Initial concept of the water path installation in the laboratory of nature in Małopolska Science Center Cogiteon

Names:

Water track. Water path. Waterscape.

General assumptions:

The water track is a closed water circuit permanently located in a designated space. Water circulation is forced and strictly regulated by means of successive modules of the water exhibit and additional hydraulic installations enabling the control of the volume of water introduced into the track. During the operation of the system, water circulates in a closed circuit, but it is possible to remove the water chanelling it into the sewage system and refill the track.

Due to the location in the Laboratory of Nature, the narration linked to the water track must be aligned with nature and biological themes. The watertrack is expected to faithfully imitate an actual river. It should on the one hand provide an opportunity to illustrate the operation of hydrotechnical devices (dams, weirs, sluices, etc.), and on the other hand accurate depiction of natural processes that take place in river valleys from the river source to its estuary.

The flow of water in the system should be visible to the observer and should give the impression of being continuous (i.e., maintaining the continuity of water's current from the source to the mouth, similarly to the case of a real river). Appropriate solutions need to be implemented that maintain the appropriate water quality (decontamination, protection against the growth of bacteria or algae, e.g., using appropriate filtration and UV lamps), as well as enable cleaning access to the water exhibit by employees of the Małopolska Science Center.

The educational objectives of the water track are to:

- inspire interest in the natural world by creating an installation referring to the natural forms occurring in nature (river valleys, course of a river from the source to the estuary).
- show a river as an interesting and varied natural system
- stimulate the need to explore nature.
- create a positive image of the natural environment, by building good associations with nature
- develop independent thinking and introduce themes and topics related to natural sciences.
- showcase geographical and geological structures associated with river valleys
- visualize the natural forms and phenomena associated with rivers in a tangible way
- provide the opportunity to perform physical experiments using the flow of water

- demonstrate the operational principles of hydrotechnical devices related to river valleys

The laboratory of nature:

The water path installation will be located in the Laboratory of Nature. It is a multi-purpose laboratory room, designated to host classes and workshops exploring biology, chemistry, physics, as well as gardening and handicrafts at various levels of advancement.

The room will have an area of 126,12 sq. meters. The space will consist of 4 coherent sections:

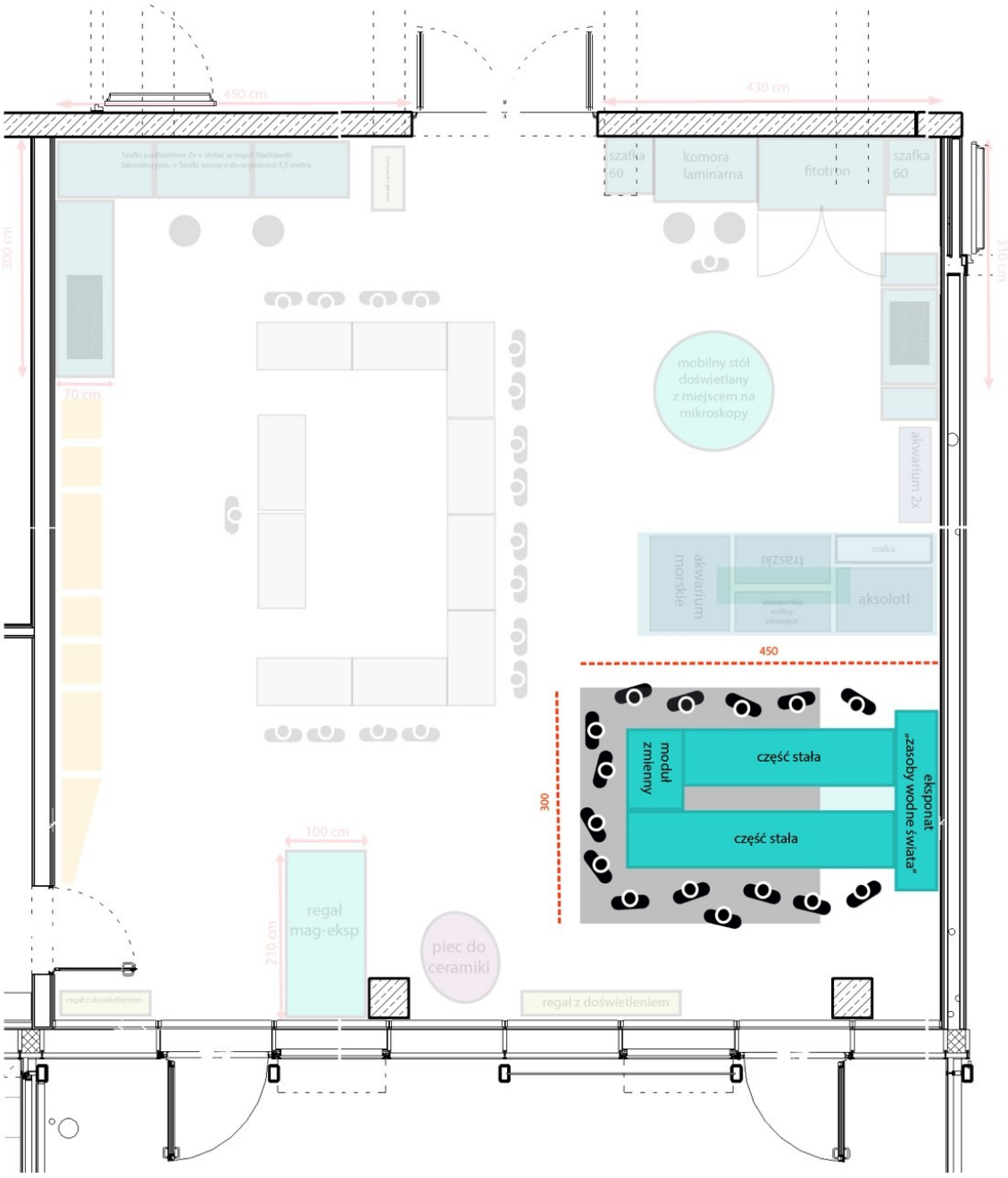
- Flora and fauna section, which will include various tanks with living animals and plants (aquaria and vivaria);
- Laboratory section designed as space for performing experiments, including molecular biology projects;
- **Section hosting the water track;**
- Handicrafts' section, with a ceramic making equipment (including a furnace).

Walls: Side walls up to a height of 219 cm, finished with ceramic glazed tiles (30x30 cm) in white and matte finish on glue, suitable for laboratory rooms, resistant to corrosive chemical substances, with acrylic joins in colouration similar to the tiles themselves. Walls above the tiles will be finished with an acrylic paint coating containing a fungicide, intended for painting walls of wet rooms, resistant to solvents, robust to washing, cleaning and disinfecting agents, resistant to washing and wet scrubbing, white RAL 9010 in a matte finish.

Ceiling: Suspended ceiling made of expanded metal – natural aluminum color RAL 9006. Height 8,24 m.

Floor: Vinyl ester resin, non-shrink, pigmented – color similar to the color of architectural concrete, resistant to chemicals with the addition of quartz aggregate in the color of the resin, non-slip. The floor's insulation will be water-tight to protect against capillary moisture build-up. In the section with the water track installation, an additional metal grating 'wema' 30 mm will be built into the floor.

The room will be fitted with underfloor heating, mechanical ventilation, air conditioning, 230V electric power sockets with anti-splash covers, 2 compressed air outlets and a sanitary installation with water-softening station serving, among others, the water path system.



Location of the water track in the laboratory of nature

Additional information can be found in the architectural blueprints. In case the above description is incompatible with the information contained in the architectural blueprints, the architectural blueprints take precedence and are decisive.

Overall description of the water track stand:

1. World's water resources exhibit:

The first element of the water track installation will have both decorative and educational functions. It can be attached to the wall behind the water track system. The main idea is to present the current water resources in the form of an artistic installation consisting of geometric shapes (cubes, cuboids etc.) hanging on the wall, varying in size. The size of each shape will be proportional to the world's water resources for a given category (see the 'water source' column in the table below). We would allow and consider introducing additional elements, e.g., imitating flowing water between individual elements of the installation.

Water source*	Water volume (m^3)	Percentage of total water volume
Oceans, seas	321000000	96,5
Ice sheets, glaciers, permanent snow	5773000	1,74
Underground waters	5614000	1,7
fresh	2526000	0,76
salty	3088000	0,94
Soil moisture	3959	0,001
Permafrost	71970	0,022
Lakes (fresh and salty)	42320	0,013
Water in the atmosphare	3095	0,001
swamps	2752	0,0008
rivers	509	0,0002
Water in living cells	269	0,0001

* Gleik, P. H., 1996: Water resources. W: Encyclopedia of Climate and Weather, ed. S.H. Schneider, Oxford University Press, Nowy York, vol. 2, 817-823

2. Fixed part – river sources.

OVERALL:
The module shows the upper course of a river, from its springs in mountains down to the foothills. The model should depict a section from mountainous landscape (including altitudinal zonation of vegatation: from the top of the mountains - subnival zone, alpine zone, zone of mountain pine, zone of spruce forests, Carpathian beech forests zone, and foothills zone). The alpine landscape gradually turns into a typical limestone (karst) landscape with protruding limestone residual hills (based on the landscape of the Ojców National Park).
The second part of the module shows underground karst formations – a system of caves and underground waters forming rivers and lakes, and it is a natural extension of the karst part of the landscape visible on the surface of the module. The "underground" part of the module can be a closed system with a mock substance imitating water in appropriate spaces

(properly illuminated). It should depict underground karst formations (with characteristic geological structures occurring in caves: stalactites, stalagmites, stalagnates, etc).

WATER FLOW: Water flows from several 'sources' located in the mountains, then flows in steep V-shaped river valleys, thus imitating several mountain streams, that combine to form tributaries of one larger watercourse. The water in this part should have strong current (resulting from steep slopes). In at least one point there is a waterfall showing the action of backward and bottom erosion through the depiction of a characteristically shaped waterbed. In at least one place there should also be a depiction of the shore washed away by a mountain stream (presentation of lateral erosion). The water flow in this module ends up in one stable stream of water representing an upland section of a river. It is important to visually connect the water shown in the 'underground' parts with the water in the parts flowing on the surface of the model.

MAIN OBJECTIVES:

- Presentation of the mountain landscape elements, with particular emphasis on the zonation of vegetation.
- Presentation of karst forms, both above- and below-ground ones – with particular emphasis on caves and groundwater (an educational element referring to the geographical location of the Cogiteon Science Center).
- Presentation of the upper course of the river
- Presentation of the mechanisms of backward, bottom and lateral erosion.

3. Exchangeable module - Carp valley

OVERALL:
This section of the water path illustrates topics related to traditional fish farming in the Małopolska region, and simple hydrotechnical devices related to those. It is a replaceable module with the possibility of disassembly and replacement in the future with a module featuring a different topic. Hence, it's crucial to carefully design the connections to prevent loss of water tightness. We also suggest that the separated modules (both fixed and exchangeable) can be connected together either via water tight connections, or by direct contact (e.i, utilizing the direct overflow of water circulating according a gravitional gradient). In the latter case, the connections may be created by simply bringing together flat edges of respective modules.
The module should present the operation of a system of breeding ponds, consisting of tanks of varying size – from small spawning ponds overgrown with grass (very shallow water), through ponds of increasing depth for larger fry, and in the end to large 'trade' ponds. The whole system of ponds should be equipped with at least two 'monks' (hydrotechnical structures) and a system of ditches and levees. The nearby river should be equipped with a damming system, used to fill and flood the ditches system of fish ponds. The key element is to consider the depth and inclination of the individual elements of the system in such a way that the whole can function properly – i.e., that it is possible to regulate the flow of water between individual elements.

WATER FLOW:

Linear flow of a slightly meandering river. Hydrotechnical devices enabling damming the river (weir) and redirecting its water to supply channels, and then to fishponds with inlet and outlet monks (connected in parallel), as well as supply and discharge ditches (the all constitute what is known as the fish farming system according to the Dubisz method; during the designing stage, you can find inspiration, e.g., from the 'Jaktorowskie meadows' pond system of the Warsaw University of Life Sciences /pol. "Łąki jaktorowskie"/)

MAIN OBJECTIVES:

- Presentation of simple hydrotechnical devices (monks, weirs, levees)
- Demonstration of the Lesser Poland carp breeding traditions using the Dubisz method
- Introduction of the topic of biodiversity related to wetlands (pond systems).

4. Fixed part – flood reservoir with a dam

OVERALL:
This fixed module shows the operation of a flood reservoir. The river in this section is separated by a dam modeled on one of the dams in Lesser Poland region (e.g., Świnna Poręba). The dam is partly made of transparent material to visualize the operation of its water turbines. The dam model is functional – it enables the regulation of water inflow to the rest of the water path. In this section, an additional hydraulic system can increase the amount of water in the water path if necessary (it has to be invisible to an outside observer).

WATER FLOW:
Water flows to this section is one stream from the preceding section. It falls into a recess forming the basin of the reservoir, ending with a dam as described above, blocking (and regulating) further flow of water. In this section, the additional hydraulic installation allows the amount of water in the water track to be increased invisible to an outside observer (additional valves allowing for influx of water into the reservoir should be placed in a discreet and inconspicuous manner, but at the same time allow for easy adjustments of the water flow). The water flows through the dam, then creates a river (it is wider than at the beginning of the module).
This module is fully automated, the system protects itself against overflow of the reservoir: in an event of reaching a certain water level in the tank, the dam drains the water (you can turbines see working inside the dam while this happens). At the same time, it is important to consider the further part of the water track in such a way that is possible to regulate the water discharged from the dam.

MAIN OBJECTIVES:

- Explaining the idea behind building dams – roles of dams (prevention of flooding and energy generation), positive and negative environmental aspects.
- Reference to the hydrotechnical infrastructure of the Lesser Poland region
- Explanation of the operation of a hydropower plant, including hydroturbines.
- Explanation of the operation of a fish ladder and of the infrastructure related to the operation of the dam.

5. **Exchangeable part – formation of the natural riverbed in the middle course of the river.**

OVERALL:
This module is a key exchangeable element of the water track installation, as it is located in the most exposed front part of the stand. Carefully designing the connections is crucial to prevent loss of water-tightness. It is permissible to connect the module to the other parts by overflow, using appropriate fittings and the level difference between the preceding and the following parts. The versatility of the connection should also be taken into account (the possibility of a potential expansion of the track with other removable elements replacing the riverbed module). Another issue that needs to be solved is the weight of the module (and all other exchangeable modules). The construction should provide the possibility of completely removing part of the track and/or replacing it with another module. The project should contaion: the main riverbed, oxbow lakes, meanders, appropriate land relief, zonal vegetation depending on the distance from the river, flooding occurrences and flood terraces.

WATER FLOW:
The water in this section flows in an extended and properly shaped bed, the key issue is to reflect the natural character of the river in this section.

MAIN OBJECTIVES:
- Making people aware of how the presence of a river influences changes in the landscape
- Drawing attention to the role of rivers in creating the natural environment
- Presentation of the structure of a natural riverbed with plant formations that accompany different parts of it.
- Introduction to the concept of oxbow lakes
- Paying attention to the issues related to natural retention and the filtering role of natural vegetation

6. **Fixed module – flood protection**

OVERALL:
This module is divided into two parts. On one side, there is a model of the city, through which an embanked, regulated and straightened river flows. The second part is occupied by a dry flood polder with functional inlet and outlet closure in the form of weirs and embankment culverts. The inlet closure allows water to spill over the polder, the outlet closure releases water from the polder into the stretch of river outside the city boundary. Possible forms of landscape management (meadows, pastures, forests) are shown in the polder. In the urban section, in the flood embankment, a part of the embankment can be opened, so that during the classes it is possible to model the situation of breaking the embankments in the urban section.

WATER FLOW:

The river retains the width of the previous section, the raised banks allow it to collect excess water that can be used in flood-wave modeling by increasing the water flow. In front of the model of the city the flow gets split, reaching the weir on one side which closes the possibility of the water flooding in the polder, the main part of the river flows through the city.

MAIN OBJECTIVES:

- Modeling a flood-wave and its effects depending on the applied flood protection measures.

7. Fixed part – river mouth, estuary

OVERALL:
This module is an obvious consequence resulting from the adopted concept of the water path. The last part is to show the mouth of a delta-type river. The following elements must be included in this section: alluvial plain, delta plain, delta lake, delta front, part of a larger body of water into which water flows.

WATER FLOW:
The river in this fragment flows from the flood protection module (one main riverbed), then the shaping of the model divides the river into branches flowing into the reservoir. The reservoir is fitted with an outlet invisible to the observers that directs the the flow of water to the hydraulic system of the water track (and the recirculation of water).

MAIN OBJECTIVES:

- Introduction of topics related to the formation of river mouths and alluvial forms arising at the mouth of a river
- End of the water track installation

8. Exchangeable elements (replacing the module with the river valley)

The purpose of the replaceable elements is to maximize the use of the water track stand and the possibility of adapting it to varying topics of practical classes. The base module is the one described in point five, showing the structure of a river valley in the middle section of the river course. The replaceable elements do not have to be thematically related to the rest of the water track, they are to be used occasionally to illustrate phenomena, devices, and laws that did not find their place or did not fit thematically in the overall adopted concept of the fairway.

Potential ideas:

- Just an empty, transparent tank through which the water flows (with the possibility of regulating the flow force).
- Water canal with locks
- Rotary elevator for transporting boats modeled on the Falkirk Wheel (in central Scotland)
- Bascule bridge

The presented concept is a proposal of the contracting authority, the contracting authority remains open to the offers of potential contractors, including independent interpretations of the presented subject and topics. The overriding condition is the substantive correctness of the presented structures and processes.