ENVIRONMENT
& NATURE

Hydrogeological documentation of a pilot terrain of COBRAMAN project in Bydgoszcz, Poland

(lots: 3/4, 3/6 and 2/4 by The Brda River at 36-38 Jagiellońska Street)

Kraków, August 2010

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Contents

1. INTRODUCTION

Present document specifies hydrogeological conditions of a former industrial object and left area, considered as likely polluting for ground waters. The documentation presents the following issues:

- describes geological structure of the area,
- explains the way of occurrence of groundwater in the soil, including occurrence of ground- and underground water,
- describes hydraulic relations between ground-, underground and surface water,
- describes basic hydrogeological parameters of water-bearing layers, which are present in the range of terrain influence, including especially aquifer first in the scope of hydraulic gradients, thickness of the aquifer, permeability of the vadose zone and zones of possible filtration, filtration rates,
- describes the status of environmental contamination, in particular the geochemical state of ground and hydro-geochemical groundwater state of aquifer first,
- describes the method and rules of monitoring of the area, including types of devices used to perform the monitoring, their construction and localization and the monitoring method.

Furthermore the documentation applies to the regulations specified in § 12 of Regulation of Minister of Environment, of 02.10.2005, regarding specific requirements of hydrogeological and geological engineering documentation (OJ no 201, pos. 1673).

In consequence of granting a public contract by tender announced by City of Bydgoszcz, to perform all the work has been selected company Ramboll Polska, headquartered in Warszawa 01-524, on 11 Wojska Polskiego Str.. Preparatory work (geological work project), field and additional work were performed on commission of Ramboll Polska Sp. z o.o. by company Omegatech Polska Sp. z o.o., located on 18A Balicka Str., 30-149 Kraków. Data included in present document are part of forthcoming reclamation project regarding relevant terrain.

2. GEOLOGICAL WORK OBJECTIVE

The objective of geological work was performing analyses and quality assessment of soil and groundwater, in order to elaborate a concept of reclamation, feasibility study for the concept of reclamation and reclamation project for the pilot terrain for UE project – COBRAMAN in Bydgoszcz, on property located in Bydgoszcz on 36-38 Jagiellońska Street.

COBRAMAN Project ("Manager Coordinating Brownfield Redevelopment Activities") aims to support reclamation of post-industrial areas in Middle Europe and implementation of homogenous concept management in this particular scope.

Within the geological work in research area of Cobraman project were installed 4 piezometers with diameter of 100 mm and collected for geochemical analysis purpose accordingly (from each piezometer) 3 ground drilling samples and 1 water sample. On this area and parcels directly neighboring have been detected before water contamination with compounds BTEX, PAHs and phenols.

Elaboration of documentation was based on results of field work, laboratory work and analysis of archival materials regarding described area.

2.1. Name and location of proposed investment

The City Office of Bydgoszcz after the sale of property at 36-38 Jagiellońska Street still is the owner of 3 parcels registered by numbers 3/4, 3/6 and 2/4 and located by The Brda River bank, which are not provided with access road and are earmarked for development as so called greenery and recreation area. The investment, which is necessary in order to create such place like play ground and recreational, involves soil and groundwater purification with harmful organic pollutants. Those compounds are residue after former exploitation of this terrain and neighboring parcels as industrial activity grounds with highly arduous nature – city gas works and building paper plant.

2.2. Technical and technological solutions of the investment

Based on results of furthermore described researches and information about causes and character of pollution occurring in soil and groundwater, on commission of the Investor, have been developed two concepts of area reclamation. According to these concepts, much likely technologically similar to each other, the project of *in-situ* reclamation is under development. It consists of leaving the anthropogenic, bank part in form of reclamation plots, which will take, in the reclamation work period, most part of the area. After dosage of bio-treatment product and statement its effectives in initial phase, the plots will be buried with humic soil. Every walls, foundations and industrial infrastructure remainders will be removed, crushed and moved away before the operation. Deeper levels, in which were also detected hydrocarbon pollutants, will be treated with bio-product as several to over dozen injections to the depth of accordingly 4 and 6 m. The area, after covering with humic soil, will be subjected to ultimate land use.

2.3. Scope and results of researches carried out in relation to the project of geological works

Earlier scrupulous recognition of neighboring areas allowed determining accurately the depth of deposition of each layer. Accordingly to the project 4 holes have been drilled, to the depth: Cobra-1 – 8.0 m; Cobra-2 – 8.0 m; Cobra-3 – 7.5 m; Cobra-4 – 7.5 m.. Small slips (of the order of 1 m) had occurred in location of holes, caused by conditions in embankment, i.e. old foundations. In each case, accordingly to Investors expectations, the piezometer ends with 0.5 m long sub-filter tube, placed in tertiary clays relining sands and quaternary pavement. All soil and water samples had been collected respectively to the project and immediately handed over to laboratory.

By using steel shuffle ground samples were collected from bore meal, pulled up on spiral drill after taking out the drilling column on the ground surface. Cleaned up from sediments of hole walls, fresh profile were collected from section c.a. 20 cm and after putting to glass, air-tight laboratory vessel, stored in chilled conditions in isothermal container. Vessels were earlier marked with labels with sample numbers and after turning down, put bottom up.

Water samples were collected the day after placing piezometer column into the hole, right after purification pumping. Samples from depth of about 6.5 m were taken with tight pipe by using peristaltic pump, with low flow and low power suction, without any turbulence, which allowed an accurate sampling in terms of dissolved gases. The tight pipe filling the laboratory bottles was immersed in water. Water samples in closed and marked bottles were analogically stored during the sampling process and transportation in isotherm, chilled container.

3. CHARACTERISTICS OF TERRAIN OF INVESTMENT

3.1. Location and general characteristics of research area

The area covered by researches is located in city of Bydgoszcz, by the Brda River, on its left bank, in the Kujawy-Pomerania Voivodeship. The area is 1130 m^2. It is divided from The Brda River by small, undeveloped green belt.

According to the partition of Poland by J. Kondracki (1998), area of research is located in centre zone of Torun-Eberswalde Ice-Marginal Valley (Torun-Bydgoszcz Valley) nearby Lower Vistula Valley (Fordon Valley).

The course of borders of relevant terrain is a result of cadastral division in this part of the City and only from south side, the natural border is determined by The Brda River. From the east side it borders on the terrain of former city gasworks and from the west with office buildings, among others CTO headquarters, and from the north with construction investment terrain (apartment building) belonging to company OG-BUD.

3.2. The outline of the history of the site

The history of developing the fragment of The Brda wharf, place where is located described area, is about 150 years old. In recent times, were located here buildings leased out for numerous private companies and workshops. Earlier, it housed the city tram depot (established around 100 years ago), but even before that, a building paper plant was located in here. In the area neighboring from the east side was located Gasworks of Bydgoszcz City, which were in operation in the years 1860-1973.

3.3. Land use in vicinity of proposed investment

Mentioned above Gasworks of Bydgoszcz City, located on the east, is a place, where since almost 150 years coal gas had been produced. Formed during process, highly noxious wastes, like volatile cyclic compounds, PAHs, phenols and gas pitch were divided into special washers and till the moment of sale, stored in underground, in general, brick tanks. Other by-products of gas purification are ammonium water, sulfur and cyanides. Parts of those highly toxic wastes were found in former tanks and directly in soil pits during few phases of researches in former gasworks. Till now there haven't been conducted any of purification works.

Terrain placed on west side had been used for years as location of office buildings (recently in general as headquarter of the Chief Technical Organization - CTO). There could be although some suspicions, that in times of operation of gasworks and paper plant, also was here located some kind of industrial plant.

From the north side was here main part of building paper plant and administrative and residential buildings (on Jagiellońska Street) – nowadays this area is a property of business developer, company OGBUD, which after removing contaminated soil form embankment, built residential buildings here. The process of bioremediation of groundwater and grounds in saturation zone is under development on OG-BUD commission, executed by company PROTE. From the south side narrow riverside, which is currently a walking along boulevard, was before a place of unloading coal from barges and trains, because a railway siding was located here.

3.4. Areas under protection, water supply conditions, location of groundwater intakes and their protected zones

Areas of water supply for the city water network are located far northwest from the research area. Until recently, when a meat processing company was in operation by Jagiellońska Str. (present shopping centre), the industry was supplied from couple intakes of artesian and sub-artesian water located in tertiary deposits. During demolition of meat processing company, the intakes were liquidated. There are no protection zones and other areas under protection in direct zone of COBRAMAN terrain.

3.5. Morphology and hydrography

In the area of the flood plain terrace Brda, in this part of Bydgoszcz City, the terrain is 32 – 34 m ASL. high and in most part is anthropogenically transformed (banks, leveling, bank strengthening, and river flow regulation). Hydrographically, terrain is located in The Brda catchment, which is a left side inflow of Vistula River. Water of The Brda is contaminated by urban wastes of Bydgoszcz City and sludge from many of industrial plants. Despite of that, The Brda is still a source of intake of surface water for industrial purpose and place of recreation (fishing) and sport (rowing and canoeing).

3.6. Geological structure

The geological structure of this area is shown on Detailed Geological Map of Poland (DGMP) 1:50 000 – the sheet: Bydgoszcz East and is described in explanation text (Kozłowska

M., Kozłowski I., 1992). Quaternary deposits covering almost whole area of the sheet are counted as glaciations: south-polish, middle-polish and north-polish. Only in places tertiary deposits are uncovered. Pliocene formations can be observed on the surface of series number of places in Bydgoszcz, on both sides of The Brda and on edges of Vistula valley. The oldest known in this area deposits don't occur on the surface of terrain and represent the upper Jurassic and Cretaceous upper and lower, and will be not explained at this point.

3.6.1. Tertiary

In the area of the sheet Bydgoszcz East, tertiary deposits were divided, based on results of palynological and planktonic analysis, on: Paleogene - Oligocene and Neogene – Miocene and Pliocene. The Oligocene deposits are represented by thick series of quartz sandstones with brown coal and silt inserts. Miocene consists of levels of brown coal and quartz sandstones with muscovite, clays and silts, in which had remained even big vegetable fragments. Pliocene deposits (clays and silts with lignite and brown coal) were heavily damaged and presently are showing out in reduced form on the both sides of The Brda in Bydgoszcz and in curves of Vistula valley.

3.6.2. Quaternary

Quaternary deposits with varying thickness (0 – 170 m within sheet Bydgoszcz East) are located on differential ground (Pliocene, Miocene, Oligocene, and Cretaceous). The highest thicknesses are in tectonic basins (i.e. in Fordon region) or egzaration basins, the lowest are in Noteć – Warta ice-marginal valley and in Vistula valley.

Pleistocene

On Oligocene deposits, in south part of Bydgoszcz, are sands, gravel with fluvioglacial boulders and glacial clays in the form of interbedding. Their thickness had been calculated as 9 meters. Next, in few drilling profiles in Fordon, there had been found tectonic breccias (calcareous – phosphorite rock) and Pliocene loam and Miocene deposits interbeddings. In glacial clays, which are remained in tectonic depressions and in Bydgoszcz – Kapuściska Wielkie egzaration basin, are Pliocene mottled loams.

To Pleistocene are counted also sandstones with gravels from river meadow terraces. As the best-formed meadow terraces sandstones V-VIII are considered fine- and medium sands occurring in Bydgoszcz down-town, on the both sides of The Brda. Those terraces have erosion and accumulative-erosion character. The average thickness of the deposits on The Brda terraces is 3 – 5 meters.

Quaternary not separated

It consists of sandstones and alluvial fan gravels, eolian sandstones, boulder clay eluvia and sandstones and slope wash gravels. The last ones can be found in Bydgoszcz on slopes of Brda valley.

Holocene

Sandstones and gravels of flooded terraces in places can be found in Brda and Vistula valley. They are mainly fine sandstones with interbeddings of middle and coarse sands with gravels. In turn, fen soils occur widely on flooded terrace of Vistula and fragmentarily The Brda. They are generally loams and blue-gray and brown sandy silts, with a thickness of maximum 6 meters. Outside the area directly planned for the researches, occur moreover: aggradate sandy and peaty mud and peats.

3.7. Hydrogeological conditions

Accordingly to the sheet: Toruń from Hydrogeological Map of Poland 1:200 000 (Płochniewski Z. and others, 1983) research area is a part of sub-region Bydgoszcz, Pomeranian-Kujawy region.

Underground water, which is the source of water supply in this sub-region, pertains to water-bearing levels: quaternary, tertiary and cretaceous. Quaternary level is created from sandy-gravel formations and it's supplied from surface water and precipitations. It is most vulnerable to contamination. The water level surface is here free or slightly strained. Water mineralization ranges from 180 to 400 mg/dm^3 and hardness 12 - 17 ^{o}n. This level is Main Groundwater Basin (MGWB) no. 138, called Toruń - Eberswalde Ice-Marginal Valley (Kleczkowski A., 1990).

Tertiary aquifer in taken by most of the wells in Bydgoszcz, consists of fine-grained Miocene sands ("adamowskie" layers with thickness 20 – 40 m), occurred on depths from 15 to 70 meters. The aquifer is MGWB no. 140, called Bydgoszcz. The efficiency of the well is 248 m^3/h, by depression to 22,0 m. general mineralization of water reaches 400 mg/dm^3.

Cretaceous aquifer is formed from more thick, down to 70 m, sandstone. Efficiencies of the wells are reaching 121 m^3/h by depression to 14 m. This level, in spite of occurring at significant depth (80 – 250 m), is exploited among others in Fordon. Mineralization here ranges from 260 to 770 mg/dm^3, and hardness 3,9 – 17,4^{o}n.

Formerly within Quaternary and Tertiary MGWB were separated top- and high water protection areas: TPA (ONO) and HPA (OWO), presently, accordingly to the decision of Hydrogeological Documentation Committee, separation is made by MGWB. Those basins have pore character and are filled with pure water, to use without treatment and slightly polluted water, easy to purify. Both basins are open type and supplied by outcrops on ground surface, and tertiary layer also indirectly by higher Quaternary deposits. Especially suggested is improvement of sanitary state of surface water, which by infiltration can affect the quality of groundwater (Bandurska-Kryłowicz H., 1992).

Based on research results, the infiltration character of the Brda was stated. But it is not a permanent state. The data of archival researches of groundwater level and river status (i.e. measurements in PGI projects: PROMOTE, INCORE) show, that there is a strong hydraulic tie with surface water. Currently the boundary of water transfer is silted-up with deposits river stream channel and paved, reinforced river banks.

Mentioned above changes of the Brda character, from infiltrating to draining, that are caused by fast incomes and as well fast outcomes of the Vistula, cause diversification of direction and speed of groundwater flow. Attached map with hydro-isohypses illustrates directions of the flow, at day of measurements – 09.06.2010 r.

To short period of research time didn’t allowed for identifying of groundwater level fluctuation by seasonal measurements.

4. RESEARCH RESOULTS

4.1. Hydrogeological parameter characteristics

The assessment of hydrogeological parameters is generally based on earlier researches and measurements on neighboring terrains, i.e. OG-BUD research. Stated - average ratio of filtration, marked only for water-logged sandstones, is $k=1x10^{-7}$ m/s (Irmiński & Pietrzykowski, 2007).

Illustrated hydro-isohypses (Fig. 1) and resulting from it direction of water flow are short-living picture, what results from good hydraulic connection of aquifer with The Brda River. In that case, it is hard to state a permanent hydraulic gradient. In time of measurement it was about 1 meter for 50 meters, which gives decrease of 2% . This situation is changing rather dynamically, what can be concluded from INCORE project data – water stagnation or total flow reverse within a few days. Should be remembered, that within days of measurement, the infiltration character of the Brda resulted from incredibly high water level. In time of field works, which was in 1st decade of June 2010, general in Poland flood conditions prevailed.

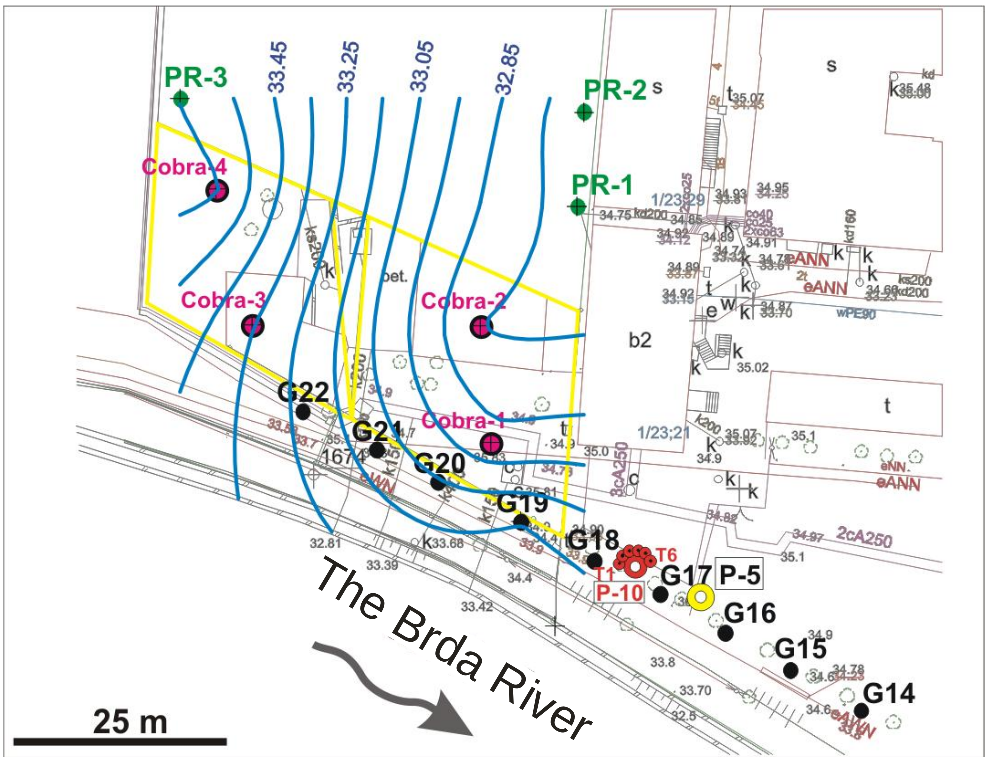

Fig. 1. Hydro-isohypses on research area on 9th of June 2010

4.2. Physical and chemical properties of the ground

Based on analysis of earlier researches (i.e. INCORE) and geological profiles of four drillings Cobra, four main lithological types can be distinguished. In the profile to a depth of approx. 8 meters occur from top to bottom:

a) Anthropogenic embankments zone: non-homogenous deposits, sandy clay, with many mineral wastes (stones, brick remnants, concrete debris, slag wastes) and organic wastes (wooden remnants and tar impurities, which consist of PAHs and BTEX mixing). Those deposits are unevenly concentrated, have variable porosity and from geological engineering angle are non-bearing. Their thickness is variable and ranges from about 1,8 m in western part of terrain to 2,7 m in eastern;

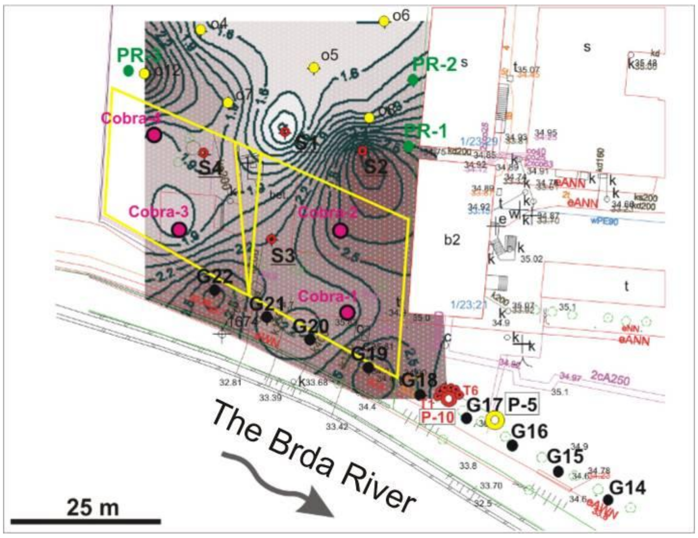

Fig. 2. Research area embankment - isopachous line map

b) River alluvial zone: mineral and organic deposits, with significant contents of loam minerals, which causes their adhesive, weakly permeable character. Black and brown colors, smell of decomposition of vegetable matter. Those grounds are non-bearing. The thickness reaches 1 meter, but in the central part of terrain, alluvium did not settled;

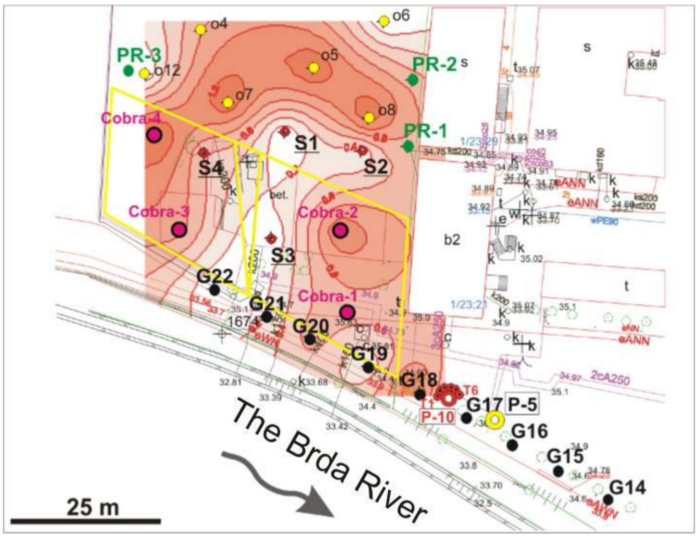

Fig. 3. Research area alluvium - isopachous line map

c) Sands and gravels with various fraction of grain: these are deposits with a good permeability, in places big porosity. Formed as streamway and by-channel deposits are not continuous, but there is a possibility to separate lenses and channels, i.e. gravel. This zone reaches about 3,5 – 4,5 meters and ends in residual pebble floor;

d) Loam with addition of brown coal zone: These rocks have weak plasticity in dry state, but after water logging – very plastic. Loam colors range from gray-red to green and blue. Thickness of this rock series reaches about 10-12 meters, which outcomes from data about drilling profiles (Matczyński, 1998) and sheet of geological map Bydgoszcz – East DGMP 1:50 000 (Kozłowska & Kozłowski, 1992).

Included below geological and chemical profiles (Fig. 4-7), based on collected samples analysis, illustrate areas of occurrence and concentration selected and analyzed compounds. Red color highlights concentrations (mainly in PAHs case), which decide about taking sample as abnormally polluted.

In many cases quantity of stated PAHs is lower than standard for group B allows (accordingly to Regulation of Ministry of Environment, dated 2002), but having in mind way of accumulation organic compounds in deposits, especially heavier tar fractions, the very presence of these compounds indicates influence of contaminations and directions of their migration. Conducted chemical analysis had also shown participation of individual components of PAHs, which can indicate to communication and directions of migration between focus and streaks of contaminations. Figure 6, and especially figure 7 (logarithmic scale) reveal, that contaminations in general, migrate to the river from north-east direction (former gasworks) – what can be deduced from morphological similarities of samples CBR1/1 and CBR 3/2 (movement of contamination under alluvial is not a problem here, because in this area there has been a lack of such isolation tension of water – Fig. 3)

General image of PAHs occurrence in three depth levels is illustrated by respectively figures 10-12. Shown as the lowest value isoline 20 mg/kg of dry matter is the allowable concentration limit for type B grounds.

Besides PAHs in a few cases there has been a presence of BTEX stated. Even that those compounds are volatile, their occurrence on depths ranging 6-7 m can not surprise, because those compounds reach here together with groundwater. Convenient ways of migration for water and contaminations are found in Cobra holes (and also in many documented holes from INCORE project) lenses and gravel old channels.

Phenols in ground are not a significant problem on analyzed area (phenols, among these kinds of carbon derivatives organic compounds, in the fastest way submit to biodegradation or decay). Although there should be stated, that results of laboratory works do not let enough to classify grounds in B class.

Analyzed, accordingly to Investor's commission, oil-derivatives (petrol and oils) do not cause the problem. There was no measurable concentration in collected soil samples.

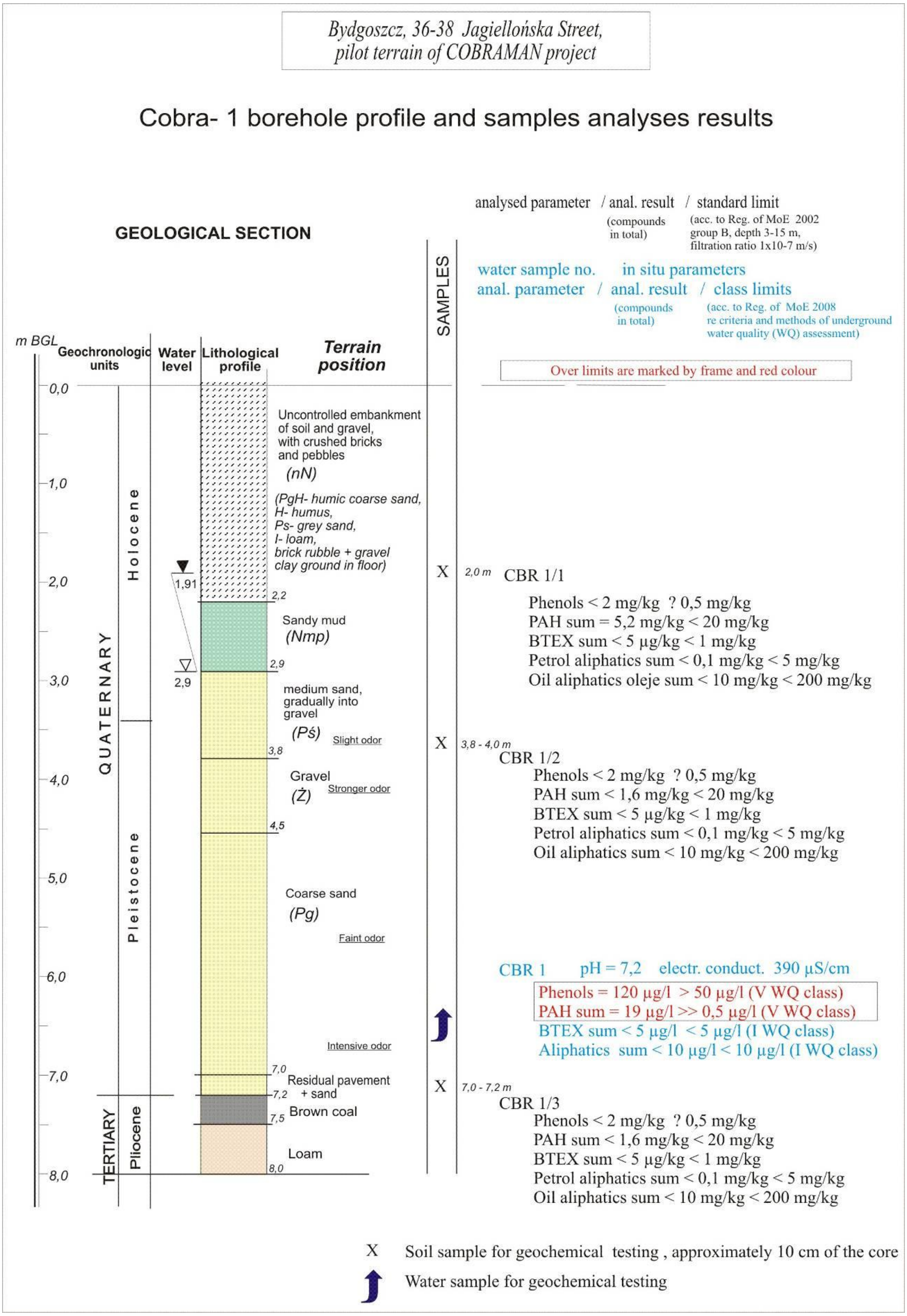

Fig. 4. Geological and chemical profile of Cobra-1 borehole

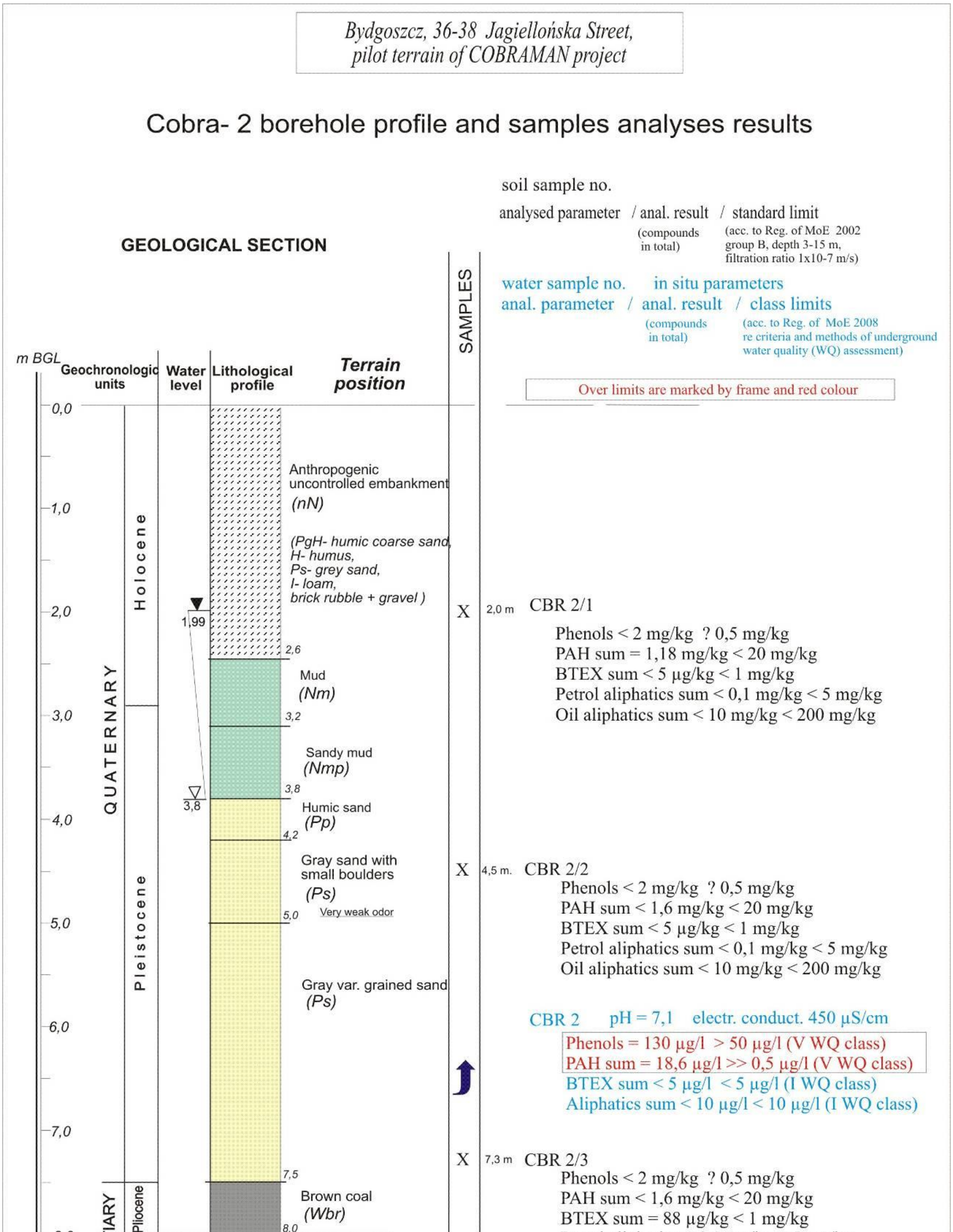

Fig. 5. Geological and chemical profile of Cobra-2 borehole

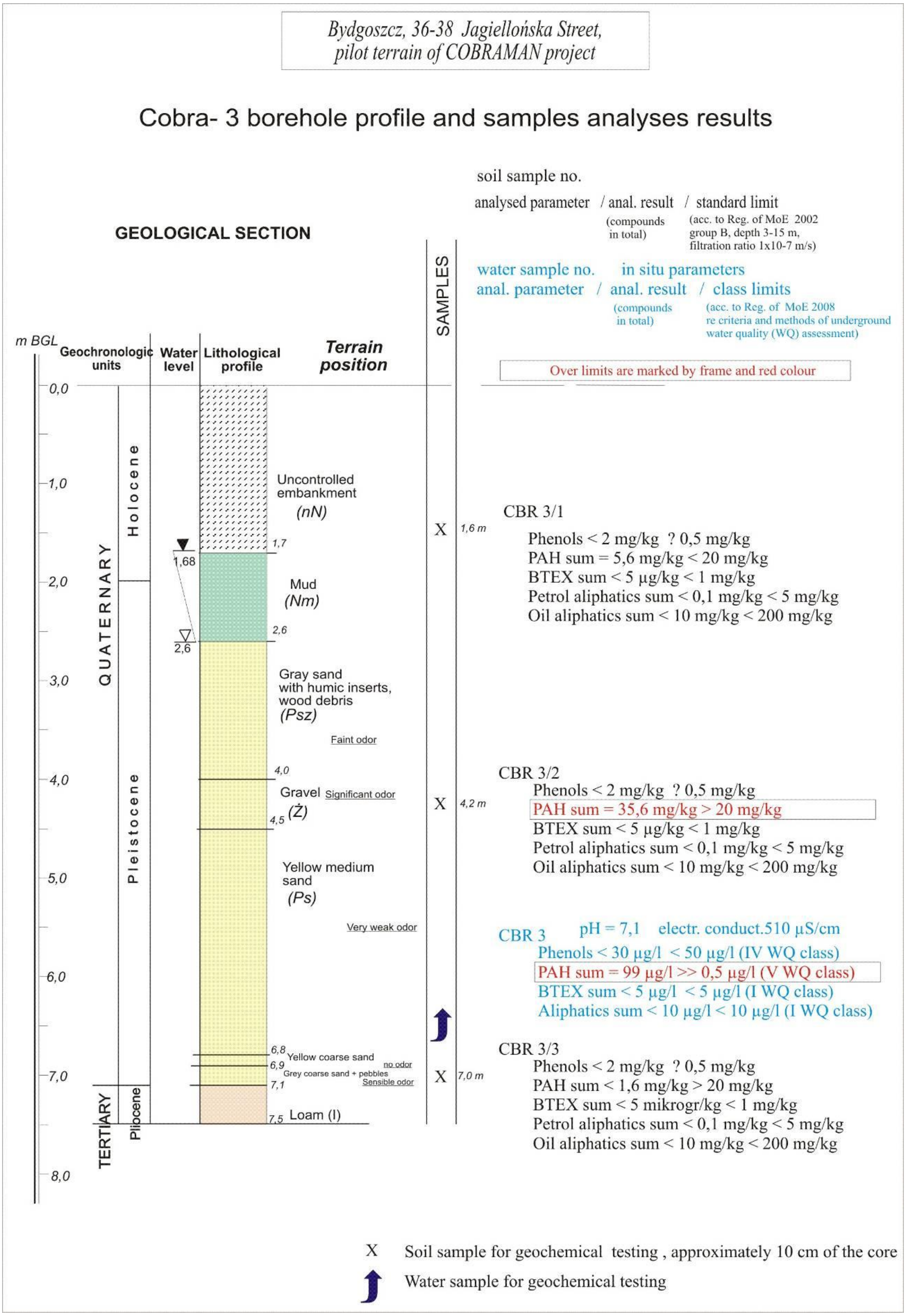

Fig. 6. Geological and chemical profile of Cobra-3 borehole

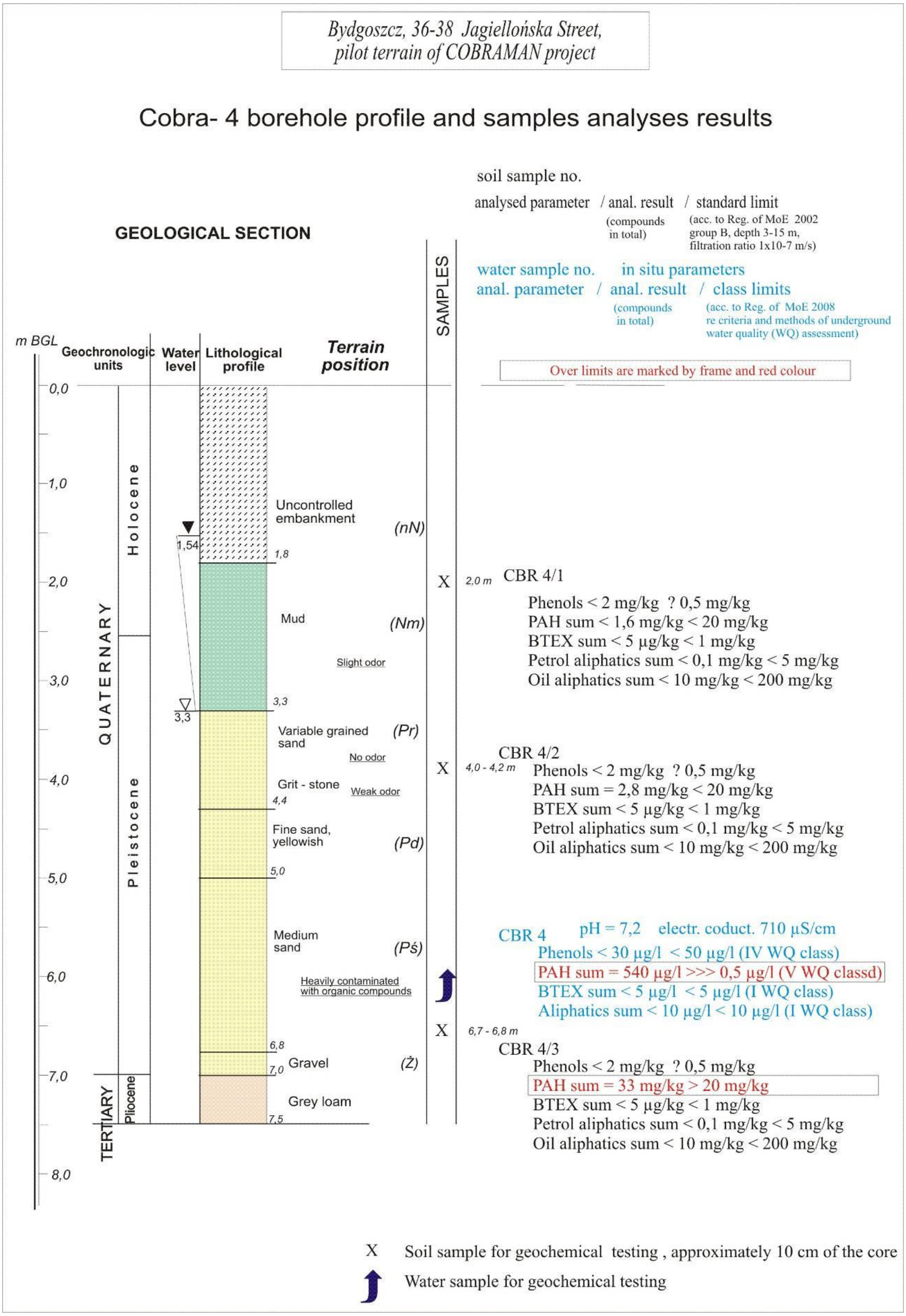

Fig. 7. Geological and chemical profile of Cobra-4 borehole

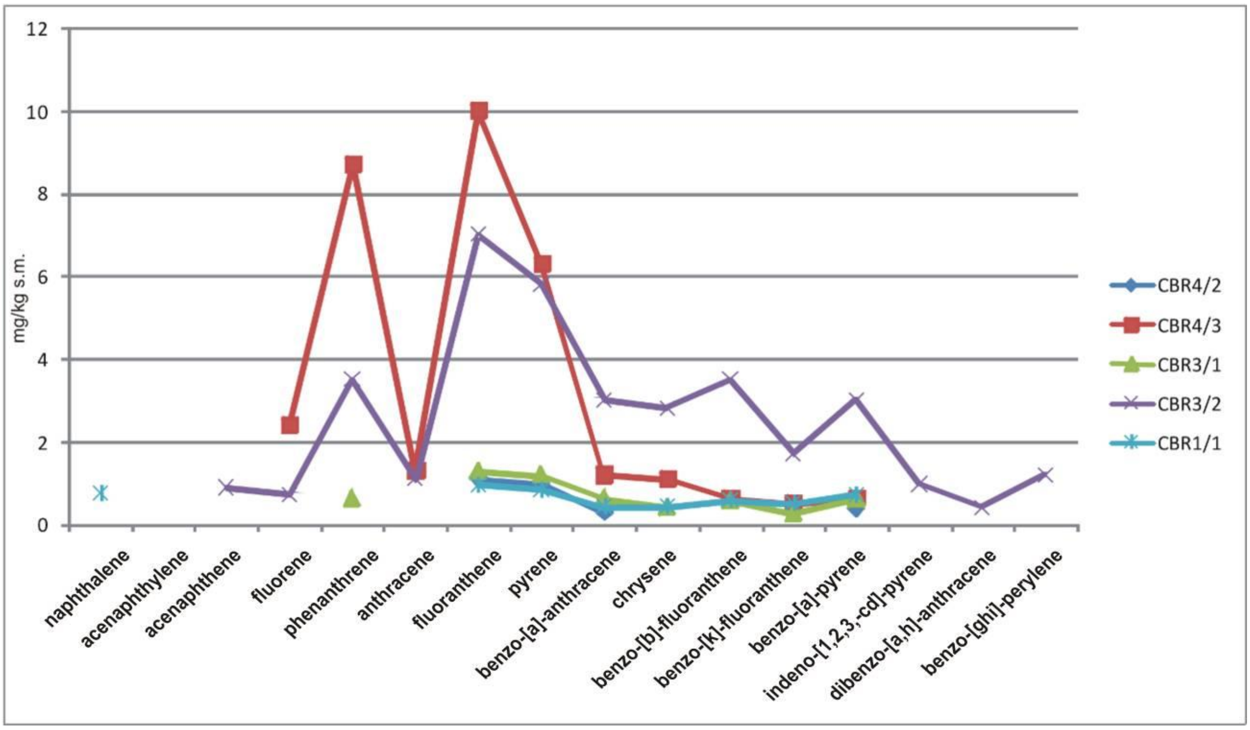

Fig. 8. The results comparison of PAHs analysis in soil samples

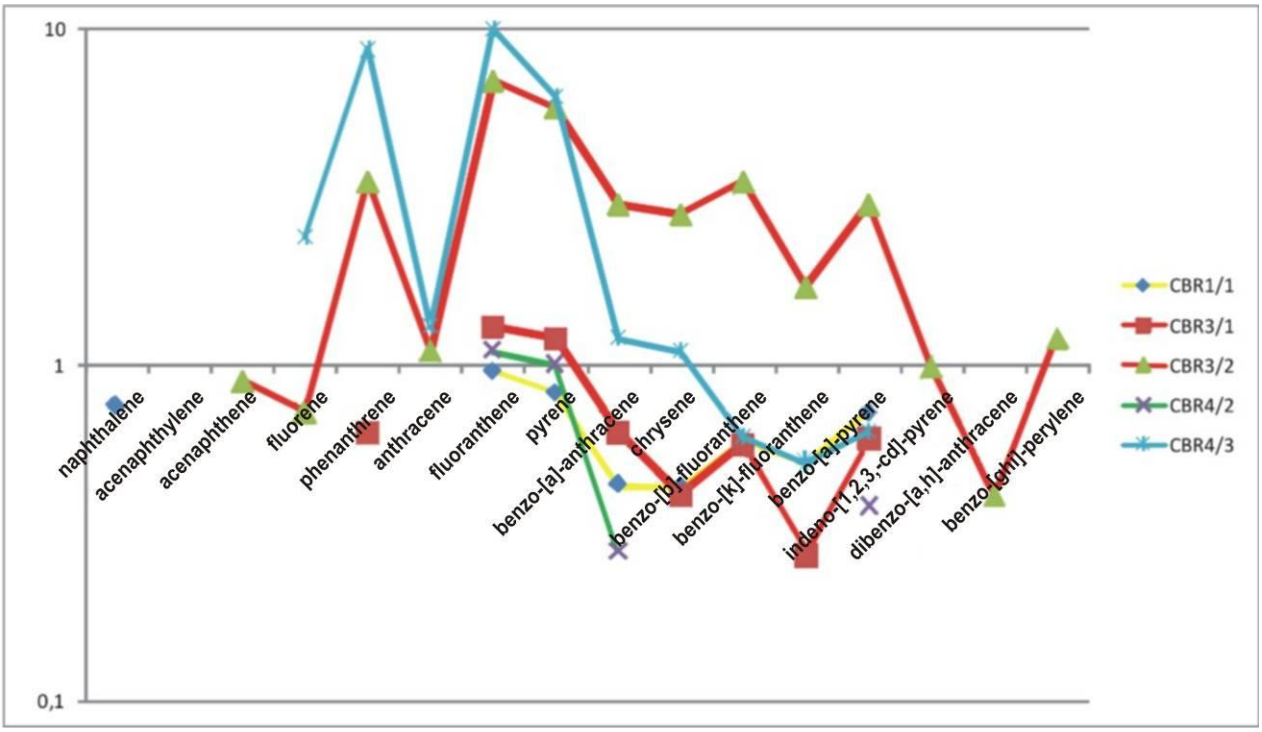

Fig. 9. The results comparison of PAHs analysis in samples – logarithmic scale. Contents in mg/kg

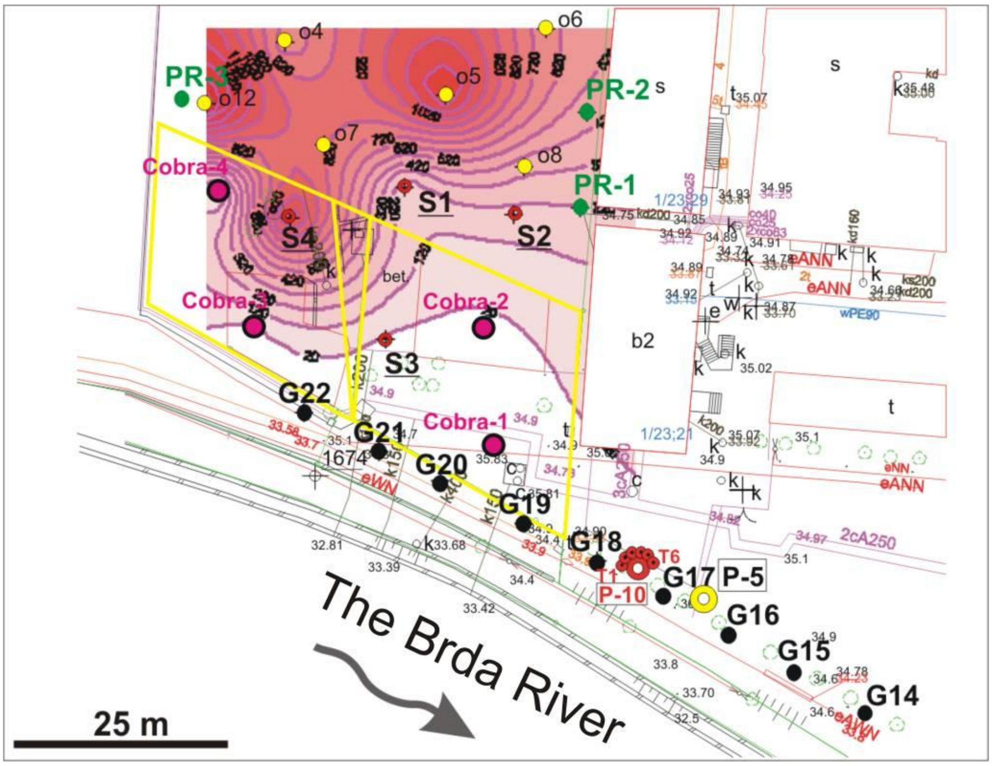

Fig. 10. The contents of total PAHs (mg / kg dm) at a depth of 1-2 m.. The first contour line - 20 - is the limit allowable concentration value for the grounds of group B.

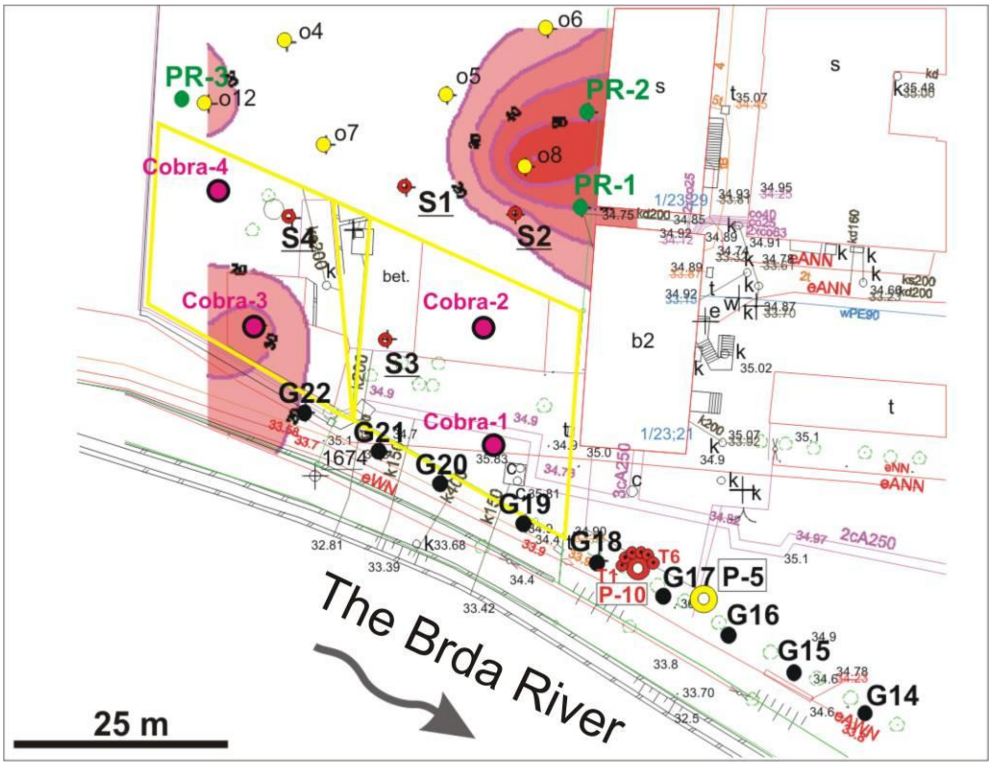

Fig. 11. The contents of total PAHs (mg / kg dm) at a depth of c.a. 4 m.. The first contour line - 20 - is the limit allowable concentration value for the grounds of group B.

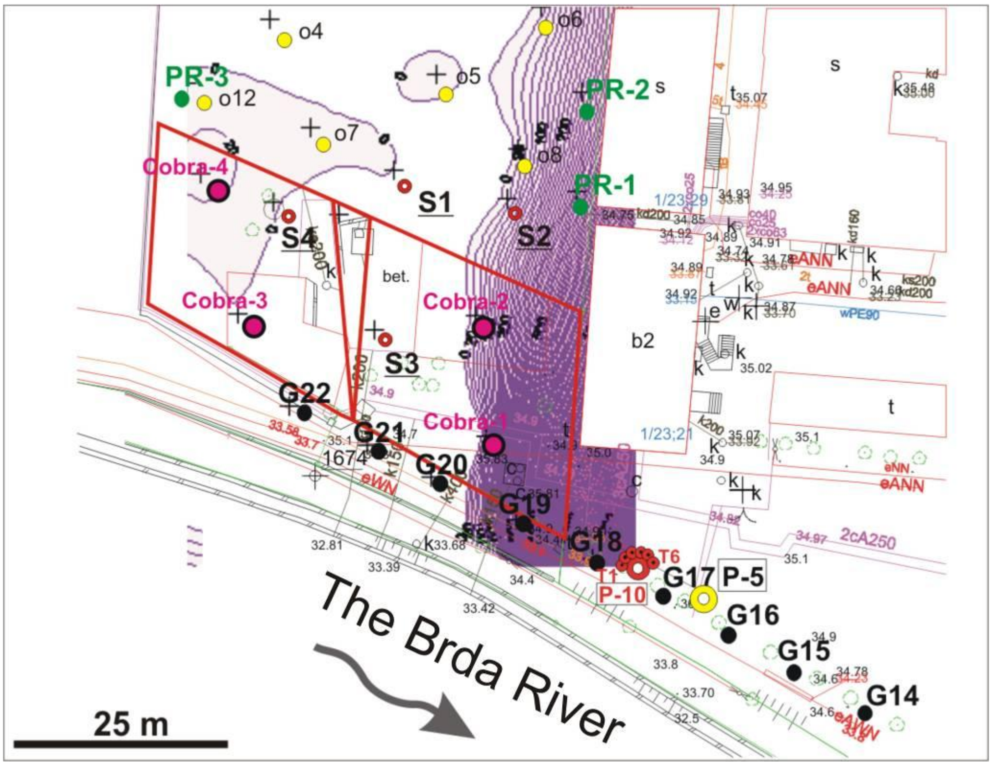

Fig. 12. The contents of total PAHs (mg / kg dm) at a depth of 6-7 m.. The first contour line - 20 - is the limit allowable concentration value for the grounds of group B.

4.3. Physical and chemical properties of groundwater

Collected from designed piezometers groundwater samples were subjected to range of laboratory research as follows:

- Amount of polycyclic aromatic hydrocarbons with individual hydrocarbon fractions;
- Amount of aromatic hydrocarbons with individual hydrocarbon fractions;
- Phenols
- Aliphatic hydrocarbons with light and heavy fractions by chromatographic method (C12-C35)

The reason for analyzing that range of parameters is a analogical procedure in other countries, where problems of former industrial localizations, emitting organic compounds, are analyzed with precision (Ertel & Alimi 2001). In case of organic substrates can be assumed, that it's a specific mixture for contamination forming by coal gasification process and producing after-gasification tars, and next using those compounds to saturate produced here earlier – isolation building paper.

In the range above 4 groundwater samples had been analyzed. The samples were collected respectively to the methodology described in chapter 2.3.

From physical angle, samples of water collected from filtered holes are clouded, even tough during pumping amount of slurry is decreasing. Color of the water is slightly yellow, caused by organic pollutants. Temperature of the water is c.a. 9°C, conductivity ranges from 390 to 710 μS/cm, and pH is about 7, 2.

Within contaminants stated dominating compounds are PAHs, which exceeds the for the worst, V class of water quality for two or even three rows (borehole Cobra-4 had shown occurrence of PAHs sum for 540 μg per liter, by limit value 0,5 μg/l). Moreover, in samples from Cobra-1 and Cobra-2, were stated very high concentration of phenols (respectively 120 and 130 μg/l), which indicates directly inflow of contaminated water from neighboring gasworks terrains.

There were no detection of significant amounts of BTEX and aliphatic compounds.

The main component of water contamination – sum of PAHs compounds is graphically shown on Fig. 13.

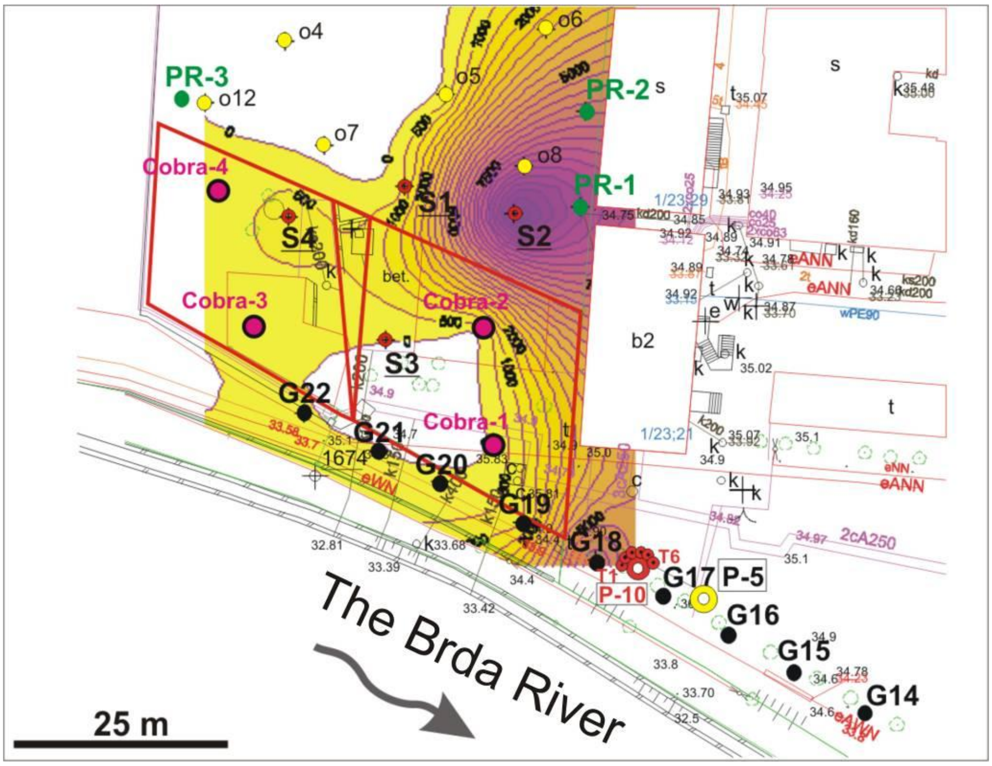

Fig. 13. Contents of total PAHs (in μg/l) in groundwater, sampling on depth of 6,5 m

4.4. Forecast of changes in soil and groundwater chemistry under the influence of the proposed investment

After removal of underground infrastructure remnants, including perhaps part of the former tank and accompanying highly contaminated grounds (in form of supersaturated sand), the biggest element of action will be construction of underground concrete and loam barrier bar, to prevent contaminated groundwater flowing back from the Former Gasworks terrain to COBRAMAN area. The barrier, with c.a. 50 m length and 8-8,5 m depth, will have once broken line course, accordingly to geodetic border of the site.

The ground chemistry on embankment level will be subjected to special remediation treatments – there's a choice of two methods: bioremediation by little plots with bio-formulations or so called method of "washing the ground" of the excavated small size sectors, and next filling with soil in an empty sector.

In saturation zone, which conventionally is located below alluvium layer, also can be conducted bioremediation works. Stated in research of the zone contamination should be drilled and next injected with bio-formula able to eliminate as complicated contaminants like after-gasification tars. Thereby the quality of the soil will gradually improve at this place and indirectly it will cause improvement of water quality state.

Proposed in one of the concepts, method of injection with ground activated coal, has a line of disadvantages and only by appearance, reminds more expensive and danger in use nano-coal method.

In sum: whole investment has in objective decreasing in radical way and in short period of time contaminations in water-ground environment without a need of exporting big amounts of soil and filling up surrounding landfills.

4.5. Type, character and level of risk in stage of investment

As each demolition- and earthworks (liquidation of foundations and infrastructure remnants), also this investment takes constant respecting of occupational safety and health rules. Additionally the type of contamination (volatile and partly volatile harmful organic compounds occurring in the water and in the ground) will be requiring shorted time work, more frequent breaks outside the pits, in other words – decreasing time of workers exposure. There may be a necessity of using individual means of respiratory protection. The workers (properly trained) have to respond correctly and each time inform supervision unit i.e. about statement of leakage from excavated pipes or accumulation of some unknown substances.

Second important risk, which is worth of mentioning, is possibility of momentary increase of mobile compounds after bio-formula treatment. It is a normal situation and short in duration situation. It outcomes from the way of microorganisms interaction with complex polycyclic compounds. It requires monitoring.

4.6. Indications and recommendations concerning changes of investment size

Taking small size of the COBRAMAN area, it could be assumed that, proposed investments will be sufficient in size. But correlation of restoration actions on the neighboring areas (including planned, thought trough and detailed dredging of the Brda) might bring even better effects.

Decreasing of remediation area size, smaller amount of bio-formula used or i.e. resign from loam barrier will contribute to the eco-worse effect in general and even totally stop the ground purification of saturation zone (constant inflow of contamination together with underground water). It will cause indirectly a threat to the ground surface, through volatile compounds migration through aeration zone.

If the Investor is able (from financial side) to pay for the exchange of at least part of the most contaminated ground (embankment), the final effect will be better and reached faster. Excavated grounds would be cleaned –up by bioremediation method in special piles, outside the city.

5. RECOMMENDATIONS REGARDING GROUNDWATER QUALITY MONITORING

Drilled within the project boreholes Cobra and existing and preserved holes from other researches (INCOR, remediation by company PROTE for OGBUD), unless they wont be destroyed or liquidated during developing works, will be used for monitoring purpose. Below are detailed monitoring recommendations regarding two, slightly different, reclamation concepts.

5.1. Monitoring in concept of bioremediation without removing contaminated embankment

In plane there is a four-times monitoring study of bio-formula effectiveness on levels I (1-2 m), II (3,5-4,5 m) and III (6-7 m), best every 3 moths. The monitoring should be carried out as: collecting each time soil samples from level I (4 samples) and water samples from 4 selected piezometers (one from level II and three from level III), analyzing of the samples for the content and composition of PAHs. The last series of monitored water and soil, should have full range of chemical markers used in this project, which are BTEX, PAH, phenols, petrol and oils. At the end of the project should be officially, by that mean with presence of the Investor and controllers representing Regional Environmental Protection Officer, collected by the probe soil samples from zones, recognized as primary contaminated. The probing in distance about 2-2,5 m from the injection borehole and control samples from the embankment level, representatively for the entire area, i.e. contents of single BTEX, PAHs, phenols, petrol and mineral oils. This test could be a proof of degree of effectiveness of bioremediation treatment.

5.2. Monitoring in concept of chemical - mechanical remediation, without removing contaminated embankment layer, and using activated coal

There is planed to conduct researches of effectiveness of activated coal on levels II and III. At the end of the project should be officially, by that mean with presence of the Investor and controllers representing Regional Environmental Protection Officer, collected by the probe soil samples from embankment zones, recognized as primary contaminated. There can be randomly performed 2-3 probing together with collecting soil samples from after "washing" ground. From deeper levels 4 water samples should be in general collected each time 4-fold during one year period from the moment of activated coal application. The analysis of the soil and water samples should be performed by certified laboratory and in range of primary assumed in the project individual markers: BTEX, PAHs, phenols, petrol and mineral oils. This test may be the proof of effectiveness of remediation actions and ability of blocking organic compounds in saturation zone by active coal.

6. LITERATURE

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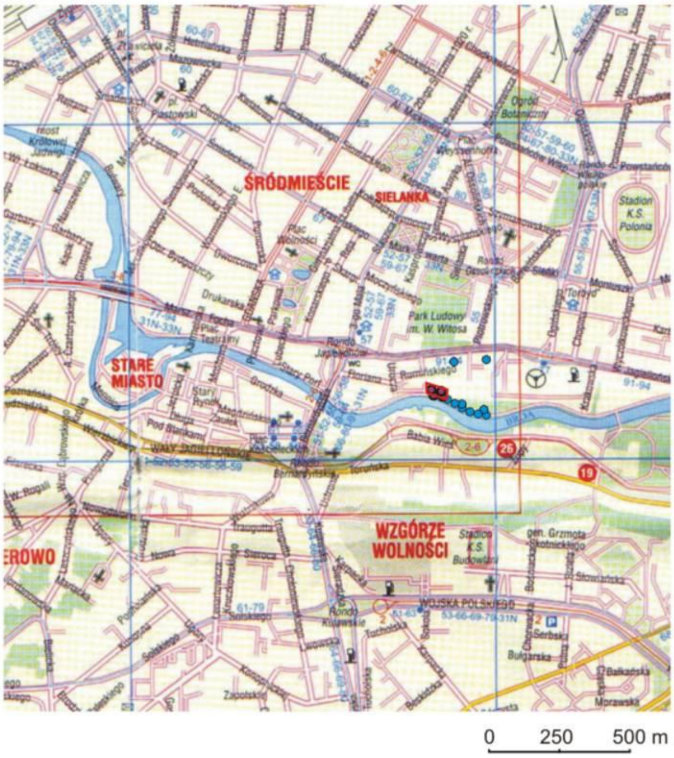
7. GRAPHICAL PART OF THE DOCUMENTATION

7.1. Review map with pilot terrain location

Bydgoszcz, 36-38 Jagiellońska Street,
pilot terrain of COBRAMAN project

Location of existing reaserch boreholes on the Cobraman project terrain and nearby scale 1:25 000

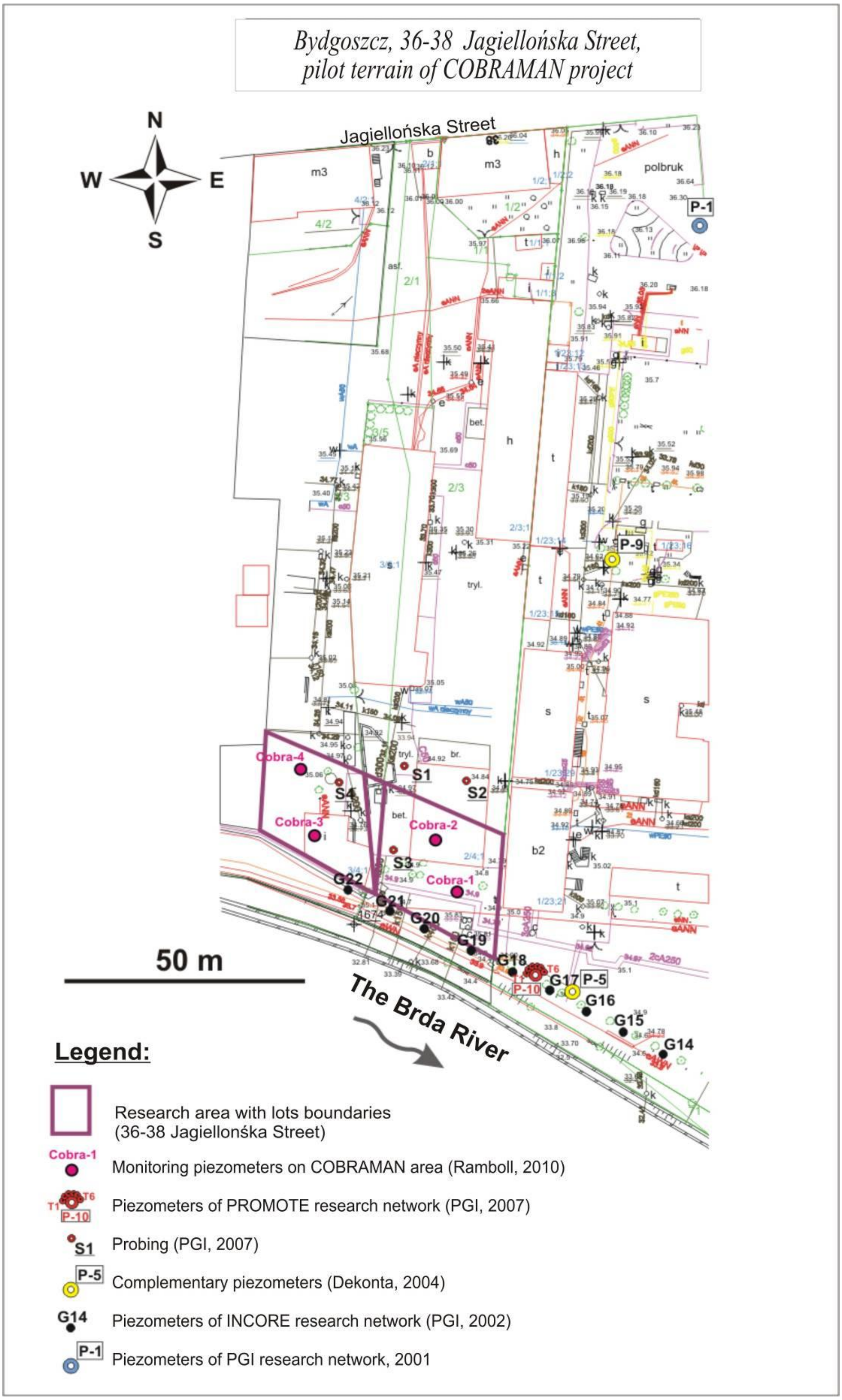


Research area boundaries (36-38 Jagiellonśka Street) precincts 149, lots 2/4, 3/4, 3/6.

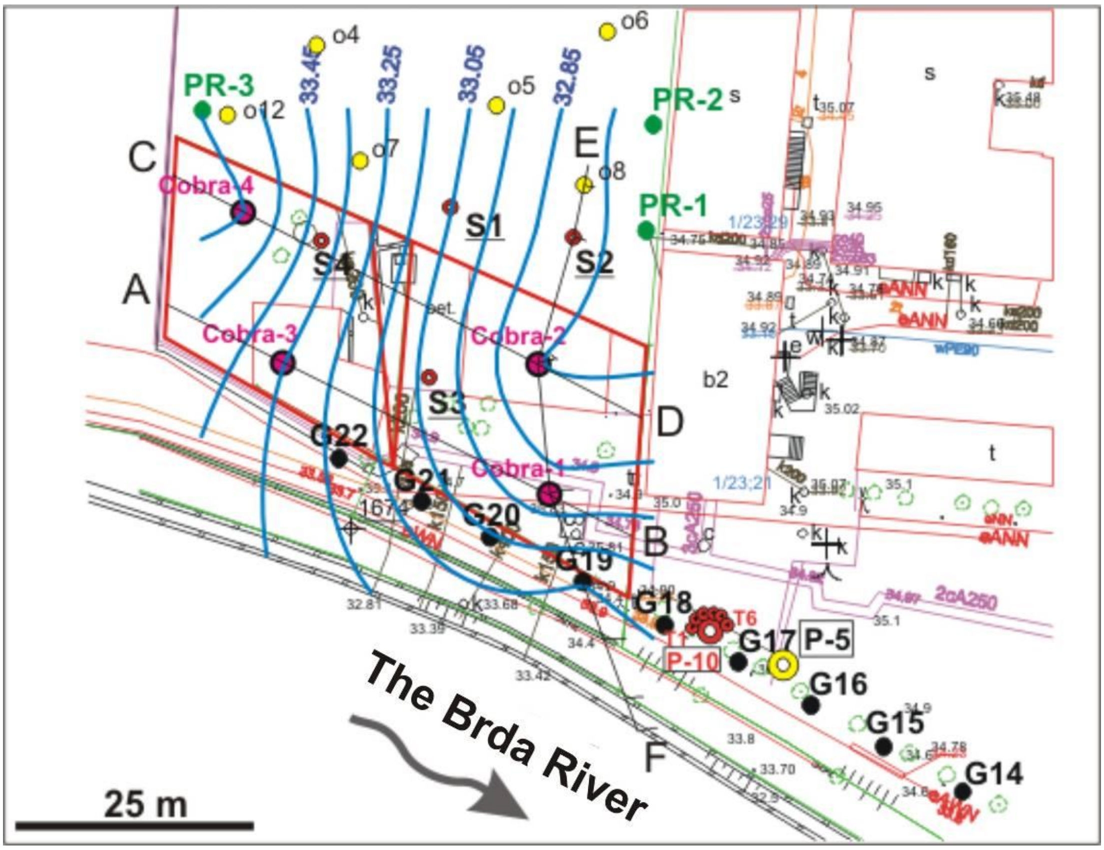
• Existing wells and research holes on neighboring to Cobraman area

• Installed monitoring piezometers (4)

7.2. Documentation map

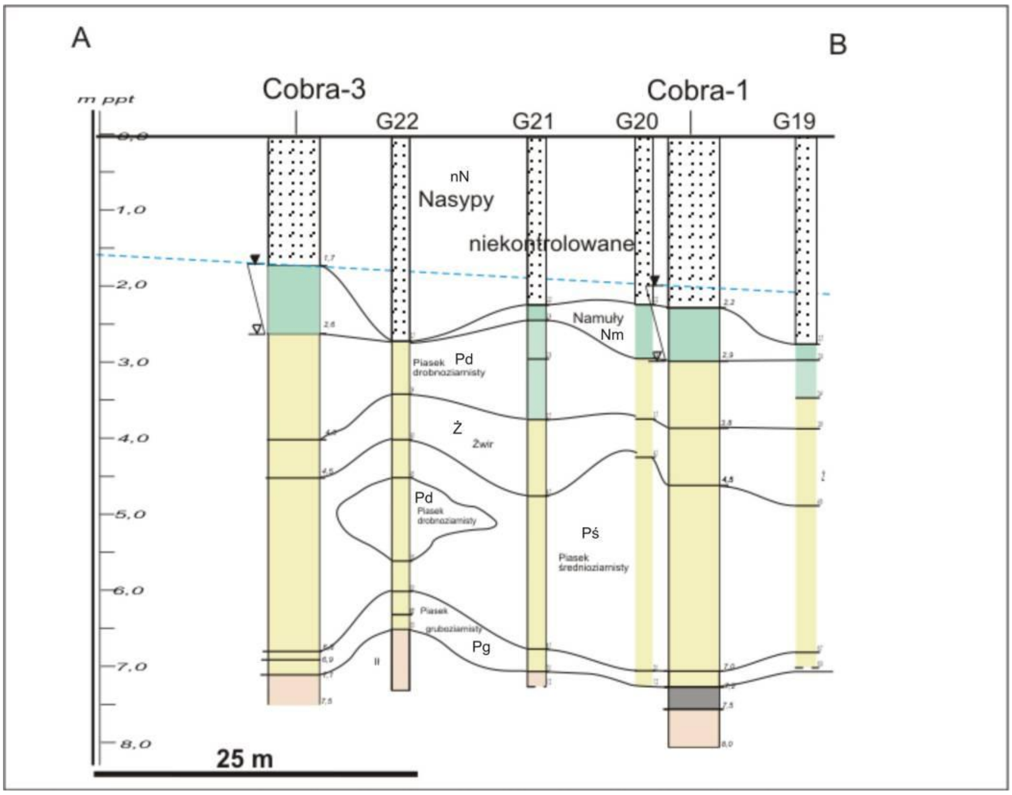


7.3. Hydrogeological map of the work field

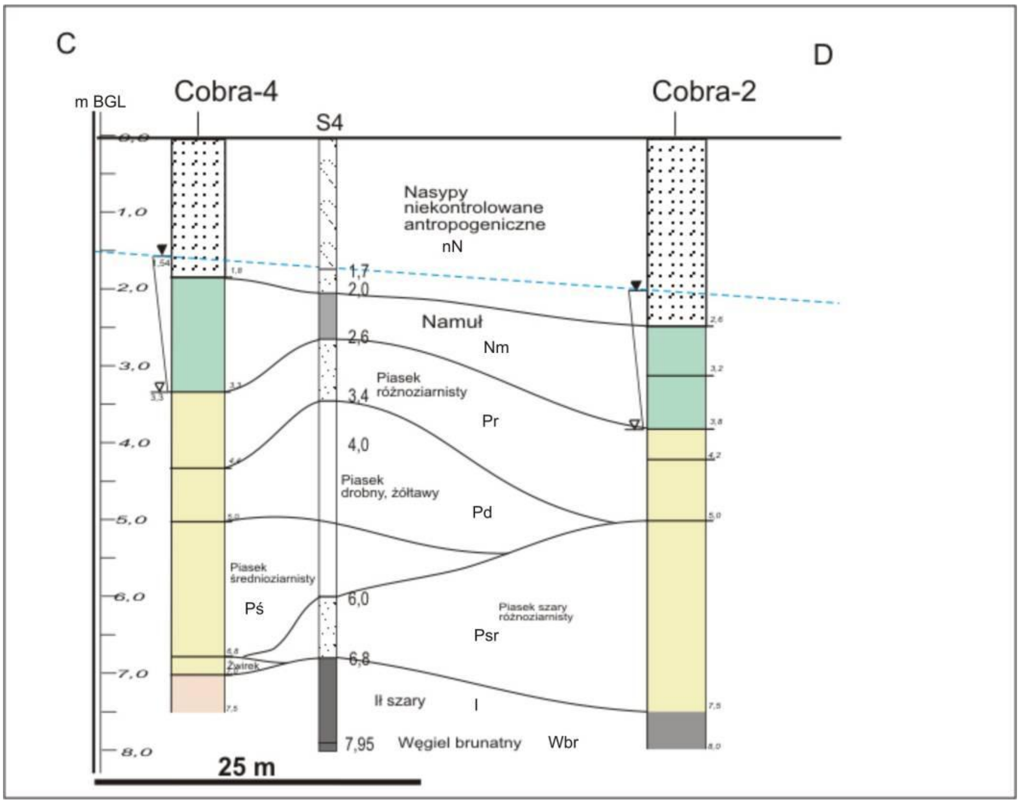


Hydro-isohypses of the underground water level from the first aquifer, remaining in the clear hydraulic communication with the Brda River. Situation from 9th of June 2010. Lines of sections are marked: AB, CD and EF.

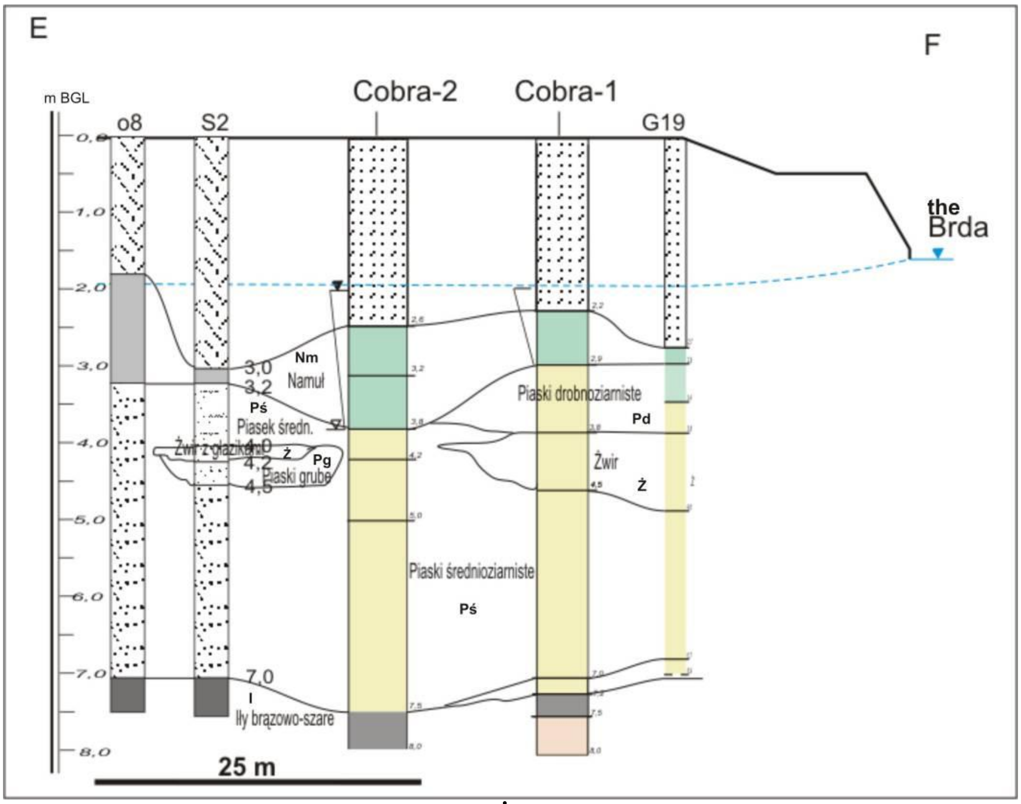
7.4. Hydrogeological cross-sections



nN– uncontrolled embankment, Nm– mud, Pd-fine sand, Ż-gravel, Pś- medium sand, Pg- coarse sand;



nN– uncontrolled anthropogenic embankment, Nm– mud, Pr - variable grained sand, Pd-fine sand, Pś- medium sand, Psr – grey variable grained sand, Żwirek – Grit stone, I – grey loam, Wbr – brown coal;

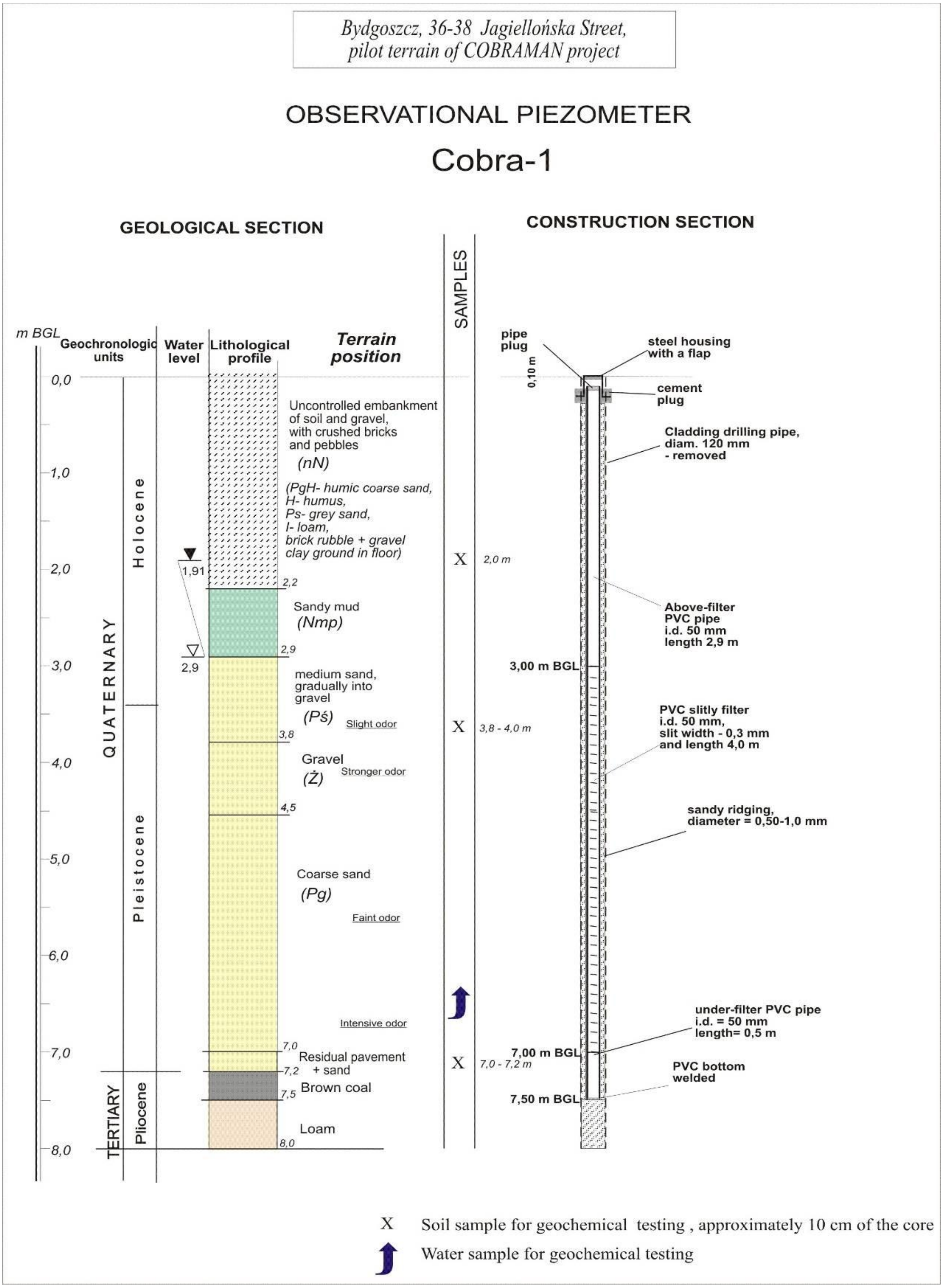


Nm– mud, Pd-fine sand, Pś- medium sand, Ż- gravel, Pg– coarse sand, I- brown-grey loam;

7.5. Pumping results

There was no research pumping in drilled bore-holes. After installation of piezometers, only cleansing pumping was conducted. During pumping, no measuring of underground water level was performed.

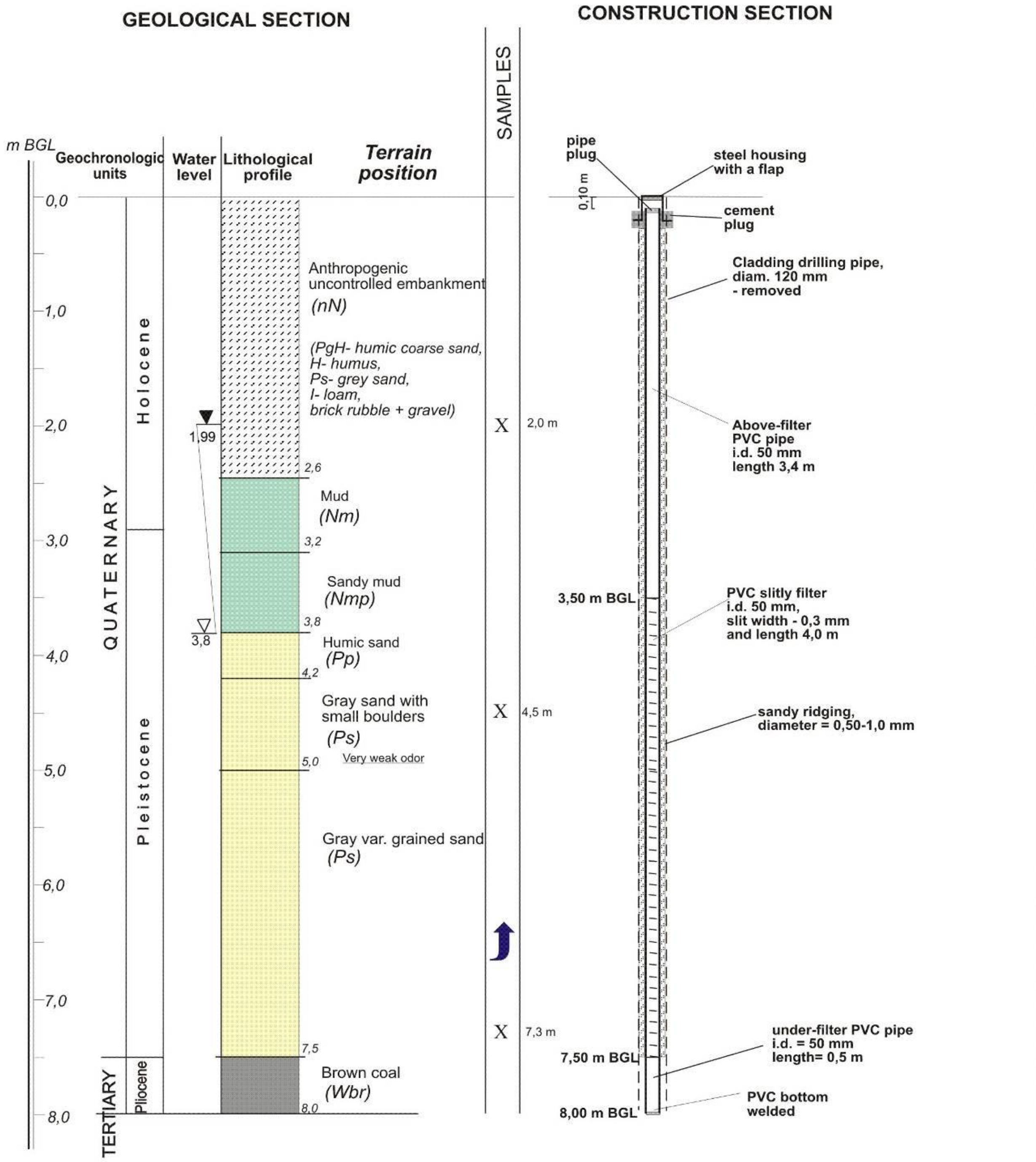
7.6. Aggregated results of drillings



Bydgoszcz, 36-38 Jagiellońska Street,
pilot terrain of COBRAMAN project

OBSERVATIONAL PIEZOMETER

Cobra-2



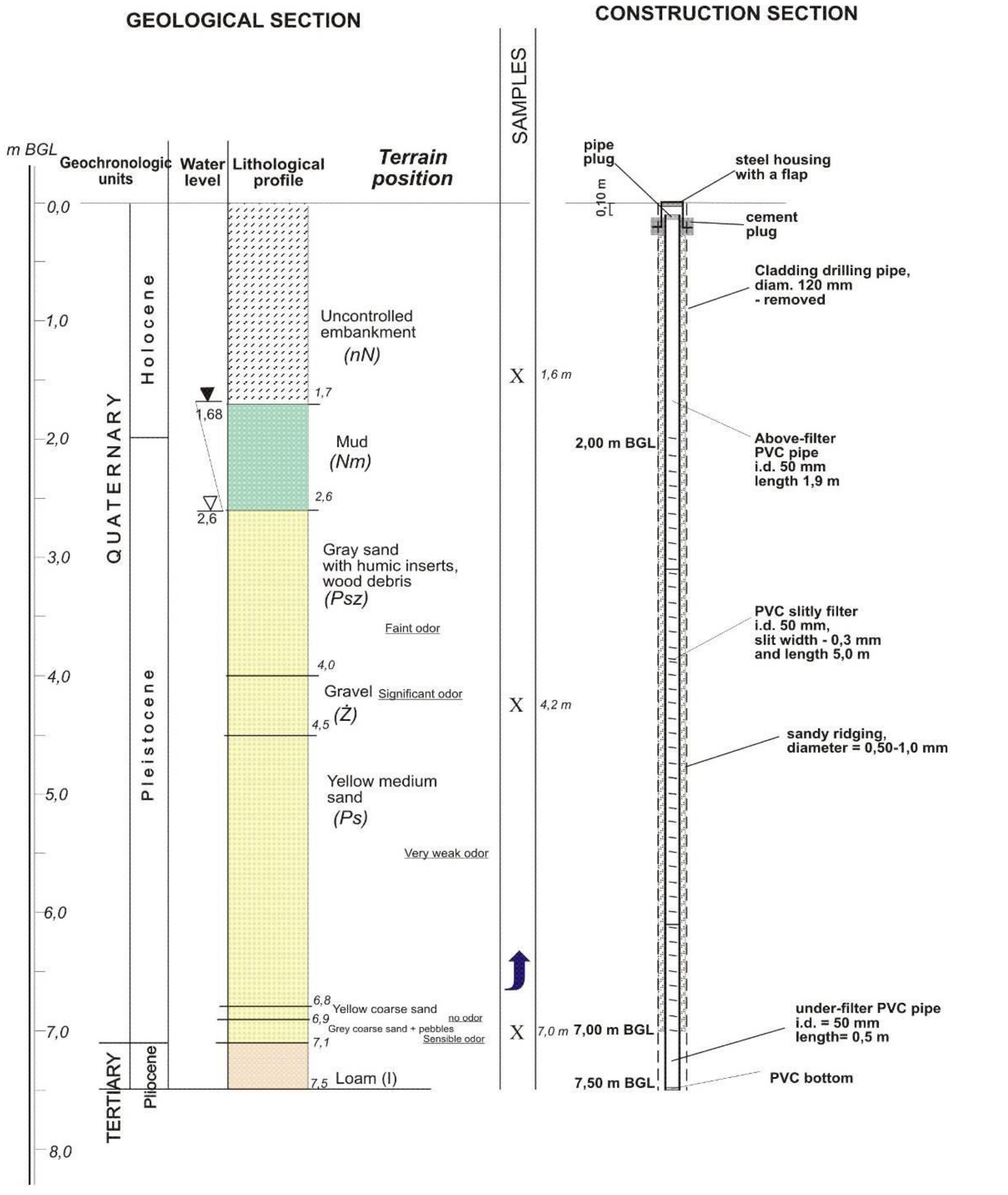
X Soil sample for geochemical testing , approximately 10 cm of the core

Water sample for geochemical testing

Bydgoszcz, 36-38 Jagiellońska Street,
pilot terrain of COBRAMAN project

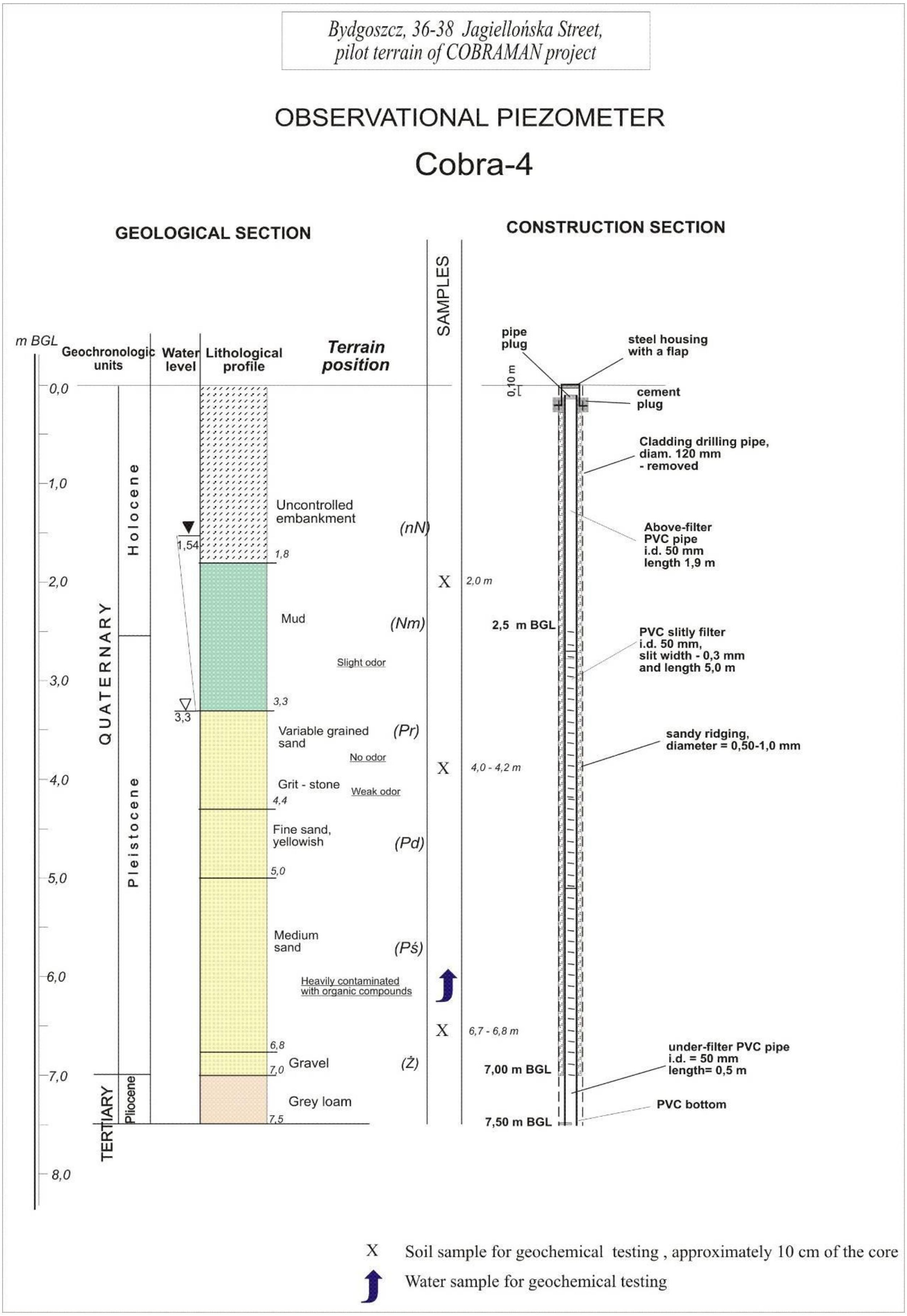
OBSERVATIONAL PIEZOMETER

Cobra-3



X Soil sample for geochemical testing , approximately 10 cm of the core

Water sample for geochemical testing


Bydgoszcz, 36-38 Jagiellońska Street,
pilot terrain of COBRAMAN project
OBSERVATIONAL PIEZOMETER
Cobra-4
GEOLOGICAL SECTION
CONSTRUCTION SECTION
SAMPLES
m BGL
Geochronologic units
Water level
Lithological profile
Terrain position
QUATERNARY
Holocene
Pleistocene
TERTIARY
Pliocene
Uncontrolled embankment
(nN)
Mud
(Nm)
Slight odor
Variable grained sand
(Pr)
No odor
Grit - stone
Weak odor
Fine sand, yellowish
(Pd)
Medium sand
(Pś)
Heavily contaminated with organic compounds
Gravel
(Ż)
Grey loam
2,0 m
4,0 - 4,2 m
6,7 - 6,8 m
pipe plug
steel housing with a flap
0,10 m
cement plug
Cladding drilling pipe, diam. 120 mm - removed
Above-filter PVC pipe i.d. 50 mm length 1,9 m
2,5 m BGL
PVC slitly filter i.d. 50 mm, slit width - 0,3 mm and length 5,0 m
sandy ridging, diameter = 0,50-1,0 mm
7,00 m BGL
under-filter PVC pipe i.d. = 50 mm length= 0,5 m
7,50 m BGL
PVC bottom
X Soil sample for geochemical testing , approximately 10 cm of the core
Water sample for geochemical testing

7.7. Results of physical – chemical water analysis

UKAS TESTING 4041

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i2 Analytical Ltd.
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Analytical Report Number : 10-80313

Project / Site name:	COBRAMAN BYDGOSZCZ	**Samples received on:**	10/06/2010
Your job number:		**Samples instructed on:**	10/06/2010
Your order number:		**Analysis completed by:**	17/06/2010
Report Issue Number:	1	**Report issued on:**	17-06-2010
Samples Analysed:	12 soil samples - 5 water samples		

DYREKTOR
Leslie Jones

Signed:

Les Jones
Managing Director
For & on behalf of i2 Analytical Ltd.

Dariusz Piotrowski

Signed:

Dariusz Piotrowski
Production Manager
For & on behalf of i2 Analytical Ltd.

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4041

Analytical Report Number: 10-80313

Project / Site name: COBRAMAN BYDGOSZCZ

Lab Sample Number			803295	803296	803297	803298	803299
Sample Reference			CBR2/1	CBR2/2	CBR2/3	CBR4/1	CBR4/2
Sample Number			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth			2m	4.5m	7.3m	2.0m	4.20m
Date Sampled			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Time Taken			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**					
Moisture Content	%	N/A	21	22	15	31	12
Total Phenols							
Total Phenols (monohydric)	mg/kg	2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Speciated PAHs							
Naphthalene	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Acenaphthene	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Phenanthrene	mg/kg	0.3	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30
Anthracene	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	mg/kg	0.2	0.47	< 0.20	< 0.20	< 0.20	1.1
Pyrene	mg/kg	0.2	0.49	< 0.20	< 0.20	< 0.20	1.0
Benzo(a)anthracene	mg/kg	0.2	0.22	< 0.20	< 0.20	< 0.20	0.28
Chrysene	mg/kg	0.3	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30
Benzo(b)fluoranthene	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Benzo(k)fluoranthene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Benzo(a)pyrene	mg/kg	0.3	< 0.30	< 0.30	< 0.30	< 0.30	0.38
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Dibenz(a,h)anthracene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Benzo(ghi)perylene	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Total PAH							
Speciated Total EPA-16 PAHs	mg/kg	1.6	< 1.6	< 1.6	< 1.6	< 1.6	2.8
Monoaromatics							
Benzene	µg/kg	1	< 1.0	< 1.0	30	< 1.0	< 1.0
Toluene	µg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	< 1.0	< 1.0	17	< 1.0	< 1.0
p & m-xylene	µg/kg	1	< 1.0	< 1.0	20	< 1.0	< 1.0
o-xylene	µg/kg	1	< 1.0	< 1.0	21	< 1.0	< 1.0
Total Btex in soil	µg/kg	5	< 5.0	< 5.0	88	< 5.0	< 5.0
Petroleum Hydrocarbons							
TPH7 - Aliphatic >C5 - C6	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C6 - C8	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C8 - C10	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C10 - C12	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH7 - Aliphatic >C12 - C16	mg/kg	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C16 - C21	mg/kg	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C21 - C34	mg/kg	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic (C5 - C34)	mg/kg	10	< 10	< 10	< 10	< 10	< 10

U/S = Unsuitable Sample   I/S = Insufficient Sample

4041

Analytical Report Number: 10-80313

Project / Site name: COBRAMAN BYDGOSZCZ

Lab Sample Number			803300	803301	803302	803303	803304
Sample Reference			CBR4/3	CBR1/1	CBR1/2	CBR1/3	CBR3/1
Sample Number			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth			6.80m	2.0m	4.0m	7.20m	1.60m
Date Sampled			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Time Taken			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**					
Moisture Content	%	N/A	19	22	10	16	28
Total Phenols							
Total Phenols (monohydric)	mg/kg	2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Speciated PAHs							
Naphthalene	mg/kg	0.05	< 0.05	0.75	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Acenaphthene	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	mg/kg	0.2	2.4	< 0.20	< 0.20	< 0.20	< 0.20
Phenanthrene	mg/kg	0.3	8.7	< 0.30	< 0.30	< 0.30	0.63
Anthracene	mg/kg	0.1	1.3	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	mg/kg	0.2	10	0.96	< 0.20	< 0.20	1.3
Pyrene	mg/kg	0.2	6.3	0.83	< 0.20	< 0.20	1.2
Benzo(a)anthracene	mg/kg	0.2	1.2	0.44	< 0.20	< 0.20	0.63
Chrysene	mg/kg	0.3	1.1	0.43	< 0.30	< 0.30	0.41
Benzo(b)fluoranthene	mg/kg	0.5	0.61	0.59	< 0.50	< 0.50	0.58
Benzo(k)fluoranthene	mg/kg	0.2	0.51	0.51	< 0.20	< 0.20	0.27
Benzo(a)pyrene	mg/kg	0.3	0.63	0.72	< 0.30	< 0.30	0.61
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Dibenz(a,h)anthracene	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Benzo(ghi)perylene	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Total PAH							
Speciated Total EPA-16 PAHs	mg/kg	1.6	33	5.2	< 1.6	< 1.6	5.6
Monoaromatics							
Benzene	µg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Btex in soil	µg/kg	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Petroleum Hydrocarbons							
TPH7 - Aliphatic >C5 - C6	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C6 - C8	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C8 - C10	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C10 - C12	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH7 - Aliphatic >C12 - C16	mg/kg	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C16 - C21	mg/kg	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C21 - C34	mg/kg	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic (C5 - C34)	mg/kg	10	< 10	< 10	< 10	< 10	< 10

U/S = Unsuitable Sample I/S = Insufficient Sample

UKAS TESTING 4041

i2 environmentalscience

Analytical Report Number: 10-80313

Project / Site name: COBRAMAN BYDGOSZCZ

Lab Sample Number			803305	803306
Sample Reference			CBR3/2	CBR3/3
Sample Number			None Supplied	None Supplied
Depth			4.20m	7.0m
Date Sampled			None Supplied	None Supplied
Time Taken			None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**		
Moisture Content	%	N/A	16	18
Total Phenols				
Total Phenols (monohydric)	mg/kg	2	< 2.0	< 2.0
Speciated PAHs				
Naphthalene	mg/kg	0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.2	< 0.20	< 0.20
Acenaphthene	mg/kg	0.1	0.89	< 0.10
Fluorene	mg/kg	0.2	0.72	< 0.20
Phenanthrene	mg/kg	0.3	3.5	< 0.30
Anthracene	mg/kg	0.1	1.1	< 0.10
Fluoranthene	mg/kg	0.2	7.0	0.21
Pyrene	mg/kg	0.2	5.8	< 0.20
Benzo(a)anthracene	mg/kg	0.2	3.0	< 0.20
Chrysene	mg/kg	0.3	2.8	< 0.30
Benzo(b)fluoranthene	mg/kg	0.5	3.5	< 0.50
Benzo(k)fluoranthene	mg/kg	0.2	1.7	< 0.20
Benzo(a)pyrene	mg/kg	0.3	3.0	< 0.30
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	0.98	< 0.20
Dibenz(a,h)anthracene	mg/kg	0.2	0.41	< 0.20
Benzo(ghi)perylene	mg/kg	0.5	1.2	< 0.50
Total PAH				
Speciated Total EPA-16 PAHs	mg/kg	1.6	35.6	< 1.6
Monoaromatics				
Benzene	µg/kg	1	< 1.0	< 1.0
Toluene	µg/kg	1	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	< 1.0	< 1.0
p & m-xylene	µg/kg	1	< 1.0	< 1.0
o-xylene	µg/kg	1	< 1.0	< 1.0
Total Btex in soil	µg/kg	5	< 5.0	< 5.0
Petroleum Hydrocarbons				
TPH7 - Aliphatic >C5 - C6	mg/kg	0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C6 - C8	mg/kg	0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C8 - C10	mg/kg	0.1	< 0.1	< 0.1
TPH7 - Aliphatic >C10 - C12	mg/kg	1	< 1.0	< 1.0
TPH7 - Aliphatic >C12 - C16	mg/kg	10	< 10	< 10
TPH7 - Aliphatic >C16 - C21	mg/kg	10	< 10	< 10
TPH7 - Aliphatic >C21 - C34	mg/kg	10	< 10	< 10
TPH7 - Aliphatic (C5 - C34)	mg/kg	10	< 10	< 10

U/S = Unsuitable Sample   I/S = Insufficient Sample

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Analytical Report Number: 10-80313

Project / Site name: COBRAMAN BYDGOSZCZ

Lab Sample Number			803307	803308	803309	803310	803311
Sample Reference			CBR1	CBR2	CBR3	CBR4	CBR4-A
Sample Number			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth			6.5M	6.5M	6.5M	6.5M	6.5M
Date Sampled			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Time Taken			None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**					
General Inorganics							
pH	pH units	N/A	7.3	7.1	7.1	7.2	7.2
Electrical Conductivity	µS/cm	10	390	450	510	710	710
Total Phenols							
Total Phenols (monohydric)	µg/l	30	120	130	<30	<30	<30
Speciated PAHs							
Naphthalene	µg/l	0.01	14	16	4.1	10	2.4
Acenaphthylene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	1.5	2.6	67	220	210
Fluorene	µg/l	0.01	2.8	< 0.01	16	150	140
Phenanthrene	µg/l	0.01	< 0.01	< 0.01	7.3	110	92
Anthracene	µg/l	0.01	< 0.01	< 0.01	1.1	11	11
Fluoranthene	µg/l	0.01	< 0.01	< 0.01	1.8	22	21
Pyrene	µg/l	0.01	< 0.01	< 0.01	0.86	10	10
Benzo(a)anthracene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total PAH							
Total EPA-16 PAHs	µg/l	0.2	19	19	99	540	490
Monoaromatics							
Benzene	µg/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Btex in water	µg/l	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Petroleum Hydrocarbons							
TPH7 - Aliphatic >C5 - C6	µg/l	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C6 - C8	µg/l	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C8 - C10	µg/l	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C10 - C12	µg/l	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C12 - C16	µg/l	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C16 - C21	µg/l	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic >C21 - C34	µg/l	10	< 10	< 10	< 10	< 10	< 10
TPH7 - Aliphatic (C5 - C34)	µg/l	10	< 10	< 10	< 10	< 10	< 10

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Analytical Report Number: 10-80313

Project / Site name: COBRAMAN BYDGOSZCZ

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and topsoil/loam soil types. Data for unaccredited types of solid should be interpreted with care.

Lab Sample Number	Sample Reference	Sample Number	Depth	Sample Description
803295	CBR2/1	None Supplied	2m	Brown topsoil and clay with vegetation.
803296	CBR2/2	None Supplied	4.5m	Light grey sand.
803297	CBR2/3	None Supplied	7.3m	Grey sand.
803298	CBR4/1	None Supplied	2.0m	Brown clay and sand.
803299	CBR4/2	None Supplied	4.20m	Light grey gravely sand.
803300	CBR4/3	None Supplied	6.80m	Light brown sand with oil / petroleum.
803301	CBR1/1	None Supplied	2.0m	Brown topsoil and clay.
803302	CBR1/2	None Supplied	4.0m	Grey gravely sand.
803303	CBR1/3	None Supplied	7.20m	Grey sand with brick.
803304	CBR3/1	None Supplied	1.60m	Light brown clay.
803305	CBR3/2	None Supplied	4.20m	Light grey gravely sand.
803306	CBR3/3	None Supplied	7.0m	Light grey sand.

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Analytical Test Name	Analytical Method Description	Method number	Wet / Dry Analysis	Accreditation Status
Determination of BTEX in water by headspace GC-MS.	In-house method based on USEPA8263	L073-PL	W	ISO 17025
Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8264	L073-PL	W	ISO 17025
Determination of electrical conductivity in water by electrometric measurement.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L031-PL	W	N
Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L019-PL	W	N
Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080-PL	W	ISO 17025
Determination of phenols in water by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080-PL	W	ISO 17025
Determination of pH in water by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L005-PL	W	ISO 17025
Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	in-house method based on USEPA 8270	L064-PL	D	ISO 17025
Determination of PAH compounds in water by extraction in hexane followed by GC-MS with the use of surrogate and internal standards.	in-house method based on USEPA 8270	L064-UK	W	ISO 17025
Determination of dichloromethane/hexane extractable hydrocarbons in soil by GC-FID.	in-house method	L064-PL	D	ISO 17025
Determination of dichloromethane extractable hydrocarbons in water by GC-FID.	in-house method	L064-PL	W	N

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.