INFLUENCE OF WASTE DUMP "CHROBRÓW" IN POLAND ON GROUND - AND SURFACE WATER
ATKRITUMU IZGĀZTUVES „CHROBROW" (POLIJA) IETEKME UZ GRUNTSŪDEŅIEM UN VIRSZEMES ŪDEŅIEM

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Abstract. *In paper an influence of waste dump "Chrobrów" on groundwater and tributary of the Bóbr river was described. This waste dump was installed in former gravel excavation. For first 10 years it had no leak stopper and sewage water could freely infiltrate. Geological structure of the waste dump subsoil is unfavourable because garbage are directly stored on gravels with high filtration coefficient which make migration of pollutants easy. At the moment the waste dump has a leak stopper made from bentonite composite but there are still polluted grounds underneath. In this paper was analyzed data about ground- and surface water quality from years 1994 – 2004. It was found that the quality of groundwater deteriorated, especially in years 1999 and 2002. The most worsening was noted in case of chlorides, ammonia nitrogen, sodium and potassium. Unfortunately there is no data before 1994 so there is no information about hydrogeochemical background. Increased values of all groundwater components in first period of investigation are results of exploitation in years 1984 – 1994, when waste dump had no leak stopper. But later deterioration of groundwater quality can not be explained in this way. It should be drawn a conclusion that the seal of waste dump bottom does not work correctly. It was found that there is no negative impact of waste dump on surface water what is caused by absence of hydraulic contact between river and groundwater on investigated area.*

Keywords. *Waste dump, waste water infiltration, groundwater contamination, groundwater pollutants***.**

Introduction

Waste dump „Chrobrów" accumulates solid wastes from Żagań – a town in the south-west part of Poland (about 50 000 inhabitants). It is located on the south edge of Chrobrów village which is situated about 6 km east from Żagań (Fig.1.). Ca. 30 m from the north border of waste dump there is a small stream – a tributary of Bóbr river (Fig.2.).

The waste dump "Chrobrów" is located on the grounds at an exploited gravel mine, one of many in the Bóbr river surroundings. Initially, in years 1985-1994, municipal wastes were stored directly in the mine's trough. In years 1994-96 the waste dump's wall and bottom were sealed with a lining of bentonite composite. This leak stopper prevents migration of effluxes from waste dump into soil and groundwater. A drainage system (above and beneath leak stopper) was also made. Drainage waters are collected in separated reservoirs. Waters from drainage above the leak stopper are exported to waste water treatment plant and waters from drainage beneath leak stopper become totally evaporated. At the moment (2004) the whole mine troughs are completely filled and overground part of waste dump has reached assumed height. A closure and the beginning of land reclamation in years 2005-2006 is planned.

Geological structure

The described area is located in the north part of Żagań-Valley (Kotlina Żagańska). This valley was created in place where four river come together: Bóbr (main river) and its tributaries: Kwisa, Czarna and Szprotawa. The valley's bed is composed from Pleistocene and Holocene fluvial (river) deposits (Kondracki, 2001).

The geological structure of the subsoil of the waste dump is presented on three geological cross-sections (Fig.3., Fig.4., Fig.5.). Two geological complexes of deposits can be distinguished: glacial and fluvioglacial (glacial outwash). Glacial deposits are represented by glacial till. from Saale glaciation (Drenthe stage).

ISBN 9984 – 779 – 06 – 8

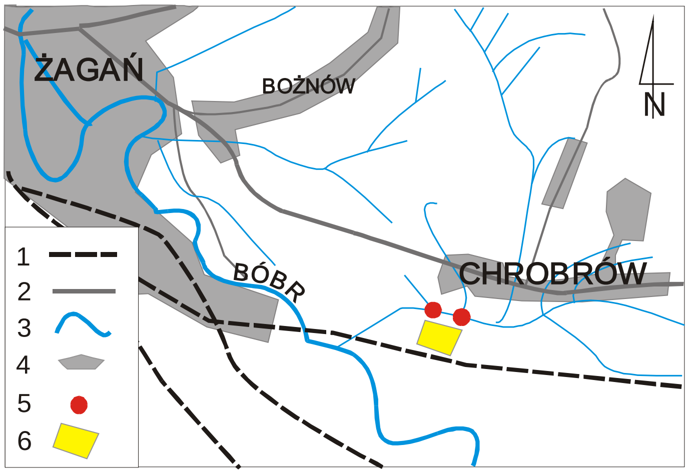

Fig. 1. **Map of environs of waste dump**

Explanations: 1 – railway trucks; 2 – roads; 3 – rivers; 4 – urban areas; 5 – points of sampling of surface water; 6 – waste dump.

The roof surface occurs irregularly, ca on 110 – 114 m a.s.l. In the south and west part of the mentioned area glacial till occur directly on the ground surface (ca 120 m a.s.l.). The glacial till of Saale glaciation is tens of meters thick [3.4]. In a lithological meaning this tills are mainly clays and sandy clays.

Fluvioglacial deposits are represented mainly by gravels, rarely by sands with different granulation with gravel admixture. In stratigraphic respect this deposits might be connected with one of the sander level of Saale glaciation (Warthe stage).

The hydrogeological conditions of the waste dump subsoil are simply. Groundwater flows into north east, in the direction of the stream (Fig.1., Fig.2.). The table of the stream water is situated above groundwater level (Fig.4.).

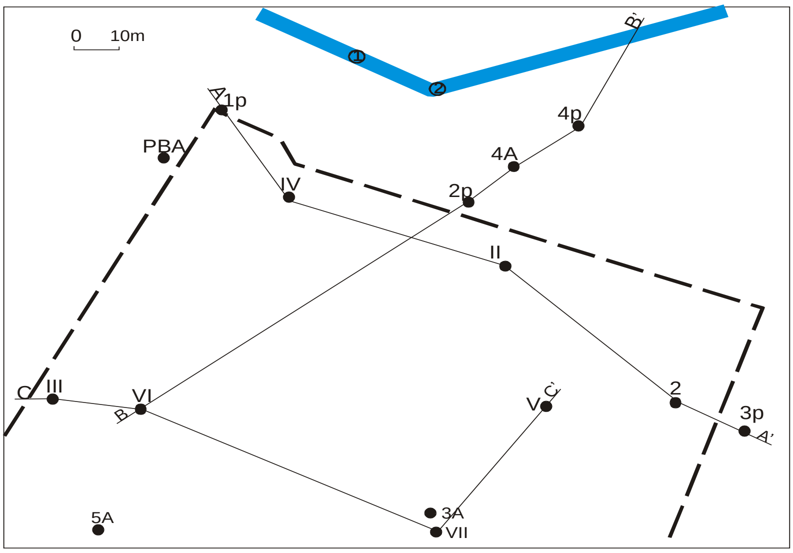

Fig. 2. **Site plan of waste dump „Chrobrów" and lines of geological cross-section.**

1p, 2p, 3p, 4p – sampling points of groundwater; 1, 2 – sampling points of surface water.

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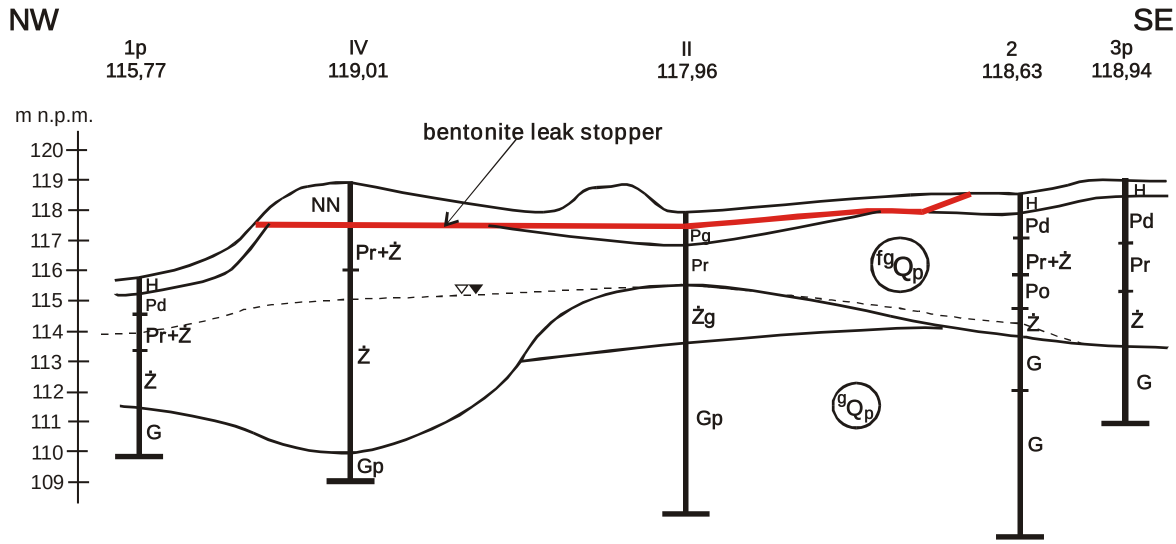

Fig. 3. **Geological cross-section A-A'**

Explanations: H- soil; NN – wastes; Pg- clayey sand, Pd – fine sand; Pr – coarse sand; Ż –gravel; G – clay; Gp – sandy clay.

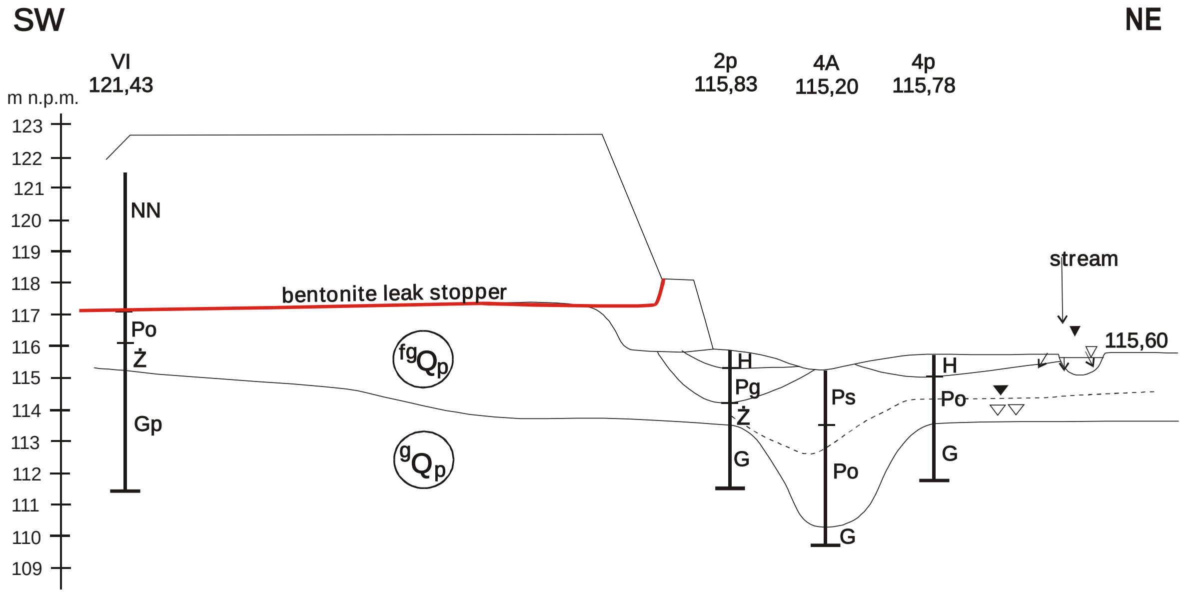

Fig. 4. **Geological cross-section B-B'**

Explanations – see Fig.3.

Changes of chemical composition of groundwater and surface water.

Discussion

The influence of the waste dump on the quality of ground- and surface water is periodically controlled in points of local monitoring net. This monitoring net is composed of four points of groundwater samples (piezometers) and two points of stream water samples (tributary of Bóbr river) (Fig.2.). All piezometers are installed in the north part of the investigated area, where the groundwater runs off from the waste dump. The monitoring net was installed in 1994, equivalently to leak stopper execution. All stored wastes were transferred into the sealed part of the waste dump. Presently the leak stopper made of bentonite composite is beneath the whole waste dump.

Laboratory tests of composition of ground- and surface water are run each three months and waste dump efflux – each six months. All the basic parameters, ions and heavy metals are examined.

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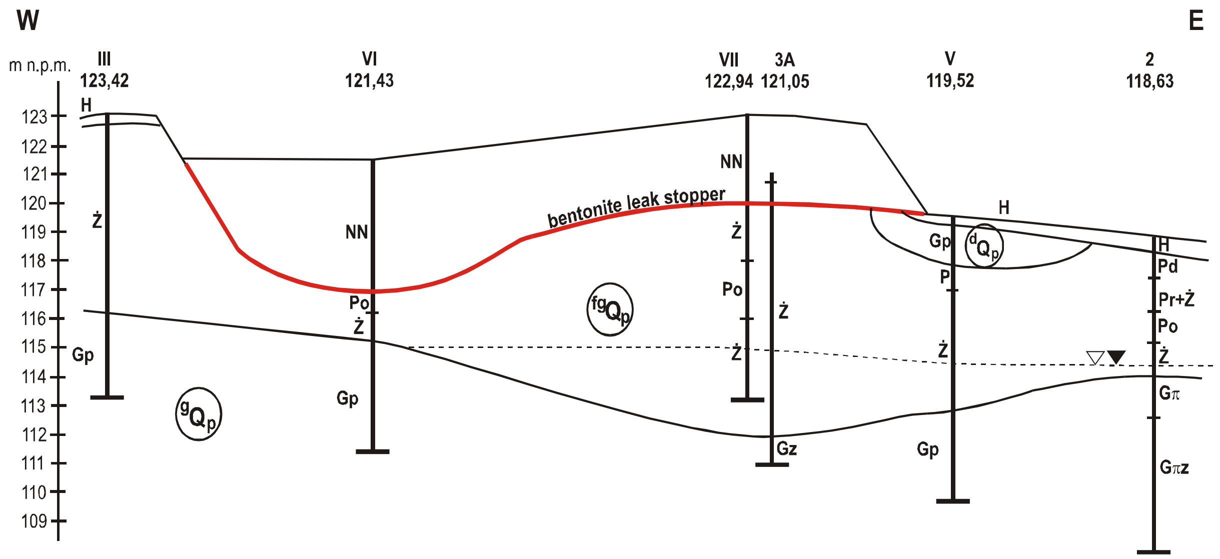

Fig. 5. **Geological cross-section C-C'**
Explanations – see Fig.3.

Unfortunately there is no data for years 1997-1998 and the piezometers P-2 and P-3 are dry since 1999 in consequence of groundwater level decreasing.
pH-value and contents of most important components of ground- and surface water are shown in diagrams below (Fig.6. - Fig.11.).
The analyse of those diagrams show that the discussed years (1994-2004) can be divided with respect of the groundwater quality into three periods: 1994–1996; 1999–2001 and 2002–2004. It is especially well demonstrated in case of potassium (Fig. 12), chlorides (Fig. 8.) and total solids (Fig. 10.).

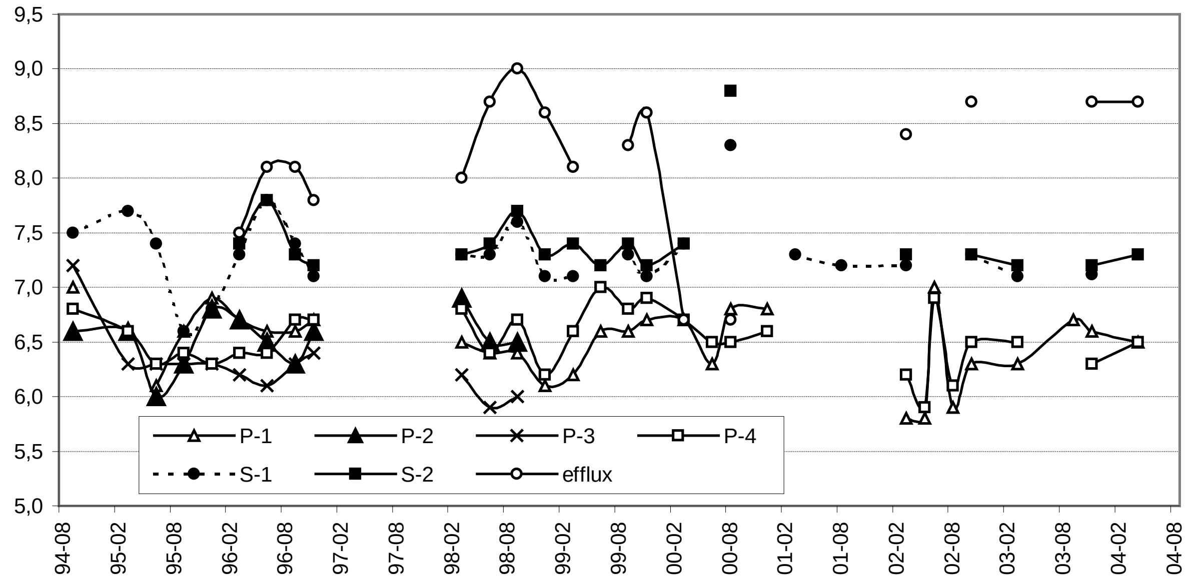

Fig. 6. **pH-value of surface water, groundwater and efflux**.

Explanations: P-1, P-2, P-3, P-4 – piezometers; S-1, S-2, – sample of surface water

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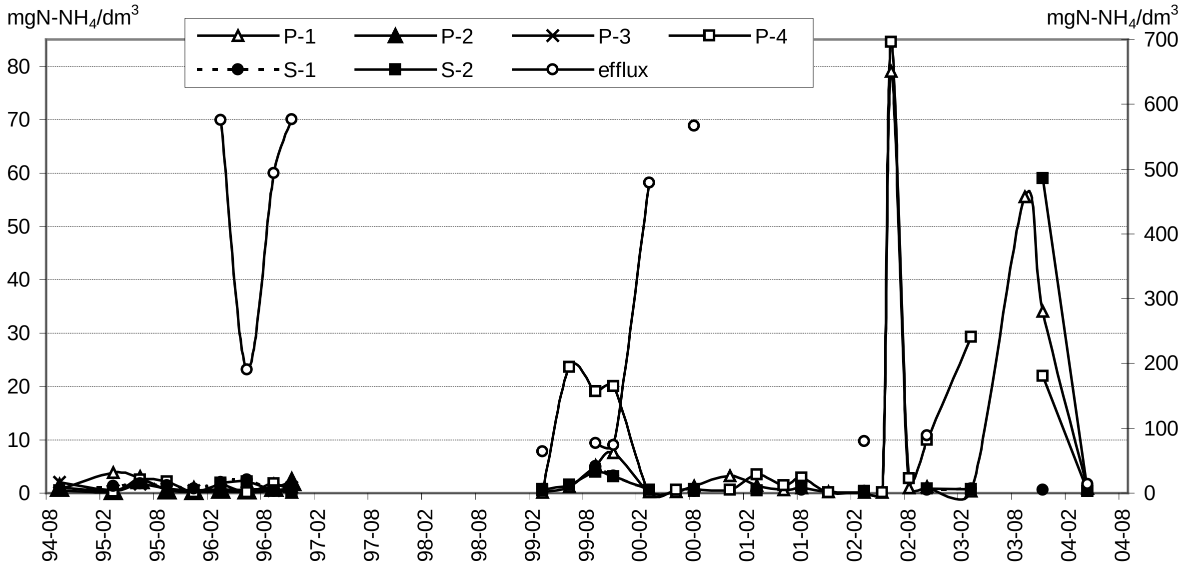

Fig. 7. **Value of ammonia nitrogen of surface water, groundwater and efflux.**
Explanations: See Fig.6. Right axis concerns to efflux.

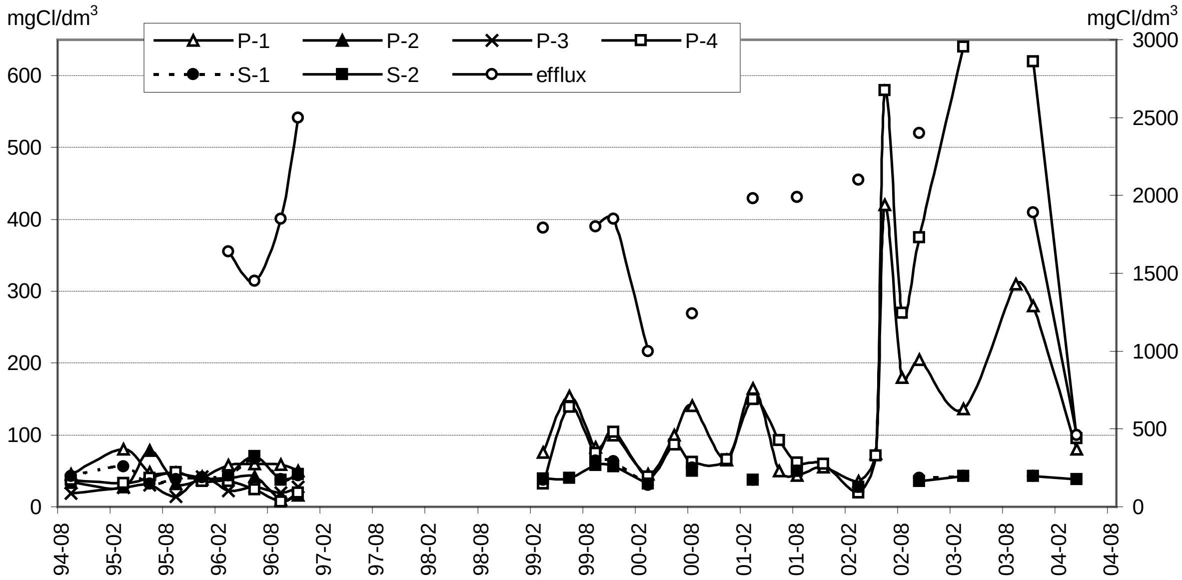

Fig. 8. **Value of chlorides of surface water, groundwater and efflux.**
Explanations: See Fig.6. Right axis concerns to efflux.

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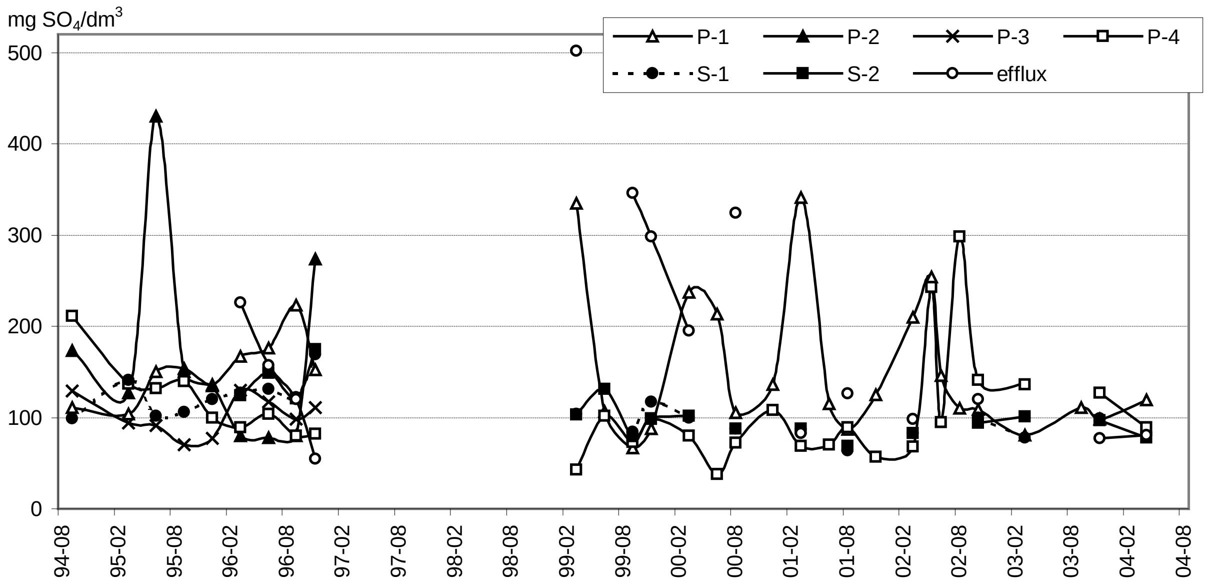

Fig. 9. **Value of sulphates of surface water, groundwater and efflux.**
Explanations: See Fig.6.

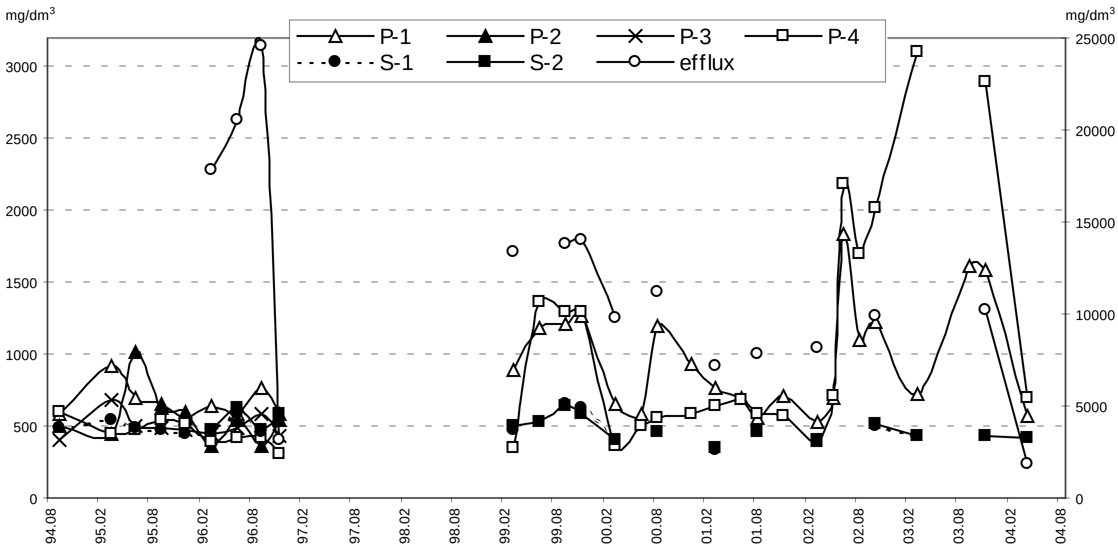

Fig. 10. **Value of total solids of surface water, groundwater and efflux.**
Explanations: See Fig.6. Right axis concerns to efflux.

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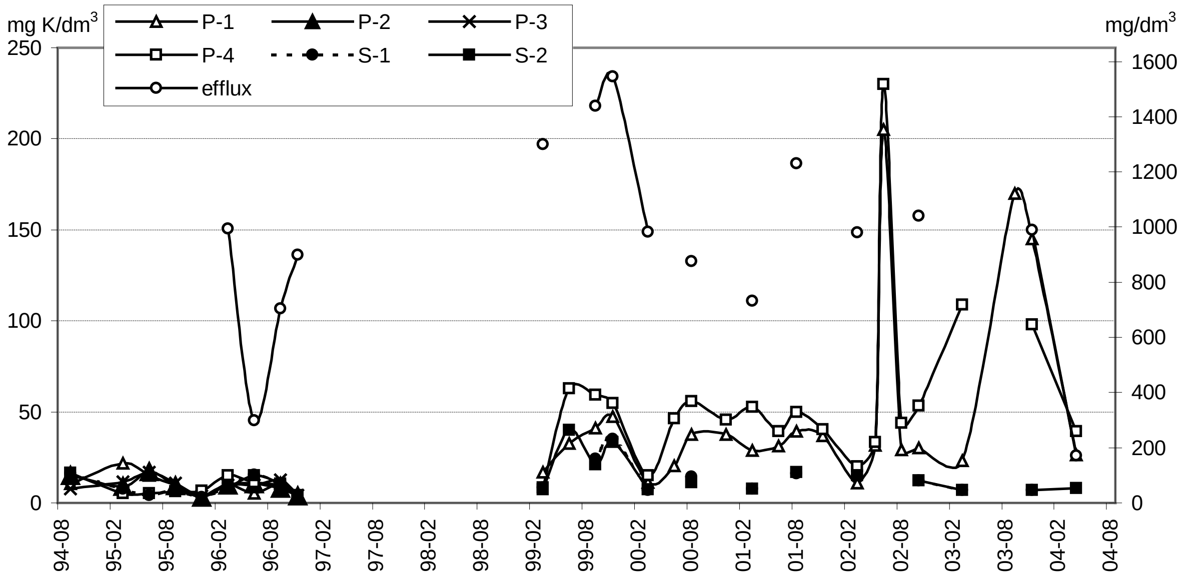

Fig.11. **Value of potassium of surface water, groundwater and efflux.**
Explanations: See Fig.6. Right axis concerns to efflux.

Table 1.

Average values of some components of groundwater and waste dump efflux in years 1994-2004

component	point of sampling	average value in years			% increment in years 1994 - 2004
		1994-1996	1999-2001	2002-2004	
chlorides Cl^-	P-1	54,3	84,9	230,1	324
	P-4	31,2	75,8	430,0	1278
	efflux	1860	1719	1583	-
sulphates SO_4^{2-}	P-1	152,6	172,9	110,6	-
	P-4	119,4	86,4	147,7	24
	efflux	139,5	246,5	92,7	-
ammonia nitrogen NH_4^+	P-1	1,1	1,6	24,5	2127
	P-4	1,0	5,2	24,8	2380
	efflux	459,4	223,5	51,3	-
sodium Na^+	P-1	25,2	67,5	169,0	570
	P-4	11,6	42,6	230,3	1885
	efflux	781	1250	539	-
potassium K^+	P-1	10,2	30,3	89,8	780
	P-4	8,9	41,7	95,6	974
	efflux	725	1136	734	-
total solids (TS)	P-1	666,4	841,5	1234,6	85
	P-4	455,7	732,1	2101,3	361
	efflux	16525	10290	7316	-

During the first period (1994-1996) parameters of groundwater and surface water had had similar value but later groundwater quality worsened. First worsening took place in 1999, next in 2002. The quality of surface (stream) water has remained without any changes or has even improve (e.g. sulphates – Fig. 8.) in the whole period of test. It means there is no connection between groundwater and surface water on the investigated area what is also shown on the geological cross-section (Fig. 4.). The hydrogeological conditions prevent pollutants migration from waste dump efflux to surface water. In Table 1. the authors have presented average values of the most important and the quickest migrating ions of groundwater and waste dump efflux. Only the

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piezometers (P-1 and P-4) which were in operation during the whole period of investigation were considered. During the 10-years period of observation the value of ammonia nitrogen risen by more than 2000% and chlorides and sodium by more than 1000%. A general content of ions expressed as total solids increased in piezometer P-1 by 85% and in P-4 by 361%. The contents of particular ions of groundwater do not correlate with its contents in waste dump efflux. Almost all waste dump efflux components have lower values than the initial ones. Chemical content of waste dump efflux is situated in a typical range for municipal waste dump effluxes [1].

Conclusions

Improper preparation of location of to waste dump storage is the most important reason of groundwater contamination [2]. The risk of groundwater contamination occurs even though all available preventives are applied. Storage of solid waste material on the waste dump is still the cheapest method of their removal. Ca 70% of wastes in the EU states are stored on waste dumps. The other advantage of this method is possibility of methane producing or waste processing in the future.

The waste dump „Chrobrów" was founded in very unfavourable conditions: in an artificial area hollow in former gravel excavation.

There were a gravel and coarse sand layer with thickness from 2 to teens meters thick in waste dump subsoil. Besides there was a groundwater table in this layer. Filtering polluted water from waste dump could migrate deep into the ground till the roof of impermeable formation and then move with groundwater. It was only 10 years after the waste damp operation when a decision was made to install a leak stopper. Quality monitoring net of ground- and surface water was installed in 1994 so there is no information about the hydrogeochemical background of groundwater. Data from the first investigation period (1994 – 1998) shows increased values of some components (sulphates, Fig.9.) which might be caused by pollutants migration from waste dump [5]. Installing of bentonite leak stopper in 1994 did not cause gradual improvement of groundwater quality. This quality remained on the same level and then it deteriorated considerably in 1999 and then in 2002. This effect should not occur if the leak stopper operated correctly. A conclusion can be drawn that the leak stopper has been damaged and there is a gap where the pollutants can filter into a deeper layer of the subsoil. There is also possibility that the parts of the leak stopper have been welded incorrectly [6].

In connection with the planned closure of the waste dump and its recultivation the technical condition of bentonite leak stopper should be precisely investigated.

The remaining of defected stopper is a menace of long-lasting negative influence on groundwater under the closed waste dump in next tens of years.

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