

# 9 Sanitary appliances

Sanitary appliances collect the waste water and discharge it into the drainage system. They can be divided according to the type and source of the waste water to be discharged.

- Domestic waste water: domestic sanitary appliances
- Rainwater: roof outlets

## 9.1 Domestic sanitary appliances

In buildings, each drinking water abstraction point must be connected to a sanitary appliance which, in turn, must be connected to the building drainage systems. Such sanitary appliances include:

- washbasins, bidets and urinals
- dammable and non-dammable shower trays
- bathtubs
- kitchen sinks and cleaner sinks
- dishwashers and washing machines
- WC facilities
- floor drains

Domestic sanitary appliances must be equipped with a trap to prevent the release of sewer gases into the building.

## 9.2 Roof outlets

Roof outlets are used to collect and drain water from the roof. They must have sufficient discharge capacity that is at least equal to the calculated rainwater outflow. It is important to note that the discharge capacity is not reduced by a grating or outlet grating.

Unlike other sanitary appliances, roof outlets do not need to be equipped with a trap as they are located outside buildings.

There are generally two different roof outlet designs:

- for partially filled roof drainage systems
- for completely filled roof drainage systems

Roof outlets must be connected to the rainwater pipe in such a way that the connection is leakproof when a lot of water has accumulated.

## 9.3 Function of the trap

A trap has the task of retaining sewer gases and must be used in every domestic sanitary appliance.

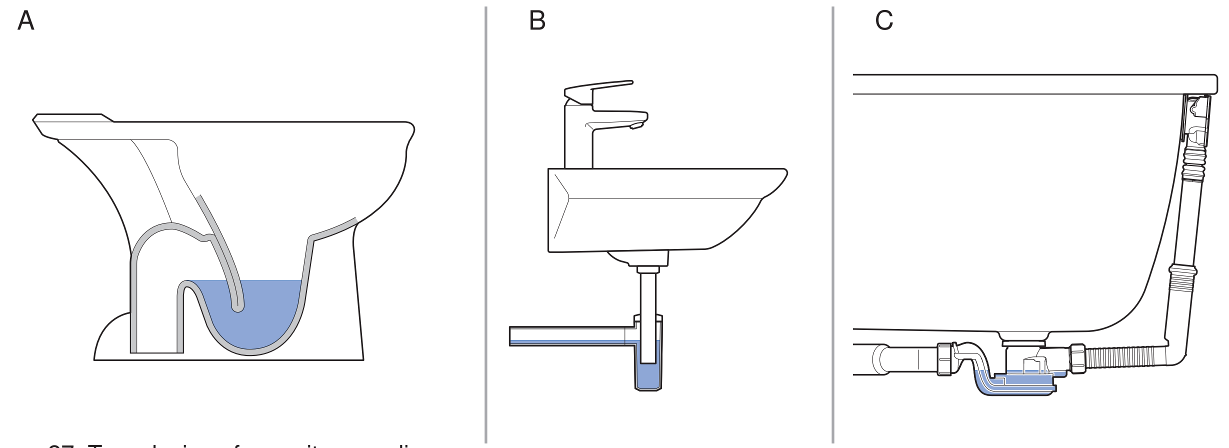



Figure 27: Trap designs for sanitary appliances

A WC ceramic with integrated trap
B Washbasin with dip tube trap
C Bathtub drain with integrated trap

A trap is designed in such a way that water remaining in the trap forms a water seal which prevents the release of sewer gases. According to DIN EN 12056-2:2001-01, the water must have a water seal depth H of 50 mm.

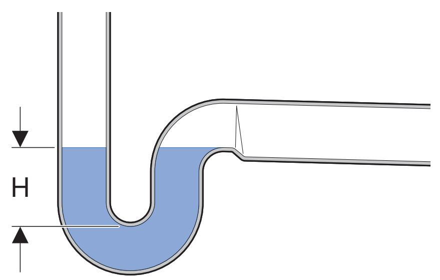



Figure 28: Water seal depth H according to DIN EN 12056-2:2001-01

The water seal depth can be reduced through evaporation if the connected sanitary appliance has not been used for a long time or in the event of unfavourable pressure conditions. The water seal depth must not be reduced to such an extent that the blocking function of the water is lost and sewer gases are emitted into the home.

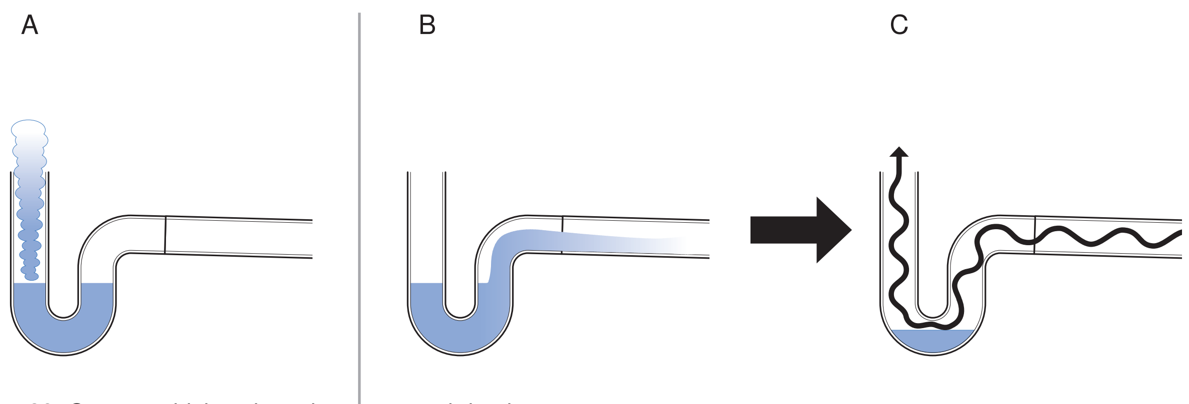



Figure 29: Causes which reduce the water seal depth

A Evaporation of the sealing water
B Extraction of the sealing water due to unfavourable pressure conditions
C Release of sewer gases due to an insufficient amount of sealing water in the trap

# 10 Pipe sections

The individual pipe sections perform different functions within a building drainage system. They must be designed and installed in such a way that the expected volume of waste water can easily be discharged. Pipe sections in partially filled building drainage systems:

- branch discharge pipes
- stacks
- underground and collector pipes
- rainwater pipes
- ventilation pipes
- pump pressure pipes

## 10.1 Branch discharge pipes

Branch discharge pipes discharge the waste water from the trap of one or several sanitary appliances to the stack. They are located on every floor, generally designed with a slight slope and dimensioned according to DIN EN 12056-2:2001-01 or a local standard.

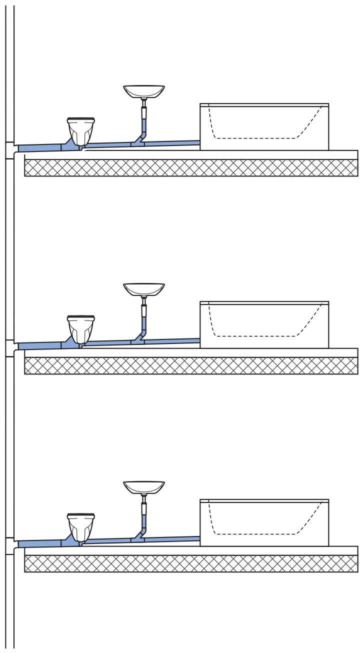


Figure 30: Branch discharge pipe per floor

## 10.2 Stacks

Stacks collect the waste water from the branch discharge pipes of the individual floors and channel it into the underground and collector pipe. They are usually routed via the roof and installed in open connection to the atmosphere to ensure that the pipe system is ventilated.

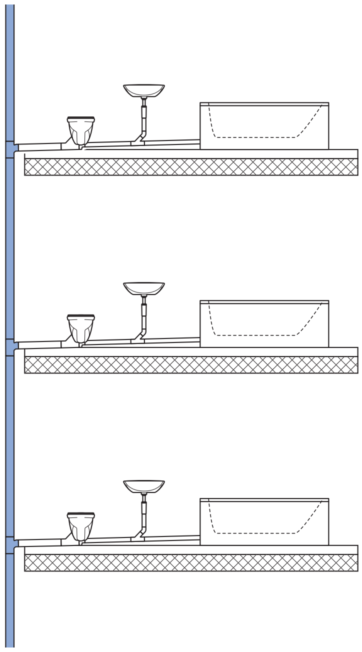


Figure 31: Stack

For structural reasons or reasons related to the laying technique, the stack might require a stack offset. A stack offset is a horizontal pipe section that offsets the axis of the stack. Due to the stack offset, the waste water which originally flows vertically is made to flow horizontally, and is then switched back to the vertical direction at the end. This means that the flow conditions are particularly important when designing the stack.

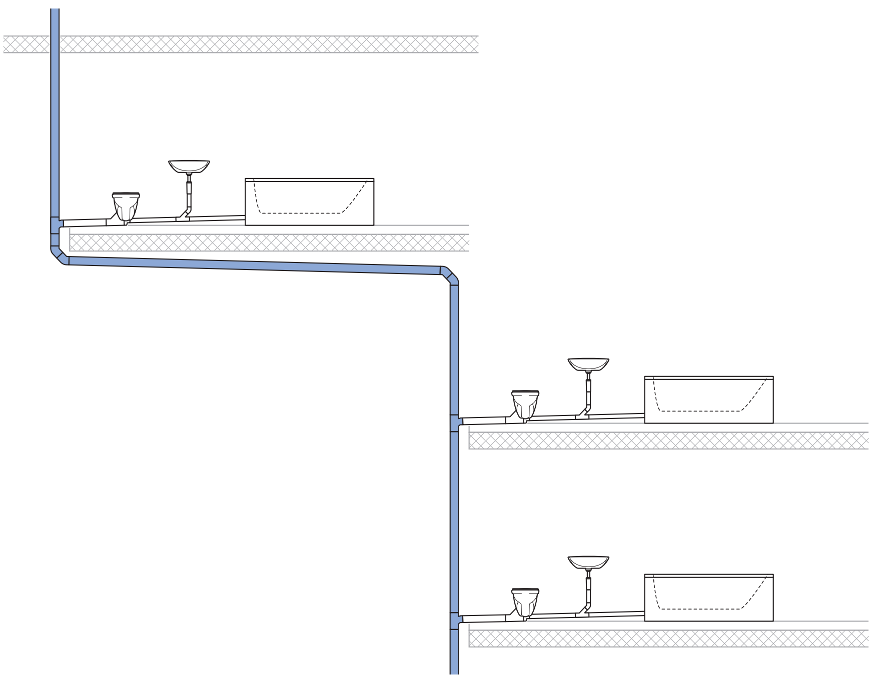


Figure 32: Stack with stack offset

# 10.3 Underground and collector pipes

Underground and collector pipes collect the waste water from one or more stacks and drain it into the sewage system.

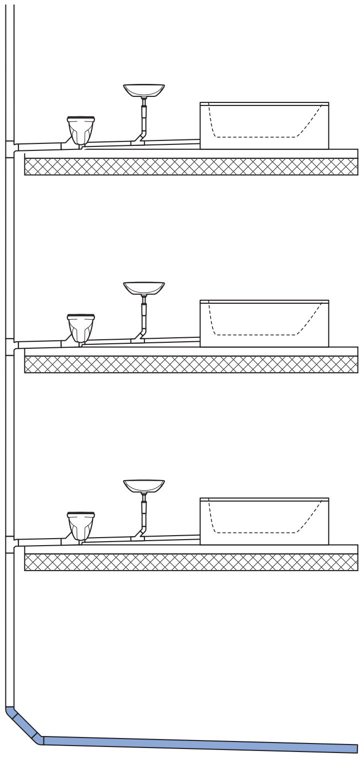


Figure 33: Underground and collector pipe

## 10.4 Rainwater pipes

Rainwater pipes collect rainwater from roofs, balconies and other extensions and are therefore part of the building drainage system. The rainwater is drained via gutters, stacks and underground pipes.

Rainwater pipes can be installed on the inside and outside of buildings. When installed inside buildings, the pipes must be insulated to prevent condensation. Each roof unit must feature at least 2 stacks to ensure that the pipes function properly in the event of blockages.

In addition, emergency overflows must be planned when draining flat roofs. The emergency overflows must be arranged and dimensioned so that all the rainwater on a partial or complete roof can run off if the stack is blocked.

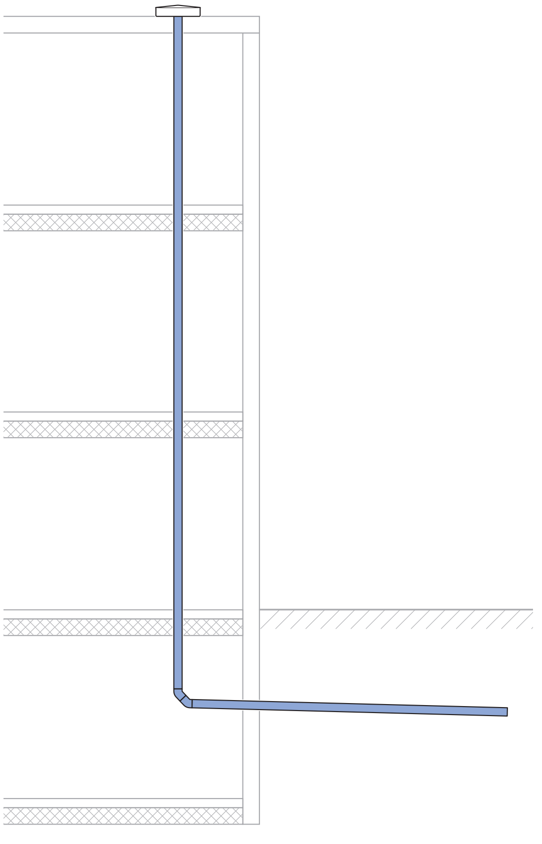


Figure 34: Rainwater pipe

## 10.5 Ventilation pipes

Partially filled building drainage systems must be ventilated due to the air that is carried along when the waste water is discharged. Ventilation ensures pressure compensation with the atmosphere and thus prevents unfavourable pressure conditions in the drainage system which can lead to the extraction of the traps in the sanitary appliances.

Ventilation pipes are used to ventilate partially filled building drainage systems. Generally speaking, there are the following different types of ventilation pipes:

- main ventilation pipes
- secondary ventilation pipes
- branch ventilation pipes
- pipes with air admittance valves

### 10.5.1 Main ventilation pipes

In the case of a stack vent, the stack is also used to ventilate the building drainage system. For this purpose, the stack is routed via the roof to ensure pressure compensation with the atmosphere.

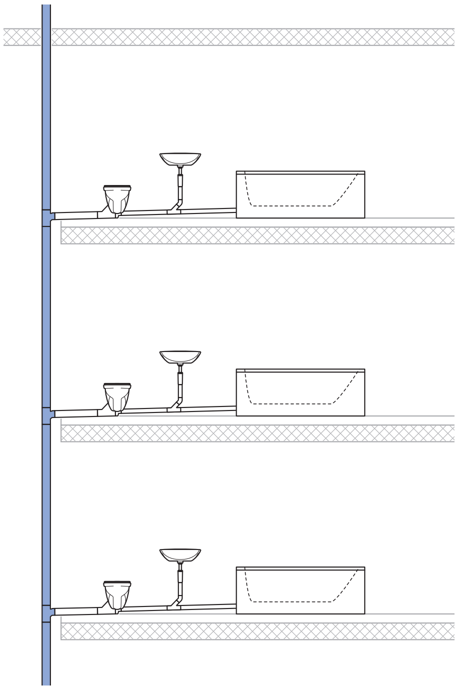


Figure 35: Main ventilation pipe

### 10.5.2 Secondary ventilation pipes

In the case of secondary ventilation, the building drainage system is ventilated with a separate ventilation pipe running parallel to the stack. The stack and ventilation pipe are connected on each floor so that pressure compensation is ensured throughout the entire stack.

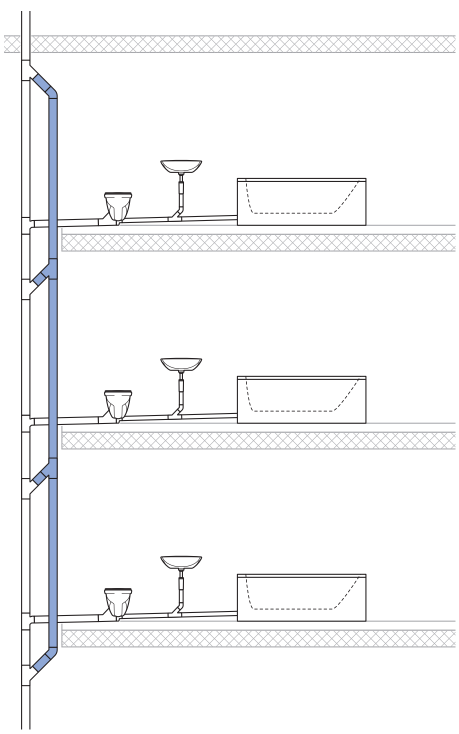


Figure 36: Secondary ventilation pipe

### 10.5.3 Branch ventilation pipes

In the case of branch ventilation, each branch discharge pipe is ventilated separately via a branch ventilation pipe. At the end, the branch ventilation pipes are led to a stack or to a secondary ventilation pipe.

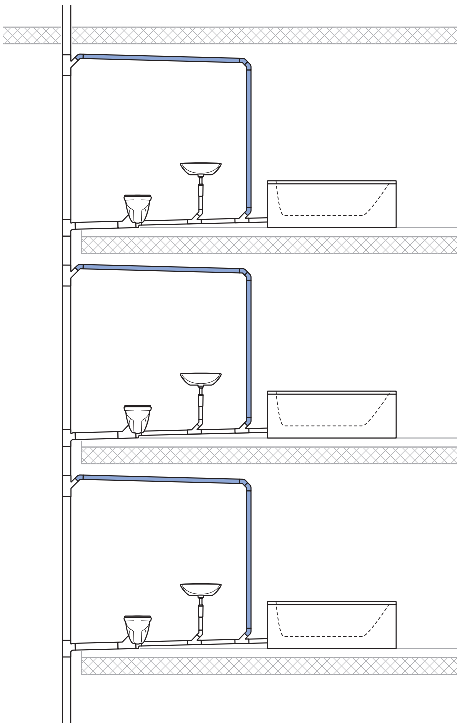


Figure 37: Branch ventilation pipe

## 10.5.4 Pipes with air admittance valves

### Using air admittance valves

Air admittance valves can be used for the following applications:

- as a second stack vent or branch ventilation
- as indirect secondary ventilation
- as individual ventilation in existing sanitary appliances with drainage malfunctions

In addition to these applications, they can also be used for renovations, extensions and conversions, since installing secondary ventilation is often difficult and expensive.

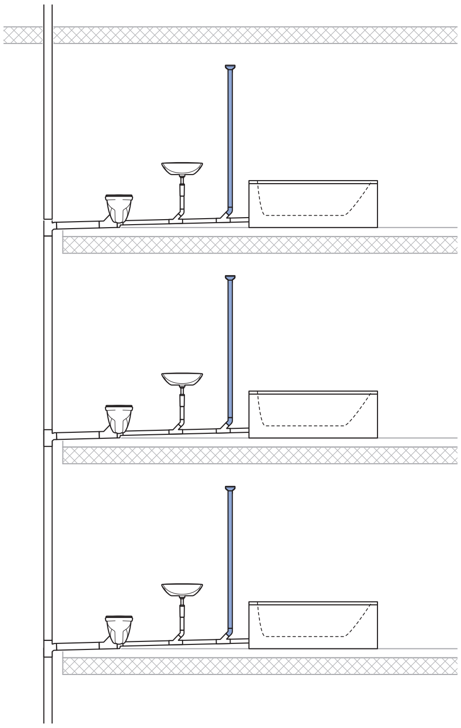


Figure 38: Pipe with air admittance valve

### Function of air admittance valves

As long as there is no negative pressure in the building drainage system, the air admittance valves are closed by the built-in seal. If there is a negative pressure in the system due to flowing waste water, the air admittance valve opens and allows outside air to flow into the system. The inflow of the outside air facilitates pressure compensation. The air admittance valve closes again once the pressure has been compensated.

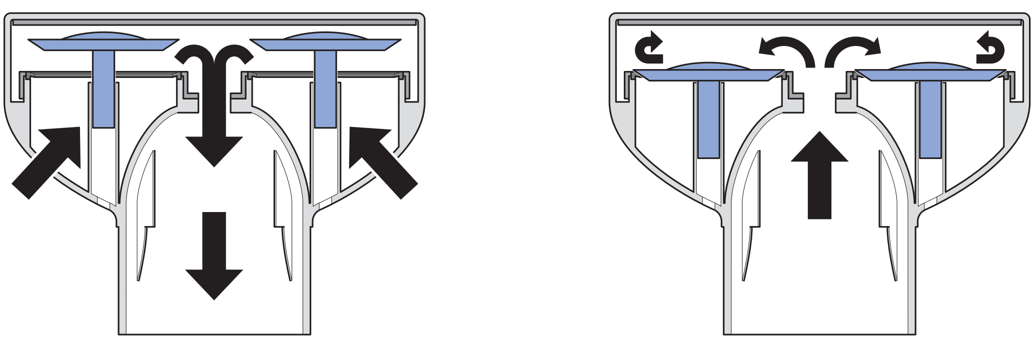


Figure 39: Open and closed air admittance valve

## 10.6 Pump pressure pipes

Pump pressure pipes connect the faeces lifting system with the underground and collector pipe. The faeces lifting system pumps waste water upwards from below the flood level. It is routed through the pump pressure pipe via the flood level and discharged into the underground and collector pipe.

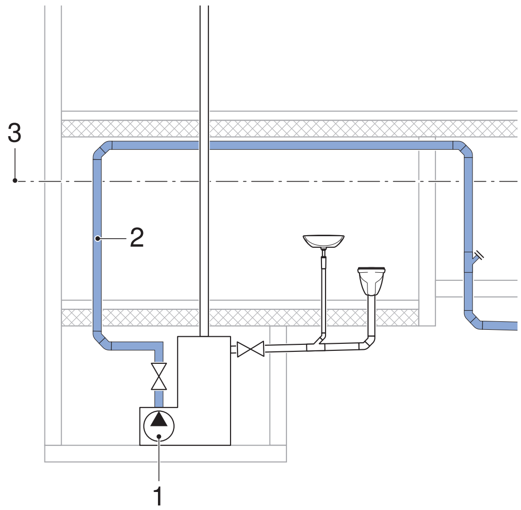



Figure 40: Pump pressure pipe

| | |
|---|---|
| 1 | Faeces lifting system |
| 2 | Pump pressure pipe |
| 3 | Flood level |

# 11 Fittings

Fittings play a key role in the pipe layout and the hydraulic properties of a partially filled building drainage system. They must be selected and used so that waste water can be drained without interferences such as turbulence or the absence of air.

The most important fittings of a partially filled building drainage system are:

- bends
- branch fittings
- reducers
- access pipes

## 11.1 Bends

### 11.1.1 Using bends

Bends are built into building drainage systems to change the direction of pipes. With stacks, they change the direction of the stack and at the end of the stack.

The stack needs to change direction when a stack offset is included. At the beginning of the stack offset, the flow is changed from the vertical to the horizontal direction and then back to the vertical direction at the end of stack offset.

Changes in direction at the end of the stack are caused by the transition of the stack into the underground and collector pipe. In this case, the flow is deflected from the vertical to the horizontal direction.

### 11.1.2 The hydraulic behaviour of bends in stacks

#### Direction change in horizontal pipe sections

With a direction change in a horizontal pipe section, the annular flow (vertical pipe section) changes to a layered flow (horizontal pipe section) in the bend. Critical overpressure in the drainage system is mainly caused by direction changes in the horizontal pipe sections. The geometry of the bend used for the direction change has a major influence on how much overpressure there is in the pipe.

If a bend 90° is used for the direction change, it significantly slows the flow as the abrupt change in direction causes the water to accumulate in the bend. This causes turbulence and the flowing water splashes up the sides of the pipe after the direction change. In such a situation, the water needs extra space in the pipe and displaces some of the air flowing in the pipe. The displaced air can then cause critical overpressure in the pipe which can expel the trap.

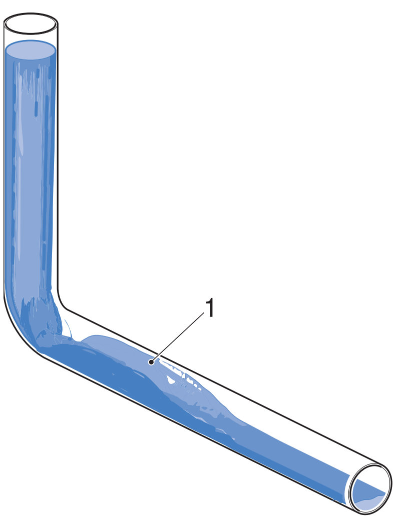



Figure 41: Waste water splashes up the sides of the pipe after a direction change in a bend 90°

1 Waste water splashes up the sides of the pipe after a direction change

For this reason, standards recommend the use of two bends 45° instead of one bend 90°. 2 bends 45° mean the change in direction is less abrupt and therefore reduce the backup of water.

## Direction change in vertical pipe sections

In contrast to the direction change from vertical to horizontal pipe sections, a direction change from horizontal to vertical pipe sections can cause critical negative pressure.

The reason for this negative pressure is that the change in direction of the waste water flow from a horizontal to a vertical pipe section can cause a hydraulic blockage in the bend that obstructs the flow of air. This causes negative pressure in the vertical pipe section (stack) which reduces the performance of the drainage system.

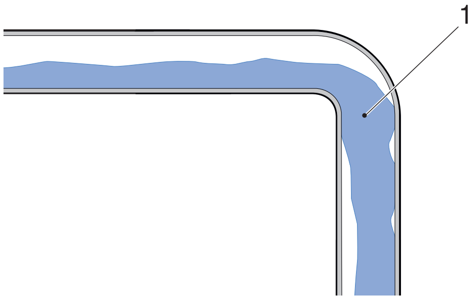



Figure 42: Hydraulic blockage when the direction is changed from horizontal to vertical

1 Hydraulic blockage

## Hydraulically optimised bends for high-rise buildings

In drainage systems in high-rise buildings, critical overpressure and negative pressure is particularly pronounced due to the high load of waste water. For this reason, drainage systems in high-rise buildings are equipped with large pipe dimensions and parallel ventilation pipes to compensate for critical overpressure and negative pressure and thereby prevent system malfunctions.

As part of the SuperTube system, Geberit has developed hydraulically optimised bends with the Geberit HDPE BottomTurn and the Geberit HDPE BackFlip bends. Combined with the Geberit HDPE Sovent fitting d110, they prevent critical overpressure and negative pressure in the drainage system, meaning that there is no need to install a parallel ventilation pipe and that the stack dimensions can be reduced for many applications.

The Geberit HDPE BottomTurn bend is used for changing from the vertical to the horizontal direction; the Geberit HDPE BackFlip bend ensures that changing from the horizontal to the vertical direction does not create negative pressure.

## Geberit HDPE BottomTurn bend

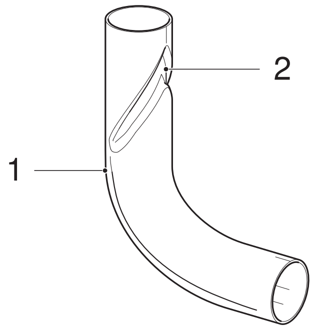



Figure 43: Components of the Geberit SuperTube technology for the Geberit HDPE BottomTurn bend

1 Guide channel

2 Flow divider

With its flow-optimised geometry, the Geberit HDPE BottomTurn bend ensures that the air column is not interrupted in the stack. By optimising the transition from an annular flow to a layered flow, critical overpressure in the drainage system is avoided. The flow divider guides the waste water to the outside of the bend, where the guide channel directs the flow into the horizontal pipe without the waste water splashing up the sides of the pipe. This reduces the energy consumption of the direction change and the pulse of the discharge stack is optimally used.

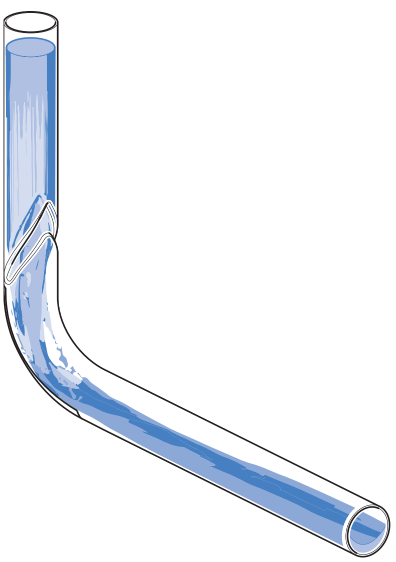


Figure 44: Flow conditions in the Geberit HDPE BottomTurn bend

### Geberit HDPE BackFlip bend

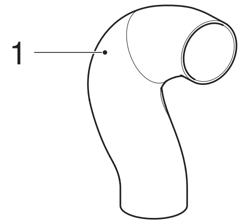



Figure 45: Components of the Geberit SuperTube technology for the Geberit HDPE BackFlip bend

1 Swirl zone

The Geberit HDPE BackFlip bend transfers the layered flow into an annular flow without creating a hydraulic blockage. This prevents critical negative pressure in the drainage system.

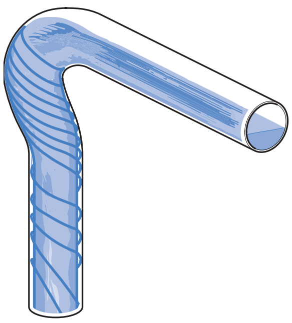


Figure 46: Flow conditions in the Geberit HDPE BackFlip bend

## 11.2 Branch fittings

### 11.2.1 Using branch fittings

Branch fittings are built into the stack to connect it with branch discharge and ventilation pipes. When selecting the branch fittings for branch discharge pipes, the dimension and type of the branch fitting must ensure that there is no negative pressure in the branch discharge pipe.

With regard to flow characteristics, branch fittings consist of a through-flow and a branch.

Depending on the dimension and angle of the branch, there are different branch configurations:

- equal branch fitting: the branch dimension is the same as the through-flow dimension
- reduced branch fitting: the branch dimension is smaller than the through-flow dimension
- branch fitting x°: the branch has an angle of x° to the through-flow, e.g. branch fitting 88.5°

## 11.2.2 Hydraulic behaviour of branch fittings

### Equal branch fitting 88.5°

An equal branch fitting 88.5° causes a hydraulic blockage in the stack which prevents air from circulating. The hydraulic blockage creates negative pressure in the stack below the connection point to the branch discharge pipe. This means that the stack has a lower load bearing capacity. On the other hand, the air can circulate freely in the branch discharge pipe, meaning that the waste water can drain from the branch discharge pipe into the stack. The water held in the traps on the floor in question is not extracted.

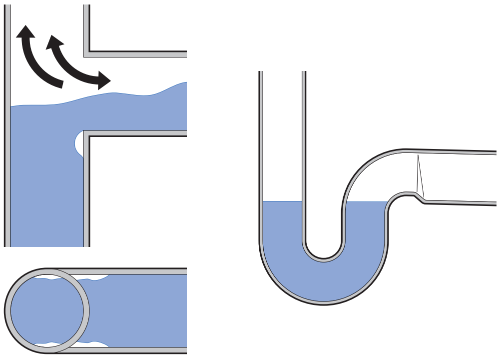


Figure 47: Flow conditions in an equal branch fitting 88.5° in the stack

### Reduced branch fitting 88.5°

If the branch discharge pipe is smaller than the stack and the dimension of the branch is therefore smaller than that of the through-flow, the connection point is not completely blocked and only slight negative pressure forms in the stack. The air can circulate freely in the branch discharge pipe and the waste water can easily drain from the branch discharge pipe into the stack. If the branch discharge pipe has the right dimensions, the water held in the traps on the floor in question is not extracted.

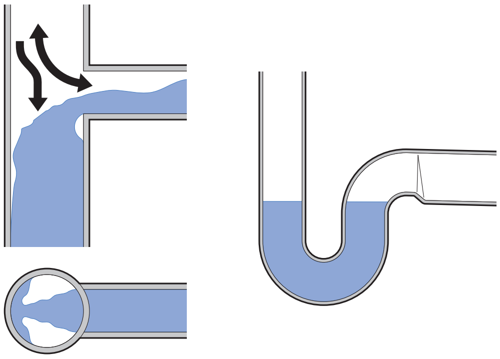


Figure 48: Flow conditions in a reduced branch fitting 88.5° in the stack

## Equal branch fitting 88.5°, swept-entry

In an equal branch fitting 88.5°, swept-entry, the draining waste water is accelerated by a slope shortly before entering the stack. The chance that the waste water forms a hydraulic blockage is slight, as air bridges occur on both sides of the stack. These allow the air to circulate despite the fact that the branch and through-flow diameters are the same. The air can circulate freely in the branch discharge pipe and the waste water can easily drain from the branch discharge pipe into the stack. The water held in the traps on the floor in question is not extracted.

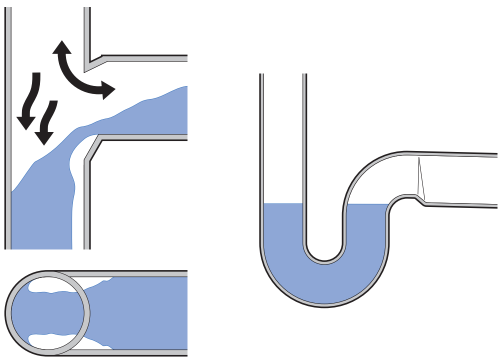


Figure 49: Flow conditions in an equal branch fitting 88.5°, swept entry, in the stack

## Equal and reduced branch fitting 45°

If the branch discharge pipe is smaller than the stack and the branch is therefore smaller than the through-flow, there is no hydraulic blockage in the stack. However, if the branch is completely filled, this can significantly impede the air circulation in the branch discharge pipe, leading to a hydraulic blockage and negative pressure in the branch discharge pipe. There is a risk that the water held in the traps on the floor in question will be extracted.

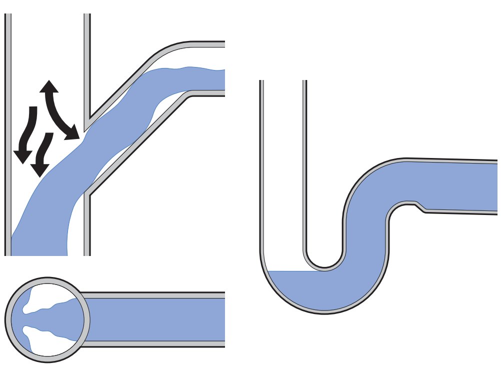


Figure 50: Flow conditions in an equal and reduced branch fitting 45° in the stack

## Hydraulically optimised branch fittings for high-rise buildings

### Geberit HDPE Sovent fittings

Hydraulic pressure compensation in a stack system is an extremely complex matter. Each stack concept is characterised by individual properties. The capacity of the stack and ventilation system is dependent on the flow capacity of the appliances, their simultaneous drainage pattern, the branch fitting inlet configuration and the drainage concept of the building. Overpressure and negative pressure in a drainage system must be limited in order to ensure the water seal in the trap.

Very high negative pressure values can arise in conventional main vent stacks. The negative pressure arises due to unfavourable flow behaviour between the stack and the branch discharge pipe. This unfavourable flow behaviour leads to a hydraulic blockage in the stack that prevents the air from circulating.

The Geberit HDPE Sovent fittings prevent a hydraulic blockage from forming in the stack. Because of the fact that the stack flow is guided around the point of connection, the incoming waste water has time to switch to the vertical direction so that it flows in a parallel direction when it meets the waste water in the stack flow. This minimises the collision turbulences of the two waste water flows and therefore reduces the pressure fluctuations in the system. Guiding the stack flow around the point of connection also causes the flow velocity to decrease which limits the kinetic pressure. In addition, the partition in the Geberit HDPE Sovent fittings prevents foam, dirt particles or splash water from getting into the branch discharge pipe.

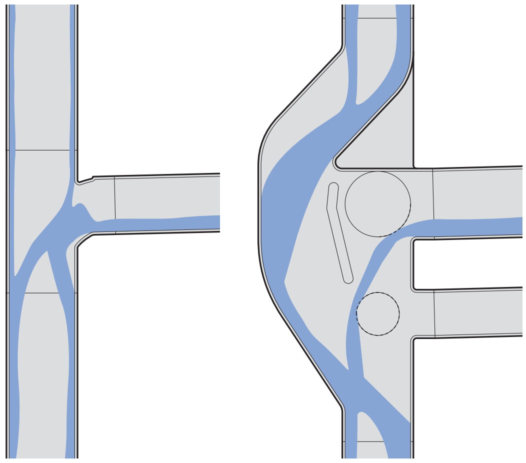
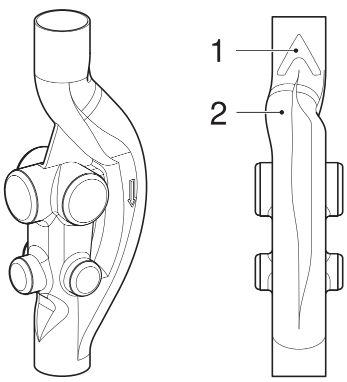


Figure 51: How the Geberit HDPE Sovent fittings function in comparison to conventional main vent stacks

**Function of the Geberit HDPE Sovent fitting d110 with SuperTube technology**

The Geberit HDPE Sovent fitting d110 is also characterised by its patented, flow-optimised design. The flow divider adjusts the flow of the water and supports functional stability in the system.

The swirl creates a rotating movement that allows the water to flow along the pipe wall, which produces a continuous column of air. This increases the discharge capacity by more than 30 % (from 8.7 to 12 l/s). The respective planning and installation regulations must be observed for planning and installation.




1 Flow divider

2 Swirl zone

# 11.3 Reducers

## 11.3.1 Using reducers

The more waste water flows in a building discharge pipe, the larger the pipe diameter needs to be.

Reducers are built into horizontal discharge pipes to widen their diameter in the direction of flow. Discharge pipes must not be reduced in the direction of flow.

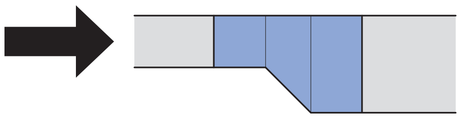


Figure 52: Reducers for widening the pipe dimension in the direction of flow

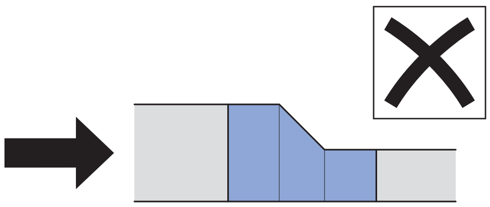


Figure 53: Not permitted: reducers for reducing the pipe dimension in the direction of flow

The structure of reducers can be divided into two types:

- eccentric reducers
- concentric reducers

### Eccentric reducer

Eccentric reducers shift the pipe axis of the smaller pipe section so that its jacket is aligned with the jacket of the larger pipe section.

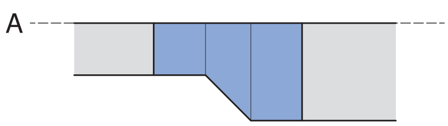



Figure 54: Eccentric reducer

A The jackets of the small and large pipe sections are aligned

Eccentric reducers must be installed level with the top of the pipe in order to avoid hydraulic damage due to air pockets.

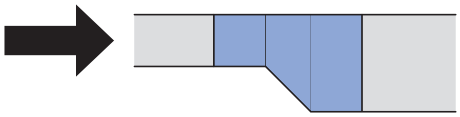


Figure 55: Eccentric reducers installed level with the top of the pipe

An exception is when reducers are used in underground pipes. In underground pipes, eccentric reducers can be installed level with the bottom of the pipe to facilitate inspection and the use of cameras.

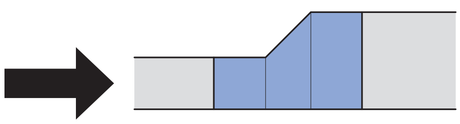


Figure 56: Eccentric reducers installed level with the bottom the pipe

### Concentric reducer

In contrast to eccentric reducers, concentric reducers are axisymmetric. The pipe axes of the smaller and the larger pipe section are aligned.

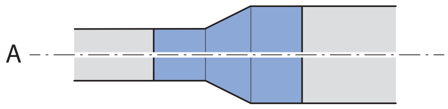



Figure 57: Concentric reducer

A The pipe axes of the small and large pipe sections are aligned

## 11.3.2 Hydraulic behaviour of reducers

### Comparing the flow characteristics of reducers

Tests with lying, non-ventilated branch discharge pipes have shown that eccentric reducers installed level with the top of the pipe feature better flow characteristics than concentric reducers.

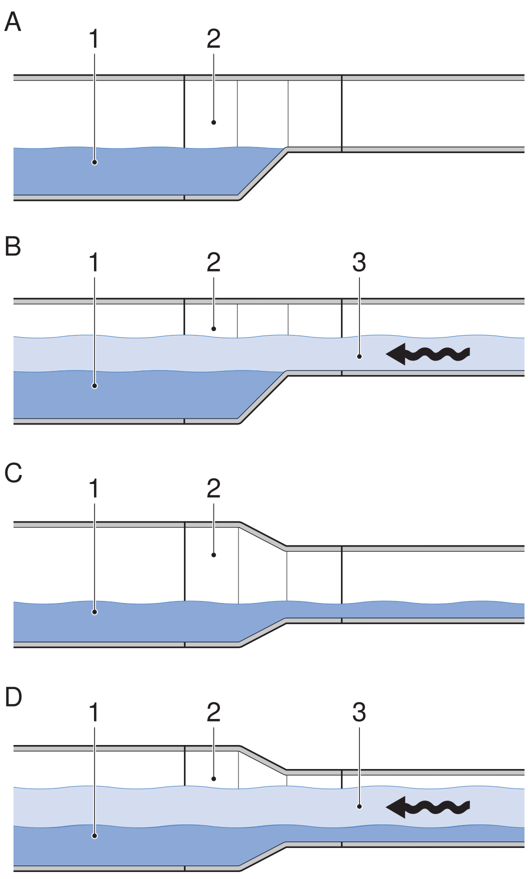



Figure 58: Flow characteristics of eccentric and concentric reducers in standing and flowing waste water

1 Standing waste water

2 Air circulation

3 Flowing waste water

A Eccentric reducer: standing waste water cannot back up further in the pipe.

B Eccentric reducer: flowing waste water flows over the standing waste water and is easily drained. Air circulation is not hindered.

C Concentric reducer: in some cases, standing waste water flows far back into the pipe. It may penetrate the trap.

D Concentric reducer: flowing waste water is slowed down by the standing waste water and drains off slowly. In the worst case, the water accumulates in the smaller pipe. Complete filling of the pipe leads to a negative pressure in the pipeline. This causes the water held in the trap to be extracted.

## 11.4 Access pipes

Access pipes are used for inspecting, cleaning and repairing building drainage systems.

Access pipes are installed at the following locations:

- in stacks, directly upstream of the connection to the underground pipe
- in stacks, directly upstream of the connection to the collector pipe
- in collector pipes
- in underground pipe ducts

The dimension of the access pipe dimensions should not be smaller than that of the downstream pipe so that the pipe system can be accessed with cleaning tools.

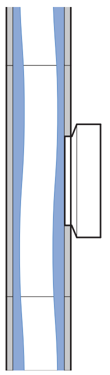


Figure 59: Flow conditions in a flow-optimised access pipe in the stack

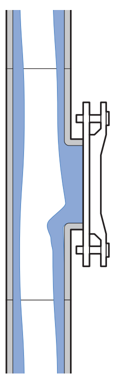


Figure 60: Flow conditions in a non-optimised access pipe in the stack

# 12 Systems for preventing backpressure

Floods and heavy rainfall can overload the public sewage system, causing the waste water to rise to the flood level. The flood level is the highest level up to which the waste water can rise in a drainage system, which is usually the road surface. If the waste water reaches the flood level, sanitary appliances in rooms below the flood level, e.g. cellars, are flooded.

In order to prevent such a situation from occurring, systems for preventing backpressure are installed in the drainage system. Systems for preventing backpressure include:

- faeces lifting systems
- backpressure seals

## 12.1 Faeces lifting system

A faeces lifting system is a pump that is installed in a duct at the lowest point in the building. The waste water is directed through a backpressure loop into the sewage system. The backpressure loop is located above the flood level. It is also referred to as a pump pressure pipe.

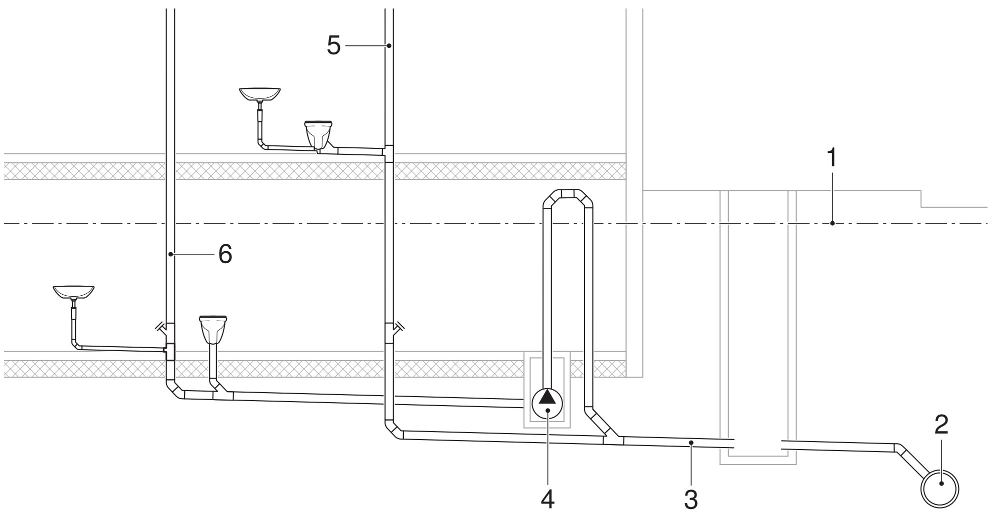



Figure 61: Preventing backpressure with a faeces lifting system

1 Flood level
2 Sewage system
3 Underground pipe
4 Faeces lifting system
5 Sanitary appliances above the flood level
6 Sanitary appliances below the flood level

## 12.2 Backpressure seal

A backpressure seal is a valve that automatically closes the discharge pipe when backpressure is generated. It therefore prevents the backflow of waste water into the building.

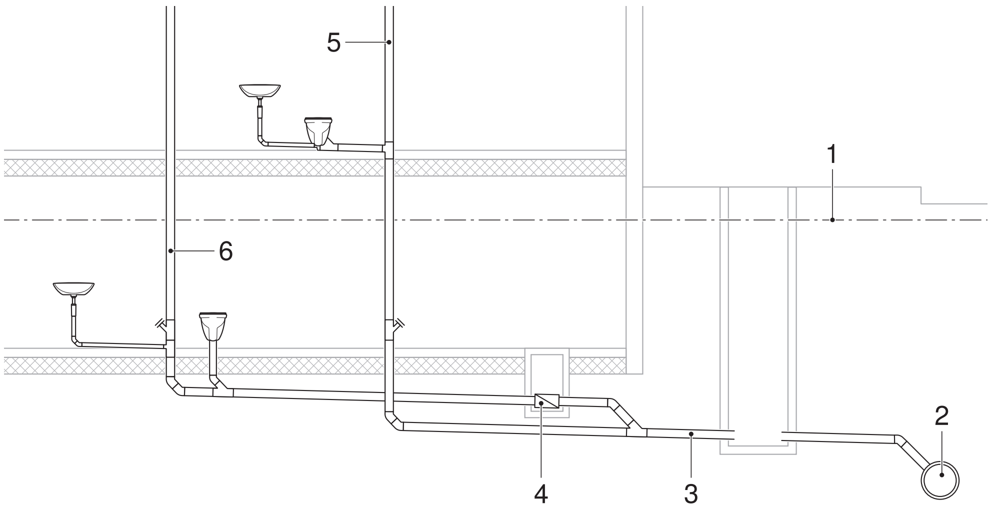



Figure 62: Preventing backpressure with a backpressure seal

1 Flood level
2 Sewage system
3 Underground pipe
4 Backpressure seal
5 Sanitary appliances above the flood level
6 Sanitary appliances below the flood level

# 13 Types of partially filled building drainage systems

Depending on the requirements, partially filled drainage systems feature different designs. The main distinguishing features are the ventilation design as well as the discharge pipe and stack designs.

## 13.1 Types of ventilation design

### 13.1.1 System with individual ventilation

In a drainage system with individual ventilation, each stack is routed individually via the roof and installed in open connection to the atmosphere. The system is therefore ventilated via the stacks and a separate ventilation pipe is not required. Since waste water and air flow together in the stack, the waste water cannot fill the entire internal cross section of the stack.

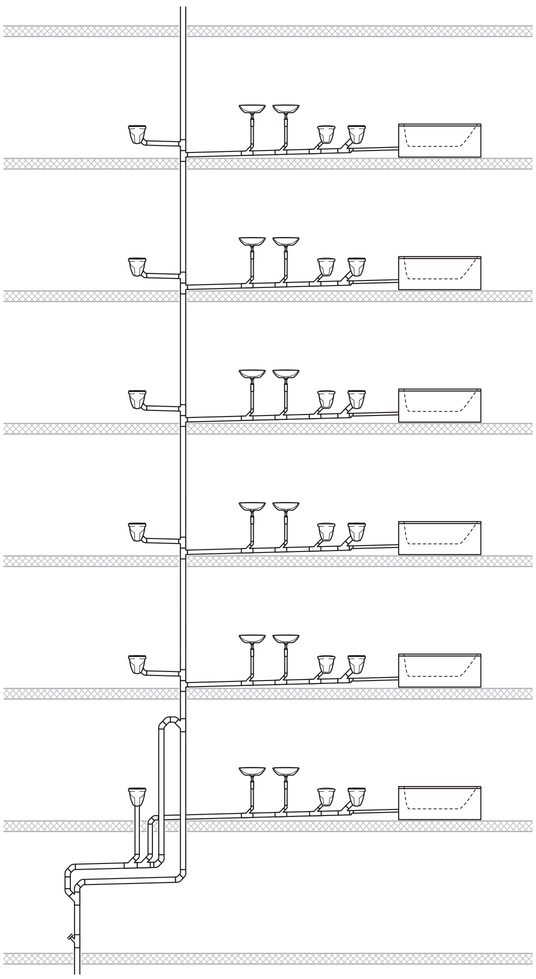


Figure 63: Drainage system with individual ventilation

A drainage system with individual ventilation has the following features:

- ventilation with same pipe diameter as the stack
- space-saving: no separate ventilation pipe is required
- piping diagram which is easily comprehensible
- low material requirements
- little planning and installation work required
- branch ventilation pipe is required for change in direction in the stack

### 13.1.2 System with collective ventilation

In a drainage system with collective ventilation, two or more individual ventilation pipes are routed in a common pipe via the roof. This reduces the number of weathering slates and the associated risks of leaks in the roof.

The collective ventilation pipe must be located above the uppermost branch discharge pipe. Direction changes from the individual ventilation pipes into the collective ventilation pipe must be executed with 2 bends 45° to maintain a low flow resistance.

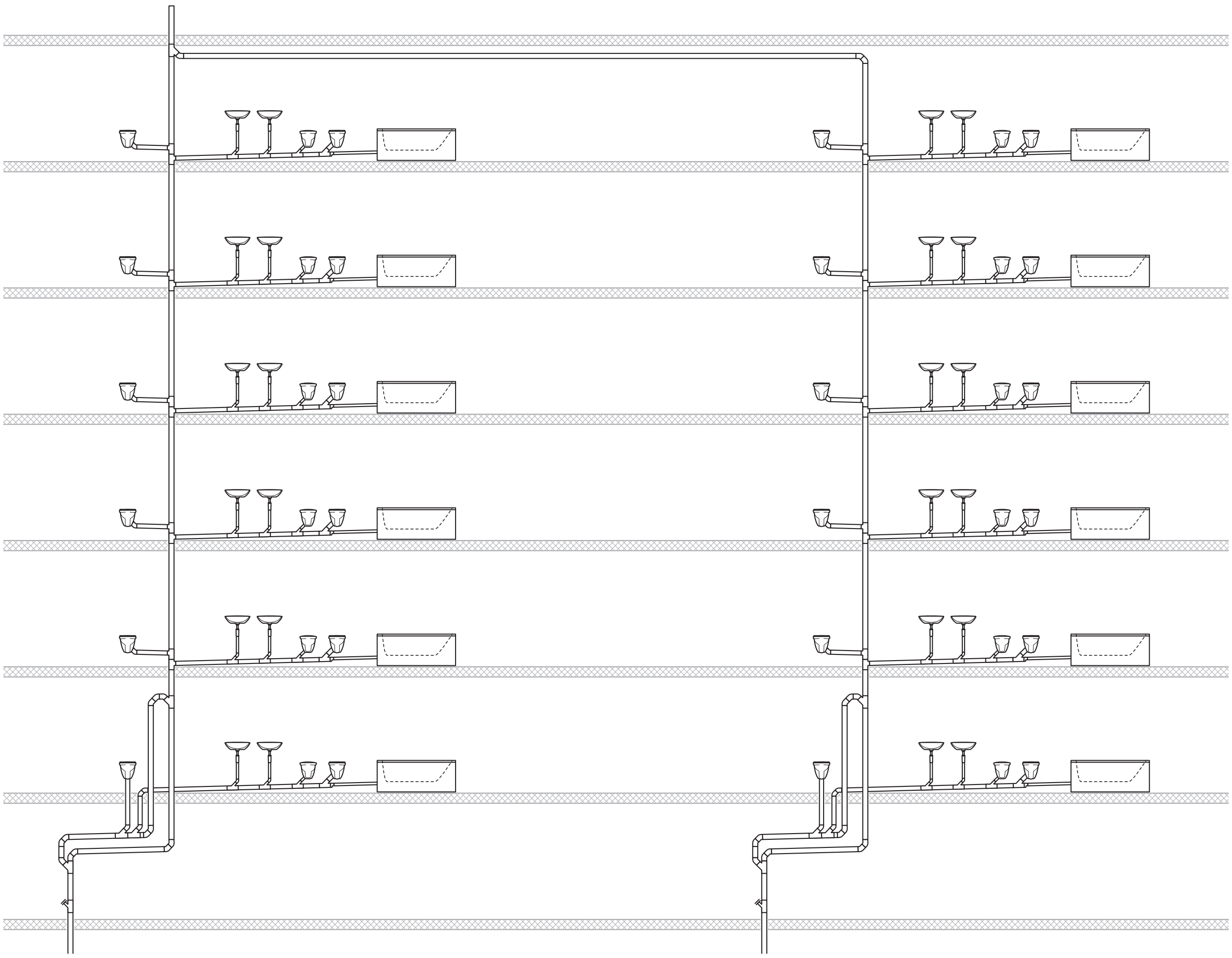


Figure 64: Drainage system with collective ventilation

A drainage system with collective ventilation has the following features:

- only one weathering slate
- ventilation with same pipe diameter as the stack
- space-saving: no separate ventilation pipe is required
- piping diagram which is easily comprehensible
- low material requirements
- little planning and installation work required
- branch ventilation pipe is required for change in direction in the stack

### 13.1.3 System with direct secondary ventilation

In a drainage system with direct secondary ventilation, the system is ventilated with a separate ventilation pipe running parallel to the stack.

The stack and ventilation pipe are connected to each other on each floor so that the entire internal cross section of the stack is available for draining the waste water.

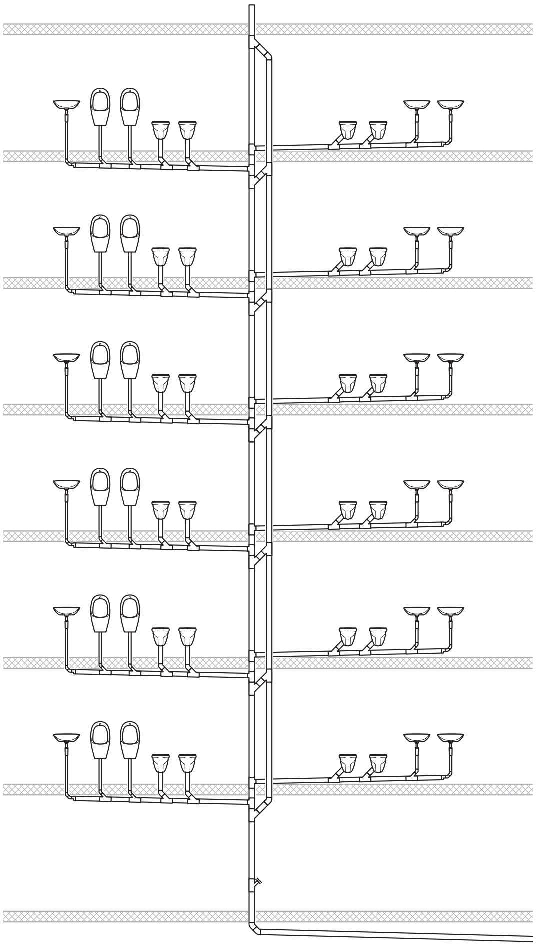


Figure 65: Drainage system with direct secondary ventilation

A drainage system with direct secondary ventilation has the following features:

- stack and ventilation pipe are connected to each other on each floor
- greater space requirements due to the separate ventilation pipe
- comprehensible piping diagram
- greater planning and installation work required

### 13.1.4 System with indirect secondary ventilation

In a drainage system with indirect secondary ventilation – unlike for direct secondary ventilation – the ventilation pipe is not laid parallel to the stack, but at the end of the branch discharge pipes.

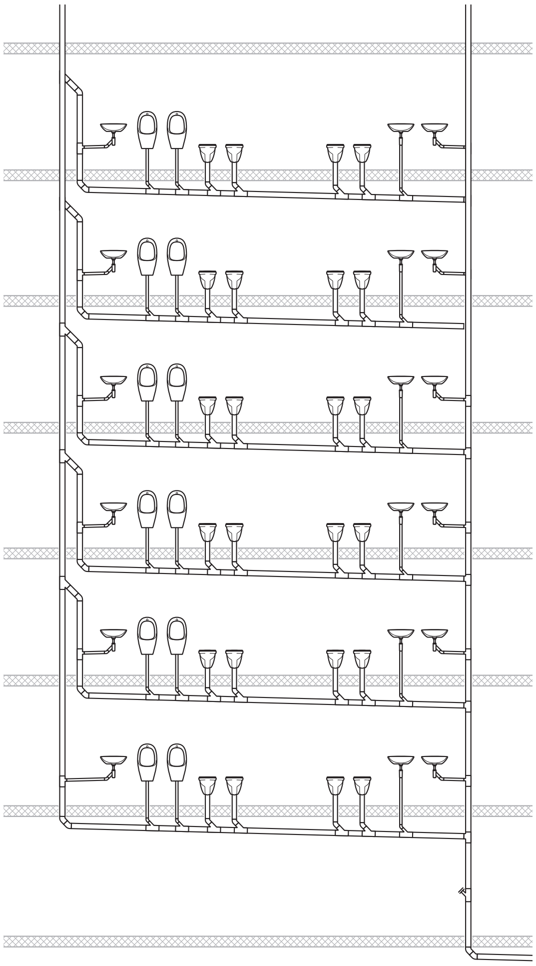


Figure 66: Drainage system with indirect secondary ventilation

A drainage system with indirect secondary ventilation has the following features:

- stack and ventilation pipe are connected to each other on each floor
- greater space requirements due to separate pipes in two ducts
- greater material requirements than a system with direct secondary ventilation
- complex piping diagram
- greater planning and installation work required

### 13.1.5 System with branch ventilation of the branch discharge pipes

In a drainage system with branch ventilation of the branch discharge pipes, each branch discharge pipe is connected to secondary ventilation via a branch ventilation pipe. Branch ventilation is used to relieve the branch discharge pipes. The secondary ventilation must be routed via the roof or at least 0.1 m above the uppermost sanitary appliance.

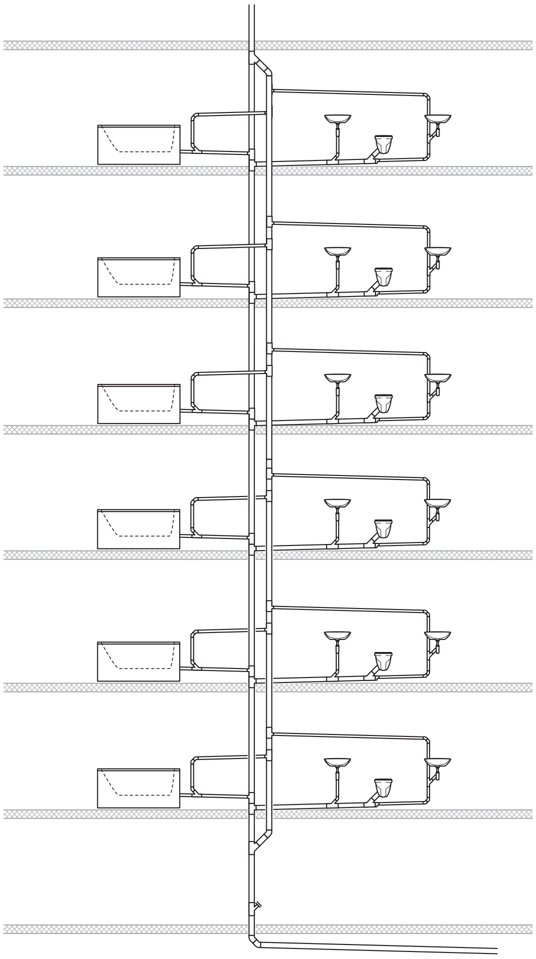


Figure 67: Drainage system with branch ventilation of the branch discharge pipes

A drainage system with branch ventilation of the branch discharge pipes has the following features:

- stack and ventilation pipe are connected to each other on each floor
- greater space requirements due to the separate ventilation pipe
- greater material requirements than a system with direct secondary ventilation
- complex piping diagram
- greater planning and installation work required

## 13.1.6 System with branch ventilation of the sanitary appliances

In a drainage system with branch ventilation of the sanitary appliances, each sanitary appliance is connected to the branch ventilation pipe. Just like in systems with branch ventilation of the branch discharge pipes, the branch ventilation pipe is connected to the secondary ventilation. The secondary ventilation must be routed via the roof or at least 0.1 m above the uppermost sanitary appliance.

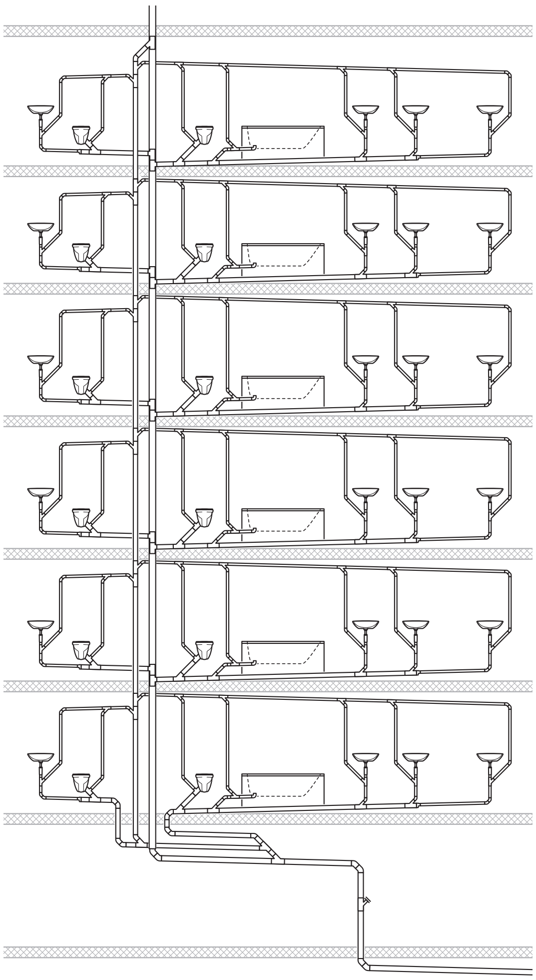


Figure 68: Drainage system with branch ventilation of the sanitary appliances

A drainage system with branch ventilation of the sanitary appliances has the following features:

- stack with complete filling is possible
- greater space requirements due to the separate ventilation pipe
- very complex piping diagram
- high material requirements
- a large amount of planning and installation work required

### 13.1.7 System with Geberit HDPE Sovent and Geberit SuperTube

In a drainage system with Geberit HDPE Sovent and Geberit SuperTube, each branch discharge pipe is connected to a Geberit HDPE Sovent fitting in the stack.

Very high negative pressure values can arise in conventional stacks with stack vents under certain circumstances. The negative pressure arises due to unfavourable flow behaviour between the stack and the branch discharge pipe. This unfavourable flow behaviour leads to a hydraulic blockage in the stack that prevents the air from circulating.

The Geberit HDPE Sovent fittings prevent a hydraulic blockage in the stack, as the special design of the fitting and patented Geberit SuperTube technology produce a continuous column of air in the stack. The discharge rate of the stack increases as a result of the continuous column of air, meaning that there is no longer any need to install a ventilation pipe running in parallel and the stack dimensions can be smaller in many applications.

The Geberit HDPE Sovent fittings are available in the dimensions of d110 and d160. The Geberit HDPE Sovent fitting d110 is equipped with the Geberit SuperTube technology.

### Geberit SuperTube

In addition to the Geberit HDPE Sovent fitting d110 with Geberit SuperTube technology, the Geberit HDPE BottomTurn and Geberit HDPE BackFlip bends are also available for direction changes in the dimension d110. They are also equipped with Geberit SuperTube technology. In combination with the two bends, fitting d110 forms the Geberit SuperTube system.

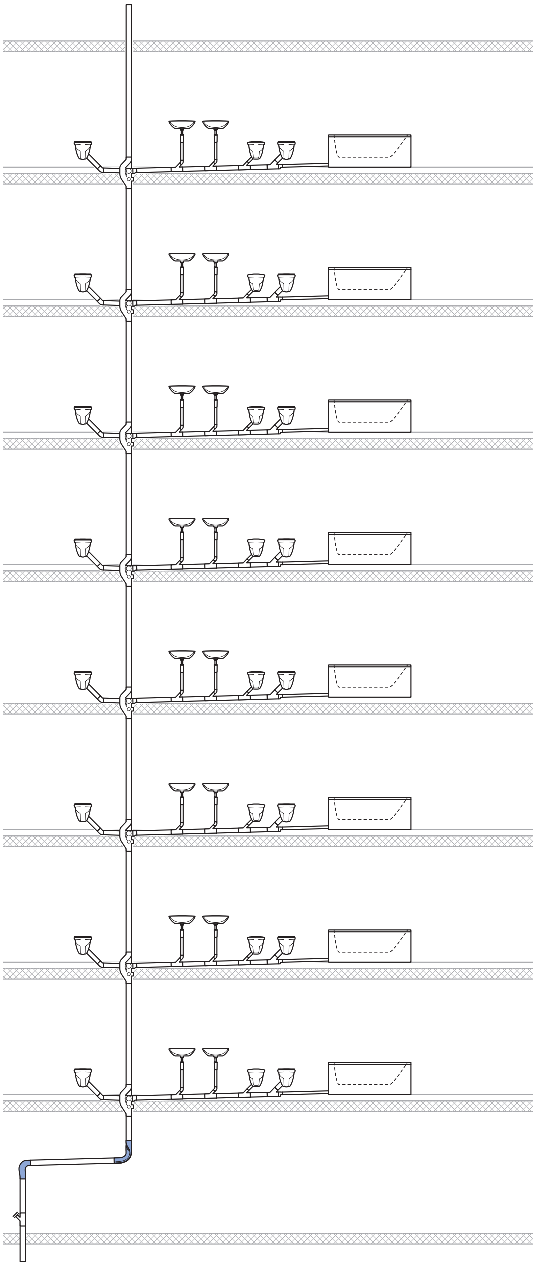


Figure 69: Drainage system with Geberit SuperTube

A drainage system with Geberit SuperTube has the following features:

- ventilation with same pipe diameter as the stack
- space-saving: no separate ventilation pipe is required
- no branch ventilation pipe is required for change in direction in the stack
- continuous diameter d110 up to a stack offset of 6 m
- no slope required for stack offsets up to 6 m
- piping diagram which is easily comprehensible
- reduces negative pressure on each floor
- low material requirements
- little planning and installation work required

## Geberit HDPE Sovent fitting d160

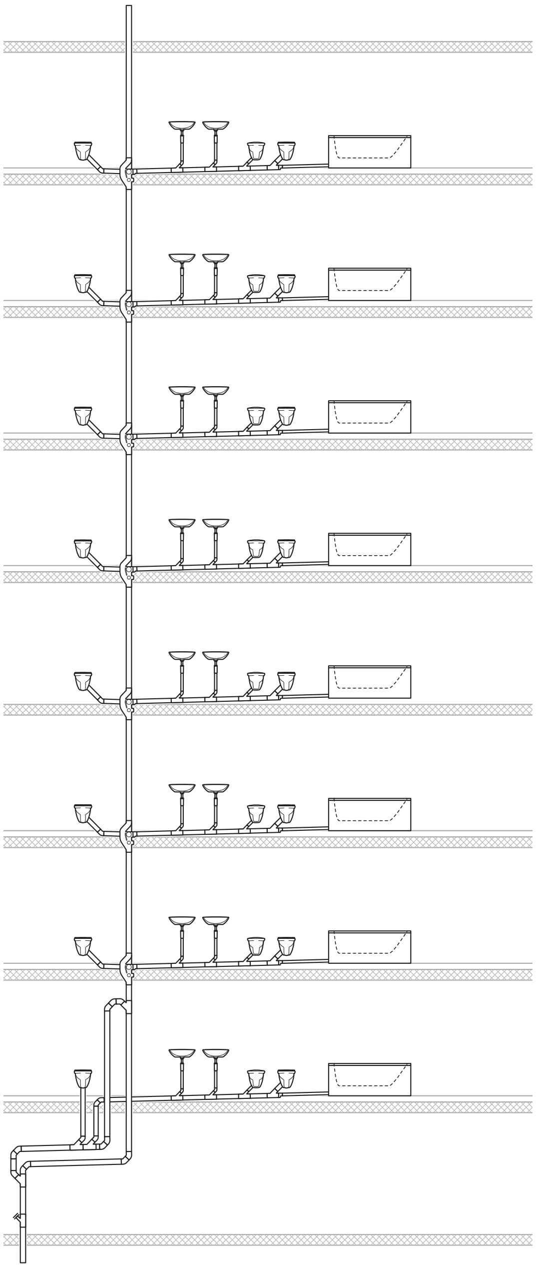


Figure 70: Drainage system with a Geberit HDPE Sovent fitting d160

A drainage system with a Geberit HDPE Sovent fitting d160 has the following features:

- ventilation with same pipe diameter as the stack
- space-saving: no separate ventilation pipe is required
- branch ventilation pipe is required for change in direction in the stack
- piping diagram which is easily comprehensible
- reduces negative pressure on each floor
- low material requirements
- little planning and installation work required

## 13.2 Types of branch discharge pipe and stack design

There are various types of branch discharge pipe and stack designs. which differ in the number of pipes and the installation type.

Two design traditions have evolved over the course of the development of building drainage systems:

- American-British design: the sanitary appliances from one floor are connected to one or more stacks via separate branch discharge pipes.
- European design: the sanitary appliances from one floor are connected to one stack via a branch discharge pipe.

The branch discharge pipes can be laid above, in or under the ceiling.

### 13.2.1 American-British design

#### Laying the branch discharge pipe under the ceiling, three stacks

Features:

- separate stacks for greywater, black water and ventilation
- separate branch discharge pipes for greywater and black water (WC, urinal, kitchen sink)
- ventilation via direct secondary ventilation running parallel to both stacks

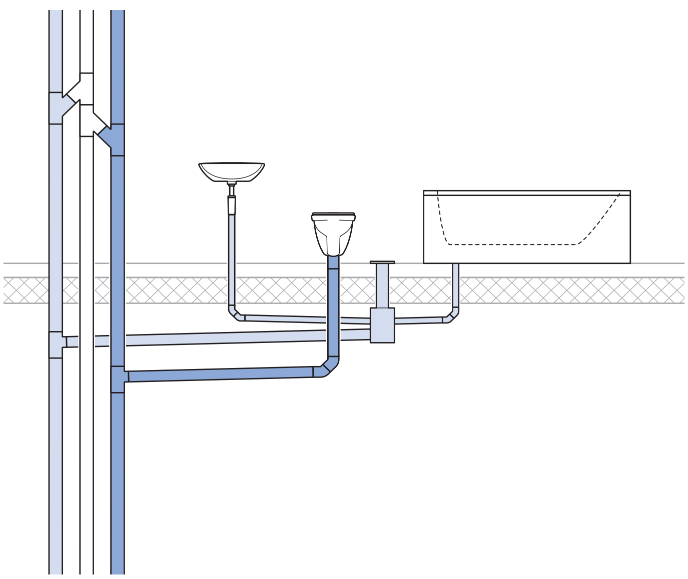


Figure 71: Laying the branch discharge pipe under the ceiling, three stacks

Advantages:

- sanitary appliances can be placed as required
- greywater can be used due to separate stacks
- high load bearing capacity of the stacks for waste water
- floor drain cannot dry out
- easily accessible via the suspended ceiling

Disadvantages:

- sound is transmitted to the neighbouring flat
- maintenance work is only possible via the neighbouring flat
- suspended ceiling required
- ceiling feed-throughs required
- additional space for floor drain required
- increased installation workload due to work in 2 rooms

### Laying the branch discharge pipe under and above the ceiling, two stacks

Features:

- separate stacks for greywater and black water
- separate branch discharge pipes for greywater and black water (WC, urinal, kitchen sink)
- branch discharge pipe for black water above the ceiling

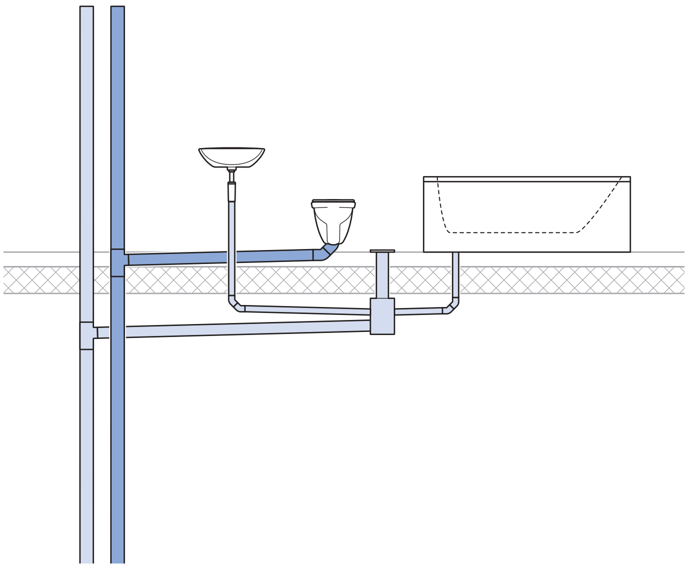


Figure 72: Laying the branch discharge pipe under and above the ceiling, two stacks

Advantages:

- sanitary appliances can be placed as required
- greywater can be used due to separate stacks
- floor drain cannot dry out
- partly accessible via the suspended ceiling
- Drainage of WC (main noise source) via user's flat

Disadvantages:

- sound is transmitted to the neighbouring flat (except WC)
- maintenance work is only possible via the neighbouring flat
- suspended ceiling required
- ceiling feed-throughs required
- increased installation workload due to work in 2 rooms

### Laying the branch discharge pipe under and above the ceiling, single stack

Features:

- one stack for all types of waste water and for ventilation
- separate branch discharge pipes for greywater and black water (WC, urinal, kitchen sink)
- branch discharge pipe for black water above the ceiling

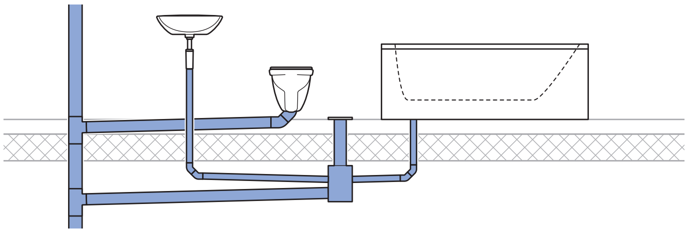


Figure 73: Laying the branch discharge pipe under and above the ceiling, single stack

Advantages:
- sanitary appliances can be placed as required
- floor drain cannot dry out
- partly accessible via the suspended ceiling
- Drainage of WC (main noise source) via user's flat

Disadvantages:
- sound is transmitted to the neighbouring flat (except WC)
- maintenance work is only possible via the neighbouring flat
- suspended ceiling required
- ceiling feed-throughs required
- greater material requirements due to second branch discharge pipe
- increased installation workload due to work in 2 rooms

### 13.2.2 European design

#### Laying the branch discharge pipe under the ceiling, single stack

Features:
- one stack for all types of waste water and for ventilation
- one branch discharge pipe for all sanitary appliances
- additional floor drainage possible

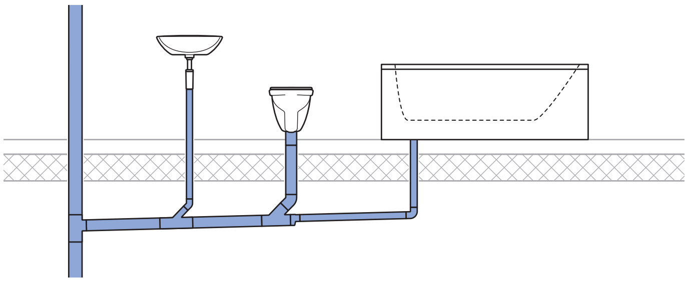


Figure 74: Laying the branch discharge pipe under the ceiling, single stack

Advantages:
- easy arrangement and installation of the branch discharge pipe
- low material requirements
- sanitary appliances can be placed as required
- easily accessible via the suspended ceiling
- no additional traps required

Disadvantages:
- sound is transmitted to the neighbouring flat
- maintenance work is only possible via the neighbouring flat
- suspended ceiling required
- ceiling feed-throughs required
- increased installation workload due to work in 2 rooms

### Laying the branch discharge pipe in the ceiling, single stack

Features:

- one stack for all types of waste water and for ventilation
- one branch discharge pipe for all sanitary appliances
- branch discharge pipe is completely embedded in concrete
- additional floor drainage possible

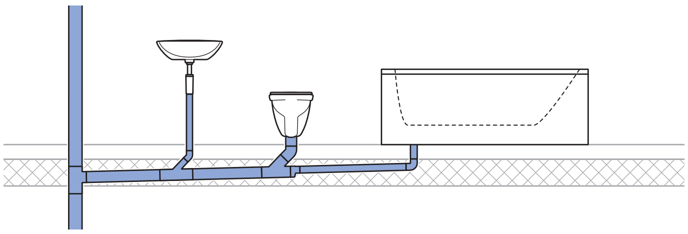


Figure 75: Laying the branch discharge pipe in the ceiling, single stack

Advantages:
- short installation time due to possible waste water prefabrication
- easy arrangement and installation of the branch discharge pipe
- low material requirements
- sanitary appliances can be placed as required
- sound insulation by embedding in concrete
- no suspended ceiling required
- no ceiling feed-throughs required

Disadvantages:
- requires precise planning and compliance with deadlines
- subsequent changes and adjustments only possible with much effort
- piping materials must be stress-resistant

## Laying the branch discharge pipe above the ceiling, single stack

Features:

- one stack for all types of waste water and for ventilation
- one branch discharge pipe for all sanitary appliances

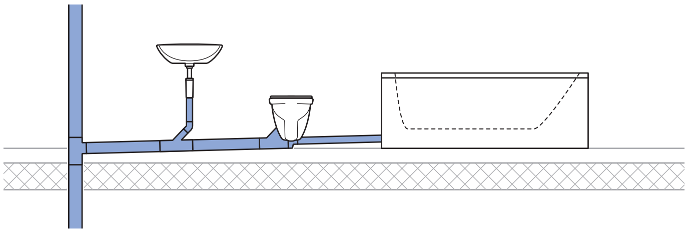


Figure 76: Laying the branch discharge pipe above the ceiling, single stack

Advantages:

- short installation time due to possible waste water prefabrication
- easy arrangement and installation of the branch discharge pipe
- low material requirements
- sanitary appliances can be placed as required
- excellent sound insulation
- no additional traps required
- no suspended ceiling required
- no ceiling feed-throughs required

Disadvantages:

- requires precise planning and compliance with deadlines
- screed required when using a floor drain or floor-even shower

# 14 Maintaining building drainage systems

## 14.1 The purpose of maintenance

Building drainage systems are exposed to heavy loads and stresses on a daily basis. They discharge the most diverse types of waste water and must withstand structural and temperature-reduced movements.

Newly built and newly renovated building drainage systems must therefore be checked for functional reliability at regular intervals in order to respond to damage in good time.

All measures relating to the regular testing of the system fall under the term of maintenance.

Maintenance includes all measures relating to the regular testing of a building drainage system and is divided into the following areas:

- inspection
- maintenance
- repair

If the building drainage system is in a building that is located in a groundwater protection zone, increased inspection and maintenance requirements are to be expected.

## 14.2 Prerequisites for maintenance measures

A building drainage system must be designed and operated in such a way that the system can be accessed for maintenance. A detailed plan of the system must be provided in order to carry out maintenance measures in full. The plan must indicate which type of waste water flows in the individual pipes.

## 14.3 Inspecting building drainage systems

The inspection is used to test the current state of the building drainage system. In a first step, all system components are inspected visually for damage. Camera systems are usually used for this purpose. If damage is detected during the visual inspection, a leak test can be carried out in a second step.

The use of a structured action plan is recommended to ensure that no system parts are forgotten. At least the following points must be inspected visually:

- state of the pipe joints, in particular for tightness and protruding parts
- state of the pipes, in particular for holes, cracks or deformations
- deposits in the pipes and branches
- roots growing in the pipes
- positional changes of the pipe due to shifts, sagging or shearing
- corrosion
- mechanical wear

## 14.4 Maintaining building drainage systems

Maintenance includes all measures that are performed to maintain the operability of a building drainage system. Maintenance work is carried out at regular intervals regardless of the system's state.

The use of a structured maintenance plan is recommended to ensure that no system parts to be maintained are forgotten. All maintenance work should be documented for traceability.

At least the following work must be carried out during maintenance:

- cleaning ducts
- pumping out the sludge collectors
- rinsing lying pipes
- cleaning drains and traps
- controlling the air admittance valves
- maintaining special system parts such as pumps, separation systems or valves according to manufacturer information

## 14.5 Repairing building drainage systems

Repairs include all measures for restoring the function of an impaired or damaged building drainage system so that is once again operable.

Repair work can range from local repairs to complete renovations.

The damage detected during an inspection is assessed and prioritised.

Possible repair work includes:

- repairing damaged areas in pipes with special techniques
- lining longer defective pipe sections
- replacing damaged pipe sections


5037289099 ©
int.en 21169-19/358