We’ll clarify it for you!
135 years of sewage disposal
in Mannheim
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Municipal services can look back on a long tradition in Mannheim. Over many generations, pioneering technologies, innovativeness, and ecological awareness have worked hand in hand towards creating the foundations and values that we are building on today.

The integrity of our environment is crucial to our quality of life. Besides clean air, healthy soils, and biodiversity, we need above all clean water. Yet the protection of our environment and our waters costs. It demands intense use of resources, technology, and knowhow. EBS and its 236 employees fulfil their assignments completely in line with their calling as a competent owner-operated service provider, by collecting waste- and rainwater from the whole city and clarifying the sewage before discharging it into the waters entering the Rhine. In doing so, they give top priority to the elimination of health hazards and the protection of waters and the environment.

As a certified owner-operated company under the environmental and quality standards ISO 9001 and ISO 14001, we see ourselves responsible for future assignments as well. Climate changes, dwindling resources, demographic shifts – these challenges are currently the top subjects in environmental policy discussions, also in water management. EBS is now applying its resources towards finding solutions before legislation imposes tighter controls. Some examples include the activated carbon powder system for the elimination of trace quantities, the pilot projects for utilising wastewater heat, and the production and recovery of biogas and other renewable energies, all intended to promote self supplying operations at the Mannheim clarification plant in the near future. As a wastewater company financed by charges, we are, of course, under an obligation to the citizens of Mannheim to maintain our waste water treatment plant and to invest prudently in the environmental protection and cost efficiency of the future.

This brochure presents an overview of how Stadtentwässerung Mannheim has evolved from its roots to the present day, from the construction of the first main collector in the town centre to our flagship projects in the clarification plant.

I sincerely hope this presentation will help the citizens of Mannheim and our clients to understand more and develop an interest in "their" municipal services – so we can continue to achieve our future objectives together.
In the 17th and 18th centuries, the fortress town of Mannheim ensconced between the Rhine and Neckar was often assailed by wars, pestilence, and floods. Like in many other towns of the time, the living conditions for the inhabitants were dire. “The water is so vile that my tea tasted like liquid stone. The culverts give forth a foul stench that is aggravated by the four churchyards, all in the town,” wrote the poet Wilhelm Heinse when he visited the town in 1780. Right into the 19th century, waste- and rainwater flowed over courtyard and street gutters into the open town pit that was connected to the Rhine and Neckar through locks.

The hygiene conditions did not improve until the first sewage system was built. In 1877, the town pit was replaced with a concrete sewer under the ring roads. Installed on the former site of the pit (now behind the MVV building), a steam powered pump house then discharged the sewage into the Neckar.

In 1890, the Mannheim town council commissioned the renowned sewage system expert and head of the Frankfurt planning office William H Lindley to build the sewage system for the town centre, and soon after for the adjoining districts. Spreading industrialisation and the associated growth in population fuelled building activities that developed new areas outside of the ring (Schwetzingerstadt) and beyond the Neckar (Neckarstadt-West). This was the beginning of municipal services according to plan. Just a few decades later, there arose an efficient sewer system that improved considerably the hygiene conditions and the quality of life for the town’s residents.

William H. Lindley (1853-1917)
The Baden Water Law – initial measures for the protection of waters

Growing industrialisation led to serious river and stream pollution towards the end of the 19th century. The grand ducal government had passed the Baden Water Law as early as 1876, the first to make the unauthorised discharge of wastewater into the rivers a punishable offence.

In about 1900, the Mannheim citizens’ committee approved about a million marks for the construction of additional sewers and pump houses and for the discharge of wastewater into the Rhine. The Mannheim plans to connect the modern water closets (WCs) to the sewage system as well were met with fierce protests from the towns further down the Rhine, which feared that the water they drank from the river would be contaminated. Also the farmers in the Mannheim outskirts joined the protest: they used the cesspools as an invaluable fertiliser for cultivating tobacco. The dispute finally ended in a compromise: The regional administration approved the sewer network into the Rhine, yet demanded at the same time the construction of a sewage clarification system. The wastewater was not allowed to carry faeces until after the mechanical clarification system on Friesenheim Island started operations with six settling tanks.

In 1892, Mannheim issued the first domestic sewage disposal ordinance regulating the connection of private sewage discharge lines to the municipal sewer system. Five years later, the sewer building authority was reorganised into the planning authority. This farsighted decision by the town council proved a resounding success only a few decades later: As early as 1932, over 95% of all Mannheim households were connected to the sewer system, then 316 km in length.

A native of Mannheim, Dr.-Ing. Karl Imhoff (1876–1965) developed in Essen in 1906 his Imhoff tank, the first of its kind to separate the settling and digestive processes on the sewage sludge in the one structure. This was a milestone in sewage sludge treatment technology.

The first clarification system on Friesenheim Island

WC advertisement (c 1900)
The costs of growth

During post war construction, the city authorities had to tackle major problems with sewage disposal. In particular, municipal services needed an extensive redevelopment concept for the growing daily consumption of water, the increasing rainwater quantities in the sewers following large scale sealing work, and the heavy pollution in the waters feeding the Rhine and Neckar.

The critical sewage situation found relief in the construction of the north main collector and a makeshift system for clarifying the sewage from the city districts in the north. This had been exacerbated by the settlements of the US occupying powers. In just eight years, a total of 158 million marks was swallowed up by the expansion to the sewer system, the required development measures, and the modifications to the sewage treatment plant.

Problems persisted with the inadequate capacity of the clarification system on Friesenheim Island, which soon reached its limits.

Tighter controls for the protection of waters required further investments in better technology and processes. Some time previously, a draft for a modern plant with mechanical and biological clarification had been tabled that in 1944 was declared “ripe for execution” by the expert Dr.-Ing. Karl Imhoff. Yet lack of funds had scuttled the building project in the post war years. Soon, the planners concentrated on the construction of a new, central sewage system with biological clarification and sludge treatment – sited in a nature reserve north of Sandhofen.
The new clarification plant

After ten years of planning and building, the new clarification plant started operations in 1973. Fitted with all the installations needed to clarify sewage, like influent pump house, screens, grit and grease traps, and primary settling, activated sludge, and final settling tanks, this new plant could now provide extensive treatment of sludge. The discharge permit was valid until 1985. After this time, tighter legislation was expected to be passed for the protection of waters. Expansions for the expected rise in sewage quantity had already been considered as early as the planning phase.

The precautionary measures for the protection of waters also extended to rainwater treatment. Since 1978, rain overflow tanks have been built at the rain outlets that even today still function as storage and purification systems, reducing the load on the sewer system.
The Töpfer Decree and the consequences

By the end of the 1980s, the extent of environmental damage had reached alarming proportions. The growing pollution to the North Sea and Baltic had culminated in tides of toxic algae and the death of huge numbers of seals. The pictures and reports in the mass media caused a huge public sensation, leading finally to the so called Töpfer Decree.

Formulated by the then Minister of the Environment Klaus Töpfer, this stipulated new minimum requirements for the quality of sewage discharged into the rivers. The discharge of the nutrients phosphorus and nitrogen was severely reduced, and the thresholds for other pollutants drastically tightened. In order to comply with these new legal requirements, clarification plants had to be fitted with additional technology.

Expansion of the clarification plant

Following the new legal requirements with their tighter pollutant discharge values, the Mannheim clarification plant needed additional investments in greater efficiency.

The biological treatment stage had already been expanded with a filtration unit as early as 1986. The following decade saw the renovation of the screening chamber and the sludge dewatering and drying systems. Ever since the expanded biological treatment stage started successful operations during the building of the clarification plant, the discharge values have been improving to a considerable extent. This meant not only an important contribution to sustainable water pollution control, but also a reduction in the legally stipulated sewage charges based on pollution levels.

Towards the end of the 1990s, high investments were again needed for further expansions to the clarification plant, this time for the fulfilment of strict discharge conditions applying to sewage in public waters. A total of DM 138m was spent on a new biological treatment stage with five activated sludge tanks, ten final setting tanks, a blower station, and an electric station.

1986
The second biological treatment stage (biofiltration) started operations in the clarification plant.

1988
The Töpfer Decree tightened the minimum requirements for the quality of sewage discharged into the rivers and reduced the thresholds for pollutants.

1990-2005
Following an external expertise, rainwater retention basins and sewer storage capacities were built with a total volume of 186,000 m³ gebaut.

1996-99
The expansion work on the clarification plant completed the sludge drying system, the screening chamber, and the new biological stage. The total expenditure was about DM 190m.
Rainwater treatment

Owing to its high pollution levels, also combined sewage had to be treated before it was discharged into the rivers. Following an expertise on rainwater treatment, a great many rainwater retention basins and sewage storage capacities were built in Mannheim between 1990 and 2005. A series of further projects helped to achieve the objectives of sustainable water pollution control on a continuous basis. The programme for rainwater retention basins and rainwater treatment concluded with new or expanded pump houses and rain overflow tanks that eased the load in their respective districts during periods of heavy rain, together making up a total volume of 186,000 m³.

Sustainable water pollution control

Twenty five years after the Töpfer Decree and the consistent implementation of a ten-point programme, most rivers now exhibit a good water quality. Following joint endeavours by the federal and state governments, the municipalities, and the industry for the protection of waters, the Upper Rhine today carries a water quality that was last measured in the late 19th century. The Rhine has again become the playground of over thirty species of fish, including the river lamprey, rainbow trout, and Atlantic salmon. Growing public awareness for the environment, tighter water laws, and technological progress have set new standards in sewage disposal.
Fifteen years as an owner-operated company

When the former planning authority outsourced its municipal services department in 1997, it set up the new owner-operated company EBS on a solid business foundation. This move was necessary to fulfil both environmental policy and economic requirements in equal measure. Today, EBS is a modern municipal service provider that utilises state of the art and complies with legal stipulations to perform its core tasks: collecting waste- and rainwater from the whole city and clarifying the sewage before discharging it into the waters entering the Rhine. In doing so, they give top priority to the elimination of health hazards and the protection of waters and the environment.

Climate friendly office and service building

From 2013, EBS will start concentrating on two locations: with a new office and service building responsible for the clarification plant in North Mannheim and Sewer Maintenance on Käfertaler Straße. Thanks to its innovative facilities complying with the low energy standard, this new building was awarded the Green Building Label and is a classic example of a sustainable municipal building. The building is heated and cooled with pumped heat recovered from wastewater and also draws from the MVV district heating system during peak load periods. The rainwater from the inner courtyard and roofs is to percolate in blind drains on site. In addition, there will be extensive roof vegetation serving as a preliminary filter for the rainwater. Thanks to low energy consumption, the use of regenerative energies, and sustainability in operations, EBS saves costs and contributes to climate protection.

The work in municipal services – not an everyday job

Day after day, EBS employees see to the smooth operations of the clarification plant and Sewer Maintenance. Highly qualified, they all contribute with their commitment and sense of responsibility to the flow of wastewater beneath the surface of Mannheim, the permanent tightness of the sewer system, and the operability of the machinery and installations in the clarification plant and pump houses. This work demands a lot from our personnel.

2006
In order to reduce its energy costs, EBS is increasingly relying on cofermentation, or the generation of biogas from sewage sludge and residual matter rejected by the foodstuffs industry.

2007
A photovoltaic installation was installed on the roof of the filtration unit. Covering an area of 2,300 m², it is one of the largest PV installations in Mannheim.

2009
The ring sewer was upgraded with ultra modern technology over a length of 1.8 km under Kaisier-, Friedrichs-, and Luisenring. The costs: 7.2m.

2010
The activated carbon powder system started operations in the clarification plant. This removes trace quantities like drug and contrast medium residue from a split sewage flow.
The clarification plant was the first in Europe to put a large-scale sewage sludge gasifier into operation.

New rainwater percolation systems were built in the public roadside environment of Gartenstadt, easing the load on the sewer system during periods of heavy rain.

The Ochsenpferch pump house was the first building in Mannheim to be heated from the sewer line.

A water wheel started operations in the treated wastewater outlet from the clarification plant. This generates about 60-80,000 kWh of electricity a year.

Trainee measuring out a sludge sample in the wastewater laboratory

For a long time now, municipal services are no more the domain of the classical sewage attendants, pump operators, and sewer technicians. Now they have been joined by electronic engineers, instrument and control technicians, industrial mechanics, plant operators, civil engineers, sewer rehabilitation consultants, chemical engineers, and laboratory assistants. And of course, EBS also promotes the next generation of employees. The six young men and women at the clarification plant must pass a series of varied training programmes before they can graduate as qualified wastewater engineers.

All work in the sewers, pump houses, and installations of the clarification plant must observe the health and safety regulations. These include antifall measures during manhole access and the wearing of personal protective equipment. For instance, underground work safety is maintained by a belt-worn multi-warning device that sounds as soon as hazardous gases start forming in the sewer or pump sump.

Qualified work depends on regular further training courses on technical and safety subjects. On the so called safety days at the clarification plant, our operative personnel not only benefit from instruction in health and safety at work, but can also take part in practical exercises for the prevention of accidents.

Antifall measures during manhole access

QEM – Processes put to the test

In 2002, a quality and environmental management (QEM) system was introduced as a means to reconcile the strict requirements under the environmental laws with the cost effectiveness of a municipal disposal company. EBS drew up its own guidelines based on the quality standard ISO 9001 and the environmental standard ISO 14001, documenting the key processes and work cycles and setting down the targets and actions for each year. At regular intervals, external experts and internal auditors examine not only adherence to the standards and laws, but also the fulfillment of the company’s own stipulations and targets. The owner-operated company has now been certified for the fourth time, confirming the long term effectiveness of the management system.

One key constituent of the QEM is the continuous improvement process. In many fields, the excellent ideas submitted by our personnel for improving plant operations have led to award winning solutions, and often they contribute to considerable cuts in costs and consumed resources.
The sewer system, or from Mannheim to Copenhagen

After over 130 years of growth, the public sewers of Mannheim represent one of the largest infrastructural assets the city can boast. EBS is responsible for about 890 km of sewers. This is about equal to the distance between Mannheim and Copenhagen. This, however, does not include the service lines. Under the Wastewater Statute, the whole length of these lines up to their connection to the municipal sewer is the property of the land owner. Mannheim treats predominantly combined sewage, i.e. waste- and rainwater are collected together. The sewer lines range in cross section from 0.25 m to 3.40 m, and their ages vary greatly: The oldest sewers in the city were built in the 1870s and 1890s, most of them lined with clinker bricks. About half of the sewers were built within the last fifty years.

The sewers are made of various materials. Vitrified clay was used for the smaller sewers between 25 and 80 cm in diameter. This material has been used for decades, so vitrified clay pipes represent the largest proportion of the sewers, covering a length of about 425 km. Concrete represents a length of 280 km. In former times, larger sewers and main collectors were built of brick, and their present length is 98 km. More recent materials, e.g. plastic pipes, currently make up about 18 km of the sewer system.

High pressure flushing

The Mannheim topography offers very few gradients that can be utilised for sewer operations. Even small discharges deposit on the sewer invert as growing quantities of sludge, grit, faeces, leftovers, and other waste that are flushed down the toilet or are washed into the sewers by heavy rain. If the sewers are to maintain their operative state and minimise offensive odour emissions, they must be flushed at regular intervals. Sewer Maintenance has six high pressure flushing and suction vehicles. These combined vehicles are fitted with high pressure flushing equipment that clean sewers at pressures up to 180 bar. Flushing uses fresh water, and newer vehicles work with water recovery. After flushing, the detached deposits and the flushing water are taken back up in the combined vehicle through a suction device and disposed of in the clarification plant.
Sewer plan of Mannheim
Inspection with the TV camera

In 2011, the inspected sewers amounted to nearly 100%. Of these, 85% were inspected with the travelling TV camera, and 15% (large sections) by access personnel. The sewer system can operate reliably only when its condition is inspected by access personnel and cameras.

The pipe in a pipe – renovation with inliner technology

In 2011, the inliner celebrated its fortieth anniversary. For twenty years, EBS has been relying on this technology for the renovation of defect sewers. This saves resources and costs.

The inliner method involves impregnating a needle felt or fibreglass hose (inliner) with a two-component resin until it is free of air voids, and sealing it at one end. It is then blown or inverted into the service line under air or water pressure. After the resins have hardened, the result is a sleeveless, tight fitting pipe in a pipe with a minimum wall thickness of 3 mm that in future takes over the collection of sewage.

Sewer rehabilitation

In sewers that can be accessed by personnel, the EBS work gang can repair minor damage. EBS repairs minor leaks in smaller sewers with short inliners or through drive pits. The classification of damage defines the duration and extent of sewer rehabilitation. If traffic conditions, for instance, do not allow an open pit for sewer replacement, the new sewer is laid with a pipe driver or through a tunnel.
A project of the century – the rehabilitation of the ring sewer

One of the largest rehabilitation projects undertaken by EBS affected the ring sewer. The oldest main collector in Mannheim is a walk-in, oval shaped concrete sewer that lies up to 6 m deep under the ring roads. It was built in 1876–77 to replace the moribund town pit.

On inspecting the ring sewer, EBS discovered severe damage on the Kaiser-, Friedrichs-, and Luisenring sections. Sewage threatened to seep into the soil through cracks in the sewer wall.

Most of the sections scheduled for rehabilitation were under pavements and private property, with some in the roadside environment, so the rehabilitation measures took place underground with ultra modern technology. There was therefore no disruption to the flow of traffic on the main artery.

It took just nine months for a specialised construction company from the north of Germany to realise the extensive sewer rehabilitation project that EBS itself had planned. In four construction stages, pits were excavated in the pavement areas, each about 4 m in diameter and max 6 m deep. From these pits, glass fibre reinforced (GFR) plastic pipes were drawn into the sewer system over a length of about 1.8 km. The curvature of the ring sewer posed a great engineering challenge to the construction company.

Since the first sewers were built about 140 years ago, hygiene conditions have improved radically for the population of Mannheim. Even in 1930, 95.5% of households were connected to the public sewers. Today, this figure is 99.87%. Under the Mannheim Wastewater Statute, the land owner is responsible for ensuring the tightness and operability of private sewage systems from the building to their connection to the municipal sewer.

Backflow prevention and flood protection

Extremely heavy rains can temporarily overload the sewers that can then collect the water quantities only to a limited extent. When this water has reached street level, it can flow into residential buildings through deep set entrances, basement windows, or garage doors. The consequence is considerable damage to buildings and household effects.

When the water level rises to the top of the sewer and can no longer discharge in some sections, we speak of “backflow”. Under the Mannheim Wastewater Statute, the backflow level is the top edge of the road. Suitable backflow prevention in the form of traps or ejectors must be installed to stop high levels of wastewater from flowing back through the service lines and then through toilets, sinks, or basement drains.

Home owners can also take structural measures to protect themselves against flooding from extremely heavy rains. For instance, they can raise the top edge to the basement window recess or garage door. The protection of property best begins in the planning phase. An additional precautionary measure involves desealing the property.
With an eye on climate change – local rainwater percolation

Many residents in the region still recall vividly the unusually heavy rainfalls in recent years. For example, on 9 June 2010, a good fifty litres of rain fell per square metre within just three and a half hours, causing floods in a number of Gartenstadt and Käfertal areas. The building of even larger street sewers would make little sense – this would swallow huge investments and lead to increased deposits, and the associated odour levels, in periods of dry weather. In residential areas, the sewers are designed for a three-year rain event in compliance with the legal stipulations. Moreover, the current German Water Ecology Act WHG prescribes, if possible, local percolation or the direct discharge of rainwater into an open body of water.

As part of a local rainwater percolation concept, EBS built for the first time in 2011 two different percolation systems in an area of Gartenstadt: a trough percolation system where water spreads over and seeps into an activated soil zone, and substrate filled percolation channels that pose no danger to groundwater even near roads with heavy traffic.

Unlike the conventional principle based on the fastest possible delivery of rainwater through the sewer system, local percolation aims to maintain the water cycle. This promotes both groundwater replenishment and plant or soil evaporation.

Further examples of operative open rainwater retention and percolation systems can be found in the ecological development area of Wallstadt-Nord. Here, part of the rainwater collecting on roofs discharges through open channels into a system of ponds (lagoons). Several ponds communicate with each other and form a biotope. They serve to retain and evaporate rainwater, and they have beneficial effects on the microclimate. In some areas, the rainwater undergoes controlled percolation.

In 2009, the so called split sewage charge was introduced that users had to pay separately for sewage and rainwater. This charge was based exclusively on the drained area, so EBS created incentives for land owners to percolate rainwater and deseal paved areas. Percolating rainwater instead of discharging it into the local sewers saved users the rainwater charges.
Pump houses and storage capacities

Owing to the Mannheim topography, a larger number of pump houses are needed for the fast discharge of sewage to the clarification plant. At present, EBS has been assigned by the municipal road services to operate forty pump houses and service 31 pump stations. During periods of heavy rain, 27 retention basins with a total storage capacity of 186,000 m³ prevent flooding in the city. These retention capacities act as an interim storage for rainwater that is directed back into the sewer system once the discharge starts falling. If, in rare cases, the quantities of water exceed the limits of the available retention capacities, then the rainwater is directed into the rain overflow tank after it has been clarified mechanically, and from there through the rain outlets into the waters feeding the Rhine and Neckar.

Hidden industrial monument – the Ochsenpferch pump house

The oldest and largest sewage lifting facility in Mannheim is the Ochsenpferch pump house. It was built in 1902–04 according to plans submitted by Richard Perrey, then Director of the Municipal Building Department. Nestled between the Neckar and the industrial port, this listed building conceals ultra modern technology behind its exterior – a lifting plant with integrated electronic process control system. In continuous duty, the four pumps can convey up to 6,200 litres of wastewater every second from the southern city districts and Feudenheim to the clarification plant in the north of Mannheim. In the event of heavy rain and flooding, two rainwater pumps switch in automatically, delivering 4,200 litres every second and so preventing widespread flooding in the whole south area of the city.

Energy efficient: heat from wastewater

In 2011, the Ochsenpferch pump house was the first public building to be heated from the sewer system. A heat exchanger in the influent sewer draws heat averaging 17 °C from the wastewater flowing at a mean rate of 400 litres per second. This heat is then transferred to the pump hall. Following fuel oil savings of several thousand litres a year and subsidised by the State of Baden-Württemberg, the new heating system had already paid off after about fourteen years.

There is great potential in the use of wastewater for heating and cooling purposes. For instance, heat exchangers can be installed not only in pump houses, but also in sewers under residential areas, sports grounds, and industrial estates.
The Mannheim clarification plant

In the influent pump house, conveyor screws lift the water masses through 6 m before the wastewater flows freely down a slope to the clarification stations. Within 24 hours, it passes through a complex cleaning process consisting of three stages involving ultra modern technology before it discharges, clarified and filtered, into the Rhine.

The mechanical treatment of wastewater involves removing its solid matter with coarse and fine screens in the screening chamber, dewatering the screenings, and disposing of them in the waste incineration plant. About a thousand tonnes of screenings are collected every year, corresponding to the contents of 15,000 dustbin liners. The grit trap and the aerated grease trap are fitted with scrapers that separate out grit and grease. The washed grit is conveyed to the landfill, and oils and greases join the sewage sludge in the digestion tank. Finally, in the primary settling tank, the rest of the coarse suspended matter is removed from the wastewater.

The biological treatment of wastewater takes place in the five activated sludge tanks where various kinds of microorganisms absorb the dissolved pollutants carbon, phosphorus, and nitrogen under controlled conditions (monitored by technology for the addition and removal of oxygen). Under particular conditions, iron salts are added to promote phosphate precipitation. In the final settling tank, minute dirt particles flocculate and settle in the sludge. The third stage of biological wastewater treatment, filtration, removes the remaining suspended matter, and the clarified wastewater flows into the Rhine.

Sludge treatment

The input material to sludge treatment is made up of raw sludge from the primary settling tank and excess sludge from the biological stage, both with a high water content of 95–99%. Thickened and separated from its water content, the sludge, now reduced to a tenth, arrives in the digestion tank where it spends forty days producing sewage gas at a constant 37 °C in an anaerobic environment. Afterwards, the sewage sludge is dewatered and dried with heat reaching temperatures as high as 500 °C. The remaining sludge now has a water content of only 5%.

About 10,000 tonnes of dried sludge granulate, or so called biosolid pellets, are produced every year, mostly serving as fuel or raw materials for the cement industry. In 2013, the sewage sludge gasifier on the clarification plant grounds started recycling 50% of the dried sludge.

Aerial photograph of the clarification plant (2011)

The central EBS clarification plant, designed for a population equivalent of 725,000, cleans the wastewater from Mannheim’s households, industry, and business enterprises. It lies in a nature reserve about 500 m from the Rhine and about 3 km as the bird flies from the centre of Mannheim-Sandhofen.

Wastewater treatment

The influent sewer to the clarification plant carries on average 100,000 m³ of wastewater every day, equalling fifty times the capacity of the decommissioned Mannheim water tower.

Aerated sludge tanks in the biological treatment stage

This generates the hot gas for drying sludge
Legend

2 Influent pump house, exhaust air scrubber
2 a Wastewater treatment facility
3 Screening chamber and container system
3 a Influent, measurement, permanent sampler
4 Grit trap with washer
4 a Grit storage area
5 Grease trap
6 Circular distributor to the primary settling tanks
7 Primary settling tank
8 Raw sludge pump house
11 High water pump house
15 Control station for rain overflow tanks
16 Stacked containers for raw sludge, excess sludge
16 a Preliminary centrifuge
16 b Cosubstrate system
17 Sludge pump house
18 Digestion tank
19 Stacked containers for digested sludge
20 Excess sludge thickener
20 a Flocculants and central pump house
21 Sludge dewatering and drying systems
21 a Overseer’s office
22 Sewage sludge gasification
23 CHP station 4
24 Gas tanks
24 a Switch room for gas tanks / flare
25 Central control room, administration, truck scales
26 Conference room, canteen, personnel rooms
26 a Laboratory
27 Power centre (CHP station)
28 Garages
28 a Workshops, electrical, measuring, and control installations
28 b Fitter’s shop / storeroom
35 Booster pumping station, filtration
36 Centre column, filtration
37 Filtering tanks / photovoltaic installation
38 Induction flowmeter
39 Water wheel
39 a Precipitant dosing outstation
40 Booster pumping station for biological stage
41 Circular distributor to the biological stage
42 Aerated sludge tanks
43 Distribution structure to final settling tanks
44 Final settling tanks
45 Return sludge pump house
46 Blower station, electric station
47 Precipitant dosing station
55 Rain overflow tank
170 Activated carbon powder system
Rehabilitation of the digestion tanks

A clarification plant cannot operate for forty years unscathed. The chief tasks of EBS include the care and maintenance of the systems and machinery.

One of the most complex maintenance measures at the clarification plant proved to be the rehabilitation of the three digestion tanks. Built in 1970 and 1983, they showed damage to their aluminium facade. Including the planning and tendering phase, the rehabilitation took over three years to complete during ongoing operations.

Precautionary water pollution control – activated carbon powder for eliminating trace quantities

The level of organic trace pollutants in wastewater has increasingly been the subject of public debate. The main concern is drug residue, which is excreted into domestic sewage and cannot be removed completely in clarification plants. These stable, low biodegradable agents are carried by the rivers into the water cycle and have already been detected in sources of drinking water for decades. Trace quantities include e.g. artificial hormones, painkillers, contrast media, and antibiotics that can promote multiresistant pathogens.

Since May 2010, EBS has been operating in the clarification plant a pilot installation intended to remove trace quantities from wastewater. The use of activated carbon powder for eliminating trace quantities is a new technology. The first project to apply this on an industrial scale was led by scientists from Biberach University of Applied Sciences investigating the effects on a split sewage flow.

Significant findings were returned by the investigation into ACP effectiveness based on fish monitoring by the Bavarian state environmental agency LfU. After four weeks, the blood of male rainbow trout kept in biologically clarified wastewater was discovered to contain levels of an oestrogenic agent that was a hundred times greater than the fish population kept in biologically treated and filtered wastewater that had been additionally clarified with ACP. The findings showed that ACP treatment can remove over 80% of the trace quantities in wastewater.

About 38 m high, these towers digest the sewage sludge, thereby generating methane gas and reducing the solids content to a considerable extent. The towers present a total capacity of about 22,500 m³. For the biological process to run unchecked, it needs a constant temperature of about 37 °C inside.

These large scale tanks present an unconventional geometry, so their rehabilitation involved a complex system of scaffolding. This enclosure was necessary to contain the lead blasted out of the lining that had to be removed and disposed of separately. In winter, this enclosure also served as a protective buffer against the cold weather.

The damage to the aluminium facade was so extensive that the lining on all digestion towers had to be replaced completely. This material, however, contained harmful substances, including lead, carcinogenic fibres, and CFCs, so the whole facade first had to be dismantled completely, together with the catwalk encircling the base.

After the old facade lining had been removed completely, the tank surfaces were blast cleaned twice prior to three coatings of anticorrosive. The total area that had to be rehabilitated on each tank amounted to about 1,400 m². Finally, the new aluminium lining was installed, consisting of outer plates each 3 mm thick. Each digestion tank received a heat insulating layer of rock wool 140 mm thick that protected them from the effects of the weather – particularly in the cold season – and maintained a constant internal temperature for the digestion process.

The new substructure for the facade and the scaffolding required extensive welding work. About 15,000 nails were shot for the heat insulation, and about 5,000 lugs and threaded pins attached for securing the supporting structure to the tanks.

Since their rehabilitation, the digestion tanks have been shining forth like bright silver in their new aluminium facade.
The Wastewater Chemistry Division

The Wastewater Chemistry Division is assigned a special role in the quality assurance of wastewater clarification. Its task involves the analytical monitoring of the clarification plant and the indirect discharger for Mannheim. This safeguards adherence to the legal stipulations under the German Water Ecology Act (WHG), the Baden-Württemberg wastewater and inhouse inspection ordinance, and the terms under the water law permit.

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Expert body for water management

Since 2001, the Wastewater Chemistry Division has been acknowledged as an “expert body for water management”. It is therefore empowered to conduct quality assured inhouse inspections for adherence to clarification plant thresholds and perform wastewater analyses by order of the water authority. Since 2007, the Wastewater Chemistry Division has been responsible for inspecting adherence to the discharge thresholds at the Mannheim clarification plant. Every month, the discharge parameters determined on each day, e.g. total organic carbon (TOC), inorganic nitrogen (N$_{INOX}$), and total phosphorus (P$_{TOT}$), etc., are transferred in digitised form to the competent regulatory authority, the Regional Council (RP) Karlsruhe.

At the same time, the procedure also determines the analytical parameters needed to control the clarification plant and subjects the online analysers to analytical quality assurance.

As an expert body, the Wastewater Chemistry Division offers sampling and analysis services for industrial wastewater. This is also used by the RP Karlsruhe to examine a number of Mannheim companies for their adherence to thresholds defined by the pertinent water laws.

Indirect discharger inspections

With a view to sustaining clarification plant effectiveness against excessive loading (TOC) or interferents like greases, oils, heavy metals, or bacterial toxins (e.g. cyanides), the Wastewater Chemistry Division regularly takes qualified random samples from the wastewater of industrial and business enterprises and analyses them in its own laboratory. If thresholds are exceeded, the affected companies are requested to make a statement. In the event that discharges exhibit above-average levels of nutrients, the so-called heavy pollution surcharge is reassessed on the basis of the thresholds and calculation methods specified under the Wastewater Statute. The data are documented in the register of indirect dischargers.

By combining these with the data returned by the measuring probes in the pump houses, the Wastewater Chemistry Division can therefore detect potential malfunctions induced by the indirect discharger to the clarification plant, trace these back to their causes, and implement the corresponding measures.

EBS enjoys good contacts with the frequently inspected companies and their authorised agents. It can therefore offer extensive advice on the elimination of pollutants and wastewater and on other wastewater disposal strategies (e.g. wastewater containing grease is routed directly to the clarification plant and not discharged illegally into the sewers). These measures help companies to learn the proper discharge of their wastewater.

This exchange of information also makes it easier for the Wastewater Chemistry Division to issue statements on water law procedures, thereby saving administration and permit times.
A clarification plant needs huge amounts of energy to operate. About 20% of the city’s electricity consumption goes into feeding it. Cleaning up the thirty million cubic metres of wastewater that arrives every year at the clarification plant from the whole city of Mannheim needs a lot of electrical energy, predominantly for aerating the sludge tanks in the biological section and for driving the pumps, motors, and units. In addition, there must be a supply of thermal energy (heat) for drying the sludge and heating the digestion towers. Every year, the clarification plant consumes about 23 million kilowatt hours of electrical energy and about 29 million kilowatt hours of energy supplied by sewage gas. By introducing a large number of measures, EBS is gradually approaching its ambitious goal of operating the clarification plant as a self-supplying system.

Electricity and heat from sewage sludge

Ever since the clarification plant was put into operation in 1973, the digestion towers have been generating sewage gas from the pretreated sewage sludge. Currently equalling about eleven million cubic metres, the annual quantity of sewage gas is used completely for the generation of energy and heat in the clarification plant. A third of the gas quantities go to firing the hot gas generators in the sludge drying section, and the other two thirds are converted into heat and energy by four-stroke internal combustion gas engines in the combined heat and power (CHP) station. The heat emitted by the sludge drying section and the gas engines covers all of the needs in the clarification plant for heating the digestion tanks and the hot water supply to the service building. Since 2007, EBS has been operating largely free of purchased natural gas.

Greater operational reliability with biogas engines

The gas engines in the combined heat and power (CHP) station serve at the same time as a backup power supply. The flow of wastewater through the clarification plant can then be maintained in the event of prolonged power outages. Also the so-called turbo gas compressor, an air compressor fuelled by sewage gas, contributes to operational reliability and energy savings. Thanks to this biogas engine, climate neutral energy can be generated to even greater efficiency.
**Cofermentation expansions**

So called cofermentation represents an important contribution to the generation of biogas. This involves collecting product residue from the foodstuffs industry, or other readily degradable organic substances together with the sewage sludge in the digesting tanks. The increased fermentation processes raise the sewage gas yield by 80–100%.

Recycling eleven million cubic metres of sewage gas in the sludge drying section, the CHP station, and the turbo compressor saves a total of 33,000 tonnes of CO₂ every year.

**Sewage sludge gasification**

In 2010, the clarification plant grounds saw the completion of the first construction phase for the sewage sludge gasifier in the form of a BOT (build-operate-transfer). The sewage sludge gasifier is a fluidised bed gasifier that extracts organic residue from the biosolid pellets at 850 °C, giving rise to synthesis gas. This is a lean gas used to dry sludge and fuel gas engines. The remaining pellets are land-filled or used as recycled material in the building industry.

On completion of the two successive construction stages, the sewage sludge gasifier will generate a total of 15.2 million cubic metres of synthesis gas. Together with the others, these measures might be enough to cover far more than 90% of the clarification plant’s energy needs. And the onsite utilisation of sewage sludge additionally saves transport routes and fuel. CO₂ emissions will then be reduced by about 40,000 tonnes per year.

**Solar energy and hydropower**

The use of local energy potential in the clarification plant also proved to be an opportunity for innovative ideas. One example is the photovoltaic installation on the filtration section. Previously open structures, the filtering tanks needed roofing to combat the formation of algae in the summer months. At the same time, there were plans to use the area of 2,300 m² for a constructive purpose, namely the installation of solar modules. In its first year of operation, the PV installation produced about 238,000 kWh of solar electricity that is fed into the grid of the local utility at the subsidised prices. One classic example embodying the interaction of engineering skills and craftsmanship is a water wheel that generates electricity from the inclined flow of clarified wastewater. This is a so called Zuppinger wheel with curved blades that, unlike turbines, also operates in varying water levels. Its efficiency exceeds 80%.

Planned, designed, and built by EBS, the water wheel has suffered no problems since it started operations. Every year it generates 40,000–80,000 kWh of electricity that is fed into the company’s power supply system.

Today, sewage gas, combined heat and power coupling, and electricity generated from solar energy and hydropower together supply 63% of the clarification plant’s energy needs. The sewage sludge gasifier will help to minimise the contribution from energy purchased from external sources.
As a municipal service provider, EBS is responsible for a range of tasks including advice and information for its customers: the citizens of Mannheim, business enterprises, and industrial companies. There are special advice centres for questions and requests concerning sewage charges and for developers and architects seeking advice on the location and execution of sewer connections. Also a hotline has been set up for ideas and complaints, ensuring that requests are handled promptly by the competent specialised offices.

At the invitation of residents’ associations and other organisations, EBS experts also give presentations at events on domestic services, backflow prevention, and other structural measures to protect private property and buildings against flooding.

Customer services at Sewer Maintenance

In most cases, it is clogged rainwater inlets, rattling manhole covers, rats, or unpleasant odours that make citizens reach for the phone. For ten years, EBS has been running a smoothly operating complaints management system. All notifications and complaints, whether from citizens, municipal offices, fire services, or the police, are documented in the customer services report. As soon as EBS receives a notification, it immediately informs the personnel at Sewer Maintenance. After consulting with the caller, they drive to the site of the incident to determine the cause of the trouble and, if possible, to remedy it there and then. All key data and the measures taken are recorded in the digitised customer services report.

The annual analysis of these notifications (see chart) provides important clues as to the frequency, location, and type of trouble. If necessary, the corresponding measures are also implemented in cooperation with other municipal departments.

Sewer notifications 2009–2011

Rainwater inlet with grating (drain)
PR work and environment education

In most cases, municipal services work behind the scenes. Correspondingly great is the interest of citizens in public tours that EBS offers at regular intervals through the clarification plant and Sewer Maintenance.

EBS also makes use of the annual theme and action days to inform visitors of its work: on World Water Day (22 March) at the historical manhole to the sewers, on the “Living Neckar” action day on the banks of the Neckar, and on Open Monument Day with tours through the Ochsenpferch pump house and the old clarification system. The municipal services regularly host an open day at the clarification plant with a great many campaigns, tours, and informational material on all aspects of sewage disposal.

Wastewater adventure

The PR pursued at EBS also includes environmental education. In the classroom, on city tours, or on location, pupils learn interesting facts about the water cycle, road drainage, and private property drainage, and follow the route taken by domestic wastewater through the sewers and the clarification plant. The children have the opportunity to discuss the relationship between personal (consumer) behaviour and its impact on the environment.

In the summer months, children can take part in wastewater adventure tours when they can win an invitation to the Mannheimer Agenda Diplom award ceremony. The toured clarification plant and sewers then become places of learning where children and adults alike can observe and experience with all their senses how complex processes and high tech installations collect, treat, and clarify wastewater.
## General data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment area</td>
<td>city of Mannheim</td>
</tr>
<tr>
<td>Area</td>
<td>approx 145 km²</td>
</tr>
<tr>
<td>Population</td>
<td>approx 325,000 inhabitants</td>
</tr>
<tr>
<td>Percentage of Mannheim households connected to the sewers</td>
<td>99.9%</td>
</tr>
<tr>
<td>Number of employees</td>
<td>236</td>
</tr>
<tr>
<td>Trainees</td>
<td>6</td>
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</tbody>
</table>

## Wastewater charges

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Sewage charge</td>
<td>€1.68/m³</td>
</tr>
<tr>
<td>Rainwater charge</td>
<td>€0.81/m² per year</td>
</tr>
</tbody>
</table>

## Wastewater collection

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drained areas</td>
<td>approx 7,100 ha</td>
</tr>
<tr>
<td>Total length of the sewer system</td>
<td>about 890 km</td>
</tr>
<tr>
<td>Company vehicles</td>
<td></td>
</tr>
<tr>
<td>Cleaning vehicles (flushing and suction vehicles, of which two with water recovery)</td>
<td>6</td>
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<tr>
<td>TV vehicles</td>
<td>2</td>
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</table>

## Pump houses and rainwater overflow structures

<table>
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<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Rain overflow tanks</td>
<td>8</td>
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<tr>
<td>Rainwater retention basins</td>
<td>7</td>
</tr>
<tr>
<td>Storage and overflow sewers</td>
<td>15</td>
</tr>
<tr>
<td>Total retention capacity</td>
<td>approx 186,000 m³</td>
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<tr>
<td>Pump houses</td>
<td>40</td>
</tr>
<tr>
<td>Pump stations</td>
<td>31</td>
</tr>
</tbody>
</table>

## Wastewater treatment, clarification plant

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population equivalent</td>
<td>725,000 (PE)</td>
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<tr>
<td>Quantity of influent wastewater for biological treatment</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1,250 l/s</td>
</tr>
<tr>
<td>Dry weather</td>
<td>600 l/s</td>
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<tr>
<td>Rainy weather</td>
<td>4,000 l/s</td>
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<tr>
<td>Max influent</td>
<td>10,000 l/s</td>
</tr>
</tbody>
</table>

## Development of fees 2000–2013

![Chart showing the development of fees 2000–2013](chart.png)
The work at EBS – not an everyday job
Disclaimer

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Biotope in the Mannheim clarification plant