# D2.2 Report describing design, implementation, construction phases and monitoring strategy of performances for the new build NBS. Part 1.

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# 1. Implementations in the City of Łódź

The City of Łódź and Łódka river catchment well illustrate problems with water scarcity, especially related with limited ground water recharge what impact ecological flows in rivers. The problem is particularly urgent in the densely populated and mostly sealed city center. The surveys indicated that citizens are not content with current water retention efforts (Fig.1.1).

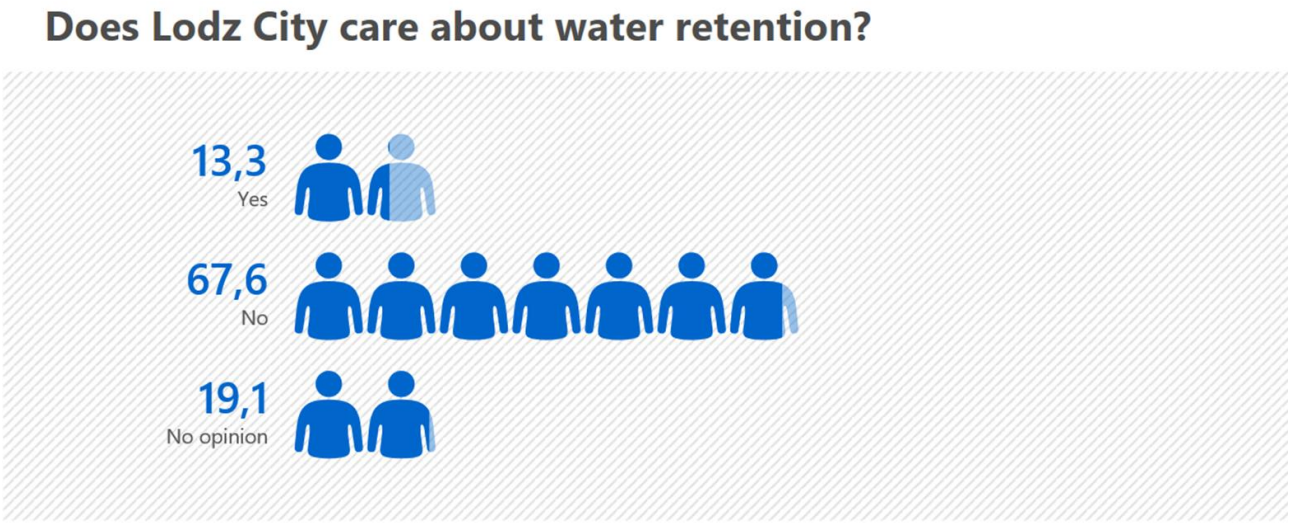



Fig.1.1. Opinions about water retention in Łódź.

The citizens, city managers and researchers get to consensus over implementation of rainwater gardens, façade gardens and infiltration basins as the most affordable, simple and acceptable nature-based solutions (NBS). Those solutions put into operation, through enabling or restoration, regulatory services of nature like: purification of water, air and soil, regulation of microclimate, soil formation, regulation of water cycle and increase of water retention capacity, provision of habitats and securing the continuity of ecosystem functions under stress.
However lack of already operating good practices has been considered as one of the issues hampering the implementations and raising concerns about the efficiency, comfort and safety of such solutions.

ATENAS contributed to establishing of two NBS.

# 2. Multifunctional pilot façade garden with a system of water storage and diversion, at the Faculty of Biology, University of Łódź | DeerGarden©

## 2.1 Purpose

- To demonstrate incorporation of blue solutions into green design;
- To create a pilot implementation of the façade garden as best practice example in the City;
- To raise awareness of students and teachers with reference to water management and water waste;
- To enrich the habitats;
- To create an aesthetic space at the university;
- To enable relaxation and create a get together space;
- To stimulate multiplication and upscaling of NBS.

## 2.2 Nature in action

With façade garden we aim at restoration of water cycle locally, what in practice helps to use water more efficiently and sustain its provision to nature.
The water caught during the rainfall does not burden the stormwater system, but instead it is directed to the soil as it happens in natural ecosystems. We mimic the nature installing the tanks that play the role of water reservoirs thus substitute the role of water bodies, groundwater augmentation and wetland systems. Together with drainage pipe in the ground they capture the surplus of water and release it slowly in rainless periods. Replacing anthrosol with soil rich in

organic matter together with layers of gravel and sand, we stimulate infiltration processes and increase soil water storage capacity. Plants complete the system with their function of provision of habitats to micro and macrofauna and flora, stimulation of soil formation (by producing litter and) structuring the soil as well as regulation of microclimate (through evapotranspiration process), and cleaning the environment (processes of respiration and phytoremediation).

## 2.3 Design

The outline: a pilot implementation focused on combining blue and green infrastructure, with predominant use of native species and minimizing maintenance effort. It is to demonstrate how the façade gardens could operate using rainwater from roofs.

Elements:

1. rebate lined with wood chips: the chips are to support water retention in soil and prevent excessive evaporation;
2. bed lined with river gravel: diversification of habitats and views by use of mixed substrates;
3. rainwater tanks: water storage devices;
4. purple willow Nana;
5. climber;
6. vascular plants, with an emphasis on native species;
7. bryophytes;
8. gravitational water drainage system;
9. decorative metal strip.

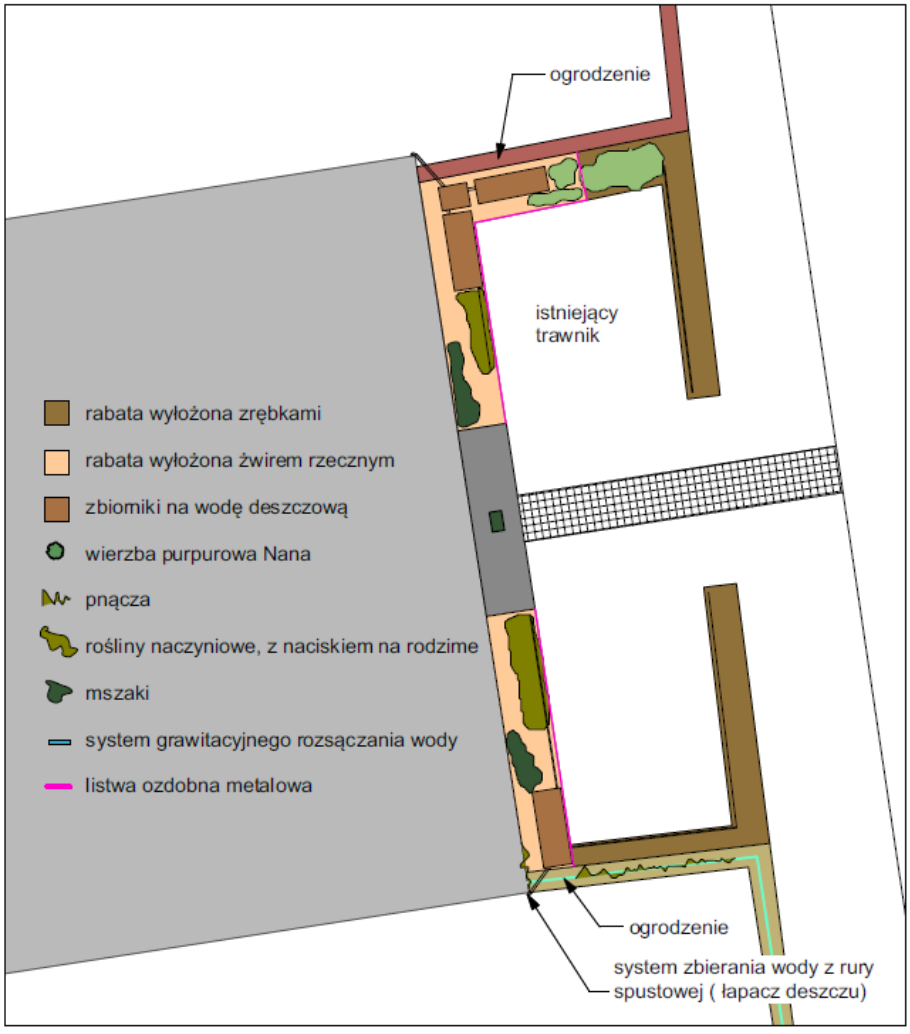



Fig.1.2 The concept of the façade garden



Fig.1.3 The project visualization.

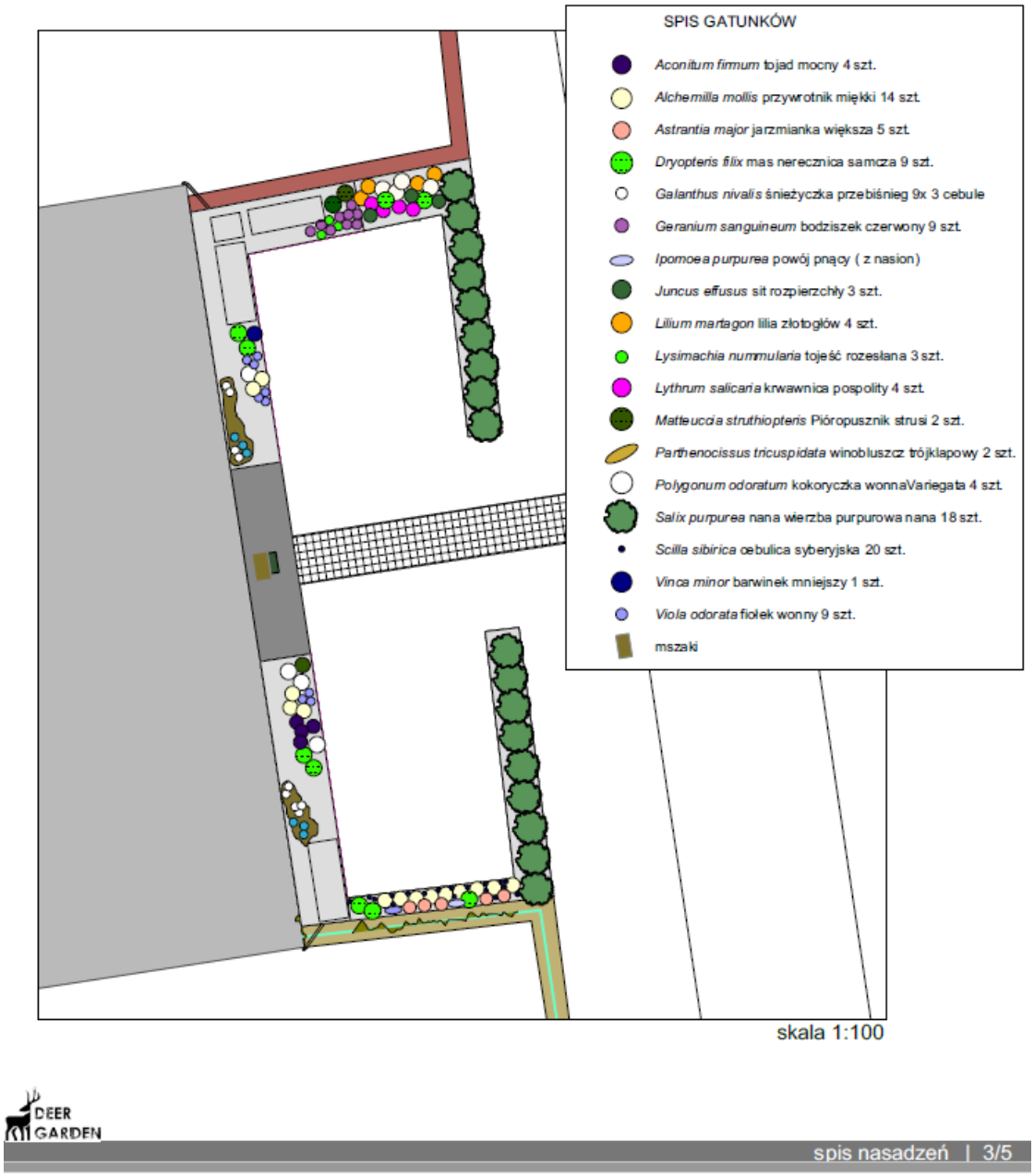
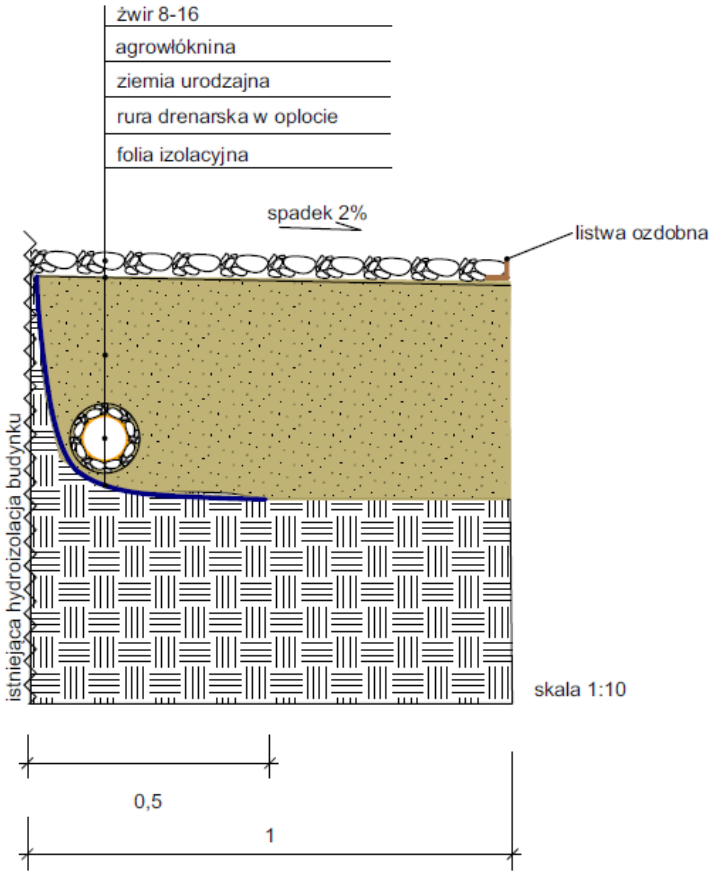



Fig.1.4 The list of species.

One of the main constraints preventing wide implementation of façade gardens in the city were concerns related to risk to the buildings resulting from increased water infiltration. The pilot garden has been designed to demonstrate the know-how (Fig.1.5).




Zabezpieczenie hydroizoloacji pionowej budynku, zastosowane wzdłuż ogrodu fasadowe przy wschodniej strony budynku przy ulicy Banach 12/16 w Łodzi



Fig.1.5 The water isolation system of the building's foundation.

The water distribution system constitutes of the rain catcher, two water tanks of the capacity of 300 liters and the braided drainage pipe, that enables water infiltration into the soil (Fig. 1.6 and 1.7). The tanks are hidden inside the benches what increases aesthetics of the solution, lower costs of the spending for earth works inevitable when tanks are to be placed underground, and also enables removal of the tanks or just water in the case of low temperatures that could destroy the system.

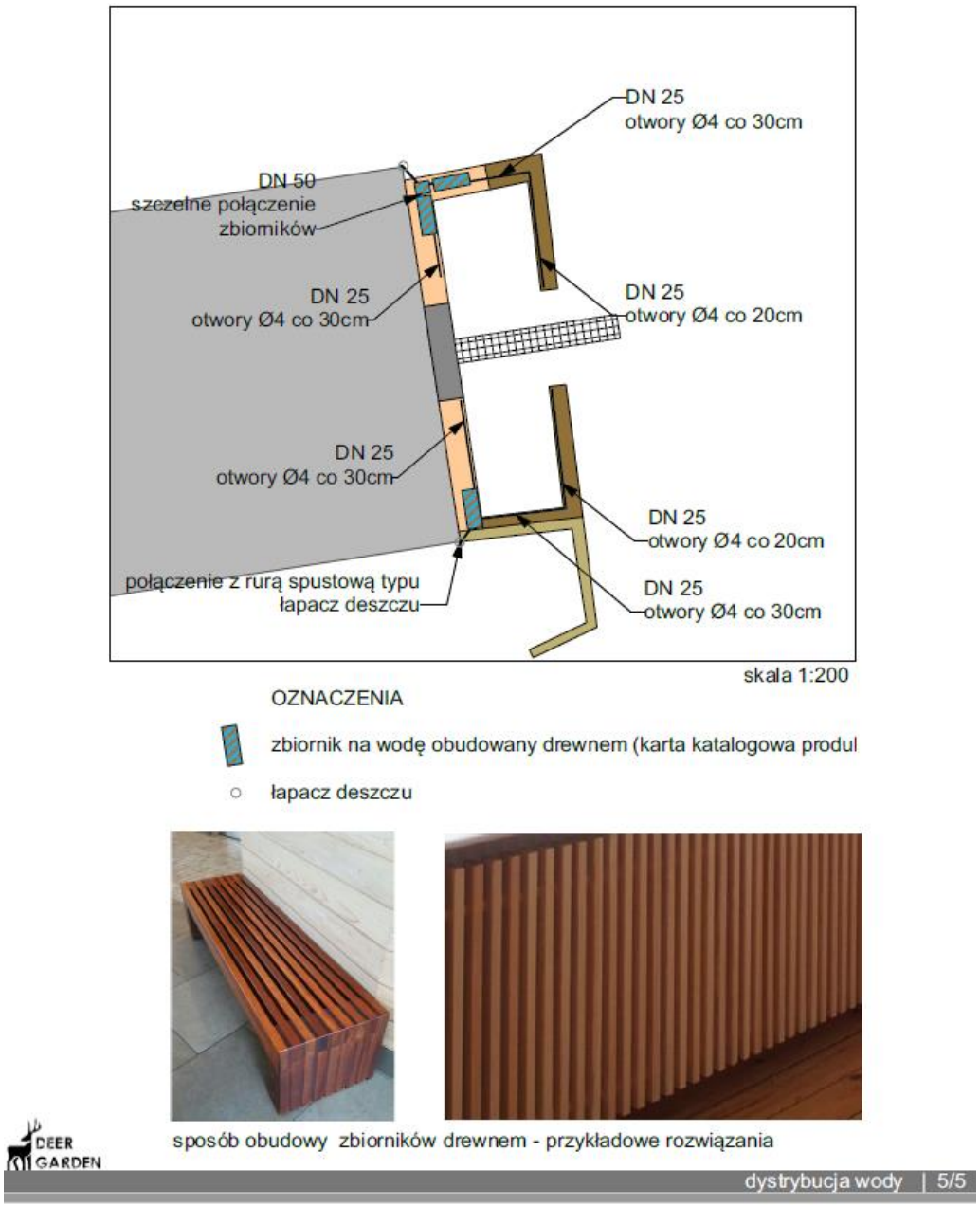



Fig. 1.6 The water distribution system.

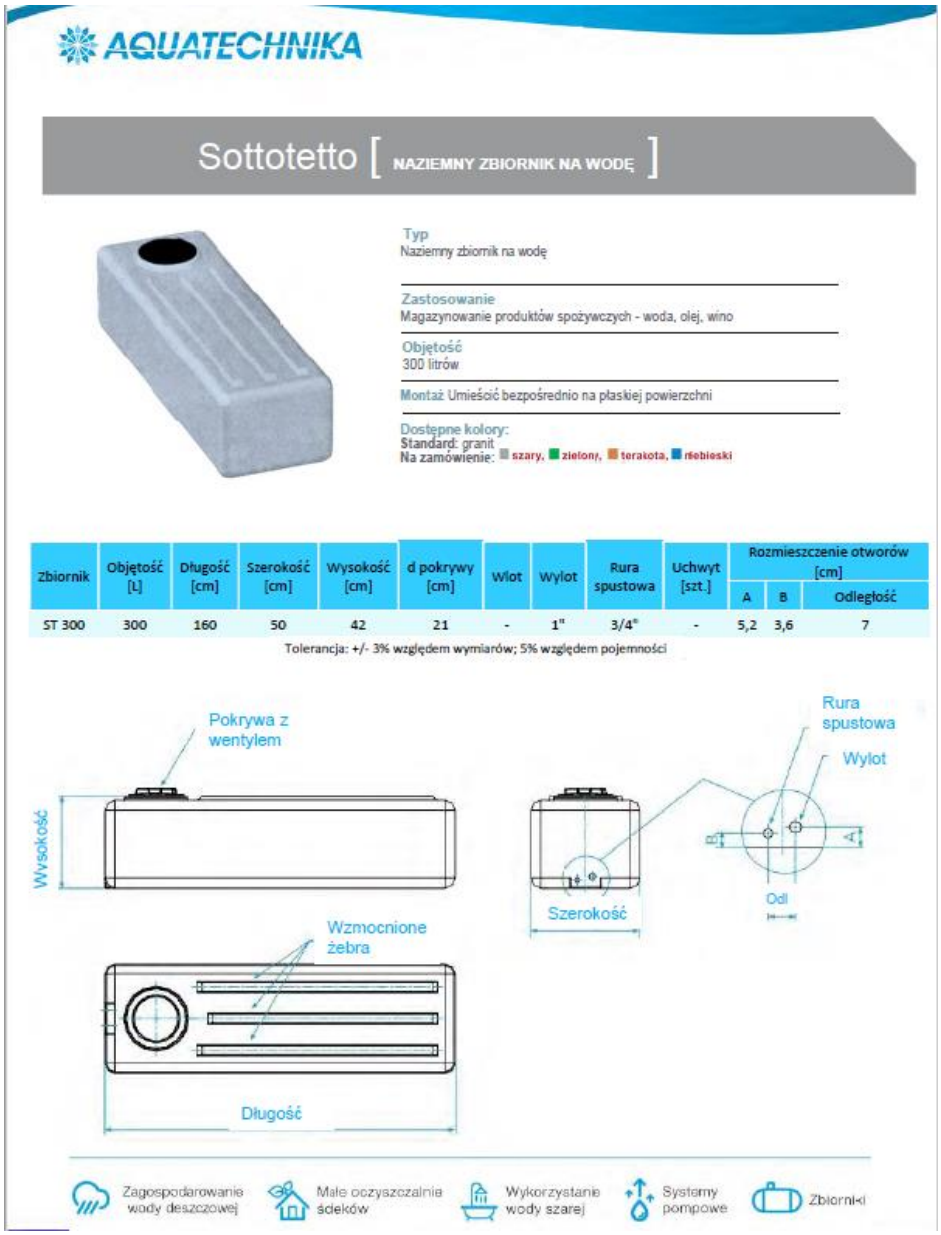



Fig. 1.7 The parameters of the water storage tank.

## 2.4 Maintenance

The maintenance operation include:

- seasonal cutting of plants and check of their viability;
- removal of weeds;
- empting the water tanks in case of temperature drop below $0^0$C;
- seasonal check and clearing of tanks and drainpipes;
- conservation of benches and technical installation.

## 2.5 Monitoring

No ecological monitoring is required although to indicate the impact on NBS, the following parameters can be monitored:

- Insects' diversity – to indicate the change in habitat quality and/or diversity;
- Soil metabolism – to identify an influence of stabilized water condition on soil formation processes;
- Soil moisture – to check influence of NBS on water availability;
- Behavioural mapping of the users of the place.

### 2.6 Early warning signals

There are a few signals of system malfunction:

| Signal | Action required |
|---|---|
| Drop of water level in the tanks not related to the use of water | Check the sealing of elements |
| Limited water supply during the rainfall | Clean the drainpipes and check the rain catcher |
| Deterioration of plants condition | Check on the presence of pathogens and pests, consider adding natural fertilizers according to the needs of particular species |

# 3. Triple infiltration basin and regeneration of greenery at the square Oblęgorska St and Widok | FPP Enviro©, ERCE PAS

### 3.1 Purpose

- To demonstrate incorporation of blue solutions into green design;
- To create a pilot implementation – the first in the City - of the infiltration basin as the best practice example and know-how source;
- To initiate restoration of water cycle in the Łódka River catchment;
- To raise awareness of citizens with regard to degradation of water cycle in cities;
- To enrich the habitats;
- To link up vegetation with the history of a place, and memories of community members;
- To create an aesthetic space and stimulate community building;
- To enable relaxation, education and create a get together space;
- To open the space for co-design and build the place ownership among marginalized communities;
- To stimulate multiplication and upscaling of NBS.

### 3.2 Nature in action

Infiltration basins of ATENAS are designed in a form for rainwater gardens and integrate grey and green infrastructure. The rain falling on the roofs of four tenement houses is captured by conventional drainpipes but then diverted to dry creeks leading to infiltration basins. The basins stimulate infiltration of water and thus augmentation of groundwaters, not water storage in place, thus serves another component of water cycle. Its next aim is to increase water storage capacity of soil and climate regulation. Consequently the square is refurbished in the way that supports natural soil formation processes. The biomass produced by plants stays on place thus the process of matter circulation is restored, while increase of organic matter content increases soil water retention and supports micro and macro organisms in their role of soil formation, and remediation of harmful substances. Additionally the diversity of habitats has been increased by adding new substrates, diversification of soil and water conditions, introduction of plants that supports birds and pollinators. The dead trees from the square were transformed into degradable infrastructure and replaced by 80 new shrubs and trees. Their presence, with time, will help to stabilize environmental conditions, thus reduction of plant water demand, exposure to extreme weather conditions: strong winds, droughts, etc. The system has been shape to mimic the agri-systems with shelterbelts playing a crucial way in development of viable ecosystems.

### 2.3 Design

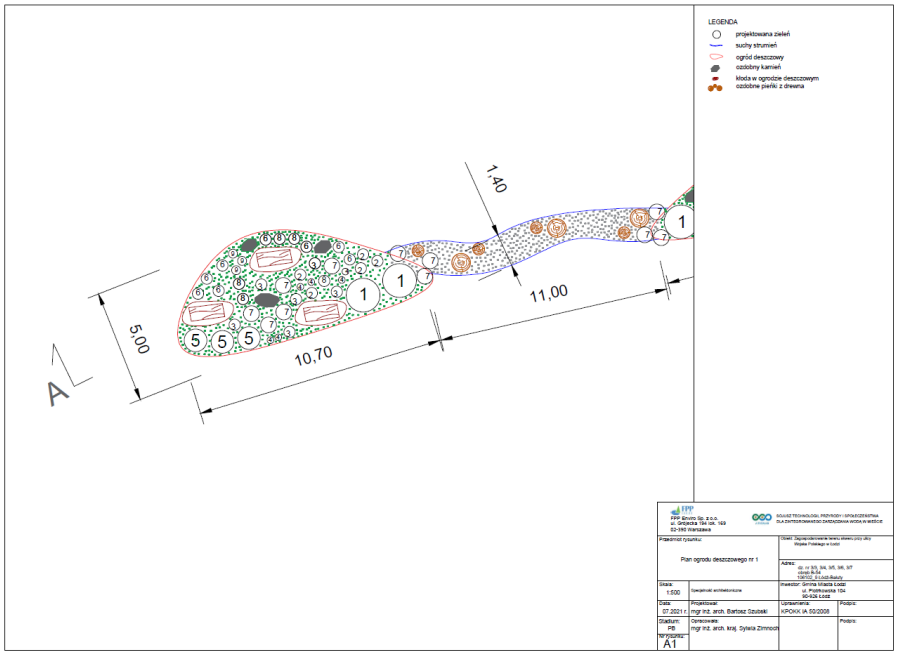
The outline: a pilot implementation focused on combining blue and green infrastructure, with predominant use of native species and minimizing maintenance effort. It is to demonstrate the construction and operation of infiltration basin in the city center, to build the trust in NBS and to provide a leverage for multiplication and upscaling of the solution. The consequent restoration of groundwater in the Łódka catchment requires building a critical mass of implementations.
Elements:

1. Three infiltration basins Fig. 1.8):
   - OG1 (roof drainage area - approx. 329.0 $m^2$; active garden area - approx. 32.9 $m^2$; active garden volume - approx. 9.87 $m^3$; average active garden depth - 0.30 m)
   - OG2 (roof drainage area - approx. 172.0 $m^2$ ; active garden area - approx. 17.2 $m^2$ ; active garden volume - approx. 5.16 $m^3$ ; average active garden depth - 0.30 m)
   - OG3 (roof drainage area - approx. 156.0 $m^2$ ; active garden area - approx. 15.6 $m^2$ ; active garden volume - approx. 4.68 $m^3$ ; average active garden depth - 0.30 m).

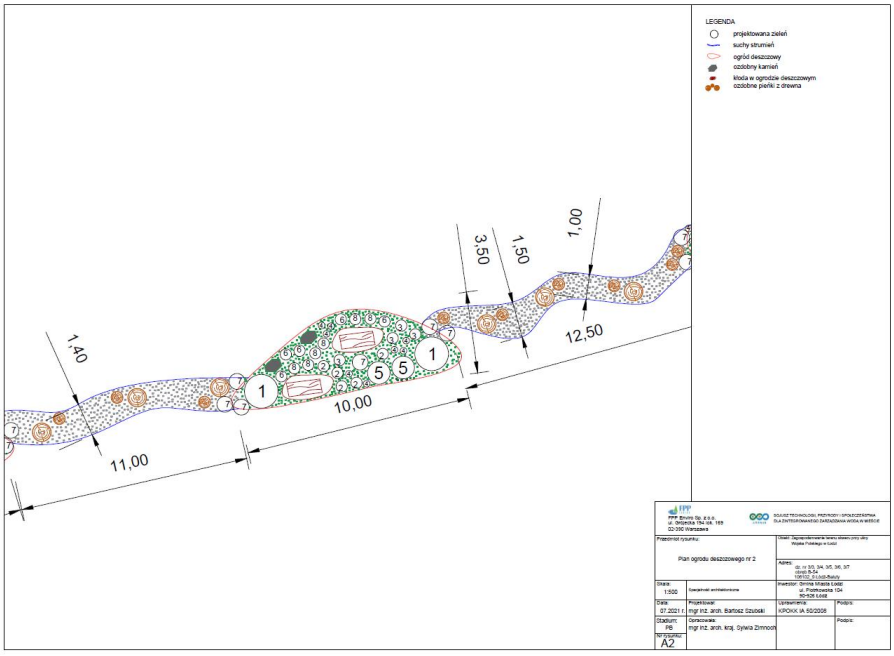
2. Five flowering beds:
   - A (Widok): area 27m$^2$, perimeter 22m,
   - B (Oblęgorska): area 45m$^2$, perimeter 30m,
   - C (W. Polskiego): area 80m2, perimeter 40m,
   - D (Oblęgorska | W. Polskiego): area 320m2, perimeter 95m
   - E (Widok | W. Polskiego): area 77m2, perimeter 46m.
3. Seven dry creeks.
4. Two sensory gardens.

The infiltration basins has been planned to accommodate rainfall of 30 mm (which corresponds to a rainfall intensity with a probability of occurrence once in 5 years and a duration of 1 h). This addresses the concerns of local communities related to the risk of water overflow and flooding of buildings and simultaneously accepted depth of the basin.

OG1




OG2



OG3

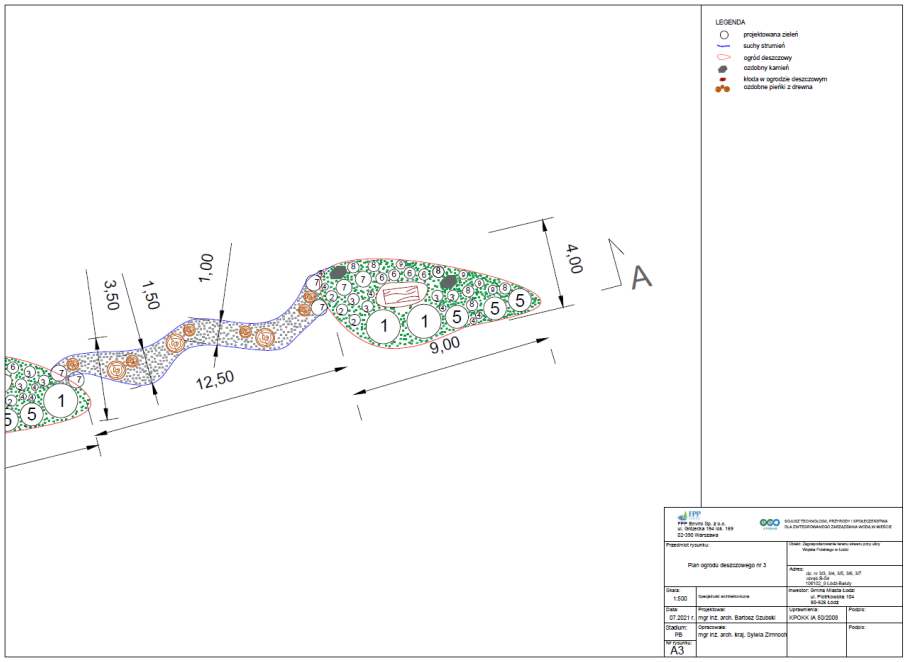



Fig. 1.8 Schemes of three infiltration basins (OG1-OG3) and connected dry creeks, including plan of greening.

All the basins are interconnected, and have been filled with 20 cm thick layer of sand to stimulate infiltration. The connecting creeks are ditches with bottom sited in two geotextile 300 g/m2 layers separated with EPDM foil of 1 mm thick, and are filled up with two gravel fractions 8-16mm and 50mm (Fig. 1.9).

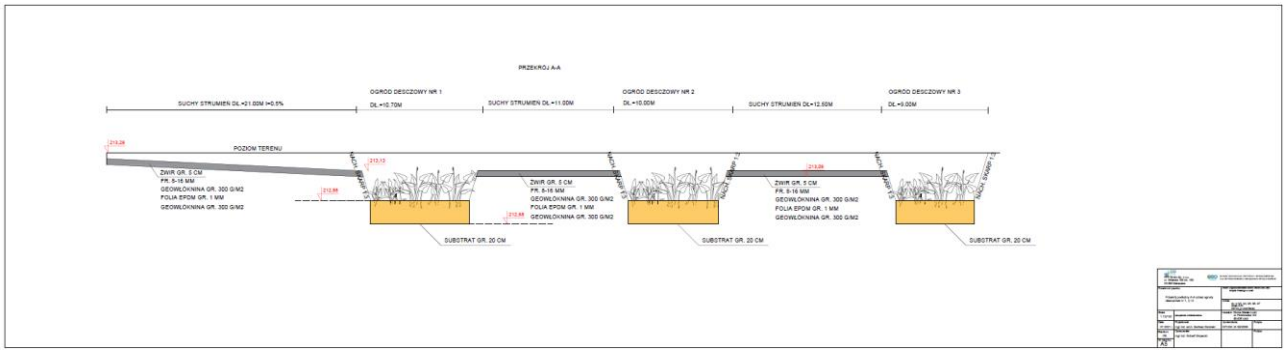



Fig. 1.9 The cross section of the basin area.

The gray and green elements of final implementation have been selected by the local community members, while the blue elements have been broadly discussed locally and with NGOs (WP1, WP3). The final project combined elements of two alternatives discussed with the locals and their proposals for the elements ranged according to importance (Fig.10).
The selection of plants reflects the aim to bring the colours, textures and species meaningful to residents with respect to historic Jewish / Gypsy getta which border exactly in the square, native species or forgotten historic ones, e.g. buttonbush (*Cephalanthus,* Polish: *Guzikowiec*), *Vitex agnus-castus (*Polish: *Niepokalanek)*, bluebeard (*Caryopteris,* Polish: *Barbula).* Also individual wishes and preferences has been considered if possible, e.g. for rowan or rosary shrub. The experience with plant textures has been also included in sensory garden greenery list (Tab.1.1).

Tab. 1.1. The list of species introduced to the implementation place, catalogue number refer to location on maps (Fig. 1.8 and 1.9).

| Catalogue No | Species | Number |
|---|---|---|
| 1 | guzikowiec zachodni | 6 |
| 2 | turzyca pospolita | 12 |
| 3 | krwawnica pospolita | 14 |
| 4 | kosaciec żółty | 20 |
| 5 | manna mielec | 8 |
| 6 | niezapominajka błotna | 17 |
| 7 | trzęślica modra | 18 |
| 8 | żabiniec babka wodna | 17 |
| 9 | knieć błotna | 7 |
| 10 | szałwia omszona | 6 |
| 11 | śmiałek darniowy | 4 |
| 12 | jałowiec pospolity | 2 |
| 13 | narecznica samcza | 2 |
| 14 | turzyca pospolita | 10 |
| 15 | nagietek lekarski | 4 |
| 16 | szałwia błyszcząca | 3 |
| 30 | kalina koralowa | 32 |
| 31 | bez czarny | 11 |
| 32 | leszczyna pospolita | 13 |
| 33 | lilak zwyczajny | 5 |
| 34 | bez czarny czerwonolistny | 11 |
| 35 | kruszyna | 6 |
| 36 | bez czarny 'Aurea' | 3 |
| 37 | bez koralowy 'Plumosa Aurea' | 2 |
| 39 | jarząb brekinia | 3 |
| 40 | wierzba purpurowa 'Nana' | 2 |
| 41 | lipa | 1 |
| 42 | hortensja piłkowana | 2 |
| 43 | dereń jadalny | 9 |
| 44 | kalina koralowa 'Boule de Neige' | 2 |
| 45 | morwa biała | 3 |
| 46 | kalina koralowa 'Boule de Neige' | 3 |
| 47 | klon polny | 2 |
| 48 | jarzębina | 2 |
| 49 | jaśminowiec | 3 |
| 50 | topola czarna | 4 |


Fig. 1.10 The masterplan of the site with indicated gray, green and blue elements and location of plant species (numbers corresponds with Tab.1.1).

The final realization (Fig. 1.11) included also the first in the city living furniture – the willow bench shading and meteorological station (meteobot).

Fig.1.11 The final look of the ATENAS square.

## 3.4 Maintenance

The maintenance operation include:

- mowing the grass along the dry creeks - 3 times a year;
- mowing the lawns 1-2 times a year (early summer and autumn), and leaving the cut grass in place, which promotes the restoration of the organic matter;
- mowing of the flower beds once a year, between June and August, with the biomass left in situ to preserve the seed bank;
- removal of weeds from sensory gardens and invasive species from the whole area;
- control of the state of infiltration basins and creeks, with special focus on erosion incidents;
- watering of willow constructions (for first 2 years, 80l per week in June – September period or during any drought event);
- protection of shrubs and trees, as well as impermeable paths in any maintenance or construction activities;
- technical assistance to meteobot.

## 3.5 Monitoring

- Insects' diversity – to indicate the change in habitat quality and/or diversity;
- Soil metabolism – to identify an influence of stabilized water condition on soil formation processes;
- Soil moisture – to check influence of NBS on water availability;
- Changes of surface temperatures over the time – to indicate impact on vegetation on microclimate;
- Behavioural mapping of the users of the place – to consider place potential to deliver recreational and educational services.

## 3.6 Early warning signals

There are a few signals of system malfunction:

| Signal | Action required |
|---|---|
| Signs of moisture on buildings (e.g. stains, appearance of algae) | Check the sealing of creeks at the outflows of drainpipes; |
| Signs of erosion of basins | Stabilize the slopes with big stones or ecotextiles; |
| Sings of erosion of the creeks | Reconstruct original ditch and refill the leyers; |
| Creeks overgrowth | Remove the plants immediately by cutting them at the edges and removing from the channel; |
| Drying off or rallying the elements of willow pergola | Start watering, bend living branches to substitute the lost elements; |
| Yellowing of coniferous trees | Increase protection against dogs; |
| Dropping off the flowering species from flowering beds | Remove the uppermost layer of soil to lower the fertility and supplement the seed bank with new seeds; |