VILLE DE
PARIS

Bring this document back at the ticket office.

I. THE KEYS OF THE SEWERS

A. PARIS SEWER MUSEUM, THE STORY CONTINUES

The first guided tours of the Paris sewers were organised during the 1867 Universal Exhibition, under the Second Empire. An opportunity to showcase the capital's modernity to the public, on the surface and underground. By boat or dredger wagon, a tour of the Paris sewers guided by the sewer workers themselves was a much sought-after outing, whether as a leisure activity or for study purposes. Crowned heads and society people in search of thrills could not wait to take part, alongside engineers on study missions.

The palace built on the Champs-de-Mars for the 1867 Universal Exhibition in Paris. Between 1 April and 31 October, over ten million visitors flocked to the palace and the hundreds of exhibition pavilions.

Postcard. stea photo library

FIRST TOURS : Socialising underground

One of the most popular visits in Paris was organised twice a month on Wednesdays between Easter and October: the tour of the sewers. It lasted almost an hour, from Châtelet to Madeleine via Place de la Concorde and the Sebastopol, Rivoli and Asnières collectors. During the first part of the itinerary; the women were seated in a boat while the men followed them on foot; then they all took their places in a dredger wagon equipped with comfortable seats and pushed by four sewer workers in white outfits. "...The demand for tours soon became so high that I had to have full-scale trains organised in the collectors. The dredger wagons used for ordinary cleaning purposes were ill-suited to receiving visitors. So I had nine special little wagons constructed, of elegant design and each equipped with enough seats for ten people."

Eugène belgrand, les travaux souterrains de paris, volume 5. 1906
Departure to Arts-et-Métiers by wagon. © léon & lévy/roger-viollet

TOURS 1906 : After inauguration of the metro

The visit itinerary changes following the opening of the first metro line. Two sections are now on offer, via the Centre or Petits-Champs and Sébastopol collectors: quai du Louvre-Châtelet by boat, and Châtelet to Arts-et-Métiers by wagon. Traction was now electric. It is a return journey with transfer at Châtelet. Each convoy carries a hundred or so visitors, admiring the spacious, well-lit and almost odourless galleries.

1913 With their admission tickets in hand, visitors wait to make their way down into the Paris sewers. © léon & lévy/roger-viollet

TOURS 1913 : The sewers visited and explained

No visit without an entrance ticket, to be obtained from the Department of Public Works or the Sewers and Sanitation Technical Service. This visit is educational, with a series of panels presenting the grit chamber and collector bypass, the waters of the Vanne and the pneumatic clocks. At the intersection of rue de Rivoli and Boulevard de Sébastopol, the proximity of the metropolitan railway, which passed beneath the point where the two sewers crossed, is indicated.

1950 – 1960 *Cruise in the collector. © albert harlingue/roger-viollet*

TOURS 1950-1960 : Boat trips without reservation

After the Second World War, the visitors' entrance was in Place de la Concorde: the itinerary took them to Madeleine after a short boat ride through the rue Royale collector. Tours were now organised twice a month on Thursdays in May and June, every week between 1 July and 15 October, and the last Saturday of each month. Visitors were admitted subject to availability of places and an admission fee was collected on the way down.

1975 Advertisement for the Sewer Museum, 1990. stea photo library

1975 : Founding of the Sewer Museum

Boat trips beneath Paris were finally discontinued. Since 1975, the story of the sewers and their various tools and machines has been told by a Museum housed in the Alma station, at the siphon start point, in the heart of an operational site. Visitors can make their way through it for 500 metres under the guidance of sewer workers.

The Museum was first refurbished in 1989 and welcomes around 100,000 visitors a year. It closed in summer 2018 in order to carry out comprehensive renovation of its visit itinerary.

B. GRAVITATIONAL AND VISITABLE NETWORK

Gravitational network

The sewerage system is organized and branched: elementary sewers flow into secondary collectors, which then join main collectors and outfalls. It operates by gravity: used water flows freely to the north-west of Paris, following the natural gradient of the Seine basin. Only a few low-lying districts in Paris are equipped with pumping stations that lift the water from the sewers so that it can resume its gravity-fed course through the network.

Visitable network

In Paris, the various sewer tunnels, from the smallest (elementary sewer) to the largest (major collectors), were designed to be accessible for maintenance. Only the outfalls, veritable sewage highways, follow a different logic.

Images :

Private sewer connection

Elementary sewer – type number 13
Collector Rapp – type number 6
Collector of the Bièvre (river) – type number 3
Collector of the Coteaux – type number 5
Galerie boulevard Sebastopol – type number 2
Main collector Asnières – type number 1
Outfall

C. UNITARY NETWORK

What happens when we use our sanitary equipment?

With "mains drainage", all the water we use, whether it comes from homes (toilets, bathrooms, household appliances), yards and roofs, but also run-off from pavements, flows into the "combined" sewer that runs under the street.

What happens when it is raining?

Rainwater from roads (run-off from pavements) and buildings (gardens, courtyards and roofs) is collected by manholes and house connections and channelled into the combined sewer system.

In the event of heavy rain, the sewers can also be flooded.

SAFETY INSTRUCTIONS

You are entering the operational part of the Alma site of the City of Paris sewers. The site is in contact with the sewage system and may present an olfactory nuisance. Visitors are asked to respect the protection and safety measures set out on this sign to ensure that the visit goes smoothly. Enjoy your visit.

Along the way, you may encounter various obstacles such as uneven floors, steps or ceiling pipes.

- **Do not touch** : For health and safety reasons, please do not touch any objects, railings or walls.
- **Caution : risk of falls and slippery floors** : Gallery floors can sometimes be slippery. Do not lean, lean or climb on the railings.
- **Food and drinks are forbidden**
- **Vigilant parents and carers** : For their own safety, children must remain under the constant supervision of the adults accompanying them.
- **Smoking and vaping are forbidden**
- **Handwashing** : Don't forget to wash your hands at the end of your visit. Sanitary facilities are available.

II. THE SEWER MEN'S WORK

01 EQUIPMENT AND RISKS

Sewer workers have always thought about protecting themselves against insalubrity. 150 years ago, sewer workers were equipped with nothing more than a simple cap and overalls. Equipment has evolved with growing awareness of hygiene and workers' safety, and is now a match for the risks that they are confronted with. Knowledge towards dangers especially to the sewer environment has increased over the years, in particular with regards to wastewater and the bacterias and viruses it carries within, lethal or explosive gases likely to develop in confined spaces, and underground accidents. Suitable responses have been created, based on the principle of risk prevention.

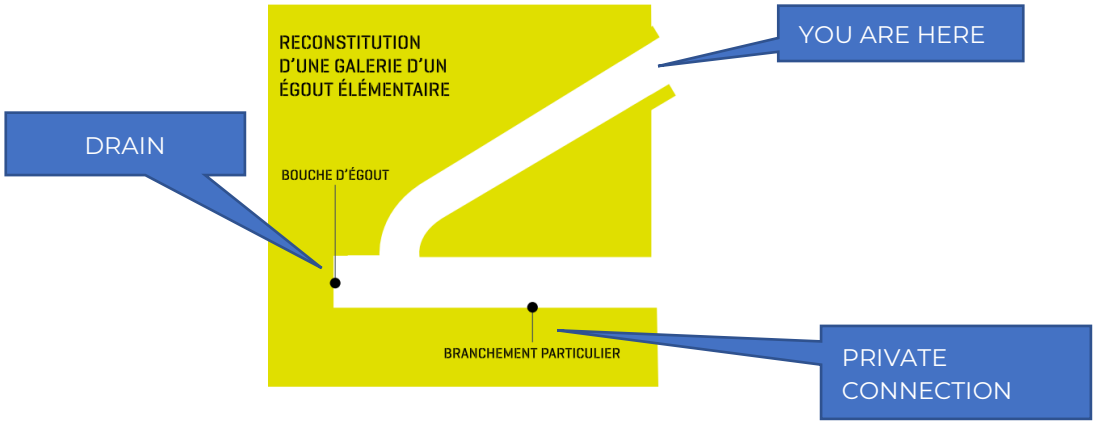
Equipment contributing to collective protection
1 – Manhole barrier
2 – Manhole grating, for prevention of falling from high surfaces
Lift-assist equipment
3 – Sewer worker's hammer, for opening the system's manholes
Personal protective equipment (PPE) and detection equipment
4 – Gas detector
5 – Self-rescue mask
6 – Helmet with headlamp
7 – Breathing apparatus: full-face visor and orinasal mask
8 – Nitrile gloves
9 – Sewer worker's long-sleeve gloves
10 – Single-use coverall, worn on top of overalls
11 – Waterproof boots with non-slip soles : thigh boots, low boots or waders depending on water level

02 IN THE HEART OF THE NETWORK

COLLECTION, CLEANING, MAINTENANCE: THE SEWER SYSTEM TRILOGY

The system's greatest enemy is solid matter, sediment known as "sludge". It is carried along by runoff water and deposited in the sewers, clogging them up. Whence the need to clean them, in order to remove as much of the deposited sludge as possible. In the modern system, the balls and all other cleaning equipment were designed at the same time as the sewers themselves. They operate by water power. Maintenance is carried out by sewer workers in visitable (i.e. accessible) systems.

03 EXPERIENCE THE SEWERS FOR YOURSELF



Visit to an elementary or lateral sewer. This gallery includes all the features that exist beneath Parisians' feet: drinkable and non-drinkable water pipes, cables transiting via the sewers, and private connection between building and sewer system.

04 DRAINS

Located along gutters, these openings collect rainwater runoff and direct it into the sewer system.

05 PRIVATE CONNECTIONS

These are links between Parisian homes and the sewers: a private connection is a gallery accessible from the building's basement (closed connection to the sewer) or from the sewer (open connection). The Paris system has over 100,000 of them.

06 UTILITY GALLERIES

Paris' sewerage system is effectively a vast utility gallery: it contains drinkable and non-drinkable water pipes, and pipes distributing iced water for buildings' air-conditioning systems, as well as telecommunication cables. Pneumatic mail systems also ran through the galleries until they went out of use in 1984.

07 CLEANING

In visitable systems, cleaning – or extraction – of matter deposited in the sewers is carried out by flushing, making use of the water's full force, or manually, with a device known as an "*aspiratrice*" (suction cleaner).

High-pressure water jetting (HPWJ) is used for cleaning non-visitable systems.

08 DREDGER BOATS

Designed to clean large collectors, the dredger boat is secured by a pair of chains attached to rings embedded in the collector's masonry. Moved along by the force of the accumulated water, which creates a flushing effect, the boat is operated by a team of between six and eight sewermen, advancing in fits and starts as one of them frees the chains' links. After each cleaning campaign, the boat is refurbished in a dedicated workshop.

Guide : Ensures the boat remains in the collector's axis
Lowering winch : For raising and lowering the valve
Valve disc handle
Anti-sinking device : Automatically prevents the boat from sinking when the water rises.
Valve disc : The sediment is in suspension after the valve has done its work and stirred up the water; the water's speed drives the sediment to the chamber
Dredging hook : Used to move large obstacles

09 GRIT CHAMBER

Collectors open at regular intervals onto chambers that are wider and deeper, whose job it is to receive sediment.

The various pieces of cleaning equipment also push solid matter into these grit chambers, where it is stored before being evacuated from the system.

10 DRAIN

These openings (there are over 20,000 of them in Paris) collect rainwater runoff and water used for washing roads and gutters directing the water into the sewer systems. Up until the end of the last century, drains also let in solid waste.

This is no longer the case today, with so-called "selective" drains protected by gratings.

11 MANHOLES

Manholes provide means of access to the underground network in sewers. They consist of a chimney, an access shaft equipped with a ladder, and a cross gallery connecting them to the sewer. They are closed at street level by heavy cast-iron covering up to 80 centimetres in diameter. Manholes are usually located every 50 metres.

There are about 30,000 of them in Paris.

12 ELEMENTARY SEWER

These galleries collect wastewater from buildings and stormwater, they discharge that water into larger sewers, which are connected to even bigger collectors. Sewer workers can stand upright in Paris' elementary sewers, which are a minimum of 1.80 metres high. They have no central sewer drain and are mainly cleaned using manual devices or directly with suction cleaners.

13 MAIN COLLECTOR

This is the largest visitable structure: it receives water from elementary sewers and carries it to outfalls leading to pumping and wastewater treatment plants outside Paris.

These collectors, which receive very high wastewater and stormwater flows, are equipped with footways enabling sewer workers to make their way through them and a central sewer drain through which the water flows. They are cleaned by special pieces of equipment: dredger boats and wagons.

14 GRAPPLES AND WAGONS

Use of grapples discontinued in 2014

The sediment caught in grit chambers used to be extracted mechanically (by dredgers and winches), and evacuated by grapples that loaded it onto wagons. These days, suction cleaners are used instead, extracting around 4,500 tonnes a year.

15 BYPASSES

Structures designed to divert water from one collector to another in order to empty the grit chamber into which it would normally be discharged: as a result, solid matter that has accumulated there can be extracted.

16 TWO-BALL WAGON

Use discontinued in 2005

Two-ball wagons were used to remove sediment that had accumulated on the bottom of collectors less than 2.20 metres wide. They were equipped with two wooden balls set in the sewer drain.

Together, the balls formed a dam that forced the water to circulate beneath them at very high pressure, so putting the sediment back into suspension.

17 CLEANING BALLS

Use discontinued in 1995

Once used in non-visitable works, siphons and outfalls, the cleaning ball has a diameter slightly smaller than the structure itself, leaving a gap at its base

through which water passed at high pressure and flushed out the sediment in front like a jet of water on the ground. It was removed at the far end and returned to its departure point.

18 DREDGER WAGON AND SECONDARY COLLECTOR

Commissioned in 1858

Secondary collectors are less than 1.20 metres wide and are cleaned by dredger wagons, simply using the power of the current. A valve flushes the sediment while water pressure on its frame pushes the apparatus forward. The support on the front increases the flushing effect and loosens agglomerated sediment.

Lowering winch : For raising and lowering the valve
Fins : Reinforce the dam and raise water level

19 LOCOMOTIVE AND WAGON

In the early 20th century, an electric locomotive was used to tow wagons filled with solid matter. The waste was then evacuated by boat along the Seine.

20 *"MITRAILLEUSES"*

Use discontinued in 1990

An almost portable cleaning device, the *mitrailleuse* was operated by a sewer worker.

It functioned like a dam with a valve at its foot, which let a strong current of water through, pushing back the matter in its path.

It owes its name (the French for "machine gun") to the sputtering sound of pebbles and bits of iron that struck its casing, and to its operation in short bursts.

21 HIGH PRESSURE WATER JETTING (HPWJ)

Non-visitable systems are cleaned with apparatus under high pressure. A "mortar" attached to a hosepipe sends jets of water backwards: sludge and solid matter are disaggregated and pushed to the next manhole. The manoeuvre is repeated until the recovered water is clear and its flow regular.

III. AUTMATING OF THE NETWORK

22 PUMP

This water lift pump was installed in a low point on the system, ready to be activated in order to reintroduce water into high parts or in the event of flooding. Its protective role has been taken over by flood pumping stations. There are 9 of them altogether in Paris, replacing spillways when the latter are closed in order to protect the system and the city against flooding.

23 FROM REGULATION TO TREATMENT

Most of waterwaste and rainwater from the 7th and 15th districts of Paris run through the Alma site before being sent to the south side in the Marceau collector or the South outfall which is a more modern construction, driving to the Seine Aval plant. Rejections in the Seine in case of saturation of the sewerage network. When huge rains happens, are very limited thanks to automated regulation equipment. The maintenance is made inside the visitable sewer by sewermen.

24 AUTOMATION

The Paris system is a regulated network consisting of four essential components: valves, pumps, sensors and control systems. As rain leads to major variations in the amount of water in the sewers, regulation optimises flows sent to wastewater treatment plants. Sensors located in sewers transmit data to local control systems and then to a supervision centre. These latter determine desired water levels and activate the valves that regulate flows. This valve on the outfall regulates the Alma site and distributes effluents between the south outfall to the Seine Aval plant and the Marceau collector to the Clichy plant.

25 DECOMMISSIONED VALVE

This valve emptied the south outfall so that maintenance work could be carried out in it when there was no threat of rain.

26 FISH AND FUTURE BATHERS

The Seine and aquatic life have become compatible once again in the 21st century, as is evidenced by the fact that some thirty fish species have returned to the river.

Its content in terms of oxygen, organic matter, nutrients, toxic substances and suspended matter is analysed in order to ensure water quality. With the

prospect of opening up the Seine to bathers, thanks to its improved health status, a close watch is also being kept on two bacteria indicative of faecal pollution.

27 MESURING STATION

Everything you need to know in real time about the quality of the water in the Seine. The measuring station records and summarises the state of the river according to five parameters: its ammonium content (an indicator of water pollution by organic waste of agricultural, domestic or industrial origin), its dissolved oxygen (the life of aquatic organisms is threatened below a certain threshold), its PH or hydrogen potential (indicating acid pollution). The last two parameters, Escherichia coli and enterococci, are used to measure water quality for bathing purposes.

Temperature

Unit of measurement : C°
Measurement location : Seine

The temperature of the Seine influences the life of the ecosystem: bacterial and microbial populations, pH, movements of fauna, etc.
In general, the temperature of the water in the Seine ranges from 6 to 25°C between winter and summer.

Dissolved oxygen

Unit of measurement : mgU_2/L (mg oxygen per litre)
Measurement location : Seine

The oxygen in the water is created by exchanges with the atmosphere (21% O2) and photosynthesis. It is essential for for the proper functioning of the ecosystem for the respiration of aquatic organisms. It is therefore an indicator of water quality. Concentrations must be higher than 6 mg/L (or even more when the water is cold !).

Conductivity

Unit of measurement : µS/cm
Measurement location : SKID

This is the ability of water to conduct an electric current because of the ions present. It is used as an indicator because it increases when polluted water is discharged into the river.

pH

Measurement location : SKID

The pH is an indicator of the acidity of water. A pH of 7 is said to be neutral. The pH of the Seine should be between 6.5 and 9.

Ammonium NH_4

Unit of measurement : mgN/L (mgnitrogen per litre)
Measurement location : SKID

Ammonium is nitrogen, an essential element essential for the growth of plants and algae. Not enough nitrogen, and plants plants won't be able to grow. Too much, and they will grow uncontrolled. Waste water is often very high in nitrogen. WFD threshold <0.5mg/L 90% of the time

Turbidity

Unit of measurement : NFU (nephelometric units)
Measurement location : SKID

Turbidity is the opposite of transparency. Turbidity is high when there is a lot of suspended matter in the water. Suspended matter is often organic matter, which consumes dissolved oxygen and therefore risk asphyxiate aquatic species. They prevents light from passing through the water and reach aquatic plants. What's more, they can act as a carrier for other pollutants.

Escherichia Coli (EC) / Intestinal enterococci (EI)

Unit of measurement : NPP/100mL
Measurement location : Seine

These two bacteria are used as indicators of water quality for bathing. If the readings are too high then there have been polluting discharges has been discharged upstream into the river.

Objectives :
EC = 900 NPP/100mL 90% of the time
EI = 330 NPP/100mL 90% of the time

28 OUTFALL AND WASTEWATER TREATMENT PLANT

A water highway to the “Seine Centre” and “Seine Aval” wastewater treatment plants starts here. This circular structure is one of the five outfalls that transport millions of m3 of water to the facilities in Colombes and Achères, Europe’s largest wastewater treatment plant. It treats wastewater from the equivalent of 5 million Île-de-France residents every day.

29 TO THE WASTEWATER TREATMENT PLANT SEINE AVAL PLANT (ACHÈRES)

WATER COLLECTION ROOMS

1 - Screening : the water passes through a grid that retains larger floating waste (rags, wood, plastic, etc.).
2 - Grit and oil removal : Heavy materials such as sand sink to the bottom of a basin, while fatty materials (oils, greases, hydrocarbons, etc.) rise to the surface where they are scraped off.
3 - Decanting : Suspended matter settles to the bottom of the tank, forming primary sludge, which is then scraped off and treated.
4 - Biologiacal purification : The water, loaded with dissolved organic matter, remains in an aeration tank. Oxygen is injected into this tank to activate the

bacteria that "digest" the pollution. As they agglomerate, they form what is known as biological sludge.
5 - Back to the river : This stage separates the purified water from the residual sludge. The water can then be returned to rivers.

SLUDGE TREATMENT

6 - Digestion : The sludge is kept in closed tanks at a temperature of 35°C. Regularly stirred, and in the absence of oxygen, it undergoes fermentation to stabilise it hygienically and produce biogas.
7 - Dewatering : Dewatering reduces the water content of the sludge and makes it suitable for spreading on agricultural land.
8 - Drying : Drying allows the sludge to be almost completely dehydrated by evaporating the water it contains, producing granules that can be used as agricultural fertiliser and also as fuel.

30 FLUSH TANK

Positioned at the head of an elementary sewer, this tank stores a large quantity of clean non-potable water.

It opens automatically once or twice a year: water makes a dramatic escape, flushing detritus and carrying it in its wake, so cleaning the sewer's drain. Flush tanks are an effective standard method of cleaning out small galleries.

31 FLOATING DAMS

In order to prevent bottles, plastic, wood and other such items being deposited in the river, floating walls, also known as siphon partitions, act as dams: set upright, they float on the surface of the water when the sewer starts discharging, in order to block such waste materials while letting the water through and preventing them from getting into the Seine via the spillway.

32 DISCHARGE BAYS

Located between sewer and spillway, discharge bays limit the frequency and volume of emissions into the Seine. They are usually equipped with valves that enable maximum storage of water in the system in the event of storms.

33 SPILLWAYS

Located between collectors and the Seine, spillways are special galleries that act as the sewerage system's safety valves.

In periods of heavy rainfall, they discharge excess water from saturated systems into the river, so preventing some low-lying areas of Paris from being flooded. These days, quantities of water discharged are strictly limited.

34 THE ALMA SIPHON

The first of Paris' seven siphons, the Alma siphon was commissioned in 1868 to channel wastewater from the Seine's left bank across the river to its right bank and onwards to the Marceau collector.

35 FLOOD PUMPING STATION

There is a flood pumping station behind this wall. In the event of the system becoming overfull, stormwater is evacuated into the Seine by means of pumps. In periods of flooding, it is essential to close spillways in order to avoid saturation due to introduction of wastewater into the river and river water into the system.

Get back to the dry gallery

IV. SEWER HISTORY, FROM YESTERDAY TO TOMORROW

36 BELGRAND'S PREDECESSORS AND SUCCESSORS, THEY TRANSFORMED PARISIAN SANITATION

Pierre-Emmanuel Bruneseau (1751-1819) : Sewer's inspector since 1805, he carries out a topographical survey of the sewers and a complete mapping of the network, the exact layout of wich was previously unknown.

Brunseau is immortalized in Victor Hugo's Les Misérables: an illustration shows him inspecting the sewers of Paris. © CCO Paris Museum/ The Victor Hugo House Paris-Guernesey

Pierre-Simon Girard (1765-1836) : He supervised work on the Ourcq canal from 1802. He was responsible for the first topographical survey of Paris, necessary for water distribution and assessment.

The new Ourcq canal inspires painters. View of the Ourcq canal basin at La Villette, near Paris. Colored etching. CCO Paris Museum/ Carnavalet museum

Alexandre parent du Châtelet (1790-1836) : Hygienist doctor, field investigator, he published on 1824 « Essai sur les cloaques ou égouts de la ville de Paris », proving that infection results from air and water stagnation. He developed a cleaning technique for the Amelot sewer that prevented sewer workers from suffocating. He is also know for is essai about the prostitution in Paris.

Cover of the essay by the medical officer of health, a pioneer in health-related field surveys. © Bibliothèque Nationale de France

Henry-Charles Emmery (1789-1842) : He works to improve the capital's water supply and , 1833, initiated the statistical map of Paris's sewers.

A plate of the statistical map of the sewers of Paris in 1839 executed under the direction of Charles Emmery. © City of Paris/ BHVP

Eugène Belgrand (1810-1878), A new vision of sewers : His name remains inseparable from the sewers of Paris. Eugène Belgrand, a graduate of the Ecole Polytechnique and the Ecole Nationale des Ponts et Chaussées, he developed a passion for hydrology in his first post at Avalon. Chief engineer at the Seine navigation department in Rouen since 1852, he was called in by Prefect Haussmann to bting clean water to Paris. He carried out several spring diversions. « Once the water had been brought in, it had to be distributed and once it had been used, it hadto be discharged into the natural outlet, wich was still the Seine » write the ingeneer Mille, his close collaborator. The Paris subsoil was notvirgin land, already cleared by his predecessors. Director of water and sewers from 1867, Eugène BElgrand build a coherent network of underground galleries, including large gravity collectors, easy to access, hosting other networks. He developed some of the tools essentiel to their operation cleaning equipment –dredger boats and dredger wagon – flushing tanks and desilting basins.

Hydrological map of the Seine basin drawn by Eugène Belgrand and published under the administration of Prefect Haussmann. Paris: Avril frères (1854-1878). © City of Paris/ BHVP

Plate from Volume 5 of Belgrand's Les travaux souterrains de Paris, showing the elements of the wagon system for cleaning a collector. © Sanitation/ City of Paris.

1324 is Eugène Belgrand's registration number at the Ecole Nationale des Ponts et Chaussées. School roll for the year 1831. © Archives of the the Ecole Nationale des Ponts et Chaussées.

The siphon of the left bank collector drawn in Belgrand'sLes travaux souterrains de Paris. © Sanitation/ City of Paris.

Profile plans of the Saint-Denis, Saint-Martin and Ourcq canals drawn by Eugène Belgrand. © City of Paris/ BHVP

Adolphe-Auguste Mille (1812-1894) : He was behind the adoption of the ovoid ewer profile. Director of the sewerage and drainage studies and works department set up in 1865, he wa a strong advocate of agricultural sewage treatment and the introduction of all sewerage.

Alfred Durand-Claye (1841-1888) : His career has been devoted to urban wastewater treatment. He assisted Adolphe Mille on the issue of agricultural irrigation using sewage water, for wich he was an ardent promoter. In 1882 he became head of the new Seine sanitation and sewage irrigation department.

Image taken from the report by Paris city engineers Belgrand, Mille and Durand-Claye on the preliminary design for an irrigation canal to bring sewage water from Clichy to the Achère plain. 1876. © Bibliothèque Nationale de France

Jean-Charles Adolphe Alphand (1817-1891) : Director of works in Paris and creator of the capital's park and gardens, the whole of Paris. He led the battle to build the sewage system.

Print from Alphand's work, illustrated by Emile Hochereau, Les promenades de Paris, published in 1868. © Paris Museum/ Beau Art Museum of Paris, Petit Palais

Adolphe Alphand portrait by Alfred Philippe Roll in 1888. At the time, he was General Works Director for the 1889 Universal Exhibition. © Paris Museum/ Beau Art Museum of Paris, Petit Palais

Georges Beshman (1848-1927) : Director of the sewer and sanitation service since 1888, he leads the construction of the Paris main drainage system and he modernizes the sanitation network: construction of Colombes and Pierrelaye stations, construction of the outfall towards Achères. He increases the sewage fields's surface area.

André Edmond Loewy (1872-1957) : He was in charge of the municipal department responsible for studies and sewerage works on the Seine from 1900, directing major sewerage works to enable the expansion of agricultural spreading. He was responsible for expanding the Colombe xaterworks.

Delegation visit in july 1901, three weeks before commissioning of Hall B at the Colombs elevator plant, carried out under the direction o fLoewy. © Memory of Sanitation – SIAAP

Pierre Koch (1895-1970) : His work on wastewater treatment and the protection of the natural environment made its mark in the 1930's, when he was head of the Seine sewerage authority, in particular his method of calculating the dimensions of sewerage networks and volumes of rainwater. Subsequently technical director of water and sanitation, he played a leading role in the general sanitation programme for the Paris region in the years following the Second World War.

Construction of the Achère aqueduct between 1893 and 1895. Above : Achères agricultural park main pipe. Right : scaffolding at the Colombes plant. Photographs of the Seine prefecture, Sanitation department © Paris, town hall library

37 BEFORE

There were very few sewers in Paris before the Revolution, or in most European cities.

Rainwater and dirty water flowed across their roads, forming muddy, stagnant pools. Water consumption in households was limited to a few litres a day per person, drawn from wells (there were around 25,000 of them in Paris) or the Seine. Urine and excrement were collected in cesspits, tanks installed beneath houses and connected to dry latrines. The matter removed from them every three to fifteen years, depending on pit, was stored for several years in order to turn it into fertiliser known as "*poudrette*", much sought after by the farmers in the surrounding area.

Sanitation has long been a recurrent concern for city officials. Ever since the Middle Ages, numerous texts have been issued governing urban activities with a view to limiting harmful effects on inhabitants. Such concern increased in the 18th century as it became clear how vulnerable Parisians were to a whole range of diseases. Referring to Hippocrates, physicians explained that city air, soil and water were corrupt. The situation was worsened by the presence of cemeteries, workshops handling organic matter in city centres, and the slaughtering of meat animals. Physicians, chemists, pharmacists and scholars campaigned for far-reaching changes to be made to the city: and so it was that hygiene came into being.

38 SQUALOR AND CONGESTION

In the 18th century, Paris was constantly afflicted with diseases and recorded dramatic mortality rates.

They were the highest in France. What were they due to?

Corrupted air caused by emanations from the ground and industrial activities, and the population's ever-increasing susceptibility, the city's medical officers explained. After the revolutionary period, First Consul Bonaparte launched major work on beautifying Paris.

Despite the revolutions and wars, and the 1832 and 1839 cholera epidemics, the capital's population grew from 500,000 to 1 million inhabitants between 1801 and 1851.

Scene of port life in the heart of Paris: Port Saint-Nicolas, the future Pont du Louvre, was a hive of activity. A wide variety of goods transited through it.

Jean-auguste gagnery le port saint-nicolas. oil on canvas, 1834. cc0 paris musées / musée Carnavalet.

LATE 18th > MID-19th CENTURY

"Paris is a great workshop of putrefaction, where squalor, plague and disease work in concert, where air and sunlight scarcely penetrate."

Victor considerant. Considérations sociales sur l'architectonique (social considerations on architecture). 1834, les librairies du palais-royal.

Shoeblacks helped Parisians cross streets turned into swamps or streams by the rain, either by laying planks or carrying them on their backs for a fee.

Le passage du ruisseau un jour d'orage (crossing the stream on a stormy day), after garnier, 19th century. © roger-viollet

1792 : Creation of the function of hydraulic engineer responsible for overseeing distribution of Paris' public water
1802 : Bonaparte decides to use the River Ourcq's waters to supply Paris
1806 : Paris' sanitation department is put into the hands of its Bridge and Road engineers
1821 : The River Ourcq's waters supply Paris via the La Villette Basin
1829 : Foundation of the Annals of Public Hygiene and Legal Medicine, by Darcet, Villermé and Parent du Châtelet
1834 : First public urinals, also known as "*rambuteaux*" from the name of the Seine Prefect, Claude-Philibert, Count of Rambuteau
1848 : 2000 hydrants in operation
1849 : Closure of the "Voirie de Montfaucon", Paris' main waste storage facility

39 "DEBATES"
CHOLERA: FINISHING WITH THE PARIS CESSPOOL

The 1832 cholera epidemic claimed 18,000 lives, the majority of them in working-class neighbourhoods. In view of this terrible toll, combating the city's abnormally high death rate became a priority. The blame was put on the "miasmas" that stagnated in the garbage-filled streets, as well as on the living conditions of poverty-stricken inhabitants crowded together in filthy tenements.

There was a public outcry against the disgusting stenches that arose when cesspits were emptied. Great remedies for great ills: engineers, physicians, chemists and civil servants joined forces to swell the ranks of the hygienist movement, prescribing such measures as waterproofing surfaces, ensuring circulation of air, flushing the streets and evacuating dirty water into the sewer.

A great many Parisians drank poor quality, sometimes even unsafe water, as cesspits and wastewater discharged into the street and the Seine infected groundwater and wells. The role played by water in the spread of epidemics was seldom highlighted. Excess death rates were over 36% in towns as against just under 24% in rural areas between 1816 and 1826.

40 AT HOME
WATER AND GAS, A PRIVILEGE

Before 1850, only 20% of Parisian buildings subscribed to water supply services and gas was still only used to provide the city's meagre street lighting. Despite supply problems, bathhouses developed (there were 101 in 1839), providing their services onsite or at home, using water from the Ourcq and the Seine.

Provisioning themselves at public fountains, water carriers supplied Parisians' homes.

Porteur d'eau (Water Carrier), John James Chalon (1778-1854). CC0 PARIS MUSÉES / MUSÉE CARNAVALET

Copper fountain. Kitchen interior known "La servante tirant de l'eau" (Servant Drawing Water), by François Bonvin (1817-1887). PARIS, MUSÉE D'ORSAY. © ROGER-VIOLLET

Mostly from Auvergne, water carriers started out by transporting their wares in tin buckets, eventually gravitating to carts loaded with barrels, in particular to supply baths in private houses.

Tableaux de paris, number 57 : les bains à domicile (baths at home). Engraving. Cc0 paris musées / musée carnavalet

A hundred or more bathhouses were well established in Paris circa 1840. © BIBLIOTHÈQUE NATIONALE DE France

41 OUTSIDE THE MODERN ROADWAY

The first crowned roadways made their appearance in 1833, with pavements and gutters running along either side (instead of a single trough), some of them asphalted. Water from over a thousand hydrants was discharged onto the city's roadways twice a day for an hour, driving waste matter into drains located at low points in gutters. In 1840, in addition to these fountains dedicated to cleaning the capital's streets, household uses and supplying pumps in the event of fires breaking out, Paris accommodated 16 monumental fountains and 84 ordinary fountains; in 1844, Prefect Rambuteau began providing its thoroughfares with enamelled street signs.

Two sections of elementary sewer: the first runs beneath a paved street where the trough (the gutter) is in the centre of the road, and the second runs beneath rue Saint-Antoine, which has gutters alongside its pavements.

Porteurs d'eau à la fontaine (Water Carriers at the Fountain). © C. BOUFFETEAU – PARIS TOWN HALL

Residual water flows into Paris' lower levels through a grating. ENGRAVING, 19th CENTURY. © ROGER-VIOLLET

The number of kilometres of asphalt pavements increased from 16 to 275 between 1833 and 1848.

Frédéric Bouchot (1798-?). les trottoirs en bitume... (asphalt pavements) no.3 in the "album les embellissements de paris". hand-coloured lithographhighlighted with gum arabic. 1844. cc0 paris musées / musée carnavalet

Fountain and urinal in rue de Rivoli, Paris, Jean-Marie Amelin. WATERCOLOUR AND INK. PARIS, 15 AUGUST 1852. CITY OF PARIS / BHVP

Rambuteau, who became Seine Prefect in 1833, made public hygiene a top priority: new streets were built and old ones widened, pavements were added and hydrants and urinals installed.

42 BENEATH THE CITY
THE SYSTEM TAKES SHAPE

Starting in 1833, under the aegis of the engineer Pierre-Simon and his successor Henri-Charles Emmery, head of the city's water authority, the first rational sewer system began to take shape. It was designed to recover stormwater and water used for cleaning the streets, both essential to the sewers' operation. Adoption of curved bottoms made of millstone and cement and galleries high enough for sewer workers to make their way through them upright made work less arduous and facilitated maintenance.

The sewerman became a figure familiar to Parisians and made regular appearances in the caricatures of the time.

Actualités numéro 100. Cc0 paris musées / musée carnavalet

Flushing the gutter with running water, collection and retrieval of rags, Paris cleans itself up in the early morning.

Scenes and Customs of Paris: Paris awakens. CC0 PARIS MUSÉES / MUSÉE CARNAVALET

1800 : 16 km of sewers for 550,000 inhabitants
1824 : 37 km of underground vaulted sewers
1848 : 96 km of sewers for almost a million Parisians.

43 "DEBATES"
PARISIANS, FERTILISER RESERVOIRS

Debate on management of urine and excrement was both sanitary and agricultural. One faction recommended discharging human urine and excrement into the Seine.

The other, larger faction advocated their agricultural reuse at a time when the need for fertilisers was on the increase. As a result, there was greater control of cesspits and emptying operations. A good many investors and industrialists filed patent applications with the aim of producing human fertilisers. In this respect, Paris became a laboratory for innovation.

The countryside demanded more urban excreta !

Topographical, historical and industrial description of Montfaucon by M. Perrot, engineer in Rouen. 1840. © BIBLIOTHÈQUE NATIONALE DE FRANCE

House with a cesspit located near a well. © VILLE DE PARIS / BHVP

Paris' only waste disposal facility on the eve of the Revolution, the Montfaucon site was located near the former gibbet, a notorious place of execution. The "*voirie*", as garbage deposit sites were known, was a huge pit for reception of the contents of Parisian cesspits. It was also flanked by a knacker's yard. The *voirie* was transferred to Bondy following its closure in 1849.

44 ELSEWHERE

Water closets (WCs) made their first appearance in London in 1810, initially connected to cesspits and then to the sewers from 1830 onwards.

At the time, a third of London's houses were supplied with water on their upper floors.

Following the elimination of cesspits in 1847, their untreated contents were discharged into the Thames.

45 TOWARDS MODERN COMFORT

Water arrives in homes! There were more than 67,000 subscribers in 1889. Luxury townhouses and apartments now included bathrooms, English-style toilets and other amenities at the service of comfort and hygiene. The working-class population still lived in slum conditions that did not include water. Under the Second Empire, between 1852 and 1870, Paris underwent a facelift under the aegis of Baron Haussmann, with creation of boulevards and spacious squares, and universalisation of pavements. Its population increased from 1.1 million to 1.7 million following the annexation of suburban municipalities in 1860. All available means were used to produce fertilisers and landfarming was tested out.

MID-19TH CENTURY > 1910

"I can confirm that the Municipal Council will vote all the funds required to ensure that sewers are constantly washed and cleaned like the courtyard of a well-kept house."

E. Deligny, chairman of the water and sewers committee, 1881.

The first Wallace Fountain was installed in Paris in 1872. André Gill A Wallace Fountain. CC0 PARIS MUSÉES / MUSÉE CARNAVALET

Map of the Seine département showing Paris' new city limits from 1860 onwards. CCO PARIS MUSÉES / MUSÉE CARNAVALET

The avenue leading to Place de l'Opéra, symbol of the new Paris designed by Baron Haussmann. CAMILLE PISSARRO, AVENUE DE L'OPÉRA, 1898, MUSÉE DES BEAUX-ARTS DE REIMS © ROGER-VIOLLET

"Today, the sewer is clean, cold, straight, correct....
It is proper and greyish, laid out by rule and line; one might almost say as though it came out of a bandbox.
It resembles a tradesman who has become a Councillor of State.
One can almost see distinctly there. The mire there comports itself with decency."

Victor Hugo, complete works.

1852 : Obligation to discharge stormwater and greywater (dirty water from buildings) into the sewers, except for urine

1859 : Responsibility for public hygiene is transferred from the Police Prefecture to the Seine Prefecture
1861 : Commissioning of the collector in Asnières
1867 : Inauguration of public tours of the sewers / Construction of the metal double siphon at Pont de l'Alma in Seine, connecting the left bank to the right bank / Eugène Belgrand, Director of Engineering of the Waters and Sewers of Paris
1876 : First water meters in the capital
1880 : Odour crisis - Paris stinks!
1884 : Cholera epidemic
1894 : Sewage laws

46 "DEBATE"
MICROBES, THEY'RE THE REAL ENEMY!

One epidemic after another (cholera returned in 1884), foul-smelling odours (The stenches in Paris became unbearable between 1880 and 1882), contamination of the Seine and increase in quantities of domestic greywater: hygiene and cleanliness were still major concerns. Stagnant air and miasmas were no longer held to blame: the microbe was deemed to be responsible for all evils after Pasteur proved the microbial origin of contagious diseases.

MARCEL ROUX. FEMME ET MONSTRE (WOMAN AND MONSTER). ENGRAVING, 1908. BnF. © ROGER-VIOLLET

Smallpox, measles and whooping cough all struck the capital in 1882. Mortality was the highest in neighbourhoods consuming water from the Ourcq. Cholera returned in 1884 and 1892. Airborne transmission was blamed once again.

Albert Robida, La lute contre le microbe, in le 20è siècle La vie électrique, 1883 Roger-Viollet

47 AT HOME
LEARNING TO USE WATER AT HOME

There were ever increasing number of happy subscribers to piped water supplies – 20,273 in 1861 and 67,800 in 1889- and affluent Parisian apartments made room for bathtubs, lavatories and the new "English" flush toilets, along with the various newly available models of washbasins and sinks.

Gas began to climb the stairs in 1859. Working-class tenements did not have water or gas available on all their floors, and evacuation of dirty water was carried out via "*plombs*", troughs set in their landings. In 1858, only 1,324 Parisian houses out of around 30,000 were connected to the sewers.

Model of a section of a Paris boulevard with its sewers and water and gas pipes: drawing by Broux after the relief model exhibited in the City of Paris Pavilion in 1878-1880. D.R.

Greywater from houses was increasingly collected by the sewers: the Decree of 26 March 1852 provided that "*All new construction in a street provided with a sewer must*

be positioned in such a way as to enable stormwater and greywater to be discharged into it underground".

In 1850, Parisians took an average of three or four baths a year.

The first bathrooms, with bathtub and bidet, were installed circa 1880, and indoor WCs as from 1885.

Cesspit emptying transport in the streets of Paris at 4 o'clock in the morning. PRIVATE COLLECTION

Advertisement for a cesspit emptying firm. © ROGER-VIOLLET

Interior of a working-class home, rue de Romainville, Paris. 1910. PHOTOGRAPH BY EUGÈNE ATGET. CC0 PARIS MUSÉES / MUSÉE CARNAVALET

Sanitary ware. Catalogue circa 1900. © CITY OF PARIS / BHVP

Bathroom, late 19th century. © LÉOPOLD MERCIER / ROGER-VIOLLET

48 OUTDOORS
NEW ROADS HELPING INHABITANTS BREATHE MORE EASILY

In order to ensure a permanent supply of pure water, Eugène Belgrand, who was responsible for the Paris Water Authority at the time, created a series of spring water catchments that provided the capital with potable water from 1865 onwards. This network transited via the sewers, along with the system supplying non-potable water for watering parks and gardens and washing streets. Over 200 kilometres of new roads were built under the Second Empire. In addition to the consequent reorganisation of city traffic and movement, they served to ventilate and dry out Paris. And thanks to early experiments with asphalting, surfaces were gradually becoming more impermeable.

Construction of the Montrouge reservoirs in 1873. © AUGUSTE-HIPPOLYTE COLLARD/ CITY OF PARIS / BHVP

Sewer work in rue de la Bûcherie, Paris, in 1889. © HENRI GODEFROY /CITY OF PARIS / BHVP

The Palais-Royal station on Paris' first metro line in August 1899, under construction on the site of the former Rivoli sewer. © CHARLES MAINDRON / CITY OF PARIS / BHDV right: Spreading asphalt on a pavement. Paris, 1908. © JACQUES BOYER/ROGER-VIOLLET

One consequence of the development of tarmacadam roads was that large quantities of grit and pebbles were swept into the sewers, too much, in fact, to be naturally carried away by the water. The solution? The cleaning system devised by Eugène Belgrand, with mechanical flushing performed by valves carried on rails or suspended from boats.

49 BENEATH THE CITY
DISCHARGING WASTE OUTSIDE PARIS

A combined sewer system for gravitational collection of greywater and runoff water (the water flowed down the slope with no need for pumping) was created: from 1858 onwards, collectors discharged dirty water from Clichy's outfall sewer. Sewers

were still evacuated into the Seine but outside Paris. The height of their galleries enabled sewer workers to move through them easily and public tours to be organised following the opening of the 1867 Universal Exhibition. The Seine Prefecture, which had been responsible for public hygiene since 1859, expanded its technical services. After the terrible odour crisis, appropriations allocated to sewer maintenance doubled between 1882 and 1884 and the number of sewer workers increased from 800 to 900. With the mains drainage system, the network collected all wastewater the city produced.

Underground Paris became a vast utility gallery: water flowed through the sewers and some of the city's mail transited alongside it. Pipes carrying potable water, non-potable water and compressed air ran through them, followed by the pneumatic mail system. Paris now had pavements on the surface and underground. Footways enabled sewer workers to move from place to place for maintenance purposes, cleaning operations in particular. An ovoid profile was adopted for elementary sewers in 1855 at Adolphe Mille's suggestion.

"Everybody knows them and has seen squads of them passing by, brooms on their shoulders and heavy boots on their feet".

MAXIME DU CAMP, PARIS, VOL 5

The Paris sewer system designed by Belgrand connected elementary sewers from houses to secondary collectors that flowed into main collectors.

Construction of the Achères aqueduct between 1893 and 1895. Seine Prefecture, Sanitation Department. © CITY OF PARIS / BHDV

Laying metal siphons connecting the Alma collector to the right bank. © ALBERT HARLINGUE / ROGER-VIOLLET

Postcard circa 1900. © ROGER-VIOLLET

Collector at Boulevard Sébastopol and corner of rue de Rivoli, circa 1900. © NEURDEIN / ROGER-VIOLLET

LE DESSUS ET LE DESSOUS DE PARIS (PARIS ABOVE AND BELOW). EDOUARD RENARD. CC0 PARIS MUSÉES / MUSÉE CARNAVALET

- 1,938 hydrants and 111 fountains, including 29 monumental works, in 1854. 1.7 million Parisians following annexation of suburban municipalities in 1860, on a surface area of 7,100 hectares.
- Length of sewers : 150 kilometres in 1855 ; 1,240 in 1914. Percentage of buildings connected to the sewer system in 1914 : 68%.
- Water distributed : 100,000 m^3/day in 1860 ; 950,000 m^3/day in 1914.
- 627 sewer workers in 1873, 900 in 1884.
- Total length of Paris streets and public conduits in 1878 : 865,863 and 1,431,000 metres.
- 50,000 m^3 of wastewater per hectare per year watered the 422 hectares of sewage farms in Gennevilliers en 1880.

50 “DEBATES”
MAINS DRAINAGE, ENGINEERS VERSUS EVERYONE ELSE

Standing firm against physicians, cesspit emptying companies and property owners, the engineers upheld the cause of the main drainage system: connecting toilets to sewers would put an end to emptying operations, a step forward indissociable from landfarming: if farmland was irrigated with wastewater, production would increase. After lengthy debate and lively opposition from physicians, who highlighted the health risks involved, the law on mains drainage was finally passed in 1894. Pasteur was at the forefront of the opposition, fearing microbial propagation. With the mains drainage system, the network became a single entity: thenceforth it received all wastewater and stormwater. Previously, solid matter had been transported to dumpsites known as “*voiries*”.

La Nymphe de la Seine. Albert Robida illustrates river pollution in his 1883 science-fiction novel Le Vingtième siècle-La Vie électrique (The Twentieth Century – The Electric Life). © ROGER-VIOLLET

51 “DEBATES”
WASTEWATER FOR VEGETABLES?

Agricultural irrigation was the priority focus of the new department of studies and works on sewers and sanitation, headed by Adolphe-Auguste Mille. Feeding the country was a major issue and fertiliser production made all the difference. Agricultural irrigation came into its own in 1869 and landfarming began to develop in Gennevilliers (422 hectares in 1880) and then in Achères (800 hectares in 1889) and Carrières-Triel (700 hectares in 1889). Yields of some crops increased dramatically as a result.

Postcard of the model garden in Asnières. Created in 1869 in the hamlet of Grésillons in order to uphold the cause of sanitation, it attracted a great many visitors who were curious about the new crop irrigation technique © MÉMOIRE DE L’ASSAINISSEMENT - SIAAP

52 ELSEWHERE

After the Great Stink that overwhelmed London in 1858, modernisation of the city’s sewer system began the following year.

Berlin had 775 kilometres of sewers in 1896 and 1,100 hectares of sewage farms.

53 FROM 1910 TO LATE 1960’s
THE PARIS-SUBURBS MARRIAGE

There were changes in the demographic maps of Paris and its suburbs: the capital's population reached a peak in the 1920s, with almost 2.9 million inhabitants, and then started to decrease.

Driven away by the scarcity of housing and high rents, many Parisians moved to estates in the suburbs, often not yet connected to distribution and evacuation networks. The situation of those "badly done by" by the suburban system only improved very gradually. Seine and Seine-et-Oise disappeared administratively speaking on 1 January 1968 to the advantage of 8 *départements* including Paris

"Today, the 'tentacular city' encompasses the working-class towns of Lilas and Drancy; it has its airport at Le Bourget, its imposing power plant and finally modern port at Gennevilliers..."

Guide bleu, 1937 edition

Old houses in Sarcelles in 1963, near large new housing estates. © ROGER-VIOLLET

"Mr Sewerman, in your opinion, how many Parisians have troubled consciences? Your estate's where they throw all the parings and refuse of their lives."

La folle de chaillot (the madwoman of chaillot). Play by jean giraudoux, first performed in december 1945.

1914-1918 : The scarcity of coal during the First World War slowed down the operation of pumping stations and partially prevented wastewater from being transported to sewage farms. Some of it was therefore discharged into the Seine.

1939-1945 : Several of Paris' collectors and sections of its sewers were damaged by bombing during Second World War, in particular in the air raids of April 1944.

During the Paris Insurrection on 19 August, the command post headed by Henri Rol-Tanguy, leader of the Ile-de-France French Forces of the Interior (FFI), was located at 9 rue Schoelcher, in a building owned by the City of Paris' Water and Sewer Authority.

The following day, Rol-Tanguy made his way to the Water Authority's passive defence shelter beneath Place Denfert-Rochereau, which was connected to a number of the capital's sewer stations by an independent telephone network.

Transmission scheme in the event of an alert.

Document from the Technical Directorate of Water and Sanitation, January 1943. STEA ARCHIVES

1910 : The Seine's Great Flood of Paris and its suburbs

1911 : Paris falls victim to drought

1918 : New status for sewer workers, who can now retire at the age of 50 after 20 years' service

1923 : Experiments with biological purification using activated sludge

1924 : New flood of Paris and decision to create four reservoir dams

1929 : The Greater Paris Region Sanitation Programme is designed to cover the Paris river basin

1940 : Completion of the first tranche of the Achères project, a single wastewater treatment plant for four collectors, built on former sewage farms.
1954 : Inauguration of the Sèvre-Achères outfall, which reduced discharge into the Seine at Clichy and enabled connection of several suburban municipalities.
1964 : Law on water and creation of water boards
1968 : The General Sanitation Plan is designed to eliminate the major disparities between the centre of the conurbation and its outskirts, which were rapidly becoming urbanised.

54 "DEBATES"
GREATER PARIS AND ITS SANITATION

The 1911 Greater Paris Region Sanitation Programme provided for three wastewater treatment sites.

In 1929, the decision was made to construct a major purification facility in Achères. As from 1927, treatment of wastewater from Paris and is suburban municipalities was the responsibility of a single entity, the *Section des Grands Travaux d'Assainissement*. Cooperation between *départements* was finally underway after decades of protests from suburban mayors against Paris' waste being sent to their municipalities, along with location of dangerously pollutant industries and cemeteries.

The Greater Paris Region Sanitation Programme provided for three purification sites. In 1929, the decision was made to build a huge single plant in Achères comprising 24 sections in all with a total capacity of 2,700,000 m3.

Construction of aeration tanks for the first tranche of the Achères wastewater treatment plant in 1940. © MÉMOIRE DE L'ASSAINISSEMENT – SIAAP

Map of the département of Seine: general sanitation, order of urgency of work. 1930. © PARIS, CITY HALL LIBRARY

55 AT HOME
ONE MORE STEP TOWARDS COMFORT

The great majority of Parisian buildings were now connected to the mains drainage system.

However, the suburbs were not nearly so well served up until the late 1950s: there were scarcely 258 km of municipal sewers in 1926 and less than half of Seine's municipalities were connected to the mains drainage system in 1955. Nonetheless, Paris and its suburbs were equally behind the times as far as their indoor facilities were concerned: in the early 1960s, 45% of homes had no toilets and two out of three had no showers or bathtubs.

With the creation of large-scale housing estates such as Sarcelles in the 1950s, and then of such new towns as Cergy-Pontoise twenty years later, apartments outside the capital were equipped with all the latest mod cons. In Paris and its suburbs alike, water consumption soared in the 1960s. Turning on the tap became an altogether natural action.

"In the last fifteen years, we have constructed 750,000 housing units in the Paris region, representing a total of 2,500,000 inhabitants housed or rehoused in new buildings."

GEORGES POMPIDOU, PRIME MINISTER, SPEECH TO THE NATIONAL ASSEMBLY, 18 JUNE 1965

Water point on the landing of a Paris building in 1946. © AKG-IMAGES / DENISE BELLON

Drinking-water tap in the courtyard of a building in Paris circa 1960, located under the former non-potable Seine water points. © COLL. PERRIN/KHARBINE-TAPABOR

1950s : school panel explaining how to use the toilet © IMAGERIE ROSSIGNOL/ KHARBINE-TAPABOR

56 OUTSIDE THE MODERNISED ROAD SYSTEM

Paris modernised its roadways and extended and improved its urban heating system, telephone, electricity and gas networks and mains drainage system. In addition to potable and non-potable water networks, the sewers' utility galleries accommodated the telephone network (since 1882) and the pneumatic mail system. Asphalt, which helped render surfaces impermeable, really came into its own in the post-war period even though it had been used to surface roads ever since the first appearance of the automobile.

It was applied to the first section of the ring road inaugurated in 1960.

The non-potable water system's final conduits were laid in 1920. The network is devoted to public usages: cleaning sewers and roads, and watering parks and gardens.

City of Paris watering and roadsweeping machines in front of the Town Hall, 29 February 1920. © EXCELSIOR – L'EQUIPE / ROGER-VIOLLET

Road sweeper on Boulevard Saint-Michel circa 1960. © ROGER-VIOLLET

The Porte de Bagnolet junction on the Paris ring road in 1969. Work on the ring road started in 1956 and was completed in 1973. © ROGER-VIOLLET

57 BENEATH THE CITY ACHÈRES, THE WORLD'S SECOND LARGEST WASTEWATER TREATMENT PLANT

Sanitation became a *départemental* affair in the 1930s, and the principle of a single treatment plant, in Achères, adopted. It was commissioned in several stages, starting in 1940, treating 43.5 million m3/year in 1954 and more than twice

as much in 1967 after the second section was opened. It was the world's second largest such facility, after the Chicago plant.

However, it still operated under capacity due to the increase in quantities requiring treatment and the fact that the Seine's water quality had continued to deteriorate.

View of shaft 27 downstream. © JC BOLLIER / SERVICE DES GRAND TRAVAUX D'ASSAINISSEMENT ARCHIVES.

Right : Ground plan of the Achères wastewater treatment plant in 1968, before start of construction of the third section, between 1969 and 1971. © MÉMOIRE DE L'ASSAINISSEMENT - SIAAP

Sewer workers on the job, first responders in the wastewater conduit to the treatment plant. © ALL RIGHTS RESERVED

Right : Pollution of the Seine in July 1964, dead fish floating on the river in Paris. The Act of 16 December 1964 on management and distribution of water resources also aimed to combat pollution. © ROGER-VIOLLET

- **1958** : Nearing the end of construction of the third section of the northeast outfall, located between Vincennes Floral Park and the Clichy plant.
- **1931** : Almost 90% of Paris households are connected to the sewer system
- **Between 1910 and 1966**, treatment capacities increase from 620,000 m3/day to 1,110,000 m3/day.
- **Between 1920 and 1970**, the percentage of Paris wastewater treated increases from 34% to 43%
- Surface areas given over to sewage farms continues to decrease **after 1909**.
- They occupy 4,500 hectares in **1949** and 4,040 hectares in **1968** before being halved over the course of the following decades.
- **Between 1910 and 1967**, water consumption in Paris increases from 265 litres/inhabitant/day to 450 litres/inhabitant/day

58 "DEBATES"
SEWAGE FARMS IN DECLINE

In 1948, one tenth of the vegetables sold at Les Halles in Paris came from sewage farms. However, the procedure was no longer as popular as it had been: there was too much wastewater given the surface area concerned and supplies did not take the seasonal nature of irrigation into account. Biological purification seemed better suited to the situation, while new industrial fertilisers helped increase crop yields and competed with urban fertilisers. With suburbs becoming ever more densely populated, increasingly less space was given over to sewage farms, much to the displeasure of their defenders, who stressed their interest as far as household needs were concerned, as, for example, shopping baskets could be filled with leeks at affordable prices even in periods of frost.

1952 : maize crops irrigated by raw water and activated sludge, at the Experimental Centre in Colombes. © MÉMOIRE DE L'ASSAINISSEMENT - SIAAP

59 "DEBATE"

WHAT DO YOU DO ABOUT WATER SHORTAGES IN SUMMER AND FLOODS IN WINTER?

The flood of January 1910 was of unusual magnitude and brought daily life in Paris and its suburbs to a halt.

The drought of 1911 went to show that water was a rare resource. The “two in one” solution of reservoir dams was put forward with a view to ensuring water supplies in summer as well as containing floods in winter by storing water when it was plentiful and caused floods. The 1924 flood, which also caused a great deal of damage, put the project high on the agenda. The first three reservoirs were commissioned in the 1930s, upstream of Paris, arousing hostility in their host *départements*, due in particular to expropriations.

A 100-year flood, such as the one in 1910, is defined in terms of probabilities: a one in a hundred likelihood of its occurrence each year. It may not happen for two centuries or take place several times in a single century.

1911, a year of drought: the Marne runs dry in Château-Thierry. POSTCARD. PRIVATE COLLECTION

Above : Household waste discharged into the Seine, upstream of the Auteuil viaduct, during the flood of January 1910. © UB/ROGER-VIOLLET

Rue de l’Université swamped by water in January 1910. © MAURICE-LOUIS BRANGER / BHVP

60 ELSEWHERE

Chicago’s wastewater treatment plant broke all records in 1927, with a treatment capacity of 660,000 m3/day. It became the world’s biggest facility.

In 1953, Switzerland adopted an article on protection of water against pollution: thenceforth, federal law required that all Swiss cantons treat their polluted waters.

The River Senne was covered over and diverted in Brussels between 1931 and 1955.

Flowing through the city centre underground, the river is visible from the sewers. The first covering work started in 1867 and resulted in the disappearance of several of the Belgian capital’s neighbourhoods.

61 1970 TO 2020
PROTECTING HEALTH, WATER RESOURCES AND BIODIVERSITY

900,000 people left the capital between 1968 and 1975; departures slowed down during the following decade, only to pick up again in the 2010s. In 2015, Ile-de-France had 12 million inhabitants including 2.2 million Parisians. Although discomfort is largely a thing of the past in the region’s housing, pollution (including noise pollution), urban expansion at the expense of nature, and climate

change have made the environmental question a major concern. In the 21st century, it is no longer just a matter of protecting health and water resources, but of doing more to protect aquatic biodiversity and ecosystems. Climate change contributes to the depletion and degradation of water resources that are essential to quality of life.

"There are more and more people these days who adopt incredible animals and then, when they've had enough of them, bam! into the sewers they go! When I saw the piranhas and felt their first bites, a wave of terror swept through me".
TRUISMES, MARIE DARRIEUSECQ, PARIS, POL, 1996.

Two views of the Clichy Batignolles-Martin Luther King Park in 2016.
Left : misters at the public's disposal.
Right : the biotope pond, a 300-m² body of water supplied with non-potable water and rainwater, which purifies water naturally by sedimentation and filtering by plants. © JEAN-BAPTISTE GURLIAT / PARIS TOWN HALL. © PAUL LE COART / PARIS REGION INSTITUTE

1968 : 5 new wastewater treatment plants as part of the new General Sanitation Plan
1970 : Creation of SIAAP, the *Syndicat Interdépartemental pour l'Assainissement de l'Agglomération Parisienne* (Greater Paris Sanitation Authority)
1971 : Creation of the Ministry of the Environment
1976 : Noisy-le-Grand plant
1987 : Valenton plant: water from the southeast avoids Paris
1990 : Programme for modernisation of the Paris drainage system
1991 : EU Urban Wastewater Treatment Directive (UWWTD), creating an obligation to treat wastewater.
2000 : EU Water Framework Directive (WFD) 2000 imposing restoration of waterways' good ecological state
2001 : Prohibition of the marketing of market-garden crops from sewage farms
2006 : Lax on water and aquatic environments
2009 : Inauguration of the Ivry-Masséna stormwater storage tunnel, the TMA
2010 : Project for "reconquest of the banks of the Seine"
2017 : Opening of the Bassin de la Villette swimming pool

62 "DEBATES"
POTABLE WATER: A RESOURCE IN ONGOING NEED OF PROTECTION

Half of the potable water consumed in Paris comes from the Seine and the Marne and the other half from underground water from natural sources. It is drawn up to 150 km and more from the capital. After transport and treatment, it is stored in 5 reservoirs. Controlled an average of 10 times between source and tap, its quality is considered excellent. Although water consumption in the Paris region started to decrease in the 1990s, it is still a precious commodity, protected thanks to controlled sampling and reinforcement of measures to prevent leaks.

Montsouris, which is one of Paris' five main reservoirs, supplies 20% of Parisians with water. It stores water from the Vanne in Fontvannes in Aube and from the Fontainebleau region in Seine-et-Marne, collected via the Vanne and

Diagram of Paris water supply, indicating capture capacities for underground water and surface water, supply areas and treatment facilities. © EAU DE PARIS.

Loing aqueducts and the Arcueil and Cachan aqueducts south of Paris. ©ARNAUD BOUISSOU / MEDDE POUR EAU DE PARIS

63 "DEBATES" FROM CENTRALIZATION TO DECENTRALIZATION

Following the era of the unique plant in Achères, à new water treatment plan is set up in the years 1970s. Five new facilities now support the original Achères treatment plant while the later still remains the main and most important installation. With new generation water treatment plants gore online, the capacity and performances in water treatment grow rapidly : Seine Amont (Valenton, 1987), Seine Centre (Colombes, 1998), Seine Grésillons (Triel-sur-Seine, 2007), Seine Morée (Le-Blanc-Mesnil, 2013) and the modernization of the original Seine Aval facility (Achères)/

Waste Water reclamation allows for the production of energy « Biogas production provides 70% of the energy needs of the Seine Aval facility
This renewable energy is extracted from the sewage sludge. Through a process called methanization, organic matter from the sludge is decompozed by micro-organisms in an oxygen- free environment, which produces biogas

Valenton water treatment plant in 1992, one of the three facilities administered by the SSIAP for the processing of Parisian waste water. © LILY FRANEY/GAMMA RAPHO

Biogas is staredin tanks at the Valenton's Seine Amont facility prior toit reuse in powering the treatment plan.

Schematic of the sewage sludge treatment plant at the Seine Amont facility

64 AT HOME
DOMESTIC SANITARY EQUIPMENT AND WASTAGE

In 1982, 21% of Parisians accomodations are still unequipped with bathrooms and water closet. It took until the years 2010s to address this issue and lower that number to less than 1% (INSEE Data - 2073).

With everyone having access to sanitary facilities, awareness rises regarding water wastage, New water efficient equipment make their way in houses, such as modern washing machine and dishwasher, dual-flush toilets, water-saving shower heads, and tap aerators that limit water flow.

À Parisian uses up an average of 120 liters of water per day of which 60% is used for hygiene and toilets alone, and 1% only for drinking.

A full bathtub amounts to around 150 liters of water, the equivalent of à 5 minute shower with a regular shower head. Using water-saving showerhead halves that consumption, *From the serie “Pauline et Pierre", 1999 etc*
Awarèness campaign against water wastage. EAU DE PARIS. 2012

65 OUTSIDE
“WORKING TOWARDS A MORE PERMEABLE AND NATURE ORIENTED CITY”

In the years 1970s, the landscape from the Seine riverbanks started to change when it was made accessible to pedestrian inside the Capital city. The renaturation of the Marne river' last loop restores îts flow, layout and riverbanks to à state close to its original, natural form. As à result, fish fauna can roam freely and aquatic biodiversity rises. Several sections of the Bièvres river are uncovered with the purpose to reconcile the needs of the sanitation network and Îts ecological, recreative and transportation purposes.

Streets in the 21st century cannot do without plants which allow another way to get water to seep into the ground without overloading the sanitation network. Soils act as sponges and the city allows à bigger place to nature. However, aquatic environment remain very delicate hence the need for both collective and individual vigilance in order to safeguard this precarious balance.

In order to let rainwater seep into the ground, Parisian paved roads are back in fashion. Other option, the draining roadway. This alternative has à reservoir structure that allows for temporary storage of water before it can be evacuated through seepage or towards a specific collection network.

Seeping water into City soils diminishes rainwater run-off and thus the risk of downsteam flooding and pollution during heavy rains.

In the years 1970s, fish variety is down to 3 different species only. Fishers and bathers are all but gone. In 1990, the acting mayor of Paris, Jacques Chirac , promises he'll bathe in the Seine in three years. Since 2010, the quality of the Seine's water improved considerably and 32 species of fish are back in Paris. Bathing in the Seine is now an objective for 2024.

But, if the water's quality has been improved, due to the cutback of industry in le-de-France andthe upgrades brought to the sanitation network, agricultural based pollution remains. Agricultural holders aren't subjected to the “polluter pays" principle the way both industries and collectivities are.

Pool in the Vilettebasin, supplied by the water from the Ourcq canal. For its fist opening during Paris Plage in the summer of 2017, the qualty of the water was monitored everyday by fine sensors.

66 BENEATH THE CITY
OPTIMIZED NETWORKS

Reducing discharges in the Seine and securing sewer workers interventions are the priorties of the 21st century for the sewer network. Îts organization has been optimized with the modernization plan started in 1990 that focused on sewers rehabilitation and the networks hydraulic operation.

The **GAASPAR** automated regulation system that manages in real time the storing and discharging of rain waters, evolves towards a predictive functioning based on meteorological forecasts and the current operating state of the sewer network.

The **TIGRE** geographical informatic system for the sewer network, designed to catalogue the sewers network patrimony and prevent its decay now allows to coordinate operations, track them in real time, and maintain the safety of sewer workers.

Adopted in 1990, a large modernization program of Paris' sewer network is dedicated to réhabilitation works in the sewers, improving the hydraulic operation of the network during rainfall, reducing discharges of waste vvater in the Seine and strengthening the network against floods. The plan also aims at improving the working conditions, especially for cleaning operations

Temporary storage of rain water “upstream” of the sewer network is reinforced through new facilities such as the TIMA : Opened in 2009, the lvry-Masséna tunnel relieves the network during rainfall, thus preventing discharges in the Seine.

The Sewer network

- 2442 km of sewers : 1446 km of basic sewers, and 133 km of « collectors » (large sewer tunnels)
- Close to 20 000 manholes, 103 000 domestic connections, and 31 000 monitoring access points
- 157 km of unaccessibles sewers (Pipelines, drains)
- 10 pumping stations including 7 permanent ones and 3 backup stations in case of floods
- 46 stormwater pipes (allowing for discharges into the Seine during important rainfalls)
- Over 300 millions m3 of waste and rain water transported every year

67 “DEBATES”
ALL PIPES OR NATURAL SEEPAGE ?

Rain water contributes to the Seine pollution even though the networks modernization in the years 2000s, through the setup of the regulation system, allowed to considerably lower the amount of discharges. Indeed, rain overloads

the network by filling the pipes. Paris is experimenting alternatives to disconnect rain water from the sanitation network by promoting natural seepage where the rain drops and using it to develop biodiversity, address the heat island effect and also participate in the water savings effort. Paris aims to transition from being a “waterproof” city to being a permeable one.

The 1991 European directive on urban residual waters (DERU) mandates EU agglomerations to collect and treat the aforementioned waters in order to prevent environmental damages caused by waste water discharges.

The ParisPluie plan ambitions to avoid the collection of rain water into the sewer network thus limiting discharges into the Seine river. From now on, all urban projects must include solutions to make the rain 100% usefull : Soil seepage towards water tables, cooling via evaporation, reuse for irrigation or cleaning purposes...

An “Oasis” school playground in Paris 12th district in 2018.

Featuring more natural spaces and vegetation, waterpoints and an emphasis on rain water management. These spaces were designed as cooling islands at the heart of Paris.

“Marianne”, a new garden on the freshly renovated and “re-greened” Place de la Nation.

This redevelopment, which fell within the ParisPluie plan, restored 4600 square meters of permeable soil which amount to 16% of the Place’s surface. The ParisPluie plan aims at limiting the risks of overflow in water treatment plants and the amount of discharges into the Seine, overall reducing pollution of the natural environment.

68 ESLEWHERE

4.4 billion people, which amounts to 60% of the world population are til deprived of safe sanitation services.

OMS and UNICED report - 2017

The potential of waste water as a resource, be it for energy production or nutrient recovery, remains greatly under-utilized.

Energy can be harnessed as biogas, or through the production of heat, cooling and electricity

Technologies now exists to allow on site collection of energy, through integrated sludge processing inside treatment plants, that allows these facilities, whom are energy-hungry, to transition towards neutrality and even consider becoming energy producers in the future.

69 AND TOMORROW ? ...

In tomorrow's world, sanitation will no longer be confined to the city's underside... All matter can be recycled and wastewater has major potential as a resource. Urine is rich in nutrients and can be used as a natural fertiliser, and heat from wastewater can contribute to energy production. Water management is also diversifying. Rather than systematically ending up in the sewers, rainwater will become an asset in preservation of biodiversity and development of future "vegetable cities"; raw water is used to water parks and gardens. Analysis of wastewater enables the tracking of pollution caused by human activity. Sanitation must play a role in preservation of the natural environment: one day, Parisians will be able to bathe in the Seine.

“TO COMPLEMENT YOUR VISIT”

CITÉ DE L’EAU ET DE L’ASSAINISSEMENT / SIAAP

A training, information and documentation centre, the Cité de l’Eau et de l’Assainissement is also the departure point for free guided tours of the Seine Centre wastewater treatment plant in Colombes.

SIAAP – Île de France sanitation public service
82 Avenue Kléber – 92700 Colombes – 01 41 19 52 33 – lacitedeleau@siaap.fr

PAVILLON DE L’EAU / EAU DE PARIS

Providing information about and raising awareness on water, the Pavillon de l’Eau is housed in the former machine room of a pumping station supplying the Passy reservoir. It accommodates a permanent exhibition on the capital’s water supply as well as organising temporary exhibitions, educational activities and thematic encounters.

EAU DE PARIS – Water. A public service
77 avenue de Versailles – Paris 75016 – 0142245402 – pavillondeleau@eaudeparis.fr