Strategy for wastewater treatment in the Lake Peipsi basin

Project report

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Pskov Region Natural Resources Committee

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Introduction

Lake Peipsi (Lake Chudskoe – in Russian) is a part of the Baltic Sea water basin and is shared by Estonia and Russia. Estonia is a EU accession country and the lake is likely to become the future border between Russia and the European Union in a few years. The main environmental issue in the Narva River and Lake Peipsi basin is water eutrophication. The most obvious pollution impact in the Lake Peipsi Basin is the increased growths of algae in the lake caused by increased phosphorus loadings, mainly from wastewater discharges in the entire water basin. Before a general decision on projects to reduce the pollution loadings to Lake Peipsi can be made, it is a prerequisite to have established goals for the future lake water quality and to have specified the measures needed to achive this quality. Therefore, a key project for the future environmental management of Lake Peipsi is to describe scenarios for future lake water quality as a function of the different options for future phosphorus loadings. These options include e.g. different levels of phosphorus removals from wastewater in cities and towns in the catchment area. Based on the scenarios and the costs involved in the different options the relevant authorities in Russia and Estonia must decide and agree upon the wanted lake water quality and the measures to achieve this and the time scale for improvements.

In 1997, the Estonian Republic and the Russian Federation signed an intergovernmental *Agreement on the Protection and Sustainable Use of Transboundary Water Bodies* and in accordance with the agreement, established Estonian-Russian Joint Commission on Transboundary Waters (further: Commission). At its second meeting in November 1999, the Commission gave a high priority to developing the Lake Peipsi/Chudskoe Basin Management Plan based on the principles outlined in the EU water legislation.

It is not a simple task to establish a general environmental management plan for Lake Peipsi basin, including the identification of measures needed for the lake to meet the quality objectives. The reason for this is mainly insufficient knowledge of the environmental impacts and their causes, e.g. nutrient loadings from wastewater and agriculture and impact on the ecosystem from fishery.

Wastewater treatment as a first step of an environmental protection strategy

However, the water qualities monitoring programs and projects carried out have given substantial information on the total nutrient loadings of Lake Peipsi and on the pollutants discharged with wastewater. Therefore, the wastewater impact on lake water quality can be roughly evaluated and also the consequences of improved wastewater treatment can be estimated. Also, the pollution impacts in rivers from wastewater can be roughly evaluated based on the discharges of organic matter and the dilution of the wastewater in the rivers.

Therefore, a first step in the elaboration of a general environmental protection strategy and protection measures for Lake Peipsi and its water basin can be a strategy for wastewater treatment.

The presented in this volume "Strategy for wastewater treatment in the Lake Peipsi watershed" was prepared within a project *"Environmental Protection Strategy for the Lake Peipsi Basin – the Estonian – Russian Border Area"*.

Objectives and history of the project

The project *"Environmental Protection Strategy for the Lake Peipsi Basin – the Estonian"* was implemented in 2000 - 2001 by the Peipsi Center for Transboundary Cooperation (Peipsi CTC) together with Aarhus and Funen Counties of Denmark and with the support from the Danish Environmental Protection Agency, Danish Ministry of Foreign Affairs and the Estonian-Russian Joint Commission on Transboundary Waters. The project is a part of a larger Danish-Estonian-Russian initiative named "Community Development and Cross Border Co-operation in the Estonian-Russian border Area" that was implemented in 1999 - 2001 and facilitated cooperative efforts between local authorities and businesses in this border zone on regional economic development and environmental protection.

The project goals were:

- To work out a strategy for wastewater treatment in the Lake Peipsi/Chudskoe Basin,
- To provide training to civil servants on the local authorities level for the new EU structural fund period, the coming cross-border cooperation programs and the co-operations perspectives for the area when Estonia becomes a member of European Union,
- To prepare proposals for starting up the Lake Peipsi/Chudskoe Basin Management Plan.

Results of the collaboration in 2000 - 2001

To develop the strategy for wastewater treatment, as a first step a common bank of data for point pollution sources in the Lake Peipsi basin was created. The bank of data gives information about water use (source of water, water amounts, purpose of use) and characterises wastewater (location of the outlet, category of the waste, treatment level and amount of pollutants). It is possible to find the common data about the whole basin or its sub-basins or enterprises from this database quite easily. It is possible to get summarised information for each branch of industry, ministry or local administration as well.

The Peipsi CTC in Estonia organised the creation of the common GIS-based register of point-pollution sources, that included the database, connected with it for the whole Lake Peipsi Basin. The data presentation form in registers was harmonised as much as possible, and the main wastewater outlets in Russia had also represented in digital form on the map in Estonia.

Main factor that determined the design of the spatial database was the fact that the locations of point sources of pollution are reported as the distance along the river between the mouth of the river and the place of the point-pollution source. This linear co-ordinate is different from customary latitude-longitude co-ordinate pairs. The main goal in designing the spatial database was to enable AUTOMATICALLY depict the locations on digital map without the need to convert additional information. In other words, we get name of the river, and distance along the river and we are able to see on the map where this point-pollution source is located. Geographic Information System software ArcView GIS 3.2 is able to do exactly this - dynamic segmentation – if the given specially prepared river map layer exists. The maps were created by Kersti Vennik and Margus Roll (Estonia), the basic information for the maps was collected by Alla Sedova (Russia) and Ülo Sults (Estonia).

The technical status of the waste- water treatment plants differs in a large scale, and very often the local administrators do not know exactly, what to do. Sometimes, and this situation is quite common, the water supply network together with sewage systems need reparation and restoring, and in these cases it has sense to restore the sewage water treatment plants at the same time. A lot of old waste- water treatment plants and bio-ponds from the Soviet period are not in use any more but storm waters are still transporting pollution from those into rivers and lakes.

According to these database and digital maps information, and using the final report of the Estonian- Russian- Swedish project *"Nutrient loads to Lake Peipsi"* (Stålnacke, P. at al., 2001), Jens Møller Andersen of the County of Aarhus Environmental Department (Denmark) worked out the draft version of the *"Strategy for waste water treatment in the Lake Peipsi watershed",* which was discussed with environmental authorities and local authorities in Estonia and in Russia as well. This strategy was under discussion at a seminar in Voore (Estonia) in November 2000 where the top-specialist of Estonia and Pskov oblast of Russia gave a good approbation to it. The second seminar was organised in Pskov and Gdov (Russia) in February 2001. The strategy was also discussed at a meeting of the Working Group on Water Quality under the Estonian-Russian Joint Commission on Transboundary Waters that took place in Tartu, Estonia, at the end of 2000.

To look at more specific wastewater treatment requirements and to study possibilities of putting the Lake Peipsi Basin strategy for wastewater treatment into the operation, two pilot projects – one in Estonia in the River Amme basin – and another in Russia – in the River Gdovka basin – were started. The pilot project in Estonia started in August 2000 and was supported by the Ministry of Agriculture of Estonia. A water basin of the medium sized river, Amme was thoroughly investigated and described. In the water basin of this river there are lot of lakes, with great importance for tourism. The environmental situation of those lakes and Amme River were evaluated in different ways (water chemistry and bottom fauna analyses, with analyse of long-term trends). The Gdovka River pilot project was started at the end of 2000. Results of the pilot projects are summarised in annexes 1 and 2 to this report and more detailed information on the pilot projects is available at Pskov Committee for Natural Resources (on Gdovka River project) and at the Peipsi CTC (on Amme River project).

Towards Lake Peipsi Management Program

The strategy for wastewater treatment is used for preparation of a comprehensive Lake Peipsi Basin Management Program. On the advice of the Commission, Estonian Ministry of the Environment has sought support for cooperative work in both countries worth US$1M from the Global Environmental Facility through United Nations Development Programme, in part, to launch the three-year Lake Peipsi Basin Management Program. The program will be managed by the Peipsi CTC. This program will build on existing water management projects in the basin supported by the Danish Ministry of Foreign Affairs, Danish EPA and Swedish EPA and by the European Union. Since Russian funding is leaner even than Estonia's, the European Union's TACIS provided Euro 2M to boost the basin management programme. A range of technical activities are included, such as monitoring and sampling, environmental assessment of pollution and pilot projects aimed at reducing nutrients in the lake. A comparative analysis of the European Union water directive and the Russian Water Basin Management approach will also be done, along with institution building activities and public education (Transboundary transformation, 2001). Methodological and research support will be provided by a three-year EU research program "Integrated Strategies for the *Man*agement of *Tra*nsboundary Waters on the *East*ern European fringe – The pilot study of Lake Peipsi and its drainage basin" (MANTRA-East) where 10 research institutes from five European countries will take part (see about MANTRA-East at www.mantraeast.org).

Background information on Lake Peipsi/Chudskoe

The Lake Peipsi/Chudskoe is one of the major lakes of the Baltic Sea water basin. Lake Peipsi/Chudskoe (3555 km^2) is the fourth largest lake in Erope. It is situated on the Estonian-Russian border and is therefore the biggest transboundary lake in Europe.

The lake consists of three unequal parts: the biggest northern L. Peipsi *s.s.* (2,613 km^2), maximum depth 12,9 at water level 30.01 m above sea level, water capacity 21,79 km^3); the southern Lake Pskov (709 km^2, 5,3 m, 2,68 km^3), and the narrow strait-like L. Lämmijärv/ Teploe connecting them (236 km^2, 15,3 m, 0,60 km^3). The watershed (including the lake itself) covers 47,800 km^2 of the territories of Russia, Estonia and Latvia.

Lake Peipsi belongs to the watershed of Narva River, a 77 km long water- course, which connects the Lake Peipsi with the Gulf of Finland of the Baltic Sea. The Narva River annual water discharge into the Gulf of Finland is 12,6 km^3 (approximately 50% of the average volume of the Lake Peipsi). The territory of the whole Narva River watershed is 56,200 km^2. About 240 rivers and streams flow into the Lake Peipsi. The major rivers are *Velikaya* (in Russian Federation) and *Emajõgi* (Estonia) with catchment areas 25,200 km^2 and 9,745 km^2, respectively. The residential time of water is about two years in the whole lake.

Regular water chemistry monitoring on the Lake Peipsi started in 1950. Hydrobiological investigations has been carried out since 1962. The monitoring was complex and integrated at the very beginning because it was a part of the surface monitoring program. So the assessment of the lake water analyses results has been done together with those from rivers in the water basinof the lake. In addition to water chemistry analyses the hydrobiological investigations in the lake and in river have included

- Phytoplankton,
- Chlorophyll,
- Zooplankton,
- Bacterioplankton,
- Macrozoobenthos,
- Macrophytes,
- Fishes and fisheries management.

According to phosphorus, nitrogen and chlorophyll *a*, the trophic state of three parts of Lake Peipsi is different with the highest concentrations in the southern parts. Lake Peipsi *s.s.* is an eutrophic lake (with a total Phosphorus level of about 50 mg m^{-3} and Chl*a* mean values 14,7 mg m^{-3}), Lake Pskov is considered to be hypertrophic (mean Chl*a* 47,8 mg m^{-3}). The long-term average primary production is 0,8 g C m^{-2} d^{-1}. Diatoms and blue-green algae prevail in phytoplankton biomass. The blue-green algae *Gloeotrichia echinulata* and *Aphanizomenon flos-aquae* dominate in summer causing the water-blooms. There are 34 various fish species in Lake Peipsi. The fish production is 25-34 kg $ha^{-1}y^{-1}$.

Strategy for wastewater treatment in the Lake Peipsi/Chudskoe basin

Project strategic objective
The strategic objective of the project is to protect the environment in Lake Peipsi and its tributaries to achieve good ecological conditions close to the natural unpolluted state.

Immediate objective
The immediate objective of the project is to propose a general and coordinated strategy for wastewater treatment in the Lake Peipsi watershed to reduce in a cost-effective way the wastewater impacts in Lake Peipsi and its tributaries to a level not preventing a good ecological quality.

Environmental objectives for Lake Peipsi and its tributaries
In this project it is presupposed that the general objective for the lake and river environmental quality is a water quality and an ecological condition only deviating slightly from the natural, unpolluted condition. This criteria is in accordance with the EU Water Framework Directive adopted 22 December 2000 generally demanding a *good quality* for surface and ground waters.

This objective implies that the sum of all different human impacts on water and ecological quality of a waterbody must be limited to a minor impact. Consequently the wastewater impacts alone must also be limited to be minor (at the highest).

Deviations from this general objective of a good water quality and good ecological conditions can be decided for some of the water bodies. Typically, the objective for streams and lakes which are totally unpolluted today can be to maintain this *high quality* and prevent any future human impact. Also, a significant pollution or other human impacts can be accepted for waterbodies, where it is not realistic to avoid this impact, and a *moderate quality* is accepted.

Wastewater treatment measures to meet the environmental objectives
The most important human impact on Lake Peipsi environmental quality is eutrophication, i.e. the increase in algal production in the lake and other changes caused by increased nutrient loadings from wastewater and from agriculture.

Nitrogen: Probably no environmental effects through reductions
Algal productivity is not likely to be much affected by changes in the nitrogen loading of Lake Peipsi from wastewater, because of the important internal processes of denitrification and nitrogen fixation and because the present wastewater contribution amounts to less than 10 % of the total external nitrogen loading.

Nitrate leakage from cultivated fields could be an important pollutant in Lake Peipsi. However, denitrification and nitrogen fixation processes within the lake are likely to counteract external changes in nitrate loadings. Therefore, it is likely that Lake Peipsi water quality is not very dependant on the external nitrogen loading, even though nitrogen occasionally is limiting algal production in Lake Peipsi.

The reasons why the nitrogen content of the Lake Peipsi water is not very dependant on the external loading are the relatively long residence time (2 years) and the shallownes of the lake and the resulting absense of summer stratification.
Because of the shallow water the entire water masses are in close contact with the sediment. Therefore nitrate from the water is easily transported into the surface sediment and denitrified here into atmospheric nitrogen (N_2). The long residence time gives sufficient time both for a denitrification of surplus nitrate and for fixation of nitrogen from the atmosphere by blue-green algae.

Therefore, the concentration of total nitrogen in Lake Peipsi and the transport of total nitrogen through Narva River to the Finnish Bay is likely to be more dependant on the phosphorus loading than the nitrogen loading of Lake Peipsi.

If phosphorus loadings and lake water phosphorus concentrations are reduced the phytoplankton biomass and therefore also the nitrogen content of phytoplankton is reduced. This leaves a larger amount of nitrogen as inorganic nitrate in the lake water, and this nitrate is immediately available for denitrification in contrary to the organic nitrogen in phytoplankton.

If the phosphorus concentration in Lake Peipsi water increases the biomass of phytoplankton will increase and therefore also the nitrogen content of phytoplankton (from nitrogen fixation or from external loading) which can not be denitrified. Therefore, increases in phosphorus loading of lake Peipsi will also increase the concentration of total nitrogen in the lake water and in Narva River and concequently also increase the nitrogen loading of the Finnish Bay.

In conclusion, because of the nutrient dynamics of Lake Peipsi, there is no need to remove nitrogen from wastewater in the water basin to protect Lake Peipsi, the Finnish Bay or the Baltic Sea.

However, if the agricultural cultivation of land in the catchment is dramatically intensified the resulting increases in nitrogen loading of Lake Peipsi can surpass the capacity of the lake for denitrification and in such a case contribute significantly to the pollution of Lake Peipsi and the Finnish Bay.

Phosphorus: The key pollutant
The external phosphorus loading must be considered the key element in the human impact on Lake Peipsi water quality. Given the time for the lake to equilibrate with the external phosphorus loadings the ecological impacts on lake water quality will be roughly proportional to the external pollution loadings. From this follows that the wastewater impact will be small, only if the sum of phosphorus discharges from wastewater is small compared to the total external loading.

All wastewater discharges in the watershed contribute to the phosphorus loading of the lake, because phosphorus retention in streams is generally small. Yet, a significant retention can occur in upstream lakes.

Water quality options

It is a political issue to decide the level of acceptable wastewater impact on Lake Peipsi, and no precise guidelines exist on the acceptable level of impact to achieve a good water quality. Maybe it is considered acceptable to have a 10 % increase in the amounts of algae in Lake Peipsi or maybe 25 % as a result of human activities in the watershed. Therefore, in this proposal for a strategy for wastewater treatment the consequences of different wastewater treatment levels are shown. The options are partly the selection of towns for phosphorus removal depending on the size of the town and partly the degree of phosphorus removal from the wastewater, maybe depending on town size.

Streams

The main pollution impacts in streams from wastewater discharges are caused by the biodegradable organic matter in the wastewater. Also, pathogens, ammonium and toxic substances can be important pollutants.

The environmental impacts from these common pollutants depend on the degree of treatment of wastewater and on the degree of dilution, when it is discharged into a stream. Through a biological treatment the content of organic matter, ammonium and pathogens can be widely reduced. There is a very substantial international experience on the needed level of biological treatment to reduce the environmental impact from wastewater in streams. This general experience is proposed to be adopted to establish general guidelines for biological treatment of wastewater discharged into streams in the Lake Peipsi watershed.

The distances between towns in the Peipsi catchment seem to be large enough to avoid combined effects of discharges from more than one town. The degradable organic matter will be mineralized in the stream through self-purification before the water will reach the next outlet from a town. Therefore, the pollution with organic matter and ammonia can be dealt with separately for each town and stream.

Severe organic pollution

It is a general experience for temperate lowland streams that a wastewater discharge into a stream leading to increases in BOD in the stream water of more than 3 mg/l during typical low flow conditions, results in a very substantial impact in the stream ecosystem and the river quality will be *poor* or *bad* downstream the discharge point. How far this inferior quality will prevail depends on rate of stream self-purification and on further dilution downstream. Therefore, if the stream BOD increase during low flow is calculated to exceed 3 mg/l an improved biological wastewater treatment is immediately needed.

Significant organic pollution
It is also a general experience for temperate lowland streams that a wastewater discharge into a stream leading to increases in BOD in the stream water of more than 1 mg/l during typical low flow conditions, results in a significant impact in the stream ecosystem. The river quality will usually be unsatisfactory (*moderate* or *poor)* downstream the discharge point, and an improved biological treatment will be needed.

These criteria for extensions of biological wastewater treatment are proposed to be adopted in the general strategy for wastewater treatment in the Lake Peipsi watershed as a first step. Further, it is necessary to include considerations of ammonia concentrations in the receiving stream to evaluate the need for a simultaneous removal of ammonium, and considerations must be given to possible hygienic problems for downstream water usage.
Whether these criteria for for protection of the watercourses against pollution are sufficient for the individual wastewater discharge must be evaluated by biological monitoring in the watercourse.

Pathogens
All waters used for water supply and recreation (swimming) must meet the relevant hygienic water quality criteria. This is accomplished through a proper selection of sites for wastewater discharges and/or extended wastewater treatment if needed.

Toxic substances
Pollution problems in surface waters caused by wastewater discharges of toxic substances usually can not be solved by wastewater treatment, because the toxic compounds very often are just transferred to the wastewater sludge if they are removed from the water. The solution to this type of pollution problems must be a reduction of toxic and xenobiotic substances at the source, e.g. by pretreatment, better household, substitution or by cleaner technology

EU requirements
Specific wastewater treatment requirements, at least relevant for Estonia, are given in the EU directive on wastewater treatment (directive 271 from 1991). According to this directive a secondary (biological) treatment must be undertaken according to the following time schedule:

- towns >15,000 PE before 2001
- towns >10,000 PE before 2006
- towns > 2,000 PE before 2006 for wastewater discharged into fresh waters.

According to the directive nutrient removal must be undertaken in towns with more than 10,000 PE, if wastewater flows into a vulnerable waterbody. Without doubt Lake Peipsi should be classified as a waterbody vulnerable to pollution with phosphorus, but it seems reasonable not to classify the lake as vulnerable to pollution with nitrogen compounds.

According to the directive the minimum outlet criteria for phosphorus removal are:

- towns>100,000 PE: 1 mg P/l or 80 % P removal
- towns> 10,000 PE: 2 mg P/l or 80 % P removal.

Improved wastewater treatment: Consequences in Lake Peipsi

Background

The background for evaluations of environmental benefits are the existing monitoring reports on Lake Peipsi and the streams and wastewater discharges in the watershed. The basic idea is to estimate future equilibrium conditions in Lake Peipsi at different scenarios for wastewater treatment.

The present phosphorus loadings of Lake Peipsi from all sources are estimated by Ståhlnacke et al (2000) and the contribution from the different towns are compiled by Russian and Estonian authorities as a part of the project.

Lake Peipsi loadings

According to Stålnacke et al (2001) and Ülo Sults (pers. comm.) the loadings of the 3.555 km^2 and 25.1 km^3 Lake Peipsi from its 47,800 km^2 watershed are 12.6 km^3/y of water containing (see Table 1):

Table 1. Lake Peipsi N and P sources av. 1995-98

Lake Peipsi N and P sources av. 1995-98	nitrogen t/year	phosphorus t/year
wastewater	1,325	179
precipitation on lake surface	2,737	18
agriculture	12,269	541
other diffuse sources (background)	9,632	208
total	25,963	946

The loadings for the period 1985-1989 are reported by Loigu and Leisk (1996) (Table 2):

Table 2. Lake Peipsi N and P sources av. 1985-89

Lake Peipsi N and P sources av. 1985-89	nitrogen t/year	phosphorus t/year
wastewater	2,010	310
precipitation on lake surface	4,360	40
agriculture	45,190	708
other diffuse sources (background)	3,500	105
total	55,060	1,163

Phosphorus sources in water flowing into Lake Peipsi
According to the estimates made by Loigue and Leisk and Ståhlnacke et al the average concentrations of total phosphorus in the river water flowing into Lake Peipsi under differents cultural influences can be calculated:

Table 3. Total P in inflowing water

Total P in inflowing water	1985 - 1989 (Loigu and Leisk 1996)	1995 - 1998 (Ståhlnacke et al 2000)
Natural background (NB)	8 mg/m^3	17 mg/m^3
NB + agriculture (agric.)	65 mg/m^3	59 mg/m^3
NB + agric. + wastewater	89 mg/m^3	74 mg/m^3

These figures can be compared with the averages of the monitored concentrations in Lake Peipsi: 46 mg/m^3 in 1985-89 (Noges et al 1996) and 42 mg/m^3 in 1995-998 (Ståhlnacke et al 2000). The source apportionment between the natural background and the contribution from agriculture is very difficult and must be considered to need further monitoring.

Wastewater loadings estimated in 2000
The information collected from Russian and Estonian authorities in 2000 as a part of the present project is given in the data sheet in the appendix and is summarized in the table 4.

Table 4. Nitrogen and phosphorus discharges with wastewater in Lake Peipsi watershed 2000

town size group	water (mio. m^3/y)	total N (t/y)	total P (t/y)
>100,000 PE	49,21	569	54,9
10,000-100,000 PE	4,97	124	16,5
2,000-10,000 PE	3,92	81	9,8
<2,000 PE	4,75	73	19,7
Total in towns	62,86	846	101,0

Comments to phosphorus loadings

Wastewater

The estimated figures for wastewater phosphorus loadings to Lake Peipsi can be compared with general experience on the phosphorus discharge with wastewater from 1 PE. In Denmark the average unit load from 1 PE (untreated wastewater) is 1 kg P/PE year. Because the use of phosphate containing detergents and possibly also other wastewater phosphorus sources are likely to be smaller in the lake Peipsi catchment compared to Danish conditions, it seems likely that the unit loading in the Lake Peipsi catchment amounts to 0.5 - 1 kg P/year.

The population in towns with more than 2,000 inhabitants amounts to 575.000 PE. Therefore, a total wastewater loading of less than 100 tons/year seems low, even though a chemical treatment is undertaken at some plants and even if a large part of the population in the towns is not connected to sewers. A wastewater loading of about 200 t/y could be expected.

Further, the figures show a decline in wastewater phosphorus loadings from 310 t/y in the 1980s to 179 t/y in the 1990s to the present estimate of 93 t/y. It must be carefully evaluated by the relevant authorities whether these figures reflect the development correctly.

Background and agriculture

The splitting of the diffuse phosphorus sources in the two main fractions: the natural background and the agricultural contribution actually requires a very targeted monitoring programme. To evaluate effects of wastewater treatment alone a splitting of these diffuse sources is not needed, but it is essential for a more general water quality management plan.

Wastewater treatment scenarios: Phosphorus removal

The scenario calculations are base on the total and diffuse phosphorus loadings given by Ståhlnacke et al (2000), because these data probably better reflect the present situation than the data given by Loigu and Leisk (1996). Up to date data on wastewater discharges are compiled for this project by CTC for all towns in the Lake Peipsi catchment with more than 200 PE.

Scenario 1: *80 % reduction in present discharges from Pskov and Tartu*

This measure will reduce their phosphorus loading from 54.9 t/y to 11.0 t/y or a total reduction of 43.9 t/y. This corresponds to a reduction in the average phosphorus concentration in the water flowing to Lake Peipsi of 3.5 mg/m^3 or about 5 % of the present concentration of 74 mg/m^3 to 70 mg/m^3.

Scenario 2: *80 % reduction in discharges from all towns with more than 10,000 PE* connect*ed*

This measure will reduce their wastewater phosphorus loading from 71.4 t/y to 14.3 t/y or a total reduction of 57.1 t/y. This corresponds to a reduction in the average phosphorus concentration in the water flowing to Lake Peipsi of 4.5 mg/m^3 from 74 mg/m^3 to 69 mg/m^3.

Scenario 3: *80 % reduction in discharges from all towns with more than 2,000 PE* connect*ed*

This measure will reduce their wastewater phosphorus loading from 81.3 t/y to16.3 t/y or a total reduction of 65 t/y. This corresponds to a reduction in the average phosphorus concentration in the water flowing to Lake Peipsi of 5.2 mg/m^3 from 74 mg/m^3 to 69 mg/m^3.

Scenario 4: *All inhabitants in towns with more than 2.000 PE are connected to sewers and discharge wastewater without phosphorus removal*

As a very rough estimate a discharge of 0.5 kg/y PE is assumed. With a population of 575.000 PE in these towns their discharge amounts to 287.5_t/y or a contribution to phosphorus inflow concentration of 23 mg/m^3 and an increase in inflow concentration from the present 74 mg/m^3 to 97 mg/m^3.
This scenario can be supplemented with scenarios for phosphorus removal.

Scenario 5: *This scenario include future urban and industrial development in the catchment area. Predictions are difficult. As an illustration a scenario is selected with a wastewater production in sewered areas corresponding to 1 mio. PE each discharging 0.5 kg P/d y.*

Without phosphorus removal from wastewater 500 t/y is discharged. This gives a a

contribution to phosphorus inflow concentration of 40 mg/m^3 and an increase in inflow concentration from the present 74 mg/m^3 to 105 mg/m^3.
With an average 90 % phosphorus removal from wastewater 50 t/y is discharged. This gives a a contribution to phosphorus inflow concentration of 4 mg/m^3 and a decrease in inflow concentration from the present 74 mg/m^3 to 72 mg/m^3.

Comments to the scenarios for phosphorus loadings

The scenarios indicate that the present wastewater loading of Lake Peipsi does not cause severe damage to the lake ecosystem generally, but the present and especially the former loading contributes significantly to a deterioration af the natural lake ecosystem - a deterioration probably big enough to prevent a classification of the ecological lake quality as good.

In the scenarios no considerations are paid to the fact that almost all phosphorus discharged with wastewater will be readily available for algal growth in Lake Peipsi, whereas a significant fraction of the phosphorus loading from natural sources and from cultivated fields will be more or less fixed in mineral particles and not immediately available. Therefore, a simple comparison of the wastewater loading with the other sources will underestimate the eutrophication effects of wastewater. Further, som of the wastewater sources are not accounted for as mentioned below under streams.

Although Lake Pskov is more vulnerable to eutrophication than the northern part of Lake Peipsi it is probably not reasonable to have more strict outlet criteria here than for the rest of the watershed.

To undertake a specific water quality planning for Lake Peipsi and for specific decisions on interventions it is necessary to establish more precise figures for the contribution of phosphorus from the different sources through a targeted monitoring programme. A prerequisite for such a planning is not only a good estimate of the wastewater contribution, but also a good quantification and separation of the natural background and the agricultural contibutions of phosphorus. Also the phosphorus contribution from direct discharges from livestock farms must be separately known to implement appropriate measures against this pollution source.

Smaller lakes in the water basin

General objective for the lakes

To avoid substantial pollution impacts from wastewater discharges the general objective for the lakes in the Lake Peipsi catchment is proposed to be, that the total discharge of phosphorus with wastewater to surface waters in the entire catchment of the individual lake must not exceed 25 % of the total external phosphorus loading of the lake.

The considerations in the above scenarios can not be used in the evaluation of the wastewater pollution of the smaller lakes in the watershed. A protection of these lakes from eutrophication will require much stricter outlet criteria than for Lake Peipsi because of the much smaller water flow through these lakes. Very often a phosphorus removal even in very small villages are needed to protect the lakes. The need for phosphorus removal from wastewater is evaluated through specific quantifications of the phosphorus sources for each lake individually.

Evaluations of the needs for phosphorus removal to protect the other lakes in the catchment must be done through an apportionment of the phosphorus sources in a similar way as for Lake Peipsi.

Improved wastewater treatment: Consequences in the streams

Based on data for the present wastewater discharges from towns and the rate of dilution at low water river flow at the discharge point (see the attached data sheet) there seems to be a significant local pollution impact in streams from the towns:

- Viljandi
- Otepää
- Gdov
- Jõgeva
- possibly from Opochka, Russia.

According to the strategy it is recommende to improve the biological treatment of the wastewater from these towns. Before final decisions are made the data background and the pollution impact should be confirmed.

In the town of Gdov the wastewater pollutes the Gdovka River with organic matter and possibly leads to unsatisfactory hygienic conditions along the shores of Lake Peipsi around the river mouth.

In the other towns with more than 2.000 PE there seems not to be much need for further biological wastewater treatment with the present discharges from the towns. The pollution impact from each discharge of wastewater from towns should, however, be monitored by biological monitoring in the watercourse. Decisions on further biological wastewater treatment should depend i.e. on these monitoring results.

Wastewater not accounted for

The wastewater impacts in the streams and in the lakes can be more important now and in the future than indicated above, because:

- some of the wastewater is discharged without being monitored
- storm water run-off is not included in the compilations
- extensions of the sewerage system and town development will increase the amounts of wastewater and pollutants collected.

Therefore, it is recommended to follow the development in pollutant discharges and the biological impacts in the streams to be able to adjust the interventions against stream pollution according to the current pollution impact.

Preliminary wastewater treatment plan

Proposals for measures to be carried out

80 % phosphorus removal is established for all wastewater before 2004 in Pskov and Tartu.

Nitrogen removal from wastewater in the Lake Peipsi catchment is not required, except for nitrification of ammonia.

Before 2006 a closer evaluation based on monitoring results is made on the benefits of extending the phosphorus removal to smaller towns to protect Lake Peipsi, smaller lakes or both.

Before 2010, phosphorus removal in towns in the catchments of the smaller lakes is established to an extent which will reduce the wastewater discharges of phosphorus in the catchments of the lakes to max. 25 % of the total external phosphorus loading of the lakes. The needed treatment is established according to a priority list. For high priority lakes the phosphorus removal must be established before 2006.

Before 2010 phosphorus removal is established in other, smaller towns where it is considered needed to protect Lake Peipsi. In the wastewater treatment planning considerations to phosphorus removal must be given even if it is not included in the present strategy. If the surplus costs are marginal phosphorus removal should also be established at smaller plants.

Wastewater treatment requirements for industrial discharges to surface waters are similar to the requrements for domestic wastewater.

Full biological treatment with at least 80 % reduction of BOD and ammonia is established before 2006

- at all wastewater discharges with more than 2,000 PE connected,
- at all discharges which lead to BOD increases above 1 mg/l in receiving waters and
- at all discharges where stream ecosystem impacts occur.
- highest priority is given to discharges with a high local environmental impact.

These measures are likely to reduce the wastewater impacts on Lake Peipsi and its tributaries to a level where the present wastewater production will not prevent the achievement of a good ecological quality in the surface waters.

Future monitoring to establish a more general environmental protection strategy

A targeted and coordinated monitoring programme is to be established before 2004 to enable the needed quantification of the different sources of phosphorus for pollution source apportionment and evaluations of possible environmental improvements in lakes and streams by further interventions. Similarly other important environmental impacts on Lake Peipsi and the waters in the catchment and their causes are monitored to establish the needed background for a more general environmental protection strategy. This strategy is to be elaborated and decided upon before 2010.

Environmental management plan for Lake Peipsi and its watershed

A water quality plan for the Lake Peipsi catchment, including the water quality objectives and the needed measures to reduce all types of pollution impacts, is established before 2010 and revised every 6 years.

The general objective for streams and lakes in the watershed is a good ecological quality only slightly affected by human activities in the watershed. The management plan is based on a sufficient quantitative knowledge of the pollution sources and on evaluations of cost and benefits by the measures to reduce pollution impacts. The management plan will describe the accepted levels of impacts, the acceptable loadings from the different pollution sources and the measures to reduce the pollution sources and other impacts to the level decided.

The water quality plan for the Lake Peipsi catchment can be extended to cover the entire Narva River catchment. This will require more specific considerations concerning water quality in the Gulf of Finland and a coordination between all three countries in the catchment.

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References

Stålnacke, P., Sults, Ü., Vasiliev, A., Skakalsky, B., Botina, A., Roll, G., Pachel, K. and Maltsman, T. 2001. Nutrient loads to Lake Peipsi. *Jordforsk Report No. 4/01*

Transboundary transformation. 2001. In *Water 21: Magazine of the International Water Association.* April 2001.

Annex 1

AMME RIVER Pilot Project

AMME RIVER PILOT PROJECT was started in August 2000 and devoted to investigation of the ecological conditions in the small river subcatchment in the Lake Peipsi Basin and for evaluation of the possibilities how to reduce nutrient loads from the catchment area, and improve ecological situation in the lakes and Amme River. Pilot project was co-financed by Ministry of Agriculture of Estonia. The sum of co-financing was 140,000 EEK. The objectives of this pilot project were:

- evaluation of the ecological conditions in *Amme River*;
- evaluation of the ecological conditions in Vooremaa lakes;
- evaluation of the municipal waste water treatment and phosphorus reduction;
- evaluation of the recreation potential of the Vooremaa landscapes and lakes;
- the main tourism routes and landscape management needs in this area;
- the strategy for nutrient loads reduction for small river catchment area and for each lake in the catchment area separately;
- estimation of the waste water treatment possibilities in small local administration unit (Saare parish), with 1700 people and without big villages.

Insufficient wastewater treatment

Waste water treatment in the Lake Peipsi watershed is a very important and serious problem because 38% of the total number of the constructed waste water treatment plants, which is 800-820 in the whole Estonia, doesn't work. The situation in Lake Peipsi watershed is even worse. In Jõgeva County, *e.g.* there are for 46 waste- water treatment plants, and 62% of them are out of order. In Tartu County those numbers are 57 and 42% respectively.

The most widespread types of waste-water treatment plants in Estonia are activated sludge plants BIO-25, BIO-50, BIO-100, and OXYD-90 and OXYD- 180. The construction of those waste-water treatment plants has been worked out in Estonia in 1970-es. The aeration tank of BIO-series plants was from steel, in OXYD-series from concrete. For tertiary treatment the oxidiation ponds had been used but very often the oxidiation ponds were the only waste- water treatment elements.

Aproximately 40% of the total amount of the waste-water treatment plants are activated sludge plants, 40% are oxidation ponds and 20% the others.

The main reason why the waste-water treatment plants don't work efficiently are as follows:

- The steel elements (aeration tanks) of BIO-series have been corroded, and the restoration of them is too expensive;
- Volume loading in aeration tanks is too low. This is a result of reduced water use and collapse in agriculture. The water use in small towns and villages has decreased from 150-200 l/day to 80 –100 l/d for 1 p.e.;
- Oxidation ponds are full of sediments;
- People in small villages are not able to use hot water from central water supply due to high price. The result of it is a very low temperature of waste water in winter period, with 2 … 4^o C instead of normal 7 … 12^o C.

However, the ecological situation in the rivers is not worsening but is even improving during 5 last year period. There are many various reasons for it :

- The number of dairy cows has reduced for 50%.
- The number of pigs has reduced for 60-70%.

The drainage systems on the river bank areas are not functioning due to insufficient maintenance, there are floods in high water periods. Therefore, mineralisation of organic matter and nitrification of ammonia in ditches and flooded meadows have increased and thus reduces the loadings of the streams with organic matter and ammonia.

- There are a lot of dams in the rivers, constructed mainly by beavers but sometimes they are man-made, and in these ways created ponds help to reduce nutrient loads in the rivers too.

All the mentioned above factors, and the good-working waste-water treatment plant in Tartu town have decreased the pollution risk to the Lake Peipsi from Estonian catchment area. But EU directives demand the good water and ecological quality in all natural water bodies. That causes problems in many small river catchment areas, particularly in upstream sections of them, if there are towns or villages.

For assessment of those problems and the real situation two pilot project areas have been selected:

1. *Amme River catchment area in Estonia, with 501 km^2*
2. *Gdovka River catchment area, with 150 km^2 in Russian Federation.*

A short description of the AMME river catchment area.

Amme river is a right tributary of the *Emajõgi River. Amme river*, with catchment area of 501 km^2 takes its beginning from Lake Kuremaa (397 hectares) in the Vooremaa (Drumlins) Landscape Reserve in Jõgeva County 83 m above the sea level, and discharges into Emajõgi River near the Kärkna village on 30 m above sea level in Tartu County.

The total length of the river is 58,8 kilometres. The upstream section (aproximately 20 km) has been straightened in 1956. It is less than 5 m wide and not deep (less than 1 m).

The Vooremaa Landscape Reserve, with area of 99 square kilometres was founded in 1964. Aims of conservation of this area were to preserve an area of typical drumlins cut by interstitial troughts filled with marshes and numerous lakes:

Lake Saadjärv – 710 hectares;
Lake Kuremaa – 397 hectares;
Lake Kaiavere – 250 hectares;
Lake Soitsjärv – 200 hectares;
Lake Elistvere – 183 hectares;
Lake Raigastvere – 122 hectares;
Lake Kaarepere Pikkjärv – 58,5 hectares;
Lake Prossa – 33 hectares

The total surface area of all lakes takes 4% of the whole river catchment area, and the sum of water volume of all lakes is as 42,4 *Mio* m^3, or 35% of the average annual flow of the Amme River, with 119,92 *Mio* m^3.

All of those lakes, except the Lake Soitsjärv are rich of fish , with average annual catches 20-25 kg/ha. The lakes Soitsjärv and Elistvere are very rich of water-fowl.

Unfortunately the ecological situation in those lakes is not very good. Most of the lakes are polluted with nutrients from wastewater and from agriculture.

There are more than 10,000 people living in the Amme river catchment area in many medium size villages (500-2000 inhabitants and 200-500 inhabitants). Some of them are located in the lake- shore areas, as Kuremaa, Palamuse, Tabivere, *e.g.*

To reduce the phosphorus loading in the Amme River catchment area is therefore very important for local people and for ecological status of those unique lakes.

Our main interest was devoted to the upper stream of the Amme River, with total area 223 km^2:

- 103 km^2 (46%) – agricultural areas;
- 100 km^2 (45%) – forest areas, wetlands and other lands;
- 20 km^2 (9%) - water areas (lakes and rivers).

62 km^2 of the agricultural lands have drainage systems, 55% of them subsurface or tile-drainage. Drained lands are located mainly on the floodplains between drumlins or on the slopes of the drumlins. A lot of them are out of use nowadays.

Ecological conditions in the Amme River

In the upstream sub-catchment from *Lake Kuremaa* down to *Lake Elistvere* (20 km) the river is straightened. It is narrow (1,5 –2 m), not deep (1 m), and is flowing in the valleys between drumlins, with relative hights up to 30 metres. There are many hundreds metres breight floodplains on the banks of the river, with meadows which are either cultivated and in use, or grown with bushes and trees. The river bed is full of reeds and aquatic plants. In very many places there are beaver-built dikes and ponds. The broken trees in the river bed are not very seldom.

The sections of the *Amme River* which connect the lakes *Kuremaa, Raigastvere* and *Elistvere* are short and with bigger flow in the spring only. In other periods the lakes collect the water of the precipitations and there is very little water in the riverbeds. The lakes are functioning as biological ponds, and water quality in the river is quite good.

In the downstream sub-catchment from *Lake Elistvere* down to *Emajõgi River* (39 km) *Amme River* is flowing through forests and agricultural lands. This subcatchment is practically without lakes. Due to bigger flow and not very intensive agricultural activities the quality of water in the river is good or very good. There are a lot of fallen trees and beaver-dams in the riverbed too.

Water quality and ecological conditions in the Lake Kuremaa

Not all lakes in Vooremaa Landscape Reserve have been thoroughly monitored and investigated. *Lake Kuremaa* as the upper lake in the Vooremaa lakes cascade is a very good example for demonstration of the main problems of sanitation of the lakes in Vooremaa.

According to the Võrtsjärv Limnological Station by Estonian Agricultural University in 1997 the ecological situation in the *Lake Kuremaa* was as follows:

The concentration of the nutrients in the lake water is 45-50 mgP/m^3 and 800-900 mgN/m^3. COD_{Cr} values have been as 24-40 mgO/l, and COD_{Mn} values 8,40 – 9,87 mgO/l. Dissolved oxygen contents had been 9-12 mgO_2/l in the surface of the lake, and close to zero near the bottom of the lake during a couple of last years.

Very dense growths of macrophytes are found around and in the lakes, such as *Phragmites australis, Shoenoplectus lacustris* and *Typha angustifolia* and some aquatic plants, as *Stratoites aloides, Ceratophyllum demersum, Ranunculus circinatus.*

Dominating algae species are *Ceratium hirundella, Aulacoseira granulata, Microphytis sp. etc.* All of the listed species and water chemistry analyzes demonstrate the eutrophication of the *Lake Kuremaa.*

Similar situation is characteristic for lakes *Elistvere* and *Soitsjärv.* A little bit better is the ecological situation in lakes *Raigastvere, Kaiavere* and *Saadjärv.*

Possibilities for improving the ecological situation in the lakes of Vooremaa.

According to estimations based on monitoring data and investigations, mentioned above, the total annual phosphorus load to the *Lake Kuremaa* is 400 kgP/year and the total nitrogen load approximately 2100 kgN/year. The load from point-pollution sources is 87-100 kgP/year and 470-550 kgN/year respectively.

As ~~if~~ phosphorus has been considered the limitation element for eutrophication, we'll try to analyze the possibilities of the reduction of phosphorus load.

1. <u>Reduction of the phosphorus load in the outlets of municipal waste water.</u> There isn't practically very much possibilities to reduce phosphorus load in the waste water outlet of Kuremaa village, with 590 people. The phosphorus reduction is here over 80% already.
2. <u>Reduction of the phosphorus load from non-point sources.</u> There are 3-4 other inlets to the *Lake Kuremaa* which transport nutrient from arable land and private farms. In the mouths of those inlets it is possible to build wetland sewage treatment systems 0,5 ha. The total area of wetland sewage treatment systems in the whole subcatchment of *Amme River* is 27,3 hectares.
3. <u>Reduction of the phosphorus load from the slopes of drumlins caused by erosion of soils.</u> On the slopes with arable land in the places where the water protection zones and protective belts of trees would close the outlook to the lake the filter-drainage systems are foreseen.

The water purification effect of the measures, mentioned above, is not very big, maybe 40-50 kgP/year for *Lake Kuremaa.* The possibilities for other lakes are better but these lakes are not in such critical situation.

The active measures affecting biological processes inside the lake

4. Regulation of the water level in the lake. It is possible to regulate water level practically in each listed above lakes. It will be the topic of heavy discussions by lakes *Soitsjärv* and *Elistvere*, because those lakes are under nature protection as valuable bird sanctuaries. It is impossible on *Lake Saadjärv* because there are buildings too close to lake-shore and difficult on *Lake Kuremaa* due to the same reasons.
5. Removing the microphytes and aquatic plants and bottom sediments from the lake. This measure is foreseen to use in *Lake Kuremaa* and *Lake Prossa* in summer period of this year.
6. Chemical treatment of the bottom sediments is not foreseen in the lakes of Vooremaa.

The combination of the listed measures for each lake with following monitoring and control is strategy which need the very good co-operation of scientists, administrators and stakeholders. The implementation difficulties are connected with big investment needs.

The improvement of the waste water treatment in the other villages, affecting the ecological situation of the lakes in Vooremaa Landscape Reserve is very important. The waste water treatment plant in Palamuse is in very bad technical status and need restoration. Two man-made ponds in the village Palamuse are functioning as biological ponds and reduce the nutrient load to the *Amme River* and downstream lakes. The sewage water treatment needs improving in villages Tabivere, Kukulinna, Äksi. It is essential for the Lake Saadjärv.

The simple biological waste water treatment technologies will be reccommended for small villages (less than 200 PE) and for private farms where the number of domestic animals or poultry is small (less than 10 milking cows, 20 pigs or 100 hen), and the nutrient load from other agricultural activities (mineral fertilizer or pesticide use) doesn't have remarkable impact to the water ecosystems.

The experiences in Saare parish would be used for the small point-pollution sources in the whole catchment area of the Lake Peipsi.

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A strategy for reducing pollution impact of streams and lakes in the Amme River catchment area will be elaborated based on the same principles as the described strategy for Lake Peipsi.

For each lake the different phosphorus sources will be estimated, and effect of possible nutrient reductions on lake water quality will be estimated. Similarly, effects of improved removal of organic matter and ammonia from wastewater on the pollution impacts on streams will be evaluated as a background for decisions on wastewater treatment. Further, possibilities for and effects of internal restauration measures in the lakes will be investigated and evaluated.

The construction of the wastewater treatment plant for Jõgeva town has been finished some weeks ago, and the modern treatment technology will hopefully improve the ecological situation around this town very soon.

The small town Otepää with 3500 PE is located on Otepää hills on the upper stream of Väike-Emajõgi River. Low flow in summer and winter periods causes the increase of BOD load to the river. It hasn't any risk to the Lake Peipsi but could be problematic for small lakes around the town. The cascade of biolagoons has been build for secondary treatment of wastewater in Otepää some years ago.

Annex 2

Wastewater treatment project in Gdov

Relations to a general strategy for wastewater treatment in the Lake Peipsi catchment

Improved wastewater treatment in the town of Gdov in Pskov Oblast will be in accordance with the proposed general strategy for point source wastewater treatment in the Lake Peipsi basin. Further, a project on improved wastewater treatment in Gdov can be an important demonstration project illustrating both the implementation of the general strategy for wastewater treatment and other important aspects of wastewater treatment planning projects.

Some reasons for these qualities of the wastewater treatment project in Gdov are listed below.

Relations to the general strategy for wastewater treatment

The strategy for wastewater treatment in the Lake Peipsi basin proposes first priority to solve existing, local pollution problems. Two aspects of this are relevant in Gdov:

Local pollution of Gdovka River

Site inspection and calculations of the wastewater induced increases in BOD in Gdovka River shows that the discharge of the insufficiently treated wastewater leads to a significant pollution impact in the river downstream the discharge point with increased contents of biodegradable organic matter and with an unsatisfactory hygienic water quality.

Hygienic water quality in Lake Peipsi

The discharge of insufficiently treated wastewater is so close to Lake Peipsi that the present hygienic quality of the water in Lake Peipsi around the river mouth probably is unsafe for swimming and similar recreational activities involving a direct contact with the water along the lake shore.

Gdov wastewater treatment as a demonstration project

The Gdov wastewater treatment project can serve as a demonstration project for the planning and priority processes needed in the selection of the specific solution to the wastewater problems in Gdov. Some of the elements of this planning proces are:

- Selection between different options on usage of existing facilities or a total new construction of a waste water treatment plant
- Including of the needed relations to the future sewerage system in the wastewater treatment planning.
- Including of the needed relations to the future water supply of the Gdov citizens in the wastewater treatment planning.
- Including possible future new outlet criteria in the planning of the treatment plant, e.g. future phosphorus removal.
- Including evaluations of different options for treatment of both domestic wastewater and all industrial wastewater in the same plant or separate treatment of part of the industrial wastewater.

Further, the existing treatment plant must be considered as totally worn out and based on an outdated technology. Therefore, the treatment efficiency is low and not likely to be improved with the present plant.

Treatment requirements

The more specific wastewater treatment requirements must be settled and specified as a part of the project. As a preliminary evaluation an effective biological treatment is considered needed. This includes a BOD and ammonia reduction of approximately 90 % and a reduction in the outlet of pathogens (eg. monitored as E. coli) sufficient to meet hygienic water quality criteria for swimming at recreational shorelines of Lake Peipsi.

With the present evaluations of the nutrient sources to Lake Peipsi it does not seem justified to require a phosphorus removal from the wastewater in Gdov. However, the plant should be prepared for a future phosphorus removal. If a phosphorus removal can be accomplished with little further costs it should be considered to be established from the start of the new plant. Nitrogen removal is not considered to be justified (except for nitrification).

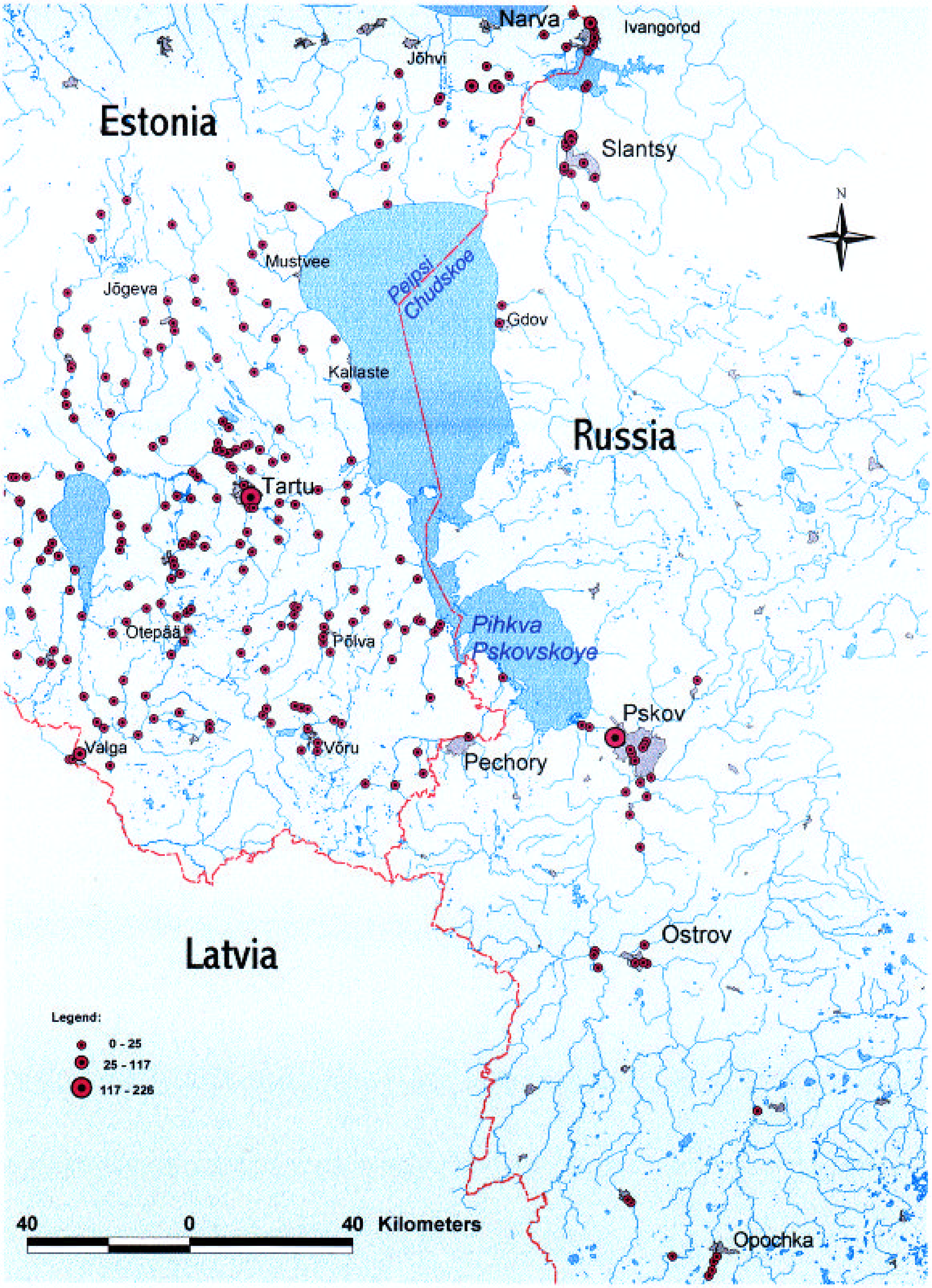
Conclusion

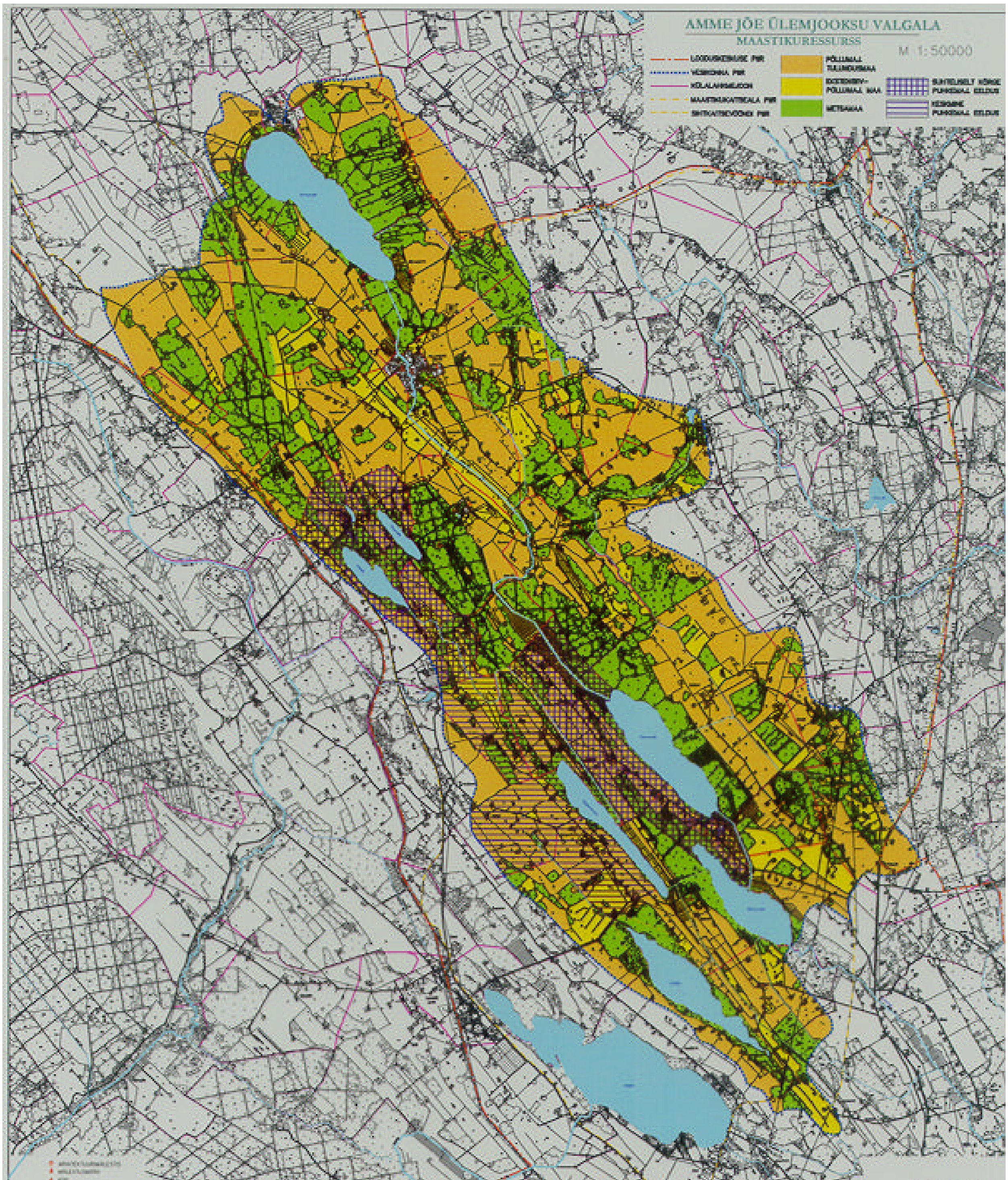
In conclusion a project on improving wastewater treatment in Gdov deserves special support because a new treatment plant will improve the significant local pollution impacts, will be a necessary element in improvements in water supply and extension of sewers and will serve as an example of integrated water and wastewater planning in a town in the Lake Peipsi catchment area.

Annual wastewater discharge in 1999 (10 m^3)

P total annual load (ton/year 1999)

N total annual load (ton/year 1999)





Amme River subcatchment area (1:50000)

Annex 3

Wastewater treatment strategy for Lake Peipsi Catchment										
Summary information on wastewater discharges to establish a treatment strategy										
Town	no of PE	Type of	Annual	Annual average outlets with wastewater				Low flow	BOD	80 % red.
		treatment	outlet	Total N	Inorg. N	Total P	BOD		increase	Total P
			mio.m3/y	t/y	t/y	t/y	t/y	m3/s	mg/l	t/y
Pskov	201200	bio	40,060	366,600	244,400	33,800	306,100	50,000	0,194	6,760
Tartu	104000	bio,chem	9,155	202,400		21,100	138,000	14,500	0,302	4,220
>100.000	**305200**		**49,215**	**569,000**		**54,900**	**444,100**			**10,980**
										0,000
Ostrov	28800	bio	1,392	25,920	17,280	2,976	37,000			0,595
Opochka	14900	bio	0,558	12,542	8,361	0,814	9,053			0,163
Võru	17000	bio-chem	1,360	23,650		4,670	30,570	1,010	0,959	0,934
Valga	16400	bio-chem	1,080	44,030		7,180	73,760	0,180		1,436
Pechory	13700	bio	0,582	17,421	11,614	0,882	12,238	1,600	0,242	0,176
10-100.000	**90800**		**4,972**	**123,563**		**16,522**	**162,621**			**3,304**
>10.000	**396000**		**54,187**	**692,563**		**71,422**	**606,721**			**14,2844**
Gdov	5800	bio	0,242	8,985	5,990	0,232	24,400	0,300	2,578	0,046
Pytalovo	7300	bio	0,454	12,900	8,600	0,613	5,721	6,000	0,030	0,123
Pushkinskie G	5000	bio	0,398	8,066	5,377	0,473	4,400			0,095
Pustoshka	6200	bio	0,097	4,365	2,910	0,165	8,010	0,710	0,358	0,033
Krasnogorodsk	5300	mech,bio	0,071	0,485	0,323	0,109	1,060	4,000	0,008	0,022
Idritsa	5300	bio	0,127	0,435	0,290	0,039	1,360			0,008
Novorzhev	4600	mech,bio	0,062	1,511	1,007	0,096	2,490	2,600	0,030	0,019
Palkino	3700	bio	0,182	12,600	8,400	0,281	7,890			0,056
Suschevo	8800									
Vybor	7600									
Piskovichy	2955									
Seredka	2302	bio	0,212	1,400	0,933	0,323	2,938			
Mustvee	2000	bio,chem	0,039	0,037		0,014	0,028	*		0,003
Jõgeva	6700	mech	0,288	4,300		0,620	46,000	0,580	2,514	0,124
Põltsamaa	5000	bio	0,321	6,500		1,660	7,300	2,060	0,112	0,332
Põlva	7400	bio	0,680	2,000		0,500	9,900	1,310	0,240	0,100
Elva	6400	bio-chem	0,089	1,010		0,170	0,800	0,360		0,034
Viljandi (1/4)	5500	bio-chem	0,320	8,240		1,550	25,450	0,050	16,135	0,310
Otepää	3500	bio	0,130	2,850		2,060	10,260	0,120	2,710	0,412
Räpina	3400	bio	0,090	2,960		0,570	2,950	2,050		0,114
Tõrva	3700	bio	0,118	2,250		0,370	3,260	0,390	0,265	0,074
2-10.000	**108457**	**0**	**3,9193**	**80,892**	**33,83**	**9,845**	**164,217**	**20,53**		**1,9044**
>2000	**504457**		**58,106**	**773,455**		**81,267**	**770,938**			**16,253**
RUS<2000	24767		1,664	25,522	0,000	6,895	38,973			1,379
EST<2000	45978		3,090	47,380		12,800	72,350			2,560
total<2000	**70745**		**4,754**	**72,902**	**0,000**	**19,695**	**111,323**			**3,939**
All towns	**575202**	**0,000**	**62,861**	**846,357**	**33,830**	**100,962**	**882,261**			**20,128**

160101JMA * outlet directly into the Lake Peipsi

Outlet from Russian towns <2000PE is calculated from Estonian figures assuming proportionality between PE and outlet

Annex 4

PRESS RELEASE 26. 11. 2000

WORKSHOP ON WASTE WATER TREATMENT AND DRINKING WATER SUPPLY IN LAKE PEIPSI WATERSHED

Center for Transboundary Cooperation and Århus County of Denmark organizes a workshop on waste water treatment in the Lake Peipsi watershed on 28-29 November 2000 in Voore guesthouse, Jõgeva County, Estonia. The workshop is held in the framework of a Danish-Estonian-Russian project "Community development and cross-border cooperation in the Estonian-Russian border area", which is a joint effort of the Center for Transboundary Cooperation in Estonia, Russian NGO Lake Peipsi Project, Funen, Frederiksborg and Århus Counties and the Association of County Councils in Denmark implemented with the support from the Danish Ministry of Foreign Affairs and Danish Environmental Protection Agency.

The workshop goal is to discuss and collect comments for a first draft of a common strategy for waste water treatment in the Lake Peipsi watershed. A draft of the strategy document was developed jointly by Danish, Estonian and Russian environmental experts under supervision of a Water Quality working group of the Estonian-Russian Transboundary Water Commission during year 2000. The waste water treatment strategy will be prepared by summer 2001. It will be used as a basis for making decisions on environmental investments into construction of wastewater treatment facilities in the lake basin at the Danish EPA and other international agencies. The workshop in Voore will discuss issues of sewage water treatment and drinking water supply for small towns and villages in the watershed. In the workshop will participate representatives of the regional environmental boards, private environmental companies, local authorities and NGOs from Estonian as well as Russian sides of the Lake Peipsi.

PRESS RELEASE 19. 02. 2001

REDUCTION OF POINT SOURCE POLLUTION IN THE LAKE PEIPSI BASIN WILL BE UNDER DISCUSSION IN PSKOV

19 - 20 February 2001, Pskov, Russia - a seminar will take place on "Development of a Strategy to Reduce Point Source Pollution in the Lake Peipsi Basin". The seminar is organized by the Center for Transboundary Cooperation, Pskov NGO "Chudskoi Project" and the Aarhus County, Denmark, with the support of the Pskov Region Committee of Natural Resources (CNR) and Danish Environmental Protection Agency.

The seminar will discuss strategies to reduce point source pollution in the Lake Peipsi Basin and specific measures to decrease lake water pollution and to improve drinking water quality in the region.

The seminar is a part of an international project "Community Development and Cross-Border Cooperation in the Estonian-Russian Border Area" supported by the Danish Ministry of Foreign Affairs and Danish EPA.

As a prt of the project, in 2000-2001, a computer based database of point sources of pollution in the Lake Peipsi basin and a first version of a strategy to reduce point source pollution in the Lake Peipsi Basin were prepared. The strategy was prepared by a joint expert group under a working group on water quality of the Estonian-Russian Transboundary Water Commission. Estonian environmental officials and local authorities at a seminar already discussed the strategy in November 2000. The seminar in Pskov is aimed to receive comments to the strategy from Russian environmental authorities and local governments.

The Strategy to Reduce Point Source Pollution in the Lake Peipsi Basin is the basis for developing priorities in the lake basin for environmental infrastructure projects (investments into construction of waste water treatment plants) and for preparation of the Lake Peipsi Basin Management Plan.

In the seminar participate representatives of Pskov Region Committee of Natural Resources, Pskov and Gdov municipalities, Neva-Ladoga Watershed Management Department, Estonian consulting company Maa ja Vesi and Peipsi Center for Transboundary Cooperation. From Danish side, a representative of Aarhus County Environmental Department Mr. Jens Andersen participates in the seminar.