01.10 Former Sewage Farms 2010

Introduction

Waste waters from Berlin households and streets were drained by a primitive **gutter drainage system** up into the 1870's. There were years of dispute over which process should be chosen for urban dewatering and sewage disposal. **Field treatment of sewage** and its parallel use for agricultural areas was generally accepted as the most favourable form of sewage disposal. A total of 12,500 ha were adapted for 20 official sewage farms and two smaller sites used for field treatment of sewage. The city of Berlin had bought the land for the fields and still owns most of them today.

The establishment of **sewage treatment plants** in Berlin led to the closure of the great majority of sewage farms by the middle of the 1980's. Large areas of sewage farms were **built-up** within Berlin, in Marzahn, Hellersdorf, and Hohenschönhausen; or **reforested**, as around Buch forest at the end of the 1980s. By 1998, the final sewage farms had been shut down in their original use. Until 2010, the Berlin Water Works (BWB) carried out elution studies (an investigation in the field of environmental chemistry to extract adsorbed substances) to discharge clear water on the fields of the Karolinenhöhe sewage farm, in the district of Gatow. Many of the former sewage farm areas are now used for purposes of **agriculture and forestry**. Both the **nutrients** and **pollutants** in waste water are accumulated in sewage farm soils. This accumulation in closed sewage farms has disadvantages for current uses and, because of the size of the areas, far-reaching consequences on the economy of nature.

Former sewage farms remain important spaces for urban development in the future. A diversity of concepts, some of them competing, have already been discussed for use of the remaining surfaces as residential areas, industrial parks, recreation spaces or for ground water accumulation. Being aware of the specific pollution connected to sewage farms, information about the location and extent of former sewage farms forms an important planning basis for assessing the soils need for protection and for avoiding future conflict regarding use.

Functioning of Sewage Farms

The sewage farms followed a dewatering concept by James Hobrecht. In 1869, the Berlin administration made him director of the Berlin Latrine System. Hobrecht divided the city into 12 districts, called **radial systems**. Each radial system had a **pumping station**. Pumping stations received domestic, commercial and industrial waste waters as well as precipitation water through gravity flow pipelines. Sewage effluents were conducted from the pumping station through **pressure pipelines** to sewage farms located outside the city. Some sewage farms were additionally supplied by direct pipelines.

Pressure pipelines discharged waste water at the sewage farms. Waste water was first collected in **sedimentation basins** made of concrete or earth. Water flowed through the tank and most sediments settled to the bottom. Immersion panels held back floating matter. Sediments settling in the sedimentation basin were regularly evacuated and dewatered at special **sludge drying areas**. Dewatered sludge was used as a soil conditioner for agriculture and horticulture in early years. The sewage farm trench system was also regularly cleaned, whereby removed sediments were usually deposited directly alongside the trench. After sewage water had passed through the sedimentation basin, e.g. had been mechanically cleaned, it flowed through gravity feeders to the terraces.

The natural soil surface was not automatically suited for processing sewage waters. Terraces were constructed horizontally or on a slope, depending on the surface. They were about 0.25 ha large, and surrounded by embankments. There were three methods of **sewage farm treatment**. **Horizontal terraces** were flooded by surrounding distribution ditches. For **sloped terraces**, sewage water overflowed the upper bank and irrigated the sloped terrace. **Bed terraces** with ditch irrigation were also initially used. Waste water flowed through bed terraces in connected parallel furrows, about a metre apart. Only plant roots received water (cf. Fig. 1).

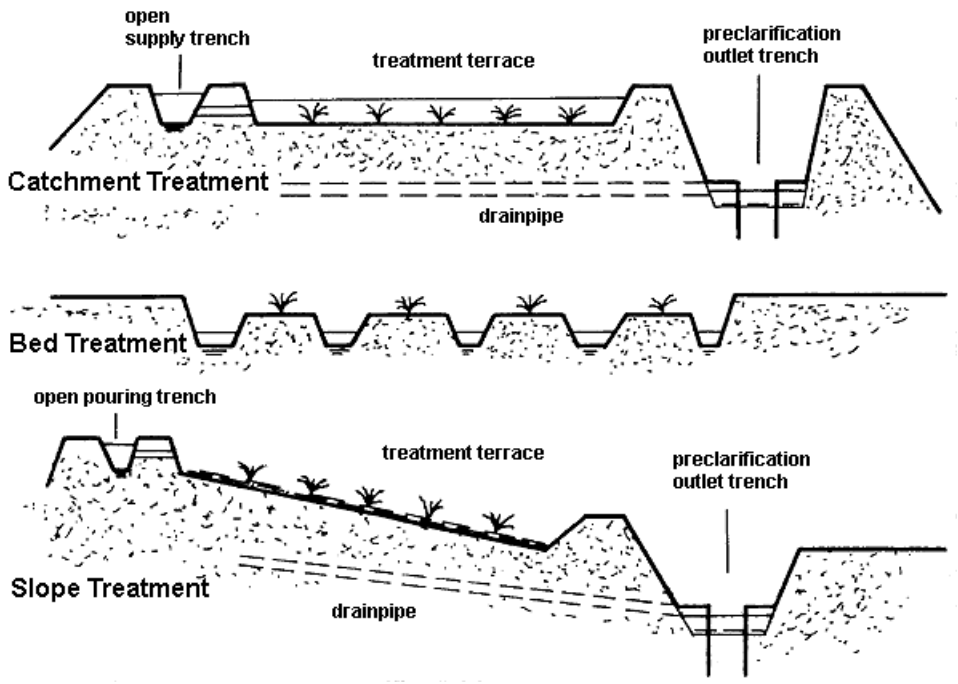

Fig. 1: Diagram of sewage farm types (according to Erhardt et al. 1991)

Wild sewage areas were often found near treatment terraces. The overloading of prepared surfaces could be met by directly diverting unpurified water through sluices onto natural land.

Sewage water contents were retained during the **passage through the soil**, adsorbed in the humic topsoil, and handled chemically and biologically. This process supplied agriculturally useful nutrients. Initial yields were high and the majority of fields were used agriculturally and served their own **sewage treatment plots**. There was a mixed use of grasslands and field cultivation.

Most sewage farms were provided during construction with **drainage pipelines** at regular intervals for a faster discharge of filtered and purified water, and to provide for aeration and regeneration of soils as well. Drainage water passed through collecting drains and dewatering trenches into the preclarification outlet trenches. Some water from soil passage percolated into ground water.

Fields were flooded in **normal operation**, and then left until water seeped away and the soil was re-aerated. The next flooding was begun only after re-aeration was completed. These **sewage farm rhythms** were also oriented to the growth periods of agricultural crops. Four to eight field treatment cycles a year were possible on grasslands, with a volume of 2,000-4,000 mm of sewage water. Areas used for cultivation of winter wheat could only be used once a year, with 100-500 mm of waste water.

Sewage farms were overtaxed with increasing amounts of waste water, an intensification of agricultural production, and the closure of other sewage farms. This stimulated some sewage farm operators to establish **"intensive filtration areas"**. These were permanently flooded and surrounded by high embankments. An inadequate degree of purification was performed here because aerobic processes could not take place. These areas were not used agriculturally.

Sewage farm structures were often levelled to a large extent after sewage treatment use was discontinued. Trenches and terraces were filled with material from the embankments, themselves land-fill material.

Contamination of Sewage Farm Soils

Waste water nutrients and pollutants were retained in the soil during water passage. All such soils were contaminated with **heavy metals**, some in considerable measure. This impaired the uses of these soils, as crops cultivated in this soil may accumulate heavy metals. Determined loads may be so high in some locations that health risks resulting from direct contact with soils cannot be ruled out. This is relevant, for example, where former sewage farms are planned to be used for sensitive purposes, such as children's playgrounds.

It may be assumed that pollutant loads of the infiltrating waste water increased during the operational span of sewage farms, because there was an increased use of household chemicals and detergents, and increased amounts of industrial waste water as well. In addition, there was an increasing load of street waste water that was introduced by the combined waste water collection system. Due to the composition of the waste water, soils that were part of a sewage farm are expected to be considerably contaminated not only with heavy metals but also with organic pollutants.

There is considerable **variation in the degree of pollution** in these soils of former sewage farms, depending upon the amounts of waste water treated. The duration of operation, the type of use and annual sewage water amounts are decisive factors for pollution loads. Particularly high loads are mainly to be expected at former intensive filtration areas. Additional variations are caused by technical processes of operations. Treatment terraces in the vicinity of sedimentation tanks are usually more heavily contaminated than areas somewhat more distant. Particularly high loads are to be expected around sedimentation tanks and sludge drying areas which have no sealing.

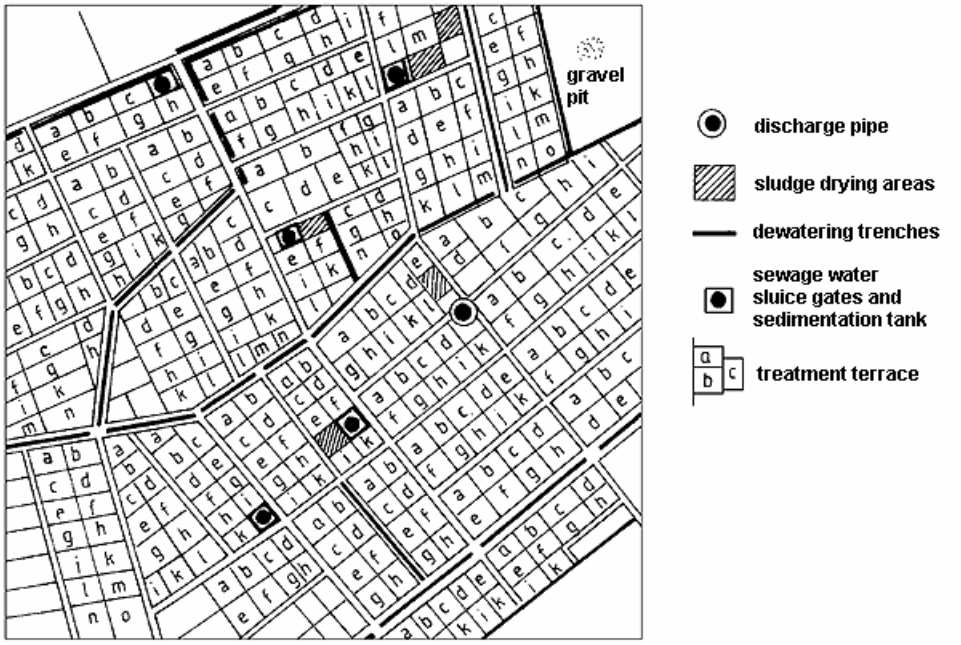

Fig. 2: Schematic illustration of sewage farm divisions

After sewage farm operations were stopped, areas no longer used were usually levelled to a large extent, filled, and ploughed up. This resulted in a **mixing** of soils with different levels of contamination. Contaminated soil material was brought into deeper soil layers in addition.

Not all contents of sewage water were retained in the soil passage. Considerable concentrations of **nitrogen and phosphate compounds** in sewage farm discharges polluted the **receiving preclarification outlet trenches**. Waters particularly affected in the urban area were Panke/ Nordgraben, Tegeler Fließ, Wuhle, Unterhavel and Rudower Fließ. The decommissioning of the sewage farms already led to an improvement of water quality in the past. Beyond the contamination of surface waters, a transfer of nitrogen compounds and organic pollutants into **ground water** has been detected (cf. e.g. Liese et al. 2004). Heavy metals, however, are largely retained in the surface soil.

Ending the intensive use of sewage farms has diverse effects on the eco-system:

Nutrients and pollutants accumulated during the operation of sewage farms are primarily bound in the soil's organic substances. The changed water economy and chemical condition of soils at abandoned sewage farms results in a decomposition of organic substances, and a **reduction of binding capacity** can be expected. As the pH value decreases, bound nutrients or pollutants can then be mobilised and washed out into the groundwater, or the bordering preclarification outlet trenches.

Discontinuing sewage farm use also had considerable consequences for the **area's water balance**. A significant drop in the groundwater level was registered at gauges in the area of the southern sewage farms. This had direct consequences for the local vegetation and for the yield potential of agricultural areas. Discontinuing sewage farm treatment also led to a reduction in the groundwater supply in the Berlin metropolitan area. After the abandonment of the northern sewage farms, problems arose with the water

flow of the Panke and the Tegeler Fließ. They had previously received some water from sewage farm outflows.

In order to mitigate the negative consequences resulting from the closure of the sewage farms, various concepts were discussed and tested. Possible measures include:

- maintaining binding strength of soils by introducing organic substances or lime to stabilise pH values
- removal of pollutants by plants with high biomass production, and
- the renewed wetting or further flooding with purified sewage treatment plant outflows to achieve groundwater accumulation (recharge) and the prevention of organic substance degradation.

Statistical Base

The sewage farm districts in the map are based on maps (scale: 1 : 10,000 or 1 : 25,000) produced in the 1960's commissioned by the Berlin Water Supply and Waste Water Treatment (WAB). The boundaries presented in these were checked against older maps from the archives of the WAB Berlin, the Berlin State Library and the Berlin Waterworks (BWB). Sewage farms discontinued before 1960 could thus be defined.

Further information on operation periods, type and intensity of use, and special-use areas was obtained from written information or information provided by employees of WAB Berlin, the Berlin Waterworks (BWB), WAB Potsdam and Königs-Wusterhausen and the Brandenburg State Office for the Environment (LfU).

The following data was used to digitise the geographical boundaries of the sewage farms:

- Geoportal Berlin / ATKIS® DTM – 2021 Digital Terrain Model with 1 m grid size (DTM1),

- Digital terrain model with a ground resolution of 1 m, Brandenburg and Berlin © GeoBasis-DE/LGB 2021,

- Geoportal Berlin / aerial photographs 1928, scale 1 : 4,000,

- Geoportal Berlin / aerial photographs 1953, scale 1 : 22,000,

- Geoportal Berlin / digital colour orthophotos from 2021 (DOP20RGBI) with a ground resolution of 0.2 m, and

- Georeferenced sewage farm district maps of the WAB from the 1960s.

Methodology

The areas are presented in the maximum extent that they were used for sewage treatment. Only areas specially prepared for sewage treatment use are included. The former sewage farms are grouped into **20 sewage farm districts**, following the system of the Berlin Waterworks (BWB). Two smaller sites used for field treatment of sewage, i.e. **Anstalt Dalldorf** (former psychiatric clinic) and **Strafgefängnis Plötzensee** (prison) are added to the 20 official sewage farm districts.

The **period of use** is given next to the **name** of each site. It is important to note that not all sections were used for waste water treatment from the beginning of operation, or during the entire period of operation.

The city of Berlin acquired a further 11,000 ha of natural land in the course of establishing the sewage farms, in addition to the areas already prepared for waste water treatment. These areas were earmarked for future expansion, but were never prepared or used for treatment. These areas, which are presented on various overview maps, were not considered here.

For sewage farms that remained operational until 1998 or 2010, a distinction is made between the **mechanical treatment** of infiltrating waste water in sedimentation tanks; and the **mechanical and biological** treatment of infiltrating waste water in clarification plants. The date of closure is indicated for all sewage farms. Based on the available map material, **seven periods of closure** may be distinguished.

The location of the **sludge sedimentation basins** and **sludge drying areas** established as part of the standard sewage farm operation is not depicted true to scale. The locations provided are based on information from the 1960s. Only areas surrounding the Karolinenhöhe sewage farm that were established at a later date were added retrospectively. The **intensive filtration areas** have also been included.

Within the sewage farms presented, further sections are indicated that were used for waste water treatment after the sewage farm was closed, mostly as part of the operations of the sewage treatment plants linked to them. The type of use is colour-coded or indicated in the description of the area. These include the

abandoned or currently still used **clarification plant sludge storage areas** and clarification plant sludge **composting** areas. At the former **Münchehofe** sewage farm, agricultural land was irrigated via pipelines with **clarification sludge mixed with clear water for fertilisation purposes** until 1985. **Fining ponds** were established in some areas as settling tanks for follow-up purification of clarification plant outflows. **Iron-manganese sludge** resulting from drinking water preparation was also stored.

The boundaries of the sewage farms were digitised using georeferenced scans of the WAB sewage farm maps, the DTM1 for Berlin and Brandenburg, and aerial photography data from 1928, 1953 and 2021.

Map Description

Use of Sewage Farms since 1874

Osdorf Manor was bought by the city of Berlin in 1874 and used as the first sewage farm. The pressure pipeline and the **Osdorf** sewage farm were completed and put into operation in 1876. A total of 20 sewage farm districts and two smaller sites used for field treatment of sewage were put into operation (cf. Tab. 1). The maximum of about 12,500 ha of prepared area was reached around 1928.

There have been increasingly severe problems with sewage farms since the 1920's. Agricultural yields were high at the beginning, but then dropped considerably. Too frequent treatment cycles caused soil surfaces to be muddied by sedimented effluent contents. This impaired the aeration balance. Imbalances in the nutrient balance and the increasing pollution of the soil led to yield reductions of crops. This **"field exhaustion"** was met by attempts to aerate the soil with regular soil processings and with structural improvement measures such as spreading lime and animal dung. But it became apparent that the yield capability of the soil could only be maintained by lowering the amounts of sewage water treated.

There was an **intensification of agriculture** after 1945. More and more land was consumed for the cultivation of root crops and cereals. Changing production cycles reduced the time available for treatment for these locations, so that less sewage water could be processed. An attempt was made to offset these losses in capacity by a more intensive use of the remaining grassland sites.

The East Berlin waterworks and sewage water system continued to use the majority of sewage farms after the Berlin Wall was built in 1961. The Berlin Waterworks (BWB) had continued to use part of the **Karolinenhöhe** sewage farm. A large portion of the southern sewage farms had been used by the city of Potsdam WAB since the 1960's. Sewage water from West Berlin continued to be handled at sewage farms in East Berlin and vicinity (cf. Tab. 1) in spite of separate administrations. The enlargement of the Nord sewage treatment plant in Schönerlinde for the improvement of water quality of the Panke, the Tegeler Fließ and the Nordgraben was financially supported by West Berlin.

Tab. 1: Sewage farm districts according to period of operation, amount and origin of the discharged waste water, area and area use										
Sewage farm district	Period of operation	Waste water volume (mio. m^3/ year) [1]	Origin of discharged waste water[2]	Max. extent of area[3]	Land cover in the former sewage farm districts, 2018 [4]					
				2010	Urbanised / built-up	Urban green space	Agriculture	Forest	Natural green space	Body of water
1. Wansdorf	1912 – 1998	10,0	Surrounding areas	138	9	0	111	18	0	0
2. Karolinenhöhe	1890 – 2010	2,6 [5]	West Berlin	407	5	19	349	35	0	0
3. Blankenfelde	1890 – 1985	18,0	West Berlin/East Berlin	1.529	161	117	893	245	105	8
4. Mühlenbeck	1911 – 1985	8,5	West Berlin	231	3	0	194	2	30	2
5. Schönerlinde	1893 – 1985		West Berlin	217	22	0	130	18	44	4
6. Buch	1898 – 1985	37,0	West Berlin/East Berlin	280	9	0	114	101	56	0
7. Hobrechtsfelde	1898 – 1985		West Berlin/East Berlin	824	5	0	38	403	378	0
8. Malchow	1886 – 1968	11,0	East Berlin	1.310	475	250	505	5	75	0
9. Falkenberg	1884 – 1969	14,5	East Berlin	1.084	689	230	103	37	25	0
10. Hellersdorf	1886 – 1969	11,0	East Berlin	808	554	162	92	0	0	0
11. Münchehofe	1907 – 1976	14,5	East Berlin/SA	126	14	0	65	5	41	0
12. Tasdorf	1910 – 1976	7,0	East Berlin/SA	210	21	0	146	9	34	0
13. Sputendorf	1890 – 1994	7,6	West Berlin/Surrounding areas	1.382	28	33	1286	25	9	0
14. Großbeeren	1893 – 1994	3,2	West Berlin/Surrounding areas	839	89	35	642	5	68	0
15. Osdorf	1876 – 1976	20,0	West Berlin/Surrounding areas	1.648	59	15	1483	75	15	0
16. Groß-Ziethen	1902 – 1988	0,4	West Berlin/East Berlin	82	0	0	76	2	4	0
17. Klein Ziethen/Selchow	1890 – 1989	14,5	West Berlin/East Berlin	513	68	12	381	15	37	0
18. Waßmannsdorf	1890 – 1989		West Berlin/East Berlin	0						
19. Boddinsfelde	1905 – 1989	3,5	West Berlin/East Berlin	145	0	0	142	2	0	0
20. Deutsch-Wusterhausen	1903 – 1994	1,8	West Berlin/East Berlin	644	10	0	83	1	550	0
21. Anstalt Dalldorf	1905 – 1927	N/A	West Berlin	5	5	0	0	0	0	0
22. Strafgefängnis Plötzensee	1869 – v1930	N/A	West Berlin	5	5	0	0	0	0	0

[1] volumes treated in the year before closure, for Wansdorf in 1971, for Deutsch-Wusterhausen, Großbeeren and Sputendorf in the year 1992,

[2] origin for Wansdorf until 1983: West Berlin/Surrounding areas,

[3] max. extent of the prepared area until year of closure,

[4] aggregated classes from the Corine Land Cover 5ha © GeoBasis-DE / BKG (2018), differences due to rounding may occur,

[5] information applies only to operational areas within the Berlin urban area

Tab. 1: Sewage farms according to period of operation, volume and origin of the discharged waste water, area and land cover

Sewage farms were largely retained into the 1960's. Only smaller portions were removed from operation, for street construction or the erection and fortification of the former border strips. Closures of large portions of sewage farms ensued after the Berlin **sewage water treatment plants** were established. The size of fields in use at the **Karolinenhöhe** sewage farm was considerably reduced after the Ruhleben treatment plant commenced operations in 1963. The Falkenberg treatment plant began operations in 1969, and large sewage farm areas were discontinued at the **Falkenberg**, **Malchow** and **Hellersdorf** sites. A large portion of these areas was used for residential housing and commercial development. The Marienfelde facility began operation in 1974, and the **Osdorf** sewage farm was subsequently closed in 1976. The **Münchehofe** and **Tasdorf** sewage farms were closed in 1976, following the start of operation at the Münchehofe sewage treatment plant.

There was a rise in waste water amounts and an increased need for treatment in East Berlin in the middle of the 1970's. The remaining sewage farms in East Berlin and surroundings were supplied with particularly large amounts of waste water. **Intensive filtration areas** were established, particularly in the northern sewage farms of **Hobrechtsfelde**, **Mühlenbeck**, **Schönerlinde** and **Buch**, and in the southern areas of **Waßmannsdorf**, **Boddinsfelde** and **Deutsch-Wusterhausen**.

The final decision to discontinue sewage farms was made at the end of the 1970's. Prerequisites were met with the operational start of the Schönerlinde sewage treatment plant in 1986, and the enlargement of the Stahnsdorf treatment plant, built in 1931. The expansion of the Waßmannsdorf treatment plant at the end of the 1980's allowed the closing of more sewage farms.

The sewage treatment plants mentioned above were frequently constructed on former sewage farm sites. Portions of these areas continue to be used in the waste water treatment process, especially for sludge storage and composting.

Studies of the **pollution and nutrient situation** of discontinued sewage farm soils started to be carried out at the beginning of the 1980's (BBA 1982, Metz/ Herold 1991, Salt 1987). The studies found considerable heavy metal contamination in soils and food crops. These findings were the basis for prohibiting cultivation of vegetables at the **Karolinenhöhe** site in 1985. Studies of the southern and northeast sewage farms had similar consequences. Cultivation of foodstuffs was limited to feed plants or crops that accumulate contaminants at lower levels.

Use of Sewage Farms from the 1990s until their Complete Closure in 2010

About 1,250 ha of fields were used for sewage treatment in portions of the **Karolinenhöhe, Sputendorf, Großbeeren, Deutsch-Wusterhausen and Wansdorf** sewage farms until 1994. Much smaller amounts of sewage water were processed than in the 1970's due to portions being removed from operation. Sewage water amounts in **Sputendorf** sank from the 1971 level of 21 mill. m^3/year to a 3.2 mill. m^3/year at the beginning of the 1990s. The same is true for the **Großbeeren** sewage farm. Sewage water amounts there fell from 25.0 to 3.2 mill m^3/year at the beginning of the 1990s. The reunification of Germany returned operating rights for the remaining sewage farms to the (West) Berlin Water Works (BWB), with the exception of **Wansdorf** and **Deutsch-Wusterhausen**, and that part of the **Karolinenhöhe** sewage farm located in the State of Brandenburg.

Parts of the **Sputendorf** sewage farm received up to 30,000 m^3 daily of mechanically-biologically purified waste water from the Stahnsdorf sewage treatment plant. The plan was to only discharge mechanically treated waste water whenever the Stahnsdorf plant was working to capacity. A **sludge decantation facility** was erected on a portion of the **Sputendorf** sewage farm used as a sludge storage area. Clarified sludge from the Stahnsdorf plant was to be dewatered by centrifuges. The resulting sewage water was then returned to the treatment plant.

Sewage water for the **Großbeeren** sewage farm was purified in sedimentation tanks there. The **Wansdorf** sewage farm mechanically purified with its own pre-purification facilities. Waste water brought to the **Deutsch-Wusterhausen** sewage farm was mechanically purified in the Königs-Wusterhausen sewage treatment plant.

The Berlin portion of the **Karolinenhöhe** sewage farm was used for percolation. About 0.9 mill. m^3 of mechanically-biologically purified waste water from the Ruhleben plant was percolated in 1990, as well as another 1.7 mill. m^3 of waste water mechanically purified in Karolinenhöhe. The most important goals were the continuing immobilisation of nutrients and contaminants accumulated in the soil and the recharge of groundwater. Only mechanically-biologically purified sewage water was discharged after technical

improvements at the Ruhleben plant were completed. The area was also held in reserve as an emergency depot should any purification plant operation be interrupted.

By 1994, the **Sputendorf**, **Großbeeren**, **Deutsch-Wusterhausen** and **Karolinenhöhe** sewage farms had been completely closed down. The **Wansdorf** sewage farm was still in use until 1998. The elution studies involving the discharge of clear water by the Berliner Wasserbetriebe (BWB) on the areas of the **Karolinenhöhe** sewage farm were completed. After almost 135 years, the era of sewage farms in Berlin and its surrounding areas therefore came to an end in 2010.

A large portion of the Karolienhöhe sewage farm, which was defined as a “landscape conservation area” in 1987, serves as an example of subsequent and ecological use of former sewage farms. The purpose was to protect the diversity and character of the landscape, to restore and permanently maintain the efficiency of the natural balance, and to preserve an extensive recreation area (Karolinenhöhe Ordinance 1987, Berlin House of Representatives 2021).

Maximum Extent of the Former Sewage Farms and their Land Cover in 2018

The map and Table 1 show the maximum extent of the sewage farm districts for each period of operation.

Figure 3 and Table 1 illustrate the land cover in 2018, after all sewage farms had been closed down. For this purpose, the land cover data extracted from the “Corine Land Cover 5ha” data (© GeoBasis-DE / BKG (2018)) was grouped into six classes:

- Urbanised / built-up (clc18: 111, 112, 121, 122, 132, 133),
- Urban green space / sports area (clc18: 141, 142),
- Agriculture incl. meadows and pastures (clc18: 211, 231),
- Forest (clc18: 311, 312, 313),
- Natural green space (clc18: 321, 324, 411, 412),
- Body of water (clc18: 512) (Federal Agency for Cartography and Geodesy 2021).

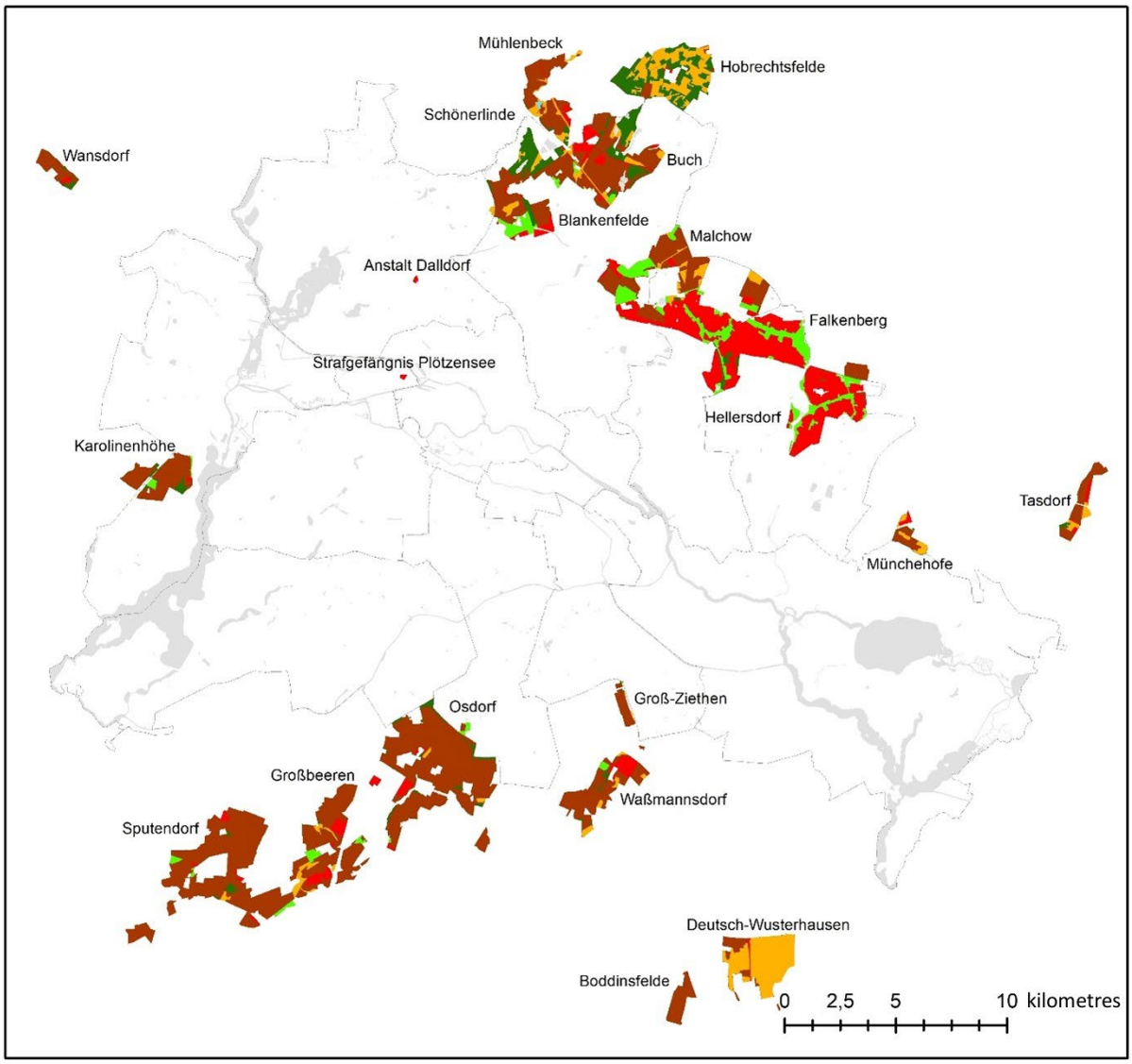

Fig. 3: Land cover of the former sewage farm districts in 2018 (combined classes from Corine Land Cover 5ha © GeoBasis-DE / BKG (2018))

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