

02.09 Management of Rain and Waste Water (Edition 2004)

Overview

In Berlin, precipitation and waste water from private households, public institutions, industry and trade, as well as run-offs from public road areas generate large quantities of rain and waste water. These need to be piped away and treated, if appropriate. In 2003 the local sewage plants treated some 690,000 m³ of waste water from private households, trade, industry, public institutions as well as rain water from Berlin and its suburban area every day. This quantity is equivalent to a little over 8 m³/s or one third of the Spree river run-off, given medium water flow. The amount of waste water generated in Berlin would be sufficient to fill the Grosser Wannsee lake within a week.

Waste waters are carried in a sewerage network with a total length of 9,228 km with 226,000 service lines. The sewerage network is operated by the Berliner Wasserbetriebe (Berlin Water Works). It was implemented in two different systems, i.e., **combined and separate sewers**, and consists of a total of 4,100 km of waste water drains, 1,894 km of combined water drains, 3,166 km of rain water drains and 68 km of special drains. It also includes numerous special structures, such as rain water overflows, rain water retention basins and culverts. Waste water collected there is pumped along a network of 1,100 km of pressurised sewage pipes to the sewage plants by 146 pumping stations.

In 1873 Berlin's combined sewage canal system was built to a design by James Hobrecht to drain Berlin as it was then. However, towns and communities surrounding Berlin, which retained their independence until 1920, mainly employed the separate sewerage system. After incorporation, their facilities were amalgamated into the present system. Drainage areas are oriented towards river courses and shipping canals and they also follow different altitudes. The boundaries of drainage areas do not follow the borders of Berlin's districts. Some three quarters of Berlin's drained areas are operated under the separate sewers system, the remaining quarter uses the combined drains system.

The separate system

In a system of separated drains waste waters and rain waters are carried by two different systems of pipes. **Waste water drains** carry domestic, trade and industrial waste waters to the pumping stations. From here, pressurised pipes are used to take it to the Ruhleben, Muenchehofe, Schoenerlinde, Wassmannsdorf, Wansdorf, and Stahnsdorf **sewage treatment plants**. After treatment, sewage plants discharge purified water into water bodies. Two other sewage treatment plants - those at Marienfelde and Adlershof - have been decommissioned as of 1990, and the Falkenberg facility was closed in 2003.

Table 1: Capacities, quantities of waste water treated and receiving water bodies of the large waste water treatment plants of Berlin and its suburbs, 2003

Waste water treatment plant	Capacity (run-off on dry days) (m ³ /day)	Quantity of waste water treated in 2003 (m ³ /day)		Receiving waters
		Total	of which suburbs	
Ruhleben	247500	212600	-	Summer season: Teltowkanal via pipes; Winter season: Spree
Schoenerlinde	85000	88200	8500	Tegeler See lake via Blankenfelder Graben/ Nordgraben
Muenchehofe	42500	40500	17500	Spree via Erpe
Waßmannsdorf	230000	200400	11500	Teltowkanal via Rudower Fließ
Stahnsdorf 1)	47000	61500	21100	Teltowkanal
Wansdorf	40000	37500	17700	Havelkanal
Falkenberg	Decommissioned as of 25/2/03	47400		Spree via Wuhle
Total	692700	688100	76300	

1) The large quantities of waste water actually treated by the Stahnsdorf sewage water plant - as against its capacity - are the results of an operational load test, carried out in the summer of 2003

Table 1: Capacities, quantities of treated waste water and receiving water bodies of the large sewage plants of Berlin and its suburbs in 2003

Rain water drains collect precipitation from sealed surfaces, cooling water from factories as well as water from drainage ditches. This is carried directly into larger or smaller surface waters. In part, considerable city areas drain into very small receiving water bodies. Altogether, some 37 million m³ of rain water are drained by the separate sewerage system into water bodies every year. To clean these quantities, rain water basins and retention soil filters operate at the main discharge points. 21 facilities for rain water treatment were commissioned until January 2003.

There are some areas situated on the inner city boundaries which originally operated a combined sewer system but later received a rain water drainage system (a modified combined sewerage system). Rain water there is drained into the rain sewage overflow drains of the combined sewerage system.

The combined system

This system is found within the old inner city of Berlin and also in the area surrounded by the inner circle line of the S-Bahn. In this combined drains system, domestic, trade and industrial waste waters as well as rain waters are collected by **one drain**, from where they are taken to the next pumping station. Afterwards, and as a rule, combined sewage waters usually follow the same route as the sewage flowing through separate sewage drains. The combined sewerage system includes rainwater discharge canals, rain water overflows, drainage canals, water retention canals and rain water basins to store combined sewage during periods of rainfall to delay its run-off to the sewage treatment plant. There are exceptions for situations of heavy rainfall. Once water reaches a certain height in the drains or in case the pumping stations can no longer cope with water coming in, the combined sewage - which in case of such downpours consists mainly of rainwater (at a ratio of about 1:9) - flows untreated into the water bodies via **rain water overflow canals**. In 2000 and at the total of about 530 rain sewage overflows, about 2.8 million m³ of such combined sewer overflow water reached the water bodies untreated. The occurrences of such overflow situations as well as the quantities discharged fluctuate as they depend on the frequency of strong rainfalls.

Also, most pumping stations are equipped with **emergency discharges**. In situations of technological malfunction, combined sewage will be discharged into outlet ditches. Of the 74 emergency discharges, 35

discharge into the Spree river, 13 into the Havel river, and 18 into the Teltowkanal. 5 discharge into standing surface water bodies and the remaining three emergency discharges take waters via waste water drains to other pumping stations. Emergency discharge operations also heavily fluctuate over the years. The average annual quantity involved is something like 20,000 m³. Retention basins were built in the immediate vicinity of large pumping stations and at the most important sites of the combined sewer system. These may cope with excess quantities of combined sewage during brief periods of high-intensity rainfalls. Sludge and suspended solid particles will be deposited in these retention basins.

Areas without any connection to the sewerage network

Despite considerable efforts by the Berliner Wasserbetriebe, not all settled areas have been connected to the sewerage net yet. In those built-up areas of Berlin without house connections, sewage will be collected in **collecting tanks without discharge**, from where it will be taken to sewage treatment plants by authorised transport companies. The waste water management of allotment gardens operates along the same lines.

In areas without rain water drains rainwater will percolate into the ground.

Rain waters from separate sewerage systems are **heavily polluted** by dust, air pollutants, rubbed-off road surface and tire particles, leaked oil, leaves, animal faeces, road grit in winter etc. After more intensive rainfalls fish die off again and again in smaller standing water bodies and canals carrying relatively little water. This is the result of oxygen-depleting processes, resulting from the oxygen-consuming decomposition of drained substances that sets in immediately after the latter reach a water body.

A separate map was worked out to document the drainage situation. This shows the **catchment areas of the rain water drains** (02.09.2). Every built-up area connected to the storm-water drainage system is matched to the water body receiving these discharged amounts of rainwater.

To reduce the polluted rainwater loads of water bodies in the area of the separated system, rain water purifications plants were built (21 until the year 2004). Some of them were provided on the Tegeler See lake, on the Hohenzollernkanal, on the lower Havel river, on the Teltowkanal, on the Biesdorf dredger lake, and on the chain of Grunewald lakes. Others are in the design stage or are already being built.

Statistical Base

Drainage network maps of the Berliner Wasserbetriebe were predominantly used as a basis to describe the type of drainage as well as the different catchment areas of rain water drainage. Drawing on the latest drainage network maps from 2001, reflecting the state of affairs at about 2000, the "Management of rain and waste water map", worked out as early as in 1992 as part of the environmental atlas was upgraded. This particular map had been digitised already towards the late nineties. Help also came from the map "Attachment 1: Periods of waste water facility development in settled areas (October 2001)" of the Abwasserbeseitigungsplan (waste water disposal plan) which offered schematic drawings of those areas which were connected to the sewage network after 1990.

This collection of descriptive data also benefited from information drawn from the information system City and Environment IX B 2 (Land use, surface sealing as of December 2001) as well as from the STEP (City development plan) concept for water supply and disposal (Senate Administration for urban development I C: Sewerage and types of sewerage as of 1999) and the water body register.

Methodology

By reference to the types, courses, and slopes of sewerage drains, it was possible mark off **catchment areas of combined sewage drains** and of **separate rain water and sewage drains**, respectively. It is not possible to exactly match individual roof and courtyard areas to the catchment areas of rain water sewers by reference to maps of the sewer network. Entire **units** and **subunits** as represented on the map were always allocated in their entirety to one of the categories or one of the first receiving water bodies, even if individual properties or parts of a unit drained differently from others under specific circumstances. It is merely stated whether – given the close spatial proximity of a property to a stormwater sewer – it would be possible to provide a connection to this system. There are - in part at least - considerable differences regarding the extent to which properties are actually connected and whether rain water from sealed surfaces is actually discharged into rain water sewers. Data describing this state of affairs was collected when map No 02.13.1 "Surface runoff from precipitation" was prepared.

To some extent, data on the type of sewers cannot be derived from maps and documents available. This is especially true of **large-scale industrial and trade areas**, where maps of the sewerage networks of the Berliner Wasserbetriebe do not offer any information as to the type of disposal of rain water. Some of these surfaces are drained directly into water bodies via private canals.

Parts of the city with green areas and open urban spaces which may be considered unconnected to sewers were not included in this analysis. They were not entered onto the map and therefore they are not included in catchment areas.

Rainwater will be drained into water bodies in areas with **separate sewers**. For every unit or subunit with stormwater drains the water body was defined into which the rain water drain discharges. This is the so-called **first receiving water body**. For easier reference and for the purposes of this map these first receiving water bodies were combined into water body sections or groups. So what is shown are the catchment areas of the water bodies concerned.

Areas in which rain water is fed into decentralised percolation facilities (such as basin or trenching systems etc.) and which only have a spillway into the sewerage system or into water water bodies, respectively, for situations of heavy rainfall were still matched to these water bodies (such as Karow-Nord).

Map Description

02.09.1 Type of canalisation

Some three quarters of the sewerage-equipped city area of Berlin is drained by separate sewers, the remaining quarter has combined sewers. Compared to the early nineties when 12 per cent of the inhabited area (7 per cent of the western and 19 per cent of the eastern parts) was still not connected to the public sewerage system, this figure has now dropped to about seven per cent. In 2000, about 96 per cent of the population in the eastern and some 99 per cent of the people in the western parts were connected to the sewerage network. The **connection rate for the entire city** is something like **98 per cent**. Some 56,000 people live in areas not connected to the sewerage network, of these some 31,000 live in water protection zones.

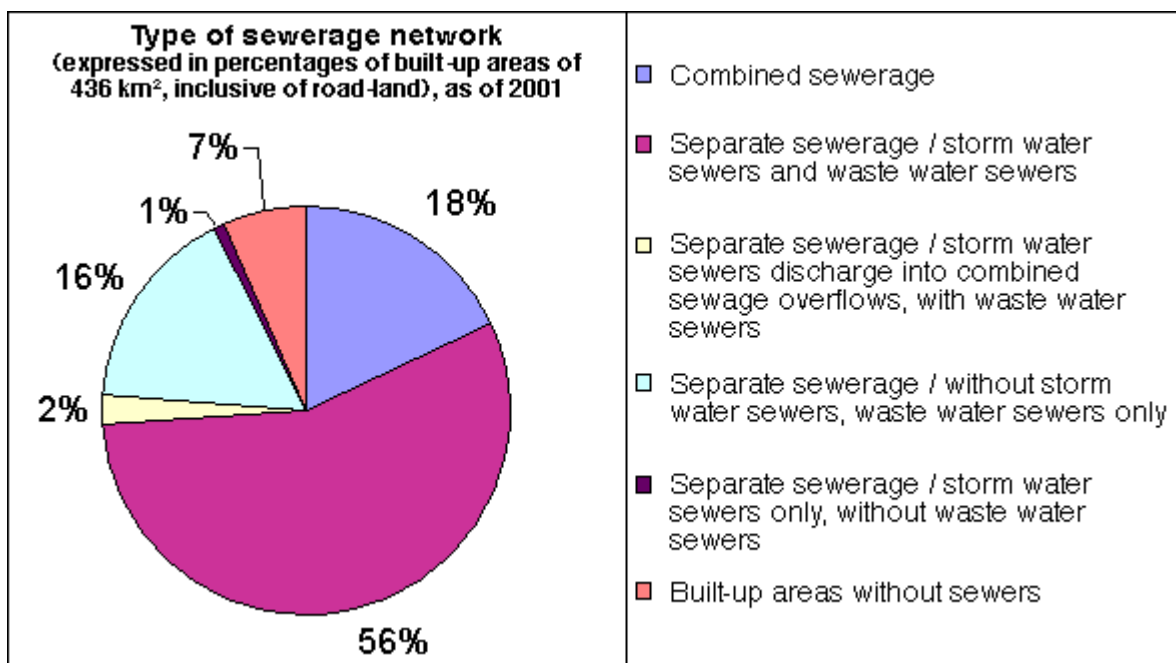


Fig. 1: Type of sewage network expressed in percentages of built-up areas, inclusive of road lands (436 km²), as of 2001

The **inner city districts** of Wedding, Tiergarten, Mitte, Prenzlauer Berg, Friedrichshain, Kreuzberg, Schoeneberg, parts of Neukoelln, and of Wilmersdorf, Westend, as well as **Spandauer Altstadt** are connected to the **combined sewerage system**.

The **outlying districts** of Reinickendorf, Pankow, Weissensee, Hohenschoenhausen, Marzahn, Hellersdorf, Lichtenberg, Koepenick, Neukoelln, Tempelhof, Steglitz, Zehlendorf, Spandau as well as parts of Wilmersdorf and Charlottenburg are connected to the **separate sewerage system**.

In Berlin **rain water sewers cum foul water drains** represent the prevalent type of **separate sewerage system**. Districts with this type of system are mainly found in closer proximity to the inner city areas. These districts cover Spandau, Reinickendorf, Pankow, Lichtenberg, Marzahn-Hellersdorf, Treptow-Koepenick, Neukoelln, Tempelhof-Schoeneberg and Steglitz-Zehlendorf, as well as some south-western sections of Wilmersdorf-Charlottenburg, a small area in the north-eastern part of Mitte as well as the Stralau peninsula in the south-eastern section of Friedrichshain.

A few city areas where **rain water drains were provided without foul water drains** are situated in the eastern parts of the city such as Blankenburg, Biesdorf-Sued, Kaulsdorf, Mahlsdorf, Koepenick-Nord and Bohnsdorf.

To reduce the load on combined sewers, some areas to the north of the municipal motorway **rain water sewers** were built which **discharge into the rain overflow drains of the combined sewerage system**. Sewage continues to pass through these combined sewers. This also holds true of the city area of Weissensee and sections of Schlossstraße in Charlottenburg, north of Bismarckstrasse.

Since 1990 sewerage connections were provided for the city areas of Weststaaken and Kladow as well as parts of Reinickendorf (areas on the western margins), Karow, parts of Buchholz-West II, Weststaaken, Kladow, Weissensee Altsiedlung, Stadtrandsiedlung Malchow, Stadtrandsiedlung Buch, Biesdorf Nord, Kaulsdorf Nord, parts of Kaulsdorf Sued, parts of Mahlsdorf Nord, parts of Mahlsdorf Sued, parts of Dammfeld West, parts of Rahnsdorf, Mueggelheim Nord, Johannistal, Dankmarsteig, parts of Bohnsdorf and Schmoeckwitz as well as of Reinickendorf (areas on the western margins), Weissensee, Koepenick and Marzahn.

Those areas of Berlin which **do not have any sewerage systems or which are only partly connected** and for which plans exist to provide connections so that they will at least have foul water drains by the end of 2005 are the following: Buchholz Altsiedlung, parts of Karow Altsiedlung, Hohenschoenhausen Altsiedlung, Wartenberg Altsiedlung, Falkenberg Altsiedlung, Gehrensee, Gartenstadt Hohenschoenhausen, Biesdorf Nord, the remaining part of Kaulsdorf Sued, parts of Mahlsdorf Nord III, Mahlsdorf Sued, Stadtrandsiedlung Biesdorf Sued, Kaulsdorf Sued, Biesdorf Sued, Elsengrund, Hirschgarten, Siedlung Spaethsfelde, Johannistal Sued, Siedlung Weiss, Gruenau Nord, Altglienicke Sued, Falkenberg, Falkenhorst, the remaining part of Gruenbergallee, Bohnsdorf West, Bohnsdorf Nord, Mueggelheim Sued, Rahnsdorfer Muehle West, Rahnsdorf Nord, Hessenwinkel, Weststaaken - Fahrlander Weg and Weststaaken - Zeestower Weg.

Parts of Berlin which have foul water drains but leave stormwater to percolate into the ground are to be found mainly in suburban areas, such as in Gatow, Spandau, Konradshoehe, Heiligensee, Frohnau, and in a few other parts of the outlying city areas.

02.09.2 Catchment areas of rain water canalisation

Depending on the main receiving water body, the catchment areas of stormwater sewers are found in the running water section of the **Spree and Dahme** rivers in the eastern and southeastern sections of Berlin, in the running section of the Havel river in the northern, northwestern and southwestern parts of Berlin as well as in the running section of the Teltowkanal in southern Berlin.

Lakes which are a part of the landscape and of parks, as well as ponds and other blind drainage water bodies are spread over the entire city area.

As a combined system prevails within the **inner S-Bahn circle line** and this area mostly does not have any separate sewers, this part of the city was not allocated to any stormwater sewerage catchment area. The only exceptions are Tempelhof airport and parts of Wilmersdorf to the north of the motorway, draining into the canals south of the Spree river (Neukoellner Schifffahrtskanal and Landwehrkanal).

Table 2: Rain water drainage into the sewer system - Catchment areas and run-offs (several year means as of 2001)			
Water body section Ilo	Catchment areas by water body section	Catchment area surface (km²)	Storm water run-off (million m³/a)
110	Oberhavel (City margin to Tegeler See estuary)	0,98	0,12
120	Oberhavel (Tegeler See estuary to Spandau lock)	4,22	0,68
130	Tegeler See	2,16	0,42
131	Tegeler Fliess	4,36	0,37
132	Nordgraben	10,25	1,28
133	Panke, north of distribution structure	4,97	0,52
210	Unterhavel from Spree estuary to Jungfernsee (exclusive of Wannsee)	11,20	1,33
220	Grosser Wannsee	2,03	0,17
230	Small Wannsee chain	1,48	0,10
310	Mueggelspree (inclusive of Großer Mueggelsee and Erpe)	5,30	0,76
320	Langer See, Dahme and Grosse Krampe	5,63	0,59
330	City Spree to Britzer Verbindungskanal branch-off	6,53	1,30
331	Wuhle	21,26	2,50
340	City Spree to Landwehrkanal branch-off	6,58	1,06
350	Rummelsburger See	9,44	2,02
351	Marzahn-Hohenschoenhausener Grenzgraben	15,66	3,02
380	City Spree to Berlin-Spandauer-Schiffahrtskanal branch-off	6,40	1,06
390	City Spree to estuary	6,61	1,22
400	Canals north of the Spree	6,39	0,99
401	Panke (as of distribution structure to Nordhafen)	16,30	2,11
500	Canals south of the Spree (Neuk. SK and Landwehrkanal)	6,92	1,28
600	Teltowkanal	59,47	7,01
610	Rudower Arm	22,14	2,36
620	Britzer Verbindungskanal	2,78	0,39
810	Chain of Grunewald lakes	9,35	1,20
820	Airport lake	5,63	0,89
830	Biesdorf dredger lake	2,77	0,33
840	Fauler See/Obersee	1,26	0,15
850	Schaefersee	2,37	0,44
860	Gross-Glienicker See	0,82	0,10
900	Small water bodies (ponds, small ponds, and ditches)	12,09	1,03
	Separated sewers (Total)	273,36	36,81
	Combined sewers	79,35	18,00

Table 2: Rain water drainage into the sewer system – Catchment areas and run-offs (several year means as of 2001)

The **Teltowkanal** with its more than 80 km² (inclusive of the Rudower Arm) offers the largest catchment area; on average and over several years it takes up over 9 million m³ of rainwater from the separate sewerage system. This is followed by the **Wuhle** with its catchment area of 21 km² and 2.5 million m³ of uptake and the **Panke** (as of distribution structure) with 16 km² and over 2 million m³ of discharges taken up. The area of the combined sewers accounts for some 58 km² and about 18 million m³ of rainwater are mostly discharged into the sewage treatment plants.

In some instances, very **small water bodies** have to cope with rain water quantities of very extended city areas. In case of heavier rainfalls this quantity is by far larger than the normal water volume. Examples of this are offered by the Schaefersee lake and the airport lake in Reinickendorf, the Dreipfuhl lake in Zehlendorf, the Obersee lake in Hohenschoenhausen, den Biesdorf dredger lake in Marzahn or small running waters like the Tegeler Fliess, the Nordgraben, the Zingergraben and the Panke in Reinickendorf und Pankow, the Wuhle in Marzahn/Hohenschoenhausen or the Neuenhagener Muehlenfliess in Koepenick.

Literature

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Maps

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