PERCOLATION DRAINAGE SYSTEMS

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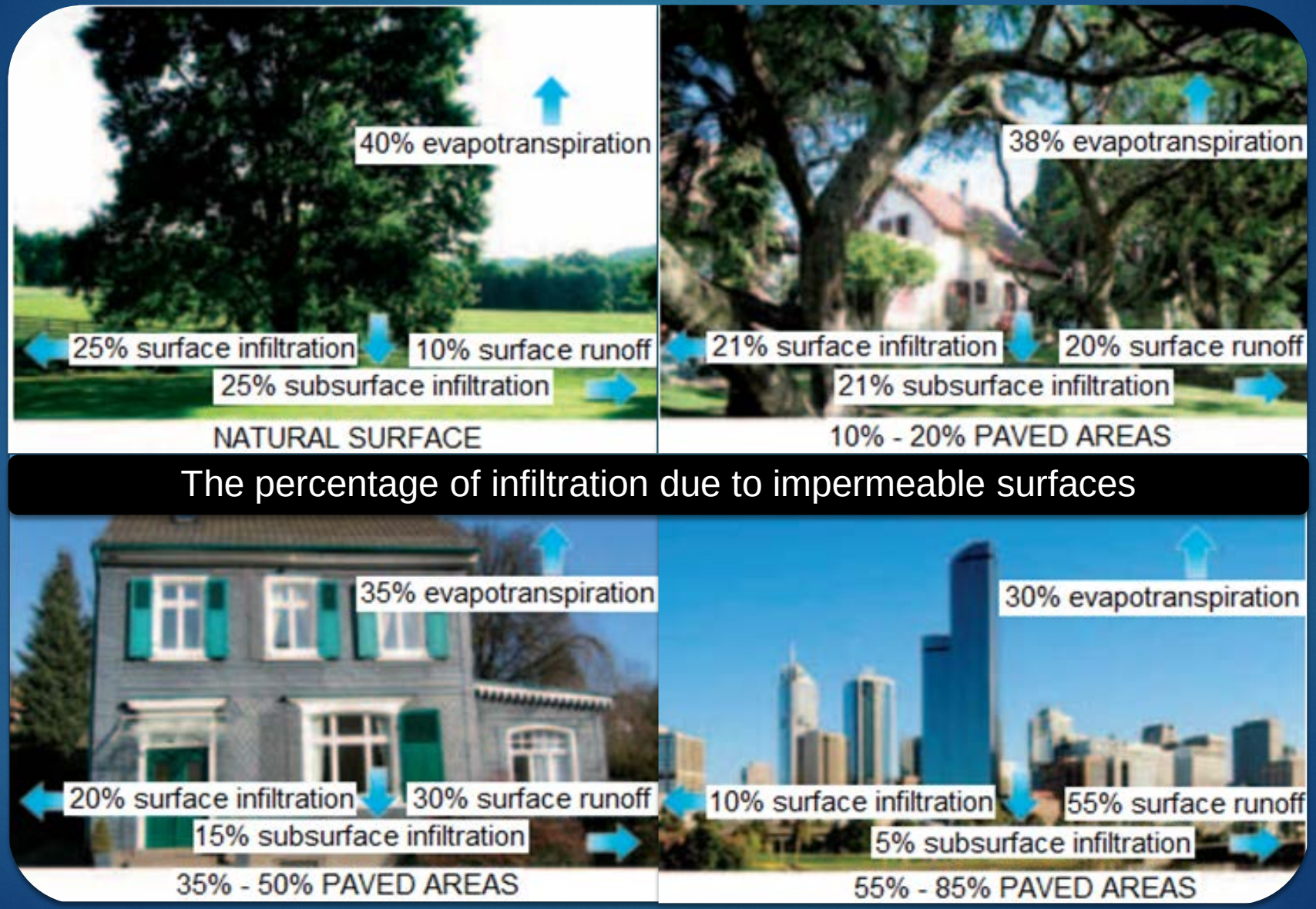
INTRODUCTION



The percentage of infiltration due to impermeable surfaces

INTRODUCTION

- With an increasing urbanization of the country is gradually reduced natural infiltration.
- The issue of drainage of rainwater is gaining more and more on its importance over the time.
- Necessity of infiltration is mainly based on increasing of urbanized areas and the cost of draining rainwater.
- Sewerage systems in urban areas are becoming overloaded.
- As a result of the mentioned are the floods followed by huge ecological and economic damage.

INTRODUCTION

- Percolation of rainwater as a part of storm water management is becoming more and more important as a drainage solution in Slovakia

- However, the biggest problem is that there is no legal framework as well as no standards or guidelines of sustainable storm water management application techniques, especially in the field of rainwater percolation

- Designers may suggest the drainage of rainwater through the infiltration facilities and at this point, the problems arise due to the lack of information and experience in designing along with the shortcomings of legislation.

- There have already been reported many cases of an inadequate design resulting in poor or insufficient functioning of the systems, many of which have resulted in a damage to the property.

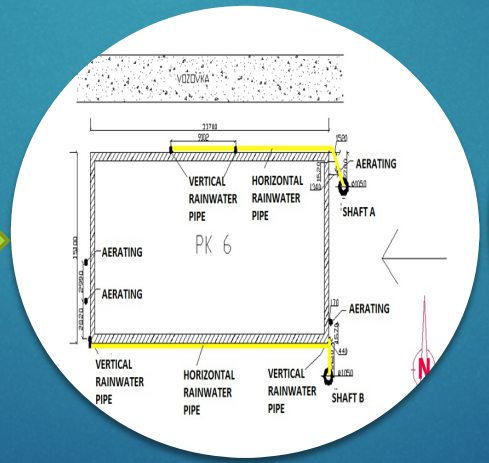
EXPERIMENTAL RESEARCH (Košice-city)

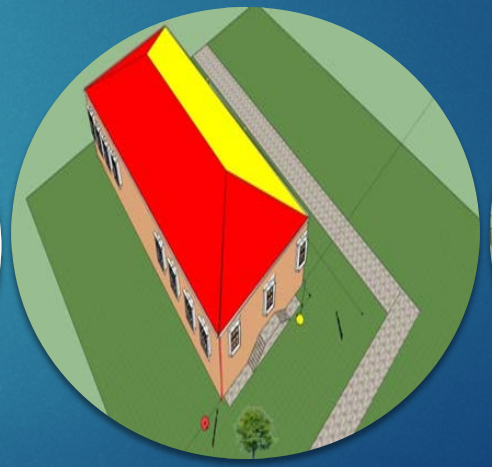
- Our research and own measurements in the field of storm water quantity and quality parameters has been started in the campus of Technical University of Košice as a part of the management of storm water project
- The objects of our research are two infiltration shafts in TU campus in Kosice, already existing prior to our research.
- These infiltration shafts were designed as a drainage solution for a real school building PK6

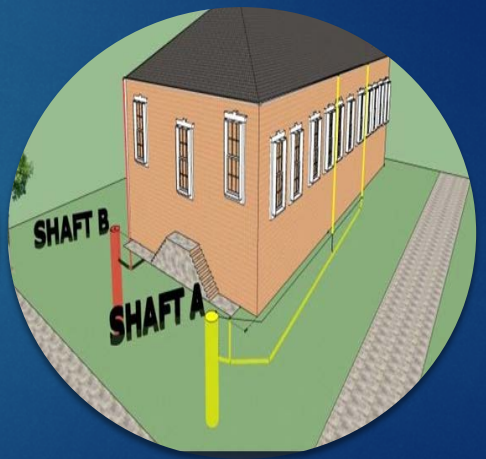
	SHAFT A	SHAFT B
The outer diameter of shaft	1000 mm	1000 mm
The inner diameter of shaft	800 mm	800 mm
Shaft depth	6,0 m	5,9 m
Depth of inflow	1,65 m	1,5 m
DN of inflow pipe	DN 150	DN 125
Infiltration coefficient at the bottom	1.10^{-3} m/s	1.10^{-3} m/s
Drainage area of roof	212 m^2	336 m^2
Accumulation volume	2,11 m^3	2,18 m^3

EXPERIMENTAL RESEARCH (Košice-city)

- The PK6 building at the Technical University of Kosice campus was selected for research into the quality and volume of rainwater draining into existing underground drainage shafts
- Two vertical shafts are located next to the PK6 building
- All of the run-off rainwater falling onto the roof flows into these underground shafts







EXPERIMENTAL RESEARCH (Košice-city)

MEASUREMENT EQUIPMENT IN INFILTRATION SHAFTS

M4016 - universal data unit

Headquarters, respectively a control / data unit for generating of measurement data, is a universal data unit M4016, which is situated in the infiltration shaft A. Infiltration shaft B, respectively devices located in this shaft, are also connected to the control unit.

Registration and control unit equipped unit M4016 includes universal data logger, telemetric station with build-in GSM module, programmable control automat and multiple flow meter if M4016 is connected to an ultrasonic or pressure level sensor.

EXPERIMENTAL RESEARCH (Košice-city)

MEASUREMENT EQUIPMENT IN INFILTRATION SHAFTS

Measurement flume with ultrasonic level sensor

Under the inflow, respectively rain outlet pipe in the shaft, the measurement flumes for metering of the rainwater inflow from the roof of PK6 building are located in both shafts. The rainwater from the roof of PK6 building is fed through rainwater pipes directly into measurement flumes placed under the ultrasonic level sensor and the sensor then transmits the data about the water level in the measurement flumes to the M4016 unit.

EXPERIMENTAL RESEARCH (Košice-city)

MEASUREMENT EQUIPMENT IN INFILTRATION SHAFTS

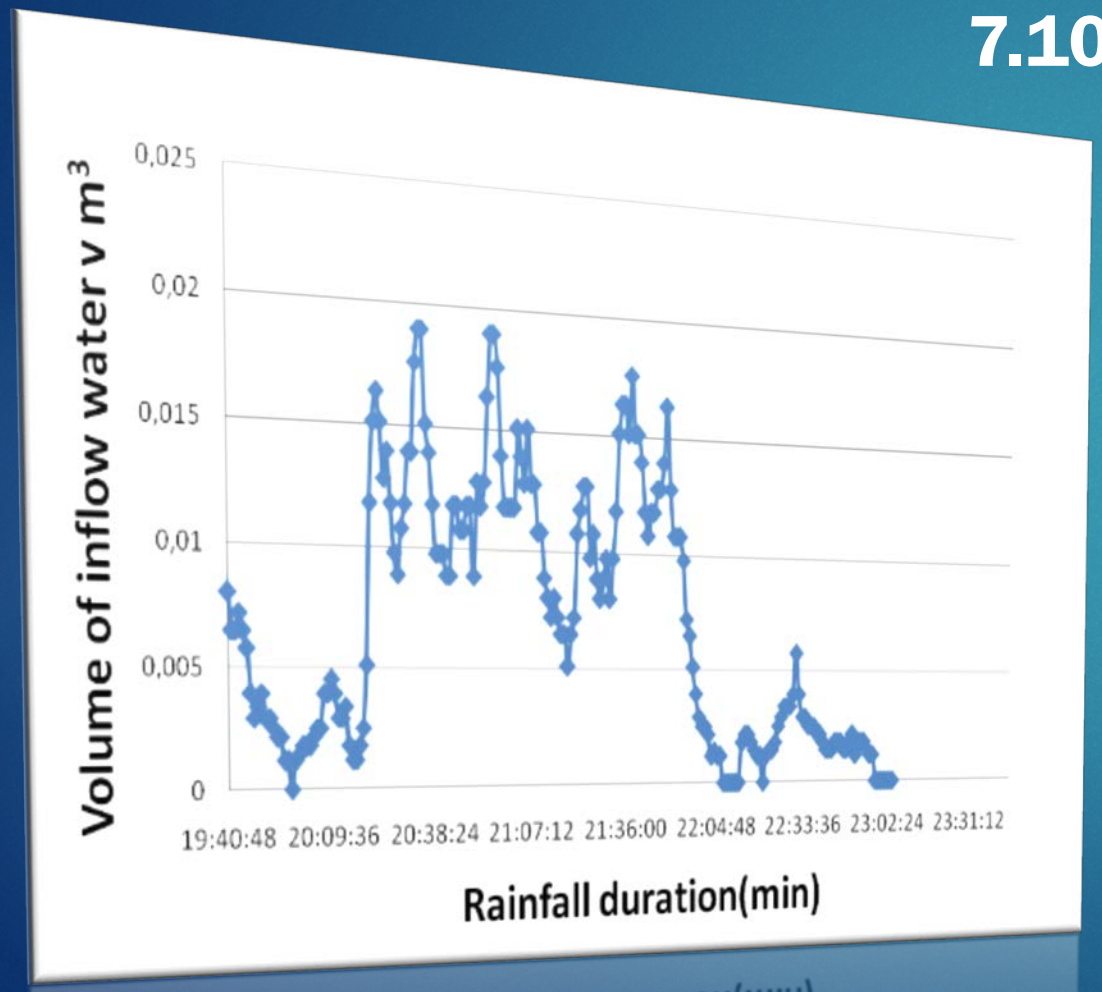
Pressure sensor LMP307

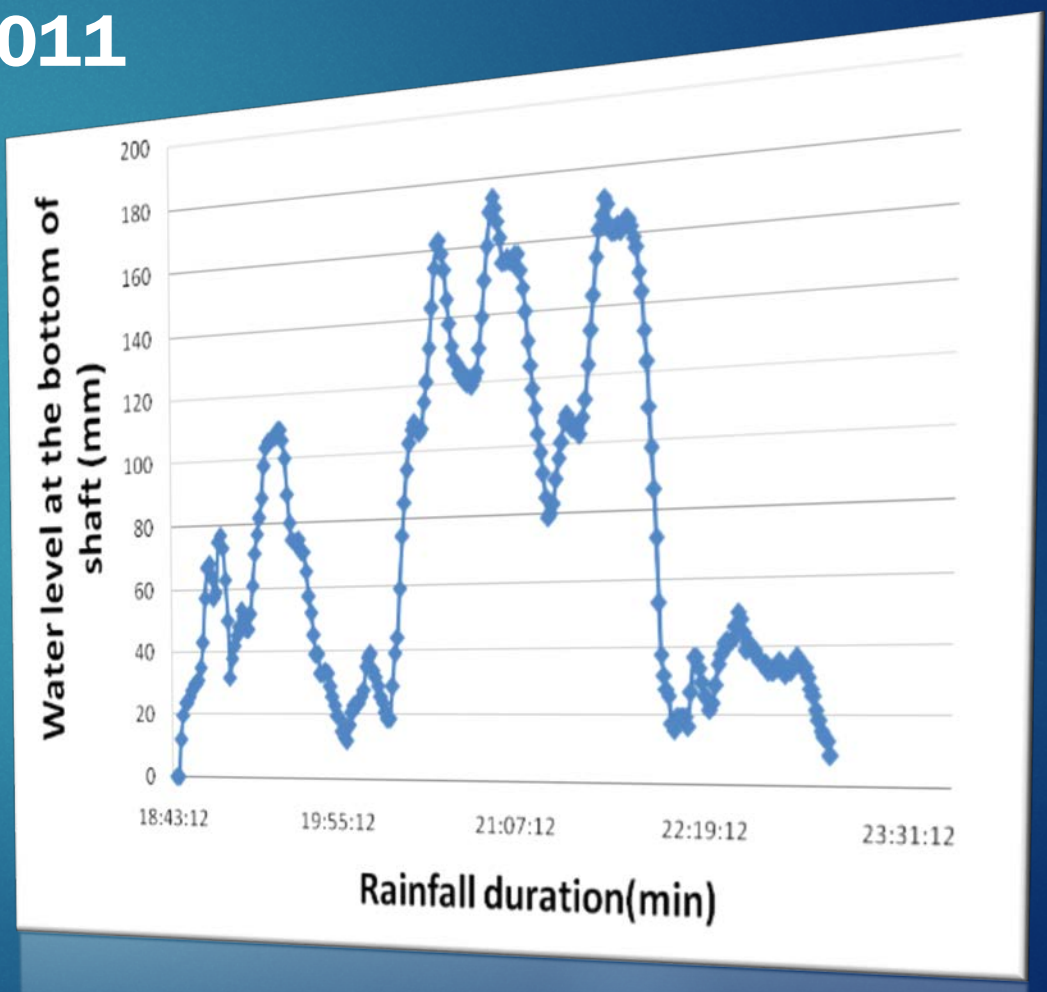
The measurement of the inflow of rainwater takes place at the bottom of the infiltration shafts, where the pressure sensors of LMP307 type are located for monitoring of water lever

The sensors are located in a metal container at the bottom of the shafts and used for continuous measurement of water levels and infiltration capabilities of the shafts. The pressure sensor is made of stainless steel with protection IP 68 and is connected with the control unit M4016 by a communication cable where the measured data is sent in a one minute interval while the data about the rainwater inflow is sent directly to the server.

EXPERIMENTAL RESEARCH (Košice-city)

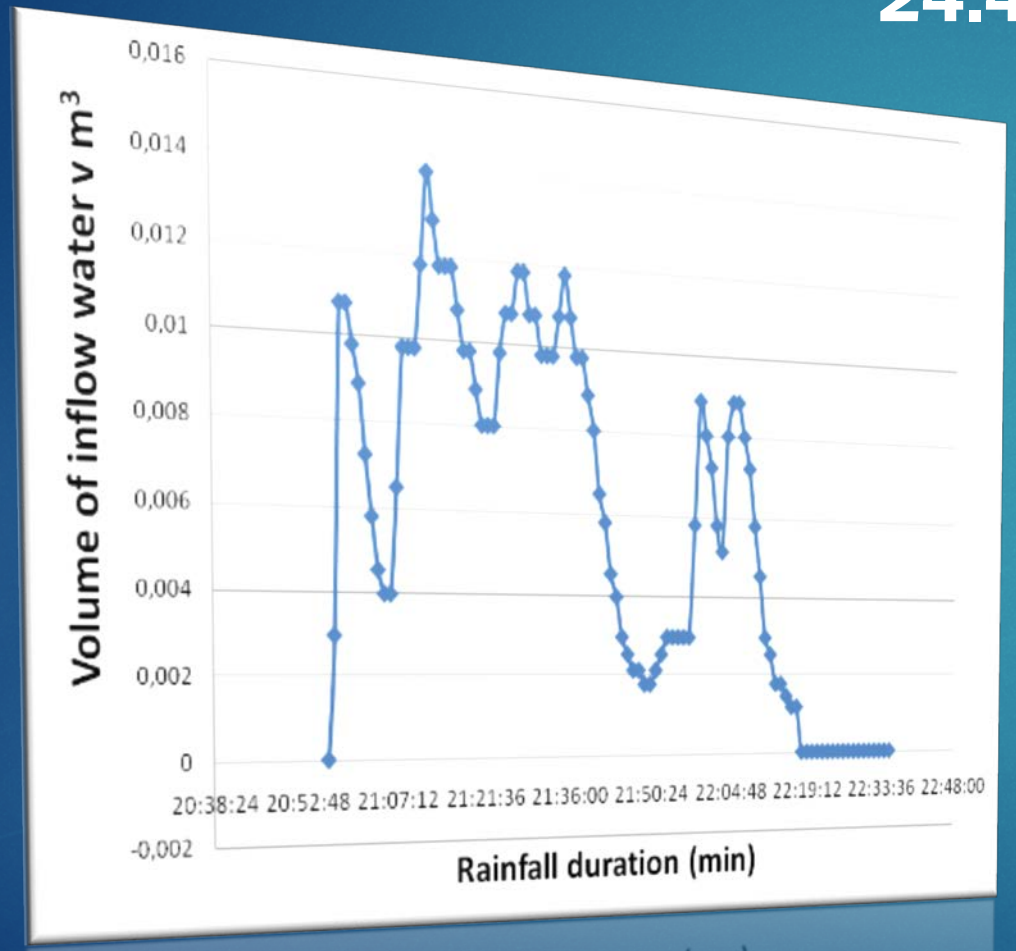
RAINFALL
7.10.2011

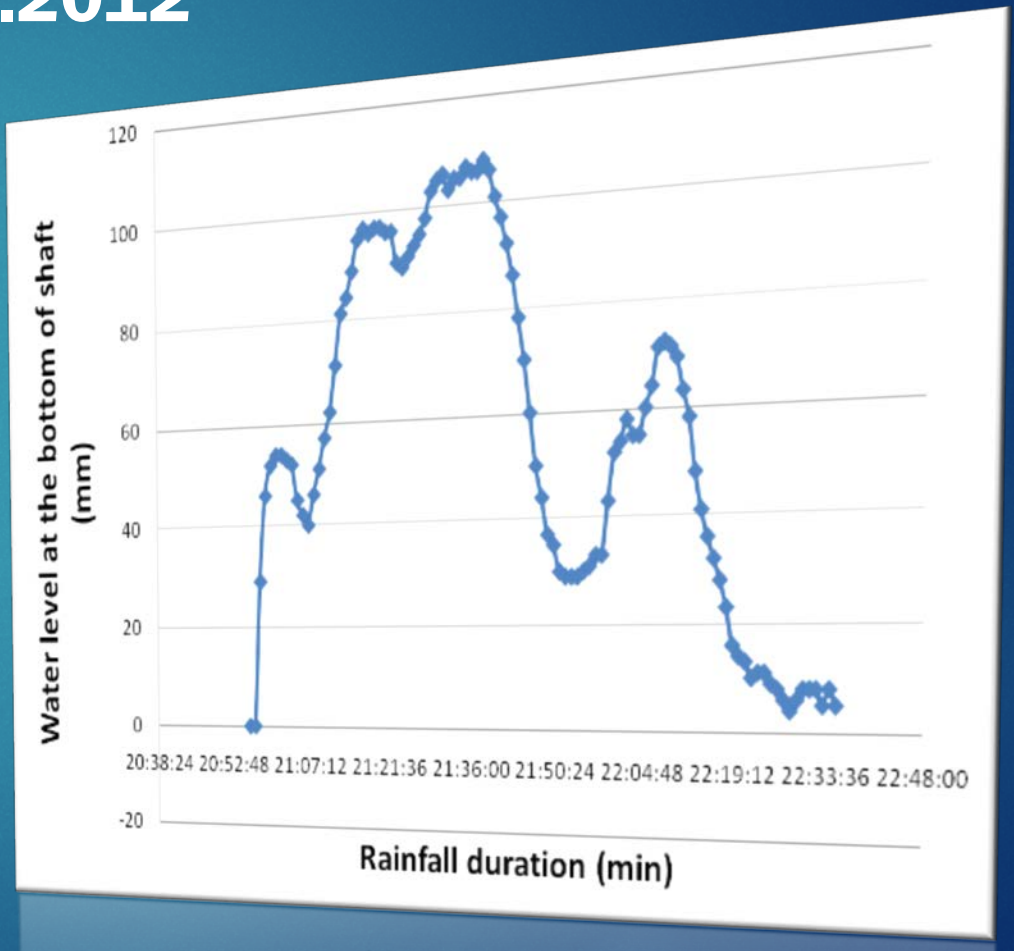




EXPERIMENTAL RESEARCH (Košice-city)

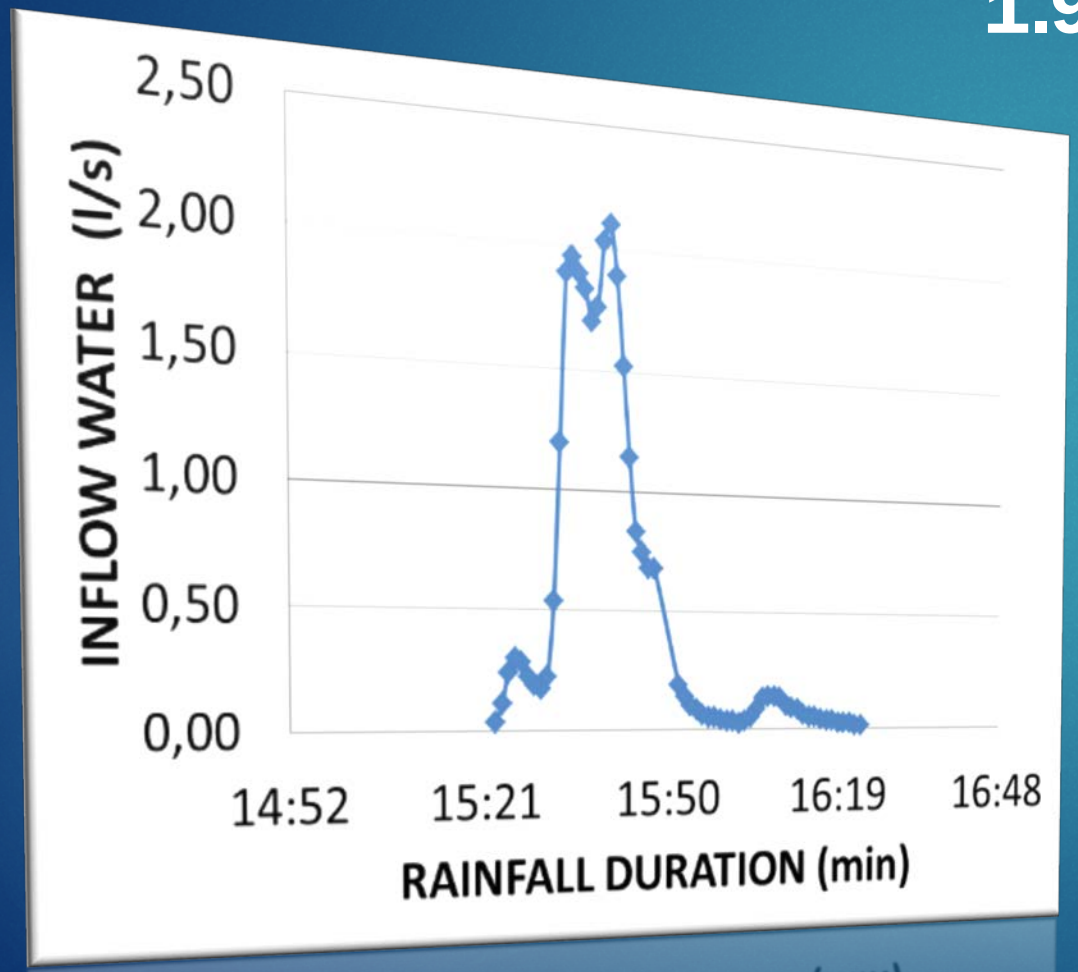
RAINFALL
24.4.2012

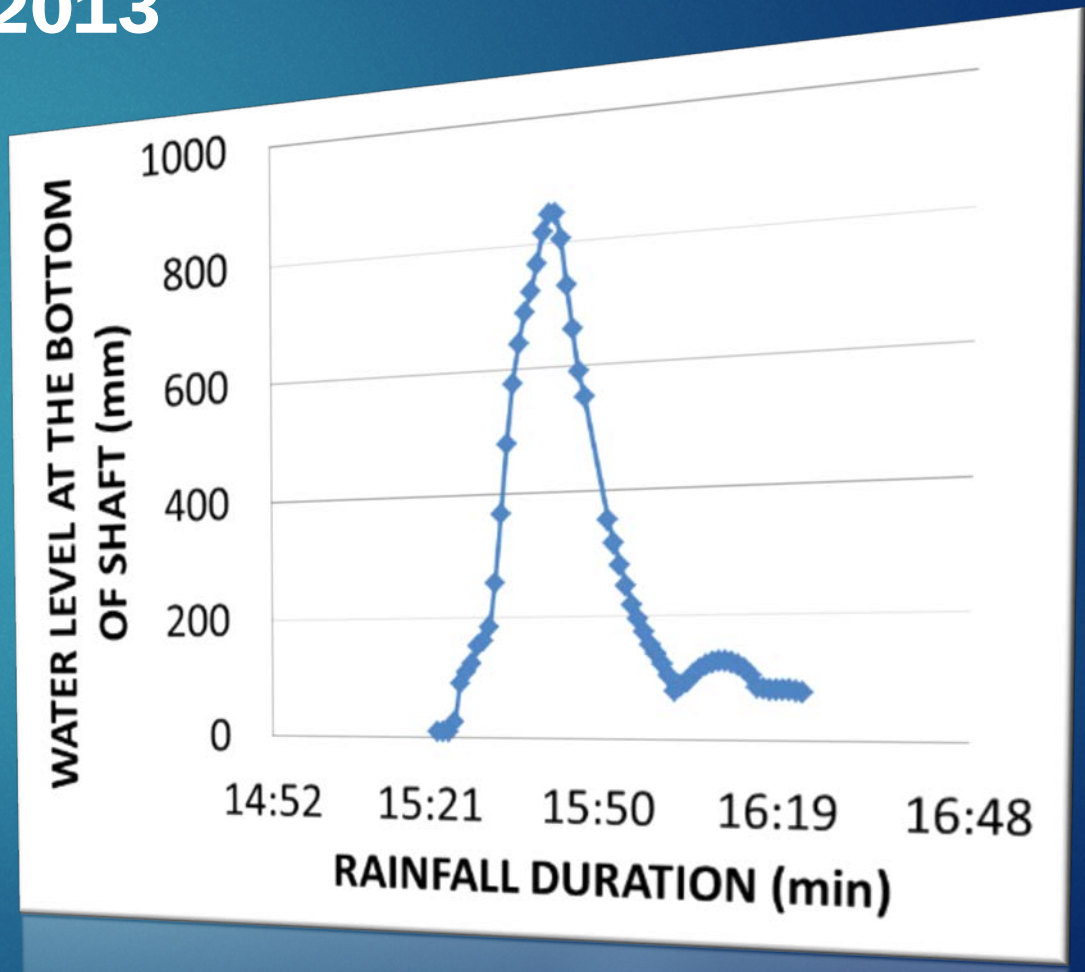




EXPERIMENTAL RESEARCH (Košice-city)

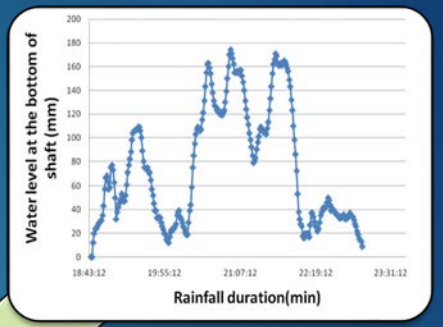
RAINFALL
1.9.2013

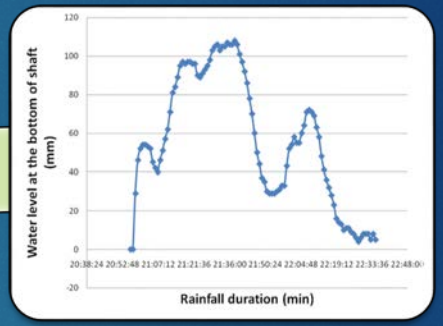


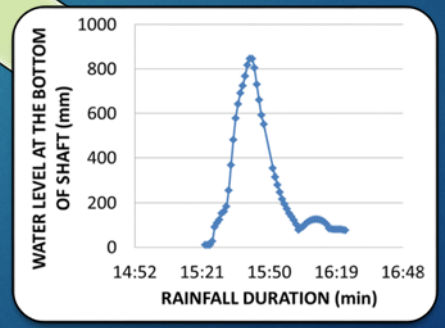


EXPERIMENTAL RESEARCH (Košice-city)

$k_f 10^{-3}$ m/s



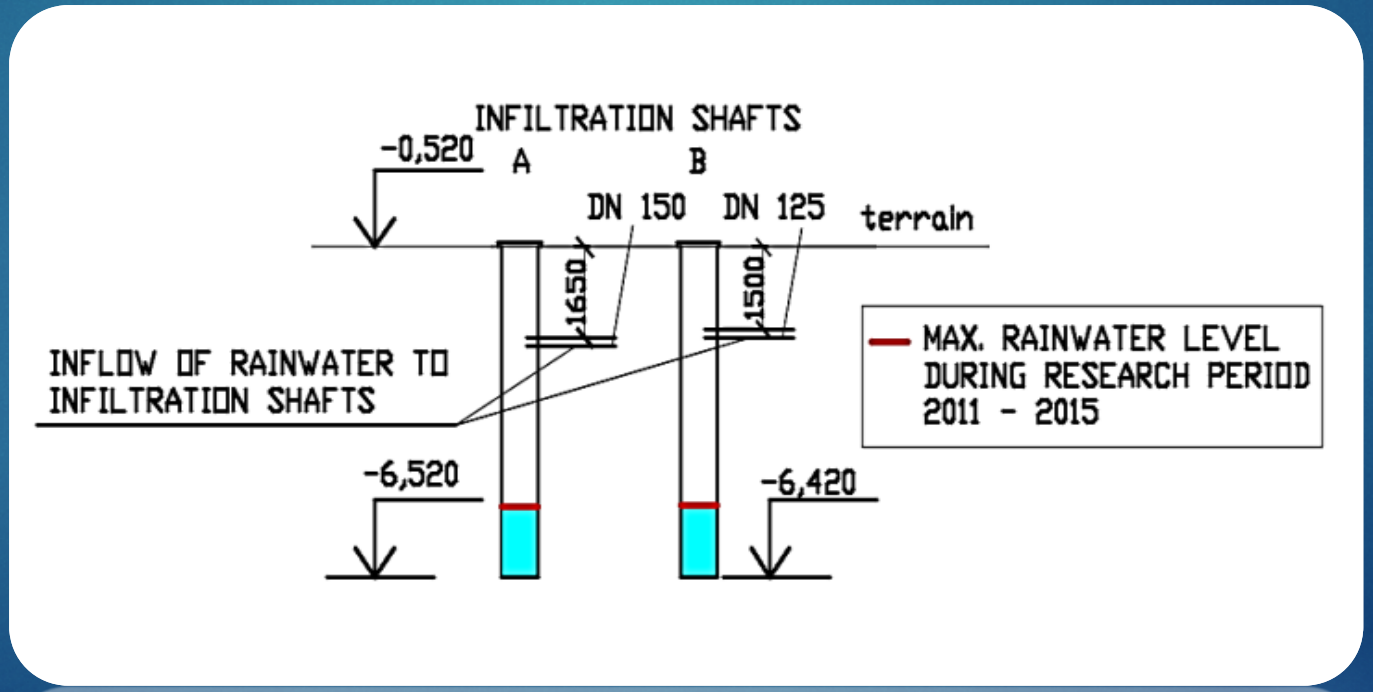




In most cases of research – time of rainfall is same as time required for infiltration of total volume (during 5 years of research)

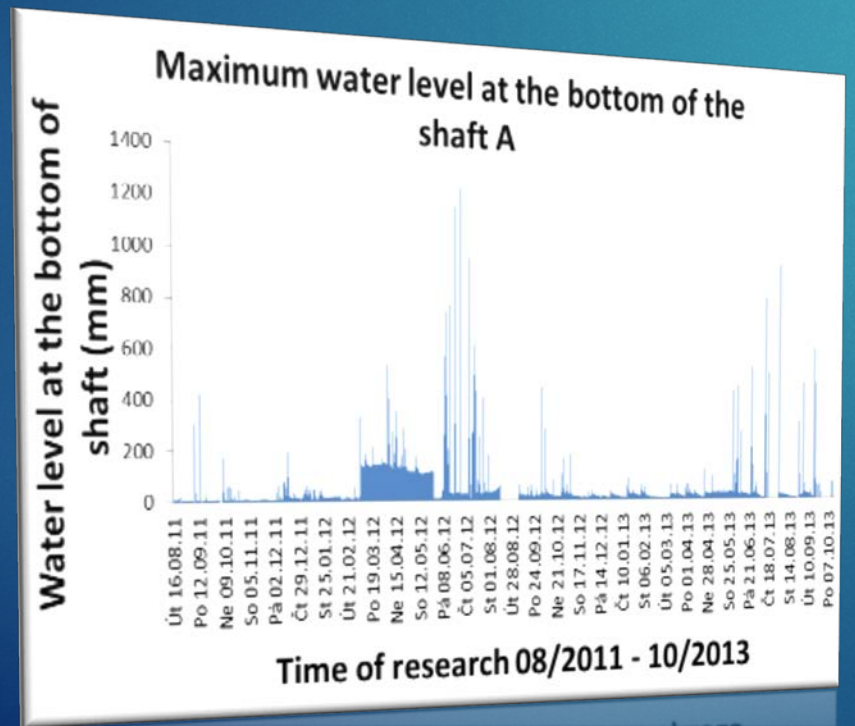
EXPERIMENTAL RESEARCH (Košice-city)

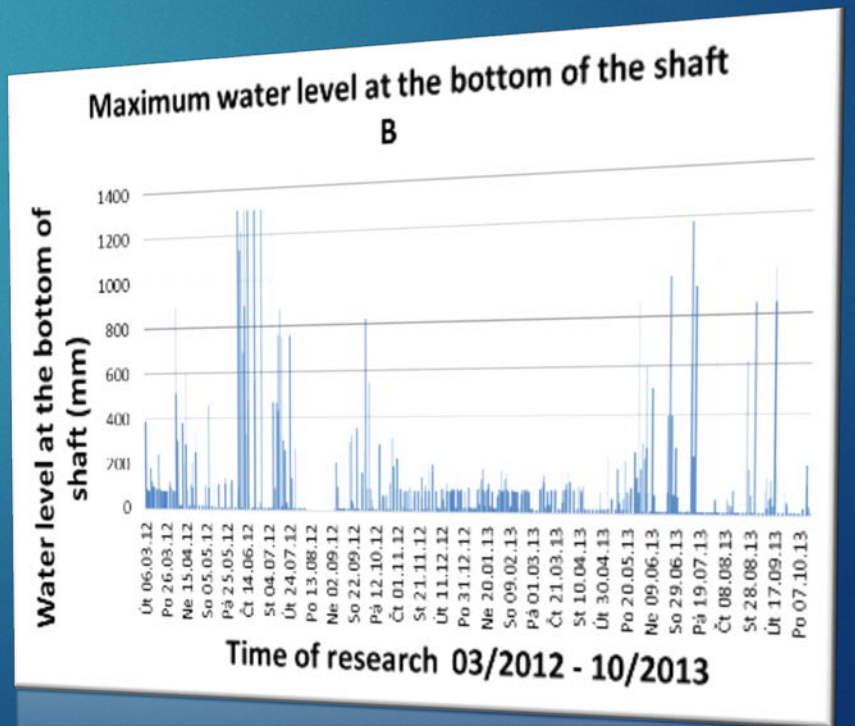
The maximum water level in the infiltration shaft A, measured during the research period of 2011-2014, was 1,28 m which is less than 1/3 of the filling depth of the infiltration shaft A. The maximum water level in the infiltration shaft B, measured during the research period was 1,31 m which is less than 1/3 of the filling depth of the infiltration shaft B, too



CONCLUSION

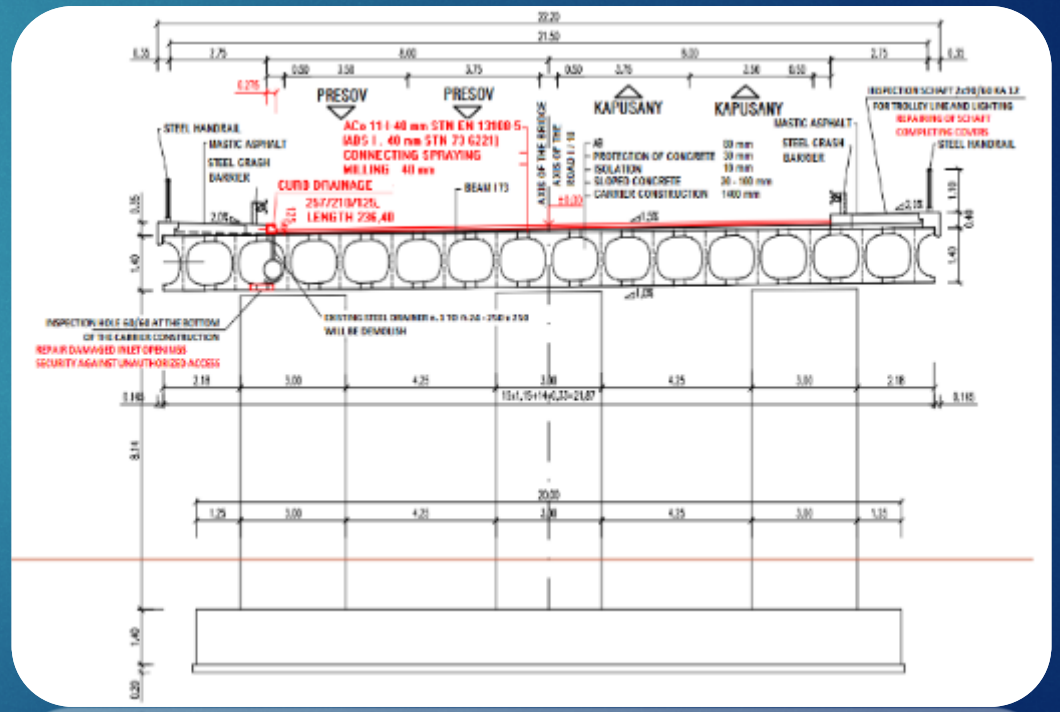
- Despite the fact that the area for infiltration, respectively the size of the bottom of the shaft is only 0,785 m^2, the process of infiltration and operation of this facility is fluent and free from complications
- Safe disposal of surface runoff is ensured by the infiltration coefficient $k_f = 1.10^{-3}$ m/s.





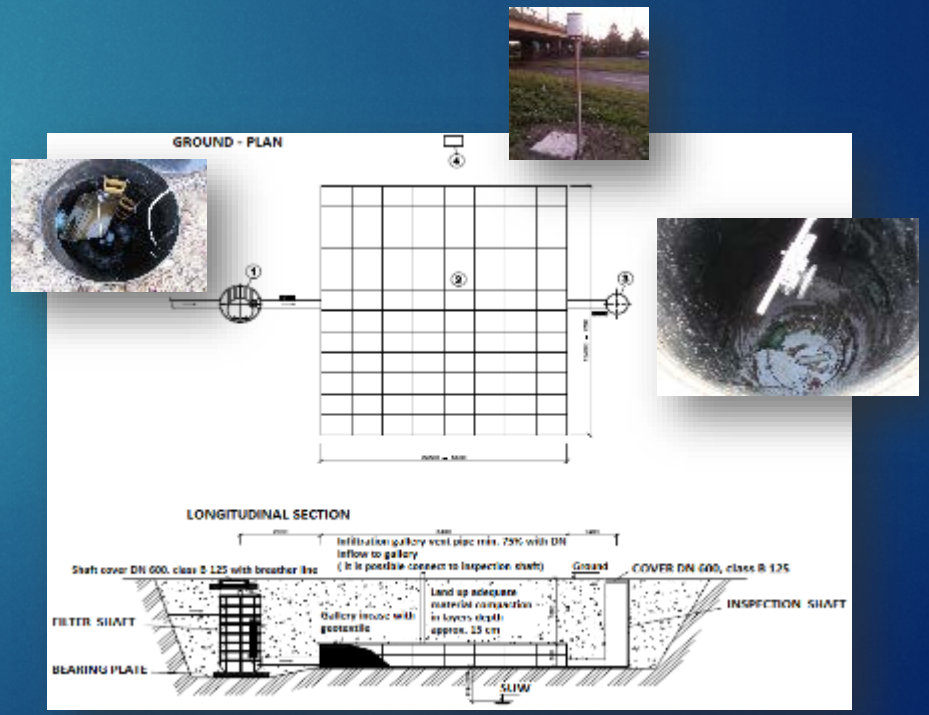
EXPERIMENTAL RESEARCH (Prešov-city)

- The second experimental research of infiltration efficiency is located in Šarišské Lúky near Prešov city.
- The rainwater infiltration as a drainage solution is installed from a bridge road after its reconstruction.
- The objects of our research is infiltration gallery



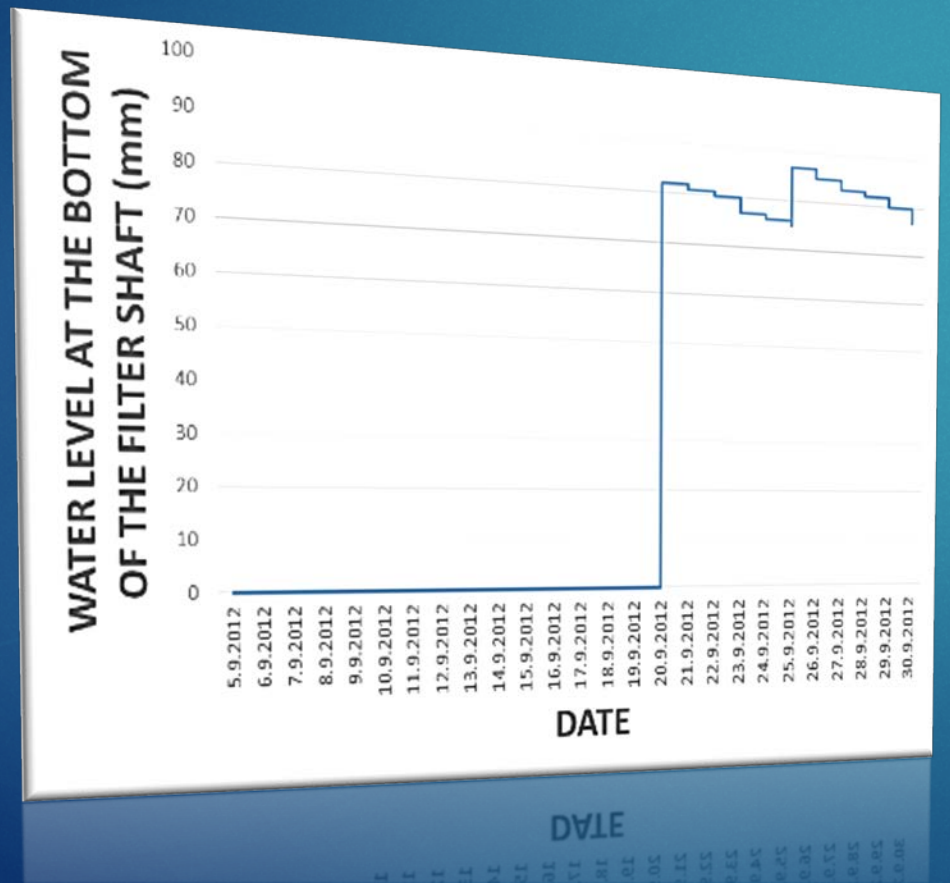
EXPERIMENTAL RESEARCH (Prešov-city)

- The infiltration gallery from the infiltration units was designed in the monitored area by the means of theoretical calculation
- The rainwater from the bridge flows into a filter shaft, which captures and sediments coarse and fine impurities.
- The rainwater then flows into the infiltration gallery, where the water is filtered with the use of infiltration into the soil. The measuring devices for the volume of rainwater are the same like in the infiltration shaft in TU campus in Kosice.

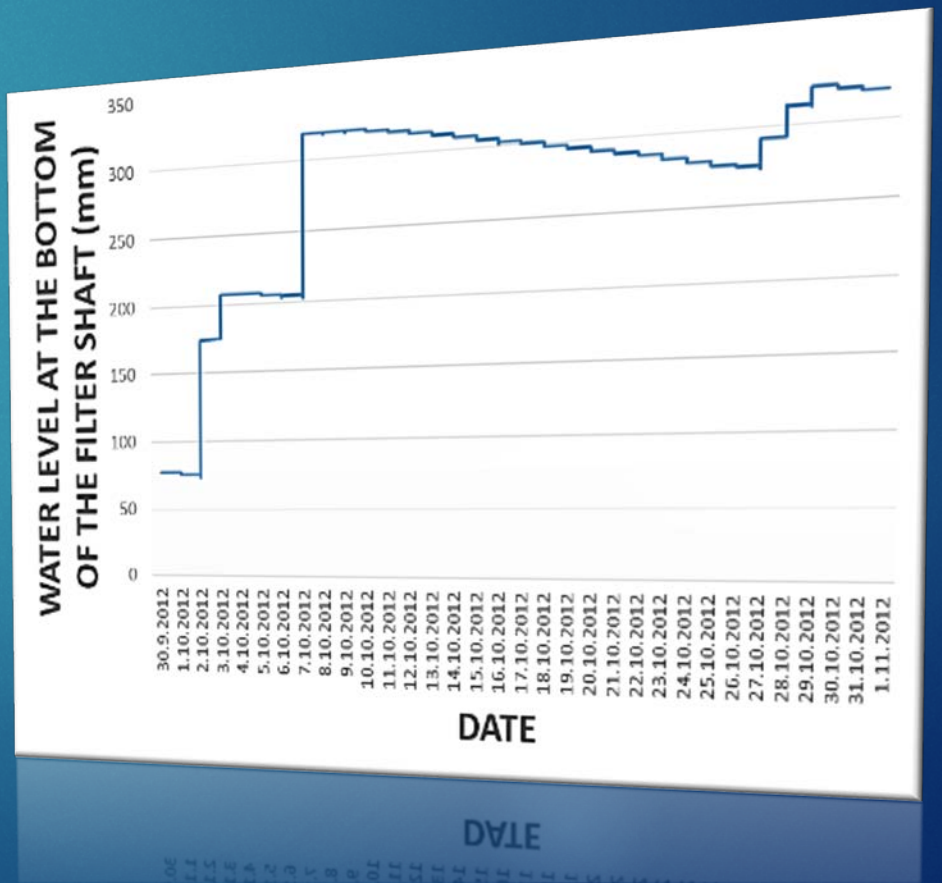


EXPERIMENTAL RESEARCH (Prešov-city)

Water level changes at the bottom of filter shaft during September 2012 – Start

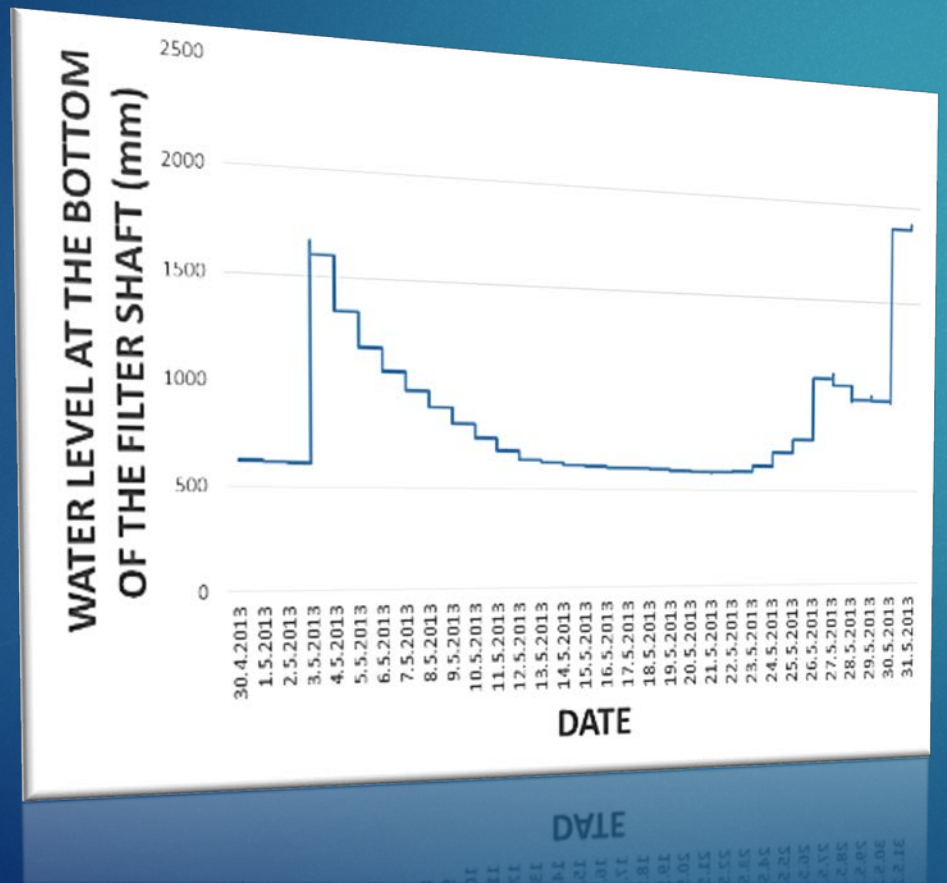


Water level changes at the bottom of filter shaft during October 2012

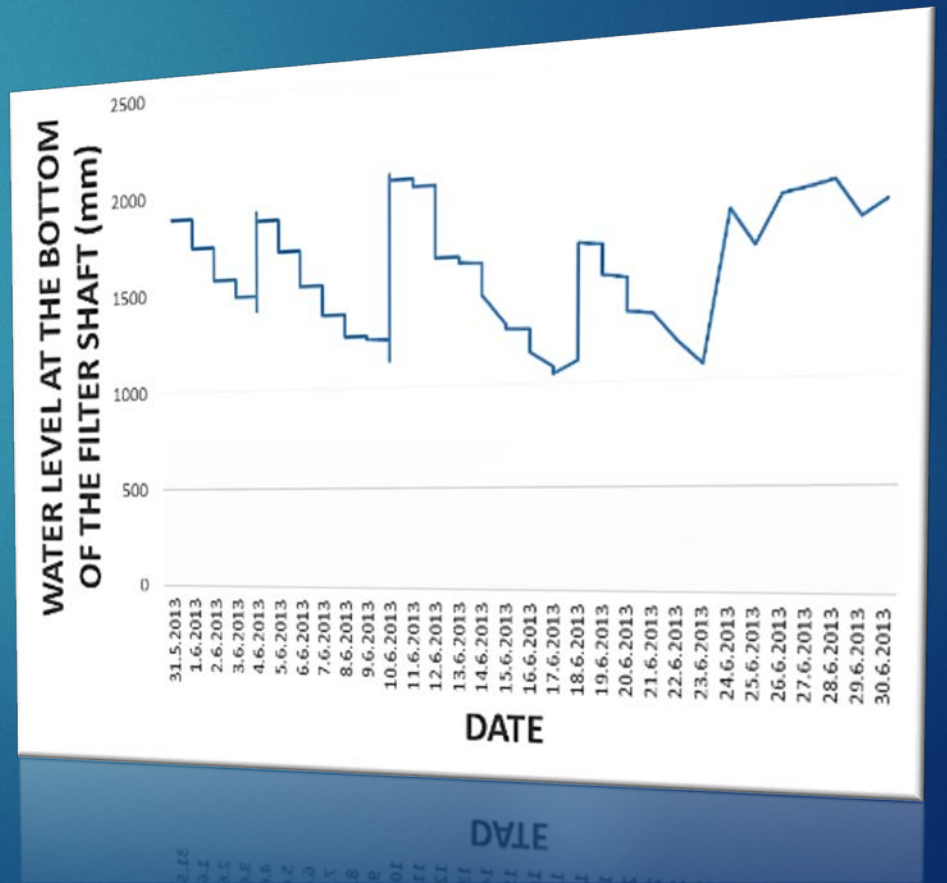


EXPERIMENTAL RESEARCH (Prešov-city)

Water level changes at the bottom of filter shaft during May 2013



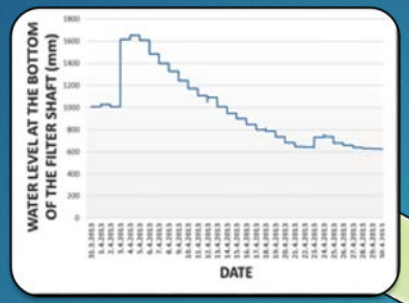
Water level changes at the bottom of filter shaft during June 2013

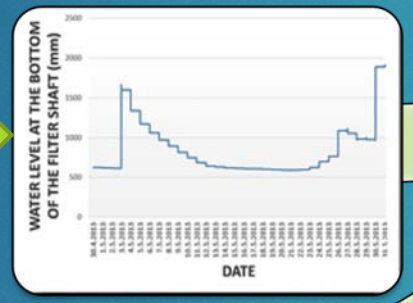


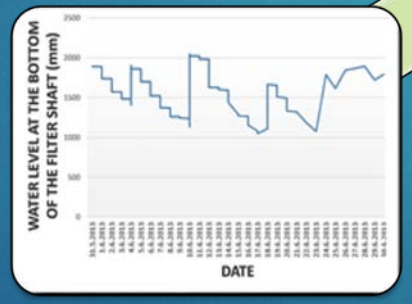
EXPERIMENTAL RESEARCH (Prešov-city)

estimated value of infiltration coefficient

$k_f 10^{-5}$ m/s







real value of infiltration coefficient!

$k_f 10^{-7}$ m/s

The research data showed that there was a continuously high water level in the percolation gallery. This represents a very low infiltration rate of this infiltration gallery given by the coefficient of the infiltration of soil at the bottom of the gallery given as $k_f = 4{,}84.10^{-7}$ m/s and it also means the overfills of the infiltration gallery and flooded filter shaft with measurement devices

CONCLUSION

- The design of infiltration facility did not consider the geological survey and the geological data was only estimated. In the design phase of the infiltration gallery, the infiltration coefficient was estimated by a designer as $8{,}2.10^{-5}$ m/s. The infiltration facility was designed according to the German standard DWA - A 138 and all the parameters of the infiltration gallery were calculated with this infiltration rate which should ensure a sufficient and suitable percolation characteristics for this facility.
- But with an incorrect determination (without hydrogeological survey) of the infiltration coefficient, the functioning of runoff disposal is too low or in many cases insufficient resulting in the overflow of the infiltration facility.

CONCLUSION

- The designers and planners of infiltration facilities need to take into account several aspects while designing:
  - It is necessary to consider the hydrogeological conditions of the site of the design – infiltration coefficient and water level of groundwater
  - Respect minimum distance from the objects
  - Calculation of required accumulation volume – for critical rainfall

- The result of our research shows that with correct planning, design, realization and maintenance of the infiltration facilities, the operation of the device should be fluent and free from complications.

Thank you for your attention