Zbigniew Świerkot, M. Sc.
"Effectiveness of a household sewage treatment plant with subsurface filtration"
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Summary of PhD dissertation

Effluent treatment in areas with scattered buildings, where a common sewage system is not available, is a difficult problem, both technically and economically. This concerns especially rural areas with scattered buildings where construction of a common sewage system is expensive and not justified economically, and often impossible due to lack of funds. Pursuant to legal regulations, construction of a common sewage system is technically and economically justified, if there are at least 120 inhabitants per 1 km of its length, and in the particularly protected areas at least 90 inhabitants [Ordinance of the Minister of Environmental Protection dated 22.07.2014, Journal of Laws 2014 clause 955]. In Poland, there are 74 inhabitants per one kilometre of sewage systems built in rural areas [Błażejewski 2012]. Therefore, for most rural areas, construction of a sewage system is technically and economically unjustified. According to [Obarska-Pempowiak and others 2015], one of the elements which could organize effluent management in non-urban areas is utilization of onsite sewage facilities. Thus the purpose of this study and the results presented in it is to determine the effectiveness of domestic sewage treatment in a PSI sewage facility.

The aim of the tests was to determine the effectiveness of domestic waste treatment in an onsite PSI (Periodic Subsurface Infiltration) sewage facility and its usefulness for farmhouses and places for seasonal accommodation e.g. campsites and periodical recreation facilities. One additional purpose of the research presented in this dissertation was to determine the effect of the sewage facility on contamination of ground waters and the possibility of its functioning during the winter season.

The scope of the research covered sampling and chemical analyses of effluents flowing into the sewage facility (so called raw effluents) and preliminarily treated and treated in the subsurface layer of soil (leachates from drainage). In addition, the effect of the sewage facility on contamination of ground water, sampled from piezometers made for this purpose, was examined. The following contamination factors were determined in effluents: total suspension, oxygen indices BOD 5 and COD, total nitrogen, total phosphorus, chlorine and pH. In ground water samples, apart from the values listed above, electrolytic conduction, content of ammoniacal and nitric nitrogen were determined. These factors constitute the criteria for evaluation of ground water quality. It should be assumed that the examined sewage facility belongs to the group of soil- and plant-based sewage facilities where plants and the size of their croppings influence elimination of contamination from effluents. During mowing of the grass sward, the size of croppings and biomass obtained from the sewage facility surface were measured. To determine the quantity of components discharged with croppings, samples of plants were taken from individual grass swaths. An additional element of the

research was determination of the botanical composition of the sward on the surface of the sewage facility in the second year of its functioning.
Based on the completed tests and observations, the following conclusions were recorded; The examined soil- and plant-based PSI (Periodical Subsurface Infiltration) sewage facility ensures very high effectiveness in treatment of effluents discharged from households.

In a PSI sewage facility, almost all main factors of effluent contamination are reduced considerably, organic matter 88 up to 99%, total nitrogen 85 up to 96% and phosphorus up to 97%. One exception is a slightly lower reduction of total suspension, 73 up to 85%. Reduction of biogenic components (nitrogen and phosphorus) is particularly high compared to the effectiveness of other effluent treatment methods. High reduction of nitrogen and phosphorus content in effluents treated in soil is the result of not only the soil's capacity to retain these components, but also of their absorption by plants and elimination with croppings. In croppings from a soil- and plant-based PSI sewage facility, 33 up to 47% of nitrogen and 64 up to 83% of phosphorus fed with effluents to the sewage facility are eliminated. To obtain high croppings of grasses, and thereby to increase the load of components discharged with croppings, the surface area of the sewage facility should be sown with species of grasses with high demand for nutritional components and water. Soil is a good filter retaining organic suspensions contained in effluents. This is indicated by very low values of BOD 5 for effluents treated in it and high reduction of organic matter amounting to 99%. This results from the fact that the suspension treated in soil is not the organic suspension coming from effluents but mineral suspension from soil. Therefore, the conclusion can be raised that in the case of effluent treatment in soil, the content of total suspension in treated effluents should not be limited by regulations. The degree of reduction for effluent contamination factors limited by the regulations achieved in the examined sewage system fulfils all requirements concerning sewage facilities located both outside of the metropolitan area and within the metropolitan area. Despite its high effectiveness with respect to the reduction of contamination factors in effluents, the PSI sewage facility has an effect on local contamination of ground water. The degree of this contamination is not high and basically it does not change the water quality class. One exception is the contamination of water with ammoniacal nitrogen directly under the sewage facility. Its content in the tested water exceeded the limit for class II, so it changed water quality from class I to III. A PSI sewage facility can be useful especially in farms dealing with livestock farming. Croppings harvested from its surface can be valuable protein-rich feed or they can be used as litter or for compost. Overground parts of plants do not have any contact with effluents so as feed they are safe in sanitary aspects. A PSI sewage facility can be used in areas with a mild winter climate. If negative temperatures occur (below - 10^0 C) for several days or longer, it is necessary disconnect the inflow of effluents to the infiltration system. The soil- and plant-based PSI sewage facility ensures easy operation, low sensitivity to variability of volume, and contamination in effluents, as well as low operating costs. However, it requires a relatively large surface area for infiltration of effluents (>15m^2/1 inhabitant).

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