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Pilot Action FUA Jaworzno

Version 1
03.2017

1. FUNCTIONAL URBAN AREA (FUA) JAWORZNO

The FUA Jaworzno is located in the southern part of Poland, in the eastern part of the Province of Silesia. Jaworzno FUA covers core part of the Jaworzno Municipality and adjacent cities partially located within the boundaries of the groundwater body.

The boundaries of Jaworzno FUA has been based on:

- existing system of drinking water supply (mostly from groundwater intakes),
- borders of the Groundwater Body no. 146(PLGW2000146),
- hydrogeological and geological structure (high vulnerability of groundwater),
- specific conditions (industrial and highly urbanized area).

The area of FUA Jaworzno is presented and characterized in the figures and table given below.

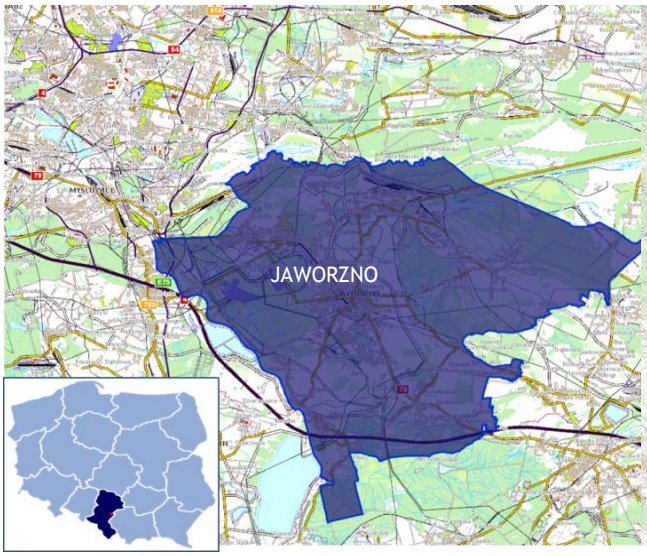

Figure 1. Location of Jaworzno Municipality

Source: GIG elaboration based on http://mapy.geoportal.gov.pl and https://commons.wikimedia.org

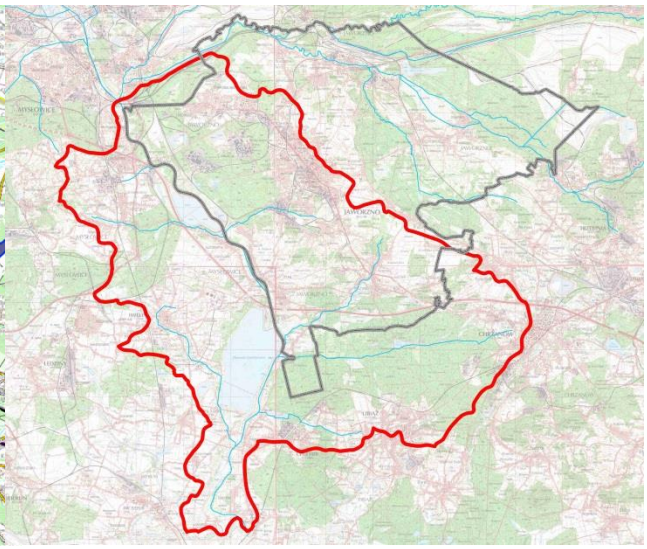

Figure 2. FUA Jaworzno (red colour of boundaries) with indicated boundaries of Jaworzno Municipality (grey colour)

Source: GIG elaboration

Table 1. A short characteristic of FUA Jaworzno

Size of FUA Jaworzno	201,9 km^2
Municipalities covered by FUA	Municipality of Jaworzno and partially Mysłowice, Sosnowiec, Bieruń, Libiąż, Chrzanów, Imielin, Chełmek
Inhibitants of Jaworzno municipality	92 473
Main contaminated site	The area of Organika-Azot factory with Central Landfill (CSO), A field, B field and K field
Area of contaminated site	300 ha
Contaminants of concern	α-HCH, ß-HCH, γ-HCH, DDT, DDE, DDD, dieldrin, endrin, organic solvents, cyanides, heavy metals etc.
Receptors and specific subjects of protection in groundwater	Water intakes: "Dobra", "Jarosław Dąbrowski", "Galmany", "Bielany", “Witold” shaft (in Jan Kanty mine), "Sobieski III" shaft (in ZG Sobieski).

The economy of designated FUA which a major part constitutes Jaworzno Municipality - covering an area about 152.7 km2 with more than 96,000 inhabitants (Figure 3) is based on power engineering connected with the extractive industry. Centuries of activities of the extractive industry (coal, dolomite and sand), power engineering, cement and chemical industry have affected far-reaching transformations of components of the environment. The most significant transformations affected surface water, including the composition of ecosystems, changes in the river network and its nature (infiltration/drainage), mining drainage and the appearing of post-mining settlers, adverse changes in water chemistry.

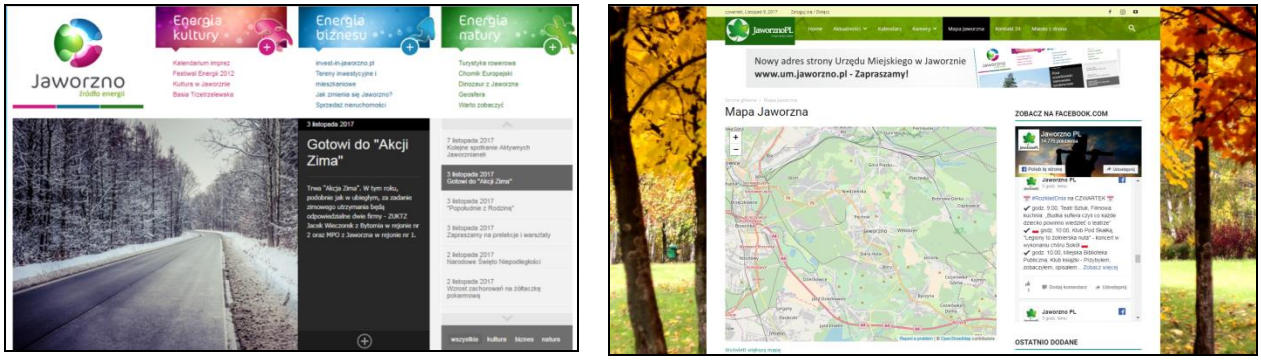

Figure 3. Jaworzno Municipality website

Source: http://www.um.jaworzno.pl/

2. Core problem on the FUA Jaworzno

Jaworzno's biggest problem is the impact of pollutants from the chemical industry in the valley of brook Wąwolnica (Figure 4).

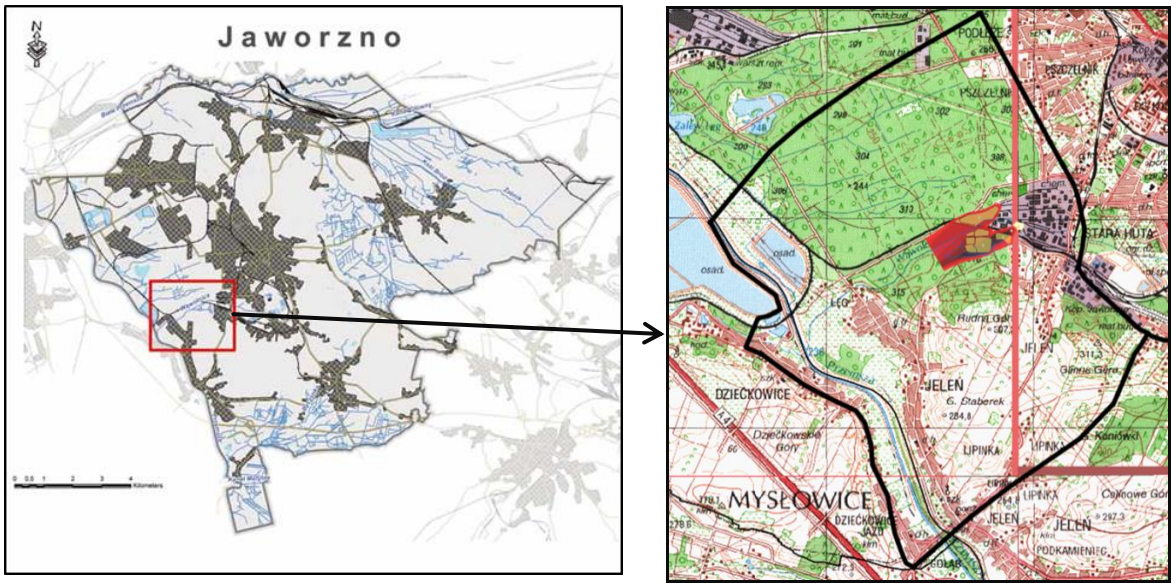

Figure 4. The location of contaminated site in Jaworzno Municipality with indicated plume of contaminants

Source: FOKS project "Transnational Guideline for Implementing Innovative Tools for Remediation", GIG, 2012

The valley of brook Wąwolnica is contaminated as a result of activity of chemical industry dating back to the First World War period, with the highest intensity from the 60's to 80's of the 20th century. The site of

former Jaworzno Organika Azot plant was recognized by the Helsinki Commission as one of the seven most important "hot spots" - dangerous sources of potential contamination for the Baltic Sea basin[1] . Up to now about 195 thousand tons of hazardous wastes have been recorded in this area and their adverse effect on the environment, especially soil, groundwater and surface water has been confirmed[2]. Among the disposed wastes there are hundreds of dangerous, persistent toxic substances, such as: pesticides, their semi-finished products and partial decomposition products. Some of them, like - DDT, DDE, DDD, dieldrin, endrin, a-HCH, B-HCH, y-HCH are considered as posing particular threat to the environment and are included in the list of persistent organic pollutants (POPs) under the Stockholm Convention. Some of the disposed substances - pesticides, volatile phenols, free cyanides - are regarded as particularly dangerous for the water environment. Although part of the contaminants is being captured through a trench system constructed at the bottom of the former sand pit, the groundwater is still being contaminated. The contaminant concentrations measured in groundwater are often several hundred to several thousand times higher than the permissible values.The groundwater aquifer in Jaworzno consists of the Quaternary sand layer, the thickness of which ranges from a few to over 10 meters. The aquifer is formed in a post-glacial buried valley of the Wąwolnica Brook. The bottom of the aquifer is covered with a layer of clays. The thickness of the layer varies, however, in the whole area of concern it seems to be continuous, as it has been found in all boreholes so far. The greatest complication for identification of the flow conditions comes from the trench system constructed at the bottom of the former sand pit. Still, the filtration field is quite uniform in this aquifer and groundwater flow is towards south-east, in general - along the Wąwolnica Brook.

3. Aim of the project

AMIIGA project focuses on multiple characterization, assessment & management strategies intends to build & capitalize on the results of project FOKS (CE 2007-2013). The activities implemented within FOKS project concerned the most contaminated area ORGANIKA-AZOT Chemical Plant and the nearby waste disposal area – Central Landfill (CSO) in the Wąwolnica Brook valley (including a former sand pit Rudna Góra) (Figure 5). The key sources of contaminants were identified in the Jaworzno test site as the result of modelling and performed studies with FOKS tool.

[1] A list of significant pollution sites around the Baltic Sea – HELCOM Hot Spots – was established in 1992; http://www.helcom.fi/Documents/Action%20areas/Industrial%20releases/List%20of%20hot%20spots%20as%20per%20December%202015.pdf

[2] for example in regional documents, such Environmental Protection Program for the Silesian Voivodship until 2019, with a view to the year 2024, https://bip.slaskie.pl/dokumenty/2015/11/04/1446627023.pdf

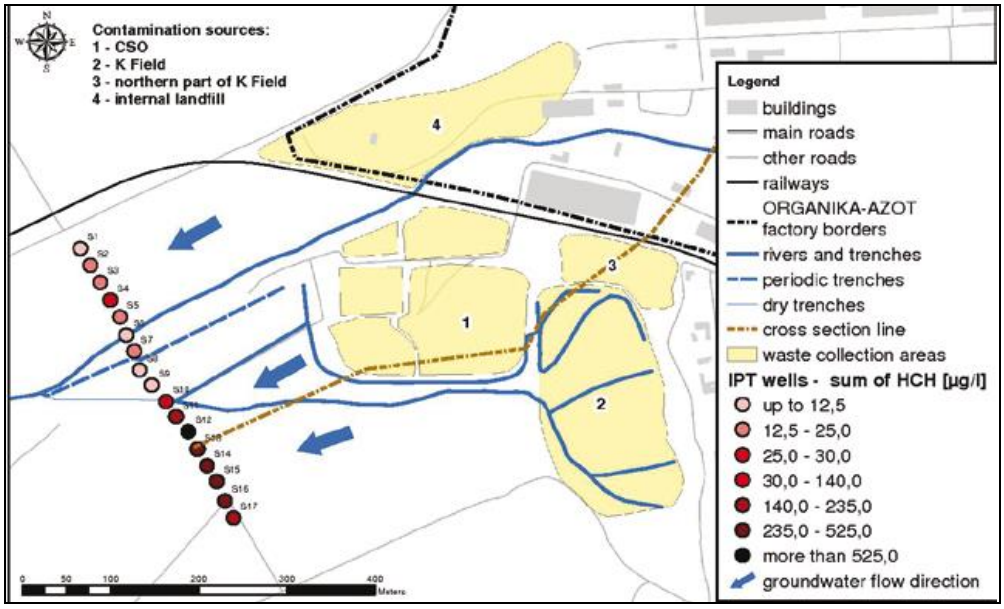

Figure 5. IPT application within FOKS project

Source: FOKS project "Transnational Guideline for Implementing Innovative Tools for Remediation"

Within the AMIIGA project the main objectives of pilot action implementation in FUA Jaworzno are as follows:

1. development and adaption tools for groundwater pollution assessment and remediation in FUA scale,
2. acquisition and store of different data for FUA Jaworzno: hydrogeological and physicochemical parameters of groundwater, river flows, surface water levels in selected water gauge profiles, precipitation.
3. supplement the existing monitoring data with new information from sampling campaigns to improve source-plume relationships and thus improving the numerical model of the site (physico-chemical analysis, isotope analysis, tree sampling, microbiological analysis),
4. development of numerical model for Jaworzno FUA groundwater for identification of groundwater contamination sources and contribution to warning system for potential future contamination flowing to drinking water intakes,
5. development of assumptions to the groundwater management plan with involvement of Regional Implementation Group considering technical, financial and legal aspects,
6. implementation of passive groundwater treatment system - the innovative bioreactive wall which will be placed accross the plume of pesticides in groundwater in Jaworzno FUA.

4. Jaworzno FUA pilot action and investment

In the framework of the AMIIGA project at Jaworzno FUA, as the pilot action, the innovative bioreactive wall will be installed with monitoring infrastructure, placed across the plume of pesticides in groundwater. It is planned to build demonstrative barrier in the "funnel and gate" system, where funnel is non-permeable wall (which will be isolating groundwater till the level of loam located in the bottom of the first groundwater level) and gate - bioreactive permeable walls filled with peat, sand, zerovalent iron, microbiological bed.

In order to collect and direct contaminated groundwater to the reactive barrier, it is envisaged to perform a barrier-collecting drainage (Figure 6). The drainage is designed as a narrow spatial ditch in which the

drainage aggregate will be laid. The total length of the drainage panel is 15 meters with thickness up to the level of loam - about 6 meters below ground level. Two parts non-permeable walls ("funnel") shall be provided on the trench wall. The sealed barrier is designed to pile up groundwater and produce a hydrostatic pressure allowing free flow through the reactive barrier. Each part non-permeable walls is 7.5 meters long with the depth of about 1 meter below the top of the Triassic loam to ensure the tightness of the barrier on vertical isolation.

Construction of the installation at the area of the brook Wąwolnica includes also "gate" - bioreactive permeable wall filled with innovative active material, such as: peat, zerovalent iron and specialized microbiological bed. Active barriers consist of reinforced concrete wells (S1, S2, S3) in which cartridges (K1, K2, K3) with active material are installed (Figure 6), and a flow system with checkpoints allowing the sampling of water. The system allows replacement of cartridges in the active barrier at the time when current control tests show the use of active substances. Barrier effectiveness monitoring is carried out on a regular basis through a pipe system connected to the bottom of the chamber at each stage of groundwater purification - at the beginning of the system (after drainage panel) and after each cartridge K1, K2, K3.

Construction of the installation also provides the S4 well, at a distance of approximately 63 meters from the active barrier (Figure 7). Well S4 is a part of the splash drainage system for purified groundwater, which also includes drainage from the level of the groundwater to the level of the impermeable layer of the Triassic loam. The flow of groundwater between the well S3 and S4 will be carried out by means of a sewer pipe made by a controlled bore.

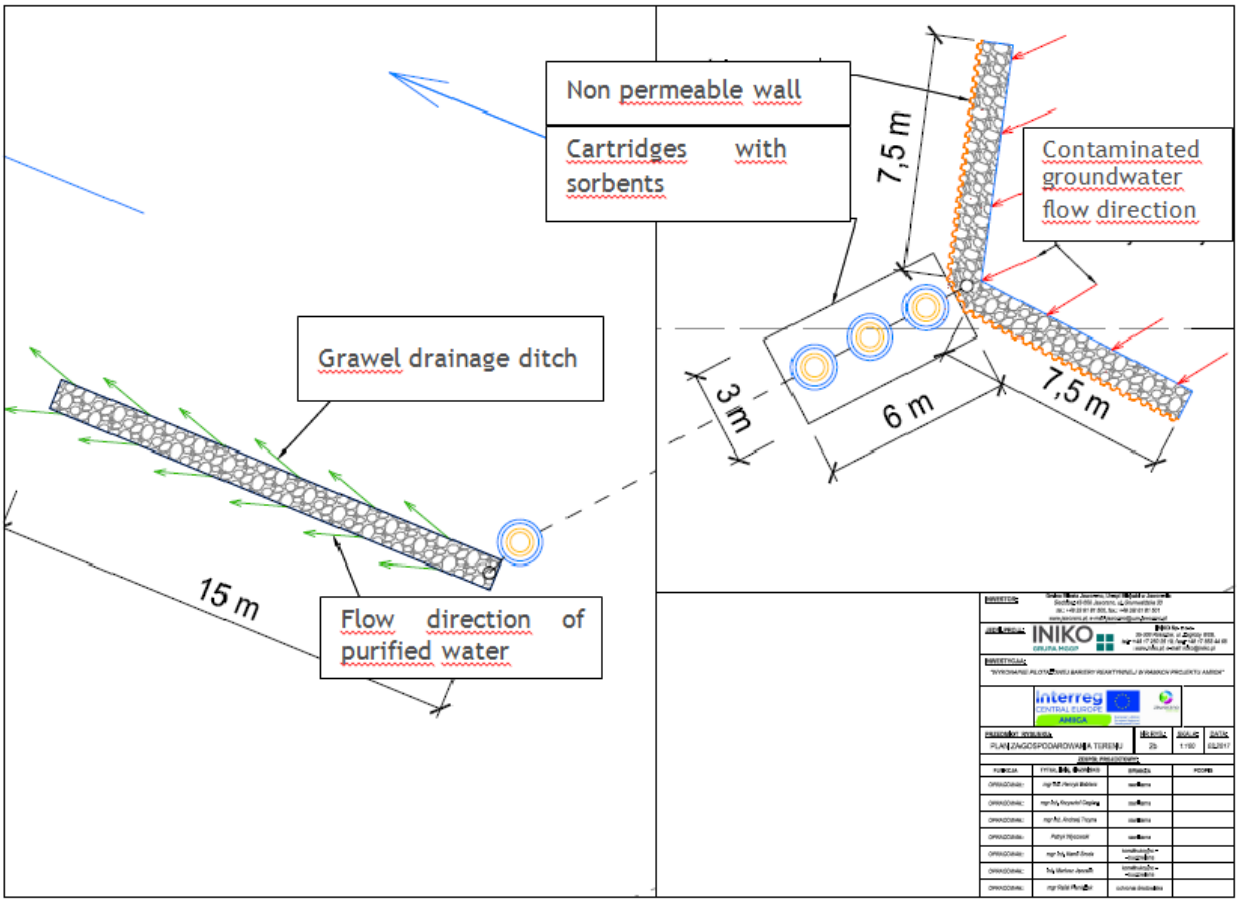

Figure 6. Technical concept of reactive barrier (1:100 scale)

Source: Technical project for bioreactive wall implementation – documentation (INIKO,2017)

As a result from elaborated tests it was decided during the technical workshop that iron chips and mixture of peat with sand will be introduced to bio-reactive wall columns, what is shown on picture below. Then, columns with peat and sand will be enhanced by microbiological inocula.

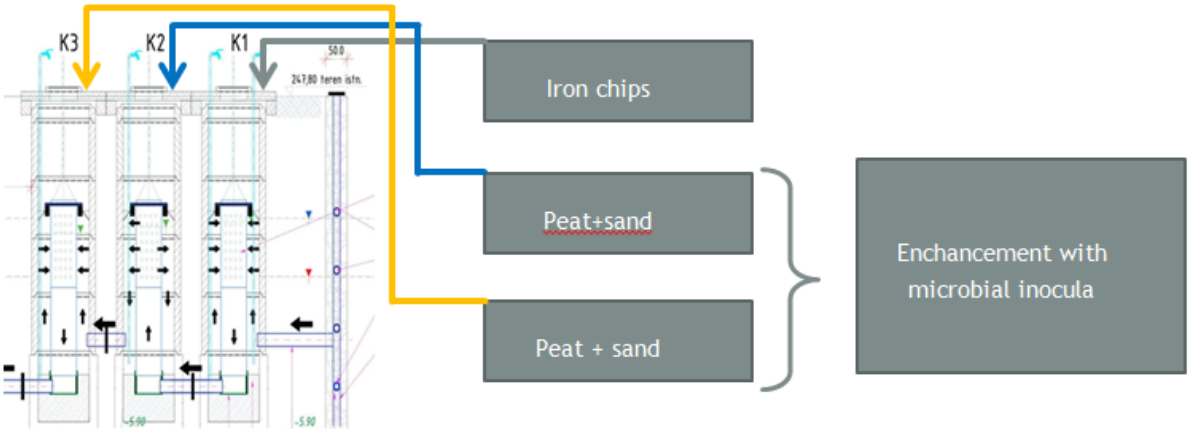

Figure 7. Concept for sorbent introduction into bio-reactive wall

Source: Technical project for bioreactive wall implementation – documentation (INIKO,2017)

The participation in the AMIIGA project will give the opportunity to implement the innovative method of passive groundwater remediation and check the possible effectiveness of implicated bioreactive wall with microbial reagents in the valley of brook Wąwolnica. We expect to find this proposed method as the solution for groundwater contamination in Jaworzno.