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Report on social, economical and environmental assessments from River Temmesjoki pilot area (Finland)

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Impact Assessment of Water Management Measures in River Temmesjoki Pilot Area, Finland

1. Introduction

This report gives an overview of the impact assessments of proposed water management measures in River Temmesjoki pilot area in Finland. The assessments have been carried out as a part of the Waterpraxis project.

As agriculture is the main loading source to watercourses in Temmesjoki River Basin, we have focused in this study on assessing the environmental and economic impacts on water management measures for agriculture. The social impact assessment covers also management measures for forestry, scattered settlements and changes of morphology of river channels and embankments. Peat production and municipal wastewaters have been excluded from the analysis as their share of total loading to watercourses is very minor.

2. Environmental impacts

The impacts of water management measures in agriculture on nutrient and suspended solids loading were assessed by VIHMA model developed in SYKE (Puustinen et al.2010). The VIHMA model provides estimations of comparative changes of erosion, phosphorus and nitrogen when changing cultivation methods, such as different tillage and cultivation methods and all-year vegetation cover. The estimations are based on the soil type, slope, P-test value of field soil and crop cultivated. The model contains also wetlands, sedimentation basins, buffer zones and different drainage methods (ditch drainage, subsurface drainage).

2.1 Scenarios

In order to compare the effects of different cultivation methods to nutrient loading, multiple scenarios were created. The baseline scenario describes the cultivation method mix estimated being used at the moment in the study area. In other scenarios cultivation methods were changed towards more environmentally friendly by increasing the area of direct sowing and wintertime stubble. These increases were made either by providing the method evenly across different field slope classes or by allocating them to as steep fields as possible. Also a scenario were the only method was ploughing was included to the study. In all scenarios the area of grass and fallow remained the same.

In current situation i.e. baseline scenario, the erosion was 6 388 634 kg/a, total phosphorus load 16 724 kg/a, and total nitrogen load 392 192 kg/a according to VIHMA. This current loading and the changes compared to it in different scenarios are presented in Table 1.

Table 1. Changes in nutrient reduction in different scenarios

	Erosion	PartP	DRP	TotP	ToTN
load in current situation kg/a	6 388 634	7 890	8 834	16 724	392 192
changes in loads					
ploughing	9 %	6 %	-6 %	-0.1 %	9 %
50 % wintertime stubble	-4 %	-3 %	3 %	0.0 %	-2 %
allocated 50 % wintertime stubble	-5 %	-4 %	3 %	-0.3 %	-2 %
100 % wintertime stubble	-17 %	-13 %	11 %	0.0 %	-13 %
50 % direct sowing	-15 %	-7 %	14 %	4 %	-7 %
allocated 50 % direct sowing	-18 %	-8 %	15 %	4 %	-7 %
100 % direct sowing	-40 %	-20 %	34 %	9 %	-23 %

As can be seen in Table 1, ploughing increases erosion, particulate phosphorus and total nitrogen loadings, whereas reduced cultivation methods lessens them. Also the allocation of wintertime stubble or direct sowing to steepest fields reduces erosion and PartP loadings even further. On the other hand these same methods are likely to increase the loads of dissolved reactive phosphorus (DRP), direct sowing especially. Incongruously, passage from cultivation to baseline situation or other reduced methods scenarios is likely to increase DRP loading. Due to this, changes in total phosphorus loads are virtually non-existent for ploughing and wintertime stubble and would even increase with direct sowing.

In order to reduce also the DRP loadings, the effects of lowering soil-test P values were also studied in same cultivation scenarios. Because soil-test P values (basically the accumulated left over DRP in the soil) contributes to DRP runoffs the most, one way of reducing the risk of DRP runoffs is to reduce soil-test P values, e.g. by diminishing fertilisation. As a result of diminishing soil-test P values, the changes in DRP loadings are parallel to the current state of soil-test P values but the loadings are distinctly lower. And the lower the soil-test P value, the smaller the changes in loadings between different cultivation methods.

On top of the cultivation method scenarios, changes in loadings enforced by buffer zones were also estimated with VIHMA. In these scenarios the field area with buffer zones was increased from current alleged 6 % of the buffer zone-potential acreage up to 10% to 100 %, starting from the steepest fields. Because the cultivation methods of the above fields affect the reduction volumes achieved with buffer zones, the calculations were made with above fields which were either ploughed, on wintertime stubble or on direct sowing. The total phosphorus load reductions achieved by buffer zones on top of cultivation methods were for example for direct sowing quite sizeable. But because direct sowing itself increases the TotP load more than buffer zones on these quite flat fields can reduce, the net reduction sums up to nil.

But when concentrated on reducing erosion or total nitrogen, the reductions after cultivation methods and buffer zones can be quite relevant, at best minus 4 to 8 % to erosion and minus 5 to 7 % for TotN. However this would require establishing buffer zones in all fields possible.

3. Economic impacts

The unit costs for reducing the total phosphorus and nitrogen loads from fields were calculated using the agricultural environment subsidies. In addition, unit costs of different measures were also calculated with the KUTOVA tool (Kunnari 2008), which provides cost-effectiveness analyses of water protection measures for phosphorus. KUTOVA tool takes also into account the measures for wastewater purification for scattered settlements.

3.1 Costs of agricultural methods according to agricultural environment subsidies

This can be interpreted loosely as the cost for the society, but obviously not for a farmer. At the River Temmesjoki area the only subsidy suited for wintertime stubble and direct sowing is *Plant cover and reduced tillage* -measure which is 11€/ha/a. This is the only cultivation method cost considered in this study for the different reduced cultivation method acreages described earlier and only for one year.

Unit costs of reduced particulate phosphorus and total nitrogen kilograms are shown in Figure 1. The effect of increased DRP to total phosphorus excludes the possibility of calculating unit costs for reducing TotP, because this load increases in most scenarios. Also because the unit cost of reduced erosion stays below 0.10 €/kg in all scenarios, that has also been left out of the Figure 1. In this study the agricultural environmental subsidy regulations were interpreted so that ploughing was considered free whereas all other cultivation methods cost 11 €/ha/a. So Figure 1 describes the unit costs of the scenarios compared to the situation where all fields are ploughed.

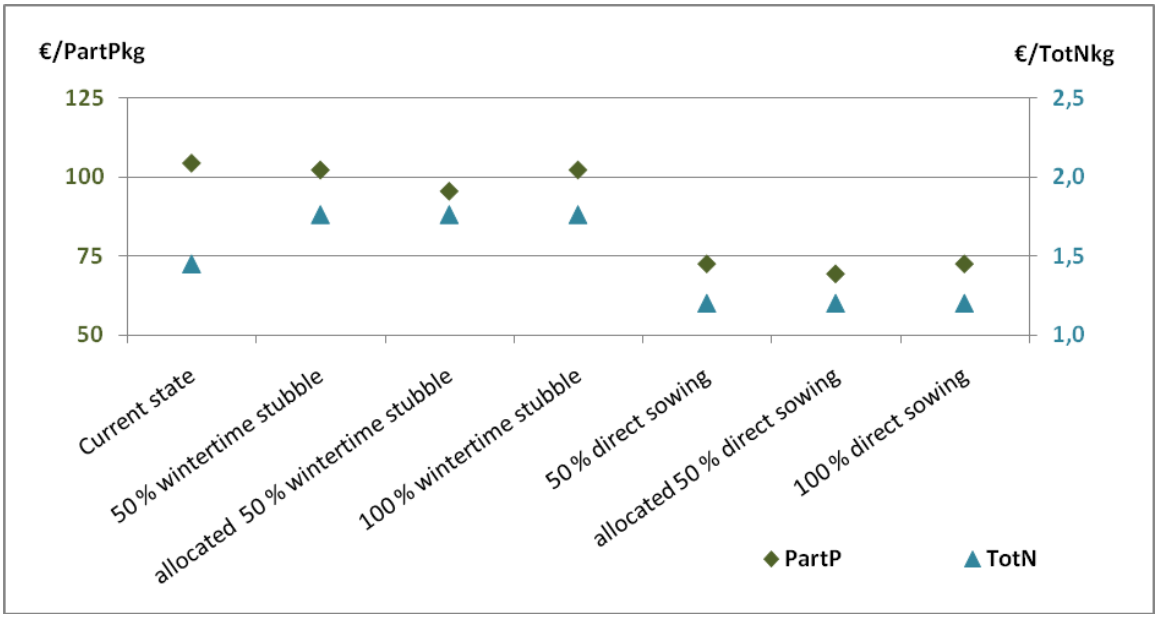

Figure 1. Unit costs of cultivation scenarios calculated with agriculture environmental aids.

As can be seen from the Figure 1, unit costs of direct sowing are distinctly lower than those of wintertime stubble for both particulate phosphorus and total nitrogen. But meanwhile the unit costs in current situation are the highest for particulate phosphorus, for total nitrogen they remain below the unit costs of wintertime stubble. The allocation of methods to steeper fields would lower the unit costs of PartP a bit with both reduced cultivation methods because the same aid would produce bigger phosphorus reductions when applied only on steepest fields. However, because steepness of the field plays no role in development of nitrogen runoffs, this allocation would have no effect on unit costs of total nitrogen.

In the same way the unit costs of nutrient reductions achieved by buffer zones were calculated assuming the subsidy being 350 € per buffer zone hectare per year. For total phosphorus the unit costs for buffer zones with ploughed fields above rises considerably as their acreage increases because more of them are being established on the flat, where their ability to cut nutrient runoffs decreases significantly while the costs remain the same. For direct sowing the unit costs are substantially lower though the development is the same. This also applies for erosion and nitrogen in all scenarios; unit costs increase when buffer zone acreages increase, but more moderately with the exception that direct sowing is the most expensive and ploughing the cheapest method.

3.2 Unit costs according to KUTOVA

In addition to previous calculations, unit costs of different measures were also calculated with the KUTOVA tool, which provides cost-effectiveness analyses of water protection measures for phosphorus. It calculates the costs more from the farmer's point of view considering e.g. yields from the grain produced. In this tool the user can choose how much of the particulate phosphorus is included in total phosphorus; everything between 0 to 100%. In the calculations made for this case

study the shares of PartP were 0%, 50% or 100% and the nutrient reduction methods involved were direct sowing and buffer zones for agriculture and different kinds of measures for treating wastewaters of scattered settlements by property-specific sewage treatment plants, land filtration or connecting the houses to the sewer network.

KUTOVA estimated that the biggest total phosphorus reductions possible in this area would be 30% or 35%, depending on how much of the particulate phosphorus is included. From the total costs and reductions provided by KUTOVA the unit costs of different measures were created simply by dividing the costs with the reductions. This was done for both phosphorus and nitrogen, erosion is not included in KUTOVA. It is good to remember that KUTOVA selects the most cost-effective measures only considering phosphorus reductions. But the same measures might not be the most cost-effective ones for nitrogen. Another problem with KUTOVA is that it considers all agricultural measures to be done always to the whole acreage of one steepness class and this inability to share the measure for only some portion of a steepness class reduces the cost-effectiveness of that measure considerably.

For both nutrients the costs of agricultural measures are significantly lower than those for scattered settlements. But when considering only the DRP loading (PartP emphasis 0%), KUTOVA recommends only scattered settlements' measures. Only when 50% or 100% of the PartP loading is being included to total phosphorus, the tool recommends also the agricultural measures on the side.

As a sensitivity-analysis the unit costs for different mixes of scattered settlements' measures were calculated also manually using the background data from KUTOVA. This allowed differing the quantities of these measures. Because KUTOVA is somewhat more flexible with constructing sacttered settlements' measure combinations than those of agriculture, the results of this analysis weren't substantially different from those provided by KUTOVA in the first place.

4. Social impacts

4.1 Methods for social impact assessment

Social impact assessment is analysing, monitoring and managing the positive and negative social consequences of projects and plans. One aim of the assessment is also to assist communities to identify development goals as well as build social networks and trust. (Vanclay, 2003).

Local knowledge and participatory processes were utilised in the social impact assessment of the water protection measures in Temmesjoki River Basin. In the beginning of the work in the pilot area, a plan to involve citizens and stakeholder groups in the project was prepared. Based on this plan, two local working groups were nominated. They consist of local and regional stakeholders, e.g. municipalities, farmers' and forest owners' unions, village associations and nature protection associations. The two groups have actively participated addressing the problems, aims and means to improve status of the River Temmesjoki watercourse.

The project organised also an open public meeting in the pilot area in February 2010 to inform the citizens about the project as well as to map the views of the public about the use and status of rivers. Based on on-the-spot survey, the status of the rivers has deteriorated over the past 20 years and was currently considered poor. The most common forms of using the rivers and shorelines were fishing,

living near the rivers, water abstraction, leisure housing and trekking. If the quality of the rivers were better, fishing, crab catching, swimming, boating or canoeing and trekking were seen as the most desired activities. The biggest problems related to river status were according to the respondents the water turbidity; lack of water in summertime; bushiness, roughness and erosion of shorelines and weakened fish stocks. Also insufficiency of water protection measures by different actors was seen to deteriorate the water quality. These problems hinder or even prevent recreational use of the rivers. The working groups' meetings as well as open public meetings have provided input for assessing the social impacts of the measures.

The local working groups have been very active in obtaining and also providing knowledge about the past and present status of the rivers as well as making initiatives. Thanks to the active involvement, the influence of stakeholders' opinions to the final outcomes is strong and the measures selected get wide acceptance at local and regional level. It can be said that the project has already increased stakeholders' knowledge of water management issues and funding possibilities and helped to build contacts, which in best case will lead to a series of small actions and projects that will continue after the Waterpraxis project.

4.2 Social impacts of water protection measures in Temmesjoki river basin

Based on information from the stakeholders and citizens in Temmesjoki river basin, the following criteria were chosen to assess the social impacts of measures:

- employment
- landscape and aesthetics
- boating and canoeing
- fishing and crab catching
- trekking and usability of shorelines
- hunting
- water abstraction for household use

The measures to improve the ecological status and/or recreational value of River Temmesjoki and its tributaries are those identified either in the Programme of Measures of the official Oulujoki-Iijoki River Basin Management Plan or highlighted in the participatory process of the ongoing project. Table 2 lists measures of different sectors: agriculture, forestry, scattered settlements and restoration and construction. Peat production was excluded from the assessment since it is a licensed activity and its water protection needs are strictly defined in producers' environment permits. Moreover, the project aims primarily at reducing diffuse loading, which is the main reason for the poor status of the rivers.

Table 2 summarises the expected impacts of different measures. Pluses and minuses have been used to describe the direction (positive/negative) and volume (low/medium/high) of the impact. As the proposed measures are not expected to have major negative social impacts, the value of the assessment is in comparing benefits of different measures.

Table 2. Comparision of the social effects of measures. (++ = major positive impacts, +=some positive impacts, +/- = either positive or negative impacts). Empty cells mean the measure has no impact on the selected criteria.

		SOCIAL IMPACTS						
		EMPLOYMENT	LANDSCAPE AND AESTHETICS	BOATING AND CANOEING	FISHING AND CRAB CATCHING	USABILITY OF RIVERSIDE	HUNTING	WATER ABSTRACTION (HOUSEHOLDS)
FIELD CULTIVATION AND ANIMAL HUSBANDRY	**Optimised fertiliser use (nutrient balances)**							
	Dry and liquid manure placement		++		+			+
	Reduced tillage							
	Wintertime plant cover		+					
	Buffer zones and broader banks		+			+	+	
	Sedimentation ponds							+
	Wetlands		++				+	+
	Optimised irrigation and water recycling		+	+				+
	Liming							
	Lime-filter ditching				+			
	Controlled drainage				+			+
	Less intensive farming / changes in fields use		+					
FORESTRY	**Reduced tillage**					+		
	Wetlands		+	+	+		+	+
	Overland flow wetlands				+			
	Sedimentation ponds, sludge pits, ditch breaks				+			

	Pipe dams			+	+	+		+
	Restoration of ditch-drained sites		+	+	+		+	+
SCATTERED SETTLEMENTS	**Household-specific wastewater treatment**	+						+
	Connecting households to sewer networks							
RESTORATION AND CONSTRUCTION MEASURES	**Restoration of drained lakes**		++	++	+	+	+	+
	Submerged weirs and artificial rapids		++	+/-	+			
	Rapids restoration		++	+/-	+			
	Restoration of cut-off channels		++		++			
	Restoration of fallen river banks		++	+	+	++		
	Liming of river water							
	Clearance and landscaping of riversides	+	++	+	+	++	+	

The water protection measures in agriculture have the most positive effects on landscape and aesthetics. The in-field measures have no particular direct social impacts, but reducing the loading of nutrient and suspended solids has a secondary impact on the usability value of the rivers, especially fishing. Wetlands and optimised manure placement seem to have the widest range of positive effects. Both affect positively on landscape and aesthetics. Manure placement may locally have a major effect to water quality and optimised placement contributes to water abstraction. Wetlands affect water quantity by increasing water storage capacity and providing habitats for game animals. Also buffer zones increase the landscape diversity and may serve as passing routes. Irrigation and water recycling affect water quantity during the most crucial minimum flow period.

Most water protection measures in forestry aim to increase water holding capacity of the river basin, which affects directly to water quantity, fishing, boating and water abstraction. Likewise in agriculture, wetlands as well as restoring the ditch-drained sites in forest management areas have positive impacts on water storage capacity, landscape and diversity. Pipe dams, besides trimming flow peaks, serve as bridges on the forest for forest workers, hunters, berry pickers and other forest users.

The Government Decree on Treating Domestic Wastewater in Areas outside Sewer Networks obliges each household to either join the sewer network or treat their wastewaters with property-specific solutions. Each solution eventually reduces the nutrient load to rivers. In addition, especially property-specific solutions may employ the local contractors and entrepreneurs manufacturing the small sewage treatment plants.

Most of the restoration and construction measures can improve both the ecological and recreational values of the river while the others, like landscaping of the riversides, serve mainly human purposes. There are several completely drained lakes in the River Temmesjoki catchment that the locals have been willing to restore. Restoring the lakes would among others serve as water storage and increase nature and landscape values. However, until now the lake restoration initiatives have failed due to big costs or opposition from forest owners who worry about the effects on forest growth. Landscaping of the river sides and restoration of the fallen river banks would have several positive impacts: they enhance the landscape as well as improve the usability of shorelines and accessibility to river. Landscaping as labour-intensive activity may also allow municipalities to employ the long-term unemployed with subsidies from the state.

Restoration of cut-off channels and rapids help to raise the water level in river channels and increase the breeding grounds for fishes, thus affecting landscape and fishing. On the other hand, submerged weirs and rapids may occasionally hinder boating, especially in minimum flow periods.

Education, guidance and communications are also important water protection measures which, besides secondary impacts on river status, may facilitate community development and self-help for the good of humans and the environment.

5. Conclusions

According to the calculations, agricultural measures wouldn't seem very potential nutrient reduction methods. Mostly this is due to the relatively flat fields of the area, where the reduction potential is much lower than what it would be on steeper fields. Nevertheless, there are many assumptions behind the results. For example it is very likely that there are also steeper fields, where many reduced cultivation methods would be very useful. Also even though effects of the measures on a river basin scale wouldn't seem very promising, the local effects might still be impressive.

Cutting DRP loads with the reduced cultivation methods included in this study seems unattainable, but diminishing the soil-test P values would be one noteworthy way to achieve this on the long run. Perhaps uniting this with some catch crop or crop rotation might also help. In addition there are many new studies evaluating the effects of gypsum application on fields to the nutrient loads and the results especially for DRP loads have been very promising.

It is also still unclear which substance (phosphorus, nitrogen or suspended solids) is the most harmful for the ecological status of the rivers or the outlet sea area, the Liminganlahti Bay. It is possible that the most affecting loading factor is different in rivers than in the sea. However, this issue requires further research.

No suggested water management measures will cause significant negative social impacts to any assessment criteria. The feasibility assessment of the measures will be included in the final report of

the pilot area activities. The feasibility analysis may bring some added value also to social impact assessment, concerning especially the acceptability of measures or the risk for conflicts. In general, the measures that take place in several private landowners' property and reduce the area used for field or forest cultivation are the most challenging in reaching consensus. These measures include wetlands as well as restoration of drainage area or drained lakes.

References

Kunnari, E. (2008). **Vesipuitedirektiivin mukainen kustannustehokkuusanalyysi maatalouden vesienhoitotoimenpiteille Excel-sovelluksena**. Pro gradu –tutkielma. Helsingin yliopisto, Taloustieteen laitos. Ympäristöekonomia. (In Finnish).

Puustinen, M., Turtola, E., Kukkonen, M., Koskiaho, J., Linjama, J., Niinioja, R. & Tattari, S. (2010). **VIHMA – a tool for allocation of measures to control erosion and nutrient loading from Finnish agricultural catchments**. Journal of Agriculture, Ecosystems and Environment (In press).

Vanclay, F. (2003) **International Principles for Social Impact Assessment.** Impact Assessment and Project Appraisal 21:1, p. 5–11.

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Waterpraxis

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Report on social, economical and environmental assessments from Suså pilot study

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1 Introduction

During the project Waterpraxis models and methods have been developed and applied to undertake environmental, social and economic impact assessment which Næstved municipality has the possibility to use in the coming planning of the water and action plans.

This report gives an overview of the social, economic and environmental impact assessments of selected water management measures in Suså Pilot area in Denmark. The project site Suså and the catchment is described in a WP4 report by Christensen, H.S., B. Hasler, B. Münier, P. Frederiksen, M. Källstrøm, P.Viuf (2010): "Analysis of existing Danish Water Protection Plans and realized water protection projects". As mentioned in this report, a special focus is on wetland restoration projects, specifically the areas around three rivers within the Suså catchment. Four river catchments within the responsibility of Næstved Municipality drain into the marine area Smålandshavet and the adjacent brackish waters of Karrebæk Fjord: Bjørnebæk, Evegrøft, Saltø Å and Fladså.

Figure 1: Map showing the project area with its most important site names. Ongoing and planned wetland restoration areas are shown in greenblue colour.

In this report, the methodological developments and analyses within Waterpraxis are exemplified using three of the above mentioned wetland restoration project sites selected by Næstved Municipality, as the Bjørnebæk project is somewhat special due to its hydrological settings and has been reported previously (Christensen et al., 2010).

Wetland restoration is a major and important measure for fulfilment of the WFD in a number of Danish river basins. The focus in the Danish study is on assessing the environmental impacts of wetland restoration. Special emphasis is given to the wetland restoration in Næstved as well as in other municipalities, and we have therefore chosen to concentrate the environmental and part of the economic assessments to these action plans. . In specified water plans actions to establish wetlands have been described or are underway, as well as river basin/catchment plans for the removal of phosphorus. In lot of municipalities action plans for wetlands are underway and have been described and coordinated by water planning steering committees, each of those related to one main WFD catchment.

Næstved municipality has got financial support from the Danish Ministry of Environment to start and undertake pilot plans and investigations of the rivers Bjørnebækken, Evegrøft and Saltø Å. The pilot plans for Bjørnebækken are finished and the final report has been delivered. A pilot plan for Evegrøft is soon finished. The assessments of Saltø Å has been started up with a call for technical pilot assessments during autumn 2011. From the Danish Government, no actions have been undertaken until now to establish phosphorus removal in the river catchments, as these have been postponed.

As part of Waterpraxis, a GIS-based nitrate retention model “WetPlan” for assessment and screening of the effects of wetland restoration projects has been developed. WetPlan is supplemented by another spatial model “WetArea” (or sometimes in the figures mentioned as “WetAreaPlan”) for modelling expected changes in the water table in new wetlands as well as in the surrounding area. WetArea has been applied to delineate areas affected by water table changes and, together with maps of agricultural land use, changes in agricultural practice as a consequence of wetland restoration projects. WetPlan has been tested on Evegrøft and together with WetArea applied to two major planned wetland restoration projects along Saltø Å and Fladså. Both models are programmed as tools into ESRI’s GIS-software ArcGIS and thus transferrable to other users and regions..

Economic assessments of the costs of wetland restoration as well as for other measures have also been accomplished. The social impacts of the water quality improvements from full WFD implementation – i.e. much more than only wetland restoration, is carried out and described in this report. The results from this survey will together with the cost assessment of full WFD implementation discussed in WP4 enable welfare economic analyses of investments and actions undertaken to fulfil the WFD in the catchment.

In addition to the monetary valuation of the social benefits of water quality improvements a study of how the population at Zealand and Lolland-Falster use the Suså area, including neighbouring rivers and the fjords, for recreational and other purposes is undertaken within the social assessment. The different methodological parts of these impact assessment enable prioritisation between projects and areas from different points of views, e.g. purely environmental effectiveness, cost-effectiveness and/or cost-efficiency (including both costs and benefits).

2 Environmental impacts

Wetland restoration in a Danish context is generally focused on former wetlands that have been drained and are located in low lying areas within river valleys where runoff from cropland drain into surface waters. In many cases, drainage systems have been established in such a way that runoff from croplands on high ground no longer passes through wetlands. The Danish landscape, formed during the Weichsel glaciation period, is dominated by a relatively flat moraine landscape intersected by these hydrosols. Formerly, river valleys have been dominated by wet meadows and bogs used for hay production and grazing. Most of these wetlands have been drained artificially during the 19th and 20th century, in order to support a growing agricultural production. These areas along the rivers are now taken into consideration for wetland restoration, mainly for nutrient removal but also to re-establish their ecological functioning. In order to establish a coherent and informed prioritization procedure regarding N-retention potential and to evaluate the relative benefits of proposed wetland projects, two Geographical Information System (GIS) models - WetArea and WetPlan - have been developed as a part of the Waterpraxis project.

2.1 GIS models as assessment tools for wetland projects

The two GIS models that will be presented have been designed as tools for quick assessment of the physical impact on hydrology as well as benefits from nitrate removal in potential wetlands projects. By using the models including the economic evaluation presented later in this report, municipalities and other governmental bodies can analyse the expected gains, costs and benefits as input to their decision process regarding certain wetland restoration projects. Part of the outcome is the opportunity to give a better delineation of the project area with respect to the wetness conditions that can be expected, opposite to the often relative coarse delineation that can be made by a first step from existing maps on hydrosol areas. In the following section, the methodology of the two models is described as well as their limitations. As an example, the result of three case studies is presented in this chapter, demonstrating the potential of the two models. However it is important to stress that the models are solely intended as screening tools for initial phase of selecting the most promising wetland restoration projects and not as a tool for detailed impact assessment. In many cases, detailed on-site studies will be needed before initiating any concrete implementation of the projects. The two models are intended to be made available to local and regional decision makers in Denmark.

2.1.1 Wetland restorations and GIS models in the Waterpraxis project

2.1.1.1 The WetArea model:

The purpose of the model is to calculate affected areas of a water level rise in a river, as a result of a wetland restoration. Although WetArea is primarily intended to be used as a screening tool for potential wetlands, the area identified by WetArea can also be used as input data, for modelling nitrate retention in a specific project, by using the WetPlan model (see below). Because it should be possible by the municipalities and other users with limited GIS capacity, the needed input is relatively limited. WetArea has 4 inputs specified as:

Table 1: List of input parameters of WetArea, keeping it simple and easy to use.

Input to WetArea model				
Input type	***Raster layer***	***Vector line(s)***	***Parameter***	***Parameter***
Description	***A high resolution digital terrain model (DTM).***	***Polylines specifying the river or river system to be modelled.***	***Raise of water table as a consequence of changing hydrological and run-off conditions, like reduced maintenance of the river bed. Can be set to 0 = no changes.***	***Slope of water table in m/m as a function of distance from the river reflecting ground water flow or slope of drainage pipes.*** ***If it is set to 0 the modelled water table level will be "flat". If it is set to 0.002 the modelled water table level will raise by 1m at a distance of 500m from the river.***

The model is designed to use any Digital Terrain Model as input, but during the development phase of WetArea the DTM from the Danish Survey and Cadastre (KMS, 2009) with a spatial resolution resampled from 1,6m has been applied. Based on the input data described in table 1, a modelled groundwater table is calculated by spreading the elevation of the river surface with a maximum distance of 1000 meters from the river. If the Field drainage raise is specified greater than 0, then the distance from the river is multiplied by the specified drainage value, which is added to the modelled water table.

Table 2: Wetness categories as distance from the modelled water table to the DTM surface

Wetness	1	2	3	4	5
Land use	Open water surface	Bog/swamp	Wet meadow	Meadow	Field/dry land
Modelled groundwater table	Above terrain	0 – 25 cm below terrain	25 – 50 cm below terrain	50 – 75 cm below terrain	> 75 below terrain

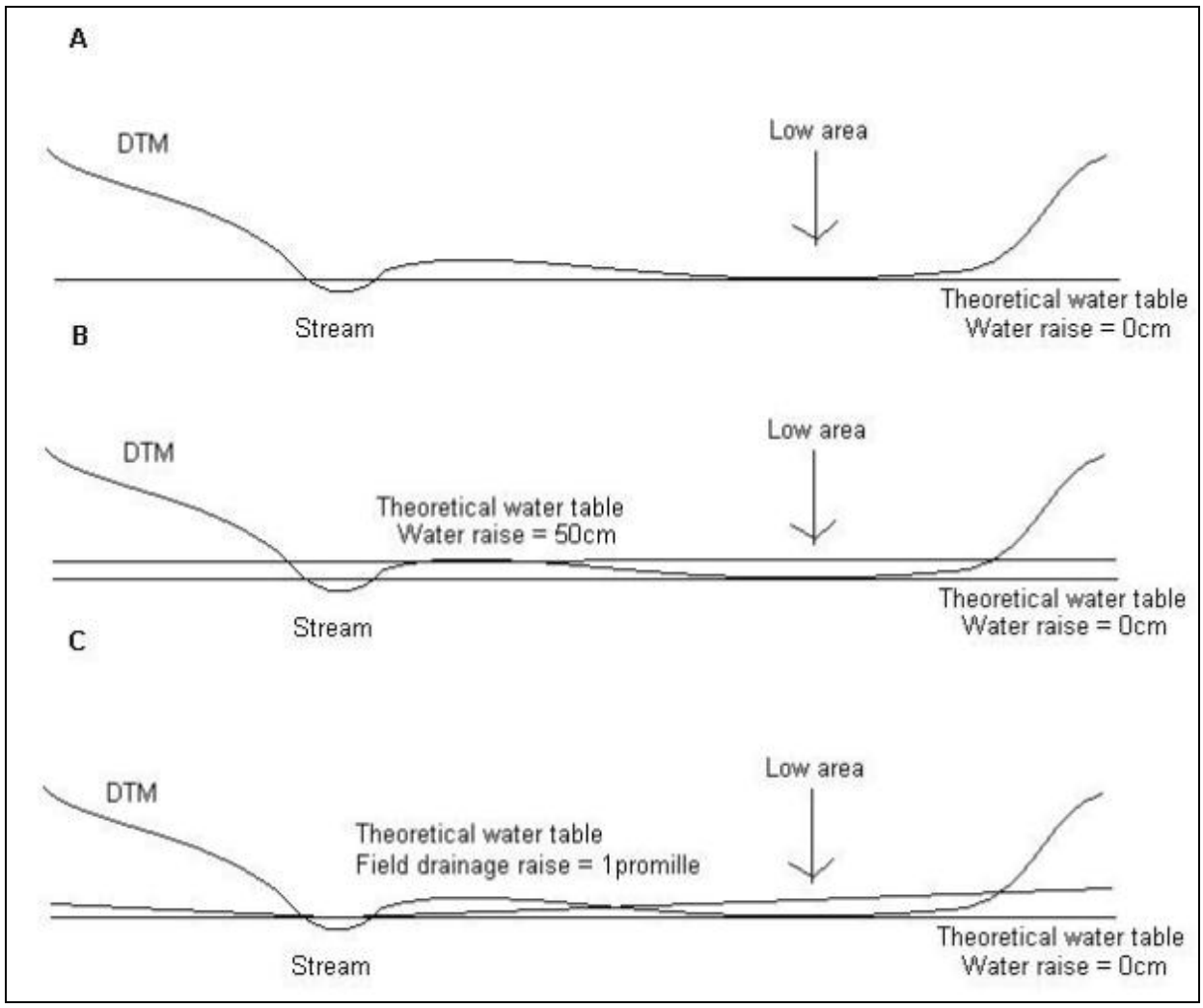


Figure 2: Illustrating the different principle of the WetArea. A. The calculated modelled water table at 0cm. B. Simulating a water level raise of 50cm and C. including field drainage raise by 1 ‰.

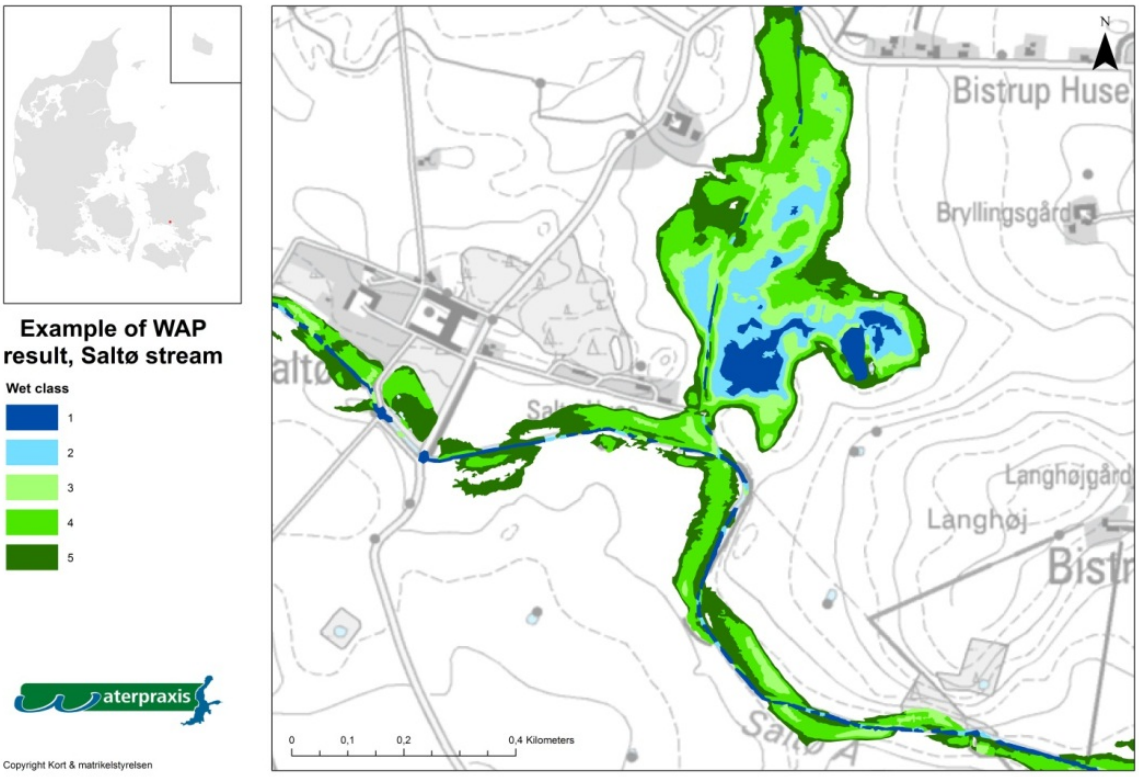


Figure 3: The result of a WetArea simulation of water raise of 30cm in a part of Saltø Å with Field drainage set to 0‰

Restrictions and limits of WetArea

As described, the input data to the model is based on a digital terrain model. This approach to modelling water level raise has some restrictions since the discharge in rivers is dynamic and depends on different parameters such as, groundwater inflow, precipitation etc. Normally water level is calculated by use of discharge measurements and hydraulic routing, from different medians. This is usually done by field measurements. The goal is to find a water level, were the water exceeds the banks, and floods the surrounding area. In WetArea the modelled water level is estimated entirely from the river surface as elevation measured in the DTM. The DTM applied here is from the KMS, derived from Light Detection and Ranging (LiDAR) data. The raw data are obtained by an airborne laser scanner and after calibration, data processing and correction it measuring the elevation above sea level for each 1.6m x 1.6m cell. Since the data is recorded from an airplane, it is dependent on the angle and time of the laser recording the picture. The raw data collection for the DTM model was done in spring 2007 in a period with varying water table (metadata at www.kortforsygningen.dk).

When the DTM model is interpolated from the raw LiDAR point cloud, a filtering and averaging over several points is used to compute the elevation in each 1.6m x 1.6m raster cell. This can lead to some inaccuracy in the calculation of the water table, since there is often points from both the bank and water table in the DTM raster cell. Therefore, the river size is an important parameter, as the resolution of the DTM restricts the detection of small rivers. In KMS DTM the spatial resolution is 1.6m and an open water surface has to be significantly wider than 1,6m as less surfaces will not be captured precisely. In general, a wide river with limited vegetation will probably give the best accuracy. Furthermore, WetArea does not account for any existing field drainage. This means that if

the groundwater table slope parameter is set to 0.0 m, the result will show the water level in a situation with no drains. This however corresponds to a case of wetland restoration from (Hoffmann et. al 2005), where all drains in the river valley bottom was dismantled. Moreover, the WetArea assumes that all soils are fully permeable and does not account for impermeable soils and geological structures.

Usage of WetArea and pre-processing of input to WetPlan

The areas identified by WetArea can be used as input to the WetPlan model, where the amount of de-nitrification is estimated. The model is designed as a screening tool and does not provide a final result, and additional detailed investigations should be made prior to establishing a wetland. WetArea output is divided in five different categories or wet classes, ranging from open water to minor rise of the ground water level. The percentage of nitrate retention is depended on the abandonment of agricultural land use, mainly related to open water or bog/ swamp. Therefore the two wettest classes of the WetArea output are used as input to Wetplan. WetArea is relatively simple and based on DTM data, it does not account for topography as well as soil permeability and other geological features. Therefore the output needs some manually adjustment and pre-processing, for instance excluding the most unlikely affected areas fare from the river or behind topographically obstacles. One example is shown below in figure 4.

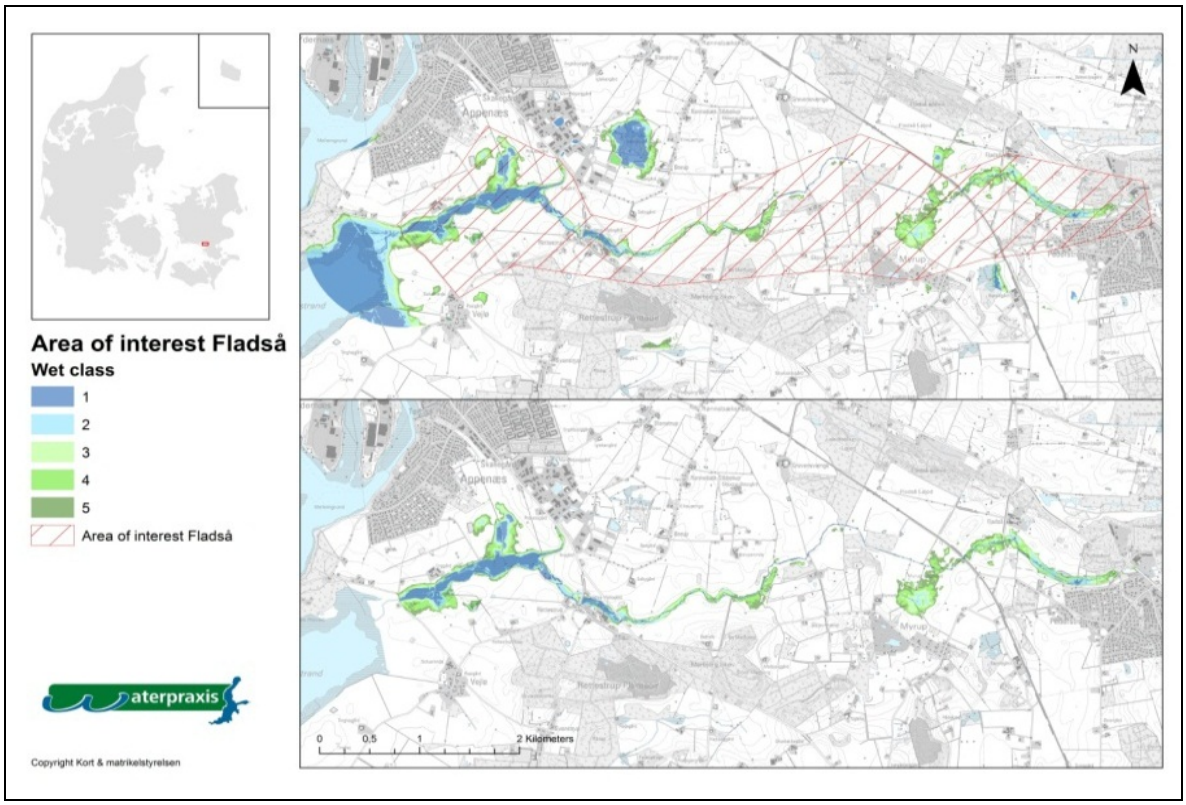


Figure 4: Adjustment of WetArea output taking the topography and the limitations of WetArea into considerations. Note that WetArea includes a marine area, which has been excluded from the Area of Impact.

There is also a need for pre-processing the output polygon to fit the river dataset used in the Wetplan model. The Wetplan model uses ESRI's ArcHydro tool (ESRI 2010) requiring

hydrological coherent rivers and defined flow-direction. In this case the river dataset is taken from the Danish Areal Information System (AIS) dataset on hydrology (Nielsen et al. 2000). These data deviate by up to 23 meters from the KMS Kort10 river data, but have been applied as it is the only river data matching requirements of ArcHydro. Therefore, WetArea results based on Kort10, with updated river data have to be added data from the AIS dataset of hydrological coherent rivers. This is done by adding a 10 meters buffer around the AIS river data, and then merges it with WetArea output polygon. An example is showed in the figure below. Another solution would be to create a new dataset of hydrological coherent rivers, which better fits the topographical reality as reflected in the DTM, but this was outside the scope of this project.

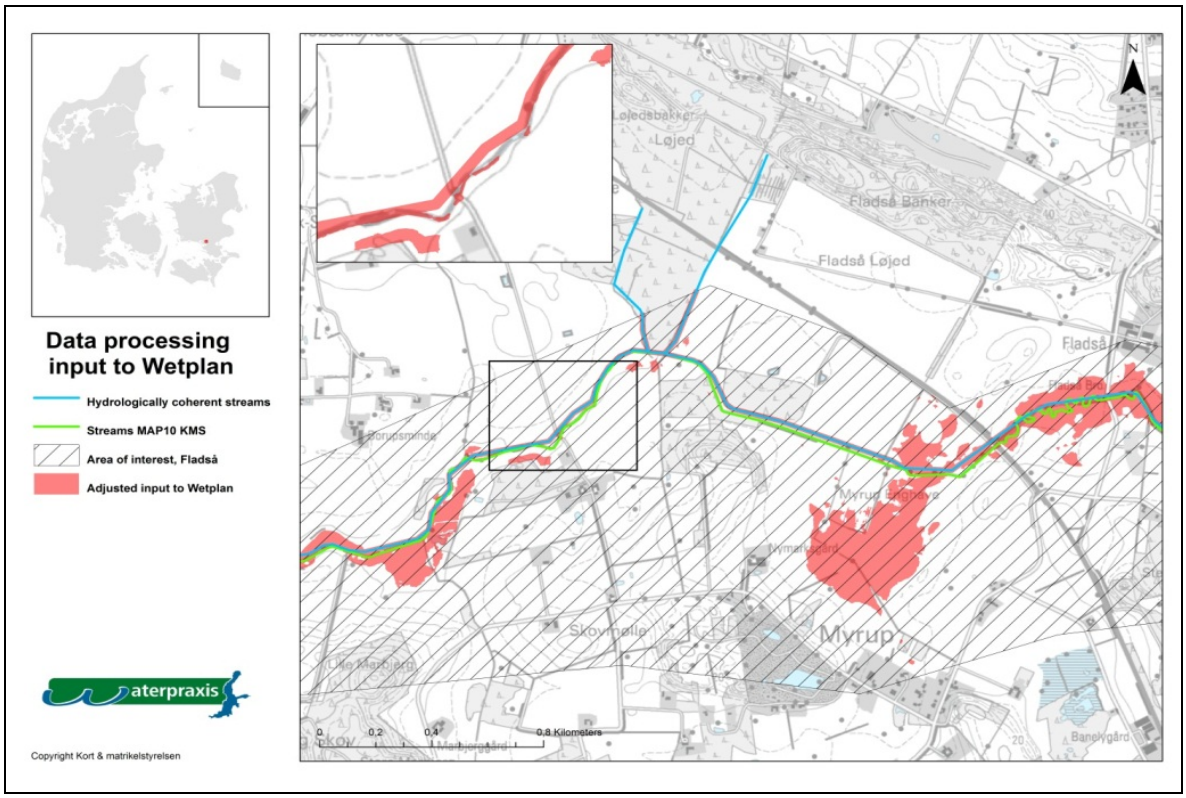


Figure 5: Adjustment of WetArea output with the 10 meters buffer around the hydrological coherent river dataset.

2.1.1.2 WetPlan – a Wetland nitrate-retention model

Nitrate retention estimation for wetland restoration projects

The WetPlan model estimates Nitrate retention based on a polygon supplied by the user, delineating the extent of a proposed new wetland restoration project. An estimated nitrate retention for the project is calculated by the model, using map-based information on river location and flow direction, topography, rainfall, soil and land use. Figure 6 illustrates the concept for wetland restoration embraced here, which is specifically targeted at the type of wetland restoration documented in NERI technical report no. 19, 2005 (Hoffmann et al 2005). The Wetland project area drained into the river and is fed from the so called direct watersheds along the river valley. It is anticipated, that all drains and ditches are removed from the wetland inside the project are in order

to force water from the direct watersheds to pass through the wetland. In the wetland, runoff water is subject to anaerobe de-nitrification in the waterlogged soils, before it reaches the river. Water from the watershed upstream to the wetland restoration area of the river also passes through the wetland, but only comes into contact with wetland soils during periods of flooding, where river waters are distributed over parts of the wetland for a limited period of time. On the basis of this scenario, which fits most of the Danish wetland restoration projects, the WetPlan tool calculates the approximate amount of surface water passing through the wetland and its nitrate concentration.

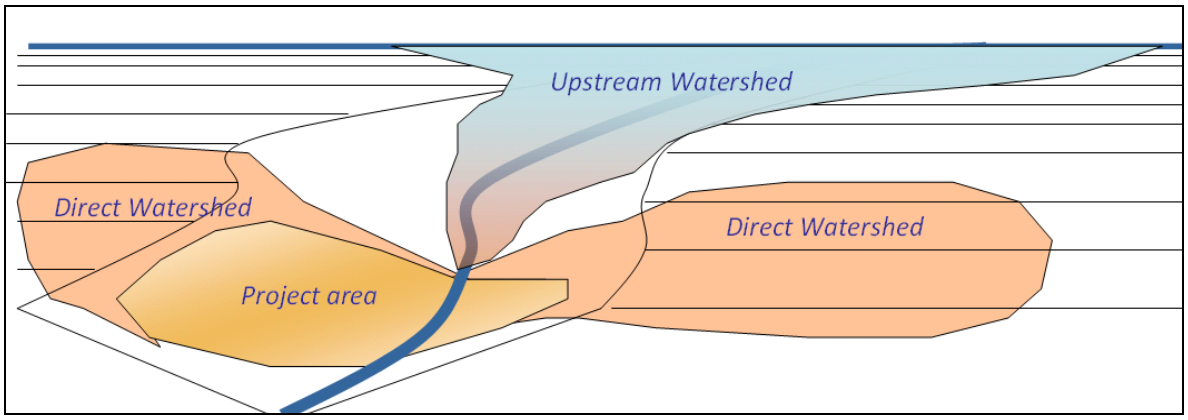


Figure 6: The wetland restoration concept implemented in WetPlan

The calculation procedures take their departure in a delineation of the direct and upstream watersheds to the proposed wetland (or calculated area of interest by WetArea), which are identified by simulating rainfall on a DTM. Based on polygons describing the watersheds, the model summarizes the soil and land use composition and annual rainfall of each watershed, using data from the so-called 'Basemap' dataset complied by Levin (Levin et al. 2010). It also calculates the annually amount of water flowing into the wetland from each watershed, along with its modelled nitrate concentration. The amount of water and its nitrate concentration is estimated on the basis of expert estimations of the average nitrate leaching per hectare from farmland, calculated as a function of the percentage of sandy and clayey soils, the annual rainfall within a 10x10km grid and the percentage of rotational cropland in each watershed (MIM 2005, Hoffmann et al 2005).

Calculating Nitrate retention estimates

Based on the outline of the proposed wetland, the WetPlan tool calculates the effect on nitrate leaching of a wetland project. The effect is modelled separately for the project area itself, for the direct watersheds and for the upstream watershed respectively. Retention of nitrate from the *upstream* watershed is calculated as a function of the estimated nitrate concentration in the water, the amount of water, and the duration and extent of annual floods. Flooding generally happens as a consequence of reduced management efforts, due to sedimentation and growth of riparian vegetation along and inside the rivers which clog the watercourse. Data on flooding is entered into the model by the user and should represent best estimates derived from relevant management plans for the area. Retention of nitrate from the *direct watershed* is calculated as a function of the level of

nitrate concentration in the water, the amount of water, the size of the proposed wetland and the soil composition of the watershed.

For the *project area* itself, the current total nitrate leaching of the area is considered an inverse expression of the effect of the wetland project, since current land use will be dismantled as a consequence of the project. This effect is calculated on the basis land use information and expert estimations of average levels of nitrate leaching from the different land use types. When added together, the figures described above constitute an estimation of the total nitrate retention effect of the wetland project, used to evaluate its efficiency by comparison with other projects. Figure 7 illustrates the development of the digital elevation model used in WetPlan, which forms the core of its input data and secures a reliable delineation of watersheds. The elevation model was pre-processed a combination of own modelling, including routines from ESRI's ArcHydro Toolset version 1.4 (ESRI 2010).

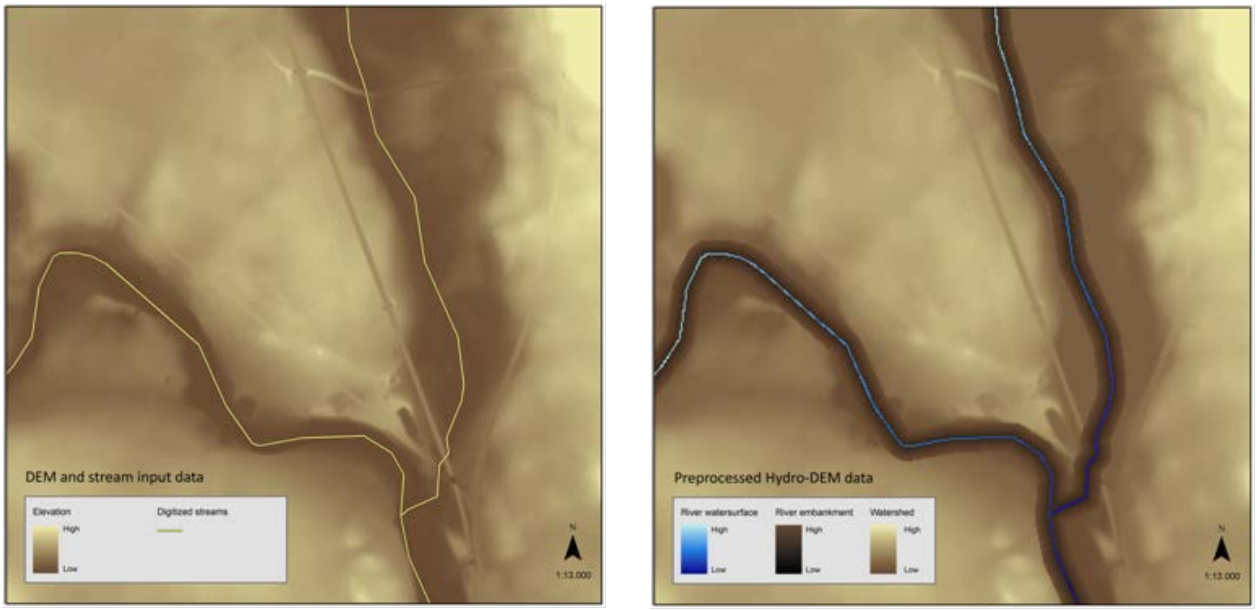


Figure 7: Example of pre-processing Hydro-DTM dataset using the WetPlan model

Refer to the figure 7 for comparison of the digitized and validated river vector lines with the DTM data (figure 7.A - left map), these two datasets are not hydrological consistent. Road and railroad bridges cross the rivers, and impose fictional obstructions to water flow direction. These would result in erroneous catchment delineation calculations if used directly for modelling purposes. In the pre-processed elevation model (figure 7.B – right map) all obstructions have been removed. The river banks have been modelled to slope towards the rivers as found in the river dataset in order to ensure a precise modelling of watersheds to allow precise flow direction and flow accumulation calculation.

Testing the models - case study "Evegrøft"

For testing purpose the two models have been used to calculate the likely effect of the Wetland project "Evegrøft" in Denmark, proposed by and located in the municipality of Næstved (Christensen et al 2010). Figure 8 and table 3 below, illustrate the output tables and watershed delineation polygons which have been the result of our first test runs of Wetplan. The Municipality of Næstved in Denmark has started establishing wetlands along "Evegrøft", in order to alleviate

Nitrate runoffs into coastal waters. The WetPlan model has been used to calculate the expected nitrate retention as a result of the establishment of the "Evegrøft" wetlands. For testing and demonstrating purposes of the models developed in Waterpraxis, three scenarios have been established: (1) a scenario which involves the restoration of a wetland with standard levels of flooding and no change of land use outside the project area, (2) a scenario involving increased flooding of the wetland, due to highly reduced maintenance of the water body, and (3) a scenario involving decreased rotational cropland in the project area and the watersheds, due to its conversion to permanent grassland in parallel with the wetland restoration.

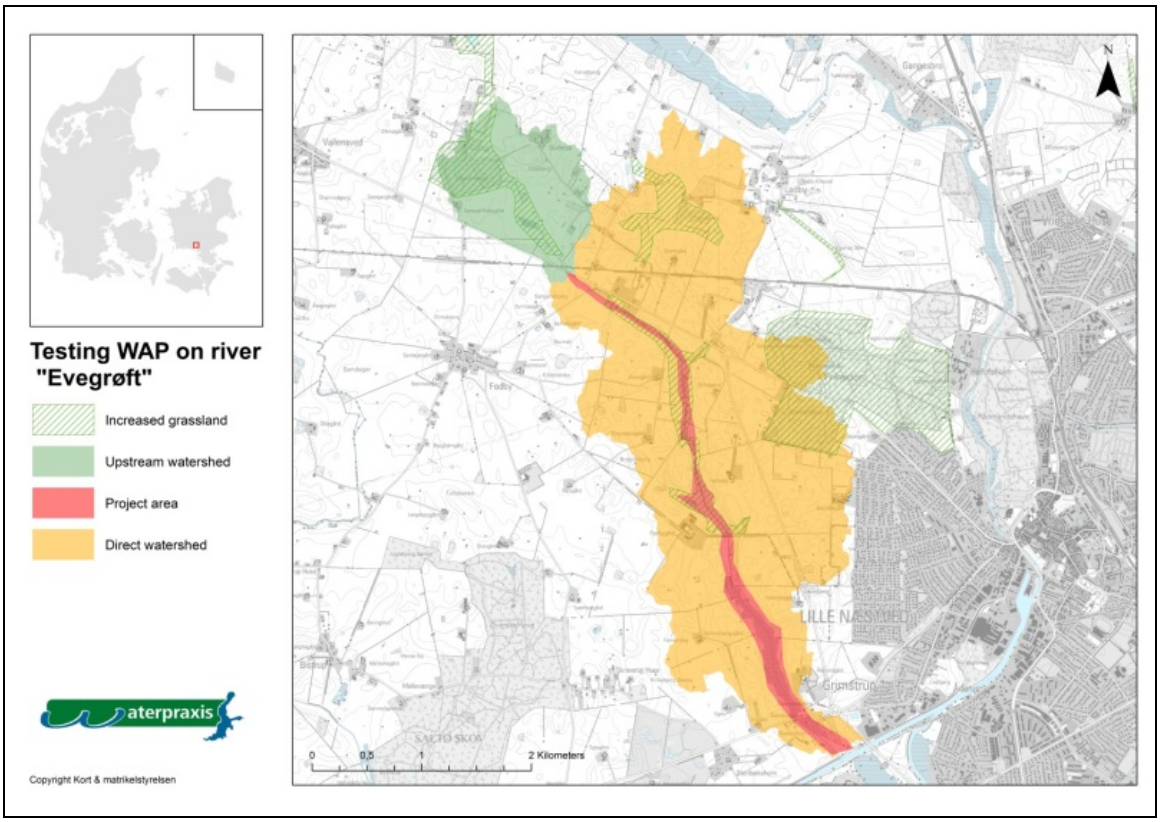


Figure 8: Overview of the hydrological context of the project test area "Evegrøft" and its watersheds calculated using the WetPlan tool. The red area along the river is the project area. The orange area is the direct watershed, and the purple area is the upstream watershed. Areas with increased permanent grassland cover (scenario 3) with green hatching

Results from scenarios #1 compared to #2 indicate, that more and longer flooding periods of the new wetland will lead to increased nitrate retention of water originating from the catchment upstream the project area via the river, as it passes and temporarily floods parts of the new wetland.

Table3 : Calculation of nitrate retention as a result of wetland restoration along Evegrøften. The land cover measurements for the project area refer to the situation before the wetland restoration project, during which all land use in the project area will be abandoned. Please note that the data has been derived from the first test run of the WetPlan tool.

Calculated results, case study Evegrøft:	Scenario # 1 – Wetland baseline			Scenario # 2 - Increased flooding			Scenario # 3 – Reduced cropland		
	Pro. Area.	Dir Ws.	Upstr Ws.	Pro. Area.	Dir Ws.	Upstr Ws.	Pro. Area.	Dir Ws.	Upstr Ws.
Total area [ha]	787	141	66	787	141	66	787	141	66
Averege precipitation [mm]	394,8	394,1		394,8	394,1		394,8	394,1	
Cropland [% of area]	77,8	77,2	41,1	77,8	77,2	41,1	72,7	64,0	26,7
Sandy soil [% of area]	0,4	1,4	0	0,4	1,4	0	0,4	1,4	0,0
Forest and bog area [ha.]			20,4			20,4			20,4
Grassland area [ha.]			0			0			11,5
Flooding time [Days / yr.]		20			50			20,0	
Flooding area [ha.]		10			45			10,0	
Nitrate Leaching [Kg. N / ha. / yr.]	33,3	32,7	19,5	33,3	32,7	19,5	29,3	23,5	18.3
Total Nitrate leaching [Kg N / yr.]	26172	4617,9	1287	26172	4617,9	1287	23060	3322,8	1208
Nitrate retention [kg. N]	13086	240	1109	13086	2700	1109	11530	240	1030
Retention [%]	50%	5%	86%	50%	58%	86%	50%	7%	85%
Total Nitrate retention [kg N / yr.]	14453			16895			12800		
Total Nitrate leaching downstream [kg N / yr.]	17642			15182			14791		

In terms of relative retention of the total amount originating from the upstream watershed, this increases heavily from 5% to 58% due to increased riparian vegetation cover hindering flow off and increasing floodings – an effect which is likely to manifest itself over a number of years if maintenance of the river bed is reduced. In comparison, the retention of the new wetland regarding nitrate originating from the direct watershed of the wetland remains constant. This is the case unless the flooded areas provide a shortcut for drainage water from the direct watershed to the river, thus reducing nitrate retention by reduced percolation through the wetland soil.

In the third scenario, we simulated reduced cropping in parts of the direct and upstream watersheds and the project area (40 + 19 + 9 = 68 ha). This of cause means a drop in nitrate leaching from the root zone of the agricultural areas. As retention is more less a percentage of the amount of nitrate entering the "Evegrøft" wetland, N-load downstream of the wetland decreases from 17642 kg N / year in scenario #1 to 14790 kg N / year in scenario #3. Compared to the total amount of nitrate leached to the downstream part of the "Evegrøft" prior to establishment of the new wetland, which comprises 32077 kg N / year, the three scenarios generate a reduction of 45%, 53% and 54% respectively. This example demonstrates how the model can be used to evaluate different land use and flooding scenarios. In the next section two case studies of potential wetland project in Næstved municipality will be presented, using both input from WetArea and WetPlan.

2.1.1.3 Two case studies of potential wetlands in Næstved municipality using WetArea and Wetplan

After testing and correcting the WetArea and Wetplan GIS models, two different case studies on wetland restoration areas in the municipality of Næstved have been carried out. The next two projects envisioned by Næstved municipality are located within the lower parts of the rivers Saltø Å and Fladså. Due to their placement close to the marine area, only very little nitrate retention can be expected downstream of the case areas and thus the marine area will benefit from the full effect of the water purification by the wetlands. The two case studies provide examples of the application of WetArea and Wetplan qualifying the initial pinpointing of potential wetland restoration areas, before initiating costly detailed studies and design plans. Input parameters of the different case studies, have been set as follows:

Table 4: Input settings of the scenarios analysed for two case areas.

Input settings	**Saltø Scenario 30/60**	**Saltø Municipality scenario**	**Fladså Scenario 30**	**Fladså Municipality scenario NAE1**
Drainage	0	0	0	0
Water level raise	30/60 cm		30cm	
Input polygon	From WetArea	Municipality	From WetArea	Municipality
Flooded area, ha total	20	20	20	20
Day of flooding pr. Year	10	10	10	10
Nitrate loss from agriculture kg. N/ha pr. Yr.	47,5	47,5	47,5	47,5
Nitrate loss from permanent grassland kg. N/ha pr. Yr.	7,5	7,5	7,5	7,5
Nitrate loss from nature areas kg. N/ha pr. Yr.	2,5	2,5	2,5	2,5

Case study Fladså

The case study is based on a proposed area from Næstved municipality for wetland restoration along the Fladså river south of Næstved. The municipality has identified a number of areas designated for wetland restoration, some very lager while others are smaller. In this case, the area is the relative small but presumably efficient project area called NEA1, as illustrated in figure 9. A modelling of wetness classes using WetArea documents that there is some relatively difference between the shape and size of the NAE1 project area and the scenario simulation by WetArea - respectively 108 ha for the NAE1 area and 52 ha for WetArea scenario area.

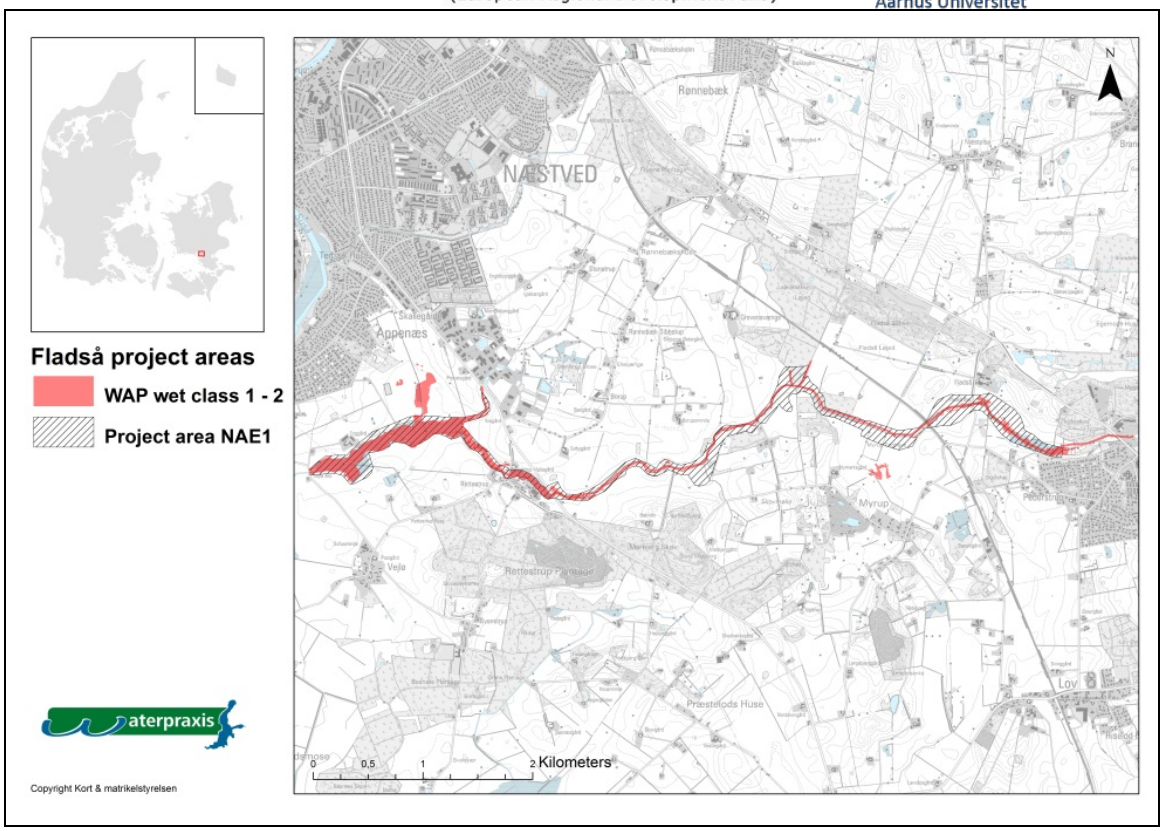
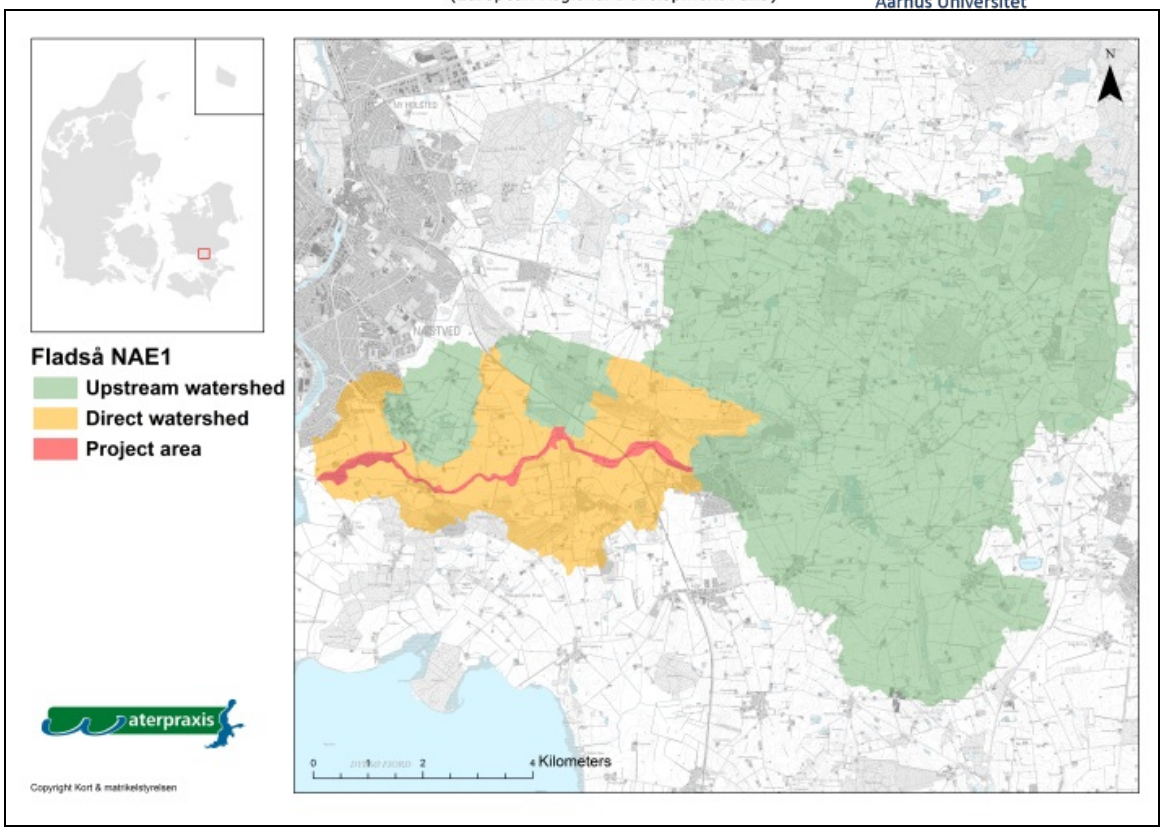


Figure 9. Overview of Fladså with the two delineations of the project area (NAE1) and the WetArea scenario 30, illustrating the difference between the municipality project area and the WetArea result of groundwater table modelling.

Different model simulations were conducted with Wetplan, using the project area NAE1 as input as well as input based on a WetArea run within the NAE1 project area. The later simulates a water level rise of 30cm due to reduced maintenance or other measures. The result is illustrated below in figure 10.



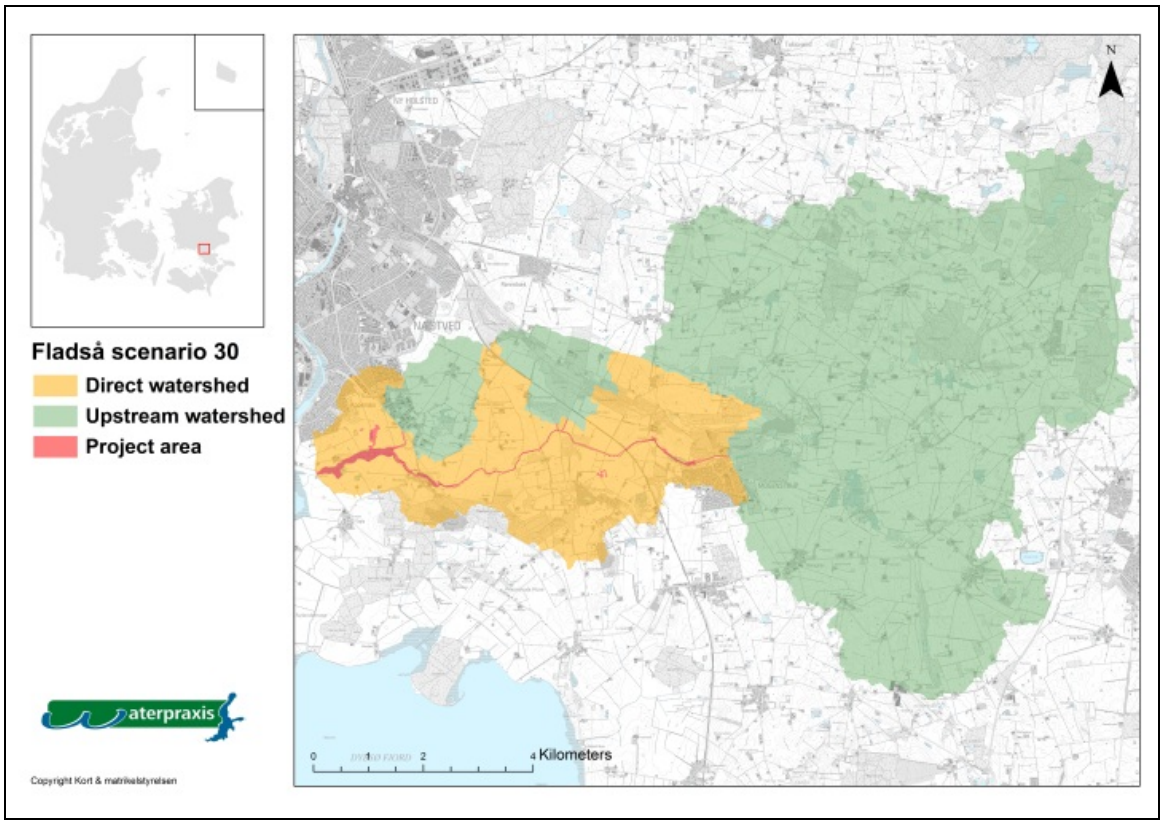


Figure 10: Result from WetPlan modelling of watersheds for Fladså, using input from the NAE1 project area and the area affected due to groundwater table modelling with WetArea.

Table 5. The calculated nitrate retention for Fladså river, using two different ways of defining future wetland classes - the municipality project area NAE1 and input from a WetArea run, with a 30cm rise of the water level. Although the distribution and size of wet areas is different between the NAE1 and WetArea 30cm scenario, the calculated nitrate retention is almost equal. The different results are mainly related to the change of land use inside the two project areas.

Calculated results:	Fladså Muncipality project area NAE1			Fladså WAP 30cm scenario		
	Pro. Area.	Dir Ws.	Upstr Ws.	Pro. Area.	Dir Ws.	Upstr Ws.
Total area [ha]	108	1468	6057	52	1619	5963
Averege precipitation [mm]	0	400	422	0	400	422
Cropland [% of area]	47	62	68	26	59	69
Sandy soil [% of area]	0	86	19	0	85	18
Cropland [ha.]	51	906	4146	14	953	4137
Forest and bog area [ha.]	40	0	0	26	0	0
Grassland area [ha.]	0	0	0	0	0	0
Flooding time [Days / yr.]	0	0	10	0	0	10
Flooding area [ha.]	0	0	20	0	0	20
Nitrate Leaching [Kg. N / ha. / yr.]	23	17	26	14	16	27
Total Nitrate leaching [Kg N / yr.]	2524	25531	158787	713	26340	160473
Nitrate retention [kg. N]	2254	12766	250	582	13170	250
Retention [%]	89%	50%	0%	82%	50%	0%
Total Nitrate retention [kg N / yr.]	15269			14002		
Total Nitrate leaching downstream [kg N / yr.]	186842			187526		

As shown in table 5, The result from Wetplan calculation of nitrate retention is almost similar form the two input polygons NAE1 and WetArea 30cm scenario, which indicates that greatest retention occurs in the direct watershed . The difference in the nitrate retention is therefore mostly related to different scale of land use change in the two project areas. In this case, the project area delineated by Næstved municipality was relatively well-defined as input to the estimation of nitrate retention, but the distribution of affected areas reveals deviations. It seems that in this case WetArea is useful as a screening tool for the physical impact of water level rise. In other cases the delimitation of the project area may be more important, as it is the case from the next study of Saltø river. Another important aspect are input maps on soil and climate data, such as net-precipitation. The Wetplan model uses the average yearly precipitation, but this does not account for higher evaporation in the summer, which probably influence the nitrate retention in a negative direction. Therefore the model tends to overestimate the nitrate retention.

Case study Saltø Å

Another case study was carried out regarding the Saltø Å west of Næstved, using the input area form the municipality and two WetArea scenarios on water level rise by 30 cm and 60 cm. The different project areas can be seen in figure 11. Note the significant differences between the municipality project area and the two WetArea scenarios, which model water level rise of 30 cm and 60 cm.

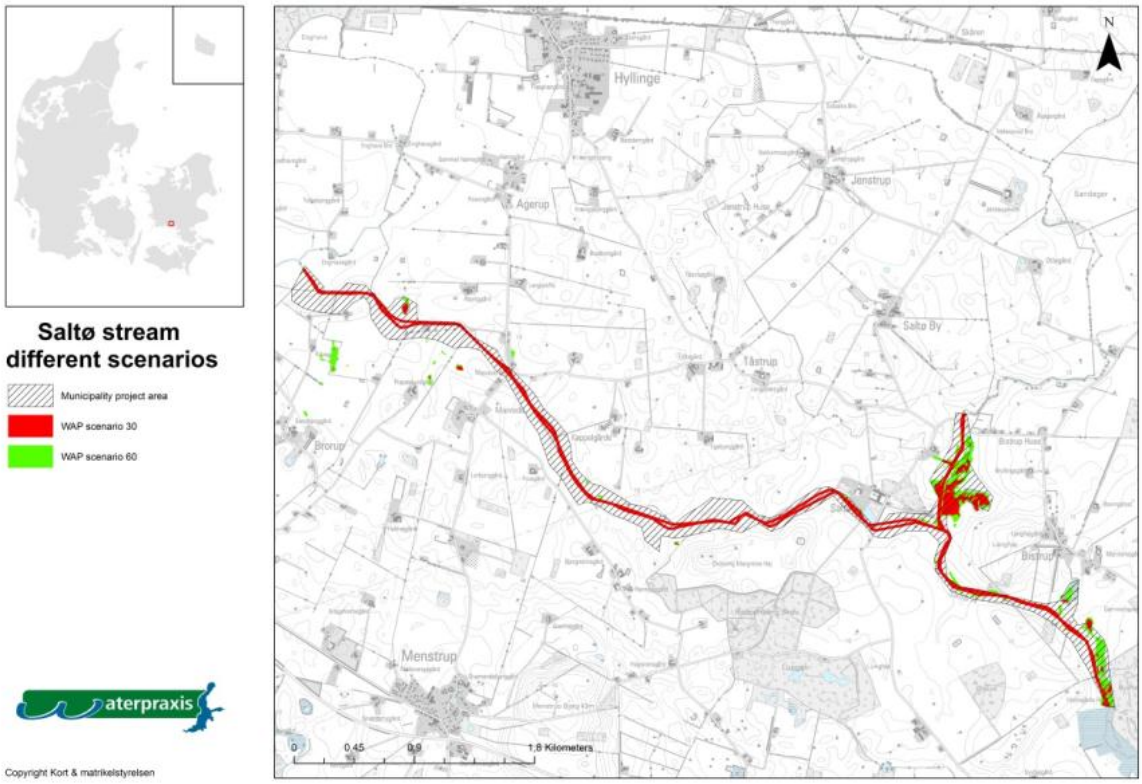
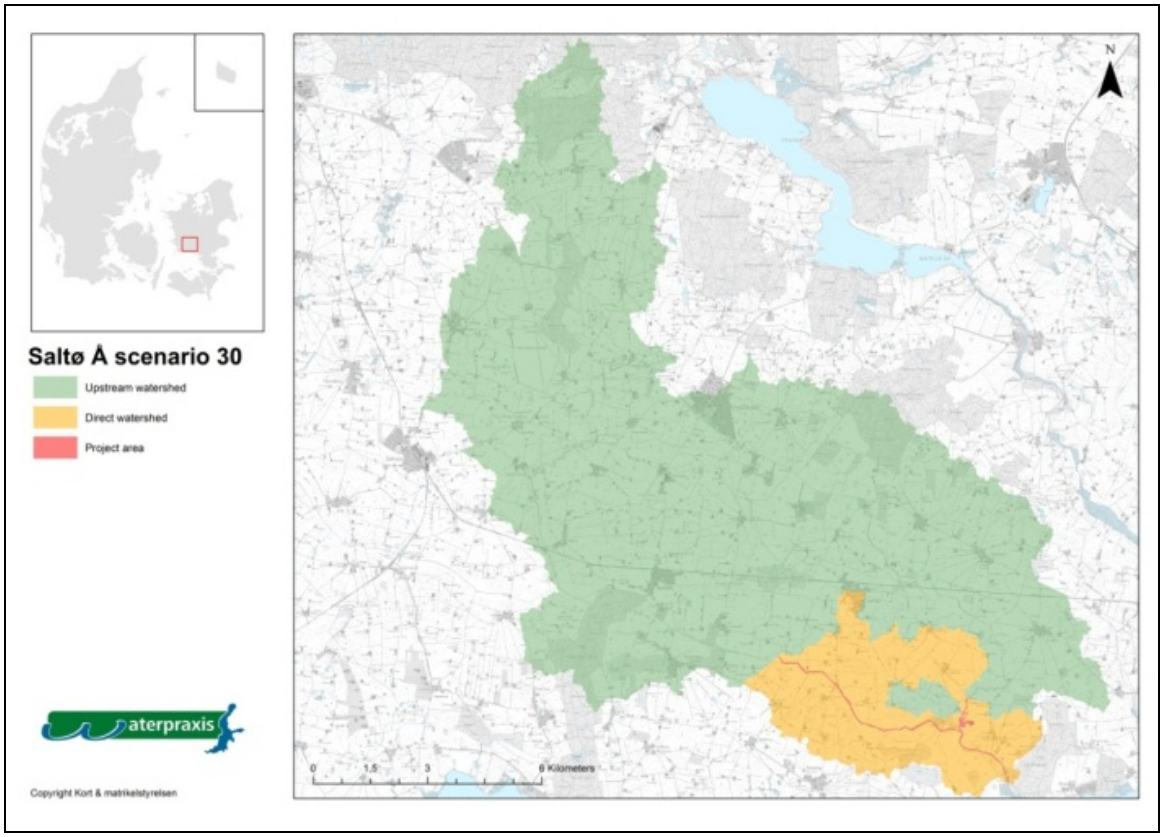


Figure 11: Difference in areal extend of new wetlands as outlined by the municipality project (based upon existing hydrosol area maps) and the two scenarios modelled using WetArea scenarios.



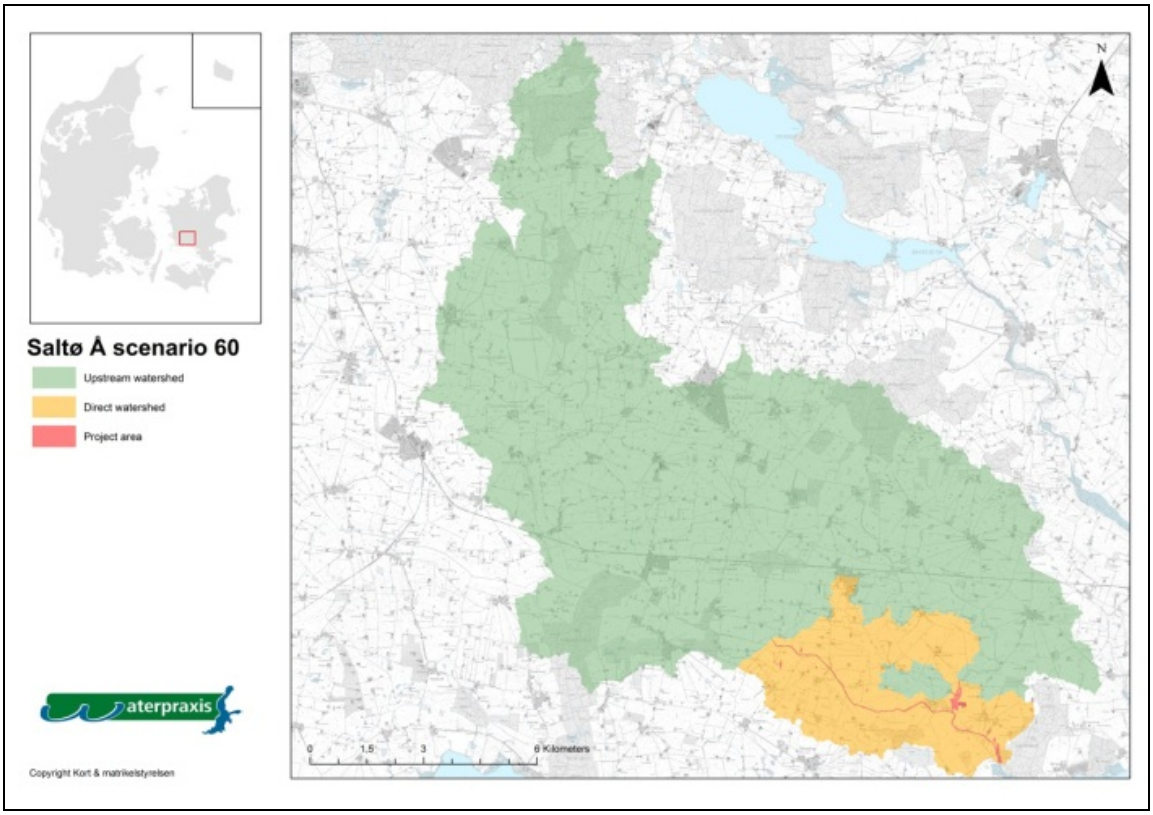


Figure 12: Nitrate retention calculated by the Wetplan model, using a WetArea scenario simulating 30 cm and 60 cm water level rise in the lower part of Saltø river.

For the Saltø case, nitrate retention has been calculated by the Wetplan model, using two WetArea scenarios simulating a 30cm and a 60cm water level raise in the lower part of Saltø river. Note that there is only a minor difference between the two WetArea scenarios, which indicate that the topography in the area makes the model relatively insensitive to minor adjustment of the water level. Projects with lowlands in connection to the river are more sensitive to water level changes, i.e. in these cases a minor water level rise will result in substantial change in the affected areas.

Table 6:. Calculated nitrate retention for the municipality project area Saltø Å and the two WetArea simulation of water level rise between 30 and 60cm.

Calculated results:	Saltø Å Muncipality project area			Saltø Å weater level 30cm			Saltø Å water level 60cm		
	Pro. Area.	Dir Ws.	Upstr Ws.	Pro. Area.	Dir Ws.	Upstr Ws.	Pro. Area.	Dir Ws.	Upstr Ws.
Total area [ha]	126	1898	13317	33	1990	13317	39	1986	13315
Averege precipitation [mm]	0	370	379	0	370	379	0	370	379
Cropland [% of area]	81	87	80	52	88	80	56	88	80
Sandy soil [% of area]	0	3	9	0	3	9	0	3	9
Cropland [ha.]	102	1660	10588	17	1744	10588	22	1741	10587
Forest and bog area [ha.]	6	0	0	1	0	0	5	0	0
Grassland area [ha.]	0	0	0	0	0	0	0	0	0
Flooding time [Days / yr.]	0	0	10	0	0	10	0	0	10
Flooding area [ha.]	0	0	20	0	0	20	0	0	20
Nitrate Leaching [Kg. N / ha. / yr.]	39	40	33	25	40	33	27	40	33
Total Nitrate leaching [Kg N / yr.]	4849	75768	436608	822	79774	436611	1060	79645	436571
Nitrate retention [kg. N]	4535	37884	250	739	39887	250	962	39823	250
Retention [%]	94%	50%	0%	90%	50%	0%	91%	50%	0%
Total Nitrate retention [kg N / yr.]		42669			40876			41034	
Total Nitrate leaching downstream [kg N / yr.]		517225			517207			517276	

Table 6 shows the calculated nitrate retention for the municipality project area and the two WetArea simulation of water level rise between 30 and 60cm. There is a relatively significant difference in the extension of the area affected between the municipality project area and the two scenarios. The project area of the two scenarios consist of almost only one-quarter of the municipality project area. The nitrate retention is only marginally lower in the two scenarios, although it is showing some relatively large variation in nitrate retention inside the project areas, because of the difference in the change of land use.

2.1.2 WetArea results as input to the economic impacts on agriculture

The WetArea output can be used to estimate the economical and physical impact of wetland restoration projects. The effect of water level rise calculated by the WetArea can be used as input for an economic assessment of a planned wetland restoration project. It is possible to evaluate the physical impact regarding areas affected and thereby the need of compensation to farmers for loss of agricultural land. Table 7 shows some indications of the impact on agricultural use and of the possibility for economic compensation (source municipality of Næstved).

Table 7: Areas affected by groundwater tables rise and related compensation measures.

Name	Class	New groundwater	Impact on	Compensation
Open water	1	0 cm below terrain	not cultivable	full
Bog/swamp	2	0 – 25 cm below terrain	not cultivable	full
Wet	3	25 – 50 cm below	grown with pasture	partial
Meadow	4	50 – 75 cm below	grown with pasture	partial
Cropland	5	> 75 cm below terrain	No impact	None

The affected area calculated by WetArea can be used to estimate the economic cost of compensation to farmers for their losses of cropland areas. The output from WetArea can be used to extract data from the Danish Agriculture Register along with information of soil types. The General Danish Agriculture Register can also be used to give information about nearby livestock, that can be used to graze the new grassland, similar to the wet classes of 3 and 4.

3 Economic impacts

The assessment of the economic impacts are done in two steps: First the costs of wetlands are estimated using the information from chapter 2 (the WetArea modelling and its implication on areas grown by agriculture as defined GAR data) and secondly these results are discussed together with analyses of the pilot areas done by the Municipality of Næstved.

3.1 Agricultural changes as consequence of wetland restoration

The costs of water level rise to 30 cm are calculated for Fladså and Saltø Å. The costs are calculated as the lost land rent from agricultural production, i.e. the opportunity costs of creating wetland in this area. Furthermore the costs are calculated as welfare economic costs, i.e. what we calculate are the costs for society and not for the farmers or other land owners. This is important since we want to calculate the costs for the whole society to enable cost-effectiveness analysis of the measures. In a welfare economic assessment the prices are adjusted for taxes and other transfers, and the prices reflect the market price. In opposite the financial economic method reflects factor prices and should be used when the allocation of costs between e.g. farmers and municipalities should be assessed. The costs are estimated as the lost land rents, i.e. the welfare economic costs described in table 8 below are not estimated by including any construction costs, costs of removing or moving pumping stations, dikes or drain-pipes etc. The costs estimated are based on the budget calculus for 2011, i.e. based on 2010 prices and the expectations for 2011 (Budgetkalkuler 2011).

As mentioned in section 3 the area is divided into wetness classes. It is assumed that the area that is converted into wet-class 1 – 2 is not suitable for agriculture while the wet-class 3-4 is suitable for pasture only. Cropping areas in class 5 is not really affected, and hence the assumption is that the current crop composition and cultivation will continue for the area covered by wetness class 5. Regarding classes 1-2 and 3-4 opportunity costs for converting the area into wetlands are assumed to be equal to classes 1-2 for classes 3-4 too, even though the area is suitable for pasture. The reason for this is comes from recent analyses of the economics of grazed grasslands and nature conservation on grasslands by grazing indicates that grazing areas and pastures in general will yield a 0 or negative gross margin (Hasler er al 2011). Even for fields grown with grass we therefore assume a loss in gross margin when the field is turned into a wetland, though it is still possible to graze these areas. As apparent from tables 8 and 9 the estimated gross margin from grass is rather high in these budgets, retrieved from Budgetkalkuler 2011. If lower gross margins are used for grass the economic loss will subsequently be reduced. .

As seen from the two tables (8 and 9) in all 39 hectares sandy soils and 30 hectares clay soils are converted into wetlands in the 30 cm scenario in Fladså, while only 10 and 20 hectares for sandy and clay soil is converted into wetlands in Saltø Å. Accordingly the total costs are higher in Fladså.

It is important to note that the estimated costs are annual costs.

In average the costs of restoring wetlands at sandy soils in the Fladså area have an opportunity cost of 1851 DKK /ha /yr, and for clay soils the average opportunity cost is 3695 DKK/ha/yr. The differences in opportunity cost between clay and sandy soils are explained by both differences in crop distribution and differences in gross margins between the soil types for some of the crops. For other crops the gross margin is equal for the two soil types, but for most crops the acreage differs. Because of these differences in soil types the costs of restoring wetlands is lower at sandy soils and in areas where there are more clay soils.

Table 8: Wetland restoration in Fladså, 30 cm scenario. Wet Class 1 to 4, hectares wetland and welfare economic costs/yr.

Crop/land use	Sandy soils (ha)	Clay soils (ha)	Welfare economic marginal return - sandy soils (DKK per ha)	Welfare economic costs, total, DKK, sandy soils	Welfare economic marginal return - clay soils (DKK per ha)	Welfare economic costs, total, DKK, clay soils	Total costs
Fallow, marginal areas	2,1	0,2	0	0	0	0	0
Grass	0,5	1,2	9.848	5.199	11.266	13.255	18.454
Grass-clover	0,0	0,3	7.503	1	7.503	2.538	2.538
Gras, Environmental Scheme (MVJ)	23,5	13,6	1.048	24.649	1.048	14.296	38.946
Permanent grass and grass-clover	0,0	0,2	1.891	40	2.634	434	473
Permanent grass and grass-clover	0,5	6,0	1.891	900	2.634	15.724	16.624
Silo maize	1,7	3,9	7.347	12.720	10.216	40.107	52.827
Uncultivated field	0,7	0,9	0	0	0	0	-
Winter wheat	7,0	2,8	2.915	20.390	7.522	21.080	41.471
Winter wheat, bread	1,9	0,0	3.477	6.601	8.212	325	6.926
Winter rape	0,5	0,1	2.882	1.552	6.414	372	1.925
Spring barley	0,6	0,8	615	380	3.337	2.722	3.102
SUM	***39,1***	***30,0***		***72.433***		***110.852***	***183.285***

Table 9: Wetland restoration in Saltø Å, 30 cm scenario. Wet Class 1 to 4, hectares wetland and welfare economic costs.

Crop/land use	Sandy soils (ha)	Clay soils (ha)	Welfare economic marginal return - sandy soils (DKK per ha)	Welfare economic costs, total, DKK, sandy soils	Welfare economic marginal return - clay soils (DKKr per ha)	Welfare economic costs, total, DKK, sandy soils	Total costs, DKK (per year)
Fallow, marginal areas	0,0	0,1	0	0	0	0	0
Grass and grass-clover	0,0	0,1	9.312	0	9.312	1.362	1.362
Grass-clover	0,0	0,5	7.503	0	7.503	3.556	3.556
Maize to ripeness	0,0	0,1	4.631	0	6.868	832	832
Permanent grass	0,0	0,9	1.891	0	2.634	2.261	2.261
Willow	0,0	1,2	2.583	0	3.424	4.126	4.126
Area for recreational use	0,0	1,4	0	0	0	0	0
Red fescue seed	0,0	0,1	585	0	5.110	760	760
Uncultivated field	0,0	0,4	0	0	0	0	0
Winter wheat	7,4	6,2	2.915	21.617	7.522	46.629	68.246
Winter rape	0,0	0,8	2.882	0	6.414	5.030	5.030
Spring barley	2,0	7,1	615	1.260	3.337	23.812	25.072
Peas	0,0	0,1	2.273	0	2.273	238	238
Peas for consumption	0,5	1,0	-979	-443	1.168	1.211	768
SUM	**9,9**	**20,1**		**22.434**		**89.818**	**112.252**

In average the costs of restoring wetlands at sandy soils in the Saltø Å area have an opportunity cost of 2262 DKK /ha/yr, and for clay soils the average opportunity cost is 4480 DKK/ha/yr; the levels of the opportunity costs are somewhat higher than in Fladså due to a different composition of crops. The differences in opportunity cost between clay and sandy soils are explained by the same factors as for Fladså - differences in crop distribution and differences in gross margins between the soil types for some of the crops.

The resulting cost-effectiveness of the wetland restoration in the two areas differs. The costs are too low however, since no technical costs for construction, moving of pumping stations or drain pipes have been included.

All water protection plans in the last 20 years have anticipated that wetland restoration is a relatively cost-effective means compared to other measures. In Hansen et al (2011) existing data regarding costs and effects on nitrate losses when re-establishing wetlands were analysed to gain insight into which types of wetland projects that are the most cost-effective, and how e.g construction and other factors influence the costs. In the former Governments Agreement on Green Growth, which are being implemented in the Water plans, it is assumed that there is a connection between large nitrate reduction and cost effectiveness. However, Hansen et al 2011 shows that such a clear-cut connection does not exist. They conclude that project type, expected nitrate reduction, cost types, size and geographical location impact the cost effectiveness, and the results of their analysis suggest that the cost level of restoring a wetland area has a relatively large impact compared to the (expected) nitrate reducing effect. I.e. land that has been bought at a high price as well as high construction costs overshadows the effect of an expected high nitrate reduction (Hansen et al 2011, page 9) . Furthermore, Hansen et al also conclude that wetlands that turns into pasture is converted to a lower costs than if the area becomes a lake or meadow. Construction

costs as well as cost in relation to land transactions explain the differences.

3.2 Cost assessments by Næstved Municipality.

Næstved Municipality has also assessed the costs of the pilot projects. The assessments cover technical pre-assessments, assessments of the properties, protect related costs as well as construction costs – i.e. the costs in addition to the opportunity costs measured above. Hence, these assessments do not cover the costs of land compensations (buying land or compensation to the farmers in other ways) as these costs are born by the Ministry of Foods.

The first assessment from May 2010: 10 mill. DKK for wetland projects in Næstved Municipality

The financial cost assessments for wetland restoration in the first phase were based on the experiences from projects in the former ”Storstrøms Amt (County)”. The Storstrøms Amt projects were technically uncomplicated and the land owners were also very interested in participation. Hence it was not necessary to secure compliance from the land owners by specific actions and incentives,

Second assessment – august 2011 – in all 22 mill. DKK to projects in Nastved Municipality

In August 2011 two pilot projects have been accomplished, which alter the prior assessments from 2010. These experiences are explaining the underlying reasons for the changes in the cost assessments:

The land owners shall accept the projects on a voluntary basis: To encourage and assist land owners participation and voluntary contribution to the wetland restoration technical adjustments such as land allocation changes and technical adjustments such as removal of pumps, establishment of dikes, removal of water courses etc. should be both accepted and established More technical

adjustment is needed as compared to the former projects, because of the short time horizon for the projects:

Short time horizons for wetland restoration project: Former projects have been implemented over a longer time horizon and in synergy with other projects, but the time horizon for the projects under the current water-plan has to be implemented much faster. That implies that there are less synergies between projects, and land allocation changes is not likely to help the implementation as can be seen when the project implementation period is longer. From these reasons more technological adjustments are needed.

Shifting expenses from land to technical solutions and changes: Land owners typically want that the acreage of the land converted to wetlands to be as small as possible – which reduce the need for land compensations paid by the Ministry as well. On the other hand the technical solutions will often be more complicated when the wetland area is reduced, and hence the cost will be higher and also be shifted from the state to the municipality. The costs for society will not necessarily be changed by this change, but the allocation of costs between the state and the municipality changes.

There is only one opportunity to apply for money from the state. The applications from the municipality to the state for grants to do the wetland restoration have to be based on the pilot projects and only one application can be sent. This means that the pilot projects have to be rather detailed. And this also shifts the cost assessments upwards to take uncertain future costs into account. Possibilities to apply for further funding would have decreased this incentive to shift the cost assessment upwards.

3.3 Concluding remarks, economic assessments

The conclusion on the assessments of costs of wetland restoration in the area of Næstved/Suså is that the opportunity costs are dependent on the soil type as well as the crops grown in the area, and that some areas will be totally wet while others can be managed by grazing. However, other assessments indicate that the gross margin by grazing is low or even negative, and therefore we have not included grazing as an income in the assessments.

The differences in costs, even in these rather homogenous areas, indicate that negotiations between land owners and the municipality can be important to avoid over- and under-compensation of the wetland restoration. At present there are some negotiations, but not enough to secure that the land owner reveals his “true price”.

The municipality’s assessments further indicate that the faster the wetland restoration has to be implemented the more difficult it is to carry out negotiations under time pressure, and there may occur claims requiring more technical solutions when the wetland restoration shall take place in a hurry compared to former projects where the municipality had much longer time.

4 Social impacts

4.1 The benefit study in Waterpraxis

As part of the Waterpraxis project a survey has been undertaken to assess to which degree the areas surrounding Suså, Saltø Å and Fladså, as well as Tystrup-Bavelse lakes and the adjacent inland brackish Karrebæk and/or Dybsø Fjord are used for recreational purposes, and to which degree the population at Zealand and Lolland-Falster is willing to pay for improved water quality and improved accessibility to the river. The questionnaire was sent out to people on Zealand, Lolland and Falster in November 2010, and 1277 respondents participated in the survey.

4.1.1 The Waterpraxis valuation survey

The questionnaire included questions on the respondents' use of the areas close to the water bodies in the Suså area, their perception of the water quality and their willingness to pay for improvements. They were also asked about socioeconomic questions, as well as about their use of the area,

The valuation of water quality improvements was performed using the contingent valuation method. The valuation question concerned how much the respondent's household is willing to pay each year for an improvement of the water quality and access to the areas improved. The payment vehicle was an additional annual payment to the annual water bill, paid by each household.

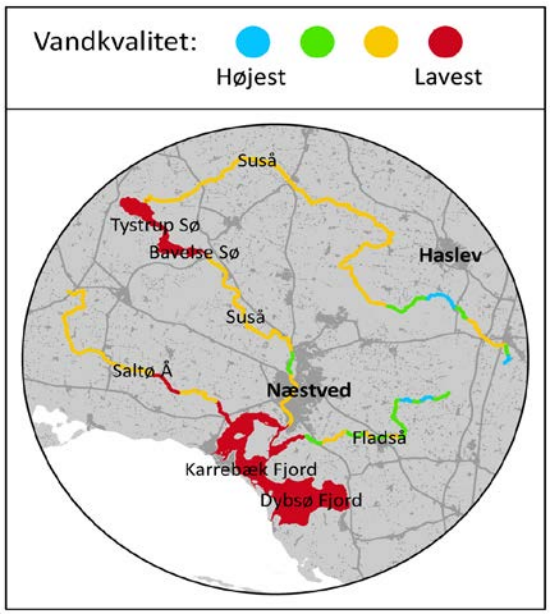
The survey is split in two, where respondents in the first sub-sample received both the water quality question and the accessibility question, while the others only received the water quality question. Thus, subsample 1 consists of the respondent valuing both water quality improvement and improved access to the waterside. Subsample 2 was only valuing the water quality improvements in Suså catchment and adjacent areas.

In the questionnaire we asked the respondents to choose from a payment card how much they would pay to improve the water quality in the water bodies in the Suså catchment, i.e. in the rivers, the lakes and the fjords. As seen in the table below the water quality in the baseline/present condition is red and yellow, which means that the water quality is in a poor or moderate state. The other table shows the improvement in the scenario, where the water quality is improved to green for all water bodies – that is improved to good ecological quality, and this is the objective in the water plan according to the Water Framework Directive,

Subsample 1

ca. 10 %

ca. 90 %



Subsample 2

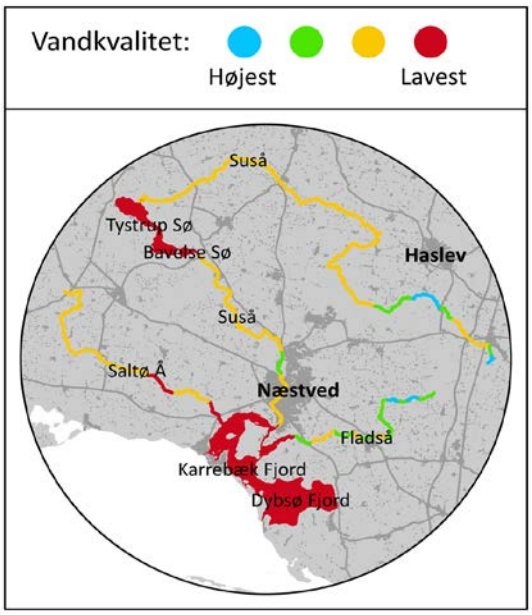
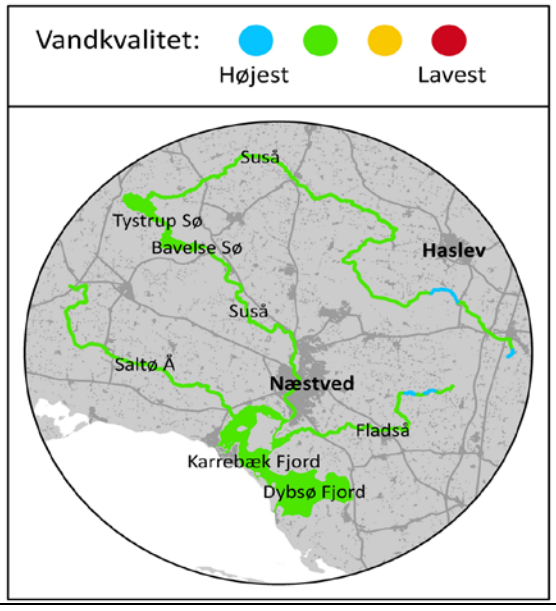


Figure 13: Present condition

Subsample 1

ca. 30 %

ca. 70 %



Subsample 2

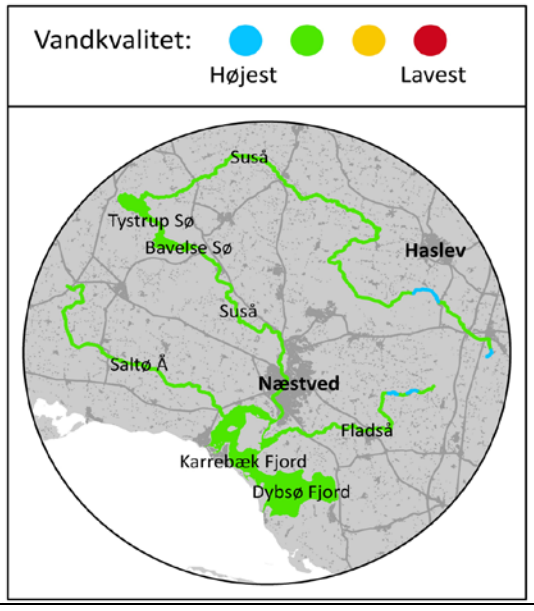


Figure 14: Improved condition

Estimation the benefits when the dependent variable range is constrained to be zero for a substantial part of the respondents and positive for the rest the Tobit model is particular suited. Using a linear model for WTP can give a good approximation especially for x_i near the mean values, but there is a possibility of obtaining negative fitted values which will lead to negative predictions for WTP. Another problem is that the distribution piles up at WTP = 0 implying that WTP doesn't have a conditional normal distribution.

A standard tobit model for the WTP:

$$WTP_i^* = x_i'\beta + \varepsilon_i \ , \qquad i = 1,2,...,N$$

$$WTP_i = WTP_i^* \qquad \text{if } WTP_i^* > 0$$

$$= 0 \qquad \text{if } WTP_i^* \le 0 ,$$

where x_i is a vector of the explaining variables, β is the parameter and where the error term, ε_i, is assumed to be NID$\left(0,\sigma^2\right)$ and independent of x_i. The model describes two things; the probability of $WTP_i = 0$ and the distribution of WTP_i given that it is positive. The expected value of WTP_i in the tobit model is not just equal to $x_i'\beta$, it also depends nonlinearly on x_i like this:

$$E\left(WTP_i\right) = x_i'\beta\Phi\left(x_i'\beta/\sigma\right) + \sigma\phi\left(x_i'\beta/\sigma\right),$$

where Φ and ϕ are the cumulative distribution function and respectively the probability density function. Sigma, σ is the standard deviation in the model. Interpreting the coefficients in the estimated tobit model is thus not strait forward. The marginal effect of a change in x_{ik} on the expected value of WTP_i is given by the model's coefficient multiplied by the probability of having a positive outcome.

$$\frac{\partial E\left\{WTP_i^*\right\}}{\partial x_{ik}} = \beta_k\Phi\left(x_i'\beta/\sigma\right),$$

where Φ and ϕ are the cumulative distribution function and respectively the probability function. The sigma, σ is the standard deviation in the model, x_i' are the matrix of the explanatory variable.

In the table below the used variables in the Tobit regression are explained.

Table 10: Used variable in the Tobit regression.

Parameter	**Explanation**
Household income	Household income in DKK pr year
Male	Dummy = 1 if male, else female
Age	The respondents age (year)
Use nature	Dummy = 1 if they use nature often for recreational purpose
Distance	Shortest distance from the respondent to the study site (minutes driven in car)
Distance to substitute	Shortest distance from the respondent to a substitute, either a river or the coast line (minutes driven in car)
Use more_Susåen	Dummy = 1 if they use Suså more if the access is improved
Use more_Tystrup-Bavelse lakes	Dummy = 1 if they use Tystrup-Bavelse lakes more if the access is improved

Note: The respondent has chosen between different household incomes, for this purpose the middle of interval has been used. The income interval called 900.000 DKK or more has been set at 1 million DKK.

The result of the Tobit regression for each subsample are showed below.

The mean WTP for the two Tobit models are 228 DKK for subsample 1 and 271 DKK for subsample 2. From the table below (table 11) it can be seen how different parameters such as income, gender. use of the area etc influence the willingness to pay.

Table 11: Estimation of the benefits. (WTP in DKK)

	Subsample 1		Subsample 2	
Parameters	**Estimate**	**Marginal effect**	**Estimate**	**Marginal effect**
Intercept	321.36	-	115.53	-
	(114.15)		(123.95)	
Household income	-0.02	-0.01	0.22****	0.14
	(0.09)		(0.09)	
Male	-72.01*	-44.38	-36.14	-22.8
	(-47.85)		(48.91)	
Age	-1.73	-1.07	0.03	0.02
	(1.84)		(1.91)	
Use nature	46.54	28.68	23.19	14.62
	(48.16)		(50.24)	
Distance	-2.10*	-1.29	-1.85	-1.16
	(-1.43)		(1.34)	
Distance to substitute	-5.10	-3.14	-5.57**	-3.52
	(8.83)		(10.72)	
Use more_Susåen	329.65****	203.16	-	-
	(107.19)			
Use more_Tystrup Bavelse lakes	-	-	537.90****	339.26
			(113.66)	
Sigma	392.08		444.43	
Log likelihood	-1678		-2.111	
Pseudo R^2	0.17		0.18	
N	311		371	
Zero bids	94		101	

Note: ****, ***, **, * indicate statistical significance at 1, 5, 10 and 15 % level

The results can be used in themselves to see what influences the WTP and how important these parameters are for the WTP, but the WTP can also be aggregated to enable comparisons with the costs when the aggregated costs for obtaining the WFD are estimated,

If the administrative area is used to aggregate the benefit for improved water quality and access to the waterside the result can be seen in the table below.

Table 12: Aggregated benefits

Aggregate benefits:		Use number of household from	
	Mean WTP (DKK)	Næstved Municipality (1.000 DKK)	Municipalities in the aggregation area (1.000 DKK)
Subsample 1 (water + access)	228	8,552	44,097
Subsample 2 (water)	274	10,290	53,063

Note that the area used for the aggregation consists of Ringsted, Slagelse, Sorø, Faxe, Næstved, Vordingborg, Guldborgsund and Lolland municipalities.

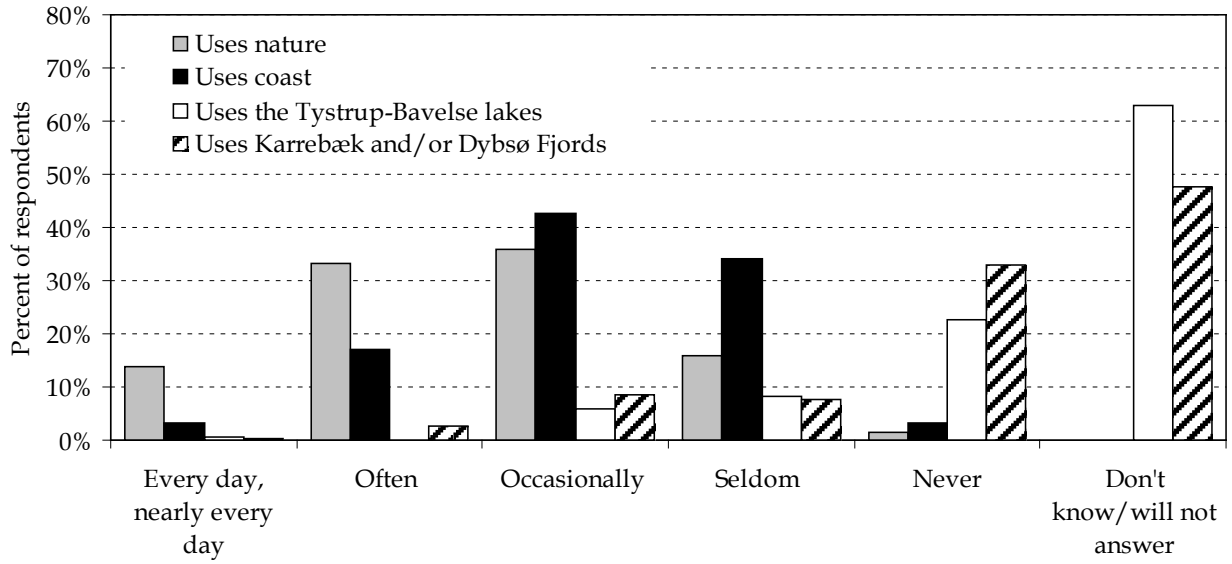
4.2 Concluding remarks

We have found that there is a clear and significant willingness to pay for water quality improvements and fulfilment of the water framework directive in the Suså area. Furthermore studies using the same methodological set up have concluded that benefit transfers between northern European countries did not yield large errors in the transfer of results, and the same picture showed up in Denmark. This means that benefit transfer of these results can be done with rather small transfer errors. It should be noticed however that Benefit transfers between e.g. Denmark and lituania or Latvia can be attributed to larger benefit transfer errors, and it is recommendable to transfer the benefit function if benefit transfers are conducted between countries with differences in e.g. income levels, and where the water bodies are very different as well.

4.3 Social assessment and use of the area

As mentioned in the introduction the social assessment is performed to get information about the use of the areas for recreational purposes. This is of course only partly a social analysis, but contributes to the knowledge of the actual use of the area.

Table 13 How often the respondent uses different recreational areas



This question is about recreational areas in general and not specifically about the Suså area.

In Table 14 the use of the lakes Tystrup Bavelse in comparison with other lakes is shown:

Table 14: The lakes the respondent are using for recreational purposes.

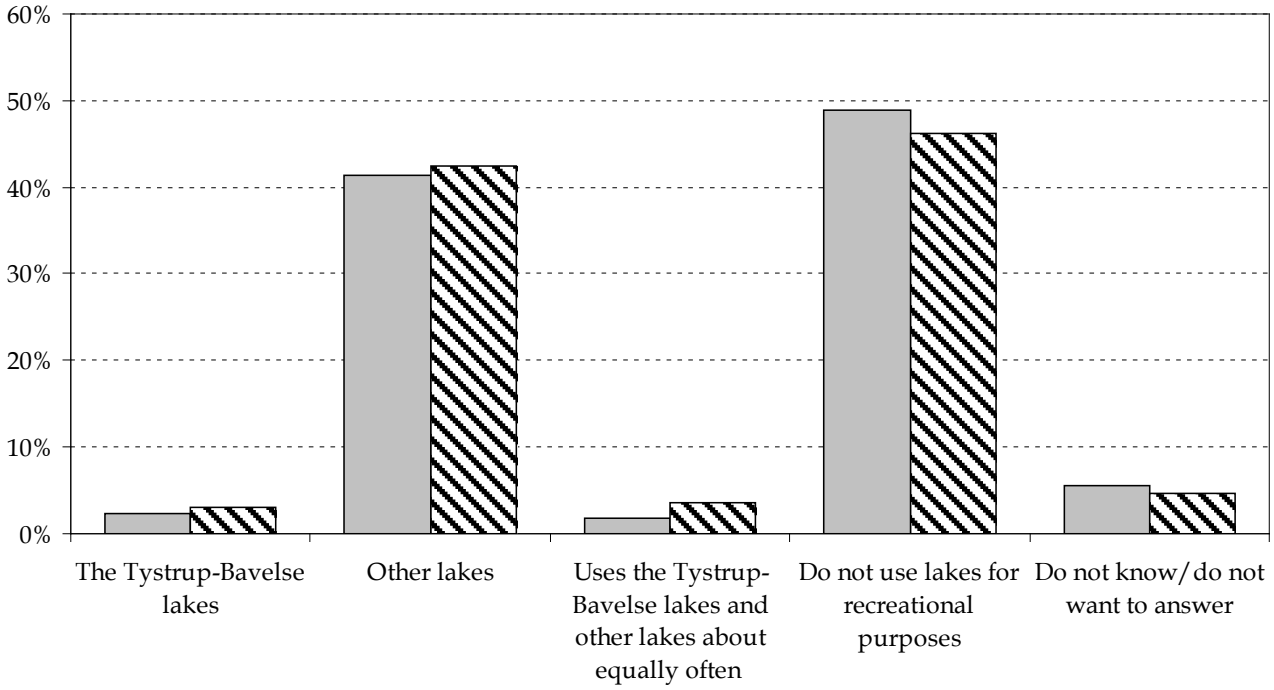
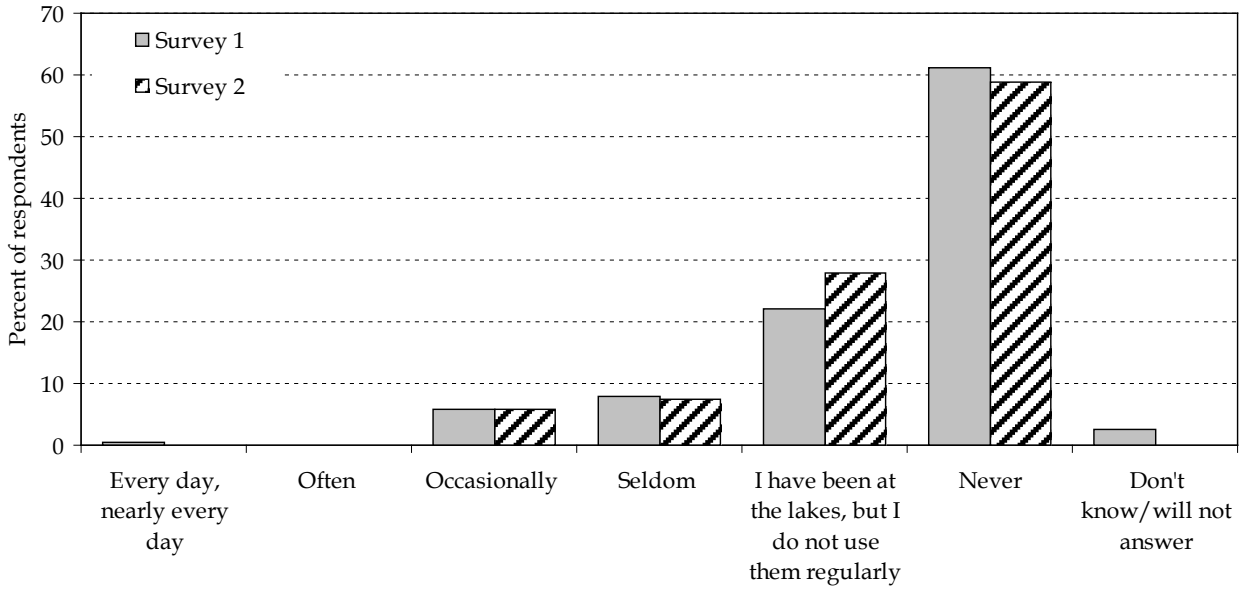


Table 15: How frequently the respondent uses the Tystrup-Bavelse lakes



As seen in table 14 and 15 the lakes are not used frequently by the respondents, and the lakes are known by between 30 and 40% of the sample (differences between the two subsamples).

Table 15 Knowledge of the Tystrup-Bavelse lakes (both surveys)

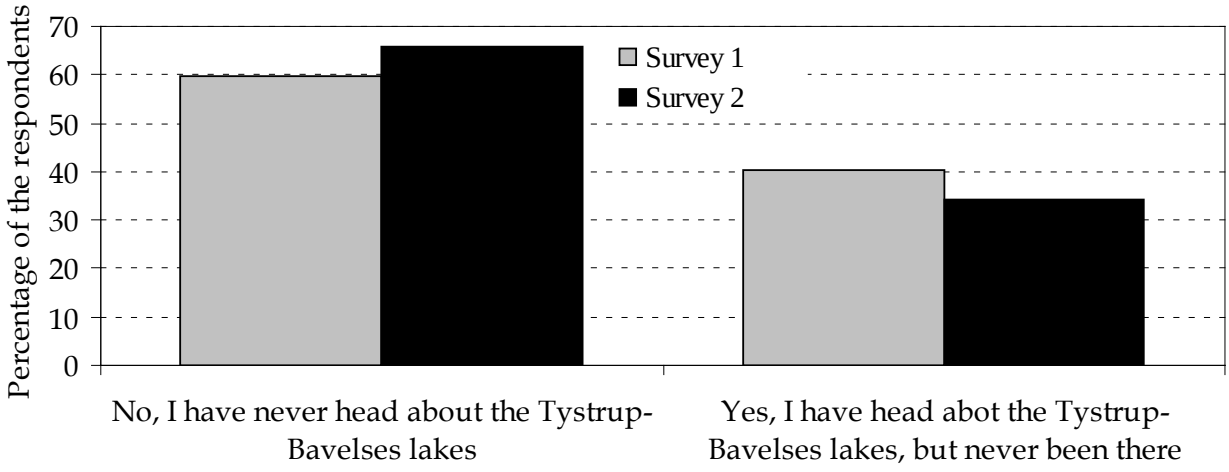
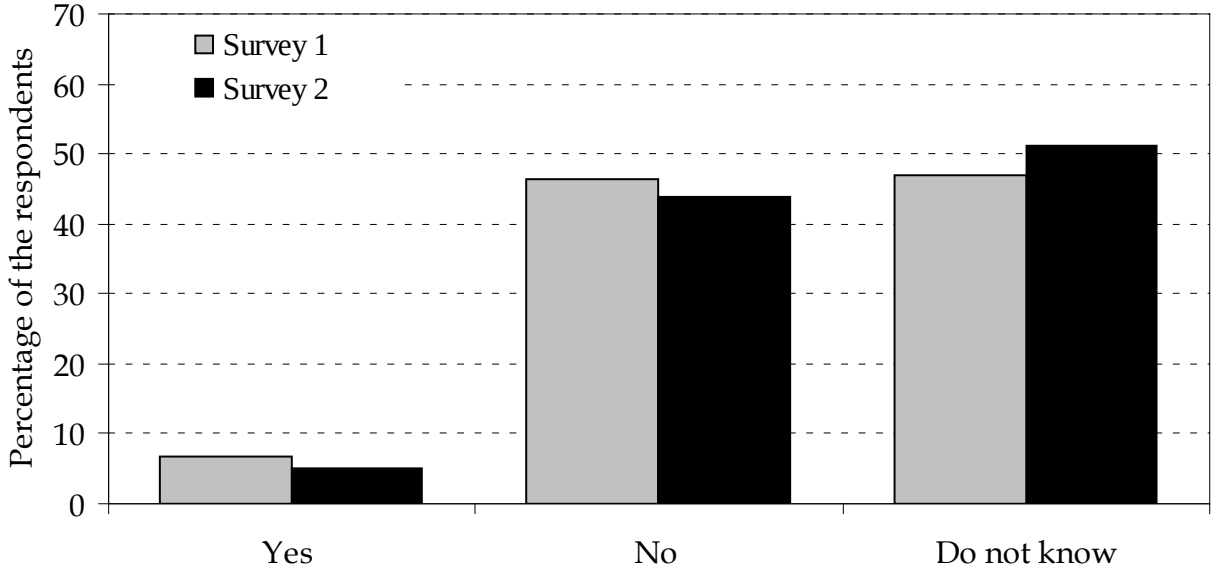


Table16: Would you use the lakes Tystrup-Bavelse if the water quality was improved?



As apparent from the tables 15 and 16, perhaps somewhat surprisingly, the respondents will not use the lakes to a larger degree if the water quality improves in the lakes, and neither if the access is improved.

Table 17: Would you use the lakes Tystrup-Bavelse more if the access to the lakes was improved?

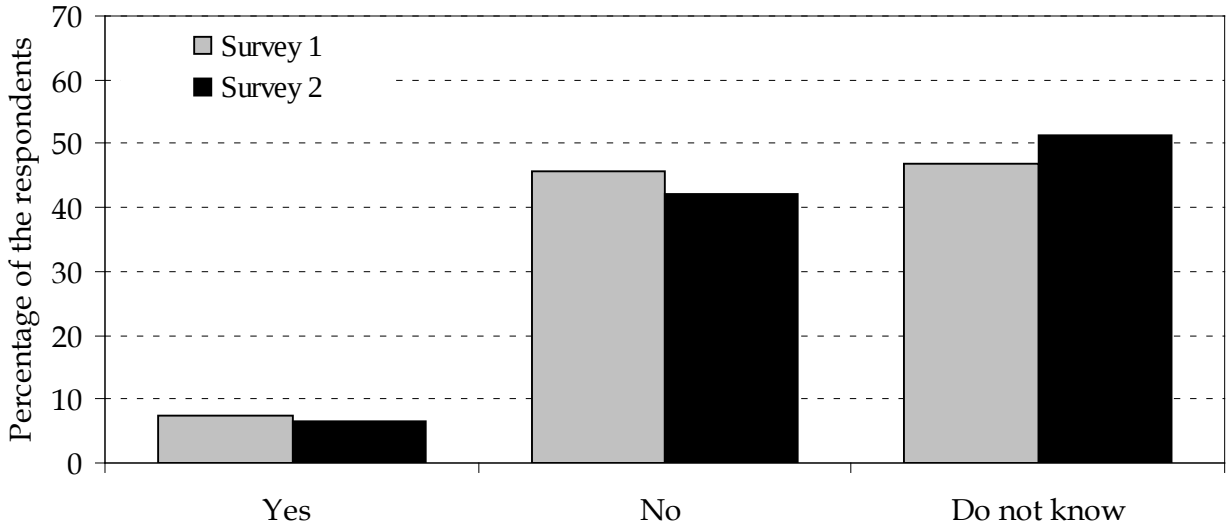


Table 18: The fjords the respondent are using for recreational purposes.

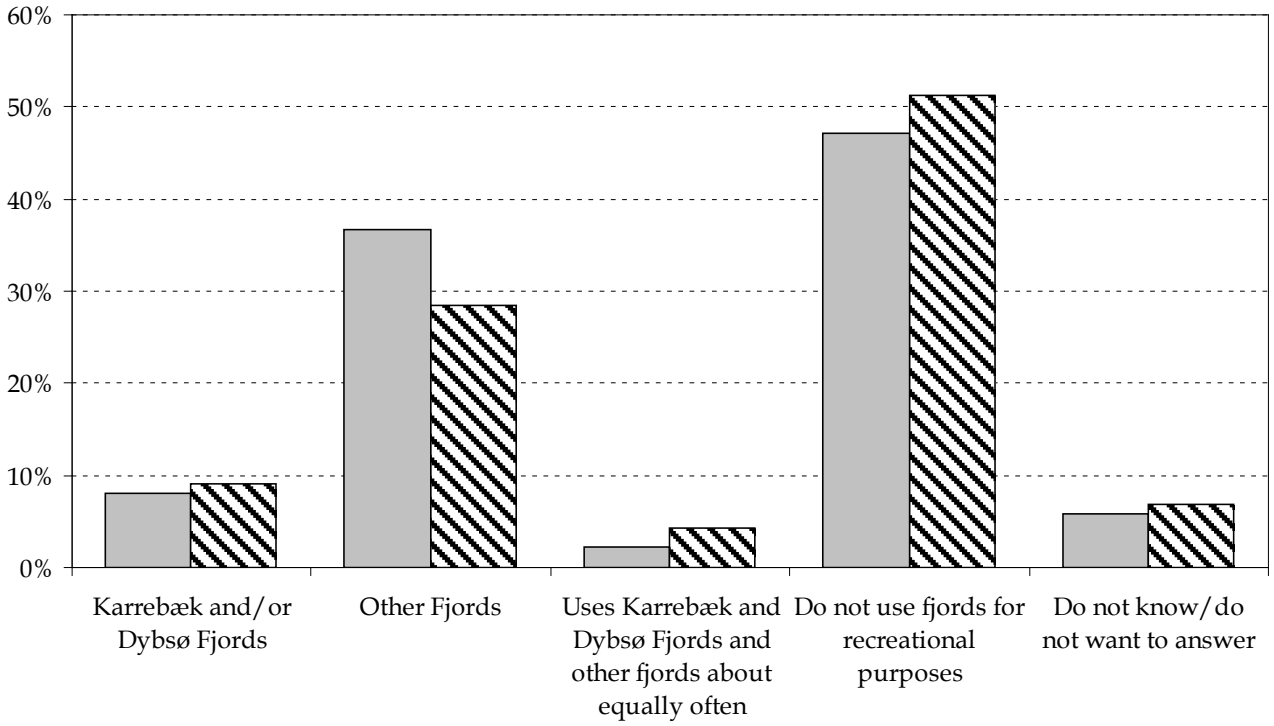


Table 19: Had you heard of the fjords before this survey?

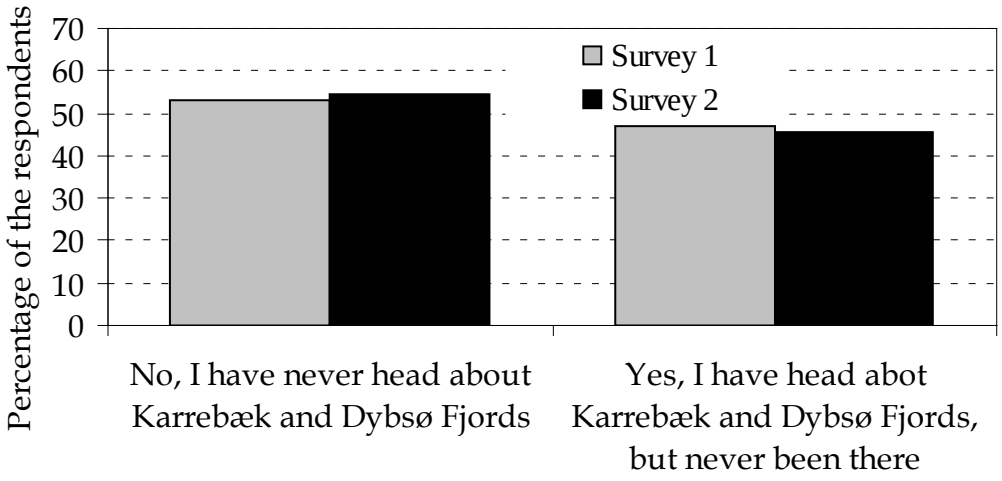


Table 20: How frequently the respondent uses Karrebæk and/or Dybsø Fjords

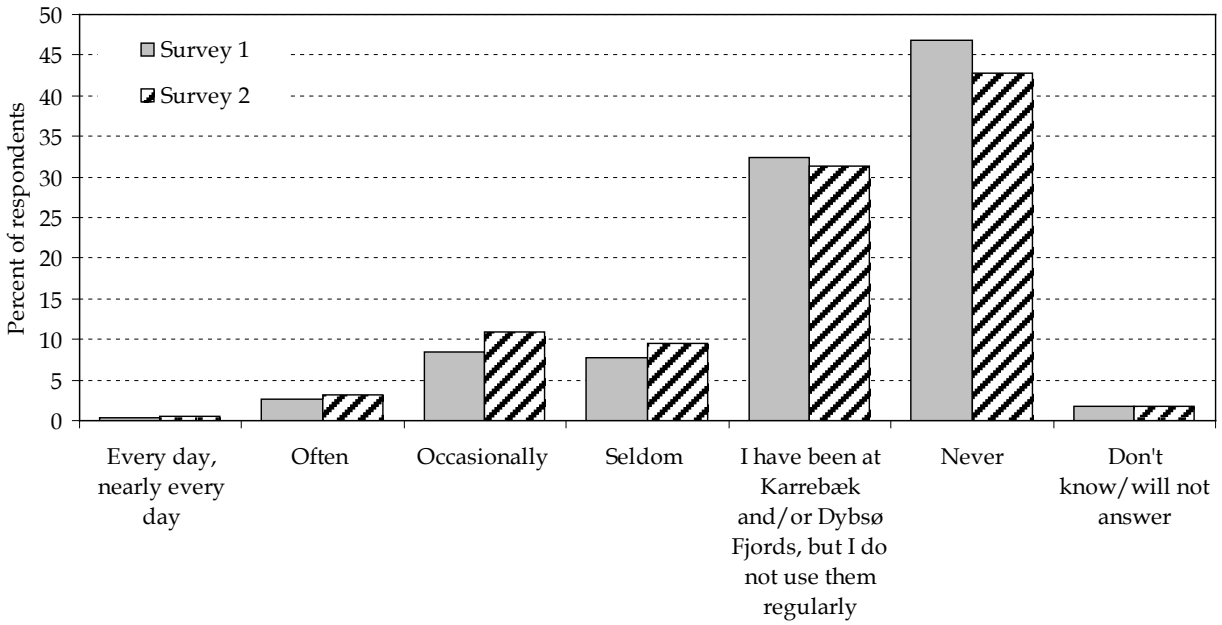
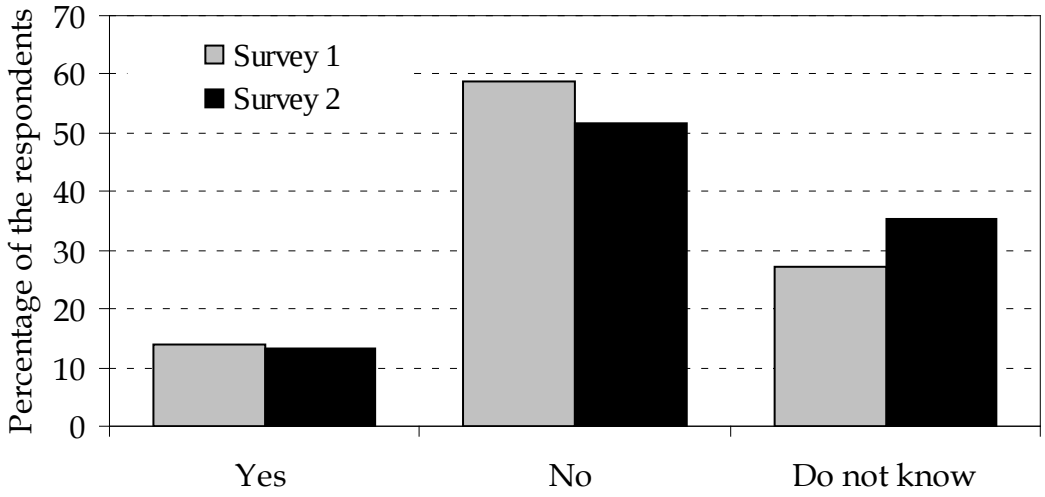


Table 21. Would you use Karrebæk and Dybsø Fjords more often if the water quality was improved?



As can be seen the effect of water quality improvements in the fjords on the respondents' potential use is somewhat higher than for the lakes, but still only 10% of the sample indicates that they would use the area more often after improvements. More surprisingly the respondents indicate that better access is not needed for most of the sample.

Table 22. Would you use Karrebæk and Dybsø Fjords more often if the access was improved?

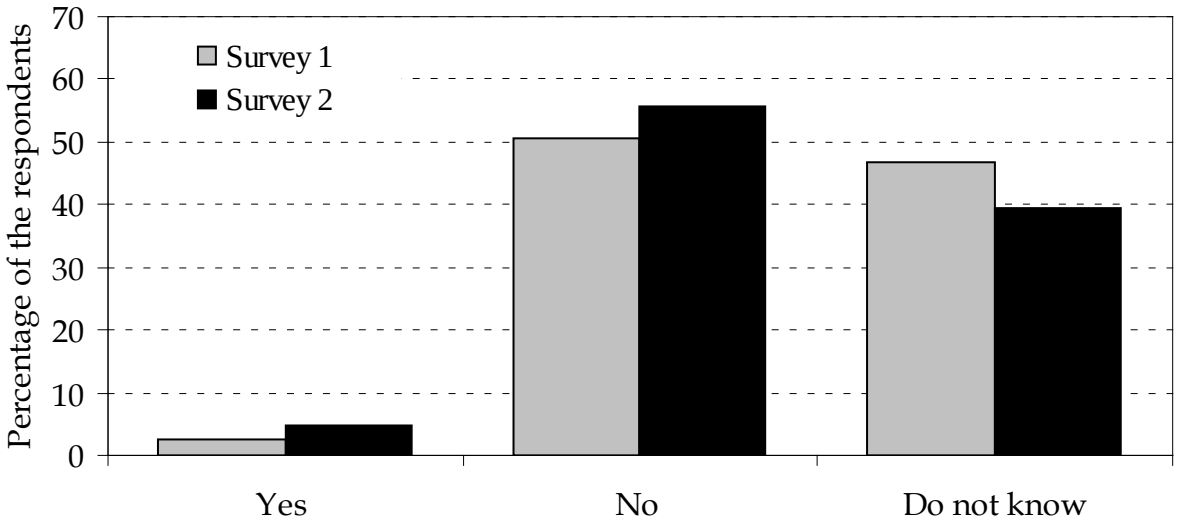


Table 23: What respondents do when visiting the different areas – survey 1

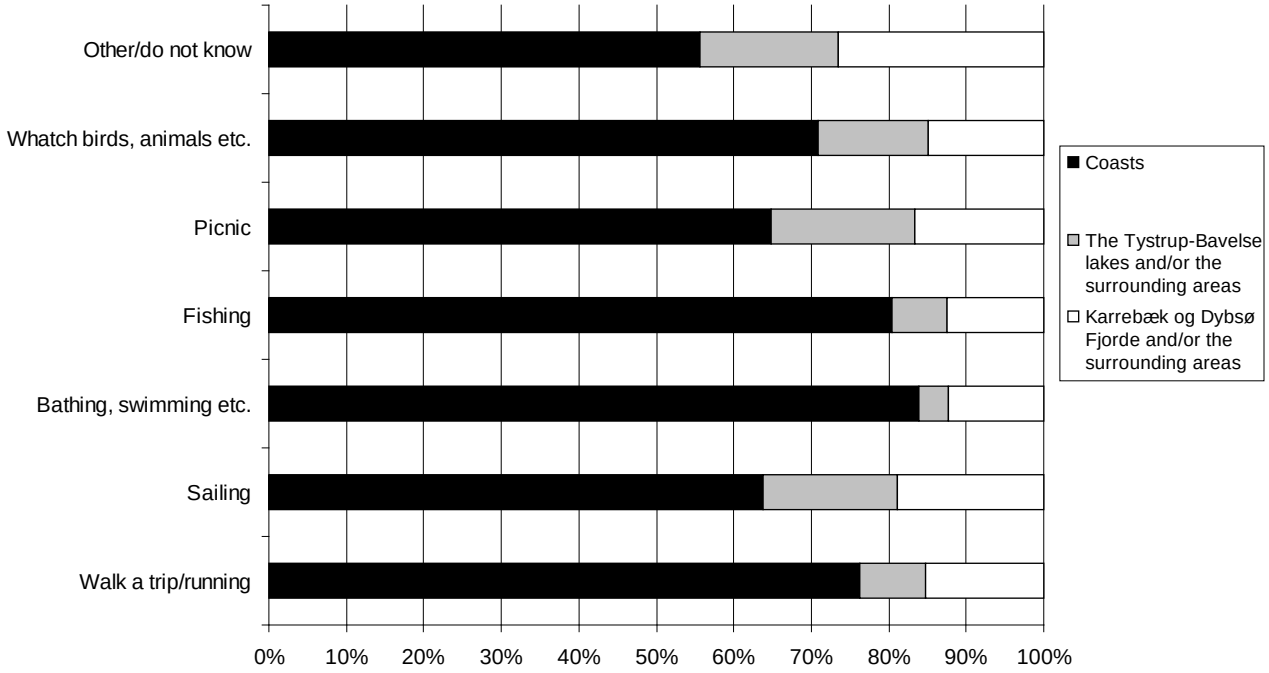
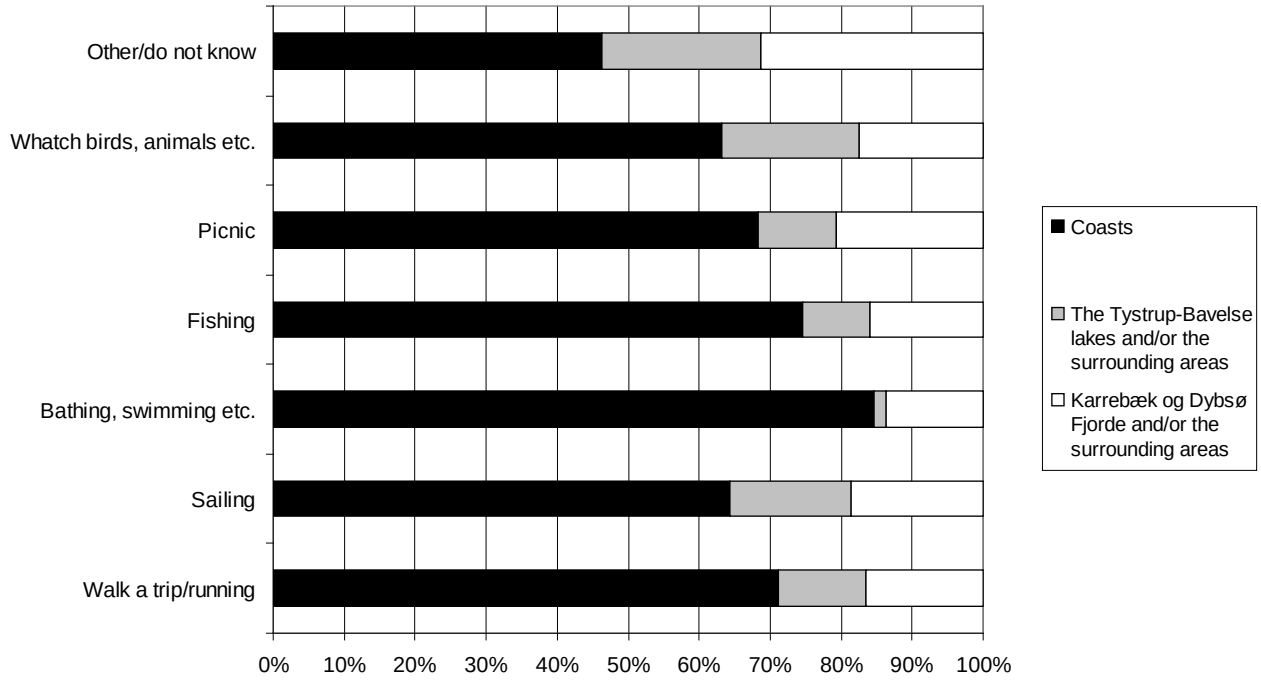


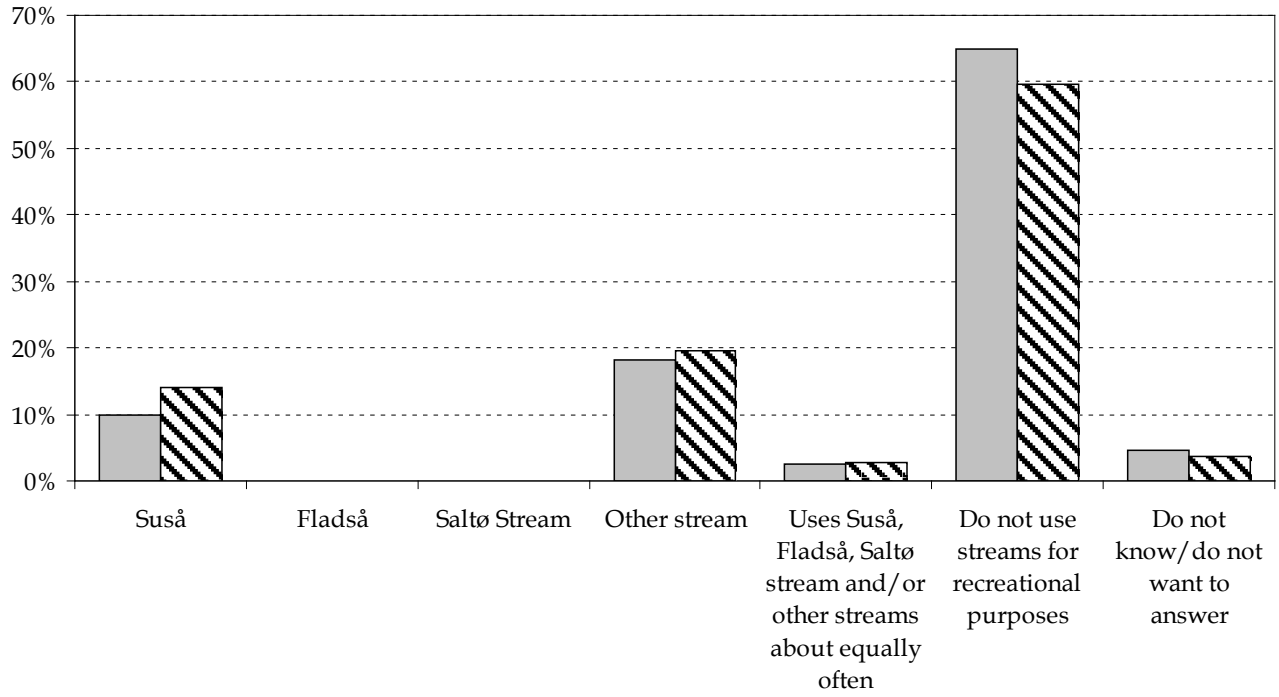
Table24: What respondents do when visiting the different areas – survey 2



The figures in table 23 and 24 shows that all mentioned activities are practiced, and mainly along the coast.

Furthermore, the same questions are asked to the rivers in the area: the Suså , Fladså and Saltø Å.

Table 25: The rivers the respondent are using for recreational purposes.



This indicate that Suså is used most in the area, but that other rivers outside the area are visited more frequently. And a large part of the sample does not use rivers for recreational purposes at all.

Table 26: How frequently the respondent uses Suså

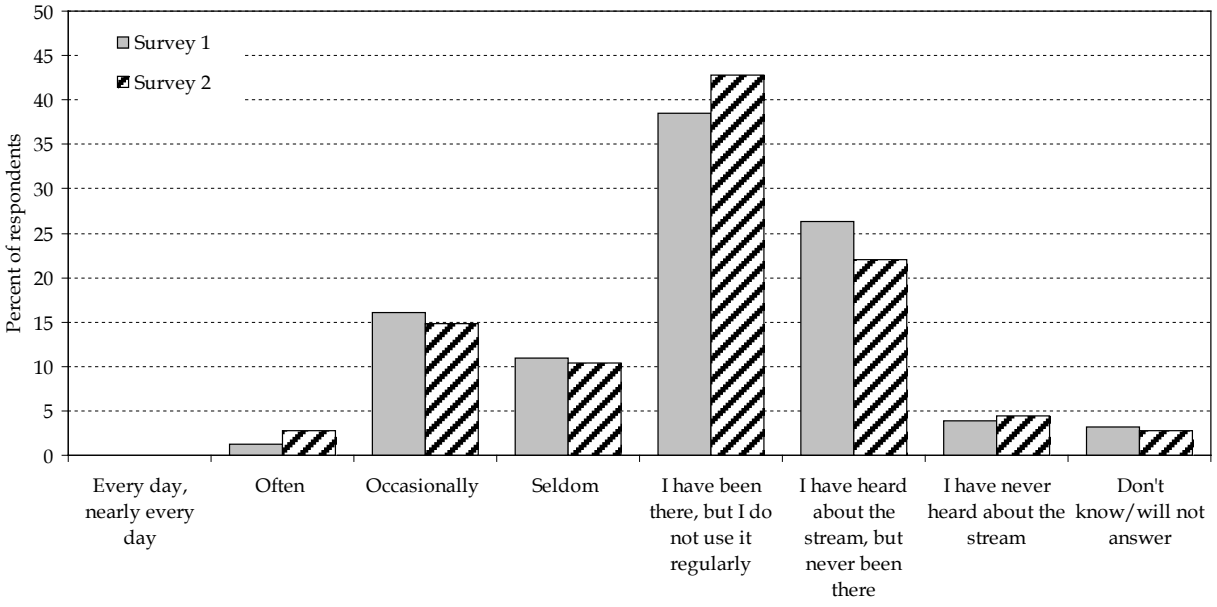


Table 27: How frequently the respondent uses Fladså

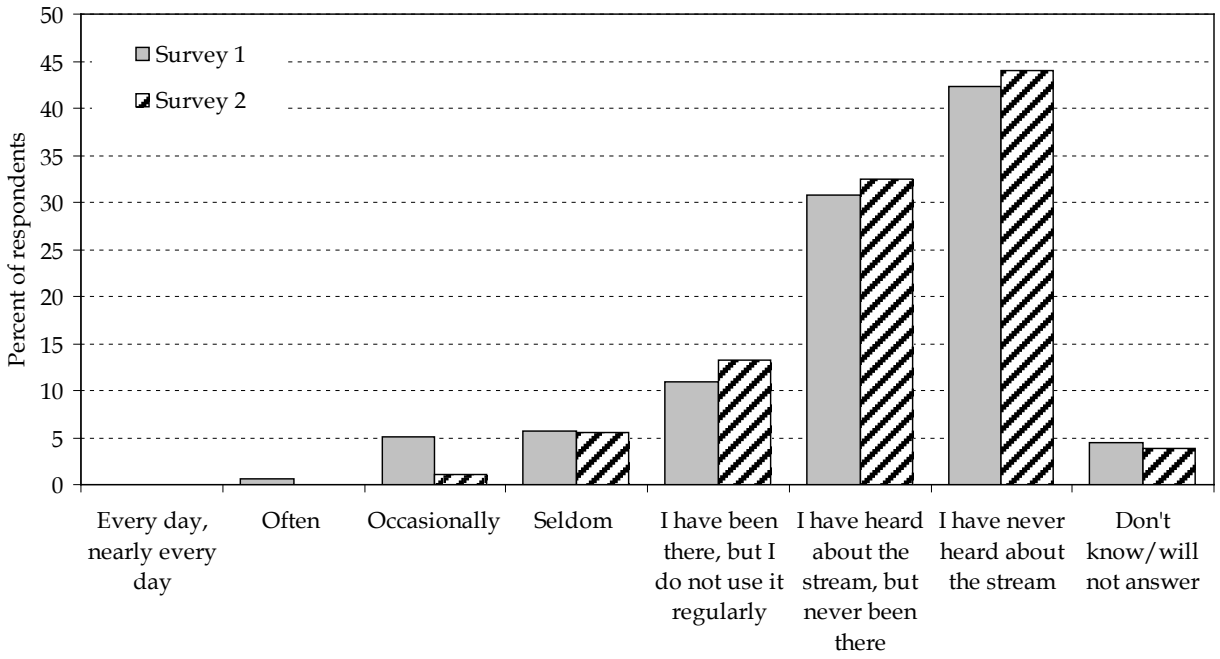


Table 28: How frequently the respondent uses Saltø Å

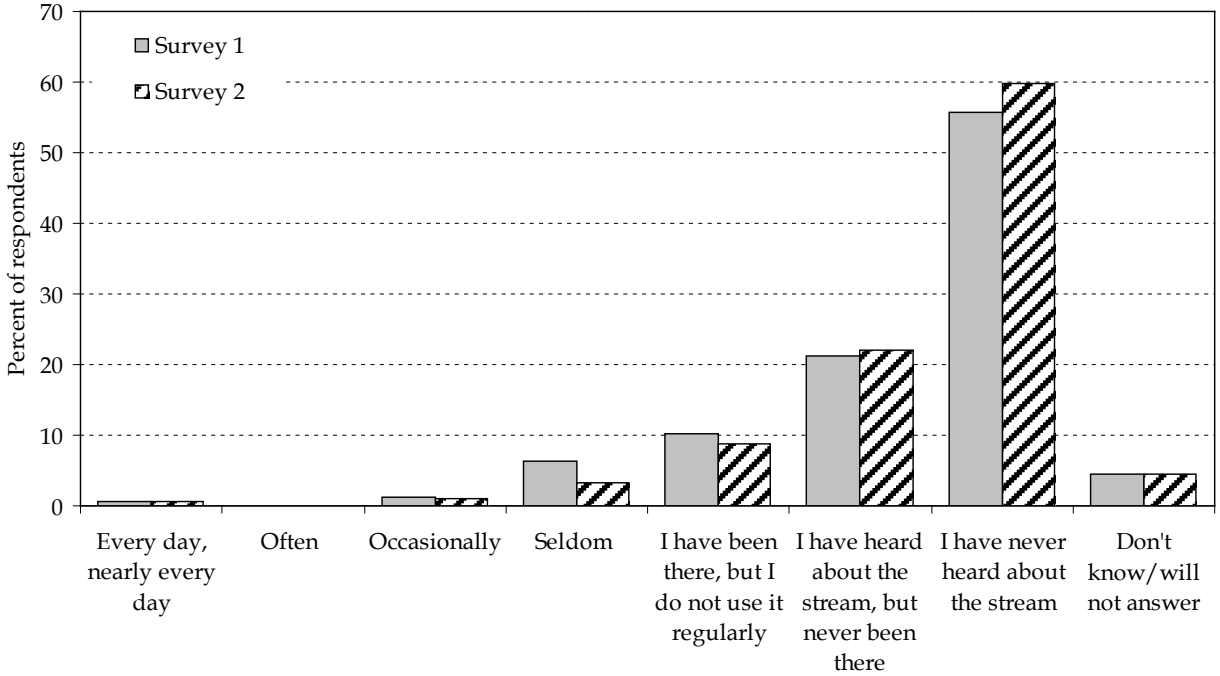


Table 29: Knowledge of the three different rivers – survey 1

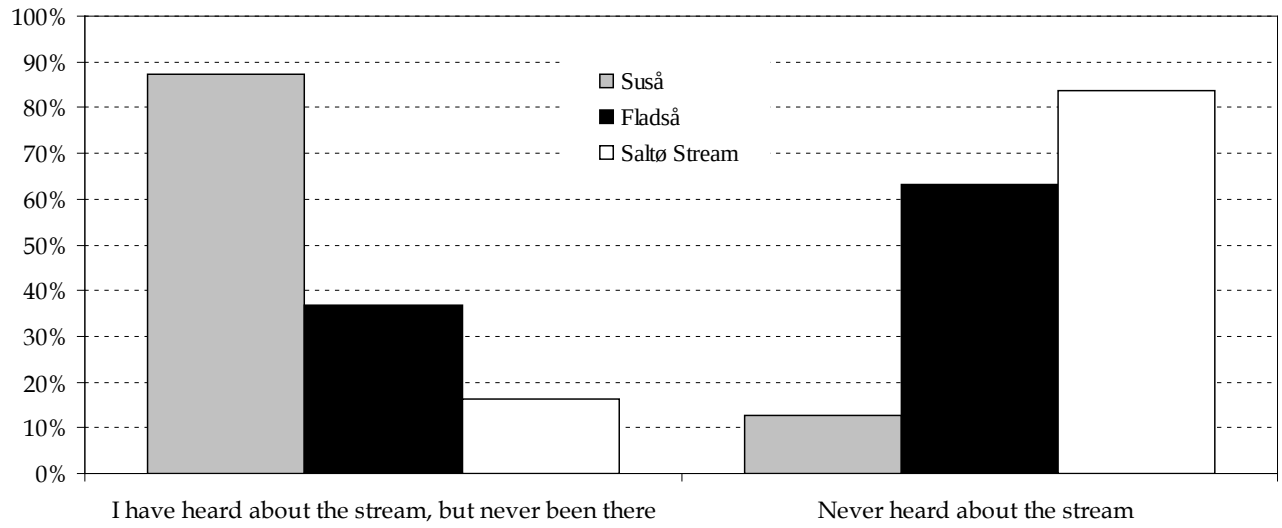
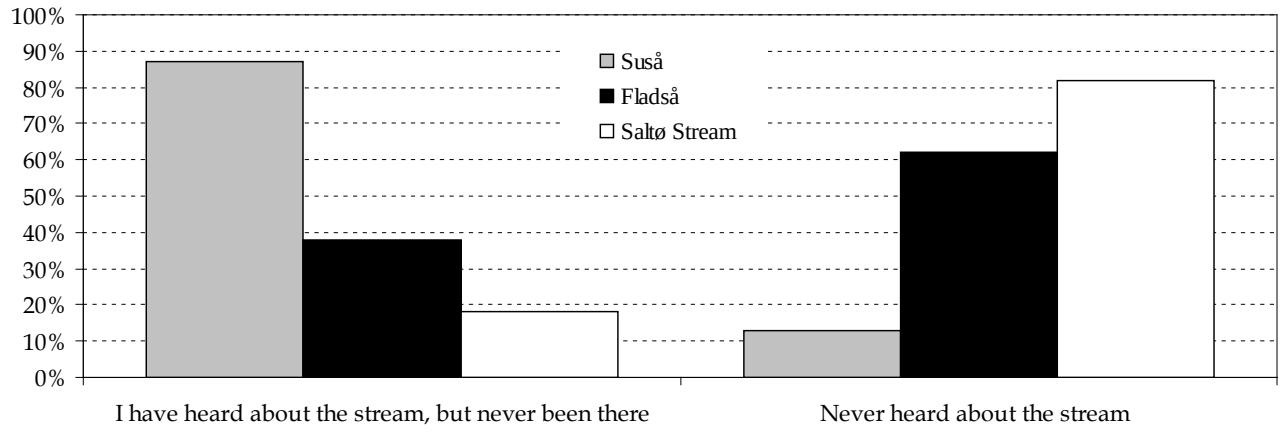


Table 30: Knowledge of the three different rivers – survey 2



5 Conclusions

Wetland restoration is a major and important measure for fulfilment of the WFD in a number of Danish river basins, and there is a large focus on this measure in Næstved and the Suså area as well. We have therefore concentrated this report on environmental and economic impact assessments of the wetland restoration, as there are several projects underway in the area. For the social assessment it has been necessary to do the assessment at a broader scale, and we have chosen to assess this part as the social impacts of water quality improvements and also on assessments of how respondents close to and farther away from the watershed perceive these water quality improvements.

The environmental and economic assessments have been accomplished by combining the geographical and economic data and model results, and we think that this analysis, although narrow in its scope, provides an improvement in the information background for projects like the wetland projects currently under establishment in Næstved. The methods developed can be used in the implementation of new projects. The methodological improvements comprise the development of a model to depict the acreage of the wet area if the water-level is rising (WetArea) and a cost calculation scheme assessing the lost gross margin in agriculture from wetting the agricultural areas (using the results from WetPlan). In addition an assessment of the benefits and welfare economic changes from improvements of the water quality in the Suså area has been conducted to shed light on the welfare economic gains – interpreted as social gains – from water quality improvements. As these improvements do not have a price, the valuation has been done using state of the art valuation method, and in this study the contingent valuation method has been used,.

The results of the combined geographical and economic methods and modelling show that the costs (measured as lost gross margin in the agricultural area), are modest compared to the estimated costs used in the water-plans (based on cost information from the Ministry of Environment). It also reveals that the cost per hectare established wetland varies between agricultural areas, and this indicates that it could be cost-effective if the compensation to the farmers for wetland restoration could be based on negotiations. Such negotiations imply that the farmers have to compete so that the “true costs” can be revealed. Otherwise there is a risk for large overcompensations, as well as under-compensation leading to lack of compliance in the voluntary projects.

The results of the valuation study furthermore indicate that the population at Zealand and Lolland Falster is willing to pay for improvements of the water quality of Suså and the fjord, but that the willingness to pay for improvements in access to the water bodies is not high. This does not mean that access is not valued as such, but the reason can be that the population regard access to Suså and the fjord as acceptable as it is, or that the population living fairly far from Suså river, Karrebæk and Dybsø Fjord does not care about increased access but do care more of the value of protecting the water from further pollution and degradation.

6 References

Christensen, H.S., B. Hasler, B. Münier, P. Frederiksen, M. Källstrøm, P.Viuf (2010). Analysis of existing Danish Water Protection Plans and realized water protection projects. www.waterpraxis.net

ESRI (2010): "ArcHydro tools version 1.4". http://resources.arcgis.com/content/hydro-data-model 10-03-2011

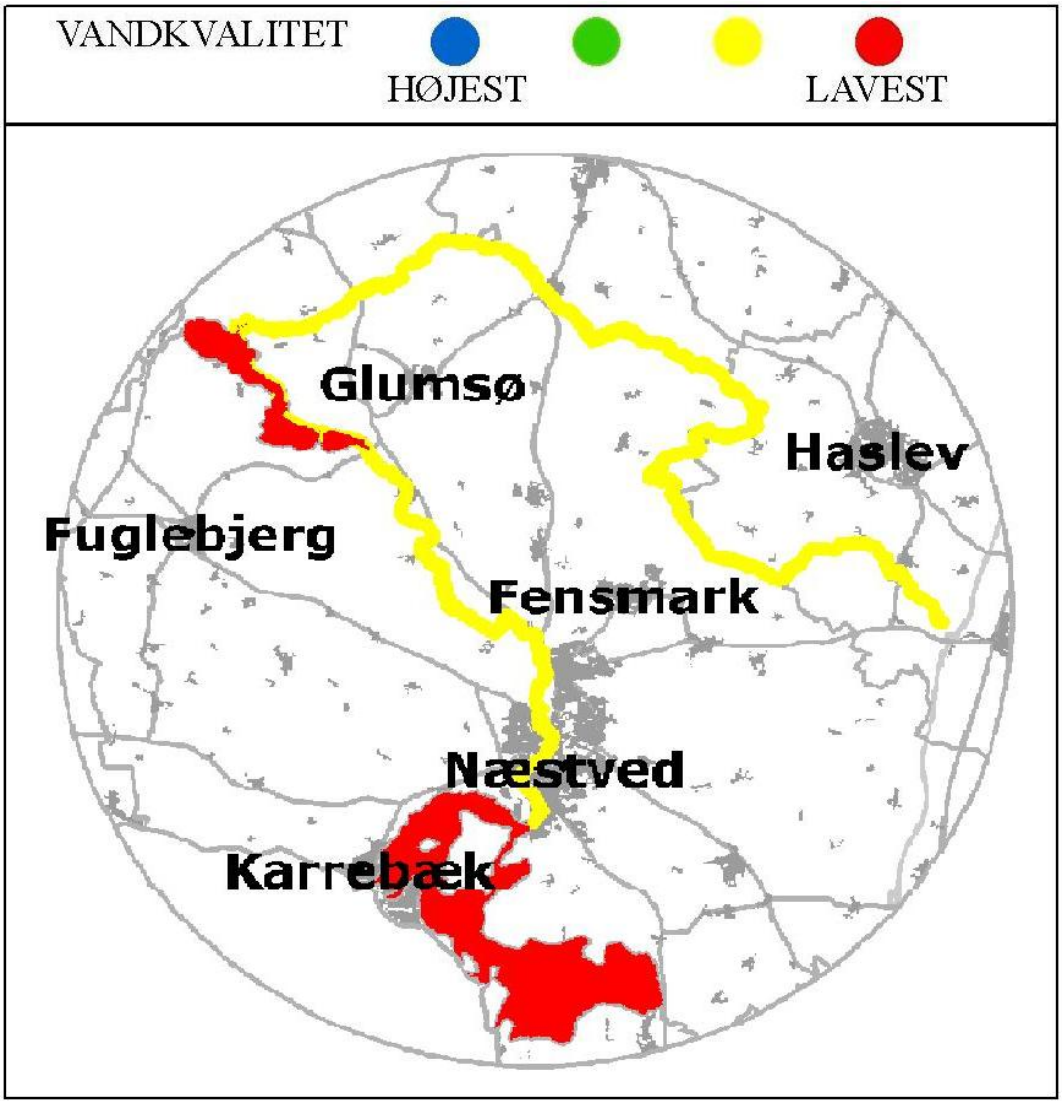
Hoffmann C.C., Nygaard B., Jensen J.P., Kronvang B., Madsen J., Madsen A.B., Larsen S.E., Pedersen M.L., Jels T., Baatrup-Pedersen A., Riis T., Blicher-Mathiesen G., Iversen T.M., Scendsen L., Skriver J & Laubel A.R. (2005). Monitoring of the effect of re-established wetlands" (in Danish: Overvågning af effekten af retablerede vådområder" Teknisk anvisning fra DMU, nr. 19. 4. udgave 2005). NERI technical report no. 19. Miljøministeriet, og Danmarks Miljøundersøgelser.

Levin, G, Christensen, A, Aa: Methodology of the Basemap – nature geo-dataset NERI SYS Whitepaper

MIM 2005: "Kortfattet vejledning til beregning af kvælstoffjernelse for VMPII". Miljøministeriet. Opdateret version af 20. oktober 2005. http://www.skovognatur.dk/Service/Tilskud/Vaadomraader/. 01-01-2005

Nielsen, K; Stjernholm, M; Olsen, B. Ø.; Müller-Wohlfeil, D.; Madsen, I.; Kjeldgaard, A.; Groom, G.; Hansen H. S.; Rolev, A. M.; Hermansen, B.; Skov-Petersen, H.; Johannsen, V. K.; Hvidberg, M.; Jensen, J. E.; Bacher, V.; Larsen, H. (2000) Areal Information Systemet – AIS. Miljøministeriet

7 Annex



The respondents were informed as follows:
The map shows the present conditions in the Suså (83 km), Fladså (21 km), Saltø River (24 km), the Tystrup-Bavelse Lakes (7,5 km^2) and the Dybsø and Karrebæk Fjords (32 km^2).

The water quality is assessed by the Environmental Centre Nykøbing Falster, who is the official authority responsible for monitoring the water quality in this area.

Notice that the water quality can differ from place to place in the rivers, lakes and fjords and that your own perception of the water quality therefore might differ somewhat from the assessment of the Environmental Centre.

The description of the water quality follows this water quality ladder:

	Highest quality
The water is suitable for boating, fishing and swimming. **The water is suitable for many types of fish, plants and birds, which are of common occurrence in pure water bodies.**	
The water is suitable for boating, swimming and fishing, even though the most pollution sensitive species are absent. **The variety of birds and plants are somewhat less than in the highest quality.**	
The water is suitable for boating, but the opportunities for swimming and fishing are somewhat limited. **The occurrence of fish, birds and plants are somewhat limited.**	
The water is not suitable for swimming and fishing and the possibilities of boating can be limited. **There is a very limited bird and plant life and there is only few or no fish.**	
	Lowest quality

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1. Does this description of the water quality in the rivers, lakes and fjords respectively correspond to your perception?

Suså:

Yes, that corresponds to my perception ..... ❑
The water is in a better state than I thought ..... ❑
The water is in a worse state than I thought ..... ❑
I do not know anything about the water quality in that area... ❑
Don't know ..... ❑

Fladså: .....

Yes, that corresponds to my perception ..... ❑
The water is in a better state than I thought ..... ❑
The water is in a worse state than I thought ..... ❑
I do not know anything about the water quality in that area... ❑
Don't know ..... ❑

Saltø River: .....

Yes, that corresponds to my perception ..... ❑
The water is in a better state than I thought ..... ❑
The water is in a worse state than I thought ..... ❑
I do not know anything about the water quality in that area... ❑
Don't know ..... ❑

The Tystrup-Bavelse Lakes:

Yes, that corresponds to my perception ..... ❑
The water is in a better state than I thought ..... ❑
The water is in a worse state than I thought ..... ❑
I do not know anything about the water quality in that area... ❑
Don't know ..... ❑

The Karrebæk and Dybsø Fjords:

Yes, that corresponds to my perception ..... ❑
The water is in a better state than I thought ..... ❑
The water is in a worse state than I thought ..... ❑
I do not know anything about the water quality in that area... ❑
Don't know ..... ❑

We now ask you to pretend, that the environmental authorities propose to improve the waterquality in the Suså, Fladså, Saltø River, the Tystrup-Bavelse Lakes and the Dybsø and Karrebæk Fjords.

(The rest of this page is only shown to subsampole 1)

In addition it is proposed to improve the accessibility from a limited accessibility to the Suså, Fladså, Saltø River and the Tystrup-Bavelse Lakes to an extended accessibility.

Limited accessibility (corresponding to the present situation):
Limited opportunities to get near the rivers. Large parts of the area around Fladså, Saltø Å, Suså and the Tystrup-Bavelse Lakes are private and it is at present not allowed to be on those areas without permission from the owner. Along these water areas there is only access to less than 10 %.

10%

90%

Extended accessibility:
There is established accessibility via public footpaths on the private and public areas along the named rivers and lakes. The accessibility will by that be increased so that it is possible to walk along about 1/3 of the rivers and lakes.

30%

70%

(page 2)

We will now ask you to answer some questions about, <u>how much your household is willing to pay for the described improvements</u>. In you answer we ask you to consider the following:

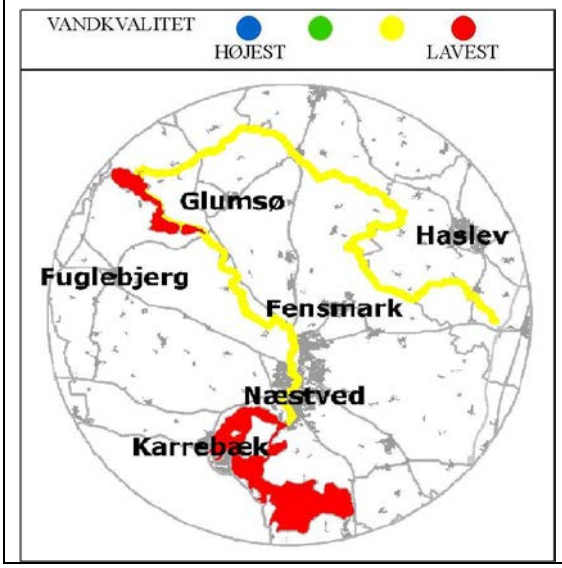
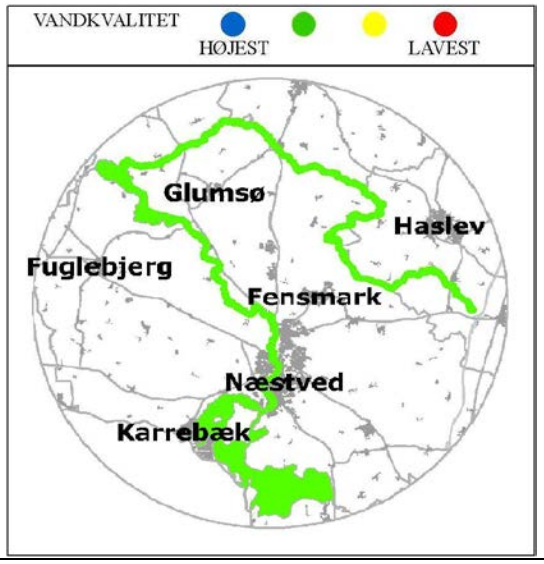
- **The payment will be collected over the annual water bill**
- **If the proposal is decided to be initiated, all users of water will have to pay this amount every year from now on**
- **The amount you choose is the total payment for the whole household for the improvement**
- **The increase in the water bill will take effect in 2011 but it can be several years before the improvements will be as described**
- **The extra amount your household is willing to pay will change and reduce yours and your households opportunities to buy other goods and services**
- **The amount will not be used for other purposes than those described and the changes will be put through**

(page 3)

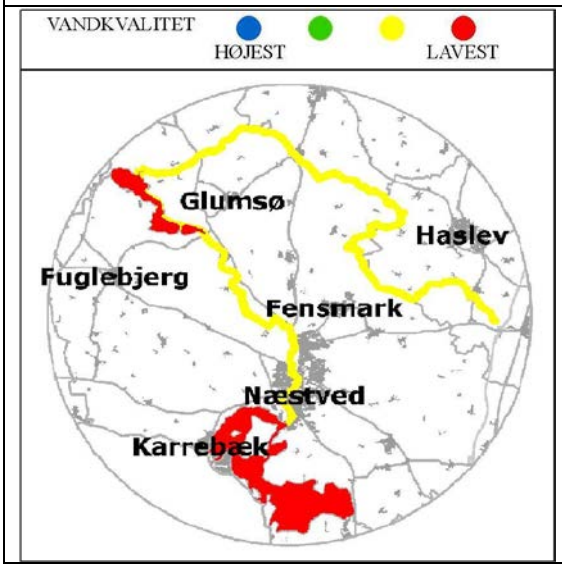
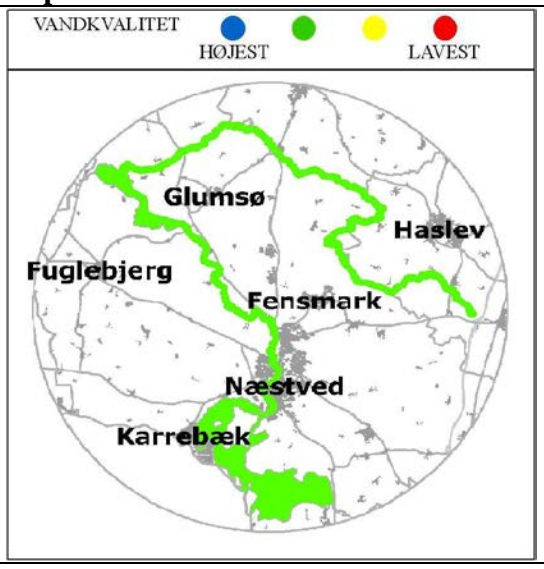
The proposed improvements are illustrated on the map below, which shows the present conditions and the improved condition respectively.

Click on this link, <u>Description of water qualities</u>, to see the description of the water qualities again.

(This table is only shown to block 1)

Present condition	**Improved condition**
<u>Limited accessiblity</u> to Fladså, Saltø River, Suså and Tystrup-Bavelse Lakes ca. 10 % ca. 90 % 	<u>Extended accessiblity</u> to Fladså, Saltø River, Suså and Tystrup-Bavelse Lakes and lakes ca. 30 % ca. 70 % 

(This table is only shown to block 2)

Present condition	**Improved condition**
	

Below a range of amounts is listed. We now ask you to choose that amount, which your household maximum is willing to pay as an extra payment on the annual water bill for the shown improvements.

2.

0 DKK	☐	-> Q30
20 DKK	☐	-> Q31
40 DKK	☐	-> Q31
80 DKK	☐	-> Q31
110 DKK	☐	-> Q31
150 DKK	☐	-> Q31
190 DKK	☐	-> Q31
220 DKK	☐	-> Q31
260 DKK	☐	-> Q31
300 DKK	☐	-> Q31
340 DKK	☐	-> Q31
380 DKK	☐	-> Q31
410 DKK	☐	-> Q31
450 DKK	☐	-> Q31
490 DKK	☐	-> Q31
520 DKK	☐	-> Q31
560 DKK	☐	-> Q31
600 DKK	☐	-> Q31
640 DKK	☐	-> Q31
680 DKK	☐	-> Q31
710 DKK	☐	-> Q31
750 DKK	☐	-> Q31
790 DKK	☐	-> Q31
820 DKK	☐	-> Q31
860 DKK	☐	-> Q31
900 DKK	☐	-> Q31
940 DKK	☐	-> Q31
970 DKK	☐	-> Q31
1010 DKK	☐	-> Q31
1050 DKK	☐	-> Q31
1090 DKK	☐	-> Q31
1130 DKK	☐	-> Q31
1200 DKK	☐	-> Q31
1280 DKK	☐	-> Q31
1350 DKK	☐	-> Q31
1430 DKK	☐	-> Q31
1500 DKK	☐	-> Q31
1690 DKK	☐	-> Q31
1880 DKK	☐	-> Q31

2060 DKK	☐	-> Q31
2250 DKK	☐	-> Q31
2440 DKK	☐	-> Q31
2630 DKK	☐	-> Q31
3000 DKK	☐	-> Q31
3380 DKK	☐	-> Q31
3750 DKK	☐	-> Q31
4130 DKK	☐	-> Q31
4500 DKK	☐	-> Q31
>4500 DKK	☐	-> Q31
Other amount:	☐	DKK
Don't know	☐	-> Q33

(page 4) (For those who answered "other amount" in the previous question)

3. What other amount would you be willing to pay?
(Write DKK per year)
……

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PROGRAMME FOR SULEJÓW RESERVOIR WATER QUALITY IMPROVEMENT IN THE MUNICIPALITY OF MNISZKÓW ALONG WITH SEWAGE NETWORK MODERNIZATION PROJECT

Part II: Sulejow social, economical and environmental assessment report

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Płock, June 2011

Programme for Sulejów Reservoir water quality improvement in the Municipality of Mniszków

Part-financed by European Union
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WATERPRAXIS project: "From theory and plans to eco - efficient and sustainable practices to improve the status of the Baltic Sea" as a part of Baltic Sea Region Programme 2007 – 2013 supported the studies described in submitted report.

Report "Programme for Sulejów Reservoir water quality improvement in the municipality of Mniszków along with sewage network modernization project" was prepared in polish language and translated. Report consist of the impact assessment of the planned water protection investments on the environment, economy and social – cultural relations of the region of Mniszków.

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Figure 1. Land development project on a scale of 1:10 000 97

II. Assessment of the impact of investments on the environment

1. Description of the proposed project, in particular its characteristics, conditions of land use during construction, operation or use, the main characteristics of the technical processes, as well as the types and amounts of pollutants resulting from the operation of the planned project

It is not required for the project to provide a report on the environmental impact. However, for the purposes of this study, the main problems of the construction of sanitary sewage system and its impact on the environment at the stage of implementation, operation and close down, have been discussed.

Report on environmental impact is to assess the impact of the 'Construction of the sanitary sewage system with connections in Zarzęcin, municipality of Mniszków ' project on all elements of the environment and health and living conditions of people.

Characteristics of the project

The project is one of the tasks of the key project: 'Improving the quality of water in the Sulejów Reservoir in the Municipality of Mniszków', which includes construction of sanitary drainage system in Zarzęcin. The project will consist of construction of basic technical infrastructure for sanitary sewage system. The detailed project scope includes the construction of ca 9.5 km gravitational sewage network, 6.9 km of pressure sanitary sewage network, construction of 9 pumping stations and construction of ca 3.7 km of sewer connections altogether. As a result, the project provides a significant improvement in the level of protection of local environment by reducing pollution from urban waste water, thereby improving the quality of surface water and groundwater. Implementation of the project will also positively affect the standard of living and business environment in the region of Sulejów Reservoir. The project will lead to the elimination of threats resulting from uncontrolled discharge of sewage: leaking domestic

septic tanks, wild leads to the ground, rivers or surface water courses.

It should be emphasized that the construction of the sewage system will not only improve the quality of life and standard of operation of economic entities, but also significantly improve the investment conditions of the area.

The investment area is located in the Lodz region, in the Opoczno county, in the municipality of Mniszków. Investment implementation will take place on the plots being at the disposal of Municipal of Mniszków under construction project performed in the framework of the investment.

Previous land use and vegetation cover

The area provided for the construction of sewage system is located in the Municipality of Mniszków where there is predominantly single-family housing and summer resorts, as well as small trade and services.

Main drainage channels will be carried in roads classified as local roads which are accessible to individual buildings. Street surface is covered with asphalt or a surface is unmade.

Within the project, the area in question is armed with both the overground and underground infrastructure such as power and telecommunication cables. Additionally, in the area of investment there are poles of telecommunication and power overhead network. Yards of residential property are partially paved (concrete, paving stones) and partially they constitute compacted earth. Plots, which are provided for the construction of a sewage system are owned by the Municipality of Mniszków and private individuals.

Projected land use

In order to provide proper sewage system management, it is planned to make sanitary sewage network of gravitational and pressure system with connections.

Sanitary sewage system is designed around the whole built-up area and not where the waste disposal system is installed. It has been assumed that 100% of sanitary sewage produced in the village of Zarzęcin will be collected by a sanitary sewage system and channelled to municipal sewage treatment plant in Mniszków.

Zarzęcin is located in the basin of the Sulejów Reservoir and the Pilica River flowing along the western boundary of the municipality, belonging to the catchment of the Vistula. Due to the diversity of land, the planning area has been divided into several sub-basins, joining in points, for which there is a need for the construction of local sewage pumping stations. Network pumping stations are to feed water to the next sub-basin and further through designed channel in Błogie Rządowe to the sewage treatment plant in Mniszków.

It is anticipated to use modern, ready-made prefabricated pumping stations with an underground polymer concrete tank with a diameter of 1.2 m.

The tank, made of a cone-shaped bottom to prevent from sedimentation of sludge and deposits of solids, will be equipped with back-pressure barrier fittings. Pumping stations will be controlled by control enclosures and will have submersible pumps with vortex type impeller installed (2 pieces alternately running). Basic electricity will be supplied by low-voltage lines and emergency power by mobile power generator, which provides technical equipment of the maintenance services of the network user. Pumping stations will be unmanned facilities. However, there will be required their constant control, aimed at early detection of possible failures, which will be conducted by the sewage network service.

Terms of land use in the construction phase

Construction of drainage system will be associated with a significant disturbance in the soil layer in the area designed for planned objects. Earthworks will be performed using mechanical equipment. In the course of construction, there will occur a noise emission associated with operation of heavy construction and transport equipment used for construction work. During the investment realization, an increased traffic of trucks delivering building materials will take place. Given the focus of construction works on the site of the investment, construction site disturbance will be limited only to the immediate neighbourhood. Arduousness will be temporary and will cease upon completion of construction.

Apart from noise emissions during construction, dust emissions may occur to the

immediate environment, but its coverage will be minimal and will not cause a major nuisance for residents. In the phase of project realization, the provisions contained in the Building Code must be applied.

Construction of drainage system will not be associated with a significant disturbance in the soil layer in the area designed for planned objects. Depth of drains foundation will be ranged from 1.4 m to 5.0 m under ground level.

Earthworks will be carried out using mechanical equipment, except for areas with close-to poles overhead lines, telecommunication, electrical and water supply cables, where the work should be done manually. All excavations will be carried out in the narrow spatial excavations in casing of shuttering panels full of two-point support or in the steel mouldings.

Before performing the excavation, the top layer of humus must be set aside and managed after the completion of construction work. In the course of construction, the land area will not be exposed to pollution and contamination of micro-organisms and harmful substances.

Passages in roads

In stretches where the planned sanitary sewage system is laid, the PVC pipes class S are to be applied. After the wiring, it is planned to rebuild the road surface.

Passages under roads

In places where the planned sanitary sewage system under paved roads is laid, it is planned to execute drilling and use HDPE pipes in a protective steel tube.

Proximity of overhead power lines

In places of close-ups to the power poles, works will be carried out manually with maximum caution.

Intersection of electricity and telecommunication cables

At an intersection of the planned drainage system with electricity and

telecommunication cables, a protection of existing fittings through a bipartite AROT pipes has been provided. At an intersection of the drainage system and cables, there are manual control excavations to be made. Until the exposure of the cable at the intersection point, the excavation will be performed manually.

Conditions of land use in the operation or use phase

During operation and use of the proposed project, no arduousness related to the land use is expected to occur. During the operation you should:

- keep the drains and wells in full operation by the systematic maintenance of the network,
- immediately remove any damage,
- pre-determine which of the channels require overhaul or replacement due to inadequate technical condition,
- comply with the conditions specified by the manufacturer of pipes and wells concerning their maximum traffic overload.

Inspection wells being a part of the sanitary sewage system laying will be made of plastic with a diameter of dn 1000 mm and dn 600 mm.
The wells will be covered with cast-iron manhole.

Discharge pipeline from a local pumping station to the existing gravitational network and from network pumping station to the existing discharge pipeline will be made of PE. All excavations will be carried out in the narrow spatial excavations in casing of full shuttering panels with two-point support or in the steel mouldings.

After laying the sanitary sewage system along with all the fittings, a restoration of original investment land will take place.

The pumping station tank is proposed to be polymer concrete. The submersible pumps, which will channel sewage to gravitational pipeline through the proposed discharge pipeline, will be installed inside the pumping station. For security reasons, the pumping station site will be fenced. Operation of the planned projects will involve the

consumption of electricity.

Estimated types and quantities of pollutants resulting from the operation of the planned project

The proposed investment in the course of its operation is not associated with any emission of substance or energy to the environment. Only periodic cleaning of drainage canals and wells will be carried out, resulting in the sludge production which, in accordance with the Ordinance of the Minister of the Environment of 27 September 2001 on the catalogue of waste (Journal of Laws of 2001 No. 112, item 1206), can be ranked among the waste falling into 20 03 06 code (waste from sewage wells - non-hazardous waste). This waste should be treated in accordance with the Law of 27 April 2001 on waste (consolidated text Journal of Laws of 2007 No. 39, item 251). The first cleaning of channels is expected within 10 years from the start of operation, and any further after the next 5 years.

Selected channel gradients will counteract the deposition of sediments, and thus prevent the emission of odours and harmful substances into the atmosphere.

The project will also cause no noise emissions to the atmosphere. Pumps in the pumping station will be built under the land surface and below the waste water surface, therefore, they will not emit noise into the environment.

During construction, noise, resulting from the operation of equipment and vehicles dropping off building materials and other items on the site of the planned investment, will arise. To minimize the arduousness caused by the above mentioned emission, there are plans to reduce some of the work to the daytime only and the use of efficient, modern equipment with low noise emission, meeting the requirements allowing it to be used. Transport of heavy equipment has been limited to daylight hours and travel time has been reduced to minimum. Unloading materials and loading waste was carried with vehicles engines switched off.

As defined by the waste producer, responsibility for manufacture, storage, transfer to the final entity that has the appropriate permit for the storage, recycling or disposal of waste, shall be borne by a building team, and not the property owner. An

exception may be a situation where the contract for services of demolition or buildings repair results in other obligations in this regard.

Waste associated with the operation of equipment used during the construction is a responsibility of a contractor.

The implementation of the intended project does not affect the landscape, vegetation nor animal world.

Waste is used on site or transferred to customers, holding the appropriate permissions for their reception and handling.

In the phase of investment realization, the required safety steps and terrain marking will be made. In addition, there will be some designated and marked areas of accumulation of building materials and waste.

Maximum minimization of the investment impact on all components of the environment is the responsibility of the Investor. At the stage of the investment realization, negative impact on the environment should be minimized through applying modern and environmentally friendly building technologies. Waste and sewage produced during construction work should be appropriately treated and / or disposed in accordance with the assumptions of the technical project and the applicable detailed regulations.

The investment can be cumbersome because of the noise only during the construction work. Taking into account the land development, scope and work duration, it should be concluded that the acoustic climate disorder, caused by the noise emitted by machinery and equipment carrying out construction and repair work, will not affect significantly human health and the acoustic climate of adjacent areas.

The amount of waste water channelled from Zarzęcin to the sewage treatment plant in Mniszków

Balance of sewage:

- total expected number of people benefiting permanently from the drainage system - LM= 200 M,

- total expected number of people benefiting temporarily from the drainage system during summer - LM = 1000 M
- rate of average daily flow of waste water - q = 120 l / dM
- rate of daily unevenness Ndmax = 1.5 (**dop.** 1.3 - 2.0)
- rate of hourly unevenness Ndmax = 2 (**dop.** 1.5 - 4.0)

Summer season

Calculation of average daily flow of waste water from Zarzęcin

$$Q_{dśś} = q \times LM = 120\ l/dM \times 1000\ M = 120\,000\ l/d = 120\ m^3/d$$

Calculation of the maximum hourly flow of waste water from Zarzęcin

$$Q_{h\max} = \frac{N_{d\max} \times N_{h\max} \times Q_{dśś}}{24} = \frac{1{,}5 \times 2{,}0 \times 120\ m^3/d}{24} = 15{,}0\ m^3/h \approx 4{,}2\ l/s$$

Autumn-winter season

Calculation of the average daily flow of waste water from Zarzęcin

$$Q_{dśś} = q \times LM = 120\ l/dM \times 200\ M = 24\,000\ l/d = 24\ m^3/d$$

Calculation of the maximum hourly flow of waste water from Zarzęcin

$$Q_{h\max} = \frac{N_{d\max} \times N_{h\max} \times Q_{dśś}}{24} = \frac{1{,}5 \times 2{,}0 \times 24\ m^3/d}{24} = 3{,}0\ m^3/h \approx 0{,}83\ l/s$$

Maximum hourly inflow of waste water during summer amounts to: **4.2 l / sec.,** while in autumn and winter: **0.83 l / sec.**

2. Description of the natural environment elements within the scope of the expected impact of the proposed project on the environment

Morphology

Municipality of Mniszków belongs to the mesoregion of Opoczyńskie Hills, being a part of the macroregion of Przedborska Upland.

Mesoregion of Opoczyńskie Hills is an area located on the curve of the Pilica river on its right bank. It consists of a series of isolated hills and mountains reaching up to 270 m above sea level. Pilica Valley is clearly outlined and the stretch from Przedbórz to Tomaszów Mazowiecki falls into the range of 150 200 meters above sea level. In the region of Zarzęcin, it reaches 160 m above sea level and is the lowest area located in the Municipality of Mniszków.

Construction of the sewage system will not affect the morphology of the terrain.

Geology

Basic geological foundations of Municipality of Mniszków were formed in the Mesozoic. At the end of the Jurassic period, as a result of tectonic movements, there has been created a great anticlinal elevation, called the Świętokrzyskie and Kujawy embankment. Mniszków Municipality area was covered by Cracov and Central Polish glaciation in its early days, when there was created an ultimate cover of loose sediments of changeable thickness. Large, dense surfaces covered with postglacial clay are in the area between Opoczno and Sulejów. Prevailing are, however, areas covered with gravel and sandy tracks embedded by glacial waters.

In the whole area of Municipality, soil made of loose sands of different origins and from till and sands lain on clays are predominant. Occasionally, there are soils formed from loams and weakly clayey loam. Soil formed from sands represents 70% of the municipality land.

Atmospheric air

The source of air pollution in the analyzed area are small heating boiler houses,

heating detached houses with coal. Coal and wood are currently basic fuel materials.

Works related to construction of infrastructure will have little impact on air pollution (typical construction works). In the course of this work, a slight emission of particulates will be observed.

Noise

The investment can be cumbersome because of the noise only during the construction work. Taking into account the land development, scope and work duration, it should be concluded that the acoustic climate disorder, caused by the noise emitted by machinery and equipment carrying out construction and repair work, will not affect significantly human health and the acoustic climate of adjacent areas.

Vegetation

Forest area in the Municipality of Mniszków is 4 090 ha, which represents 33% of afforestation.

Forests serve multiple functions: protective consisting in a positive impact on the environment, productive providing timber, forest fruits, herbs and social as a site for recreation and tourism. Forests advantageously influence climate, air, water, soil, conditions of human life, and the natural balance.

Forests are planted mainly on sandy morainal hills and pleistocene river sands. In other areas, especially where there are good soils developed on tills, forest areas were replaced by farmlands. In all forests, a stand of pine trees dominates. The most natural forest phytocoenoses can be found in well-head zones in upper sections of rivers. These are mostly riparian forests and swamp alder forests.

In many places in the municipality within the fields and river valleys there can be seen pine groves, young pine forests, rare birch and alder groves, which may fulfil recreational function.

In the Municipality of Mniszków there are the following protected nature areas:

1. Forest reserve, 'Gaik', is located in the municipality of Mniszków in Smardzewice

Forest District, within Błogie, in Małe Końskie forestry. Reserve protects a variety of forms of continental broadleaved forest, ie. components of: low broadleaved forest and variant of stenothermic broadleaved forest. This is an example of the forest with outstanding natural and landscape beauty. This testifies that nearly 80% of the reserve is covered with old, nearly 200-year-old stands of oaks, which are among the oldest in the Park. There is an interesting ornithofauna in the reserve; nearly 50 species of birds nest here. There are also rich vascular plants, including over 250 species.

2. Forest reserve, 'Błogie', is located in the municipality of Mniszków in Smardzewice Forest District, within Błogie, in Małe Końskie forestry. The aim of establishing the reserve is to preserve a fragment of natural stands of firs and mixed stands of firs on the northern edge of fir range in Pilica Forest. The reserve is dominated by fir broadleaved forest, occurring often in a mosaic with riparian forest. A significant part of the reserve is a forest mixed well with fir. Furthermore, at its western boundary there is a precious area of great scenic beauty, almost 200-year-old ancient forest of pine trees and oaks.

Sewage system will be designed in a way avoiding collisions with trees and bushes and their cutting down should be treated as the final solution, with no reasonable alternatives. The contractor must be familiar with all the regulations of cutting down, replanting or trimming trees and shrubs. Contractor at his own expense will, as indicated in the advisable decisions, cut down (along with the removal of rootstock), replant or trim trees and shrubs. Any materials obtained in the felling of trees are the property of the entity specified in the authorization for felling. In other cases they remain the property of the Employer, who in consultation with the Engineer makes the final decision about the form of their management.

Animal world

The area covered by the project is limited to the so-called synanthrope species, occurring near the man's existence.

Natura 2000

On Polish territory, the most valuable natural areas are liable to legal protection under the Law of 16 April 2004 on environmental protection (Journal of Laws of 2004 No. 92, item 880 with subsequent amendments). The national system of protected areas involves national parks, nature reserves, landscape parks and protected landscape areas. Recently, the non-point forms of nature conservation were extended by Natura 2000 areas. The increasing importance of this form of nature conservation results largely from its European character.

European Ecological Network Natura 2000 is a system to protect endangered components of biodiversity of the European continent, implemented since 1992 in a consistent manner in terms of methodology and organization on the territory of all EU Member States. The Natura 2000 network includes:

- **special protection areas for birds** (SPAs) - (eng. Special Protection Areas - SPAs) designated under Council Directive 79/409/EEC on the conservation of wild birds, so called 'Birds Directive';
- **special areas of conservation** (SAC) - (eng. Special Areas of Conservation - SAC) designated under Council Directive 92/43/EEC on the conservation of natural habitats and wild flora and fauna, so-called 'Habitats Directive', for the natural habitats listed in Annex I and species of plants and animals listed in Annex II to the Directive.

The aim of establishing the Natura 2000 network is to preserve both endangered natural habitats and plant and animal species across Europe, but also typical, still commonly occurring natural habitats, characteristic for nine biogeographical regions (ie., Alpine, Atlantic, Boreal, Continental, Pannonian, Macaronesian, Mediterranean, Steppe and Black Sea). In Poland there are two regions: continental (96% of the country) and

alpine (4% of the country). For each country there shall be defined a reference list of habitats and species, for which Natura 2000 areas should be created by biogeographic regions.

The impact of such an investment on the environment (in this case on the protected areas) should be considered in two aspects. Firstly, the most cumbersome and interfering in the environment phase for linear investment (sewage system) is the phase of construction - mainly due to the disturbance of ground and water conditions. The very operation of this type of infrastructure (excluding emergency events) does not significantly impact the environment, and with a functioning system, in many cases we can talk about improving the environment through the construction of infrastructure, particularly sewage.

Zarzęcin with Sulejów Reservoir is in close proximity to the area of special birds protection Natura 2000 called the Valley of the Lower Pilica. This area lies at an altitude of 94 - 173 m above sea level and covers 80 km of latitudinal stretch of Pilica Valley, above the estuary of the Vistula River and the Drzewiczka Valley. Pilica channel of 100-150 m wide meanders. There are numerous islets, shoals and sandbanks, and old river beds in varying degrees of succession. Meadow terrace is partially drained. In the south-western area there are Błota Brudzewskie, the largest (several hundred hectares) bog in the valley-most drained and dried. Nearby Promna town there is a complex of over 16 ha of exploited bogs with peat body waters. Watercourses represent 4.00% of the area.

From the north, the valley slope ends in relative height of 20 m, in places overgrown with xerothermophil vegetation. The southern part is flat, mostly covered with riparian forests with parts of old oaks - this is a remnant of 'Spała forests'. The most valuable part of the forest - a mosaic of forest habitats from fresh forest through riparian forests to ash and alder swamp forests - is located between Gapin and Grzmiąca. In the vicinity of Ducka Wola there is a valuable complex of pine forests with patches of deciduous stands of alder and oak - Majdan. In total, forests cover 33% of the area, including 20.00% of coniferous forests, 7.00% of deciduous forests, 5.00% of mixed forests. Vast open areas - meadows and pastures occupy 31.00% of the area,

agricultural lands occupy 25% and built-up areas 2.00%. The refugium has rich flora - there was confirmed the presence of 575 species of vascular plants, including rare, endangered and legally protected ones. There are 10 habitat types from Annex I of the Habitats Directive - from xerothermophil to marshy, and 9 species from Annex II of the Directive.

Pilica is one of the major rivers in Poland to protect the fish fauna (there are 7 fish species from Annex II of the Habitats Directive). The Valley since 1984 is inhabited by beavers, and since the mid-1990s by the otters. The refugium for the most part coincides with the bird refugium of national importance - Pilica Valley SPAs. There are at least 32 confirmed bird species here, listed in Annex I of the Birds Directive, and 6 species placed in Polish Red Book of Animals.
The area lies between Inowłódz and Ostrówek-Mniszew

Forms of Nature Protection
Pilica and Drzewiczka Valley [area of protected landscape],
Majdan [nature reserve],
Sokół [nature reserve],
Tomczyce [nature reserve],
Spała Landscape Park [landscape park],
Głowice [nature reserve],

Threats :

The most serious threats include:

- reduction in Pilica water flow, caused by the Sulejów Reservoir built in 1973. Since then, the flow of water in the river decreased by about 25%. Natural flooding of the valley is now a rarity, which influences reduction in irrigation of the valley,

- lowering of groundwater levels and drying of meadows and pastures,
- turning grasslands into farmlands,
- recreational buildings,
- abandonment of meadows and pastures exploitation, which initiates a natural succession of shrub and tree vegetation,
- water pollution,
- outdoor sports and different forms of active leisure,
- fishing.

Sulejów Landscape Park

Sulejów Landscape Park was created in 1994 on the territory of the following municipalities: Sulejów (municipality and town), Ręczno, Aleksandrów, Mniszków, Wolbórz, Tomaszów Mazowiecki (municipality and town), Rozprza, Piotrków Trybunalski, Łęki Szlacheckie, Przedbórz and Sławno. The park area amounts to 17 444 ha, and buffer zones - 38 927 ha. Half of the Sulejów Landscape Park area is covered by forests while waters cover (including Sulejów Reservoir) - less than 5%. There are 11 nature reserves in Sulejów Landscape Park, covering a total area of 624 ha. Sulejów Park amenities form mainly: natural landscape of the river, especially the middle section of Pilica between Przedbórz and Sulejów (proposed for inclusion in the European network of protected areas Natura 2000), Luciąża 'delta', Czarna Maleniecka, mid-forest streams such as Strugi Młynki (beavers refugium). Geological features such as Bąkowa Góra (in the borderland of Central Polish Lowlands and Lesser Polish Upland), high edges of the Pilica Valley (eg. in Barkowice and Sulejów) and the most valuable landscape and water nature reserve in central Poland - Niebieskie Źródła. Forests - which are the remnant of the Pilica Forest with fragments of natural wildlife, protected, among others, in nature reserves. Less than 10% of all SLP forests has the character similar to the natural

landscape, however, landscape of forests represents only 5 stretches of forest with a total area of merely 170 ha. Features of forest relicts, being over 250 years old, can be observed in the following objects: Lubiaszów (oak, fir and alder forest), Gaik (oak forest), Kaleń (oak forest), Błogie (oak-pine and fir forest) and Jaksonek (oak wood). In the area of SLP there have been 17 scrub forest complexes and a number of alternative communities confirmed. Very characteristic in this area are hygrophilous forests, especially ash-alder and willow riparian forests, riverside osiers and alder swamp forests. Mesophilic mixed forests are mainly distributed in the broadleaved Pilica Forest. The group of mixed forests involves also bright oak grove, which represents the vanishing forest type. A common complex is mixed pine-oak forest, a rare one however - upland mixed fir forest. Pine forests are represented by the complexes: cladonia forest, boron suboceanic fresh forest, wet forest and swamp forest. Non-forest vegetation is characterized by floristic richness and phytocenotic diversity. In the area of SLP there are 70 wetland and meadow communities and some communities of psammophilic and xerothermophil vegetation. Significantly transformed areas are characterized by the development of synanthropic vegetation. In the area of SLP there have been so far confirmed almost 1 000 species of vascular plants, among them floristic peculiarities such as orchids (12 species), clubmoss (4 species), royal fern, twinflower, lupine clover and whorled solomon's-seal. Among the strongly represented, different groups of animals of the world, a special attention deserves entomofauna and ornithofauna. Butterflies alone are represented by about 30 species. In the area of SLP there were observed about 200 species of birds; nearly 150 species breed here. A refugium was found here by: black stork, hazel grouse, flycatchers, numerous groups of birds of prey (common buzzard, hobby, kestrel, marsh harrier and others) and wetland species (little ringed plover, bittern, kingfisher, penduline tit and others). There are 11 nature reserves in SLP covering a total area of 624 ha. For years, it has been planned to create five reserves with a total area of 140 ha. The most numerous forest reserves are represented by: Lubiaszów, Meszcze, Twarda, Gaik, Błogie, Wielkopole, Jawora and under plan: Kaleń, Prucheńsko and riparian forest at Pilica. Floral reserves are: Las

Jabłoniowy and Jaksonek and under plan - Forests at Pilica. Other objects are represented by 3 different types of reserves: landscape-Niebieskie Źródła, peat-bog - Czarny Ług and water - Struga Młynki (under plan).

3. Description of the anticipated environmental impacts in case of project inaction

Resignation from the construction of sanitary sewage system in the Municipality of Mniszków in Zarzęcin village council office will have negative effects:

- sewage generated by households will continue to be discharged into the leaking domestic septic or sedimentation tanks. Discharge of untreated waste water into surface waters and soil causes gradual environmental degradation and health risks. This also leads to continued deterioration in the quality of surface and groundwater in the area,
- the existing partial sewage system is in large part exploited for many years. Channels and wells are old, damaged and probably leaking. This leads to contamination of soil and groundwater by untreated sewage, and thereby contributes to the deterioration of the environment,
- using septic tanks is cumbersome due to emitted odour and pathogenic bioaerosols, formed as a result of domestic waste water digestion held in household septic tanks. Such nuisances increase in time of collection of digested domestic waste water by the septic tanker truck, and additionally fumes and noise are emitted into the environment. Moreover, the shuttle to the sewage collection stations alone may cause road contamination.

After considering the zero option - concerning not taking up the project - it is concluded that not taking up the project will entail further negative impact on the environment. It may cause further gradual degradation of environment, health risks and

continued deterioration of surface and groundwater quality in the area of the Sulejów Reservoir.

4. Description of the analyzed variants and their expected impact on the environment

OPTION PROPOSED BY AN APPLICANT AND RATIONAL ALTERNATIVE OPTION

Given the scope and type of work, it can be stated that the construction of drainage system will have a decidedly positive impact on the environment and surroundings. This concerns such elements of environment as soil and water quality, spatial management quality, nature, nuisances and impact of their functions on the environment.

The report should include and define the expected impact of investments on the environment, taking into account that this is an environmentally friendly project, contributing to environmental protection on a broader scale. Location of the proposed project will comply with the development directions of the Municipality and areas surrounding the Sulejów Reservoir. The area of the proposed project will not be located within the protection zone subjected to preservation maintenance.

As part of the works included in the project of construction of sewage system in the Municipality of Mniszków, in Zarzęcin village council office, some less than burdensome impacts on the elements of the environment (water, land, flora and fauna, air quality, sound climate and vibration, people and their health and on the landscape, material assets and monuments) will occur. This impact will be short-lived and totally transitory. Completion of the project will entail complete disappearance of arduousness. Using industry regulations and safety regulations, implementation of the project will not be a threat to the environment both during its construction and during operation.

Alternative option considered, involving the partial refurbishment of the existing sanitary sewage system in the area of Zarzęcin, which receives sewage from approximately 50 parcels that are discharged through the sewage pumping station into

the biological treatment plant, turned out to be not interesting enough. The renovation works require the involvement of large financial resources at a similar interference in the environment compared with the construction of a new sanitary channel. For these reasons, this option was rejected.

VARIANT BEST FOR ENVIRONMENT

Most favourable to the environment proved to be the option concerning making an investment in the construction of a municipal sewage system. At the stage of preparation, the investment was subjected to a thorough technical and financial analysis.

The expected effect of the project is:

- meeting the ecological standards of Polish and European Union legislation in terms of sewage treatment compliance with directives,
- proper water and sewage management,
- improvement of sanitary conditions in the Municipality of Mniszków through the elimination of septic tanks, household sedimentation tanks and "wild" untreated sewage outlets to the sewage receivers,
- improvement of the environment through reduction of pollution load discharged into the receiver point and improvement of water quality in the Pilica river (protection of source areas of the Vistula and the Baltic waters),
- protection of groundwater being a drinking water reservoir for Lodz agglomeration,
- improvement of sanitary conditions in the area,
- increase in the equipment of investment areas, surrounding the Sulejów Reservoir,
- improvement of the investment attractiveness,
- unemployment reduction and giving equal civilization opportunities to the residents of rural areas.

To sum up, it can be concluded that in the context of the above technical analysis the solutions are:

- technically and technologically feasible,
- compliant with best practice in the field,
- compliant with applicable laws,
- optimal in terms of satisfying users demands,
- most suitable among the options considered and represent the optimum value for money.

ANALYZED VARIANTS' IMPACT ON AIR

Duration period

During construction, the analyzed variants' impact on the air is similar, it results from a similar nature of construction works carried out.

The implementation phase will involve some earth or assembly works, during which it may occur merely coincidental emission of pollutants into the air and it will practically be dust pollution resulting from the movement of masses of earth, installing technological equipment (surface cleaning, etc.) and traffic of vehicles transporting technological elements and construction materials. In order to reduce emissions of gaseous substances, there should be roadworthy cars, cranes and excavators used. At this stage, the extent of possible influence will be located practically on the construction site, to which the investor has legal title. These interactions will always be local, short-term and will be kept to a minimum by the proper organization of works and will cease upon completion of works.

Due to the nature of the work under construction, the arduousness of the construction site will be limited only to the immediate neighbourhood especially that the lifted dust from building materials are thickly fractional and their lifting distance is small.

Liquidation period

Liquidation of drainage system can be done in two ways:

- traditionally - digging the open trenches, removing the old pipes and laying new ones. This method involves the reduction of land use during construction work. In this case, there will occur similar arduousness as in the phase of facility construction.
- trenchlessly - enabled replacement of the old fittings with no major restrictions on land use for the duration of the construction work. This method will reduce the environmental impact of the work to a minimum.

Nuisances associated with the liquidation of the investment may be similar to the impacts arising during the implementation of the chosen variant. Demolition work may be followed by emission of gases and dust from welding and tearing down, carried out in the open space. These processes will be short-lived and will not contribute to deterioration of air pollution.

In the short term investor does not provide for the liquidation of the sewage system.

IMPACT ON SURFACE WATERS AND GROUNDWATER AND THE EARTH'S SURFACE.

Implementation period

In the course of these variants realization, used materials and substances will not cause negative impact on the earth's surface, groundwater and surface water. Construction equipment will be technically efficient and will not cause contamination of water, aquifers and soil with oil derivatives.

Occupied time

Due to the similar nature of the options analyzed, the impacts on the earth's surface, surface water and groundwater during the occupied time will be very similar.

In order to avoid negative effects of raw sewage on the earth's surface, groundwater and surface water, a system of PVC and PE pipes and their object-oriented connections is planned to be tight. In addition, new facilities will be constructed to be tight and the existing ones will be subjected to maintenance.

Liquidation period

During the possible liquidation of variants discussed, the impact on the earth's surface, groundwater and surface water will be similar, as in the case of the investment realization.

In the short term, investor does not provide for the liquidation of the sewage system.

IMPACT ON ACOUSTIC CLIMATE

Implementation period

In the phase of implementation during construction work, the adverse acoustic phenomena will occur in the zone of works carried out and in their vicinity. These interactions can cause deterioration of the acoustic climate, because the heavy machinery carrying out works related to the construction of the drainage system will be the source of emission of high levels of sound. Due to the similar nature of works in terms of noise, there was no need to analyze the different options separately. The analysis of the noise emission to the environment has been made for the period of operation, implementation and liquidation.

During the construction, noise emission of the analyzed variants to the environment will be similar. It results from a similar nature of construction work carried out.

In the course of construction, there will occur noise emission associated with operation of heavy construction machinery used for construction work. During the investment realization, increased traffic of trucks delivering building materials will take place. Given the focus of construction works in a small area, construction site disturbance will be limited only to the immediate neighbourhood of the investment. In order to reduce nuisance related to the implementation of the project, performing works will be limited to the specific time of the day, between 6^{00} and $22^{00.}$. Nuisances associated with noise emissions during construction will be temporary and will cease after the construction of drainage system.

Occupied time

The variants discussed will not constitute a significant source of environmental noise. Sewer pipes are located under the surface, which protects against possible noise emission to the environment. Submersible pumps running in pumping stations are under the surface of sewage, which minimizes the noise emissions to the environment. The occupied time of the investment will not be associated with the emission of noise into the environment.

Liquidation period

During the possible liquidation of the project, the emission of noise to the environment will be similar, as in the case of the investment realization. Nuisances associated with the liquidation of the realized variant may be similar to the impacts arising during its implementation. Disturbance will be short-lived, transient and of local nature.

In the short term investor does not provide for the liquidation of the sewage system.

CROSS-BORDER IMPACT ON THE ENVIRONMENT

Due to the nature and location of the investment, **the cross-border impact on the environment** will not take place.

EXTRAORDINARY ENVIRONMENTAL THREATS

Major accidents within the Environmental Protection Law are events, in particular emissions, fires or explosions, taking place during the industrial process, storage or transport, where there is one or more hazardous substances, leading to an immediate threat to life or human health or environment or the creation of such a threat with delay.

A serious disaster is an event that may cause one of the following effects:

- loss of life of at least 10 people,

- pollution of surface water (load > 15 g / cm^2 in the case of oil derivatives and > 5 g / cm^2 in the case of substances that can alter significantly the quality of water) at a distance of at least 10 km, in the case of current water or in the area of at least 1 km^2 for lakes and reservoirs,
- threat to groundwater (violation of pollution norms of water-storage intake in protected areas designated by the coefficients of permeability of the soil and the depth of the piezometric layer).

The probability of a severe transport accident is:

- in case of population, the sum of the probabilities of scenarios with serious consequences associated with fire, explosion and release of toxic substances,
- in case of surface water and groundwater, the sum of the probabilities calculated for scenarios with serious consequences associated with the release of hydrocarbon compounds and other liquid chemicals that could significantly change the quality of these waters.

Implementation period

Regardless of the chosen variant, at the stage of construction, storage of hazardous substances (fuels supplying construction equipment) is not expected in the area of carrying out the investment.

Occupied time

During the operation of the analyzed variants, there are no dangerous substances which could lead to an immediate threat to life or human health or the environment or the creation of this threat with delay. Therefore, the possibility of a major accident during the occupied time of the analyzed variants is excluded.

The pumping station will be equipped with an alarm system that immediately communicate the failure of individual devices. The pumping station will be operated by a

designated by the investor employee, trained to handle the emergency.

It should be noted that during the operation of the selected variant, it is mandatory to carry out conservation works and regular maintenance of network and technical facilities. Occurring damages should be removed temporarily by the employed conservators.

Liquidation period

Nature of the works at the stage of liquidation is very close to building works carried out during the implementation period. At the stage of project liquidation it must be assumed that there will be no risk of a major accident.

IMPACT ON FLORA AND FAUNA, LANDSCAPE, CLIMATE AND CULTURAL GOODS

The analyzed variants are not expected to have an impact on the NATURA 2000 network areas.

In the vicinity of the planned investment, there are no legally protected monuments.

Implementation of the options analyzed will have a negative impact on flora and fauna, due to the limited scope of the project and planned management of the land surface in accordance with the project after completion of construction process. The main representatives of the fauna in this area may be insects and birds, however the presence of small rodents and mammals can not be excluded. The investment carried out will not make local animals to change their habitat.

After completion of earthworks associated with construction of a sewage network, this area will be restored to its original state. Completed elements of the discussed variants do not introduce significant changes in spatial management of land and landscape.

The analyzed variants are located in an area not covered by the forms of nature protection under the law 'On Nature Protection'. This area is located outside of national parks and nature reserves. During the possible liquidation of projects, regardless of the

variants discussed, an impact on flora and fauna, landscape, climate, material assets and cultural property will be similar, as in the case of the investment realization.

EFFECTS ON HUMAN BEINGS

During the project realization, adverse effects on humans may be caused by local dusting and noise, increased traffic of cars and mechanical equipment within the ongoing construction work and access road to the construction site. Nuisances, however, will have a local, periodic and transient character after the completion of the investment.

During the occupied time, analyzed variants will not have an adverse effect on people because of their minimal nuisance to surrounding residential buildings such as the lack of significant pollutants emission to the air, soil and water and low noise emission.

During possible elimination of variants discussed, the effect on people will be similar, as in the case of the investment realization.

In the short term investor does not provide for the liquidation of the sewage system.

5. Justification of the variant proposed by the applicant with an indication of its impact on the environment

In case of construction of sewage system in Zarzęcin, due to the landform features, as well as to a small range of investments, there was only one variant taken into consideration concerning channelling sewage to the designed sewage system in Błogie Rządowe and on to the sewage treatment plant in Mniszków.

The impact of the proposed project, with justification, on health and living conditions of people and on various elements of the environment was presented below.

EFFECTS ON HUMANS, ANIMALS, PLANTS, MUSHROOMS AND NATURAL HABITATS, WATER AND AIR

Nuisances for people and the environment associated with noise emissions during sanitary sewage system construction will be temporary and will cease after the

construction of drainage system. The planned investment during maintenance will not exert negative effects on people because there will be no significant source of noise and odour emissions nor bacterial contaminants to the atmosphere.

Implementation of the investment will also have no negative impact on flora and fauna, due to the limited scope of the project and planned development in accordance with the project. Due to the fact that the investment is not designed in a way so as to conflict with existing objects, vegetation, and underground infrastructure, the planned drainage system will be routed so as to preserve existing trees and to cause no need for felling them within the investment area. Sewage system will be designed in a way avoiding collisions with trees and bushes and their cutting down should be treated as the final solution, with no reasonable alternatives. In the drafting of project documentation, the contractor must agree with the investor all the proposed network collisions with trees and shrubs.

In the course of construction work - carried out within the root mass of trees or shrubs - earthworks and works associated with the use of mechanical equipment must be performed in a manner least damaging trees and plants.

As mentioned above, conflict with the nature is not expected. In case of route changes for reasons beyond control and when a collision with the greenery occurs, the contractor is required to obtain consent for the felling and to pay appropriate fee. The obligation to pay for removal of trees or shrubs is based on Article 84 of Nature Conservation Act. The rates for the removal of trees are calculated according to the circumference of the trunk and its growth rate, genus and species of the tree, and also depending on the production costs of individual genuses and species of trees. Territorial factor is also significant. Charge rates are indexed to the Consumer Price Index, which was adopted in the budget for the next financial year and published in the Polish Monitor (valorized rates are published). There are also rises in basic rates provided by the law.

The Contractor must be familiar with all the regulations of cutting down or replanting, and trimming trees and shrubs. In certain cases, he obtains all required permissions

necessary to carry out felling, replanting, trimming and waste management. Before felling or replanting trees, which requires appropriate permission, the investment Contractor will perform (at his own expense) a 'dendrologic report' inventorying greenery state in the area covered by the investment and other necessary studies and documentation.

The removal of trees older than 5 years old or shrubs requires permission of the municipality leader. Permission is necessary even in case of felling the self-sown plants or dead plants. No authorization is required for care and sanitary treatment. There is a category of trees not covered by these requirements. These are for example trees damaging road infrastructure, fruit trees, trees limiting visibility at intersections, railway crossings, trees younger than 5 years old, etc. Fees for removal of trees (permission required) is not collected, among others, in case of treatments for trees and shrubs, removing trees that threaten the safety of persons or their property, dead trees, removal of poplars with a circumference exceeding 100 cm (measured at a height of 130 cm from the ground), if they are replaced by other trees planted.

Applicants for a permission to remove trees and shrubs should submit a request to the appropriate environmental protection department of the municipal office, including:

- data on tree species;
- tree trunk circumference (measured at a height of 130 cm from the ground) or in the case of shrubs - shrubs overgrown area in m2 - if the tree has more than one trunk, the fee for removal will be calculated separately for each trunk;
- use of the land on which a tree or a shrub grows;
- cause and date of the intended removal of trees or shrubs - on the situational plan there must be selected a tree or a shrub to be cut down;
- document confirming the right to dispose of an area.

The area designated for implementation of the project is located outside the areas subjected to nature conservation, including NATURA 2000 areas. The planned

investment is not expected to have an impact on the NATURA 2000 network areas.

During properly conducted exploitation, the sewage system in question will not have negative impact on surface water, groundwater and soil. This statement is supported by the fact that the investment in question will be made as a closed and tight system and sewage stretches will be sited below the freezing zone.

IMPACT ON CLIMATE AND LANDSCAPE

The planned investment will not significantly affect the environment, and thus will not cause changes in climate.

The land for the investment in question is outside the mining area. The project will not cause mass movements of the earth.

IMPACT ON MONUMENTS AND CULTURAL LANDSCAPE, COVERED BY EXISTING DOCUMENTATION, INCLUDING THE REGISTER OR THE RECORDING OF MONUMENTS

The area where the investment will be realized is not subject to preservation maintenance. Within the investment there are no landmarks, there is also no cultural landscape, and therefore no impact analysis was performed on these elements.

INTERACTION BETWEEN THE ELEMENTS

The environment can be divided into two basic groups:

- elements of inanimate nature, ie. abiotic (rocks and the lie of the Earth's surface built out of them, water and air),
- elements of living nature, ie. biotic, including the organic world, ie., plants and animals.

Abiotic and biotic elements form a joint natural environment, these elements are closely interrelated and linked. The lie of the Earth's surface is subject to changes under the influence of climate-dependent factors (ventilation, water activity, winds). The water conditions are determined by the characteristics of climate, geology, and the lie of the

land. Vegetation plays an important role in the regulation of water conditions, modifying the climate and soil-forming processes.

The natural environment, transformed by a man is called geographical environment, such as rural community, municipalities, cities, etc. It is a complex system comprising:

- elements of the environment (animate and inanimate nature),
- elements of nature introduced by humans (arable land, orchards, parks, artificial lakes, roads, embankments, etc.).

Natural resources are necessary to balance the whole system, which is the environment, so that necessary to preserve the continuity of its natural functions (constant energy flow and circulation of matter). The following types of resources are distinguished:

- non-renewable, can be found in the lithosphere and are associated with its construction (liquid and solid fossil resources),
- partially renewable (specific biosphere air, particular waters of terrestrial ecosystems),
- renewable - other environmental resources such as water, air, soil and organic world.

Their special feature is the ability of regeneration that is regeneration of damaged properties and restoration of natural features that have been disrupted.

Investment in question will not negatively affect the individual elements of the environment, so there have to be no negative interactions between them. In the event of failure of the sewage network, the impact of the project will have a spot character and will cause no permanent damage to the environment. Within the proposed project there are components classified as renewable resources. Regeneration ability of these components of the environment is a factor that balance the whole system.

6. Description of the expected significant effects of the proposed project on the environment

EXISTENCE OF THE PROJECT

After the analysis of point 4, the possibility of occurrence of potentially significant effects of the planned project on the environment is not stated. During exploitation of the built sewage system there will occur no permanent, medium nor long term impacts. The proposed sewage system will allow to comprehensively solve the problems of waste water management in the area of investment.

Given the scope and type of work, it can be stated that the investment will have positive impact on the environment and surroundings. This concerns such elements of the environment as soil and water quality, spatial management quality, nature, nuisances and impact of their functions on the environment. Sewage infrastructure, planned to be built, will allow drainage of sanitary sewage from the area of investment to the existing sewage treatment plant. This will allow to achieve measurable environmental results. The effect of water protection will be a supralocal effect.

The area of the proposed project will not be located within the protection zone subjected to preservation maintenance. Treatment of waste water coming from human living and activity (included in the collective sewage systems), by sewage treatment facilities to the required and specified by law degree (before their discharge to the receiver), will constitute sufficient and adequate protection of surface water and groundwater. Competent management of waste produced in the process of waste water treatment will provide protection for the earth's surface.

Sanitary sewage system will not endanger the environment and human health and life, and will not violate the interests of third parties. It will not require an area of limited use, because its impact will not extend beyond the area intended for its construction.

The investment at the stage of construction work poses no threat to plant and animal world. At the stage of construction work, the investment will not adversely affect the earth's surface.

ENVIRONMENTAL RESOURCES EXPLOITATION

During exploitation of the sewage system, it is not expected to directly use

environmental resources. The planned project in terms of construction does not provide for meaningful environmental resources exploitation.

Emissions of pollutants to air

Works related to construction of infrastructure will have little impact on air pollution (typical construction works). In the course of this work, a slight emission of particulates will be observed.

It is expected that with the proper exploitation, closed and underground sanitary sewage network will not be a source of emission of pollutants to air.

Noise emission to the environment

The investment can be cumbersome because of the noise only during the construction work. Taking into account the land development, scope and work duration, it should be concluded that the acoustic climate disorder, caused by the noise emitted by machinery and equipment carrying out construction and repair work, will not affect significantly human health and the acoustic climate of adjacent areas.

The basis for determining the level of noise emitted into the environment at the stage of exploitation was the analysis of equipment used in the proposed sewage network together with pumping stations. Used equipment is quiet and additionally built under the land surface or the surface of sewage.

It is expected that with the proper exploitation, closed and underground sanitary sewage network will not be a source of noise emission to the environment.

Waste emission

During the implementation of the task, some waste will be produced. The Contractor must provide transportation and disposal of waste in accordance with the Act on Waste. Contractor obtains in this respect all the required permissions and decisions on production and transportation of hazardous waste. Contractor will each time extend documents of waste management, in particular:

- copies of contracts with entities operating in the field of recycling and neutralizing waste,
- list of the quantity and type of waste generated, together with giving waste transfer site,
- copies of waste transfer cards endorsed by the entity operating in the field of recycling and neutralizing waste.

Materials that are harmful to the environment only during construction and after its completion their harmfulness disappears (eg, dusting materials) may be used provided that the technological requirements concerning their placement are met. Materials that are permanently harmful to the environment will not be allowed to be used. Materials that cause harmful radiation that exceeds the allowable concentration are not allowed to be used.

All waste materials used for construction will have the approval certificate issued by an approving body, clearly defining the lack of harmful effects of these materials on the environment.

7. Description of the expected actions aiming at preventing, reducing or compensating for adverse impacts on the environment

Investment realization provides a significant improvement in the level of protection of local environment by reducing pollution from urban waste water, thereby improving the quality of surface water and groundwater. The project will lead to the elimination of threats resulting from uncontrolled discharge of sewage: leaking domestic septic tanks, wild leads to the ground, rivers or surface water courses. The expected effect of the project is:

- compliance with environmental standards of Polish and EU legislation within the scope of waste water treatment and compliance with Directive 91/271/EEC,

- proper water and sewage management,
- improvement of sanitary conditions in the Municipality of Mniszków through the elimination of septic tanks, household sedimentation tanks and "wild" untreated sewage outlets to the sewage receivers,
- improvement of the environment by reducing the pollution load discharged into the receiver point and improvement of water quality in the Pilica river and the Sulejów Reservoir,
- protection of groundwater being a drinking water reservoir for Lodz,
- improvement of sanitary conditions in the region.

Contractor is required to know and use at the time of conducting the work all provisions relating to environmental protection. Contractor will be responsible for removal of hazardous materials, waste, debris or other masses of earth to approved, appropriate landfill, in accordance with the Environmental Protection Law. Contractor requests permissions and arrangements referred to the Environmental Protection Law. During the construction and finishing works contractor will:

a) keep the site and excavations without standing water,
b) take all reasonable steps to comply with the regulations and standards regarding the environment in and around the construction site and will avoid damage or nuisance to persons or public property and others, resulting from contamination, noise or other causes arising as a result of his actions. Following these requirements he will have particular regard to:

- location of bases, workshops, warehouses, landfills, borrow-pits and access roads,
- precautions and safeguards against:

    o polluting reservoirs and watercourses with dust or toxic substances,
    o polluting air with dust and gases,
    o the possibility of fire,

c) Contractor is required to know and use at the time of conducting the work all provisions relating to environmental protection, in particular:

- comply with the Act of 16 April 2004 on Nature Conservation, as amended,
- comply with the Act of 27 April 2001 Environmental Protection Law, as amended,
- comply with the Act of 27 April 2001 on waste, as amended,
- comply with the Regulation of the Minister of Environmental Protection, Natural Resources and Forestry dated 13 May 1998 on the permissible noise levels in the environment,
- comply with the Act of 18 July 2001, the Water Law, as amended.

Within the implementation of the plan the following technical solutions have been developed to reduce and eliminate the negative impact of the planned investment on the environment:

- use of watertight pipes, manholes and their connections, which effectively prevents the penetration of water into soil and groundwater,
- use of a closed system, separated from the atmosphere - which does not deteriorate the environment in terms of emission of pollutants or odours,
- laying sanitary sewage system below freezing level,
- ensuring proper sewage treatment by channelling sewage to the modern treatment plant in Mniszków,
- high degree of automation,
- provision of the network designed to effectively prevent leakage and water penetration to the ground and groundwater,
- issues of noise protection according to the applicable requirements have been met in design solutions by using appropriate building materials.

As part of the works included in the project, some less than burdensome impacts

on the elements of the environment (water, land, flora and fauna, air quality, sound climate and vibration, people and their health and on the landscape, material assets and monuments) will occur. This impact will be short-lived and totally transitory. Completion of the project will entail complete disappearance of arduousness. Using industry regulations and safety regulations, implementation of the project will not be a threat to the environment both during its construction and during operation.

8. Comparison of the proposed technology with technology meeting the requirements of Article 143 of Environmental Protection Law

The proposed solutions meet the requirements of Article 143 of the Environmental Protection Law:

1. efficient energy consumption - use of modern technological equipment with engines of high efficiency, which comes down to a reduced demand for electricity,
2. rational use of raw materials and materials - the rational use of water,
3. scarce emission of pollutants and noise to the environment,
4. considering the latest materials and solutions (with PVC pipes, HDPE pipes and a new generation of vitrified clay pipes, wells made of PE and concrete),
5. use of sanitary sewage system as a solution of low energy consumption.

9. Indication whether it is necessary for the proposed project to establish a restricted use area and to define the borders of such an area

The proposed technological system of channelling sewage through the drainage system is characterized by low environmental nuisance. Utilized materials and equipment ensure the reduction of noise and smells, as well as the spread of aerosols.

Based on the presented in this report analysis of the planned sewage system impact on the environment, it is concluded that the emission will not exceed the limit values of:

- contaminants in the air,
- sound level at the height of the nearest residential development,
- concentrations of substances in waste water discharges.

It is concluded that the proposed sanitary sewage system is a structure that does not require an area of limited use according to the Act of 'Environmental Protection Law'.

10. Presentation of issues in graphic and cartographic form

The issues presented in graphical form are included in the drawing part, presenting the location of investment (land development project).

11. Presentation of the proposed analyses of the project impact on the environment

Due to the fact that the planned investment will not adversely affect the environment, the need for analysis of environmental impact of the project is not expected.

Nevertheless, the Contractor is required to know and use at the time of conducting the work all provisions relating to environmental protection. Contractor will be responsible for removal of hazardous materials, waste, debris or other masses of earth to approved, appropriate landfill, in accordance with the Environmental Protection Law. Contractor requests permissions and arrangements referred to the Environmental Protection Law. During the construction and finishing works Contractor will:

- keep the site and excavations without standing water,
- take all reasonable steps to comply with the regulations and standards regarding the environment in and around the construction site and will avoid damage or nuisance to persons or public property and others, resulting from contamination, noise or other causes arising as a result of his actions. Following these requirements he will take particular account of: location of bases, workshops,

warehouses, landfills, borrow-pits and access roads, precautions and safeguards against polluting reservoirs and watercourses with dust or toxic substances, polluting air with dust and gases, the possibility of fire.

Contractor is required to know and use at the time of conducting the work, all provisions concerning the protection of the environment, in particular, to comply with the Act of 16 April 2004 on Nature Conservation, the Act of 27 April 2001 Environmental Protection Law, the Act of 27 April 2001 on waste, the Regulation of the Minister of Environmental Protection, Natural Resources and Forestry of 13 May 1998 on the permissible noise levels in the environment and comply with the Act of 18 July 2001 Water Law.

Contractor must be familiar with all regulations of cutting down or replanting, and trimming trees and shrubs. In certain cases, he obtains all required permissions necessary to carry out felling, replanting, trimming and waste management. Before felling or replanting trees, which requires appropriate permission, Contractor will make an inventory of greenery state in the area of works and other necessary studies and documentation.

Contractor is fully responsible for maintaining the intact state of all inventoried trees and plantings (expected to be left). Any comments and exceptions of the actual to the inventoried state at the design stage has the right and obligation to report before the start of works. In case of a damage or destruction of shrubs intended to be left, Contractor is obliged to regenerate them. Illegal felling of trees will be covered by an administrative penalty in accordance with applicable regulations.

12. Analysis of possible social conflicts associated with the proposed project

Occurrence of the events constituting a source of conflicts in local community is not expected. The prospect of execution and above all exploitation of properly functioning drainage system that would meet the requirements of environmental protection, in a

prominent way will improve the quality and comfort of everyday life and use of basic municipal infrastructure.

It should be also emphasized that the nuisance of closed, gravitational and underground sanitary sewage system is slight.

13. Presentation of a proposition of monitoring the impact of the proposed project at the stage of its construction and operation

At the stage of conducting construction works within the sewage system, it is not expected to carry out monitoring because of the high level of standardization of technology of objects construction and works conduction. The scope of the implementation of security policy with regard to environmental protection includes all activities that Contractor will be required to perform and which result from the acts relating to the issue of waste water treatment (Law of 16 April 2004 on the protection of wildlife, of 27 April 2001 Environmental Protection Law , of 27 April 2001 on waste, of 18 July 2001 Water Law and the Regulation of the Minister of Environmental Protection, Natural Resources and Forestry of 13 May 1998 on the permissible noise levels in the environment).

In the phase of drainage system exploitation, the proposed scope of monitoring includes:

1. Waste. In terms of waste management, there should be kept a record of the number of all types of waste that will be generated during system operation by specimens documents that are to register the waste, included in the Regulation of the Minister of the Environment of 27 September 2001 (Journal of Laws, No 112, item 1206),
2. Pollutants emitted into the air. Due to the nature and scale of the project, there are no reasons to oblige the investor to monitor emissions of gases into the air.
3. The quantity and quality of waste water. Pursuant to Article 5 of the Regulation of the Minister of the Environment of 24 July 2006 on conditions to be met during

placing waste in water or ground or on substances particularly harmful to the aquatic environment (J. of L. No. 137, item 984), sampling of waste water placed in water and measuring the quantity and quality should be made at regular intervals during the year and always in the same place. The number of samples can not be less than 12 samples per year, and if it is shown that effluent meets the required conditions - 4 samples in subsequent years. However, in case when one of the four conditions does not meet the required degree of purification, the next year again 12 samples are collected. The following parameters are to be measured in the samples:

- five-day biochemical oxygen demand (BOD5) - marked with the addition of nitrification inhibitor;
- chemical oxygen demand (ChZTCr) - marked by dual-chromium method,
- general suspensions.

4. Noise. Due to the nature and scale of the project, as well as selected devices, there are no reasons to oblige the investor to monitor emissions of noise into the air.

14. Indication of any difficulties arising from technical deficiencies or gaps in current knowledge

During preparation of this report, there were no more difficulties associated with shortages of technology or gaps in today's knowledge because of the typical technical and technological solutions used in planned investment.

15. Summary in non-specialist language

DESCRIPTION OF THE PLANNED PROJECT

The project is one of the tasks of the key project 'Improvement of water quality in the Sulejów Reservoir', which includes the construction of sewage system with

connections and pumping stations in Zarzęcin in the Municipality of Mniszków.

The project will consist of construction of basic technical infrastructure for sanitary sewage system. The detailed project scope includes the construction of 9.5 km gravitational sewage network, 6.9 km of pressure sanitary sewage network, construction of 9 pumping stations and sewage construction of 3.7 km sewer connections.

As a result, the project provides a significant improvement in the level of protection of local environment by reducing pollution from urban waste water, thereby improving the quality of surface water and groundwater. Implementation of the project will also positively impact the standard of living and business environment in the Municipality of Mniszków. The project will lead to the elimination of threats resulting from uncontrolled discharge of sewage: leaking domestic septic tanks, wild leads to the ground, rivers or surface water courses.

DESCRIPTION OF THE NATURAL ENVIRONMENT ELEMENTS WITHIN THE SCOPE OF THE EXPECTED IMPACT OF THE PROPOSED PROJECT ON THE ENVIRONMENT

Municipality of Mniszków belongs to the mesoregion of Opoczyńskie Hills, being a part of the macroregion of Przedborska Upland.

Mesoregion of Opoczyńskie Hills is an area located on the curve of the Pilica river on its right bank. It consists of a series of isolated hills and mountains reaching up to 270 m above sea level. Pilica Valley is clearly outlined and the stretch from Przedbórz to Tomaszów Mazowiecki falls into the range of 150 200 meters above sea level. In the region of Zarzęcin, it reaches 160 m above sea level and is the lowest area located in the Municipality of Mniszków.

The whole area of the Municipality is covered with soil formed from loose sands of different origins and with boulder clay and sand lying on the clay. Occasionally, there are soils formed from loams and weakly clayey loam. Soil formed from sands represents 70% of the municipality land.

In the Municipality of Mniszków, there are the following protected nature areas:

1. Forest reserve, 'Gaik', is located in the municipality of Mniszków in Smardzewice Forest District, within Błogie, in Małe Końskie forestry. Reserve protects a variety of forms of continental broadleaved forest, ie. components of: low broadleaved forest and variant of stenothermic broadleaved forest. This is an example of the forest of outstanding natural and landscape beauty. This testifies that nearly 80% of the reserve is covered with old, nearly 200-year-old stands of oaks, which are among the oldest in the Park. There is an interesting ornithofauna in the reserve; nearly 50 species of birds nest here . There are also rich vascular plants, including over 250 species.
2. Forest reserve, 'Błogie', is located in the municipality of Mniszków in Smardzewice Forest District, within Błogie, in Małe Końskie forestry. The aim of establishing the reserve is to preserve a fragment of natural stands of firs and mixed stands of firs on the northern edge of fir range in Pilica Forest. The reserve is dominated by fir broadleaved forest, occurring often in a mosaic with riparian forest. A significant part of the reserve is a forest mixed well with fir. Furthermore, at its western boundary there is a precious area of great scenic beauty, almost 200-year-old ancient forest of pine trees and oaks.

SULEJÓW LANDSCAPE PARK

Sulejów Landscape Park was created in 1994 on the territory of the following municipalities: Sulejów (municipality and town), Ręczno, Aleksandrów, Mniszków, Wolbórz, Tomaszów Mazowiecki (municipality and town), Rozprza, Piotrków Trybunalski, Łęki Szlacheckie, Przedbórz and Sławno. The park area amounts to 17 444 ha, and buffer zones - 38 927 ha. Half of the Sulejów Landscape Park area is covered by forests while waters cover (including Sulejów Reservoir) - less than 5%. There are 11 nature reserves in Sulejów Landscape Park, covering a total area of 624 ha. Sulejów Park

amenities form mainly: natural landscape of the river, especially the middle section of Pilica between Przedbórz and Sulejów (proposed for inclusion in the European network of protected areas Natura 2000), Luciąża 'delta', Czarna Maleniecka, mid-forest streams such as Strugi Młynki (beavers refugium). Geological features such as Bąkowa Góra (in the borderland of Central Polish Lowlands and Lesser Polish Upland), high edges of the Pilica Valley (eg. in Barkowice and Sulejów) and the most valuable landscape and water nature reserve in central Poland - Niebieskie Źródła.

Analysis of environmental impact indicates that the project will not negatively impact the indicated elements of the natural environment.

DESCRIPTION OF MONUMENTS EXISTING IN THE NEIGHBOURHOOD OR IMMEDIATE RANGE OF IMPACT OF THE PLANNED PROJECT

In the neighbourhood and in the area of the development, there is no monuments protected under the provisions of protection of monuments and the guardianship of monuments.

DESCRIPTION OF THE ANTICIPATED ENVIRONMENTAL IMPACTS IN CASE OF PROJECT INACTION

Resignation from the construction of sanitary sewage system in the Municipality of Mniszków will have negative effects. Sewage generated by households will continue to be discharged into the leaking domestic septic or sedimentation tanks. Discharge of polluted waste water into surface waters and soil causes gradual environmental degradation and health risks. This also leads to continued deterioration in the quality of surface and groundwater in the area. This leads to contamination of soil and groundwater by untreated sewage, and thereby contributes to the deterioration of the environment. Using septic tanks is cumbersome due to emitted odour and pathogenic bioaerosols, formed as a result of digestion of waste water kept in domestic septic

tanks. Such nuisances increase in time of collection of digested domestic waste water by the septic tanker truck, and additionally fumes and noise are emitted into the environment. Moreover, the shuttle to the sewage collection stations alone may cause road contamination.

After considering the zero option - concerning not taking up the project - it is concluded that not taking up the project will entail further negative impact on the environment. It may cause further gradual degradation of the environment, health risks and continued deterioration of surface and groundwater quality.

DESCRIPTION OF ANALYZED VARIANTS

Given the scope and type of work, it can be stated that the construction of drainage system will have a decidedly positive impact on the environment and surroundings. This concerns such elements of environment as soil and water quality, spatial management quality, nature, nuisances and impact of their functions on the environment.

As part of the works included in the project of construction of sewage system in the Municipality of Mniszków, in Zarzęcin village council office, some less than burdensome impacts on the elements of the environment (water, land, flora and fauna, air quality, sound climate and vibration, people and their health and on the landscape, material assets and monuments) will occur. This impact will be short-lived and totally transitory. Completion of the project will entail complete disappearance of arduousness. Using industry regulations and safety regulations, implementation of the project will not be a threat to the environment both during its construction and during operation.

Alternative option considered, involving the partial refurbishment of the existing sanitary sewage system in the area of Zarzęcin which receives sewage from approximately 50 parcels that are discharged through the sewage pumping station into

the biological treatment plant, turned out to be not interesting enough. The renovation works require the involvement of large financial resources at a similar interference in the environment compared with the construction of a new sanitary channel. For these reasons, this option was rejected.

MOST FAVOURABLE VARIANT TO THE ENVIRONMENT

Most favourable to the environment proved to be the option concerning making an investment in the construction of a municipal sewage system. The expected effect of the project is:

- compliance with environmental standards of Polish and EU legislation within the scope of waste water treatment to achieve compliance with directives,
- proper water and sewage management,
- improvement of sanitary conditions in the Municipality of Mniszków through the elimination of septic tanks, household sedimentation tanks and "wild" untreated sewage outlets to the sewage receivers,
- improvement of the environment by reducing the pollution load discharged into the receiver point and improvement of water quality in the Pilica river (protection of source areas of the Vistula and the Baltic Sea),
- protection of groundwater being a drinking water reservoir for the agglomeration of Lodz,
- improvement of sanitary conditions in the region,
- increase in equipment of investment areas surrounding the Sulejów Reservoir,
- increase in investment attractiveness,
- reduction of unemployment and giving equal opportunities for rural population.

IMPACT OF ANALYZED VARIANTS ON AIR

The implementation phase will involve some earth or assembly works, during which it may occur merely coincidental emission of pollutants into the air and it will practically be dust pollution resulting from the movement of masses of earth, installing

technological equipment (surface cleaning, etc.) and traffic of vehicles transporting technological elements and construction materials. In order to reduce emission of gaseous substances, there should be roadworthy cars, cranes and excavators used. At this stage, the extent of possible influence will be located practically on the construction site to which the investor has legal title. These interactions will always be local, short-term and will be kept to a minimum by the proper organization of works and will cease upon completion of works.

Due to the nature of the work under construction, the arduousness of the construction site will be limited only to the immediate neighbourhood especially that the lifted dust from building materials are thickly fractional and their lifting distance is small.

Nuisances associated with the liquidation of the investment may be similar to the impacts arising during the implementation of the chosen variant. Demolition work may be followed by emission of gases and dust from welding and tearing down, carried out in the open space. These processes will be short-lived and will not contribute to deterioration of air pollution.

IMPACT ON SURFACE WATERS AND GROUNDWATER AND THE EARTH'S SURFACE

In the course of these variants realization, used materials and substances will not cause negative impact on the earth's surface, groundwater and surface water. Construction equipment will be technically efficient and will not cause contamination of water, aquifers and soil with oil derivatives.

Due to the similar nature of the options analyzed, the impacts on the earth's surface, surface water and groundwater during the occupied time will be very similar.

During the possible elimination of variants discussed, the impact on the earth's surface, groundwater and surface water will be similar, as in the case of the investment realization.

IMPACT ON ACOUSTIC CLIMATE

In the phase of implementation during construction work, the adverse acoustic

phenomena will occur in the zone of works carried out and in their vicinity. These interactions can cause deterioration of the acoustic climate, because the heavy machinery carrying out works related to the construction of the drainage system will be the source of emission of high levels of sound.

In the course of construction, there will occur noise emission associated with operation of heavy construction machinery used for construction work. During the investment realization, increased traffic of trucks delivering building materials will take place. Given the focus of construction works in a small area, construction site disturbance will be limited only to the immediate neighbourhood of the investment. In order to reduce nuisance related to the implementation of the project, performing works will be limited to the specific time of the day, between 6^{00} and $22^{00.}$. Nuisances associated with noise emissions during construction will be temporary and will cease after the construction of drainage system.

The variants discussed will not constitute a significant source of environmental noise. Sewer pipes are located under the surface, which protects against possible noise emission to the environment. Submersible pumps running in pumping stations are under the surface of sewage, which minimizes the noise emissions to the environment. The occupied time of the investment will not be associated with the emission of noise into the environment.

During possible liquidation of the project, the emission of noise to the environment will be similar, as in the case of the investment realization.

Variant most favourable to the environment

Most favourable to the environment proved to be the option concerning making an investment in the construction of a sewage system. At the stage of preparation, the investment was subjected to a thorough technical and financial analysis. The expected effect of the project is:

- compliance with environmental standards of Polish and EU legislation within the scope of waste water treatment,

- proper water and sewage management,
- improvement of sanitary conditions in the area of the Reservoir through the elimination of septic tanks, household sedimentation tanks and "wild" untreated sewage outlets to the sewage receivers,
- improvement of sanitary conditions in the region,
- increase in equipment of investment areas,
- increase in investment attractiveness of land in the immediate vicinity,
- reduction of unemployment and giving equal opportunities for rural population.

DETERMINATION OF EXPECTED ENVIRONMENTAL IMPACT OF THE ANALYZED VARIANTS, INCLUDING IN CASE OF MAJOR INDUSTRIAL ACCIDENT AND POSSIBLE CROSS-BORDER ENVIRONMENTAL IMPACT

IMPACT OF ANALYZED VARIANTS ON AIR

The implementation phase will involve some earth or assembly works, during which it may occur merely coincidental emission of pollutants into the air and it will practically be dust pollution resulting from the movement of masses of earth, installing technological equipment (surface cleaning, etc.) and traffic of vehicles transporting technological elements and construction materials. In order to reduce emission of gaseous substances, there should be roadworthy cars, crane and excavator used. At this stage, the extent of possible influence will be located practically on the construction site to which the investor has legal title. These interactions will always be local, short-term and will be kept to a minimum by the proper organization of works and will cease upon completion of works.

Due to the nature of the work under construction, the arduousness of the construction site will be limited only to the immediate neighbourhood especially that the lifted dust from building materials are thickly fractional and their lifting distance is small.

Liquidation of the project regardless of the implemented variant will entail the need to remove the old pipes from the ground and make new channels in the same place.

Nuisances associated with the liquidation of the investment may be similar to the impacts arising during the implementation of the chosen variant. Demolition work may be followed by emission of gases and dust from welding and tearing down, carried out in the open space. These processes will be short-lived and will not contribute to deterioration of air pollution. In the short term investor does not provide for the liquidation of the sewage system.

Impact on surface waters and groundwater and the earth's surface

In the course of these variants realization, used materials and substances will not cause negative impact on the earth's surface, groundwater and surface water. Construction equipment will be technically efficient and will not cause contamination of water, aquifers and soil with oil derivatives.

Due to the similar nature of the analyzed options of the realized investment, the impacts on the earth's surface, surface water and groundwater during the occupied time will be very similar. In order to avoid negative effects of raw sewage on the earth's surface, groundwater and surface water, a system of PVC and PE pipes and their object-oriented connections is planned to be tight. In addition, new facilities will be constructed to be tight and the existing ones will be subjected to maintenance.

During possible elimination of variants discussed, the impact on the earth's surface, groundwater and surface water will be similar, as in the case of the investment realization. In the short term investor does not provide for the liquidation of the sewage system.

Impact On Acoustic Climate

In the phase of implementation during construction work, the adverse acoustic phenomena will occur in the zone of works carried out and in their vicinity. These interactions can cause deterioration of the acoustic climate, because the heavy machinery carrying out works related to the construction of the drainage system will be the source of emission of high levels of sound. Due to the similar nature of works in terms of noise, there was no need to analyze the different options separately. The

analysis of the noise emission to the environment has been made for the period of operation, implementation and liquidation.

In the course of construction, there will occur noise emission associated with operation of heavy construction machinery used for construction work. During the investment realization, increased traffic of trucks delivering building materials will take place. Given the focus of construction works in a small area, construction site disturbance will be limited only to the immediate neighbourhood of the investment. In order to reduce nuisance related to the implementation of the project, performing works will be limited to the specific time of the day, between 6^{00} and $22^{00.}$. Nuisances associated with noise emissions during construction will be temporary and will cease after the construction of drainage system.

It is anticipated that on the construction site there will be a backhoe loader, a vibratory compactor, and a crane in operation. It is assumed that the crane and the backhoe loader will not work simultaneously. Works will take place only during daytime. It has been agreed that the operation of the devices will be no longer than 3 hours within 8 hours of the day. Smooth operation of the devices both in the area of the proposed multifunctional building and the area across the division is expected.

The variants discussed will not constitute a significant source of environmental noise during their operation. Sewer pipes are located under the surface, which protects against possible noise emission to the environment. Submersible pumps running in pumping stations are under the surface of sewage, which minimizes the noise emission to the environment. The occupied time of the investment will not be associated with the emission of noise into the environment.

During possible liquidation of the project, the emission of noise to the environment will be similar, as in the case of the investment realization. Nuisances associated with the liquidation of the realized variant may be similar to the impacts arising during its implementation. Disturbance will be short-lived, transient and of local nature. In the short term investor does not provide for the liquidation of the sewage system.

Impact on flora and fauna, landscape, climate and cultural goods

The analyzed variants are not expected to have an impact on the NATURA 2000 network areas.

In the vicinity of the planned investment, there are no legally protected monuments.

Implementation of the options analyzed will have a negative impact on flora and fauna, due to the limited scope of the project and planned management of the land surface in accordance with the project after completion of construction process. The main representatives of the fauna in this area may be insects and birds, however the presence of small rodents and mammals can not be excluded. The investment carried out will not make local animals to change their habitat.

After completion of earthworks associated with construction of a sewage network, this area will be restored to its original state. Completed elements of the discussed variants do not introduce significant changes in spatial management of land and landscape.

The analyzed variants are located in an area not covered by the forms of nature protection under the law 'On Nature Protection'. This area is located outside the national parks and nature reserves. During possible liquidation of projects, regardless of the variants discussed, an impact on flora and fauna, landscape, climate, material assets and cultural property will be similar, as in the case of the investment realization.

Effects on human beings

During the project realization, adverse effects on humans may be caused by local dusting and noise, increased traffic of cars and mechanical equipment within the ongoing construction work and access road. Nuisances, however, will have a local, periodic and transient character after the completion of the investment.

During the occupied time, analyzed variants will not have an adverse effect on people because of their minimal nuisance to surrounding residential buildings such as the lack of significant pollutants emission to the air, soil and water and low noise emission.

During possible elimination of variants discussed, the effect on people will be similar,

as in the case of the investment realization. In the short term investor does not provide for the liquidation of the sewage system.

Cross-Border Impact On The Environment

Due to the nature and location of the investment, the cross-border impact on the environment will not take place.

Extraordinary threats to the environment

Major accidents within the Environmental Protection Law are events, in particular emissions, fires or explosions, taking place during the industrial process, storage or transport, where there is one or more hazardous substances, leading to an immediate threat to life or human health or environment or the creation of such a threat with delay.

At the stage of sewage system construction, storage of hazardous substances (fuels supplying construction equipment) is not expected in the area of investment carried out.

During the operation of the analyzed variants, there are no dangerous substances which could lead to an immediate threat to life or human health or the environment or the creation of this threat with delay. Therefore, the possibility of a major accident during the occupied time of the analyzed variants is excluded.

It should be noted that during the operation of the selected variant, it is mandatory to carry out conservation works and regular maintenance of network and technical facilities. Occurring damages should be removed temporarily by the employed conservators.

Nature of the works at the stage of liquidation is very close to building works carried out during the implementation period. At the stage of project liquidation, it must be assumed that there will be no risk of a major accident.

JUSTIFICATION OF THE VARIANT PROPOSED BY THE APPLICANT WITH AN INDICATION OF ITS IMPACT ON THE ENVIRONMENT

In case of construction of sewage system in Zarzęcin, due to the landform features, as well as to a small range of investments, there was only one variant taken into consideration, concerning channelling sewage to the sewage treatment plant in Mniszków.

Effects on humans, animals, plants, mushrooms and natural habitats, water and air

Nuisances for people and the environment associated with noise emission during sanitary sewage system construction will be temporary and will cease after the construction of drainage system. The planned investment during maintenance will not exert negative effects on people because there will be no significant source of noise and odour emissions nor bacterial contaminants emitted into the atmosphere.

Implementation of the investment will also have no negative impact on flora and fauna, due to the limited scope of the project and planned development in accordance with the project.

During properly conducted exploitation, the sewage system in question will not have a negative impact on surface water, groundwater and soil. This statement is supported by the fact that the investment in question will be made as a closed and tight system and sewage stretches will be sited below the freezing zone.

Impact on the earth's surface, including the mass movements of land, climate and landscape

The planned sewage system will be routed underground, so that it will not cause significant changes in land use and landscape of the land surface. After the earthworks, the investment area will be developed in accordance with the project.

The planned investment will not significantly affect the environment, and thus will not cause changes in climate.

The land for the investment in question is outside the mining area.

Impact on material goods

The analysis of the impact on material goods leads to the conclusion that in the area of the proposed investment, no negative impact on material goods will take place.

Impact on monuments and cultural landscape, included in the existing documentation, in particular in the register or the recording of monuments

The area where the investment will be realized is not subject to preservation maintenance. Within the investment there are no landmarks, there is also no cultural landscape, and therefore no impact analysis of these elements was performed.

Interaction between the elements

Investment in question will not negatively affect the individual elements of the environment, so there have to be no negative interactions between them. In the event of failure of the sewage network, the impact of the project will have a spot character and will not cause permanent damage to the environment. Within the proposed project there are components classified as renewable resources. Regeneration ability of these components of the environment is a factor that balance the whole system.

DESCRIPTION OF THE EXPECTED SIGNIFICANT EFFECTS OF THE PROPOSED PROJECT ON THE ENVIRONMENT

Existence of the project

After the analysis of point 4, the possibility of occurrence of potentially significant effects of the planned project on the environment is not stated. During exploitation of the built sewage system there will occur no permanent, medium and long term impacts. The proposed sewage system will allow to comprehensively solve the problems of waste water management in the area of investment.

Environmental resources exploitation

During exploitation of the sewage system, it is not expected to directly use

environmental resources.

Emission of pollutants to air

Works related to construction of infrastructure will have little impact on air pollution (typical construction works). In the course of this work, a slight emission of particulates will be observed.

It is expected that with the proper exploitation, closed and underground sanitary sewage network will be a source of scarce emission of pollutants to air.

Noise emission to the environment

The investment can be cumbersome because of the noise only during the construction work. Taking into account the land development, scope and work duration, it should be concluded that the acoustic climate disorder, caused by the noise emitted by machinery and equipment carrying out construction and repair work, will not affect significantly human health and the acoustic climate of adjacent areas.

Waste emission

During the realization of the tasks some waste will be generated, including hazardous ones. Contractor must provide transportation and disposal of waste in accordance with the Act on Waste. Contractor obtains in this respect all the required permissions and decisions on production and transportation of hazardous waste.

All waste materials used for construction will have the approval certificate issued by an approving body, clearly defining the lack of harmful effects of these materials on the environment.

Method of recycling waste, generated in the process of their treatment, will not pose a threat to the environment.

DESCRIPTION OF THE EXPECTED ACTIONS AIMING AT PREVENTING, REDUCING OR COMPENSATING FOR ADVERSE IMPACTS ON THE ENVIRONMENT

The project is realized within the key project 'Improvement of water quality in the Sulejów Reservoir', which includes the construction of sanitary sewage system in the area of Zarzęcin.

Contractor is required to know and use at the time of conducting the work all provisions relating to environmental protection. Contractor will be responsible for removal of hazardous materials, waste, debris or other masses of earth to approved, appropriate landfill, in accordance with the Environmental Protection Law. Contractor will be required to implement precautionary measures and safeguards against polluting water bodies and watercourses with dust or toxic substances, polluting air with dust and gases, the possibility of fire.

Contractor is required to know and use at the time of conducting the work all provisions relating to environmental protection.

Within the implementation of the plan, the following technical solutions have been developed to reduce and eliminate the negative impact of the planned investment on the environment:

- use of watertight pipes, manholes and their connections, which effectively prevents the penetration of water into soil and groundwater,
- use of a closed system, separated from the atmosphere - which does not deteriorate the environment in terms of emission of pollutants or odours,
- laying sanitary sewage system below freezing level,
- ensuring proper sewage treatment by channelling sewage to the modern biological treatment plant,
- high degree of automation,
- due to using leakproof, closed containers, the impact of treatment plants on the environment will be greatly limited,
- provision of a network designed to effectively prevent leakage and water penetration to the ground and groundwater,
- issues of noise protection according to the applicable requirements have been met in design solutions by using appropriate building materials.

As part of the works included in the project, some less than burdensome impacts on the elements of the environment (water, land, flora and fauna, air quality, sound climate and vibration, people and their health and on the landscape, material assets and monuments) will occur. This impact will be short-lived and totally transitory. Completion of the project will entail complete disappearance of arduousness.

COMPARISON OF THE PROPOSED TECHNOLOGY WITH TECHNOLOGY MEETING THE REQUIREMENTS OF ARTICLE 143 OF ENVIRONMENTAL PROTECTION LAW

The proposed solutions meet the requirements of the Environmental Protection Law:

1. during the exploitation of the constructed sewage system, there will be used substances with low hazard potential,
2. efficient energy consumption will be implemented by using modern technological equipment with engines of high efficiency, which comes down to a reduced demand for electricity,
3. rational use of raw materials and materials will be implemented - the rational use of water,
4. scarce emission of pollutants and noise to the environment will be implemented,
5. latest materials and solutions will be taken into consideration,
6. sanitary sewage system as a solution of low energy consumption will be used.

INDICATION WHETHER IT IS NECESSARY FOR THE PROPOSED PROJECT TO ESTABLISH A RESTRICTED USE AREA

The proposed sewage system is a structure that does not require an area of limited use according to the Act of 'Environmental Protection Law'.

ANALYSIS OF POSSIBLE SOCIAL CONFLICTS ASSOCIATED WITH THE PROPOSED PROJECT

The occurrence of the events constituting a source of conflicts in local community is not expected. The prospect of execution and above all exploitation of properly functioning drainage system that would meet the requirements of environmental protection, in a prominent way will improve the quality and comfort of everyday life and use of basic municipal infrastructure.

PRESENTATION OF PROPOSAL FOR MONITORING THE IMPACT OF THE PROJECT AT THE STAGE OF ITS CONSTRUCTION AND MAINTENANCE OR USE, IN PARTICULAR ON THE AIMS AND CONSERVATION OF THE NATURE 2000 AREA AND ON INTEGRITY OF THIS AREA

At the stage of conducting construction works within the sewage systems, it is not expected to carry out monitoring because of the high level of standardization of technology of objects construction and works conduction.

In the phase of drainage system exploitation, the proposed scope of monitoring includes:

1. Waste. In terms of waste management, there should be kept a record of the number of all types of waste that will be generated during system operation by specimens documents that are to register the waste.
2. Pollutants emitted into the air. Due to the nature of the project, the scale of purification and the selected technology, there are no reasons to oblige the investor to monitor emission of gases into the air.
3. The quantity and quality of waste water. Pursuant to Article 5 of the Regulation of the Minister of the Environment of 24 July 2006 on conditions to be met during placing waste in water or ground or on substances particularly harmful to the aquatic environment (J. of L. No. 137, item 984), sampling of waste water placed in water and measuring the quantity and quality should be made at regular intervals during the year and always in the same place.
4. Noise. Due to the nature and scale of the project, as well as selected devices and technology, there are no reasons to oblige the investor to monitor emission of noise into

the air.

INDICATION OF ANY DIFFICULTIES ARISING FROM TECHNICAL DEFICIENCIES OR GAPS IN CURRENT KNOWLEDGE, THAT HAVE BEEN ENCOUNTERED WHILE WRITING THE REPORT

During preparation of this report, there were no more difficulties associated with shortages of technology or gaps in today's knowledge because of the typical technical and technological solutions used in planned investment.

III. Assessment of the investment impact on socio-economic relations

1. Description of the proposed project

The project will consist of construction of basic technical infrastructure for sanitary sewage system. The detailed project scope includes the construction of 9.5 km gravitational sanitary sewage network, 6.9 km of pressure sanitary sewage network, construction of 9 pumping stations and sewage construction of 3.7 km sewer connections.

As a result, the project provides a significant improvement in the level of protection of local environment by reducing pollution from urban waste water, thereby improving the quality of surface water and groundwater. Implementation of the project will also positively impact the standard of living and business environment in the area of Sulejów Reservoir. The project will lead to the elimination of threats resulting from uncontrolled discharge of sewage: leaking domestic septic tanks, wild leads to the ground, rivers or surface water courses.

It should be emphasized that the construction of the sewage system will not only improve the quality of life and standard of operation of economic entities, but also significantly improve the investment conditions of the area.

The investment area is located in the Lodz region, in the Opoczno county, in the municipality of Mniszków. Investment implementation will take place on the plots being at the disposal of Municipal of Mniszków under construction project performed in the framework of the investment.

2. Description of the environmental aspects and social, economic and cultural consequences resulting from the ongoing investments

To assess the impact of the investment on socio-economic relations, the following methodological approach was applied:

1. Research area was divided into two orders: social and economic,
2. Each order specifies the field of development and exploration of the investment effects.

Social order		**Economic order**	
1.	Standards of civilization and the quality of life	1.	Finances of municipalities
2.	Demographics - the level of migration	2.	Enterprise
3.	Housing	3.	Tourism
4.	Human health	4.	The level and structure of employment
5.	Burden on residents	5.	Institutional strengthening
6.	Greening	6.	Impact of activity
7.	Education	7.	Availability of products and services

The impact of investment on improving standards of civilization and the quality of life

The impact of the project on the improvement of the standards of civilization and the quality of life can be measured using the following criteria:

1. improvement of the quality of sewage services,
2. improvement of living conditions (inhabitants environment).

Improvement of the quality of sewage services

Improvement of the quality of sewage services will be reflected in the amount of failures and the number of complaints of residents about reduced quality of service. This applies mainly to the existing partial sewage system, which does not meet the technical requirements. Sanitary channels, inspection wells and most of all the biological treatment plant is the cause of complaints about the malfunctioning system of channelling sewage.

Construction of a new stretch of sanitary sewage system, together with the dismantling of the existing but not properly working sewage treatment plant will improve living standards by obtaining sufficient capacity in the system of sewage collection. Total length of stretches intended for the reconstruction is about 700 m.

Improvement of living conditions (inhabitants environment)

Investments in the field of waste water management involve activities that are not directly the result of the project, but its consequence. Appreciably discernible to the environment is a phenomenon such as the number of removed household septic tanks for liquid waste (ie. septic tanks) as a result of the construction of the sewage network. Bringing the sewage to the property will enable residents to significantly accelerate and facilitate process of making connections to the sewage network and will dispense with the more expensive maintenance of septic tanks for clean and eco-friendly network solution. One of the effects of such actions is to eliminate ‘odours’ from the network of untight septic tanks in the non-sewered areas. The rate of the 'number of removed tanks' refers to the investment of 'the construction of sanitary sewage system' type.

Local government units do not always keep records of household septic tanks of liquid waste, and the data are based on the number of houses in the area, assuming that if there is no sewage system, there is a septic tank on each property and on the

number of connections to the sewage network. It can be assumed that the rate of the number of removed septic tanks, equivalent to the number of premises connected to the sewage system, is reliable.

In total, there will be ultimately 120 households/buildings connected to the sewage system as a result of the project implementation. The assumption can be made that as a result of the project the number of removed septic tanks will be close to the number of newly connected households / buildings.

Realization of investments in waste water management often involves the implementation of other investments. Examples of activities carried out as a consequence of the investment in question, though not directly connected with it, is the location of new road surfaces in areas where sewage system was built. In places where the surface has not been paved so far, or require repair, its modernization has been planned and partially carried out.. Connecting these investments maximizes social effect: the standard of living is rising not only due to the construction of sewage systems, but also due to paving temporary roads. In addition, proper activity coordination minimized nuisances associated with the construction work carried out and helped to reduce costs.

Subsequently, as a result of additional investments in roads, an improvement of communication in the areas covered by the impact of the project will be observed.

The impact of the investment on the migration level

Impact of the investments in the scope of waste water management on the migration of the population can be determined only on the basis of a theoretical relationship between phenomena. It can be recognized that the impact on migration to the city with better level of plumbing service is possible.

Construction of sewage infrastructure, which directly raises the standard of living, which in turn encourages people to settle in the area, can be considered as a direct impact of the investment.

Indirect impact of the investment on migration can be described as the impact of

projects on environmental improvement, and thus on a positive level of migration into these areas. Society perception of the area as an ecologically clean is associated with many other activities, not only with the implementation of the investment itself, but also with promotional activities of the Municipality.

In summary, the impact of investments on the migration of people in the area covered by the investment is not measurable, however it can be noticed that improved living and hygiene standards is connected with the decision to live in the area. Definitely, an indicator that more accurately reflect the impact on the social sphere is the development of housing, as described in the following chapter.

Impact of the investment on housing development

Investments in plumbing management have a direct impact on housing development. Undoubtedly, accessible and affordable sewage services are city-forming factors.

Impact of investments in plumbing management can have a direct impact on housing development, so in urban areas (availability of plumbing services is a city-forming factor) and rural areas (suppression of the outflow of young people and the motivation to settle and invest). Construction of infrastructure for land development is pre-emptive compared with the issuance of location decisions for the estates of compact multi-and single-family buildings.

The construction of underground infrastructure has a direct impact on the development of previously undeveloped areas. In the areas around Zarzęcin there are now many plots, but not maintained. Implementation of sewage investments can trigger the development of the industry, business and housing in the so far unused land. The immediate effect of the investment is an increase in land prices, investors' interest, population growth, business creation, etc.

It should be assessed that the investments in the field of water supply and sewerage may be crucial for the development of housing, but it will never be the only factor in the construction of new estates and houses. However, the impact of

investments in this area can often be considered as direct.

Impact of investment on sanitary conditions and health of residents

Impact of investment on sanitary conditions is important in culturally deprived rural areas. Connecting households and rural infield facilities to the sewage network allows, firstly, elimination of septic tanks and wells (ie. septic tanks) and, secondly, the construction of residential premises and installation of sanitary facilities. Number of eliminated household septic tanks of liquid waste (in case of sewage investments) will be in this case the indicators of the impact of plumbing projects on the improvement of sanitary and hygiene conditions. Indicator of the number of removed household septic tanks of liquid waste has been discussed earlier.

Investments in water and sewage management have a limited impact on human health, such as incidence rate. It should be assessed that rather reducing the risk of incidence, than a measurable reduction of its number should be looked into. It is to be recognized that such an impact will be indirect through the impact of investments on the improvement of the environment. In case of sewage investments, through reducing water and ground pollution, thereby improving the water quality of the local intakes.
In summary:

- Protecting the quality of health is one of the main factors justifying interventions in environmentally sensitive sectors, including the plumbing management sector.

However:

- It is difficult to prove the thesis that the current state of plumbing management poses a particular threat to human life and health, but certainly, at least in some places the risk of incidents may be a little higher, which means that the problem of health improvement does not actually exist.

Impact of investment on residents' financial burden. Social assistance

As the results of detailed research on the project level show, the impact of investments on the financial burden of residents has an indirect meaning. Constructing and putting the new sewage system into exploitation has an impact on the level of necessary income of the plumbing enterprises. Representatives of enterprises and local governments justify that in the accounting and property records of the enterprises, there are new items and fixed assets, which must be re-created with funds coming from services recipients. Fee rates are determined in accordance with the requirements imposed by law of 7 June 2001 on the public water supply and collective sewage disposal. The basis for determining fees is the level of necessary income, ensuring adequate quality of service and payment of reasonable expenses associated with the operation, maintenance and development of the plumbing system.

It should be noted that such a methodology does not include the poorest group (receiving income at the minimum subsistence level) and charging them for plumbing services. This group is particularly sensitive to price increases for these services. Therefore, financial assistance from the municipality may be needed in order to neutralize potential price increases.

In rural areas, municipal regulatory authorities refrain from price increases, primarily for social reasons, knowing that in the future they will be forced to take unpopular, but economically justified prices interventions. Price increases in these areas also mean an increase in subsidies for enterprises from budgets of municipalities and increase in the value of social assistance.

Impact of investments on greening the spatial planning

Impact of investments in plumbing management in the field of 'greening the spatial planning' is based on the assumption that the level of accessibility and quality of plumbing services is a city-forming factor. This means that villages, which previously and with adequate reserves will build the proper infrastructure, can count on the accelerated development of the construction and growth of population which, of course,

involves the development of local market. In turn, the backward villages may experience developmental stagnation, or even simply disappear.

Thus, due to legal regulations, the scale of the problems and the importance of this area for a coherent socio-economic policy, there is a clear need for definitive confirmation of whether the field of 'greening the spatial planning' should be subjected to detailed ratio analyses or not.

Impact of the investments on greening the spatial planning and considering all aspects of sustainable development may be of an indirect importance. Intervention can have an impact on improving the development and spatial planning policy. The result of coordinating activities would be an interaction of implemented investments and spatial and environmental policy.

It is planned to increase the number of municipalities and regions working the locations and effects of ecological and socio-economic impact of all environmental investments in the documents of the development programming: spatial studies, local land use plans, development strategies, sector strategies and Long-lasting Investment Plans and Long-lasting Financial Plans. However, the impact of interventions on greening the spatial planning is just one of many elements of influence on making space and landscape decisions. Apart from environmental factors these are political, social and economic ones.

Impact of investments on the development of environmental education and socially and ecologically minded activities

The implementation of major investments in plumbing management is often associated with taking educational and promotional actions.

It should be noted that all informative, promotional and educational actions are significant as they allow to build good relationships between population and plumbing enterprises. Therefore, it becomes possible to obtain an increase in social acceptance for the implementation of planned projects in the area of plumbing management. Appropriate shaping of public awareness may allow the elimination of existing barriers

such as reluctance to implement new investments for fear of possible increases in services prices.

Informative activities on the project conducted

In case of implementation of infrastructure projects, it is important to take timely action to inform the local population about the intention and the scale of the investment carried out. Neglects in informative activities at the planning stage of the project may affect the occurrence of difficulties in its implementation.
In the municipality of Mniszków there are the following informative activities carried out:

- general meeting with residents of Zarzęcin, which took place this spring with participation of the Mayor, the Secretary of the Municipality, village leader, representatives from the Technical University of Lodz and Designer,
- meetings with residents and landowners on their plots run by Designer,
- making the concept of building sanitary sewage system available and putting it on the website of the Municipality and presenting during the meeting with residents,
- direct information about the investment intention.

Educational and promotional activities

The effects of promotion and information about projects constitute the reduction in the amount of misuse of sewage systems (notably the introduction of solid waste and grease to the system).

Proper implementation of the informative, educational and promotional activities can have a direct impact on the perception of the locality in which they are carried out as an ecologically attractive. Consequently, in the long term, there may occur increased interest in this location, for example, from people just wanting to settle in such a place or who want to spend their free time there. Properly carried out activities to promote the Municipality as supporting the ecology and being environmentally friendly through

modern concepts of plumbing management, increases its attractiveness to potential investors.

Impact of investments on development of entrepreneurship

The extent to which project implementation can help to increase investment opportunities for the service and industrial sector is associated with an increase of investment attractiveness of the area and the availability of plumbing services, enabling enterprise location.

There is a direct link between plumbing infrastructure development and entrepreneurship development. Representatives of the governments most often pointed to two main areas of business development: construction and tourism. In the first case, bringing sewage systems into new regions allows the development of companies engaged in building houses. In the longer term, there will be created basis for the development of services in the areas of new homes and neighbourhoods. Deficiencies in the infrastructure of the above curb the investment growth.

The second direction of the entrepreneurship development has a direct connection with the environmental effects of the investments. Improving the quality of the environment will result in the development of tourism. Technical development of residential and investment areas, combined with effective promotion of the municipality and the region will ensure the development of social infrastructure, tourism and recreation and sports industry, thus contributing to the employment of persons operating sectors like: hotel, catering, entertainment, sports, social services, etc.

Impact of investments on the development of tourism and recreation

Impact of investments on the development of tourism and recreation will indirectly result from environmental effects of projects, namely the improvement of environmental standards, felt by residents, which will positively influence the development of recreation. Another indirect effect in case of municipal investments will also improve the quality of plumbing services, which will encourage the development of

tourism business (hotels, farm tourism, water and sport and gastronomic infrastructure).

Estimating the impact of interventions in the development of tourism and recreation, which is possible to measure, requires the identification of areas that without the investment could not be used for tourist and recreational purposes. These are the areas where as a result of the investment implementation, in a fast and direct way, the environmental standards will be improved. For projects subjected to deeper investigation, such areas are mainly in the river quays being directly influenced by the project.

Zarzęcin is a particular case where the improvement of sanitary sewage systems plays a decisive role in the protection of surface water of the Sulejów Reservoir, which is one of the most important attribute of recreation with great potential for tourism development.

Impact of investments on the creation of new jobs

Impact of intervention in the activation of the labour market and job creation can be viewed at two levels:

- Jobs created directly by the investment,
- Jobs created indirectly as a result of the investment.

Employment directly created by the investment, are the positions connected with exploiting of the investment, equipment and plumbing network operation etc. In the second case, the creation of jobs is related to other areas, developing in the effect of the intervention: housing, tourism and recreation, entrepreneurship, etc.

Impact of direct investments on employment is not significant, because the built investments do not generate large number of jobs. Investments have a direct impact on employment growth mainly during the construction phase, through the employment of individual contract workers by Contractors, necessary for the investments realization. Indirectly, it can also be mentioned that new jobs will be

created during realization of the investment parallel to plumbing investment (eg. construction of road surfaces).

Entrepreneurship development will entail the creation of new jobs. It can be assumed that as a result of improved hygiene and sanitary conditions and the conditions for investment, the investment attractiveness will rise in a given area, which in the long term will influence the increase in the number of newly established enterprises, and thus - jobs.

The development of tourist and recreational infrastructure will contribute to the need to develop base in the form of employment of persons responsible for its current service (restaurants, ski rentals, bathing beaches, hotels, etc.).

In case of investments realized in companies, a direct impact of investments on employment growth is small (one or two employees to operate equipment). Indirectly, the implementation of investments in plumbing management in the enterprise can affect the activation of the local labour market. Realized investments provide opportunities to increase production, and open new production lines and thus affect the activation of the local labour market.

3. Justification of the proposed variant with an indication of its impact on socio-economic relations

Implementation of the project, which involves planned investment activities in the sphere of municipal infrastructure, will have an activating influence on the socio-economic development of the Municipality of Mniszków and Zarzęcin. Conditions for the following purposes shall be imposed:

- improving living conditions of local communities,
- improving technical and sanitary conditions of doing business,
- preparing land for housing and recreational tourism,
- monitoring discharged and treated waste water,

- improving attractiveness of the Sulejów Reservoir as the area of tourist attraction,
- improving the sanitary and epidemiological state,
- restructuring of small plot rural households with a focus on rural tourism.

The project implementation will be a further step towards the improvement of water quality in the Sulejów Reservoir.

IV. Source of information as a basis for drawing up the study

In the course of preparing this document, information included in the following documents was used:

- 'The environmental programme for the Municipality of Mniszków',
- 'Programme and spatial concept for the area covered by the Pilica programme' by Bureau of Spatial Planning of the Lodz Region in Lodz,
- 'Feasibility Study of Pilica Regional Programme' by WPPU SUMAX LLC. in Lodz,
- 'Feasibility Study of sewage treatment plants and sanitary sewage system in Mniszków',
- 'The concept of expansion of sewage system in the Municipality of Mniszków' by WPPU Sumax LLC.,
- Report. State of the environment in the Lodz region issued by the Regional Inspectorate for Environmental Protection in Lodz,
- Act of 27 April 2001 Environmental Protection Law (Consolidated with 2008, J. of L. No. 25 item 150),
- The Act of 3 October 2008 on the sharing of information on environment and its protection, public participation in environmental protection and the environmental impact assessment (Journal of Laws No. 199, item 1227, as amended),
- The Act of 7 June 2001 on mass water supply and mass sewage discharge (consolidated text: OJ of 2006 No. 123, item 858),

- The Act of 27 April 2001 on waste (consolidated text: OJ of 2007 No. 39, item 251),
- The Act of 18 July 2001, Water Law (consolidated text: OJ of 2005 No. 239, item 2019),
- The Act of 7 July 1994 Construction Law (consolidated text: OJ of 2006 No. 156 item 1118, as amended),
- The Act of 27 March 2003 on Spatial Planning and Development (OJ 2003 No. 80, item 717, as amended),
- The Act of 16 April 2004 on the nature conservation (consolidated text: Journal of Laws of 2009 No. 151, item 1220),
- Regulation of the Council of Ministers of 9 November 2004 on defining the type of projects likely to significantly affect the environment and the specific criteria for qualifying projects to report upon the impact on the environment (OJ of 2004 No. 257 item 2573, as amended),
- Regulation of the Minister of the Environment of 24 July 2006 on conditions to be met for the introduction of sewage into water or soil and on substances harmful to the aquatic environment (Journal of Laws of 2006 No. 37, item 984, as amended),
- Regulation of the Minister of the Environment of 27 September 2001 on the catalogue of waste (OJ of 2001, No. 112, item 1206),
- Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their location (OJ of 2002 N. 75, item 690, as amended),
- Regulation of the Minister of the Environment of 3 March 2008 on the levels of certain substances in the air (OJ of 2008 No. 47, item 281),
- Regulation of the Minister of the Environment of 14 June 2007 on the permissible noise levels in the environment (OJ of 2007 No. 120, item 826, as amended),
- Regulation of the Minister of the Environment of 4 November 2008 on requirements for conducting emission measurements and measurements of absorbed water (OJ of 2008 No. 206, item 1291),

- Regulation of the Minister of the Environment of 4 June 2004 on the conditions in which waste is recognized as non-hazardous (OJ of 2004 No. 128, item 1347),
- Regulation of the Minister of Construction of 14 July 2006 on the way of fulfilling the duties of industrial waste provider and the conditions of waste water discharge to sewerage devices (Journal of Laws of 2006 No. 136, item 964).

Information collected during the on-site visit and websites were used as well.

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Impact assessment of drinking water quality improvement measures in small settlements, River Šešupė Pilot Area

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Background information

This report gives an overview of the impact assessment of proposed drinking water quality improvement measures in small settlements of River Šešupė pilot area. The assessments have been carried out as a part of the Waterpraxis project.

There are a number of groundwater deposits/well fields in the Šešupė river sub-basin, where iron (Fe) concentrations fail to meet the quality requirements of the drinking water. The planned investment at small settlement in this region (water consumption < 100 m^3/day) constitutes implementation of 'Ground drinking water quality improvement system with automated iron removal filters'. The non-reagent technology implies oxidation of contaminants in the drinking water and their containment in the filters. The contaminants are removed by washing the filter. The maximal capacity of the system – 9.0 m^3/h.

The investment will be realized in the existing ground drinking water well, supplementing it with the water quality improvement system. The existing water well belongs to local community. The investment creates a pilot model, which includes technical and financial planning as well as implementation phases.

1. Water quality assessment

The ground drinking water samples were taken within the water wells in the pilot area and analyzed at the Department of Environmental Engineering, Kaunas University of Technology. The following ground drinking water parameters were examined in the water wells and water supply system: total iron, chlorides, NH_4^+, permanganate index, oxidation reduction potential in the ground drinking water extraction sources and after transporting to the consumers.

The results of the drinking water quality analysis in the small settlement are presented in this section. Determined iron concentrations in all the analyzed samples from the water well field, exceeded the specific limit value (SLV), listed in the Lithuanian Hygiene Norm. SLV_{Fe} = 0.2 mg/l, see Figure 1. Iron concentration in the samples from private well also exceeded the SRV, but, during most of the sampling periods, it was several times lower than in the well field samples.

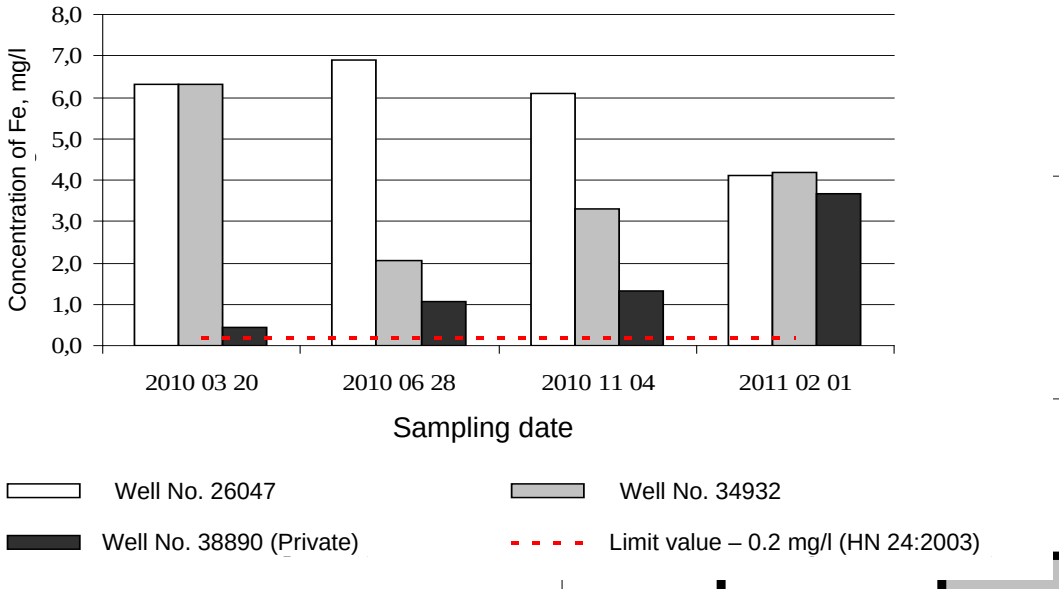


Fig. 1 Concentrations of total iron in the groundwater, mg/l

Depth of the analyzed wells in the wellfield is 73 and 57 meters. Both wells are situated in the same aquifer and the concentration of total iron in the water is similar. The highest concentrations during the sampling period, were determined in the deeper well (6.9; 6.30; 6.10 mg/l). Depth of the analyzed private well is 57 meters. Determined iron concentration in the water samples from the private well were lower – 0.45 and 1.08 mg/l, respectively. It should be mentioned, that in this case

of private wells the water samples were taken form the water supply system, not directly from the well, therefore the obtained results can slightly vary.

Ammonium nitrogen concentration in all analyzed water samples exceeded the SLV (0.5 mg NH_4-N/ l) during spring and winter sampling periods (Fig. 2). The concentrations of ammonium nitrates in the samples, taken in summer and autumn, did not exceed the SLV.

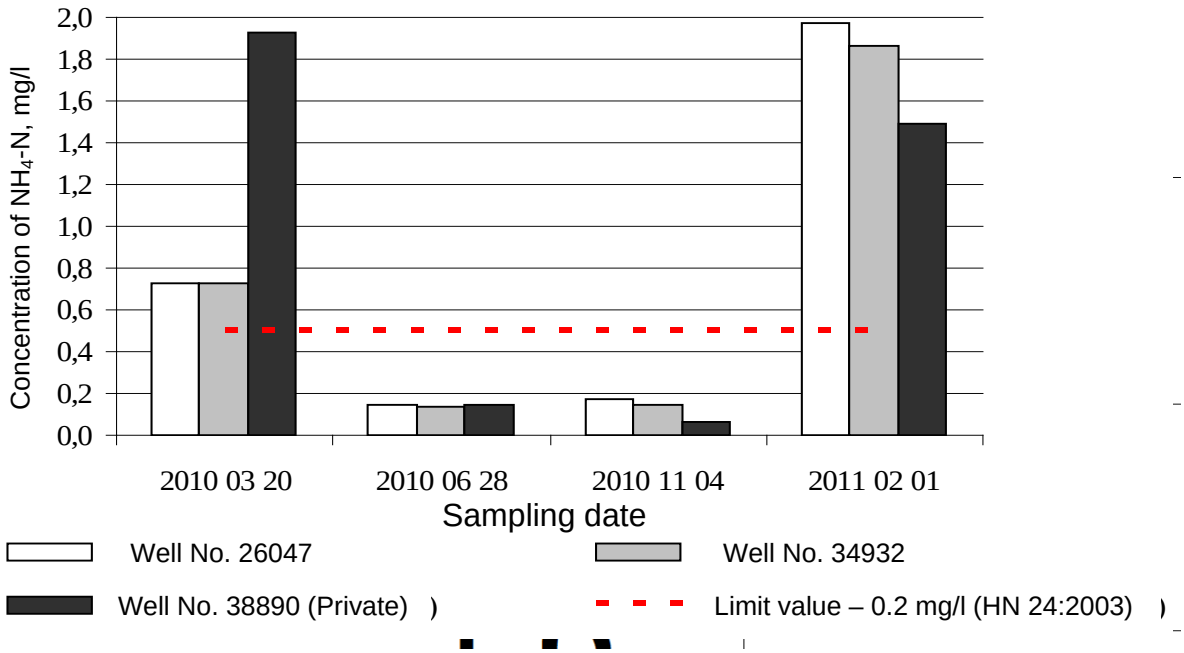


Fig. 2 Concentrations of ammonium nitrates in the groundwater

The highest concentration of ammonium nitrates during spring sampling period was observed in sample from private well (1.7 mg/l) and during winter sampling campaign concentrations were higher in all the analyzed samples. Determined concentrations exceeded SLV almost three times. Because of ammonia, present in the water, required amount of oxygen for oxidation process of Fe^{2+} during iron removal from water would be higher. This should be estimated in the technological project.

Increased concentration of chlorides in the drinking water is also observed in the region. It is explained as chlorides intrusions from lower situated chalk layer to the aquifer, occurring above it. As the concentration of chlorides varies in different parts of the selected region, it was important to analyze this parameter. The chlorides concentration, exceeding the SLV (250 mg/l), was obtained only one time in one sample, during the sampling period (Fig. 3). The highest concentration (333 mg/l) was observed during summer sampling campaign in the deepest well in the well field. All the other results were within the limits of SLV.

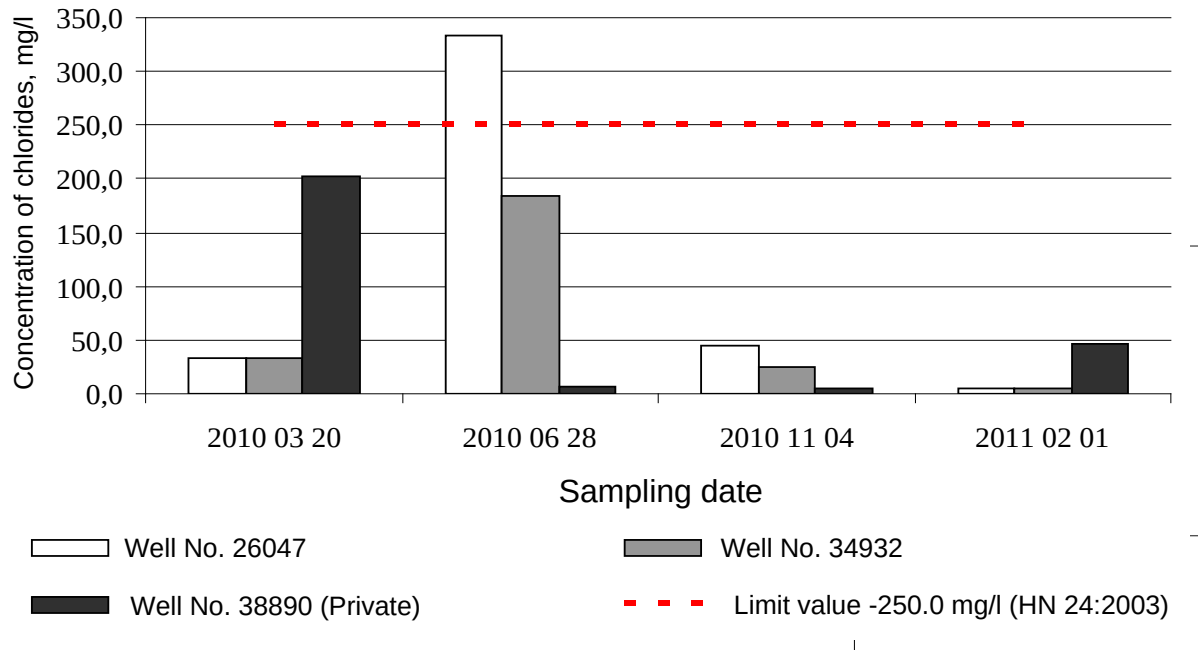


Fig. 3 Concentrations of chlorides in the groundwater

Other analyzed and determined groundwater quality parameters were within the limits, provided in the Hygiene Norm 24:2003. The water temperature in selected wells varied from 7.5 to 11,0 ^{o}C pH value – between 7.3 and 8.0 (SLV = 6.5 – 9.5). The observed pH values were higher during the summer sampling campaign – the determined pH values varied from 9.0 to 9.5. If pH value of water is increasing, the oxidation rate is increasing as well, enhancing bivalent iron and manganese ions oxidation efficiency.

Oxidation reduction potential (ORP) values in the analyzed water were ranging from 80 to -250 mV (usually, the observed ORP in the groundwater is between -0,48 and 0,55 V. According the ORP value, the reductive conditions of the groundwater are confirmed. The reductive state is caused by the reducing agents, present in the groundwater. The analytical results confirmed that the reducing ammonia and bivalent iron ions are present in the analyzed water.

Permanganate index (PI) is water quality parameter, regulated by Hygiene Norm (SLV = 5.0 mg/l O_2) and also important indicator in the iron removal process. PI of analyzed water was determined once in each well. Monitoring results were also analyzed. The PI value did not exceed the SLV. It was ranging from 0. to 2. mg/lO_2. Lpw PI indicates that iron compounds in the water are of inorganic origin and there, their oxidation scheme is simpler.

In order to consider the deterioration of water supply system and water stagnancy influence on drinking water quality, analysis of tap water was performed in the selected housing. The selected houses are situated approximately in 450 m, 560 m and 780 m distance from the well field. It should be taken into account, that water is supplied to the water supply system from two different wells. Water can be supplied from each well, selected automatically, or can be mixed from both wells (therefore iron concentration can vary depending on the water source). The results are also influenced by different sampling time (although samples were collected on the same day).

Variation of iron and ammonia nitrogen concentrations, determined in the tap water during the sampling period is shown in Fig. 4.

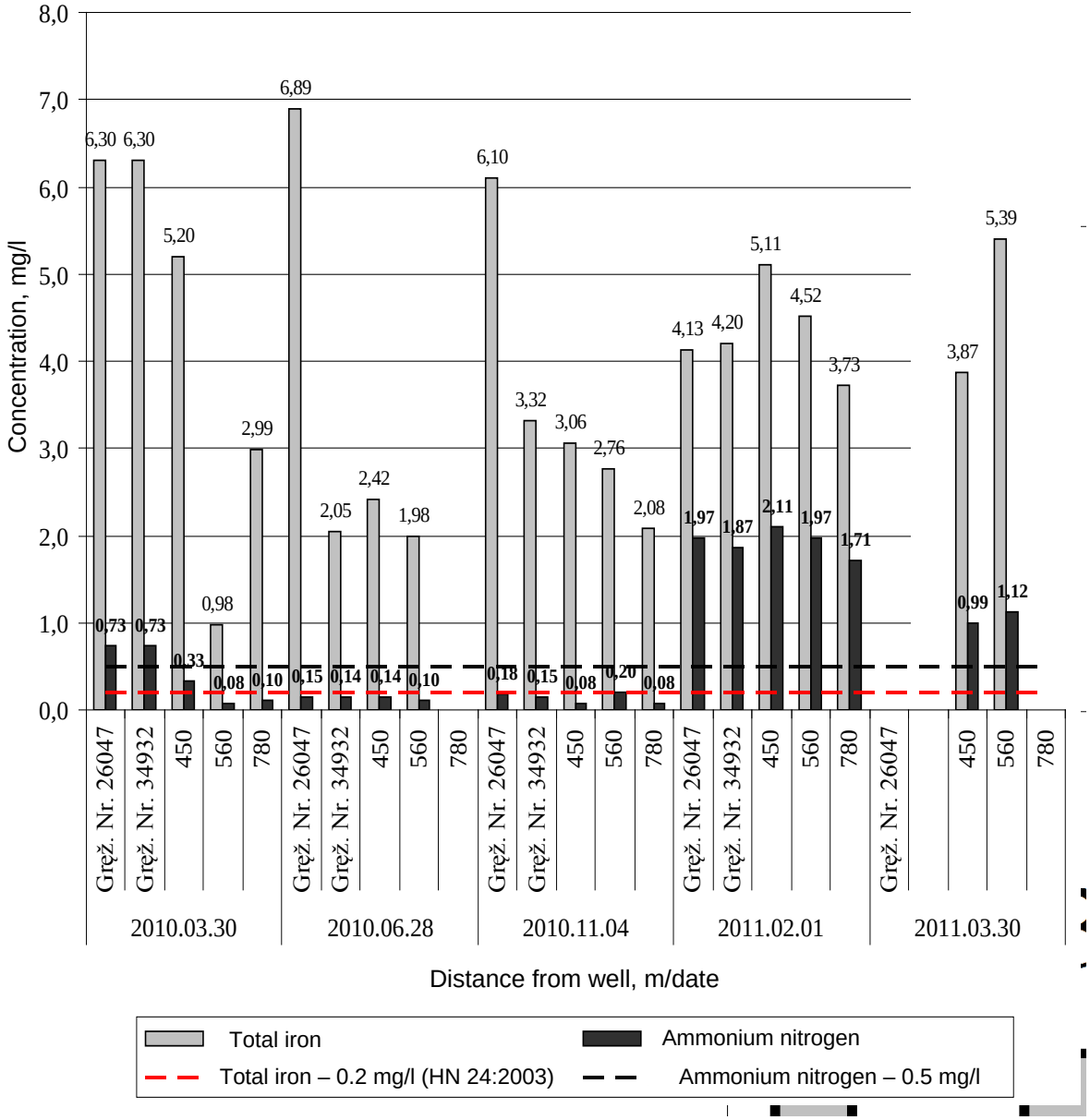


Fig. 4 Concentrations of total iron and ammonium nitrogen in the water supply system

The decreasing iron concentration was observed in the water supply system, depending on the distance from the well field. Iron concentration in the tap water was lower than in the well fields. In most cases, the tap water, taken in 450 m and 560 m distance from well field, contained higher iron concentrations than the tap water 780 m away from well field (Fig.. 4). One of the explanations of this phenomenon is that the bivalent iron ions are oxidizing and precipitating in the pipes of water supply system. Water from the hydrophore vessel is fed to the water tower, where it is partly aerated.

Ammonium nitrogen concentration was not influenced a lot by the distance of water supply system. The determined concentration of ammonia nitrogen in the tap water samples was similar or a little higher than recorded in the well field wells. Concentration of ammonia nitrogen in the wells and in the water supply network exceeded the SLV during the winter and spring sampling campaigns.

The iron concentration in the drinking water is decreasing in water supply networks, but the sedimentation of iron oxide in the pipe network is reducing pipe's throughput and also creates the conditions for biofilm formation, leading to microbiological contamination of drinking water. Increasing ammonia nitrogen concentration in the water supply network is one of the indicators of pipelines contamination and water stagnancy.

2. Economical impacts

The cost-effectiveness analysis (CEA) of planned drinking water quality improvement measures is assessed. The main questions are: is it financially beneficial to remove iron from drinking water? Is it more profitable to remove iron at home, to receive good quality water from the central supply system, or better to buy drinking water in the PET bottles at the food stores? Is a central iron removal a good option?

Comparative analysis of costs related to central iron removal of tap water using iron removal plants and domestic iron removal facilities was performed. The estimations have included not only investments and operational costs but also side effects related to comfort. The analysis estimates purchase, installation and operating costs.

The costs of iron removal technologies (both centralised and individual) include investment and operation expenses. Both components were evaluated in this assessment.

Iron removal units for individual household use

The average household size in Lithuania is 2.4 persons (Statistics Lithuania, 2009). One tap water source is draining 0,4 m^3/h of water (water source - laundry, shower, sink, bath, etc.). If household of two to four persons would use 4 water sources at one time, 1.6 m^3/h water yield would be required. Average costs of purchase, installation (Table 1) and operating (Table 2) of iron removal filters having the 1.6 m^3/h throughput is assessed. Several Lithuanian filter supply companies are selected for this evaluation.

46 m^3 of drinking water is daily produced in the settlement. One household consumes approx. 0.1484 m^3 of tap water per day. 54.16 m^3 of tap water is consumed during one year in one household. Operating costs for treatment of 1 m^3 of water are calculated for comparison (Table 2).

Table 1 Average cost of iron removal unit purchase and it's installation

Type of iron removal filter	AF-IR-70-FeG-Air-St	PRIOR SD - 20T	GA-FT-50-13MXO	AGO-5014"
Supplier	SIA Aqua Vilnius	SIA Pireka	SIA Filteka („General Electric (Smart Water™)"	SIA R.O. "Optimalūs sprendimai"
Filter throughput, m^3/h	1.2-1.8	< 2,0	1,3 - 2,0	1,0-1,6
Price, Euro	1025	706	1804*	804
Air compressor, Euro	116	116	-	116
Installation work, Euro	103	71	180	80
Total, Euro	1243	893	1984	1000
Average cost of purchase and installation, Euro	**1280**			

* Iron removal filter with an air injector and oxidation tank.

Table 2 Operating costs of iron removal unit

Key indicators	**Expenditures index coefficient**	**Expenditures per year**	Unit price, Euro	Price, Euro/year
Maintenance cost (Filter load replacement (40l)	290 Eur per 6 years	48,3 Euro	-	48,3
Electric energy consumption	0.003 kW	26,28 kWh	0,13	3,43
Water loss (filter	225-300 l /1	3,6 m^3	0,89	3,21

backwashing)	regeneration cycle			
Operating costs of equipment, Euro/year				**54.94**
Operating costs of equipment, Euro/m^3 of water				**1**

Iron removal plants

Financial costs of the centralized iron removal plant are assessed with reference to commercial tender, proposed for the settlement. In order to ensure drinking water supply during the backwashing stage, two parallel lines of filtration equipment are proposed. Two automatic iron removal filters are selected, with the flow rate of 5.4 m^3/h (maximal flow rate – 9.0 m^3/h). Purchase and installation costs are given in Table 3. Operating costs for treatment of 1 m^3 of water are calculated for comparison (Table 4).

Table 3 Cost of iron removal plant purchase and installation

No.	Installation unit or work description	Quantity, units	Unit price without VAT, Euro	Price without VAT, Euro	VAT	Price with VAT
1	**Filter P2NWS1,5 18X65**	2	2629.058	5258.116	1104.206	6362.322
2	Oxidator	2	982.1536	1964.307	412.5043	2376.812
3	Compressor	1	715.2928	715.2928	150.2116	865.5043
4	Internal pipeline	1	1696.012	1696.012	356.1623	2052.174
5	Air flow regulator	3	36.24928	108.7478	22.83768	131.5855
6	Selenoid valve	2	44.43768	88.87536	18.66377	107.5391
7	Water meter Ø40	2	335.3681	670.7362	140.8551	811.5913
8	External pipeline	1	4790.991	4790.991	1006.107	5797.099
9	Flow switch	1	163.371	163.371	34.30725	197.6783
10	Tank 2,5x6 (with transportation)	1	5480.896	5480.896	1150.988	6631.884
11	Installation work	1	3024.313	3024.313	635.1043	3659.417
				Total:	5031,948	28993,61

Table 4 Operating costs of iron removal plant, Eur

Key indicators	**Expenditures index coefficient**	**Expenditures per year**	Unit price, Euro	Price, Euro/year
Maintenance cost (Filter load replacement (200 - 300l)	1449 Euro per 6 years	241.5 Euro	-	241.5
Electric energy consumption	0,003 – 0,015 kW	262.8 kWh	0,13	34.28
Water loss (filter backwashing)	720-1320 l /1 regeneration cycle	963.6 m^3	0,89	860
Operating costs of equipment, Eur/year				**1135.78**
Operating costs of equipment, Eur/m^3 of water				**0,07**

Use of untreated water

Use of untreated water, containing high concentrations of iron, is safe for people, but it is negatively influencing comfort of water use. If water is brown in colour, it negatively affects laundry and dishwashing, therefore additional treatment is required in these processes. Table 5 presents possible additional costs of untreated water use.

Financial costs of chemical products purchase, electric energy consumption and bottled water purchase are assessed. It is supposed, that one household consumes approximately 5 litres of bottled water every day. It amounts to 1825 litres of water per year and at least 365 pieces of waste

plastic bottles. An average price of 5 litres bottle of drinking water is 0.87 Euro and in total it amounts to 317.39 Euro per year. Average expenses on additional chemical products comprise 2.90 Euro per month and 34.78 Euro per year. Statistically, each household's electric energy costs for use of electric appliances and food preparation is 104 Eur. Because of the use of water, containing high amount of iron, electric energy consumption is increasing by 5% or 5.22 Euro per year.

Table 5 Financial cost of untreated water use

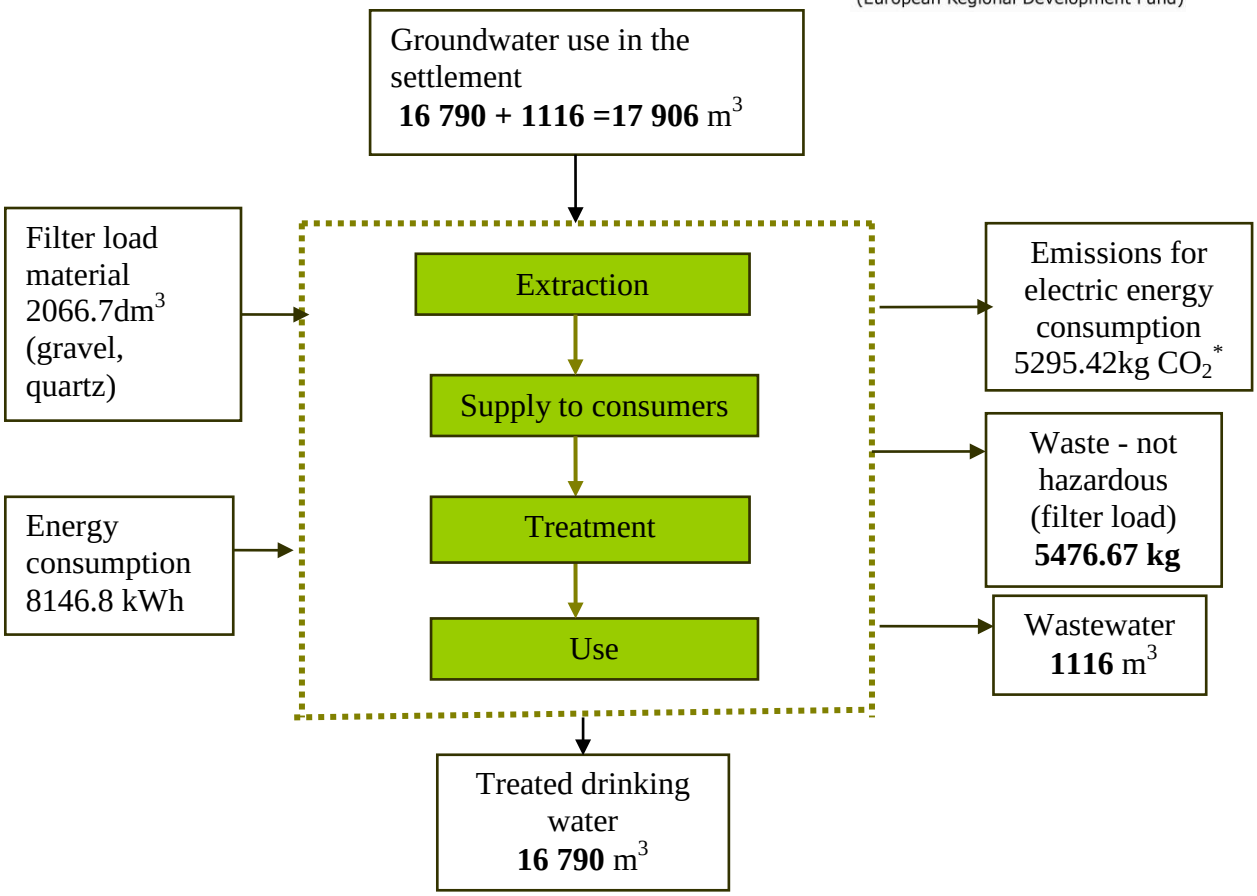
Indicator of financial costs and environmental impact	*Financial costs, Euro/year/1 household*
Household products	
Detergents and bleach	34.78
Chemicals for bathroom and toilet cleaning	
Chemicals (vinegar) for dish cleaning	
Energy consumption	
Water boiling	5.22
Laundry	
Comfort	
Purchase of bottled drinking water	317.39

3. Environmental impacts

The environmental impact of installation of different water purification technologies is assessed in this section. The material balance is calculated for each possible scenario: iron removal units use in the individual households, centralized iron removal plants for the water supply system, use of untreated water.

Iron removal units for individual household use

16790 m^3 of drinking water is consumed in the settlement during one year period. For the environmental impact assessment, material balance of the technology of iron removal units was performed. The results are presented in picture 5.



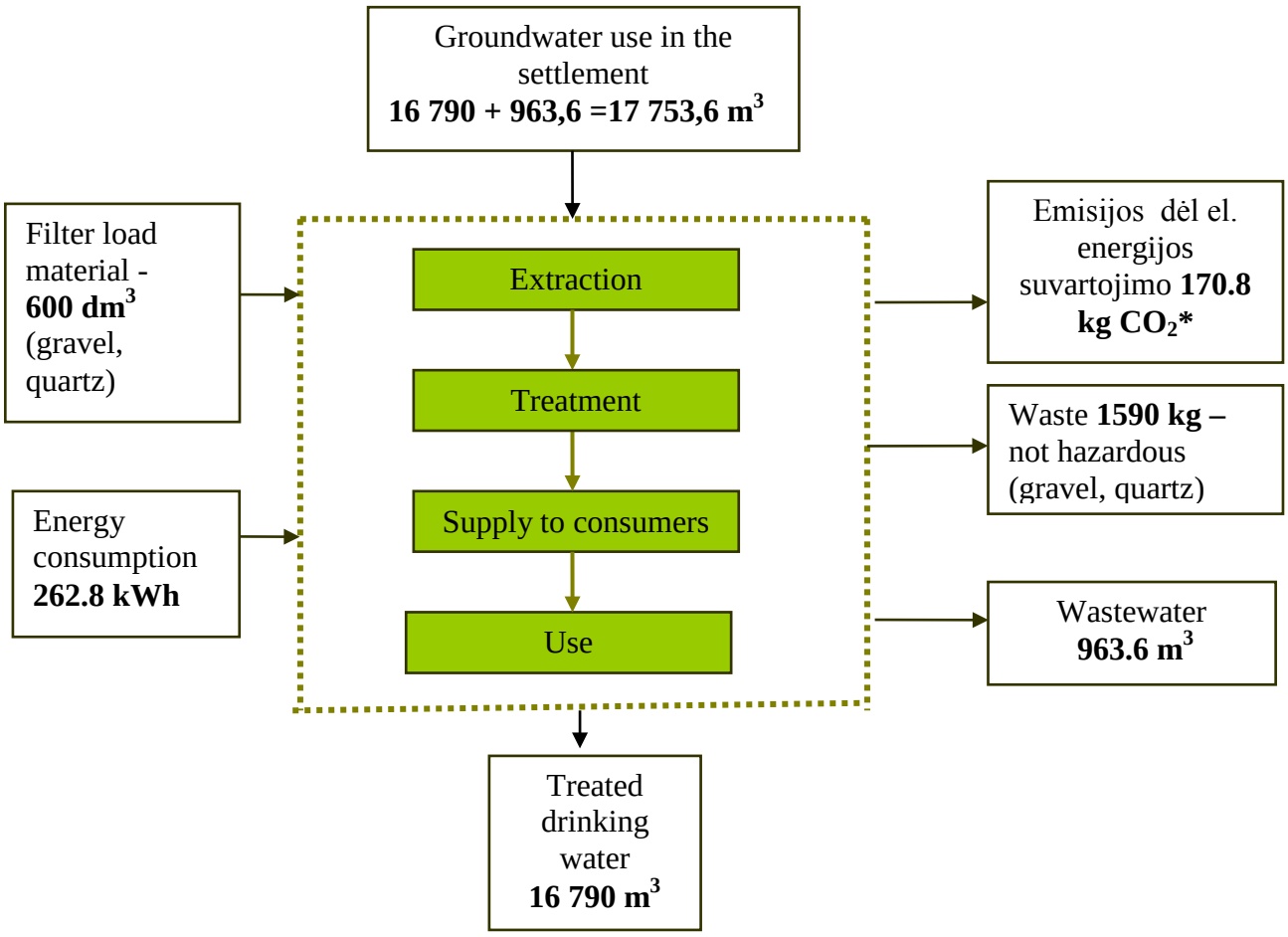
* 650g CO_2/kWh (European Comission, http://ec.europa.eu)

Fig. 5 Material balance of iron removal units for individual household use

If water would be treated individually in each household, using iron removal units, 8146.8 kWh of electric energy would be consumed and approximately 5477 kg of waste generated in the settlement. Although filter can be regenerated by backwashing, but filter load has to be changed to the new quartz and gravel composite every 3 - 7 years (6 years period accepted in the calculations). Wastewater is generated during filter backwashing process (1116 m^3 per year approximately). Wastewater can be treated in wastewater treatment system or released directly to the environment. This kind of wastewater, containing iron and manganese oxides, washed from the filter, is not hazardous to the environment.

Iron removal plants

Material balance of the technology of iron removal plant installation in the settlement was performed. The results are presented in picture 6.



* 650g CO_2/kWh (European Comission, http://ec.europa.eu)

Fig. 6 Material balance of iron removal plant

262.8 kWh of electric energy would be consumed and approximately 1590 kg of waste would be generated in the settlement, if iron removal plant would be installed in the settlement. 963.6 m^3 of non hazardous wastewater would be generated during the backwashing process.

Use of untreated water

If water, containing high concentration of iron is used, negative impact on the environmental is caused by: chemical products use for the daily living needs (detergents, bleach, sanitary cleaning, and dish washing); higher energy consumption (water boiling, laundry, etc.). If bottled drinking water is purchased, it results in higher household's financial expenses and generates large amounts of plastic waste.

4. Social impacts

At present, great number of small settlements in Šešupė pilot area is not connected to the drinking water supply/waste water treatment networks. Populations from the small settlements extract water from the wells that are physically and technologically outdated and worn-out to meet consumer's needs. Abandoned water supply facilities have negative effect on health of local population, ecosystem, limits processing of agricultural production, creation and development of small business, as well as attraction of investments.

Local community and politicians are interested and support potential investment, therefore it will minimise possible investment risks. Thus, the influence of stakeholders' opinions to the final outcomes is strong and the measure selected get wide acceptance at local and regional level.

The benefits of the proposed measure were identified, according the criteria of water quality improvement, benefits for stakeholders and local community, benefits of public water use.

If iron concentration in water is exceeding the SLV, water has to be treated for the following reasons: precipitated iron provides brownish colour of the water, then contacting with the air; iron, present in the water, gives the taste of metal; water softening filters are blocked by precipitated iron and the efficiency of filters is reduced; precipitates are accumulating in the water pipes and causes diameter reduce and pipe clogging; iron bacteria cause odours, corrosion and some other problems.

People in the selected settlement extract water from private wells and are not satisfied with water color, sediments, bad smell and taste. They are willing to receive the good quality water. Part of the residents does not pay for water – they use alternative water supply strategies, as drilling private wells or buying drinking water. As poor people pay significantly higher percent of their income for an alternative water source, this social group would profit the most from an improved supply system.

Drinking water is the main natural resource of life, but the drinking water is still not accepted as usual product to pay for. In the past, water was free product, but now water costs are becoming a significant part of family expenditure. Drinking water supply planning and market is not very effective because people have several possible choices: the possibility to use private wells, buying bottled water, etc.

In general, it can be stated, that all segments of the population in the settlement would profit from an improved public water service. No social group would be adversely affected by the project. Installation of centralized water supply system and water purification technology would create some additional working places in the settlement – for maintenance and control of the water purification system and consumption accounting. Therefore, several social benefits can be achieved – improving life quality, economical benefits and new employment possibilities.

5. Conclusions

Physical iron removal methods were selected for installation in the small settlement after the water quality assessment and analysis of the possible iron removal technologies. Chemical methods are not considered for iron removal because of higher exploitation costs and environmental impact.

The economical assessment revealed that investment costs of the centralized iron removal plant equipment are 29 000 Eur. If every household would install individual iron removal filters, they would totally cost 107 000 Eur. Operating costs for preparation of 1 m^3 of water would comprise of 0.07 Euro and 1.0 Euro, respectively. It indicates that use of centralized water treatment technology is cost-efficient alternative.

It was estimated, that use of the individual iron removal filters would result in formation of 5.5 tons of waste, 1116 m^3 of wastewater, and consume 8147 kWh of energy. In case of se of centralized iron removal plant, it would be generated 1.6 tons of waste (almost 70% less), 964 m^3 of wastewater (13 % less) and 263 kWh of electric energy consumed (97 % less). These results of materials and energy balance evidently prove that centralized iron removal plant is more efficient alternative.

According to the results of the technological, economical and environmental evaluation of iron removal technologies, if the groundwater in the small settlements contains enlarged concentrations of iron and nitrogen compounds, the centralised automatic iron removal filters, based on physical methods, are recommended to use.

Evaluation of social impacts revealed, that stakeholders and local community would benefit from the proposed measures by improved life quality, economical values and new working places for local people.

References

1. 2008 m. gruodžio 18 d. Europos Parlamento ir Tarybos direktyva 2008/105/EB dėl aplinkos kokybės standartų vandens politikos srityje, iš dalies keičianti ir panaikinanti Tarybos direktyvas 82/176/EEB, 83/513/EEB, 84/156/EEB, 84/491/EEB, 86/280/EEB ir iš dalies keičianti Europos Parlamento ir Tarybosdirektyvą 2000/60/EB.
2. AB "Mažeikių nafta" Būtingės terminalo lokalinis naftos išsiliejimų jūroje likvidavimo planas, 2009;
3. AB "Mažeikių nafta". Vamzdynų ir terminalo padalinio Būtingės naftosterminalo jūrinės dalies galimų avarijų pavojaus ir rizikos analizė , 2009;
4. Advokatas Paulius Docka, advokatas Marius Devyžis ir advokatas Andrius Iškauskas. Miestų paviršinių nuotekų tvarkymo studija, 2007;
5. Aktualiausių tarpinių ir pakrantės vandenų valdymo ir apsaugos problemųapžvalga. Tarpinių ir pakrantės vandenų būklė. Jūrinių tyrimų centras, 2007;
6. AM Klaipėdos RAAD Jūros aplinkos apsaugos agentūros 2008 metų ataskaita, Klaipėda, 2009;
7. Ataskaita „Vandens aplinkai pavojingų medžiagų nustatymas Lietuvoje", Lietuvos aplinkos apsaugos agentūra, Suomijos aplinkos institutas, Baltijos aplinkos forumas ir Aplinkos apsaugos politikos centras, 2007;
8. Baltijos jūros aplinkos apsaugos komisijos (HELCOM) rekomendacijos;
9. Baltijos jūros rajono jūrinės aplinkos apsaugos konvencija, 1992m. (Žin., 1997, Nr.21-499);
10. Blicher-Mathiesen, G., Grant, R., Jørgensen, U. and Poulsen, H.D. (2003): Vandmiljøplan II, Slutevaluering af de enkelte virkemidler. Status 2002, Prognose for 2003. Baggrundsnotat til Vandmiljøplan II – slutevaluering. DMU and DIAS. 35 pp.
11. Blicher-Mathiesen, G., Grant, R., Jørgensen, U. and Poulsen, H.D. (2003): Vandmiljøplan II, Slutevaluering af de enkelte virkemidler. Status 2002,Prognose for 2003. Baggrundsnotat til Vandmiljøplan II – slutevaluering. DMU and DIAS. 35 pp.
12. Canfield, D.E., Bachmann, R.W., 1981, Prediction of total phosphorus concentrations, chlorophyll a and secchi depth in natural and artificial lakes, Can. J. Fish. Aquat. Sci. 38: 414-423
13. Diliūnas J. Kaminskas M., Karvelienė D. 2002. Azoto junginių sklaida aliuvio vandeningajame sluoksnyje. Litosfera, Nr. 6, p. 94 –104.
14. Dillon, P. J., Rigler, F.H., 1974, A test of simple nutrient budget modelprediction of the phosphorus concentration in lake water. J. Fish.Res.Bd.Can.31, 1771-1778.
15. Dr. N. Blažauskas, Dr. S. Gulbinskas, V. Langas, D. Depellegrin. „Kuršių nerija – UNESCO pasaulio paveldo dalis. Naftos transportavimo ir naftos gavybos ties Lietuvos pakrante pietryčių Baltijoje grėsmių socialinio – ekonominio poveikioįvertinimas", Baltijos pajūrio aplinkos tyrimų ir planavimo institutas, 2008;
16. EMEP modelled air concentrations and depositions. http://webdab.emep.int/Unified_Model_Results/AN/);
17. EPA 2007, Procurement of services for the Institutional building for the Nemunas River Basin management, Final Report 2007, Appendix 13
18. Gailiušis B., Jablonskis J., Kovalenkovienė M. Lietuvos upės. Hidrografija ir nuotėkis. Kaunas, Lietuvos energetikos institutas, 2001.
19. Gamtos paveldo fondas. Studija „Šlapžemių įrengimo/atstatymo, siekiant sumažinti organinių ir biogeninių medžiagų patekimą į vandens telkinius, galimybių analizės atlikimas ir šlapžemių įrengimo/atstatymo rekomendacijų parengimas". 2009.
20. Gauss M., Nyıri A., Klein H. Transboundary air pollution by main pollutants (S, N, O3) and PM, Lithuania. Norwegian Meteorological Institute. (2000-2009 m ataskaitos).

21. Giedraitis R. ir kt. 1999. Gyvulininkystės kompleksų eksploatacijos poveikis požeminio vandens būklei (Ataskaita). Vilnius, LGT GF.
22. Gylling, M. (2001): Energiafgrødeprogrammet. Rapport nr. 131. Fødevareøkonomisk Institut.
23. Grant, R. (2002) Genberegning af effekten af Vandmiljøplan I og II. Notat from DMU (National Environmental Research Institute)
24. Graversen, J. and Gylling, M. (2002): Energiafgrøder til fastbrændselsformål – produktionsomkostninger, håndteringsomkostninger og leveringsplaner. FØI Working Paper, No. 7/2002.
25. Gregorauskas M. Požeminio vandens išteklių įvertinimas Lietuvoje. Viršutiniovidurinio paleozojaus hidrodinaminės sistemos turimi požeminio vandens ištekliai. Galutinė ataskaita. UAB "Vilniaus hidrogeologija", 2008.
26. Gregorauskas M., Klimas A., Plankis M. Viršutinio paleozojaus hidrodinaminės sistemos regioninių požeminio vandens išteklių įvertinimas. Vilnius, LGF, 2003.
27. Jacobsen, B.H., Abildtrup, J., Andersen, M., Christensen, T., Hasler, B., Hussain, Z.B., Huusom, H., Jensen, J.D., Schou, J.S. and Ørum, J.E (2004): Omkostninger ved reduction af landbrugets næringsstoftab til vandmiljøet – Forarbejde til vandmiljøplan III. Rapport nr. 167. Fødevareøkonomisk Institut.
28. Juodkazis V., Arustienė J., Klimas A., Marcinonis A. 2003. Organic matter in fresh groundwater of Lithuania. A Monograph. Vilnius: Vilnius University Publishing House. 232 p.
29. Jūrinių tyrimų centro metinės 2005, 2006, 2007 m. ataskaitos.
30. Klimas A. 2001. AB "Krekenavos agrofirma" lietinimo laukų, laistomų atskiestomis kiaulių srutomis, požeminio vandens monitoringo 2002–2005 metais programa.
31. Klimas A., Marcinonis A., Zabulis R. 1994. Filtracijos laukų perspektyvos Lietuvoje. Gelmių geologinio tyrimo, naudojimo ir apsaugos problemos Lietuvoje. Str. rinkinys. Vilnius, p. 120–122.
32. Klimas A., Žemaitis L. 2007. Požeminio vandens monitoringas AB "Zelvė" kiaulininkystės komplekso teritorijoje ir vandenvietėje pagal 2003–2007 metų programą. Baigiamoji ataskaita.
33. Kristensen, P., Jensen, J.P., Jeppesen, E., Eutrofierings modeller for søer, NPo- Forskning fra Miljøstyrelsen 1990, Nr C9.
34. Lithuanian Hygiene Norm HN 24:2003 „Requirements for drinking water quality and protection".