



**INFRASTRUKTURA  
I ŚRODOWISKO**  
NARODOWA STRATEGIA SPÓJNOŚCI



MIEJSKIE PRZEDSIĘBIORSTWO  
WODOCIĄGÓW I KANALIZACJI  
W M. ST. WARSZAWIE SPÓŁKA AKCYJNA

**UNIA EUROPEJSKA**  
FUNDUSZ SPÓJNOŚCI



## **Experiences and practices with CBA: Water supply and waste water treatment in Warsaw – Phase V**

**JASPERS Networking Platform  
DG REGIO-JASPERS CBA Forum meeting on Environment sectors  
Brussels, 12 may 2017**



Miasto  
Stołeczne  
Warszawa

# Plan of the presentation



- **Introduction**
- Steps of the economic analysis
- Assumptions
- Valuation of external effects
- Results of the analysis
- Discussion

# Water supply and waste water treatment in Warsaw – Phase V - Beneficiary



- **Beneficiary:**

**Municipal Water Supply and Wastewater Company of Warsaw Municipality**

- **The Company operates water supply and wastewater systems in:**
  - **Warsaw Agglomeration 2 491 811 p.e. (ca. 1 800 000 inhabitants)**
  - **Pruszkow Agglomeration 236 282 p.e. (ca. 80 000 inhabitants)**
  - **Serock Agglomeration 14 981 p.e. (ca. 5 000 inhabitants)**
- **1886 - first Water treatment station, water supply and wastewater networks**
- **Since 2003 the Company is a Joint Stock Company with 100% shares owned by Warsaw Municipality**



# Water supply and waste water treatment in Warsaw – Phase V - Beneficiary

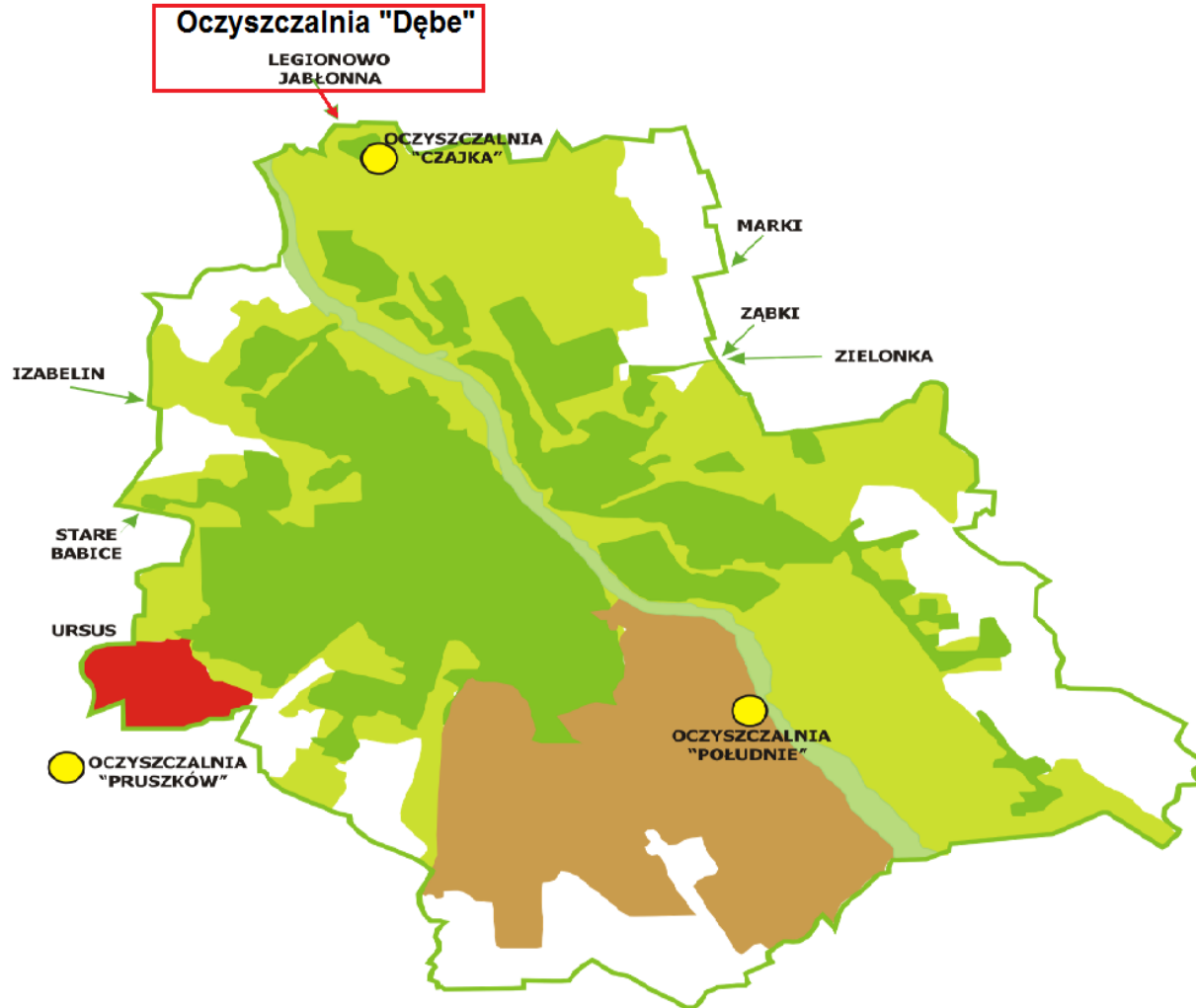


Water for Warsaw inhabitants is supplied from:

- Central Water Treatment Plant (Warszawa and Pruszków agglomeration), consisting of:
  - Water Treatment Plant Filtry (blue area)
  - Water Treatment Plant Praga (yellow area)
- Northern Water Treatment Plant in Wieliszew (Serock agglomeration) (green area)
- In emergency case Northern Plant may take over the water supply zone of the Central Plant
- Total length of operated water supply network is ca. 2 445 km.
- Water supply ratio for Warsaw is 98 %



# Water supply and waste water treatment in Warsaw – Phase V - Beneficiary



- Waste water treatment in Warsaw:
  - waste water treatment plant Czajka (Warsaw agglomeration) (green area)
  - waste water treatment plant Poludnie (Warsaw agglomeration) (brown area)
  - waste water treatment plant in Pruszkow (agglomeration Pruszkow) (red area)
  - waste water treatment plant Debe (agglomeration Serock) (outside plan)
- total length of operated waste water network is ca. 3 272 km
- 40% the network is a combined sewer
- Waste water collection ratio for Warsaw is 98%

# The complete Project:



## Water supply and waste water treatment in Warsaw

- The Project „Water supply and waste water treatment in Warsaw consists of:”
- **Phases I – IV** (concluded), executed between 2003 and 2015
  - Total eligible cost: 855 milion EUR
  - CF share: 529 milion EUR
- **Phase V** (present project)
  - Total eligible cost: 201 milion EUR
  - CF share: 128 milion EUR
- **Phase VI** (future project, currently under assessment at national level)
  - Total eligible cost: 238 milion EUR
  - CF share: 152 milion EUR
- **Total value of the complete Project**
  - Total eligible cost: 1 294 milion EUR
  - CF share: 809 milion EUR

# Project Water supply and waste water treatment in Warsaw - Phase I and II



## ■ The objectives of the project

- treatment of waste water from the southern part of the left bank,
- optimization of water supply system (after this phase of the project one can drink the tap water in Warsaw).

## ■ Implementation of the Project: 2004 – 2010

## ■ Cost of the Project and the EU contribution

- total cost                   179 964 603 EUR,
- eligible costs               176 969 071 EUR,
- CF share                     108 697 054 EUR.

## ■ Project effect

- erection of wastewater collectors for WWTP Poludnie (total length of 19 km),
- modernization and erection of water supply network of a total length of 157 km,
- modernization of treatment process in Central water treatment plant,
- modernization of treatment process in Northern water treatment plant.



# Project Water supply and waste water in Warsaw - Phase III



Autor wizualizacji: Dominik Rudnicki  
2009 ILF Consulting Engineers Polska



- **The objectives of the project**
  - treatment of all waste water from Warsaw agglomeration (up to 2012 more than half of waste water in Warsaw was untreated),
  - extension and modernization of water supply and waste water networks.
- **Implementation of the Project: 2006 – 2012**
- **Cost of the Project and the EU contribution**

• total cost	631 181 532 EUR,
• eligible costs	358 609 798 EUR,
• CF share	224 131 124 EUR.
- **Project effect**
  - ca. 21 km of waste water network erected,
  - ca. 1,2 km of water supply network erected,
  - ca. 30 km of waste water network modernized,
  - modernization and extension of WWTP Czajka,
  - erection of the collectors under the bed of Vistula river to supply waste water from the left part of Warsaw to WWTP Czajka.



# Project Water supply and waste water in Warsaw – Phase IV



- **The objectives of the project**
  - utilization of sewage sludge from all WWTP,
  - modernization of WWTP Pruszkow and WWTP Poludnie
  - extension of water supply and waste water networks,
  - improvement of water quality - continuation from Phase II.

- **Implementation of the Project: 2007 – 2016**

- **Cost of the Project and the EU contribution**

• total cost	329 747 196 EUR
• eligible costs	316 215 963 EUR
• CF share	196 507 667EUR

- **Project effect**

- ca. 62 km of waste water network erected,
- ca. 4 km of water supply network erected,
- ca. 25 km of waste water network modernized,
- modernization and extension of WWTP Pruszkow and WWTP Poludnie,
- erection of Sewage Sludge Thermal Utilization Plant
- modernization of Central Water Plant,  
(Water Treatment Plant Filtry and Water Treatment Plant Praga).



# Project Water supply and waste water treatment in Warsaw Phase V (ongoing) and VI (future)



## ■ Stated deficiencies

### ■ **Wastewater management:**

- Access of all inhabitants to wastewater network;
- Significant exfiltration of wastewater to environment and infiltration of ground water into wastewater network, caused by poor technical condition of the collectors;
- Lack of retention capacities in combined sewage system;
- Lack of effective control over wastewater network, pumping stations not adapted to cooperate with control system.

### ■ **Water supply:**

- Northern Water Treatment Plant not adapted to the needs and variable operational conditions – lack of alternative source of potable water for the inhabitants of Warsaw and Pruszkow agglomerations;
- Access of all inhabitants to potable water network
- Problems with water supply reliability.

### ■ **Other**

- Increased energy consumption,
- Lack of alternative energy sources (renewable)

# Project Water supply and waste water treatment in Warsaw - Phase V



- The project „Water supply and waste water treatment in Warsaw - Phase V" is a continuation of water and wastewater management in the agglomerations: Warsaw, Pruszkow and Serock.
- The major objectives of the project (in respect to stated deficiencies):
  - improving access to water and wastewater collection through the extension of water supply and waste water networks,
  - improving the technical condition of waste water network (prevention of exfiltration of waste water into the environment and groundwater infiltration into waste water network),
  - improving the functioning of waste water network – increasing the retention capacity, introduction of the real time control system,
  - improving the reliability of supply and quality of water in result of the modernization of the water treatment plant and water supply network,
  - reduction of energy consumption using renewable sources of energy (photovoltaics).
- The project will enable within Warsaw agglomeration:
  - to connect 13 214 inhabitants to the waste water network,
  - to connect 4 270 inhabitants to the water supply network.
- Cost of the Project and the EU contribution
  - total cost                   247 443 908 EUR
  - eligible costs               201 172 725 EUR
  - CF share                     128 247 612 EUR

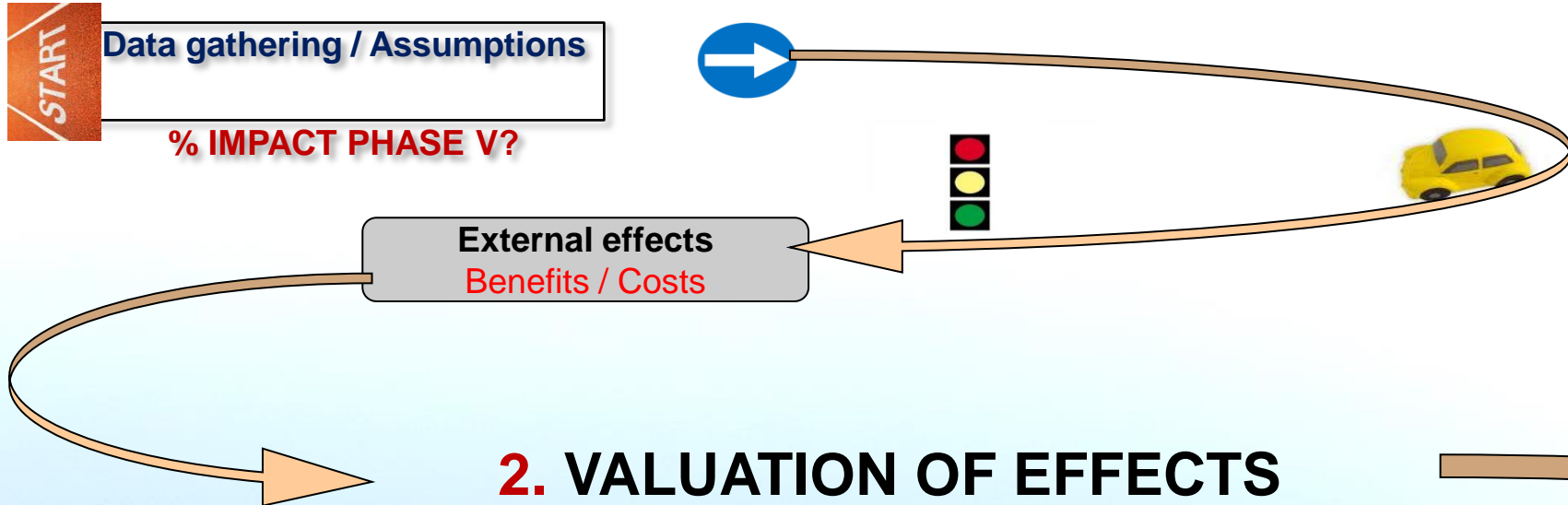
# Plan of the presentation



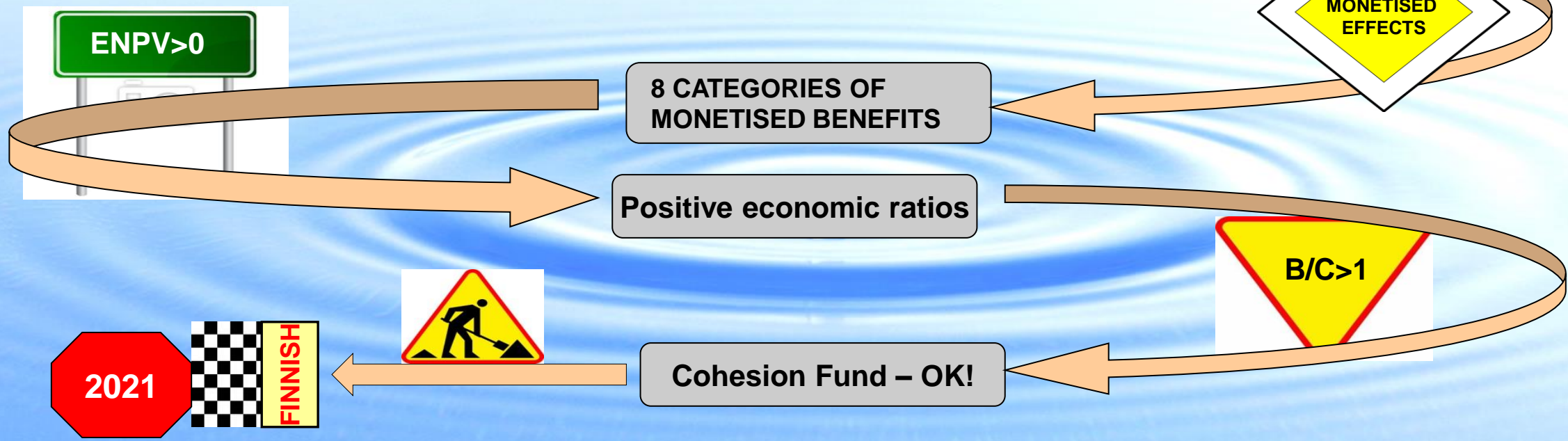
- Introduction
- **Steps of the economic analysis**
- Assumptions
- Valuation of external effects
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# Steps of the analysis



## 2. VALUATION OF EFFECTS



# Plan of the presentation



- Introduction
- Steps of the economic analysis
- **Assumptions**
- Valuation of external effects
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## Assumptions

- **Analysis time: 30 years, i.e. 2016- 2045**
- **Discount rate: 5%**
- **Analysis in fixed prices (without inflation) in Polish Zloty**
- **Residual value: income valuation till end of lifecycle in the final year of the analysis**
- **Deterioration of the infrastructure in the do nothing scenario: 3% per year**
- **Financial analysis assumptions: Polluter pays and Full cost recovery principles, good financial liquidity and sound financial situation of the Beneficiary**



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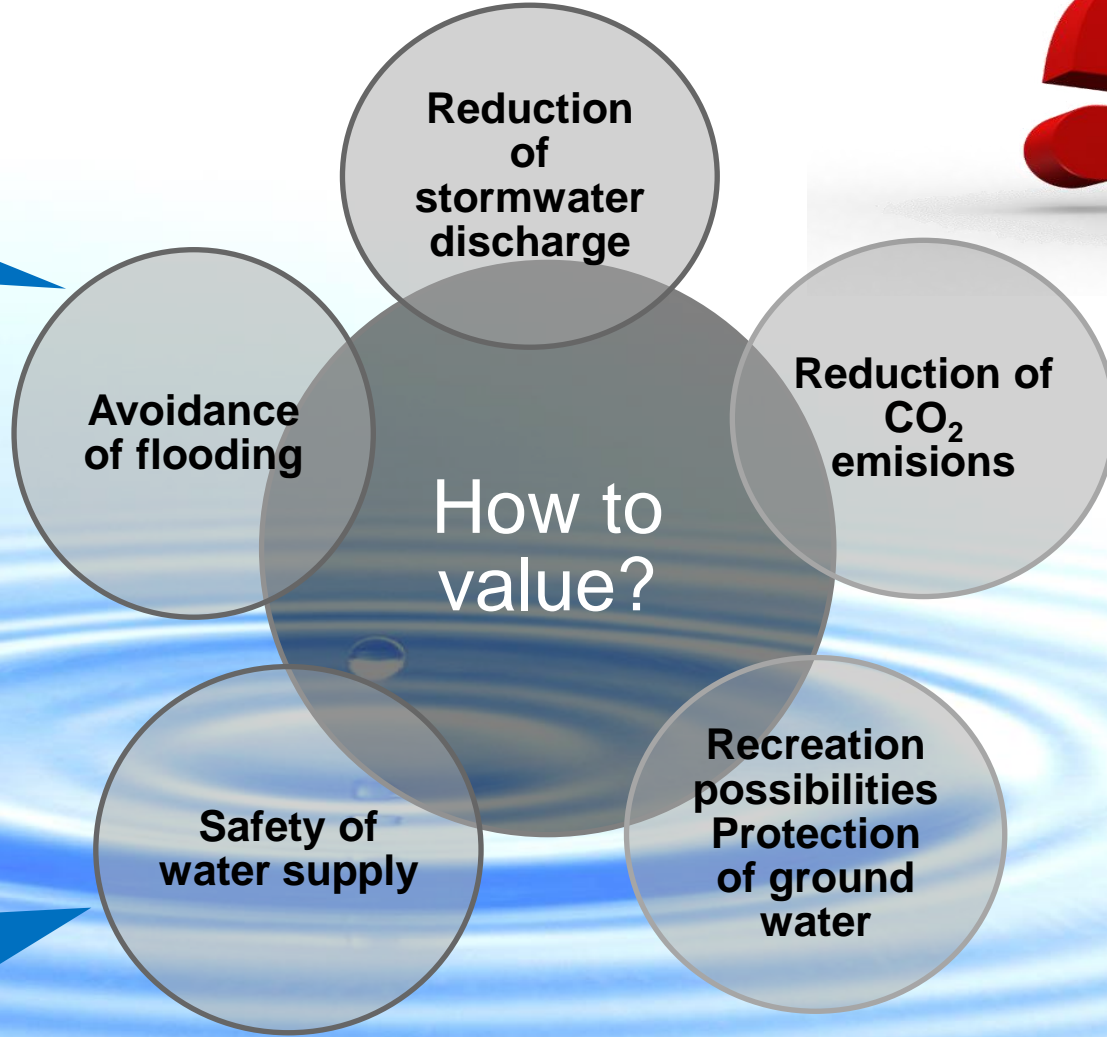


# What are the quantifiable benefits?



**Tangible damage**  
**Saved time**  
**Repairment costs**

**1-day without water – inhabitants of Warsaw**  
**1-day without water – companies in Warsaw**



## Avoidance of flooding



*Infiltration  
and exfiltration*

## Construction of a stormwater tank & Modernisation of the sewerage system



*Poor quality of the  
pipelines*

# Improving the functioning of waste water network – genesis



- **The Warsaw sewer network:**
  - **40% is the combined network**
  - **has been designed as a gravitational network**
  - **collectors were built more than 50 years ago - poor technical condition**
  - **after modernization of WWTP Czajka and the construction of the collectors system (under the bed of Vistula River) all waste water is treated, however, the network bears the additional load during heavy rainfalls**
  - **number of emergency overflows, whose function is to protect from overload and uncontrolled floods**
- **In recent years there are much more extreme weather conditions (torrential rains)**
- **Network overload causes direct discharge of the excess waste water into the Vistula River**
- **Polish legal regulations accept maximum 10 emergency overflows during the year (currently this value is 3 times exceeded)**

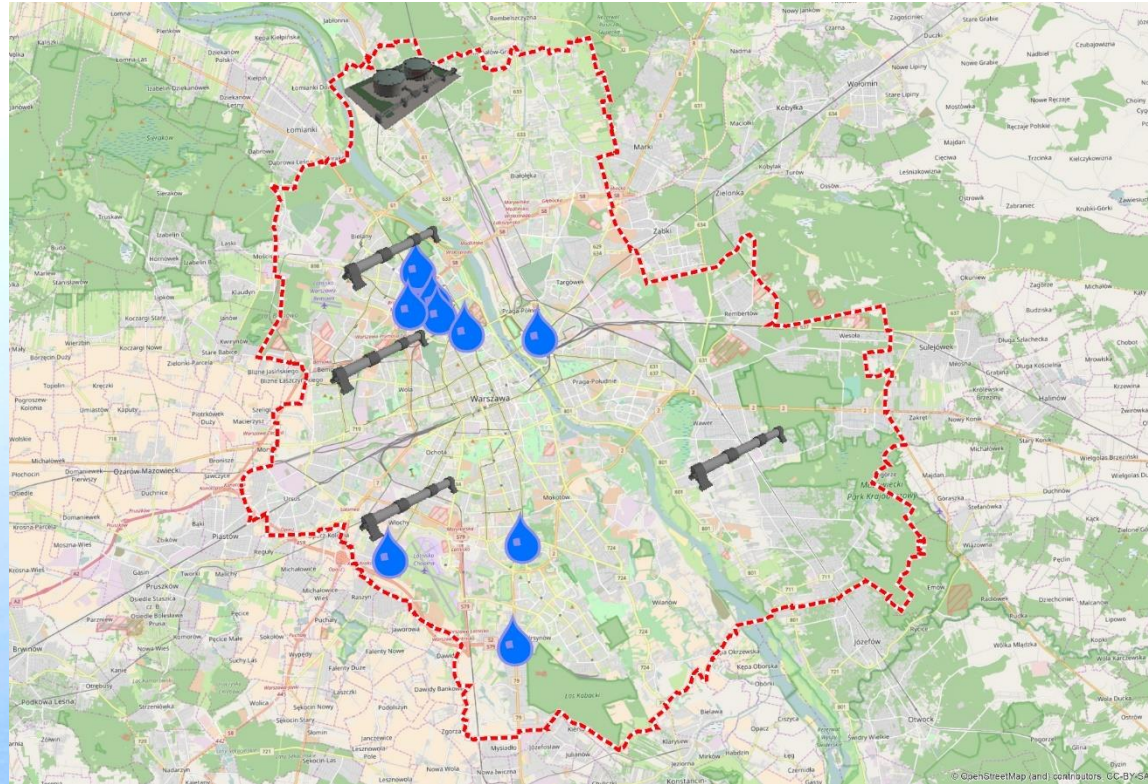
# Improving the functioning of waste water network — risks



- **Environmental pollution of the Vistula River and indirectly the Baltic Sea waters**
- **Fines for each discharge exceeding 10 a year**
- **Environmental disaster - damage to main collectors and waste water land spills and contamination of the environment**
- **Building disaster - depressions in the streets, adjacent areas, landslides**
- **Difficulties in communication (floods blocking streets and roads)**
- **Increase of the operating costs of maintenance and disaster recovery.**



# Scope of investments included in the Project

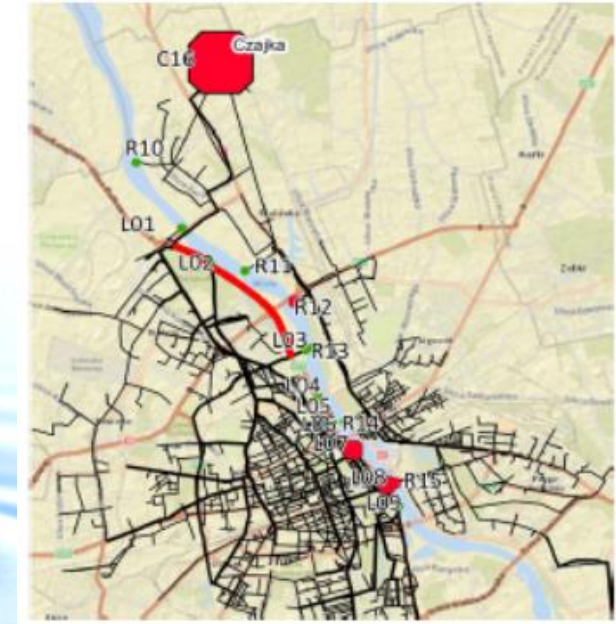


- Introduction of the central control system of the sewage network
- Adaptation of existing objects of the network to the needs of the system
- Construction of new channels and collectors, providing retention capacity necessary for the proper operation of the combined waste water network
- Modernization of the waste water network
- Construction of the retention tank in WWTZ Czajka

# Improving the functioning of waste water network — studies



- The implementation of the system to control the combined sewage network (RTC - Real Time Control) is the culmination of long-term investment activities conducted by the Company since 2001, including investments implemented in the previous phases of the Project aimed at reorganization of the waste water management in Warsaw agglomeration.
- Over 15 years of efforts, lead to creation of the infrastructure based on which the RTC system can be now implemented.
- The scope of the investment in the present and future projects (Phase V and VI) is the result of analyses carried basing on the mathematical model of the Warsaw wastewater network (analyses carried out by the consortium of CDM Smith and ITWH GmbH).
- The storm water data from past 25 years has been included in the analysis.
- 886 weather scenarios were compiled on the mathematical model.
- It was assumed to eliminate completely the discharge of untreated wastewater into Vistula River
- On this basis a variant 0 was developed, which was used to estimate the needs of wastewater network. The total need for retention capacity of 224,500 m<sup>3</sup> was determined.
- Variant 1 included the construction of retention facilities at all waste water overflows, without any limitation (land acquisition, infrastructure availability, environmental impact, etc.).
- In addition to these two variants, another 93 variants were considered, considering all the limitations (each of these variants was recalculated for all 886 weather scenarios).
- On this basis the scope of investments was established and divided into two projects (Phase V and Phase VI).





## Scope of the Project:

- **Phase V** 12 investment tasks, including:
  - Introduction of RTC system
  - Construction of nearly 80.000 m<sup>3</sup> retention tank in WWTP „Czajka”
  - Modernization of 2 main wastewater collectors
  - Modernization of 5 pumping stations
  - Modernization of wastewater networks in Warsaw and Pruszkow agglomerations
  
- **Phase VI** 3 investment tasks, including
  - Construction of 2 main wastewater collectors
  - Construction of the collector along Vistula River including discharge pumping station and chambers to connect to the existing collectors

## Ecological effect



- Reducing the amount of waste water discharges to the Vistula River from all storm overflows to a maximum of 10 per year
- Reducing the volume of waste water discharged untreated to the receiver of about 2 160 000 m<sup>3</sup>, which corresponds to the load Bod<sub>5</sub> of 365 040 kg, which is ca. 16 500 p.e./d.
- Avoid floods and their effects

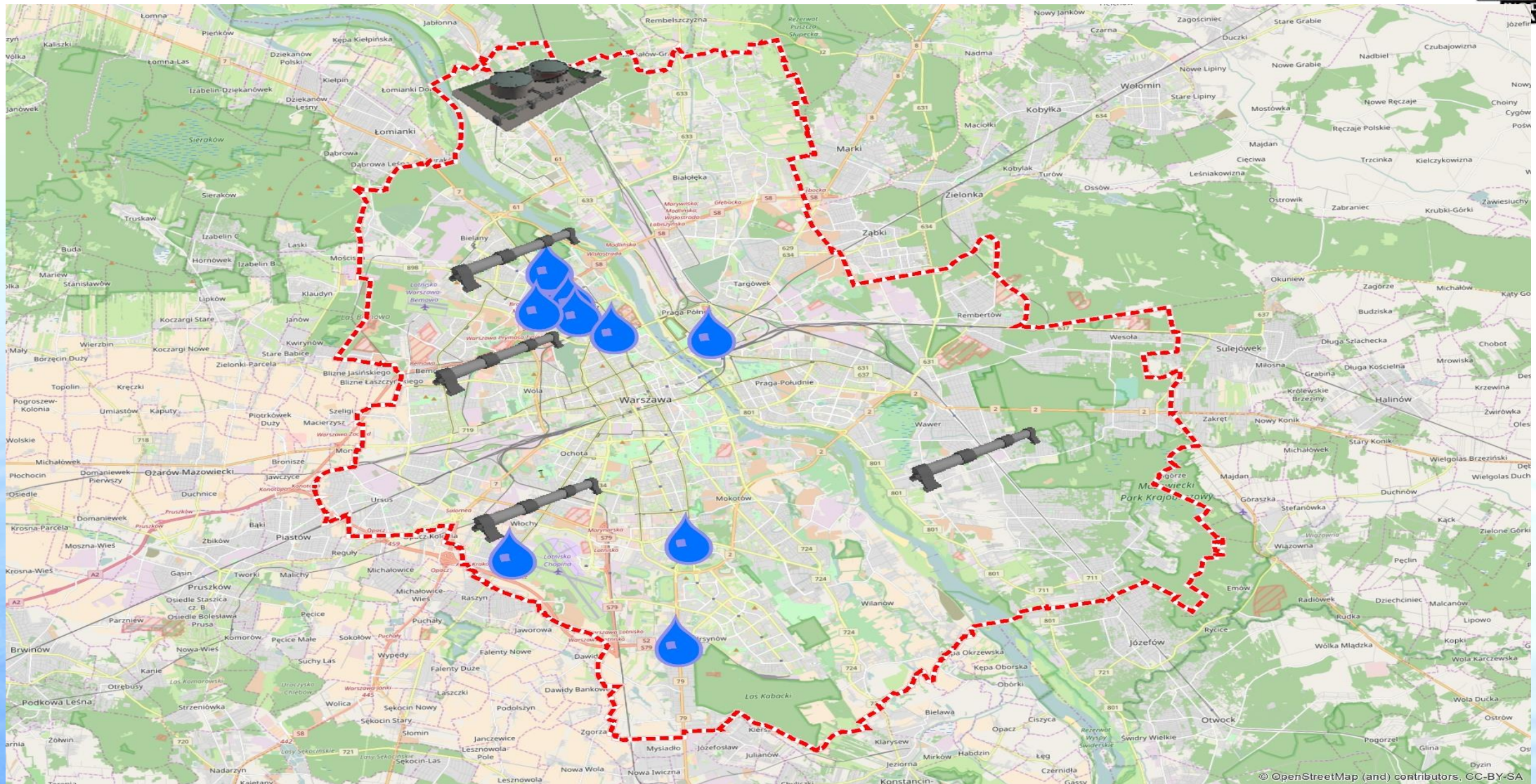


## Alternatives



- **The main alternative to the construction of combined waste water network control system is the erection of divided network (more than 1500 km)**
- **Such a solution is practically impossible due to the following issues:**
  - **combined waste water network in Warsaw is present in heavily urbanized area - in practice preventing the expansion or construction of a new network,**
  - **the need to preserve the decline (gravitational network),**
  - **the density of the underground infrastructure and numerous collisions,**
  - **the need to acquire the rights to the land properties (outstanding issues of ownership of the land)**
- **In order to optimize the alternative variant the Beneficiary considered limiting the construction of the network only to places where there are the most serious issues**
- **After optimization the need for new network is still approximately 500 km**

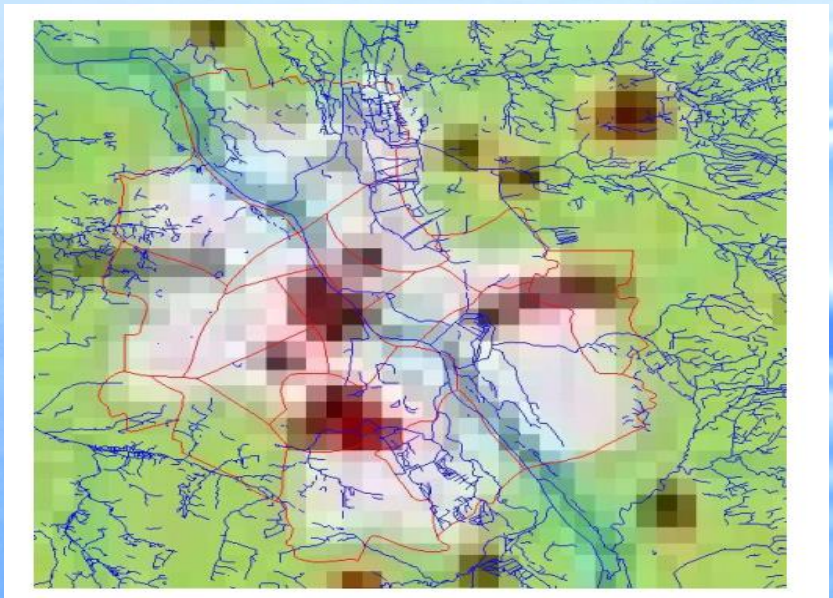
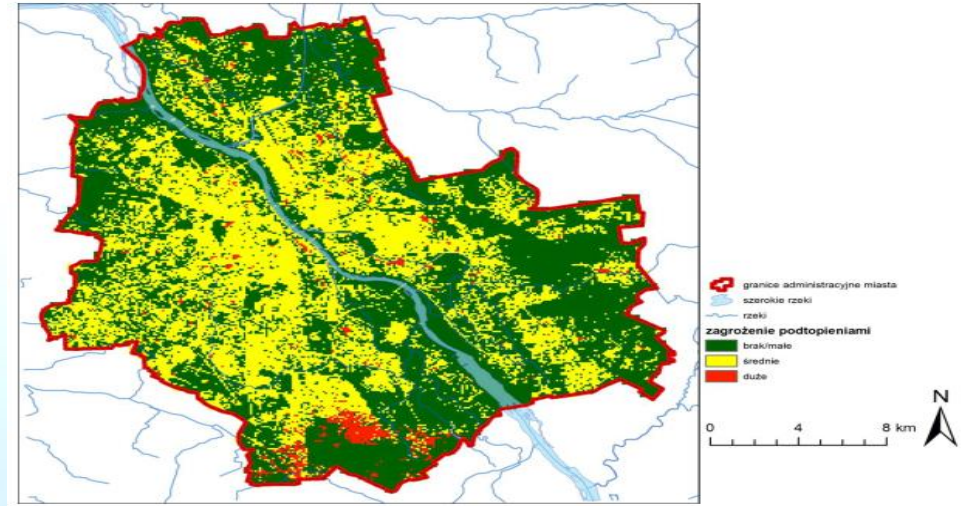
# Effect in economic analysis of storm water tank and pipelines renovation – avoidance of flooding



# Avoidance of flooding



## *Flood risk in Warsaw*



## *Flash floods in Warsaw*

## Avoidance of flooding – tangible damage



***Flooding events in  
Warsaw in the past:  
320 flooding events  
per year***

- Impact of Phase V of the Project: **40% = 130 events**
- Impact of Phase VI of the Project: **50% = 160 events**
- Number of buildings affected by a flooding event: **5**
- Average damage in each affected building: **EUR 5 000**
- **BENEFIT: EUR 3.7 M in 2021**



## Avoidance of flooding – saved time



- Traffic in Warsaw: 20 000 cars / day



**60 minutes / car saved  
due to Phase V**

- Impact of Phase V of the Project: 4 events
- Impact of Phase VI of the Project: 5 events
- **BENEFIT: EUR 0.8 M in 2021**

## Avoidance of flooding – repairment costs

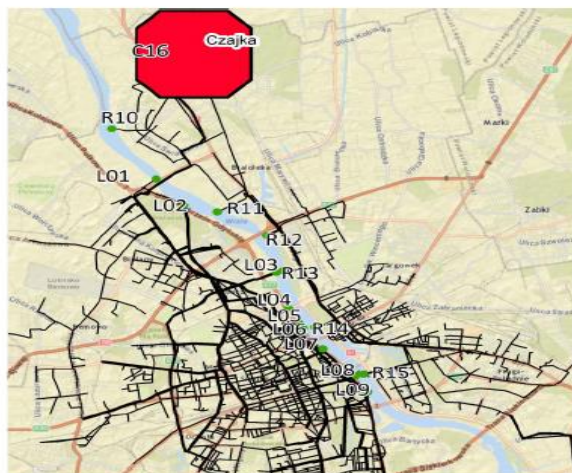


# 160 actions / year

- Impact of Phase V of the Project: **40% = 64** repairment actions / year
- Impact of Phase VI of the Project: **50% = 80** repairment actions / year
- Cost of one action: **EUR 1000**
- **BENEFIT: EUR 80 thous. in 2021**



# Reduction of stormwater discharge to the Vistula river



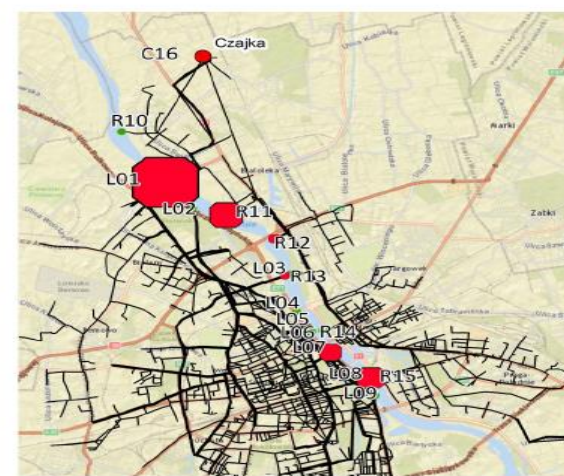
Nazwa	$V_{CSO-Basin}$
L01 - Farysa / Rytm	0 m <sup>3</sup>
L02 - Bielański	0 m <sup>3</sup>
L03 - Krasieńskiego	0 m <sup>3</sup>
L04 - Wenedów	0 m <sup>3</sup>
L05 - Kościelna	0 m <sup>3</sup>
L06 - Mostowa / Bolesć	0 m <sup>3</sup>
L07 - Karowa / Powiśle	0 m <sup>3</sup>
L08 - 3-go Maja	0 m <sup>3</sup>
L09 - Płyta Desantowa	0 m <sup>3</sup>
R10 - Nowodwory	0 m <sup>3</sup>
R11 - Żerań	0 m <sup>3</sup>
R12 - Pelcowizna	0 m <sup>3</sup>
R13 - Gołędzinów	0 m <sup>3</sup>
R14 - Ratuszowa	0 m <sup>3</sup>
R15 - Saska / Przewalowa	0 m <sup>3</sup>
16 - Czajka zbiornik centralny	224.500 m <sup>3</sup>
<b>Suma</b>	<b>224.500 m<sup>3</sup></b>

Rysunek 7: Szkic systemowy z przedstawieniem punktów zrzutów oraz tabela wymaganych objętości retencyjnych (V0)

**ASSUMPTION:**  
*The stormwater tank will reduce discharge to the Vistula river*

- Amount of reduced BOD<sub>5</sub>: 242 thous. Kg/year
- Fee for the raw wastewater discharge: 6 EUR/kg BOD<sub>5</sub>
- **BENEFIT: EUR 1.5 M in 2021**

*Impact beyond Warsaw – better water quality of the Vistula river*



Nazwa	$V_{CSO-Basin}$
L01 - Farysa / Rytm	86.500 m <sup>3</sup>
L02 - Bielański	0 m <sup>3</sup>
L03 - Krasieńskiego	2.900 m <sup>3</sup>
L04 - Wenedów	0 m <sup>3</sup>
L05 - Kościelna	1.300 m <sup>3</sup>
L06 - Mostowa / Bolesć	0 m <sup>3</sup>
L07 - Karowa / Powiśle	13.000 m <sup>3</sup>
L08 - 3-go Maja	1.300 m <sup>3</sup>
L09 - Płyta Desantowa	0 m <sup>3</sup>
R10 - Nowodwory	0 m <sup>3</sup>
R11 - Żerań	26.000 m <sup>3</sup>
R12 - Pelcowizna	4.300 m <sup>3</sup>
R13 - Gołędzinów	0 m <sup>3</sup>
R14 - Ratuszowa	0 m <sup>3</sup>
R15 - Saska / Przewalowa	19.500 m <sup>3</sup>
16 - Czajka	0 m <sup>3</sup>
<b>Suma</b>	<b>154.800 m<sup>3</sup></b>

Rysunek 8: Szkic systemowy z przedstawieniem punktów zrzutów oraz tabela wymaganych objętości retencyjnych (V1)

## Lower costs of sewage treatment for the inhabitants



*Amount of sewage from the new connected inhabitants: 575 thous. m<sup>3</sup>/year*



- Cost of septic tank exploitation: EUR 5 / m<sup>3</sup>
- Cost of sewerage: EUR 1.9 / m<sup>3</sup>
- **BENEFIT: EUR 1.7 M in 2021**



## **Main investment tasks of the Project: Modernization of Northern Water Treatment Plant**



- **The Northern water treatment plant is the second source of water for the Warsaw agglomeration**
- **The plant is located North of Zegrze Lake from which the plant intakes the surface water**
- **Company works since 1986. The maximum production capacity of the plant after modernization is 240 000 m<sup>3</sup>/d**
- **Currently Northern water treatment plant requires further modernization in order to maintain the high quality, chemically stable water introduced to the network, due to fluctuations in the quality of raw water taken from Zegrze Lake. This phenomenon is increased due to climate changes (draughts, torrential rains)**

## Modernization of Northern Water Treatment Plant



- Due to the periods of drought and prolonged drop of the water level in the Vistula River, the importance of Northern water treatment plant - intake of water from another source - Lake Zegrze, has significantly increased
- Over the last dozen years the water in Zegrze Lake underwent systematic deterioration.
- Notwithstanding the foregoing, raw water quality changes occurring in recent years cause the risk of failure to the quality of water, especially in case when significant increase in water production is required, for example in order to assist the production of Central water treatment plant in a crisis situation
- As stated above, the situation-requires second stage of modernization of the process in Northern water treatment plant, including modernization of Ozone treatment, Rapid sand filters and Lime dosing
- Within the framework of the future project (phase VI) the construction of active carbon filters is also planned

# Modernization of Northern Water Treatment Plant



- **Assumed effects of II stage of the modernization of the process in Northern water treatment plan**
  - **improvement of water quality (chemical stability)**
  - **Improvement of the stability and reliability of process (reliable equipment)**
  - **improving the safety of the process (stable quality of treatment processes - mainly ozone treatment)**
  - **reduction in operating costs (use of energy-efficient solutions, process optimization)**

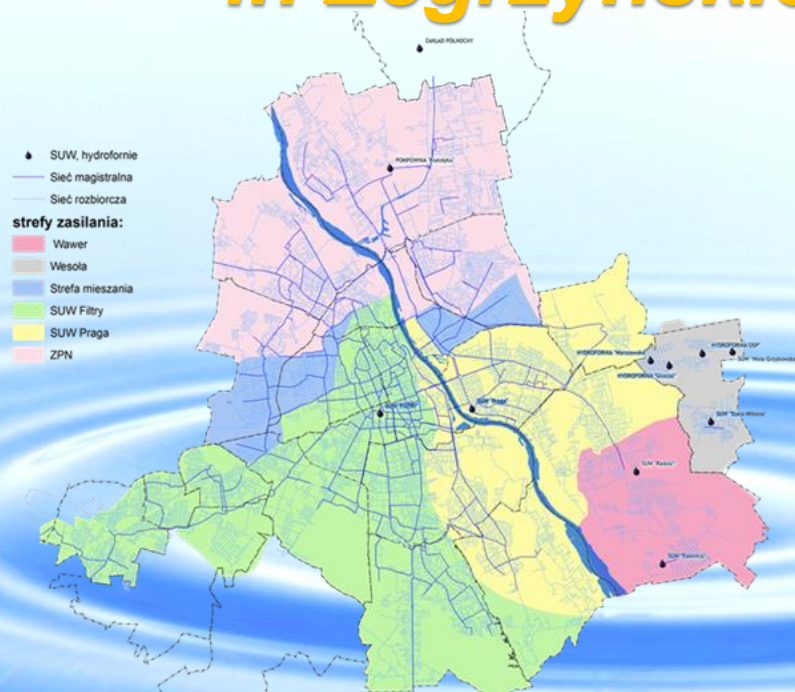
# Modernisation of the water supply system



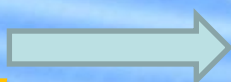
**North Water Treatment Station**



**Problem with worsening surface water in Zegrzynskie Lake**

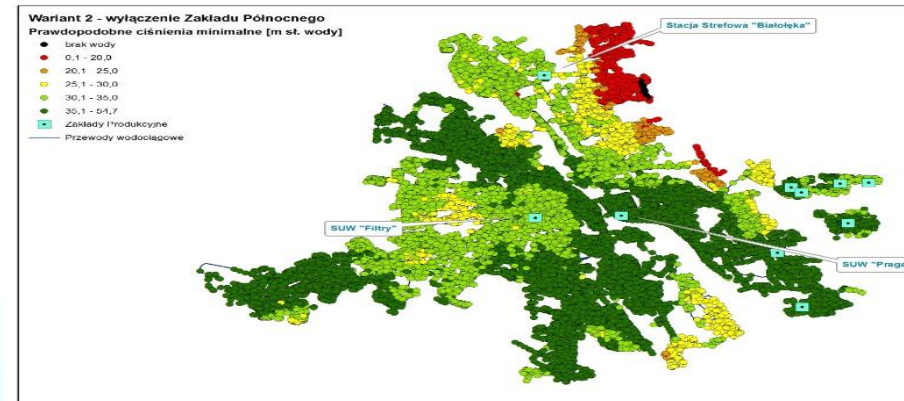
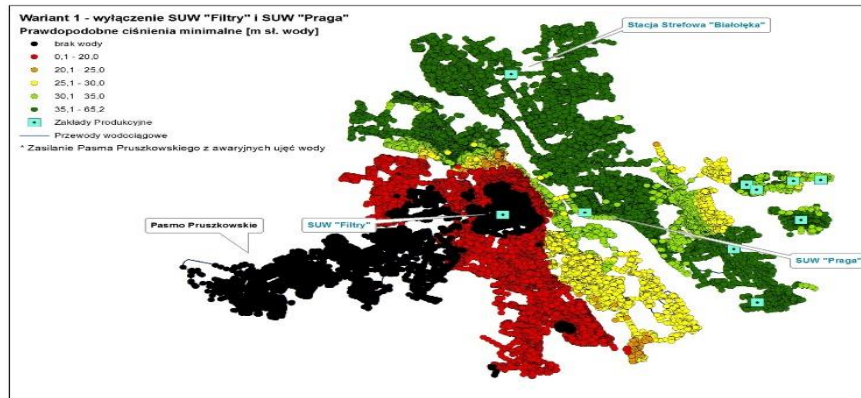


**Central Water Treatment Station**



**Problem with low water level in Vistula river**

# What is the cost of 1 day without water?



***In case of a failure of water supply from the North or from the Central Water Treatment Station***



***Insufficient water pressure***

## Safety of water supply – 1 day without drinking water



### *Market analogy method: Using price of an analogous good*

**ASSUMPTION:  
80% inhabitants  
would buy bottled  
water**

- Impact of Phase V of the Project: **60%**
- Impact of Phase VI of the Project: **40%**
- Number of inhabitants willing to buy bottled water: **1.5 M**
- **BENEFIT: EUR 0.4 M in 2021**



## Safety of water supply, 1 day without water - cost for firms



**ASSUMPTION:**  
*80% Warsaw firms  
can't function without  
water*

2021

**ASSUMPTION:**  
*1 day without water  
every 2 years till  
2027, every year till  
2037, 2x/year after  
2037*

- Impact of Phase V of the Project: **60%**
- Impact of Phase VI of the Project: **40%**
- Daily net revenues of Warsaw firms in 2014: **EUR 24 M**
- Benefit = **EUR 24 M x 80% firms x 60% due to Phase V**
- **BENEFIT: EUR 11 M in 2021**

**Lost  
production  
method**

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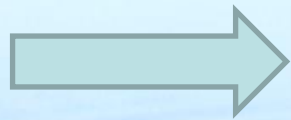




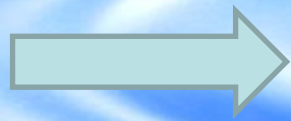
## Positive economic ratios – recommendation to implement



**EUR 30 M**



**5,9%**



**1,11**



## JASPERS involvement and added value



- **Support in description of investments in light of the shortcomings of the system**
- **Adaptation of the scope of the Project in order to meet the requirements of the EU law and the Cohesion Fund Operational Programme**
- **Consultation with regard to the environmental impact assessment**
- **The thorough verification of the application form and feasibility study allowed for a clear presentation of the Project objectives and tangible and ecological effects**
- **Fast track approval – no interruptions**
- **Advice with regard to the economic analysis methodology**



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