

## More than just water-tightness

### Requirements for private site drainage systems

There are many water management and operational targets for wastewater systems which can be achieved only if private site drainage is included, as early as the conceptual planning stage concerning construction, operation and rehabilitation. This is legally supported by identical technical requirements for both private and public sewers in the German Water Management Act. Municipalities are therefore obliged to provide timely information and advice to site owners on both technical and legal requirements.

Neither legal nor technical codes of practice differentiate in principle between public and private sewers. This is true both of European requirements and their specific expression in national legislation [1-3]. What does this mean for site owners and for municipalities who bear responsibility for the disposal of wastewater? It is clear that more than just the water-tightness of the sewers is involved. The condition and functioning of the public and private network as a whole must be included and assured. Questions range from controlling the risk of blockages to the elimination of illegal connections, the prevention of infiltration and the avoidance of nuisance odours. Thus, it is clear that water management needs to start at the individual site.

#### Public and private sewers: Legal aspects

Across Europe, a watertight network of underground wastewater pipes and sewers assure the reliable collection and disposal of sewage and rainwater. The total length of public sewers within the European Union has been estimated at around 2.5 million kilometres [4]. No information is available on the total length of private site drainage pipes, since the focus is usually on public wastewater networks. However, wastewater disposal does start on the individual site, with the consequence that private site drainage networks must always be included when

considering overall water management issues and the protection of soil and groundwater. This holistic approach is supported by legal requirements, technical codes of practice and standards.

The European directive concerning urban wastewater treatment (Directive 91/271/EEC) does not differentiate between private and public sewers, but instead refers to sewers as a piping system in which domestic, industrial and precipitation water is collected and conveyed. Annex I of this EC directive requires optimum technical knowledge for the design, construction and maintenance of the sewer system. It also clearly points out that leaks must be avoided. European standard DIN EN 752 [5] specifies targets for drainage systems located outside of buildings. Here, again, no differentiation is made between

private wastewater pipes and public sewer systems. Four aims of drainage systems are defined very clearly in this standard: public health and safety, the health and safety of the workforce, environmental protection and sustainable development.

The German Water Management Act (WHG) [2] is no less demanding and specifies, in Article 60



Site drainage system in accordance with generally accepted standards of technology

# Site drainage systems

of the current edition, that wastewater systems may be constructed, operated and maintained only in accordance with the generally accepted standards of technology. The drainage/sewer system is therefore to be observed as a whole, and no differentiation made between private site drainage pipes and public sewers. The WHG also states that the necessary action on any wastewater systems which do not conform to the requirements must be taken within appropriate periods of time.

The requirements of the federal Water Management Act are set out more specifically in the individual state water management acts. For example, The State Water Act in North Rhine-Westphalia (LWG) [3] states that the responsible authority is empowered to specify the nature, scope and frequency of inspections of wastewater systems. More detail is provided in the Self-Monitoring Ordinance Wastewater (SüwVOAbw) [6] issued by the state's Ministry for Climate Protection, Environment, Agriculture, Conservation and Consumer Protection. It defines not only the inspection intervals but also quality requirements for inspection.

More extensive requirements can be imposed in by-laws at municipal level. For example, The North Rhine-Westphalian State Water Act [3] empowers the municipality to set specific periods for the inspection of sewer laterals and/or site connections by means of by-laws. This option is useful when it is necessary to perform extensive rehabilitation work on the public sewer system in order to reduce infiltration. Here, private site drainage pipes must be included in the scope of work in order to achieve holistic water management. Only in this way can the overall aim of rehabilitation - i.e., a significant reduction in the volume of extraneous water treated - be achieved in such cases.

## Requirements for the private site drainage system

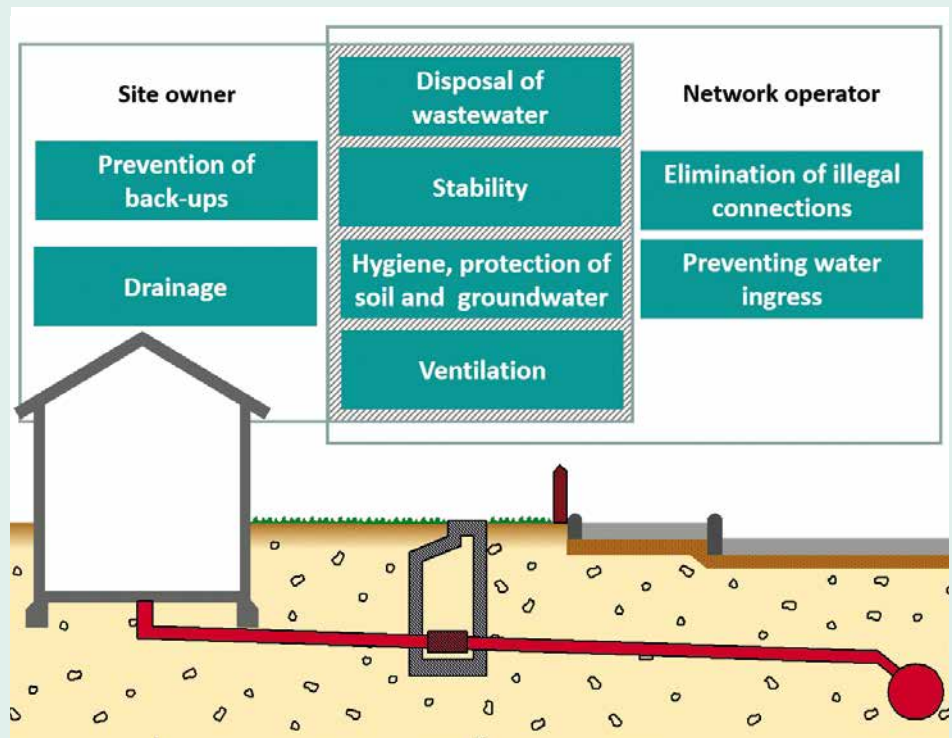
The sewer system is in all cases regarded in the legal and technical provisions as a whole, i.e., both public and private sewers must be operated in accordance with the generally accepted standards of technology, and their condition and function surveyed at regular intervals and monitored accordingly. This is understandable

from a technical viewpoint, since essential water management targets, such as assured hazard free disposal, can be only be achieved provided the entire system, consisting of public and private sewers and piping, remains operationally reliable, stable and watertight throughout its specified service life.

An examination of the many diverse requirements made on private site drainage systems makes it possible to differentiate between aspects which are of primary importance to the site owner and other aspects which are of greater interest to the municipal network operator. However, there are areas of overlapping common interest.

Non-aggressive cleaning methods must be used by the service provider when eliminating obstructions to flow (such as blockages and depositions) in private site drainage to avoid damage to the pipe [7].

In certain cases, there may also be a public responsibility for the elimination of obstructions to flow. A particular case is in public roads where the intrusion of roots from municipal trees or from roadside greenery into private sewer laterals may occur. In many cases, the owner of the tree bears co responsibility for eliminating root intrusion ([8], Article 1004 German Civil Code [9]).



Requirements for private site drainage systems

## Disposal of wastewater

The availability and reliability of private site drainage systems must ensure the collection and removal of wastewater from a particular site. However, the correct functioning of private site drainage may be significantly impaired by obstructions to flow, damage, and/or installation errors. The site owner is responsible for ensuring that such problems are eliminated within an appropriate timescale.

## Prevention of back-ups

For both economic and technical reasons, public sewer systems cannot be designed to immediately handle the volumes of water from every heavy rainfall event. Therefore, back-ups of sewage into the private sewer laterals/private site drainage pipes can occur for a short time when there are extreme burdens on the public drainage/sewer system. Back-ups can also occur if flow in the public sewer or in the private pipe is disrupted as a result of blockage. The site



Root intrusion into private sewer laterals

owner is responsible for ensuring that his or her building is protected against back-ups. If protection against back-up is lacking, the wastewater may be able to penetrate from the drain/sewer into the building, potentially causing serious damage and other problems [10].

Retrospective analysis of heavy rainfall events regularly shows that private sewers are, in many cases, not operating with any back-flow prevention. In inspections of twenty basements in Dortmund effective backflow prevention was lacking in all cases [11], whilst in Münster [12] no such safety features were in place in two thirds of some 150 sites examined.

### Drainage systems

The long-term aim of municipalities is to eliminate surface water drainage system connections to sewers, whereas the overriding priority of site owners is to avoid damp in their buildings. The „Handling of drainage-system water from private sites - Pragmatic conceptual solutions and aids to argumentation“ guideline [13] provides municipalities and system operators with useful notes on defusing this conflict of interests.

The discharge of groundwater and surface water into the public sewer system is prohibited in

principle in the majority of municipal wastewater by-laws. Drainage system connections can, nonetheless, be found in virtually all municipalities. Estimates for North Rhine-Westphalia [14] assume that a drainage system is connected to the public sewer system for approximately 20 to 40% of all sites. These are systems designed for continuous drainage of plots of land. However, there are also drainage systems which were intended to only operate during the construction of buildings, that have not been disconnected from the public sewer system after completion of building work.

The result, particularly in zones with high groundwater tables, is a significant increase in the proportion of extraneous water in the public sewer system. The introduction of groundwater and surface water dilutes the wastewater, impairs treatment plant performance and endangers surface water if treatment plants and rainwater retention basins are overburdened. An increase in heavy rainfall events exacerbates the situation. In addition, the groundwater table may rise after refurbishment of public sewer systems resulting in further influx of drainage system water.

### Stability

Severe damage to private site drainage pipes may endanger the stability of the pipe/soil system. This is true, in particular, in the case of Class A damage scenarios in accordance with DIN 1986-30 [15], such as „Cavity, or soil visible“, „Infiltrating soil material“, „Infiltration“ or „Pipe fracture“. Private wastewater pipes (such as sewer laterals) are also frequently located in the public road space. Hazard result from sagging and surface collapse, as was shown by an IKT survey of around seventy sewer system operators in North Rhine-Westphalia [16] during the „Concept for informing and involving citizens concerning private sewer laterals“ research programme [17].

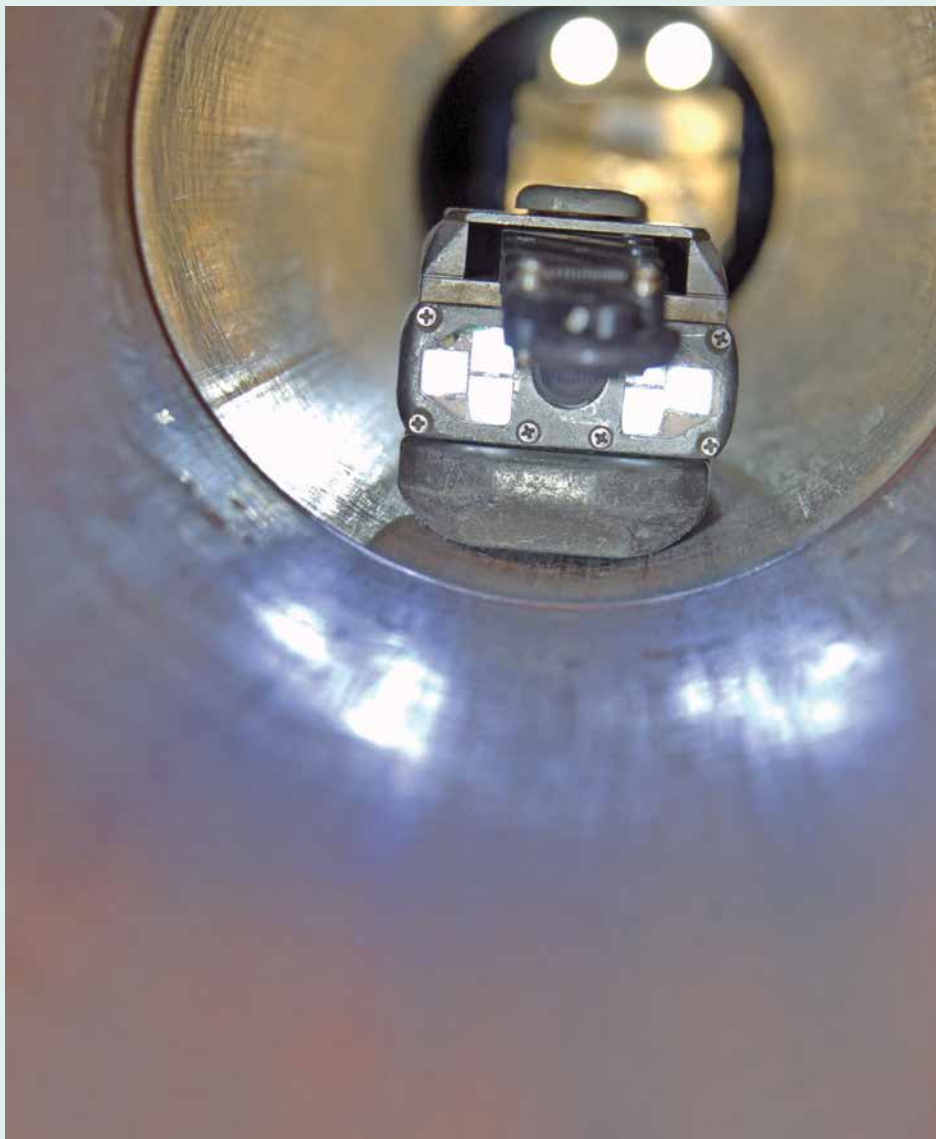
The site owner has an obligation to take action where damage which endangers stability occurs in private site drainage pipes. DIN 1986-30 [15] stipulates that immediate action must be initiated in circumstances that require it, on the basis of the principle of „cause for concern“. Such circumstances include damage which causes danger of collapse, and consequently a threat to the safety of traffic and/or to the stability of nearby structures, traffic facilities or other amenities.

### Hygiene and protection of soil/groundwater

Contaminated drinking water, including well water polluted with sewage, caused major cholera epidemics in London in the 1840s [18]. It was possible to systematically contain such epidemics only by constructing the London sewer system. Great importance therefore attaches to a correctly functioning and water tight sewer system, since damage to and/or leaks in sewage pipes and ducts can result in the escape of sewage into the soil and the groundwater [19–21]. The incidence of damage to public sewers in Germany is around 17% [22], while the incidence of defects in private site drainage pipes is estimated at around 70% [23]. Therefore, there is a particular need for action in the private sector on holistic sanitation provisions.

### Ventilation

The air space in the sewer system serves as a volume and pressure equalisation space to assure the flow at different fill levels of a drainage



Condition and function of private sewers must be surveyed

system [24]. The movement of air also provides for air exchange and of the removal of moisture and gases from the sewage. A large number of openings assure the natural ventilation of drainage systems (see ATV-DVWK-M 154) [25]. These include, primarily, the roof vent of the private site drainage system connected to the public sewer system, in addition to the ventilation openings in the system's manhole covers.

Incorrect design and installation of the roof vent, that impairs or prevents air change and pressure equalisation, can result in odour nuisances [26].

The importance of correctly functioning ventilation for the sewer system was also documented in the IKT Comparative Test „Odour filters for wastewater manholes“ [27]. For this cleaning

performance (the odour-laden flow of waste-air) and air permeability, were selected as test criteria for manhole filters. Sewer system operators' practical experience demonstrated that greater corrosion [28, 29], attributable to inadequate air exchange, can occur in concrete manholes when odour filters are used.

### Preventing water ingress

Groundwater can enter the sewer system via leaking private site drainage pipes and can cause various problems: impairing performance at the treatment plant, greater energy consumption at pumping stations and overflow at rainwater retention basins [30–32]. The consequences are significantly greater costs for wastewater treatment and disposal and impacts on surface-water quality.

Private site drainage lines must be included in extraneous water rehabilitation work on the sewer system in order to achieve a reduction in the ingress of water. If only the sewer network is sealed, there is a danger that more groundwater will enter the public sewer system via leaking private site drainage pipes and that the basic aim of reducing water ingress will not be achieved.

### Elimination of illegal connections

Roof drainage systems and surface runoff from private sites on the site are frequently connected to the sewer system without permission. Such illegal connections increase the volume of extraneous water, with corresponding consequences for wastewater treatment/disposal, and for surface water quality (see „Preventing water ingress“).

Overall, the large number of illegal connections can have significant effects on extraneous water volumes. During investigations of the town of Rheine's extraneous water burden [33] a smoke tracer was fed to all the private sites in the affected district to detect illegal connections. Illegal connections were discovered on approx. 6.5% of the sites investigated.

### Support from the municipalities and the federal states

Against the background of the issues discussed above, the municipality comes under considerable pressure because of its obligation to dispose of wastewater. It can perform the tasks entrusted to it consistently, only if private site drainage is included. Numerous municipalities are already pursuing this route [33–36]. Extraneous water has, up to now, been the essential driving force behind developing holistic approaches to the influx of extraneous water. It affects the performance of public systems directly and solutions would appear to be very difficult without the inclusion of private site drainage systems.

Further examples of support from municipalities [37, 38] include the marketing and provision of municipal services to the private sector, such as condition and functional inspection of private site drainage systems.

The implementation of sanitary provisions frequently requires the involvement of citizens and/

or site owners. They require support, particularly with respect to the following:

● **As-built plans and documentation obligation**

Under Article 61 (2) of the WHG [2], the operators of wastewater systems are obliged to monitor the condition and functioning of their systems, their maintenance and their operation, together with the content and quantity of the wastewater. A statutory instrument requires that records of this data be drafted, kept and submitted to the responsible authority upon request. In this respect, the WHG makes no differentiation between private and public wastewater systems, placing an obligation for both to maintain documentation. For private site drainage systems there is frequently inadequate documentation, even of the existing situation. In many cases, particularly old systems, pipe layouts are inadequately documented, if at all, and as-built plans are completely lacking [39].

● **Consumer protection for „New systems“**

The generally accepted standards of technology apply, in accordance with Article 60 WHG [2], to the construction of wastewater facilities. However, errors in the planning, design and execution of new private site-drainage systems are common. To protect consumers, site owners need to be informed at an early stage about the potential risks - at the award of contract, and during performance of construction work. In addition, proof of quality criteria, such as a water-tightness test, should be required as part of the acceptance inspection of the works.

Municipalities can support citizens and/or site owners in the following ways:

- **Information:** to advise citizens on the issues and encourage involvement in joint (public/private) refurbishment projects.
- **Advisory services:** to provide more detailed information and in some cases feedback and observation, such as inspection of a site's drainage system and provision of advice.
- **Technical services:** construction, operation and rehabilitation involve many questions concerning condition surveying, evaluation and quality assurance. Quality assurance is always particularly difficult for citizens if the actual work takes place underground or is buried. Municipalities can provide specific

advisory and information services on rehabilitation methods and quality assurance.

Where the environment and consumer affairs are the responsibility of the same ministry in a federal state (such as Bavaria and North-Rhine Westphalia), the issues described above may receive greater attention through special state regulations. It has been stipulated in Bavaria that only appropriately accredited persons are to be entrusted with inspections of wastewater facilities (see „Self-monitoring Ordinance“ [EÜV] [40]). It also requires that technically qualified contractors (see specimen wastewater by-laws [41]) are employed specifically for work on private site drainage lines.

It is clearly stated in Article 53c of the State Water Act NRW, that the advisory obligation for implementation of the duties arising from WHG Article 60 and Article 61 [2] may also be funded from wastewater charges, as part of the wastewater disposal obligation. Municipal advisory services are supported by conceptual notes and PR materials [17]. In addition, the NRW Consumer Center has been integrated into the state's range of information services, in order to assure the availability of information for citizens throughout the state. The state of NRW has also regulated the approval of expert inspectors in the „Self-monitoring Ordinance: Wastewater“ [6] to cover those technical services which, for citizens, largely take place „out of sight“ (pipe inspections, in particular).

### Conclusions

Water management starts on the site. Many water-management and operational aims can only be achieved if private site-drainage and its functions are included as early as the conceptual planning stage for construction, operation and refurbishment. This technical requirement is legally underpinned in the amendment to the Water Management Act and the formulation of identical requirements for private and public sewers in Articles 60 and 61 of the WHG [3]. The municipalities are, consequently, under pressure to inform and advise site owners in good time about the technical and legal requirements. Certain federal states have already taken consumer protection orientated action and are

providing assistance in the form of regulations containing more specific detail and supporting provisions.

### The Authors

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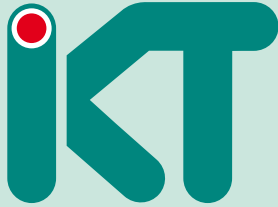
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The initial funding for setting up the institute has been provided by the Ministry for the Environment of the State of North-Rhine Westphalia, Germany's largest federal state.

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