

02.09 Management of Rain and Waste Water (Edition 2009)

Overview

In Berlin, precipitation and waste water from private households, public institutions, industry and trade, as well as run-off from public road areas generate large quantities of rain and waste water. These need to be piped away and treated, if appropriate. In 2008, the local sewage plants treated some 645,000 cu. m of waste water from private households, trade, industry and public institutions, as well as rainwater from Berlin and its suburban area every day. This quantity is equivalent to a little over 8 cu. m./sec., 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 9,360 km with 233,000 service lines. The sewerage network is operated by the Berliner Wasserbetriebe (Berlin Water Works). It was implemented in two different systems, the **combined** and the **separate sewerage systems**, and consists of a total of 4,178 km of waste water drains, 1,894 km of combined water drains, 3,166 km of rainwater drains and numerous special structures, such as rainwater overflows, rainwater retention basins and culverts. Waste water collected there is pumped to the sewage plants by 145 pumping stations, through a network of 1,120 km of pressurised sewage pipes.

Berlin's combined sewage canal system was built in 1873 according 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 built systems based on separate drainage. After their incorporation into Berlin, their facilities were amalgamated into the present system. Drainage areas are oriented towards river courses and shipping canals, and also in accordance with the different terrain heights. The boundaries of drainage areas do not follow the borders of Berlin's boroughs. Some three quarters of Berlin's drained areas are operated under the separate system, and the remaining quarter under the combined system.

The Separate System

In a system of separated drainage, waste water and rainwater are handled by two different systems. **Waste water drains** carry household, commercial and industrial waste water to the pumping stations. From there, pressurised pipes are used to take it to the Ruhleben, Münchehofe, Schönerlinde, Wassmannsdorf, Wansdorf, and Stahnsdorf **sewage treatment plants**. After treatment, sewage plants discharge purified water into Berlin's bodies of water. Two other sewage treatment plants – at Marienfelde and Adlershof – were decommissioned as of 1990, and the Falkenberg facility was closed in 2003.

Sewage treatment plant	Capacity ¹⁾ (run-off on dry days) (cu.m./day)	Quantity of waste water treated in 2008 (cu.m./day)		Receiving waters
		Total	of which suburbs (%)	
Ruhleben	247,500	223,375	-	Summer season: Teltow Canal via pipes; Winter season: Spree
Schönerlinde	105,000	107,660	10	Tegel Lake via Blankenfelde Ditch/ North Ditch
Münchehofe	42,500	37,044	45	Spree via Erpe
Wassmannsdorf	200,000	191,173	7	Teltow Canal via Rudow Creek
Stahnsdorf 1)	47,000	49,959	40	Teltow Canal

Wansdorf	40,000	35,841	60	Havel Canal
Total	682,000	645,052	13	
1) Theoretical measurement approach; rated purification capacity for dry weather conditions, which can be exceeded up to an amount equal to double the dry-weather drainage, depending on catchment area and precipitation level.				

Table 1: Capacities, quantities of treated waste water and receiving water bodies of the large sewage plants of Berlin and its suburbs in 2008

Rainwater drains collect precipitation from impervious surfaces, cooling water from factories, and water from drainage ditches. This is carried directly to the larger or smaller surface waters. In some cases, very considerable areas of the city drain into very small receiving water bodies. Altogether, some 47 million cu. m. of rainwater per year are drained into water bodies by the separate sewerage system. Rainwater from the separate sewerage systems is 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 rainfall, there have been repeated fish kills in smaller standing water bodies and canals with 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 the water body. To reduce the pollution of water bodies, rainwater basins and retention soil filters for the treatment of rainwater operate at the main discharge points. Thirty facilities for rainwater treatment had been commissioned as of 2009.

There are some areas on the boundaries of the inner city which originally operated a combined sewerage system, but later received a rainwater drainage system (a modified combined sewerage system). There, the rainwater 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 (urban railway). In this combined drainage system, household, commercial and industrial waste water is collected in a **single drain** together with the rainwater, and then fed to the next pumping station. From there, the combined sewage water usually takes the same route as the sewage from the separate drainage system. The combined sewerage system includes rainwater discharge canals, rainwater overflows, drainage canals, water retention canals and rainwater basins to retain combined sewage during periods of rainfall, and to thus delay its passage to the sewage treatment plant. There are exceptions for situations of heavy rainfall. Once water reaches a certain height in the drains, or if the pumping stations can no longer cope with volume of water received, 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 **rainwater overflow canals**. In 2008, some 5.4 million cu. m. of such combined sewer overflow water reached the water bodies untreated at the approx. 530 rain sewage overflows in operation. The occurrences of such overflow situations and the quantities discharged fluctuate, as they depend on the frequency of strong rainfall.

Also, most pumping stations are equipped with **emergency discharges**. In situations of technical malfunction, combined sewage will be discharged into outlet ditches. Of the seventy-four emergency discharges, thirty-five discharge into the Spree river, thirteen into the Havel river, and eighteen into the Teltow Canal. Five discharge into standing surface water bodies, and the remaining three emergency discharges carry water to other pumping stations via waste water drains. Emergency discharge operations also fluctuate heavily between the years. The average annual quantity involved is something like 20,000 cu. m. Retention basins were built in the immediate vicinity of large pumping stations and at the most important sites of the combined sewerage system. These may cope with excess quantities of combined sewage during brief periods of high-intensity rainfalls. Sludge and suspended solid particles are deposited in these retention basins.

Areas with no Connection to the Sewerage Network

Despite considerable efforts by the Berlin Water Works (BWB), not all inhabited areas have been connected to the sewerage network as yet. In those built-up areas of Berlin with no house connections, sewage is collected in **septic tanks with no discharge**, from where it is taken to

sewage treatment plants by authorised transport companies. The waste water management of allotment gardens operates along these same lines.

In areas without rainwater drains, rainwater seeps into the ground.

A separate map has been developed to document the drainage situation. It shows the **catchment areas of the rainwater drains** (02.09.2). Every built-up area connected to the storm-water drainage system is matched to the water body receiving these discharged quantities of rainwater.

Statistical Base

The sewerage network maps of the BWB provided the primary base to ascertain the type of drainage as well as the various catchment areas of rainwater drainage. With the aid of the current digital drainage network maps from 2006, the map "Management of Rainwater and Waste Water", developed as part of the Environmental Atlas as early as 1992 and already upgraded once in 2003 and 2005, was again upgraded; it had already been digitised in the late nineties.

Methodology

By reference to the types, courses, and slopes of sewage drains, it was possible mark off **catchment areas of combined sewage drains** and of **separate rainwater and sewage drains**, respectively. It is not possible to exactly match individual roof and courtyard areas to the catchment areas of rainwater sewers by reference to maps of the sewerage 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 are drained differently from others under specific circumstances. It is merely stated whether, given the close spatial proximity of a property to a rainwater sewer, it would be possible to provide a connection to this system. There are – at least in many places – considerable differences regarding the extent to which properties are actually connected, and whether rainwater from impervious surfaces is actually discharged into rainwater sewers. The text accompanying map 02.13.1 Surface Runoff from Precipitation documents the corresponding data, based on information from the BWB.

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

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

In areas with **separate sewersage**, rainwater is drained into water bodies. For every unit or subunit with rainwater drains, the water body into which the rainwater drain discharges was defined. 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 respective water bodies.

Areas in which rainwater 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 bodies used in case of heavy rainfall were still assigned to these water bodies (such as Karow North).

Map Description

02.09.1 Type of Drainage

Some three quarters of the sewerage-equipped urban area of Berlin is drained by separate sewerage; the remaining quarter has combined sewerage. Compared to the early nineties, when 12 percent of the inhabited area (7 percent of West Berlin and 19 percent of East Berlin) was still not connected to the public sewerage system, this figure has dropped to about two percent, as of 2006. The population-referenced **overall connection rate** for the city is thus **99 percent**.

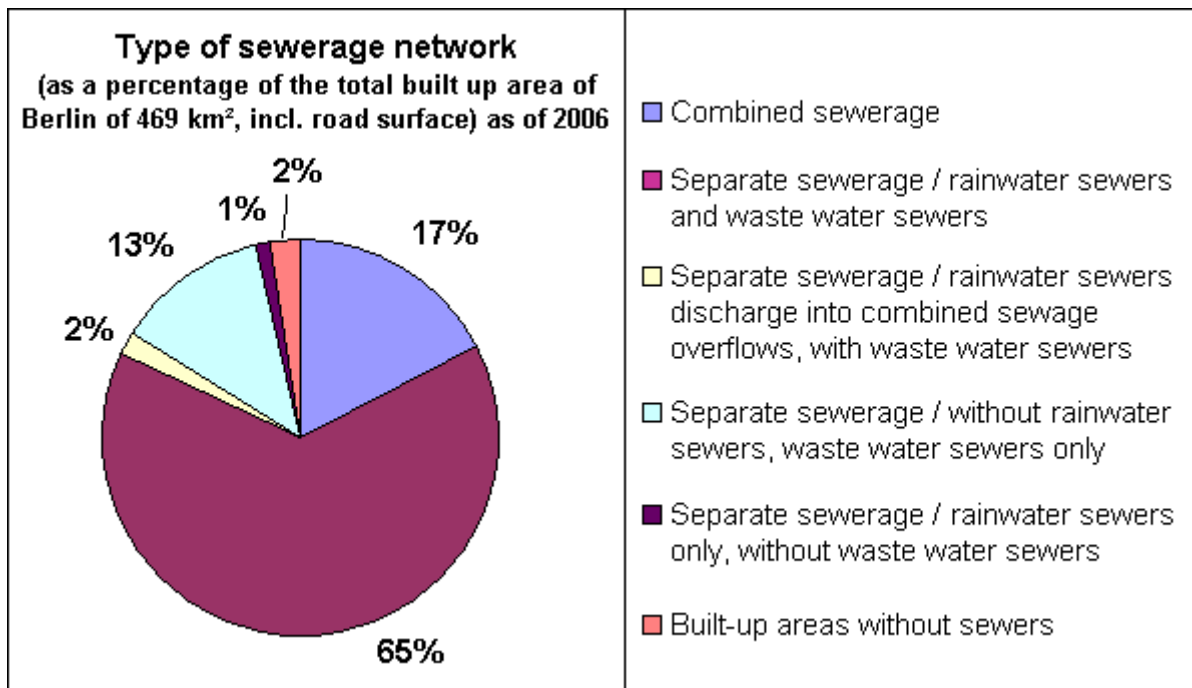


Fig. 1: Type of sewerage network, as a percentage of built-up areas, including road surfaces (469 sq. km), as of 2006

The **pre-2001 inner city boroughs** of Wedding, Tiergarten, Mitte (all now in the borough of Mitte), Prenzlauer Berg, Friedrichshain, Kreuzberg (the latter two now combined) and Schöneberg, as well as parts of Neukölln and Wilmersdorf, the Westend area and the old town of **Spandau** are connected to the **combined sewerage system**.

The **outlying former boroughs** of Köpenick, Neukölln, Tempelhof, Reinickendorf, most of Spandau (the latter both still single boroughs), Pankow, Weissensee (now combined), Hohenschönhausen, Lichtenberg (now combined), Marzahn, Hellersdorf (now combined), and parts of Wilmersdorf and Charlottenburg (now combined), are connected to the **separate sewerage system**.

In Berlin, the prevalent type of **separate sewerage system** is that of **rainwater drainage plus a sewage system**. Areas with this type of system are mainly found in closer proximity to the inner city areas, in the new boroughs of Spandau, Reinickendorf, Pankow, Lichtenberg, Marzahn-Hellersdorf, Treptow-Köpenick, Neukölln, Tempelhof-Schöneberg and Steglitz-Zehlendorf, as well as some south-western sections of Wilmersdorf-Charlottenburg, a small area in the north-eastern part of Mitte, and the Stralau peninsula in the south-eastern section of Friedrichshain.

There are a few residential areas with **rainwater drainage with no sewage system** in the eastern parts of the city, including Blankenburg, Biesdorf South, Kaulsdorf, Mahlsdorf, Köpenick North and Bohnsdorf.

To reduce the load on the combined sewerage system in some areas of Wilmersdorf to the north of the municipal motorway, **rainwater sewers** were built which **discharge into the rain overflow drains of the combined sewerage system**. Sewage continues to pass through these combined sewers. This is also true of Weissensee and some areas of Charlottenburg along Schloßstraße, north of Bismarckstraße.

Areas with existing sewerage systems but percolation of rainwater can be found at the outskirts in Gatow, Spandau, Konradshöhe, Heiligensee, Frohnau and also sporadic in other parts of the periphery. There are still some old settlement areas without sewerage systems. Some of these areas like Mahlsdorf Nord IV, Buchholz West II, Altsiedlung Blankenburg, Stadtrandsiedlung Blankenfelde, Altsiedlung Heinersdorf, Buchholz Nord II, Steinstücken, Siedlung Spreetal und Siedlung Wartenberg will be connected to the sewage systems depending on the costs for local public infrastructure and issues of urban development (planned realisation period 2009 up to 2015).

02.09.2 Catchment Areas of Rainwater Drainage

Depending on the main receiving water body, the catchment areas of rainwater sewers are found in the intake areas of the **Spree and Dahme** rivers in the eastern and southeastern sections of Berlin, of the Havel river in the northern, northwestern and southwestern parts of Berlin, and of the Teltow Canal in southern Berlin.

Lakes, park lakes, ponds and other blind drainage water bodies are spread over the entire area of the city.

Since within the **inner S-Bahn circle line**, the combined system prevails, and this area for the most part has no separate sewerage, it has not been assigned to any rainwater drainage catchment area. The only exceptions are Tempelhof Airport and parts of Wilmersdorf to the north of the motorway, which drain into the canals south of the Spree (the Neukölln Schiffahrts Canal and the Landwehr Canal).

Water body section No	Catchment areas by water body section	Catchment area surface (sq.km)	Rainwater run-off (million cu.m./yr.)
110	Upper Havel (City line to above entry to Tegel Lake)	1.6	0.16
120	Upper Havel (entry to Tegel Lake to Spandau lock)	4.4	0.80
130	Tegel Lake	2.5	0.46
131	Tegel Creek	5.9	0.60
132	North Ditch	11.4	1.60
133	Panke, north of Delivery Tank	6.4	0.68
210	Lower Havel from mouth of Spree to Jungfern Lake (exclusive of Wannsee Lake)	14.1	2.06
220	Great Wannsee Lake	2.4	0.21
230	Small Wannsee chain	1.8	0.16
310	Müggelspree (incl. Great Mueggel Lake & Erpe)	8.8	1.13
320	Langer See, Dahme & Grosse Krampe	7.8	0.83
330	City Spree to Britz Link Canal branch-off	7.4	1.37
331	Wuhle	23.4	3.12
340	City Spree to Landwehr Canal branch-off	7.2	1.11
350	Rummelsburg Lake	10.4	2.25
351	Marzahn-Hohenschoenhausen Boundary Ditch	15.8	2.71
380	City Spree to Berlin-Spandau-Schiffahrt Canal branch-off	6.8	1.24
390	City Spree to mouth	6.9	1.28
400	Canals north of Spree	7.8	1.61
401	Panke (from Delivery Tank to North Port)	19.2	3.07
500	Canals south of Spree (Neukölln Schiffahrt Canal, Landwehr Canal)	6.7	1.70
600	Teltow Canal	65.4	9.34
610	Rudow Branch	25.4	3.20
620	Britz Link Canal	2.8	0.52
810	Grunewald Chain of lakes	10.6	1.58
820	Airport Lake	6.3	1.14

830	Biesdorf Dredger Lake	4.6	0.52
840	Fauler See/Obersee lakes	1.4	0.21
850	Schaefer Lake	2.3	0.50
860	Gross-Glienicke Lake	0.9	0.12
900	Small water bodies (ponds, water holes, and ditches)	18.2	1.85
	Separated sewerage (Total)	316.5	47.1
	Combined sewerage	81.7	20.5

Table 2: Rainwater drainage into the sewer system – ascertained from data from the ISU, using the updated ABIMO 3 programme; as of data base June 2006; evaluation, Oct. 2009)

The **Teltow Canal** has the largest catchment area, with more than 90 sq. km (including the Rudower Branch); its long-term average intake is nearly 13 million cu. m. of rainwater from the separate sewerage system. It is followed by the **Wuhle**, with a catchment area of 23 sq. km. and 3 million cu. m. of intake, and the **Panke** (downstream from the delivery tank) with 20 sq. km. and over 3 million cu. m. of intake. The area of combined sewerage accounts for some 80 sq. km. and about 20 million cu. m. of rainwater, mostly discharged passed to the sewage treatment plants.

In some instances, very **small water bodies** have to cope with rainwater quantities of very extensive areas of the city. In case of heavy rainfall, this quantity is by far larger than the normal water volume. Examples of this are Schäfer Lake and the Airport Lake in Reinickendorf, Dreipfuhl Lake in Zehlendorf, Obersee Lake in Hohenschönhausen, the Biesdorf dredger lake in Marzahn, or such small streams as Tegel Creek, the North Ditch, the Zinger Ditch and the Panke in Reinickendorf and Pankow, the Wuhle in Marzahn/Hohenschönhausen, and the Neuenhagen Mill Creek in Köpenick.

Literature

- [1] **Abwasserbeseitigungsplan Berlin 2001:**
Waste water disposal plan with particular reference to immission target planning, SenStadt Section VIII (Ed.): Berlin.
Internet:
<http://www.berlin.de/sen/umwelt/wasser/abwasser/ab-plan/abplan2001.shtml>

Maps

- [2] **Berliner Wasserbetriebe (Ed.) 2006:**
Berlin Waterworks - Karten vom Abwassernetz [Maps of the sewerage network]: Regenwasser, Mischwasser, Schmutzwasser [Rainwater, combined sewerage, sewage water], Scale 1:4,000 & 1:2,500, Berlin.
- [3] **Unterlagen der BWB zum Ausbau der Schmutzwasserkanalisation**
[BWB documents on expansion of the sewage drainage system] June 2005