Interreg Baltic Sea Region

Co-funded by the European Union

SUSTAINABLE WATERS WaterMan

Water Recycling Toolbox

Recycling treated wastewater for commercial use

KWB – Berlin Centre of Competence for Water gGmbh

Feasibility study: pilot replication blueprint

Interreg Baltic Sea Region

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SUSTAINABLE WATERS WaterMan

Introduction to the pilot measure

Recycling treated wastewater for commercial use

KWB – Berlin Centre of Competence for Water gGmbh

15 March 2023

WaterMan – Berlin Case Study

Overview on industrial water reuse using water from large scale WWTP

Background - Berlin

Source: Berlin water utilities (BWB)

- Population: approx. 3.75 million inhabitants
- Area: 892 km²
- Surface waters coverage: approx. 60 km² of the city's area
- Annual average precipitation: 580 mm/a
- 2 local rivers (Spree & Havel): extreme periodic widenings & alternating river/lake-like characteristics

Berlin – Urban water cycle

Source: Berlin water utilities (BWB)

- partially closed water cycle
- low input and exchange rates
- Surface water serves as recipient for treated wastewater
- groundwater recharge & bank filtration → drinking water resource

→ **integrated management of urban drainage, wastewater treatment and drinking water production**

Climate challenge: more frequent heats and droughts increase the water demand & at the same time reduce the water supply capacities in Berlin

Overview on Berlin case study

Feasibility study of industrial water reuse in Berlin-Ruhleben

Context:

- large city WWTP near industrial zone
- Summer period: treated WW discharge into Teltowkanal (16 km distance)
- Winter period: treated WW discharge in Spree river
- fit for purpose purification & water reuse
- industrial & commercial use: e.g. power plant, car wash

Participating countries through expert panel:

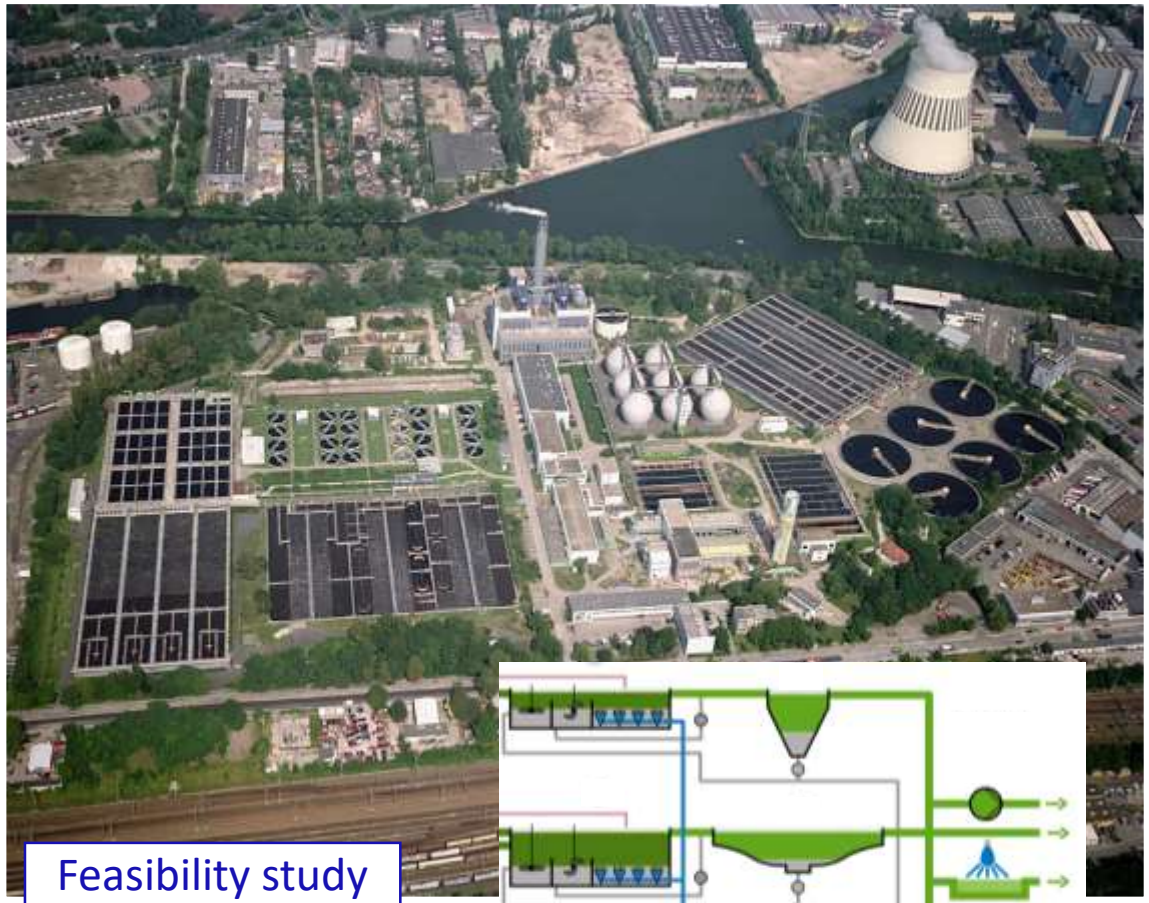
PL (GUT), LT (Klaipeda University)

+ external experts & temporary members

Source: Berlin water utilities (BWB)

WWTP Berlin-Ruhleben

capacity: 1.6 mio. PE (247,500 m³/d in dry weather, max. 600,000 m³ in rainy weather)



Feasibility study

commissioning in 1963

Source: Berlin water utilities (BWB)

Treatment:

1. **Primary/Mechanical**:
   - 6 automatically cleared screens & grit chambers
   - 16 primary sedimentation tanks
2. **Secondary/Biological:**
   a) 16 activated sludge tanks for the reduction of phosphorus (Bio-P), nitrogen & organic substances (denitrification & nitrification)
   b) 54 secondary clarifier
3. **Advanced:** UV partial flow system for disinfection
4. **Sludge** dewatered with centrifuges & incinerated in fluidized bed combustion (850 °C)
   - flue gases cleaned electrostatically & wet-chemically
   - heat & electrical energy
   - **incineration capacity**: 11,22 t dry matter/h
   - ash: 30t/d

WWTP Berlin-Ruhleben & WaterMan

investments for advanced wastewater treatment since 2021:

flocculation filtration + full stream UV-disinfection

→ Most probably also removal of micropollutants through ozone or activated carbon

Activities in WaterMan:

- **workshops with local stakeholders (**water users, utility & AO in Berlin**)**
- Strategy with public administration on **involvement & data collection** from private industry, its water usage & quality demands
- **Strategies** to overcome **barriers/bottlenecks** (risk, health, legal, acceptance, costs)
- **awareness measures** to expand network of possible industrial/commercial water users in large industrial zone
- **promotion video** on industrial water reuse
- Connect local strategy with updated of Berlin Master Plan Water

Industrial area around

Water use:

- Process water
- Cleaning water
- Cooling water

→ **Efficient water use through industrial water reuse**

→ **Reduced water stress of Spree river**

→ **Reduction of industrial emissions**

Industry & commerce	Distance, route [km]	Water demand [m³/a]
Combined heat and power plant	7	199,640
Waste-to-energy plant	1	100,000
Cement plant	2	94,265
Zitadelle (commercial area)	5	399,280
BMW motorbike works	6	151,032
Gartenfeld (commercial area)	8	520,800
Siemensstadt (commercial area)	7	631,904
Thelen Technopark (Office, manufacturing, storage)	6	556,388
Messe Berlin (exhibition/fairground)	6	260,400
Ikea	2	165,240
Brunsbüttler Damm (commercial area)	6	700,476

Source: Heinrich, Wilmes, 2022

THANK YOU

Contact: Elisa Rose
elisa.rose@kompetenz-wasser.de

Interreg Baltic Sea Region

Co-funded by the European Union

SUSTAINABLE WATERS WaterMan

1st Peer-review session

Recycling treated wastewater for commercial use

KWB – Berlin Centre of Competence for Water gGmbh

7 November 2023


Source: Berliner Wasserbetriebe

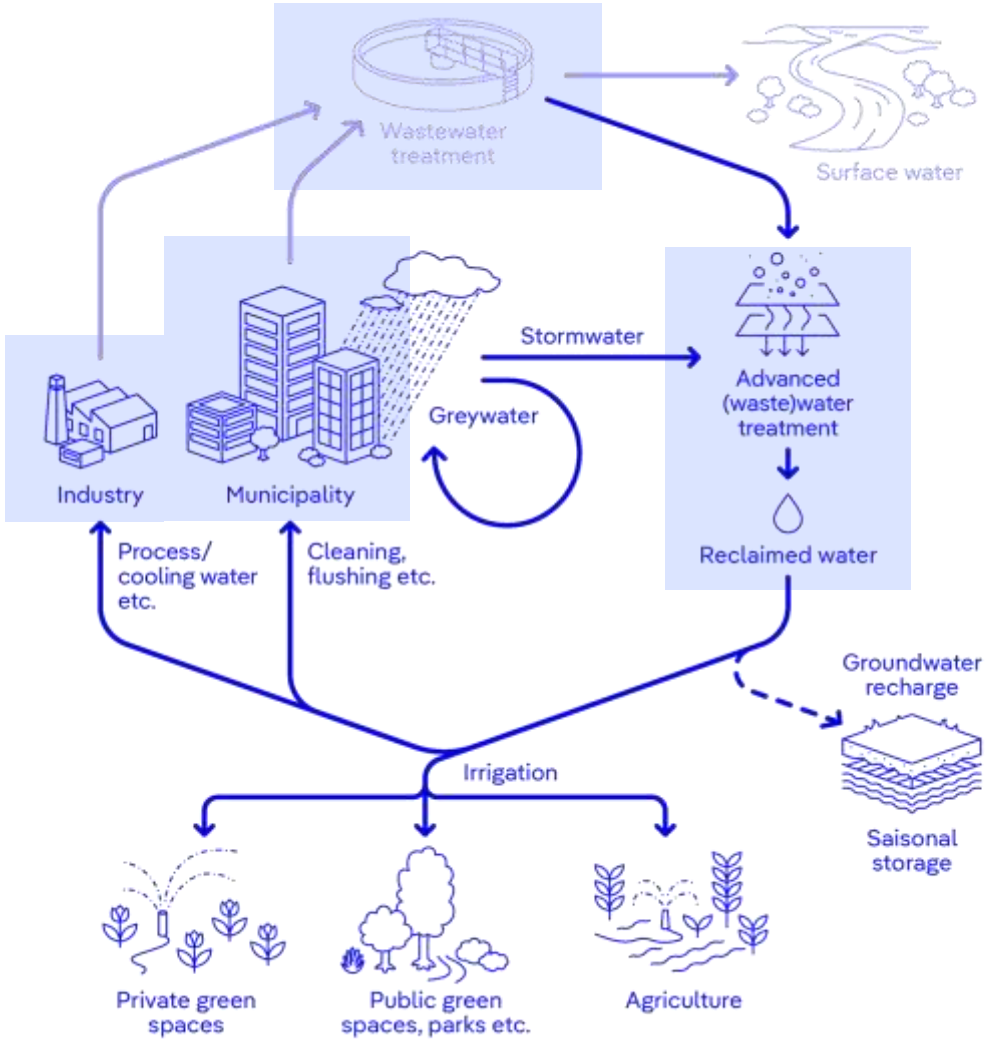
WaterMan – Feasibility Study Berlin:

Industrial Water Reuse Using Water From a Large WWTP – Bornholm 2023

Pia Schumann

Feasibility Study Berlin – Water Reuse Case

Water cycle with non-potable water reuse options



Water reuse case Berlin

- Water source: Municipal wastewater
- Reclaimed water use: industrial/commercial use
- Water quality requirements: depending on water use → fit-for-purpose
- Legal requirements: none (yet); technical guidelines available for specific applications

Feasibility Study Berlin – Local Background

Context

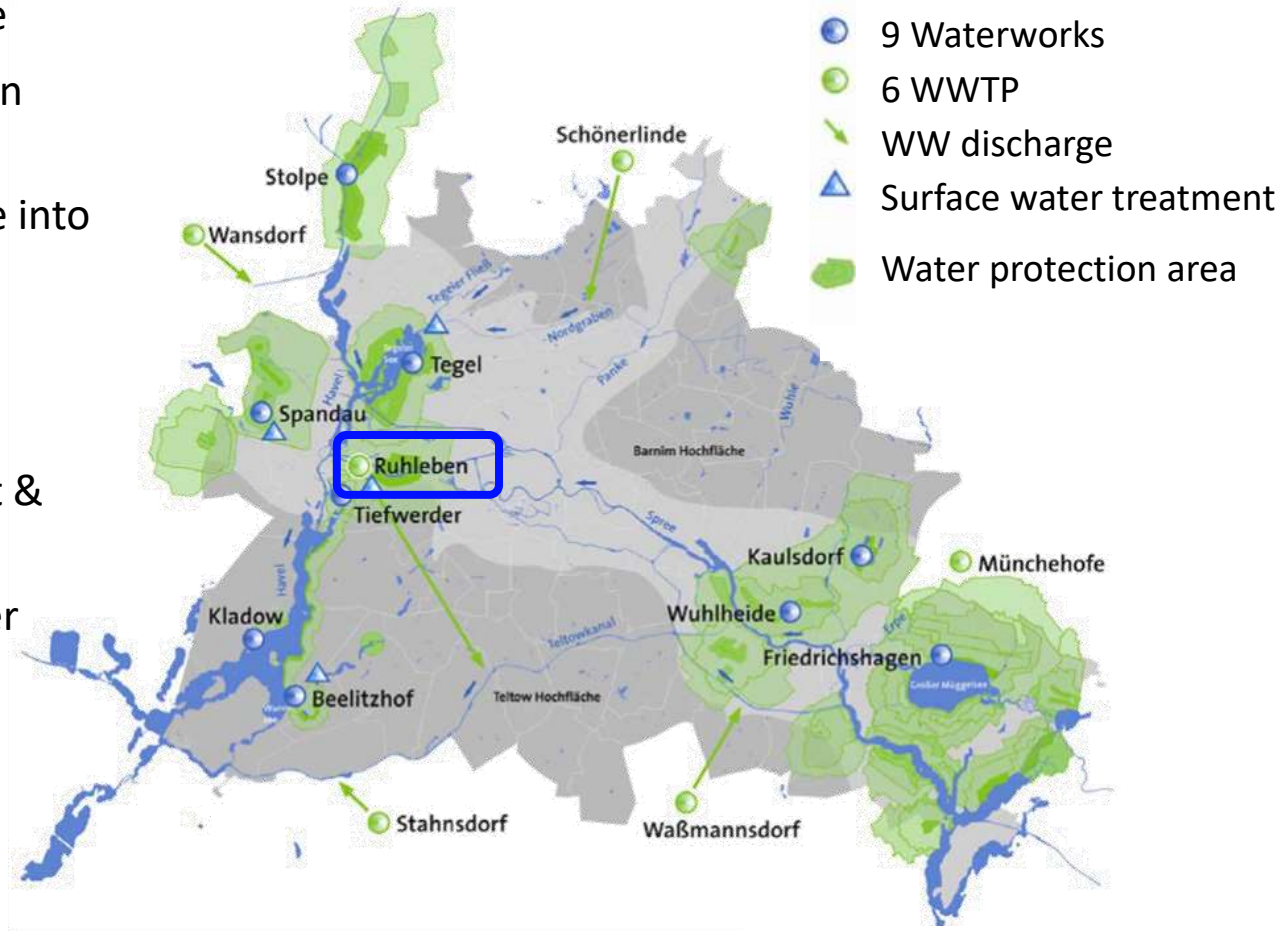
- large urban WWTP near industrial zone
- Winter period: treated WW discharge in Spree river
- Summer period: treated WW discharge into Teltowkanal (16 km distance)

Aim:

- Assess fit-for-purpose water treatment & water reuse potential
- Industrial & commercial use: e.g. power plant, car wash

WWTP: wastewater treatment plant
WW: wastewater

Wastewater Treatment Plant Ruhleben



Source: Berlin water utilities (BWB)

WWTP Berlin-Ruhleben

Capacity: 1.6 mio population equivalents

WWTP: wastewater treatment plant

Source: Berlin water utilities (BWB)

Existing wastewater treatment:

1. Primary/mechanical:
   - 6 automatically cleared screens & grit chambers
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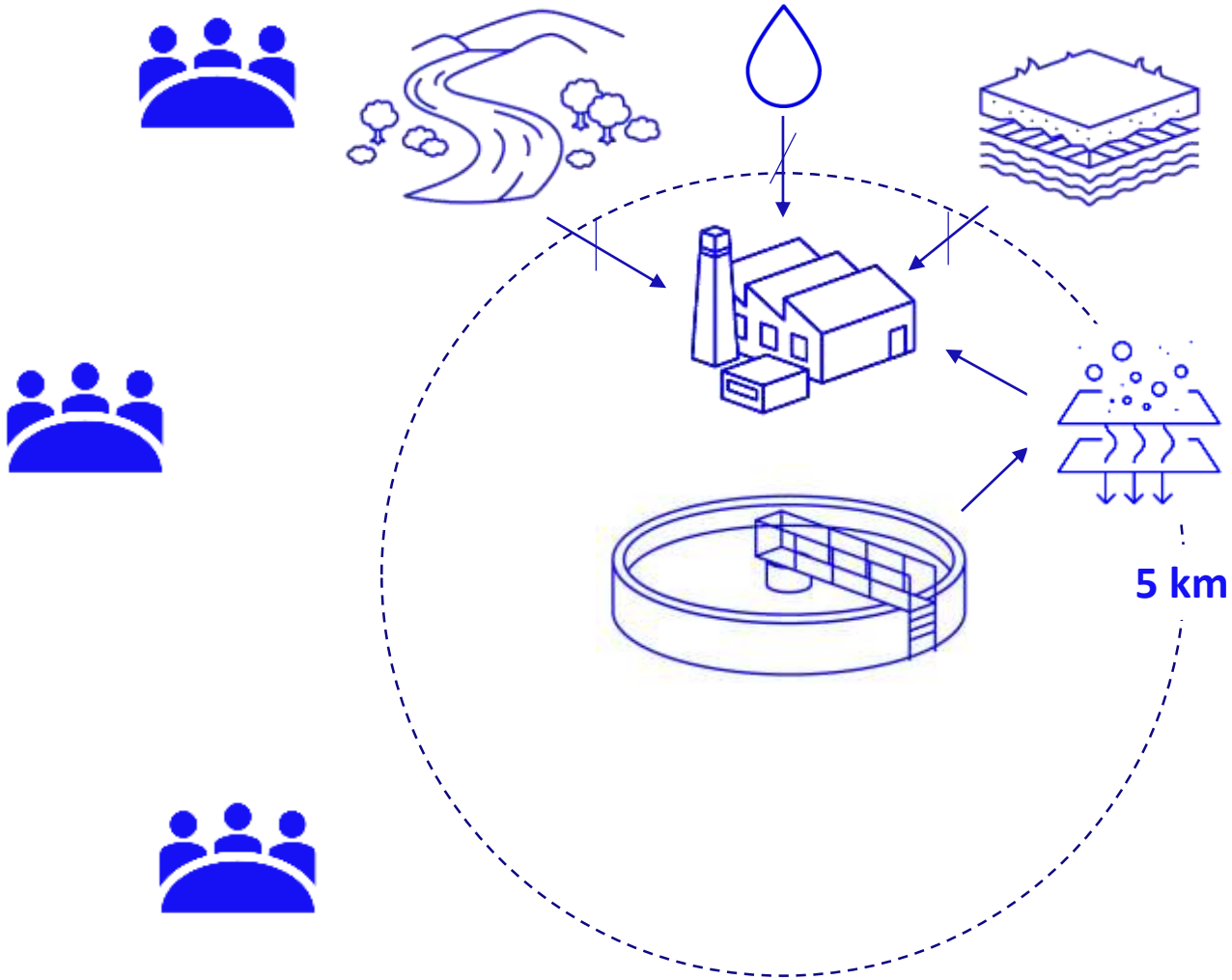
   - 54 secondary clarifier
3. Advanced: UV disinfection of partial secondary effluent flow

Planned extensions:

- Coagulation filtration for nutrient removal + full-stream UV disinfection (until 2027)
- Advanced treatment for micropollutant removal (e.g. activated carbon, ozonation)

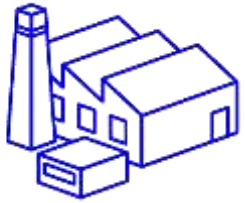
Tentative Approach



1. Wastewater quality and quantity inventory
2. Set a perimeter & assess potential industrial/commercial end-users
3. Identify stakeholders and get in contact
4. Identify promising end-users & assess water quantity and quality needs
5. Identify & evaluate suitable water treatment (including planned WWTP upgrades) options for required water qualities
6. Assess water storage & transport options
7. Carry out human health risk assessment for selected end-uses
8. Evaluate effect of German implementation of water reuse regulation (EU 2020/741)

Tentative Approach

Start Nov 23



Potential water uses:

- Process water
- Cleaning water
- Cooling water
- Steam production

Source water quality:

- Data on secondary effluent and planned extension
- Assessment if additional microbial data is necessary

Water quality requirements, e.g.:

- Cooling water: e.g. Spanish Water reuse regulation, VDI guideline
- Steam production: DIN EN 12952-12:2003-12 standard

Potential end-users

Industry & commerce	Distance, route (km)	Water demand (m^3/a)
Combined heat and power plant	7	199,640
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Ikea	2	165,240
Brunsbüttler Damm (commercial area)	6	700,476

VDI: Verein Deutscher Ingenieure; Association of German Engineers

Source: Heinrich & Wilmes, 2022

Stakeholder Engagement

Activities

- Develop strategies to overcome barriers/ bottlenecks (risk, health, legal, acceptance, costs) of water reuse
- Awareness measures to expand network of possible industrial/ commercial water users in large industrial zone

→ **Events & workshops** with local stakeholders (water users, utility & AO in Berlin) on industrial water reuse

- In communication with Berlin chamber of commerce and industry:
  - "Water Innovation Challenge Berlin"
  - Other joint formats planned

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Cicerostraße 24, 10709 Berlin

1st Peer & expert review session: Recommendations & conclusions

- Legal & regulatory framework: Needs to be further analysed, in particular in view of the following questions: How can Berlin Water sell different qualities of water to different end users? What is possible according to regulations?
- To make the industry more motivated to reuse water, the legal framework needs to be changed to allow different prices for the citizens, and for the industry. This could form an economic incentive for the industry. It should therefore be further investigated if / how different pricing levels would have a lobby, and how this discussion could be started.
- KWB has already outlined a very good strategy to involve the stakeholders, which can also serve the purpose of capacity building within the industry.
- There are good examples of reuse applications within the industry (e.g. Tesla reduces because of political and societal pressure its water demand to ¼ of the initial level). Perhaps the issue could start with small steps: To promote small scale or household type applications (e.g. flushing toilets with greywater, cleaning machines, cooling) towards companies, which could use them as "eco-friendly" conduct in their PR activities.
- A similar case that could be worth investigating is a CHP plant in Katowice – reuse for cooling purposes (Economic Chamber "Polish Waterworks" can deliver further details).

Interreg Baltic Sea Region

Co-funded by the European Union

SUSTAINABLE WATERS WaterMan

2nd Peer-review session

Recycling treated wastewater for commercial use

KWB – Berlin Centre of Competence for Water gGmbh

1 April 2025


Source: Berliner Wasserbetriebe

WaterMan – Feasibility Study Berlin:

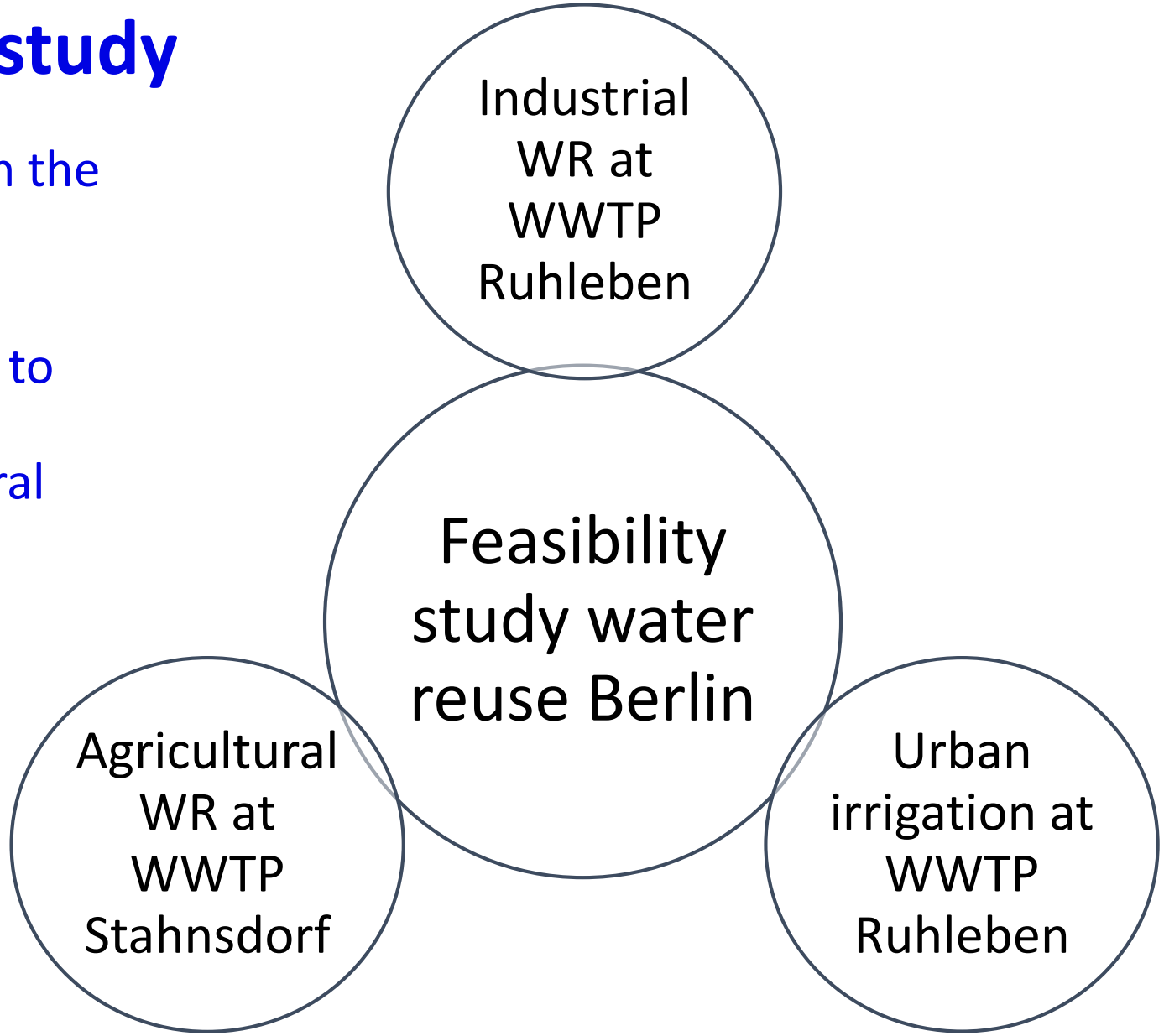
Potential of Water Reuse in Berlin – Latvia 2025

Elisa Rose, Pia Schumann

Scope of feasibility study

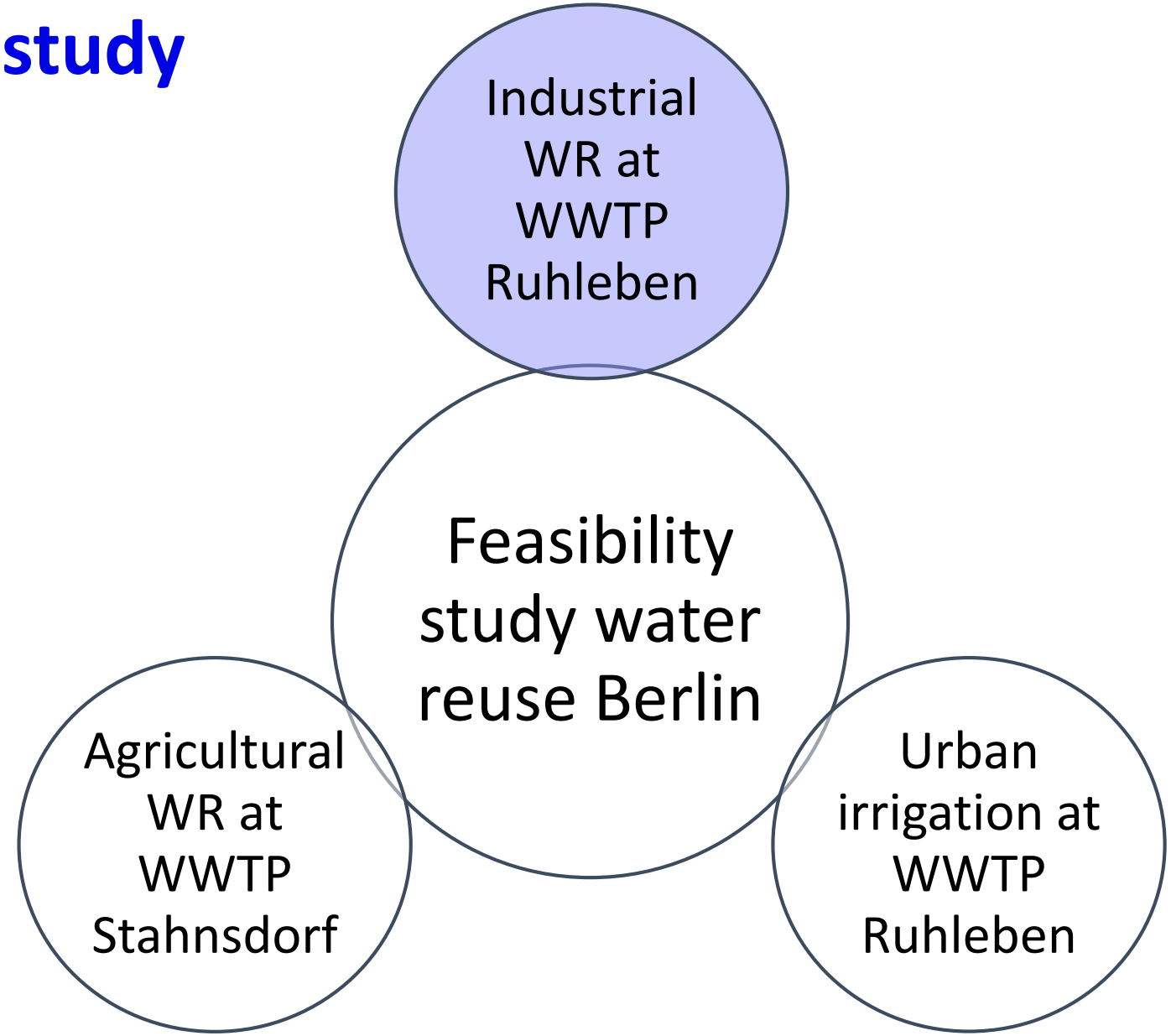
More and more water stress in the Metropolitan region Berlin Brandenburg

→Expansion of the scope due to stakeholder interest of urban irrigation in Berlin & agricultural irrigation around the WWTP Stahnsdorf



WR: Water reuse
WWTP: wastewater treatment plant

Scope of feasibility study



Feasibility Study Berlin – Local Background

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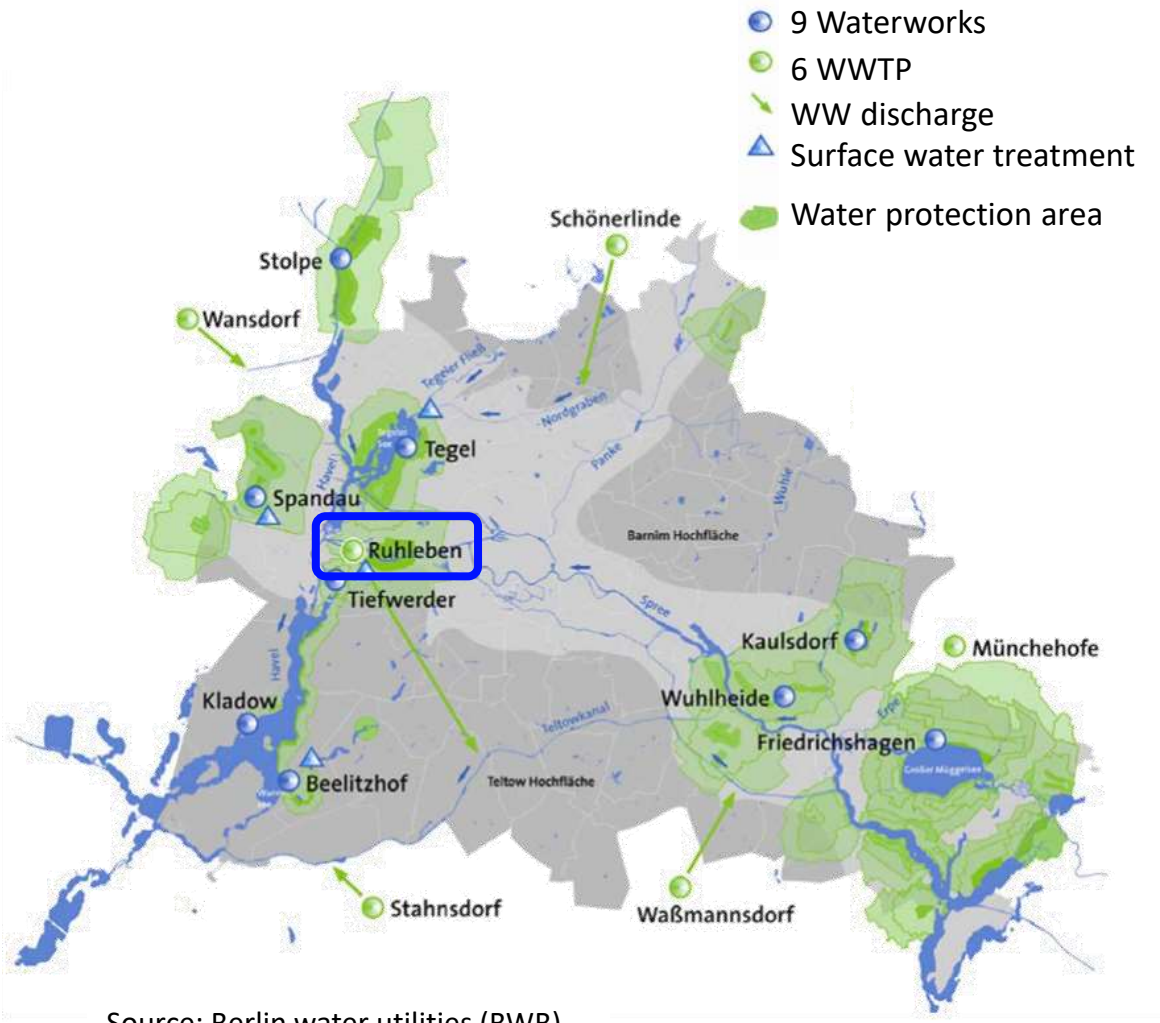
Aim

- Assess fit-for-purpose water treatment & water reuse potential
- Industrial & commercial use: e.g. power plant, car wash

Wastewater treatment plant Ruhleben



Source: Berlin water utilities (BWB)

WWTP Berlin-Ruhleben

Capacity: 1.6 mio population equivalents

Source: Berlin water utilities (BWB)

Existing wastewater treatment:

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Planned extensions:

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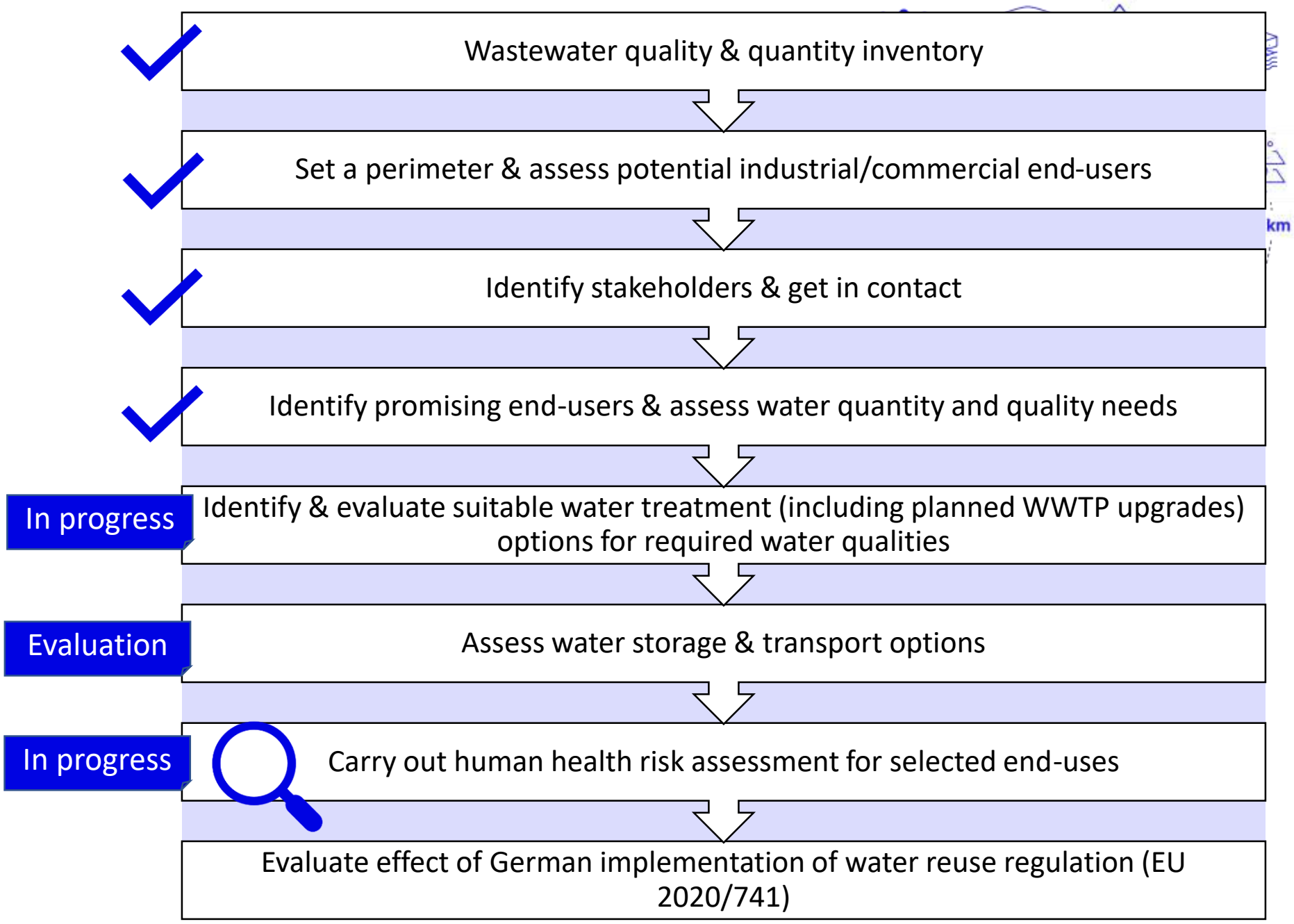
Approach


Wastewater quality & quantity inventory
Set a perimeter & assess potential industrial/commercial end-users
Identify stakeholders & get in contact
Identify promising end-users & assess water quantity and quality needs
In progress
Identify & evaluate suitable water treatment (including planned WWTP upgrades) options for required water qualities
Evaluation
Assess water storage & transport options
In progress
Carry out human health risk assessment for selected end-uses
Evaluate effect of German implementation of water reuse regulation (EU 2020/741)

Microbiology in municipal wastewater

Indicator organisms indicating faecal pollution

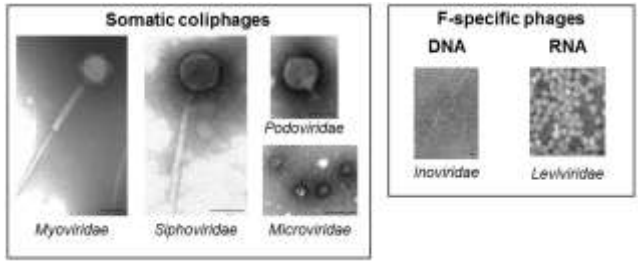
Escherichia Coli

Source: Rocky Mountain Laboratories

Intestinal enterococci

Source:https://commons.wikimedia.org/w/index.php?curid=1669200

Coliphages



Source:https://www.mdpi.com/2073-4441/8/5/199

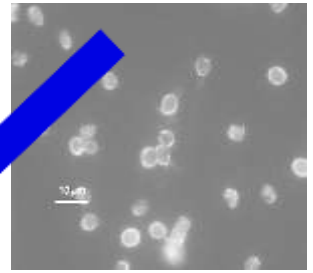
Clostridium perfringens

Source:https://de.wikipedia.org/wiki/Clostridium_perfringens#/media/Datei:Clostridium_perfringens.jpg

Real pathogens causing illness (e.g. gastroenteritis)

Parasites

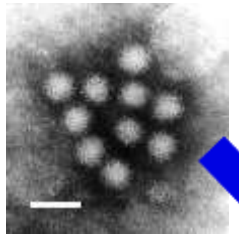
Giardia intestinalis



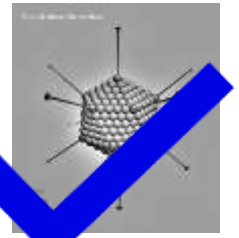
Cryptosporidium parvum

Source: Cryptosporidium parvum – Wikipedia
Giardia duodenalis - Wikipedia

Viruses



Norovirus

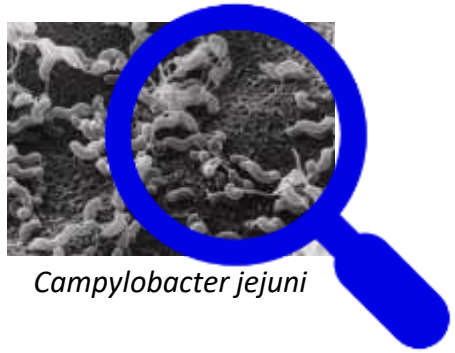


Adenovirus

Rotavirus

Von Gleiberg - Eigenes Werk, CC BY-SA 2.0 de, https://commons.wikimedia.org/w/index.php?curid=11869453

Bacteria



Campylobacter jejuni

Source: Campylobacter Jejuni Bacteria by Science Photo Library

Monitoring at WWTP Ruhleben

- What:
  - Montoring of *Campylobacter jejuni* in Ruhleben WWTP influent (and effluent)
- When:
  - Started in March 2025
  - Covering maximum period of time possible – planned until autumn 2025
- Why:
  - To close knowledge gap and produce a representative data set for WWTP effluents in Berlin
  - To complement QMRA data set
  - Conduct a QMRA on the basis of real data (instead of literature data that are available e.g. in the QMRA tool)

Scope of feasibility study

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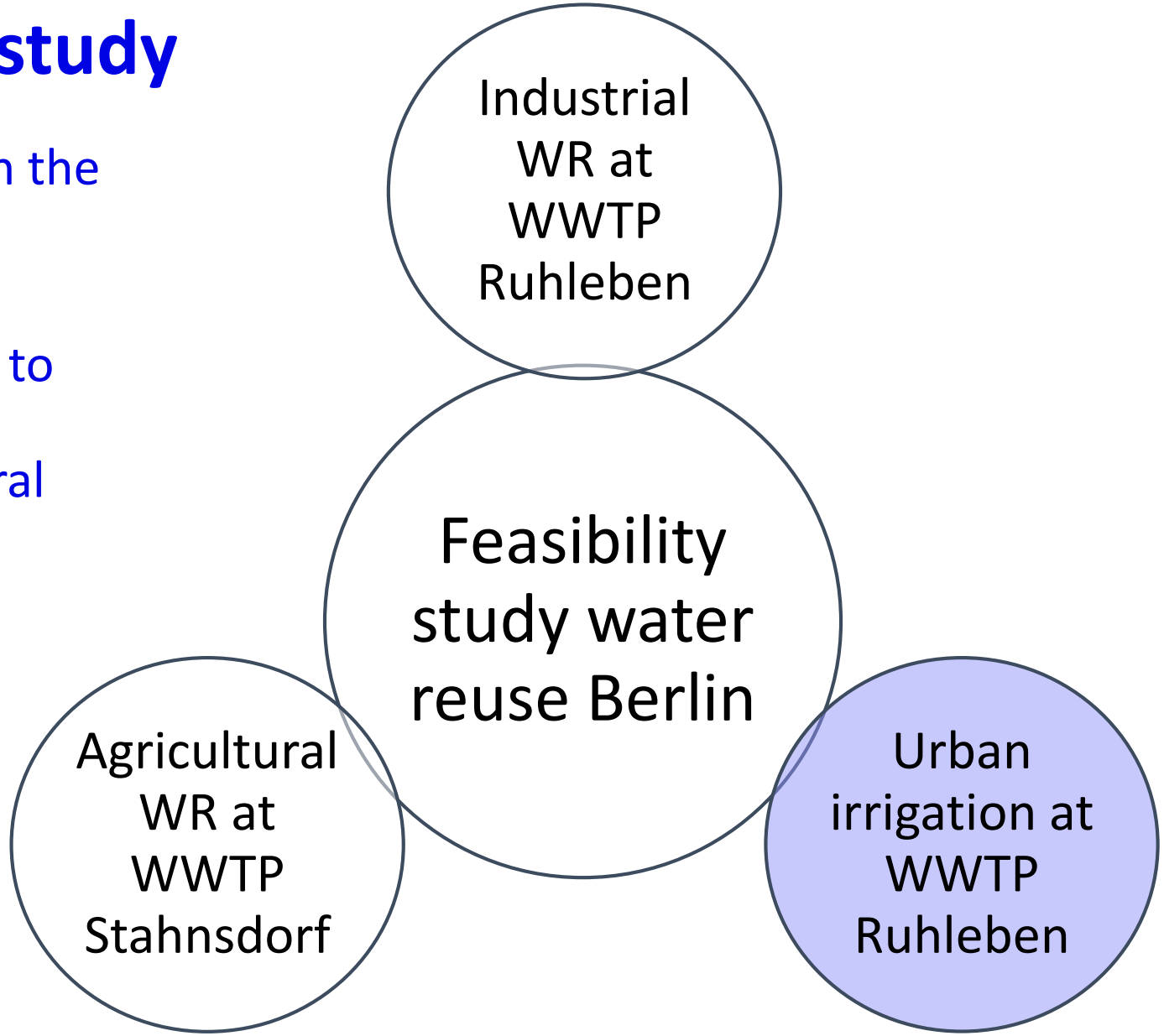
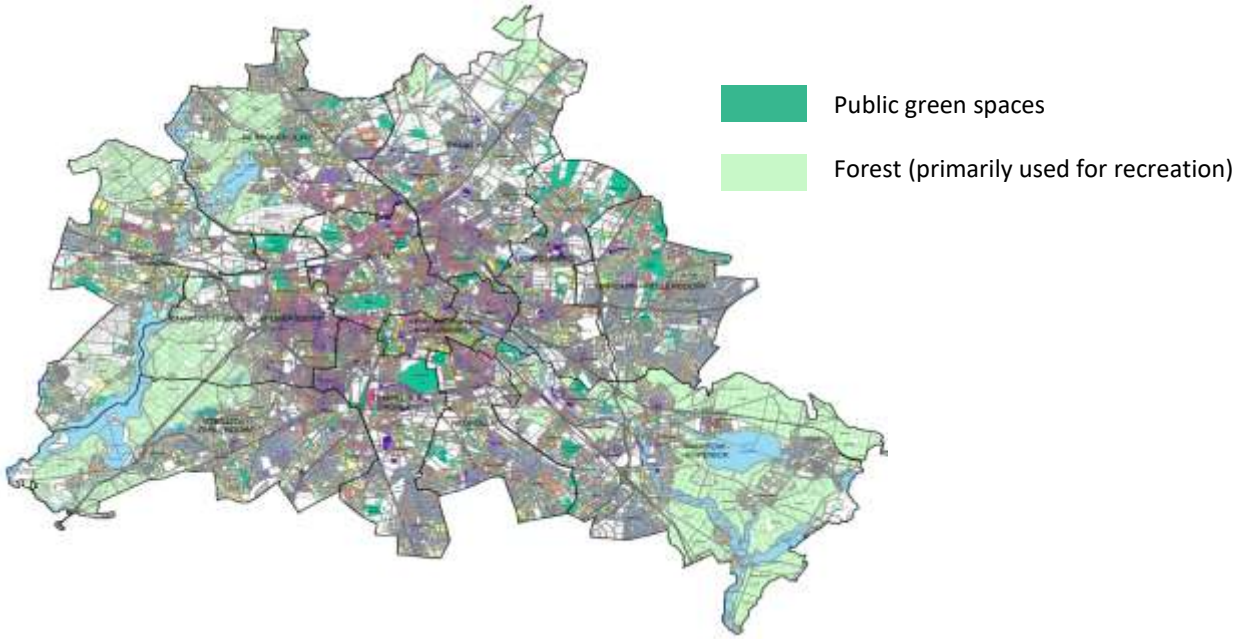
→Expansion of the scope due to stakeholder interest of urban irrigation in Berlin & agricultural irrigation around the WWTP Stahnsdorf

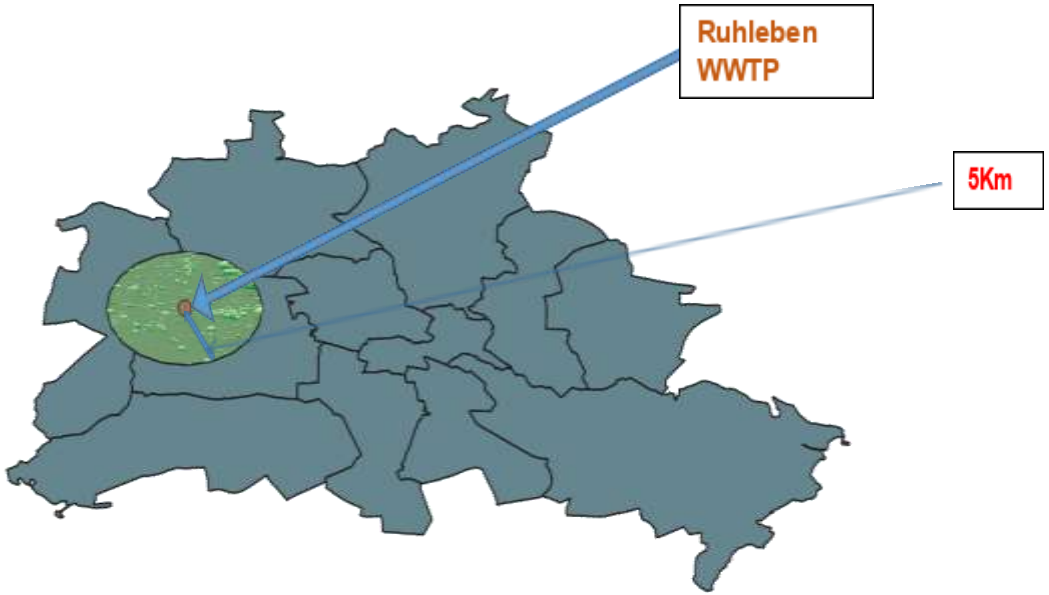


Assessment of urban irrigation potential

1. Identification of green urban spaces within a 5 km radius around the WWTP Ruhleben

- Green spaces were identified using the Environmental Atlas Berlin
- The total area of green space coverage were estimated to be ca. 8.6 km²



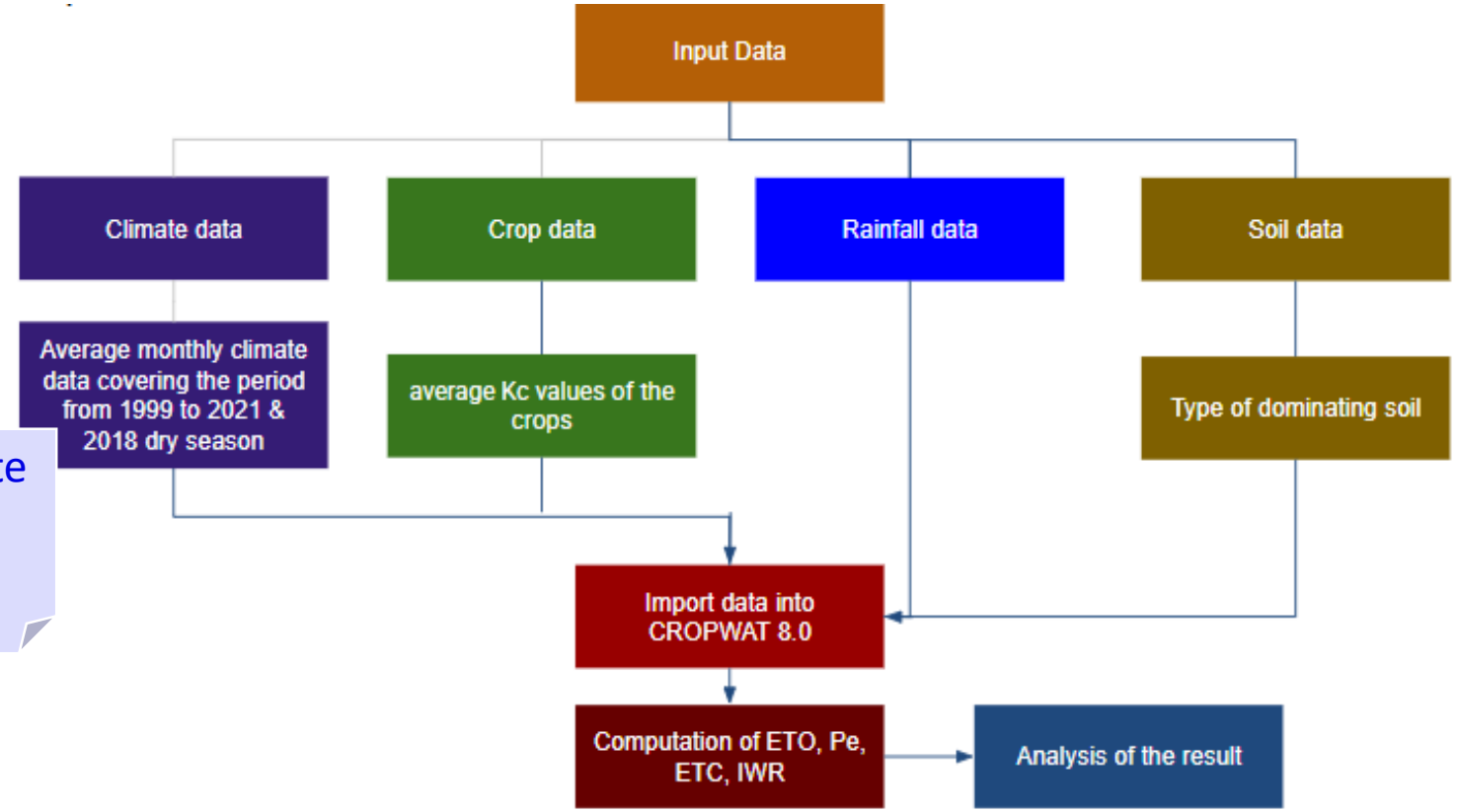


Sources: https://fbinter.stadt-berlin.de/fb/index.jsp?loginkey=showMap&mapId=ek06_05gruenversorg2020@esenstadt&Szenario=fb_en.

Assessment of urban irrigation potential

CROPWAT is a decision support tool developed by the Land and Water Development Division of FAO.

1. Identification of green urban spaces
2. Assessment of irrigation demand using CROPWAT 8.0[1]



2 different climate baselines were considered

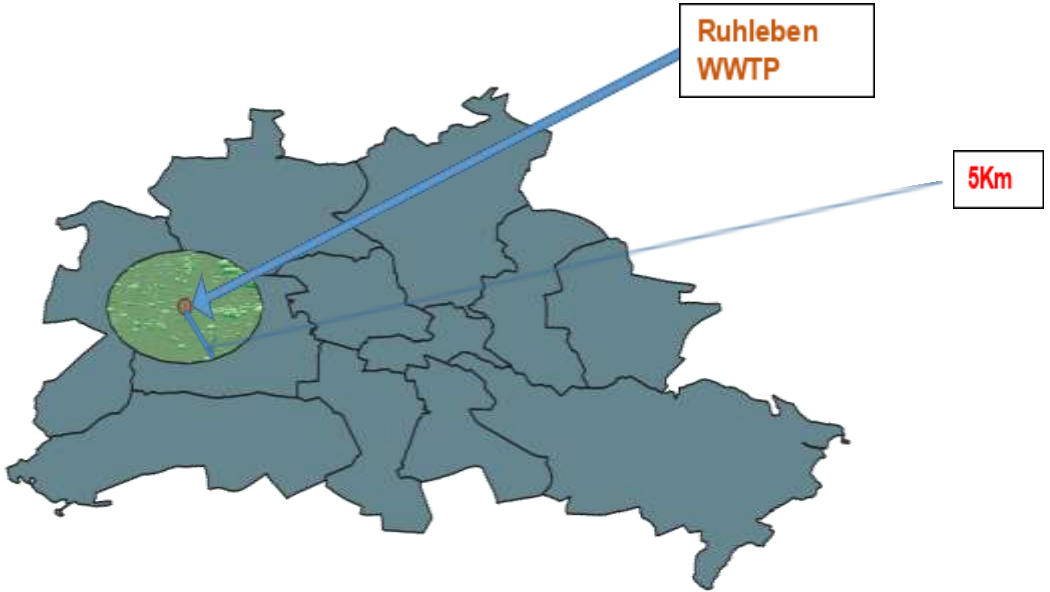
[1]https://www.fao.org/land-water/databases-and-software/cropwat/en/

Assessment of urban irrigation potential

1. Identification of green urban spaces
2. Assessment of irrigation demand using CROPWAT 8.0[1]

Total Green Space Area	8.6 km²
Total Irrigation Demand (2018)	200,400 m³
Total Irrigation Demand (20-year average)	59,800 m³
Categories of Green Spaces	Allotments, Parks, Cemeteries, Grass, Scrub, Meadow

More than 3 times higher irrigation demand in dry year of 2018 compared to 20 year average



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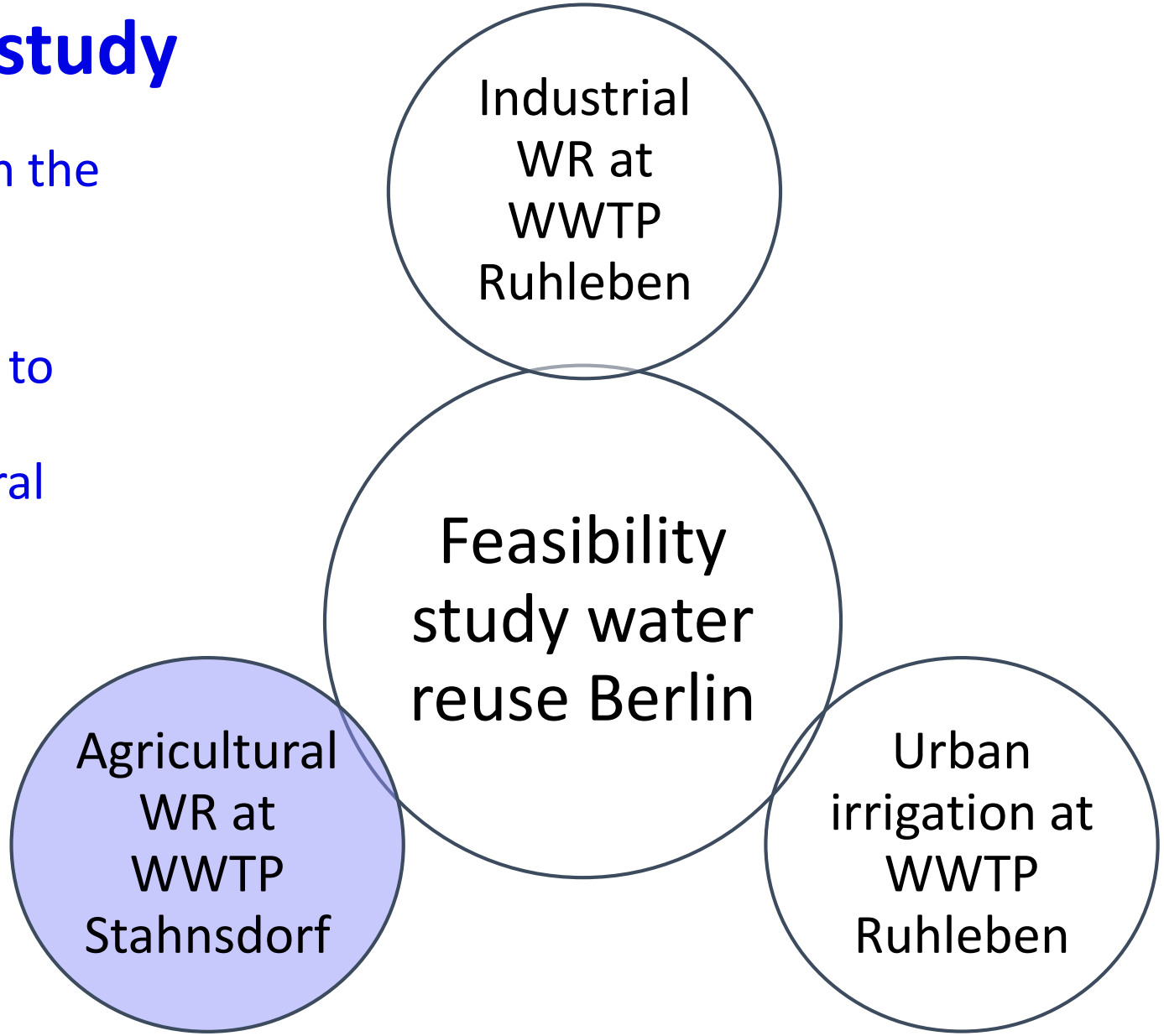
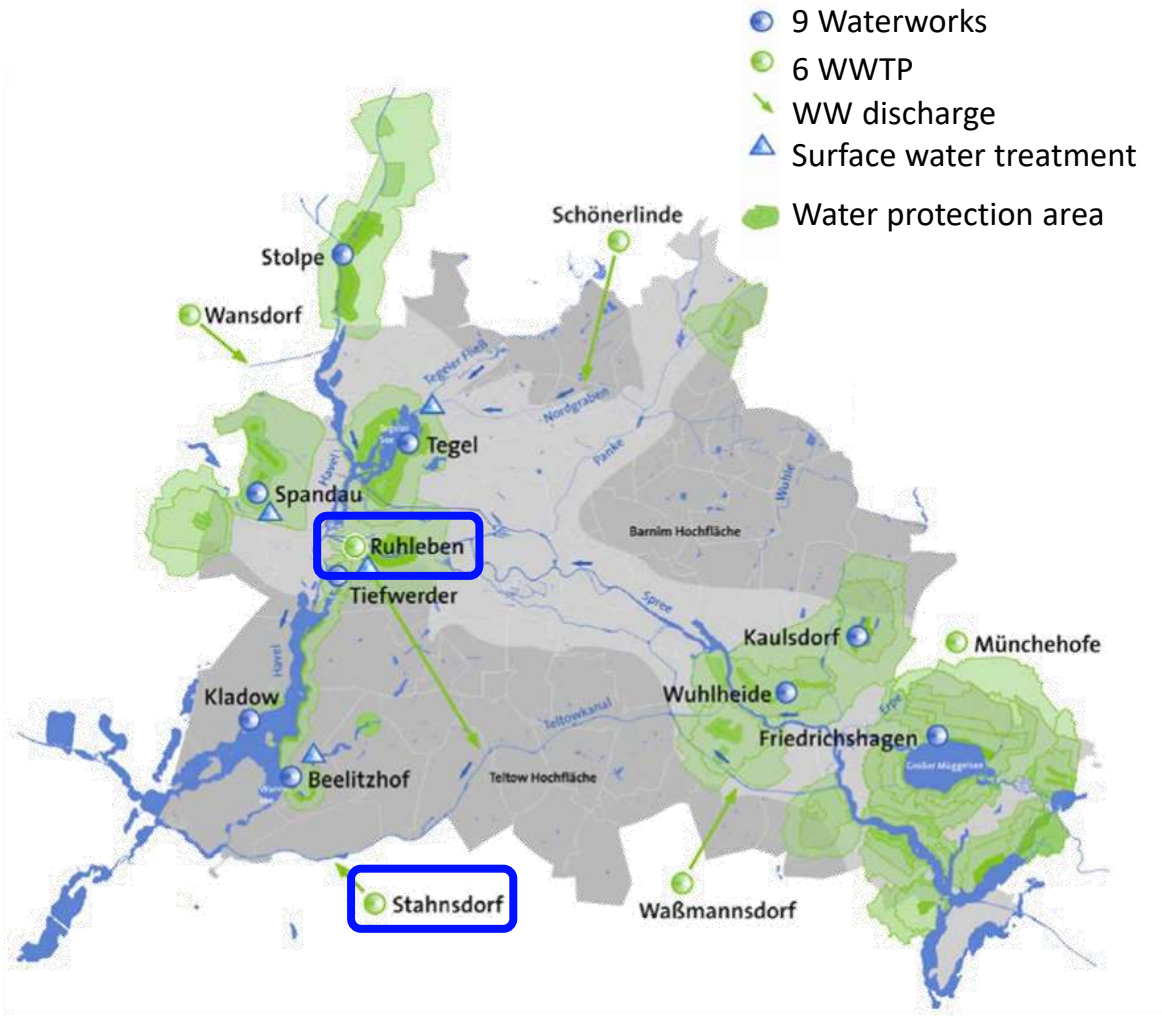


Reuse of municipal wastewater for agricultural irrigation – case study at the WWTP Stahnsdorf

Source: Berlin water utilities (BWB)

Wwtp Stahnsdorf

- Aim to assess the potential of reuse of municipal wastewater at WWTP Stahnsdorf
  - Focus on agricultural reuse
  - Urban irrigation may be included as well
- Close cooperation with Berlin water utility (BWB)
- Boundary conditions:
  - New wwtp will replace old wwtp by 2037
  - Assessment shall include current wwtp and wwtp of the future
  - Capacity current WWTP 410,000 p.e./50,000 m³/a
  - Capacity future WWTP 900,000 p.e./100,000 m³/a

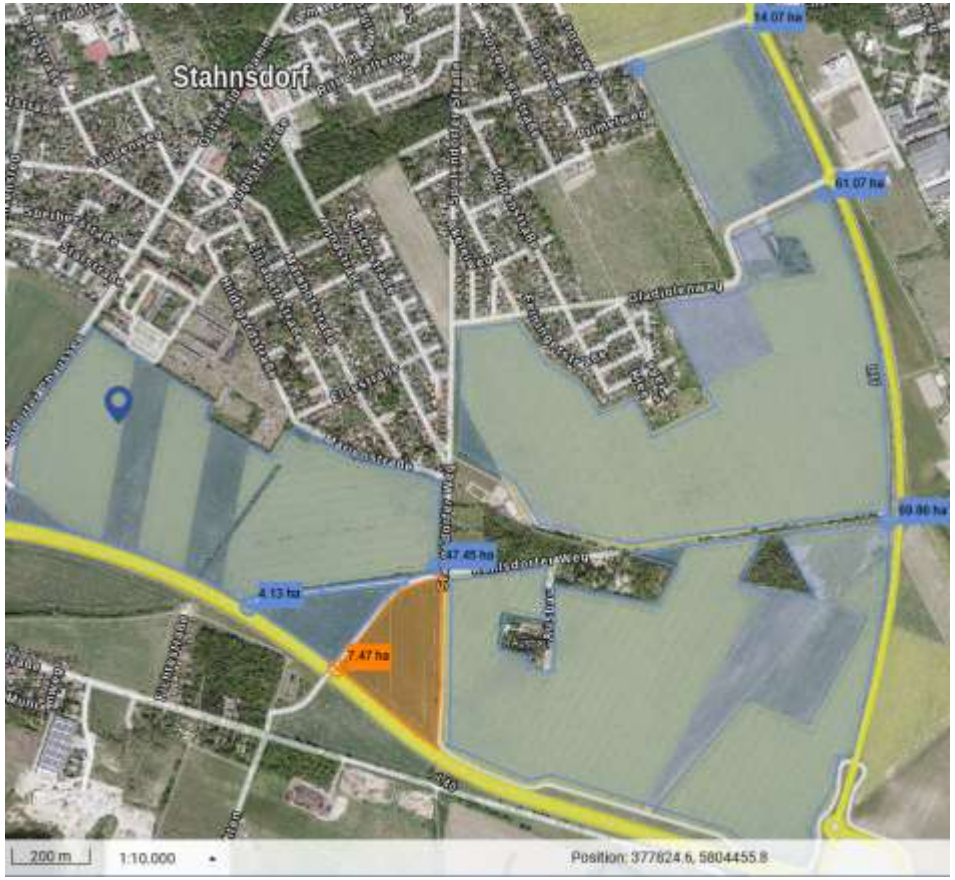


Source: Berlin water utilities (BWB)

Assessment of irrigation demand

Requirements for irrigation systems:

- Min area traveling gun irrigation system 25 ha / radius of 300 m
- Min area linear irrigation system 20 ha, square area



Possible organization of irrigation systems:

- Area covered by linear irrigation system: approx. 80 ha
- Remaining area to be irrigated by traveling gun irrigation system: approx. 130 ha

Source: Google amended by KWB

Assessment of irrigation demand & treatment capacity need

Input

- precipitation
- Pot. evapotranspiration
- spec. evapotranspiration
- spec. root depth
- plant-available water capacity

modell

Output

- spec. Additional water demand
- amount per irrigation cycle
- Number of irrigation cycles p.a.
- Water demand per year
- **Capacity of the treatment system**

	Winter crop
Surface area (ha)	**209**
Amount per irrigation cycle (mm)	**21**
Number of irrigation cycles per year (n)	**11**
Water demand per irrigation cycle (m^3)	**43,827**
Additional water demand per year (mm/a)	**193**
Water demand per year (m^3/a)	**482,100**

Common irrigation practice:
7 days, 20 hours

	Scenario 1	**Scenario 2**	**Scenario 3**
Irrigation cycle (d)	7	5	2
Daily operation time (h)	20	20	20
Water demand (m^3/h)	**391**	**548**	**1.370**

Treatment options
Aim: Class B 2020/741

Upgrade of existing wwtp plant

Minimum requirements

Filtration[1] → UV disinfection

Including organic micropollutant removal

Filtration[1] → Granular activated carbon filtration → UV disinfection

From 2037

Partial treatment of new wwtp effluent

Ozonation → Biological activated carbon filtration → UV disinfection (high dose)

[1]Filtration options
- Micro sieve, cloth filter, cartridge filter
- Fixed-bed filter (DynaSand, DynaCarb)
- Ultrafiltration

Stakeholder analysis for Stahnsdorf

Identification of all relevant actors incl. responsibilities (WR 2020/741)

1. **Operators of the Treatment Facility & Municipal Wastewater Treatment Plant (public/private):**
   - BWB – Stahnsdorf Wastewater Treatment Plant
   - Water and Wastewater Association (WAZV) "Der Teltow“
   - Mittemärkische Wasser- und Abwasser GmbH (Service provider for WAZV "Der Teltow")
2. **Operators of Facilities for the Storage and Distribution of Treated Water (if applicable):**
   - See references (1) or (3).
3. **Operators Responsible for Irrigation** (Farmers/Agricultural Associations/Irrigation Associations):
   - e.g., Agro Saarmund GmbH
4. **Relevant Authorities (excluding the primary responsible authority):**

- Water, Health & Environmental Authorities:
  - Upper Water Authority – State Office for the Environment (LfU) Brandenburg
  - Health Department – Potsdam-Mittelmark District
- Lower Nature Conservation Authority
- Lower Soil Protection Authority
- State Office for Rural Development, Agriculture, and Land Reorganization (Plant Protection)

5. **Other Stakeholders:**

- Entities responsible for parts of the water and wastewater system or located within the affected area.
  - E.g. users of surfaces close to farm land to be irrigated

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2nd Peer & expert review session: Recommendations & conclusions

- Integrate Climate Scenarios in Water Demand Planning: use climate-based precipitation and demand forecasts instead of average or peak values to better plan irrigation and reuse strategies, especially under changing climate conditions.
- Agricultural irrigation reuse:
  - Investigate if the nearby farmers (5km radius from WWTP) would be willing to start producing more economically viable crops (more expensive crops) on the condition that they have a stable source of water for irrigation (using WWTP treated effluent but having to pay for it).
  - Irrigation intensity planned in the feasibility study (7 days a week) seems to intensive for the currently produced crops – this needs to be reconsidered, as it determines the quantity of water to be supplied.
- Municipal irrigation reuse: consider salinity as a parameter of the recycled water - some urban plants & trees & crops are very sensitive to salinity. On the other hand experience of Kalmar shows that in the 3-year establishment phase it should not be a factor for municipal trees. Currently Kalmar Municipality will establish measurement of salinity for irrigated grass at football field, and can share the intermediate results of measurements.
- All reuse cases: monitoring microbiological parameters of the recycled water is important, in all applications where humans have contact with water (e.g. agricultural, municipal, but also some industrial applications). It also allows KWB to produce transferable outcomes of the analyses – that can be applied also in other WWTPs
- It's very good that the decision makers of the new WWTP (to be built in 2037) are open for extensions / modules of the already decided partial treatment train, also with focus on the recycling of water (e.g. tap-points allowing for municipal irrigation). This topic should remain appearing in discussions.

Pilot replication blueprint: Berlin / DE – Recycling treated wastewater for commercial use

Interreg Baltic Sea Region

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SUSTAINABLE WATERS
WaterMan

Access the „BSR Water Recycling Toolbox" here.
https://www.eurobalt.org/waterrecyclingtoolbox/

The „BSR Water Recycling Toolbox" was elaborated as part of the project "WaterMan - Promoting water reuse in the Baltic Sea Region through capacity building at local level", The project is co-financed by the European Union (European Regional Development Fund) and implemented within the Interreg Baltic Sea Region Programme. More information:

eurobalt.org/WaterRecyclingToolbox
interreg-baltic.eu/project/waterman

WaterMan promotes a region-specific approach to water recycling, which intends to use the alternation of too much and too little water that has become typical in the Baltic Sea Region to make the local water supply more resilient, and supports municipalities & water companies in adapting their strategies.